CHAPTER 8 OPERATION AND MONITORING SYSTEM

8.1 Existing Monitoring and Operation System in the Iguaçu River Basin

Table-8.2 indicates the existing operation and monitoring system for water environmental management and its present situation is described in the following sub-sections:

8.1.1 Operation System

The existing domestic water supply systems using surface and subsurface water sources have been operated by the SANEPAR and OUTONOMO, and its system management has been done well on measuring intake discharge, counting distributed water amount, and so on. While, industrial water users are mainly taking water in from the both water sources individually. These industrial water users are divided into two (2) parts; authorized and unauthorized water users. The former users apply for their water uses with their intake discharges and industrial waste water amount to the IAP, and the IAP permits/registers them taking into account the water availability. But, operational records are not submitted to the IAP. As for the later users, there is no management work done by the IAP and SANEPAR. Especially, there is a report that a number of the bore holes managed with permission by the IAP are 3,400 while unmanaged ones are more than 10,000 in the whole Paraná State.

There are four (4) dams operated by the ELETROSUL and COPEL for hydropower generation and three (3) dams operated by the SANEPAR and PETROBRAS for D&I water supply in the Iguaçu river basin. The existing dams have been constructed for a single purpose not for multifarious uses. However, there are needs for such multifarious use of the existing and planned reservoirs as hydropower generation, water supply, flood control, and fish culture in order to effectively use the available water resources. There are such plans and possibility as the Irai dam development for water supply and flood control, possibility of hydropower generation and fish culture development in the reservoirs in the Iguaçu river, and so on.

Six (6) hydropower stations in the Iguaçu river basin are operated and managed by the ELETROSUL and COPEL.

8.1.2 Monitoring System

Monitoring of meteorological and hydrological data in the Iguaçu and Tibagi river basins has been made by the DNAEE, IAP, COPEL and IAPAR. A number of the observation stations in the Iguaçu river basin is summarized as follows:

Table-8.1 Number of Observation Stations in the Iguaçu River Basin

Observation Items			Iguaçu River	
Catchment area (km²)			68,700	
Meteorological stations			16	(4,294)
Rainfall observation stations			301	(228)
Rate of automatic and telemetering gauges (%)			17	
Flow observation stations	a)	Main stream	39	
	b)	Tributaries	58	
Water quality observation			58	
Sediment observation stations	a)	Main stream	9	
	b)	Tributaries	31	

Note: Figures in parenthesis indicate density of observation station (1 no. / km²).

Table-8.2 Existing Monitoring and Operation Systems in the Iguaçu River Basin

Monitoring and Operation Systems	Iguacu River Basin	Related Institutions
I. OPERATION SYSTEM		
(1) Ground water supply	Insufficient data	SUCEAM,IAP, SANEPAR
(2) Surface water supply		
a) Water amount taken from the river based on data base system established by JICA Study Team	12.6	SANEPAR, OUTNOMO
(3) River-reservoir Operation for Multifarious Water Use	None	COPEL, SUCEAM
(4) River-reservoir Operation for Flood Control	None	COPEL, SUCEAM
(5) Power Load Operation		COPEL
a) Nos. of hydropower stations	6	
b) Total installed capacity (MW)	5,375	
II. MONITORING SYSTEM		
(1) Meteological data observation (nos. of stations)	16 with an automatic gauge	DNAEE, IAP, COPEL, IAPAR
(2) Precipitation observation		
a) Nos. of stations with manual reading gauge	248	DNAEE, IAP,
b) Nos. of stations with automatic recording gauge	36	COPEL, IAPAR
c) Nos. of stations with telemetering system	17	
(3) FLow observation system		
a) Nos. of stations with manual reading gauge		
• Main stream	21	
• Tributary	40	DNAEE, IAP,
b) Nos. of stations with automatic reading gauge		COPEL, IAPAR
• Main stream	9	
• Tributary	13	
c) Nos. of stations with telemetering system		
• Main stream	9	
• Tributary	5	
(4) Flood forecasting and warning system	A telemetered data collection system provided by DNAEE	DNAEE, COPEL, SUCEAM, IAPAR
(5) River water quality		
a) Nos. of observation stations		
• Main stream	21	DNAEE, IAP
• Tributary	33	
(6) Aqua ecology monitoring	Macro-invertebrate monitoring by IAP	IAP
(7) Fish resources monitoring	Pilot investigation in Segredo reservoir by COPEL	EMATER, COPEL, COPATI
(8) Waste discharge monitoring	not available	IAP, SANEPAR
(9) Watershed and sediment monitoring		
a) Nos. of sediment flow observation stations		EMATER, COPEL,
• Main stream	9	DNAEE, IAP
• Tributary	31	
(10) Surface and sub-surface water supply monitoring	done by individual users	SUCEAM, SANEPAR

The DNAEE has developed flood forecasting and warning system (FFWS) composed of telemetering rainfall and water level gauges and forecasting model in the Iguaçu river basin in order to distribute information and data on flood to the COPEL and ELETROSUL for their reservoir operation and to Civil Defense for the activities against flood as shown in Figure-8.1. Also, the COPEL and ELETROSUL have own operation system including meteorological and hydrological observation and data transmission system.

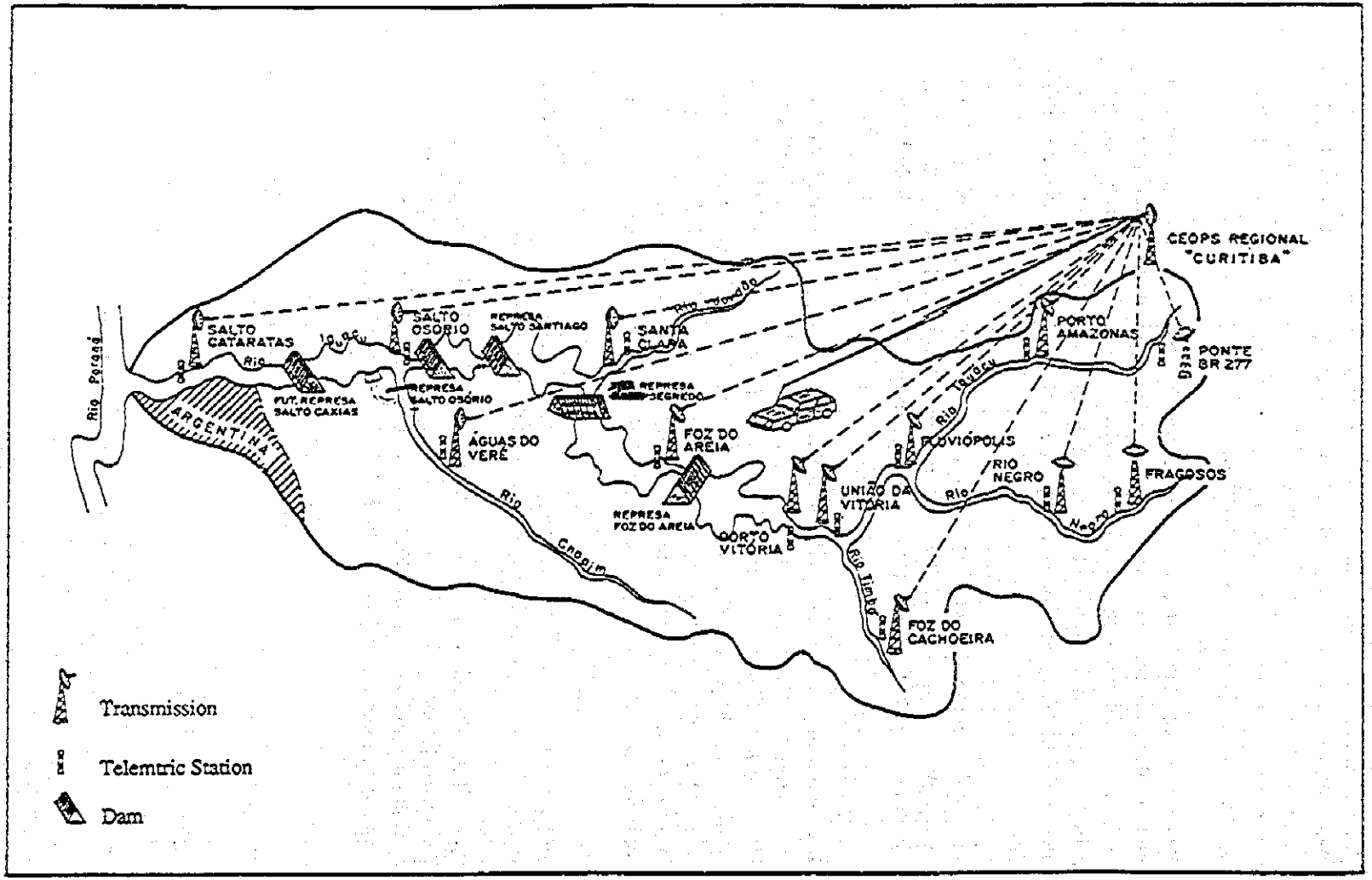
The DNAEE will start the project named as National Strategic Network in 1995, which will consists of installation of 513 rainfall and water level telemetering stations covering whole Brazil, data transmission system using the satellites of TIROS, NOAA and SCD 1 and data storage and analyzing system to raise reliability of data transmission network. The existing telemetering system in the FFWS in the Iguaçu river is scheduled to be incorporated into this nationwide system.

The SIMEPAR is implementing the weather observation system described in the Main Report I for the Strategy and will improve the meteorological and hydrological observation network by introduction of rainfall radar and telemetering system covering the whole Paraná state.

River water quality monitoring has been carried out at the main stream and tributaries of the aforesaid rivers with a frequency of four (4) times or more a year by the IAP and DNAEE. However, it is identified that there are interrupted periods in the large part of observation records at many stations and that it is impossible to evaluate its change on river water quality there. Test items are 1) water temperature, 2) pH, 3) dissolved oxygen, 4) coliform fecal, 5) BOD, 6) total nitrogen, 7) total phosphate, 8) turbidity, and 9) total solid in general. Water quality analysis for heavy metal have been undertaken in accordance with the requirement.

As for monitoring on aquatic ecological system, there have been no integrated and/or periodical investigation but it is initiated by the IAP and COPEL in these years.

Sediment sampling and its analysis have been made at 40 sites in the Iguaçu river by the IAPAR, COPEL, DNAEE and IAP. However, the frequency of observation is quite insufficient for evaluating soil erosion rate with high accuracy. While, the gross soil erosion rate has been examined by the pilot projects by the IAPAR under the EMATER.



Source : CEOPS (Warning System Operation Center) / DNAEE 1993

Figure-8.1 Flood Warning System in the Iguaçu River

8.2 Master Plan for Operation and Monitoring System

8.2.1 General Conditions

Currently, the Iguaçu river basin faces the problems in water environment as described in the previous chapters and summarized in Figures-8.2 and 8.3. In order to manage the water environment in Paraná state, the Master Plan was studied by applying the methodology for planning and the Strategy for the operation and monitoring system. Figure-8.4 indicates issues to be monitored in the Iguaçu river basin.

The Study employed an integrated management framework composed of; 1) integrated institutional framework; 2) water uses and waste water forecasting for planning in socio-economy-hydrology-aquaecology system; 3) project management for multifarious water use and water environmental improvement; 4) monitoring and operation of surface and subsurface water system; and 5) global hydrological cycle model.

The current study has established the following implementation targets for monitoring and operation system as illustrated in Figures-8.5 and 8.6:

Target-A: High density and multi-dimensional monitoring

Target-B: Unified monitoring

Target-C: Integrated operation and monitoring for effective operation for water use facilities, river structures, water treatment facilities and water quality facilities

The Master Plan aims to enhance the existing monitoring and operation systems to the target levels during 20 years till 2015.

8.2.2 Master Plan

The current level of the existing monitoring and operation system was evaluated by comparing the targets of A to C and the required activities for reaching these target levels were studied together with their urgencies and implementation schedule. The result is described as follows:

(1) Strengthening of monitoring system for meteorological and rainfall observation

The required number of additional meteorological and rainfall gauging stations are estimated by applying required density of 1,200 km^2 per a station for meteorological observatory and 170 km^2 per a station for rainfall observation network.

The on-going SIMEPAR's project are scheduled to provide the meteorological gauging stations with telemetering equipment in the Iguaçu river basin. The SIMEPAR's system will give more detailed data and information related to water environment management. However, taking into account the current density of the observation network, it is required to further provide 4 meteorological observatories and 103 rainfall gauges.

The spatial distribution of the proposed new gauges are recommended to be decided taking into account the meteorological characteristics based on the data to be provided by the SIMEPAR's system and the existing observation network after its completion of the project.

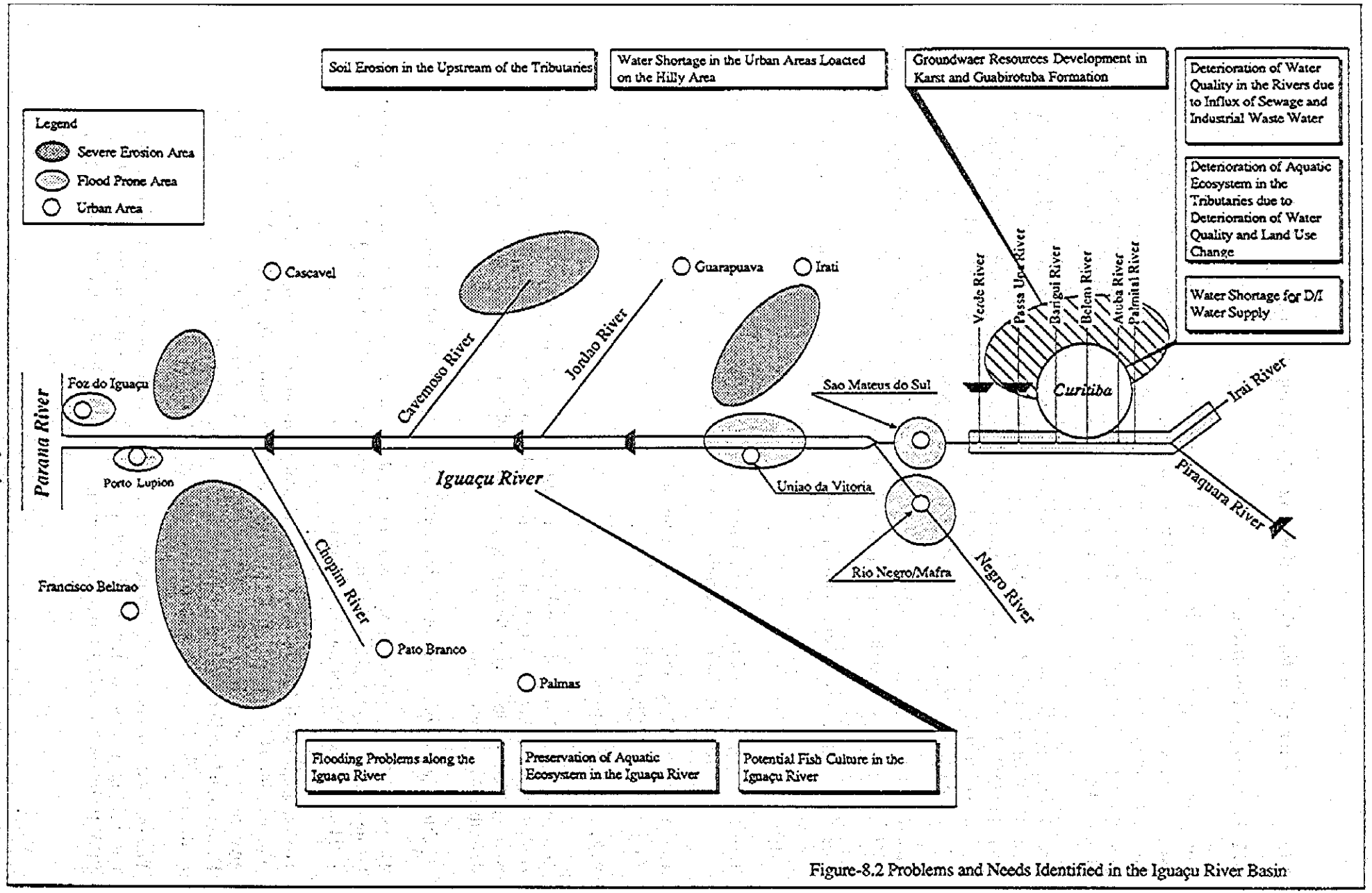


Figure-8.2 Problems and Needs Identified in the Iguaçu River Basin

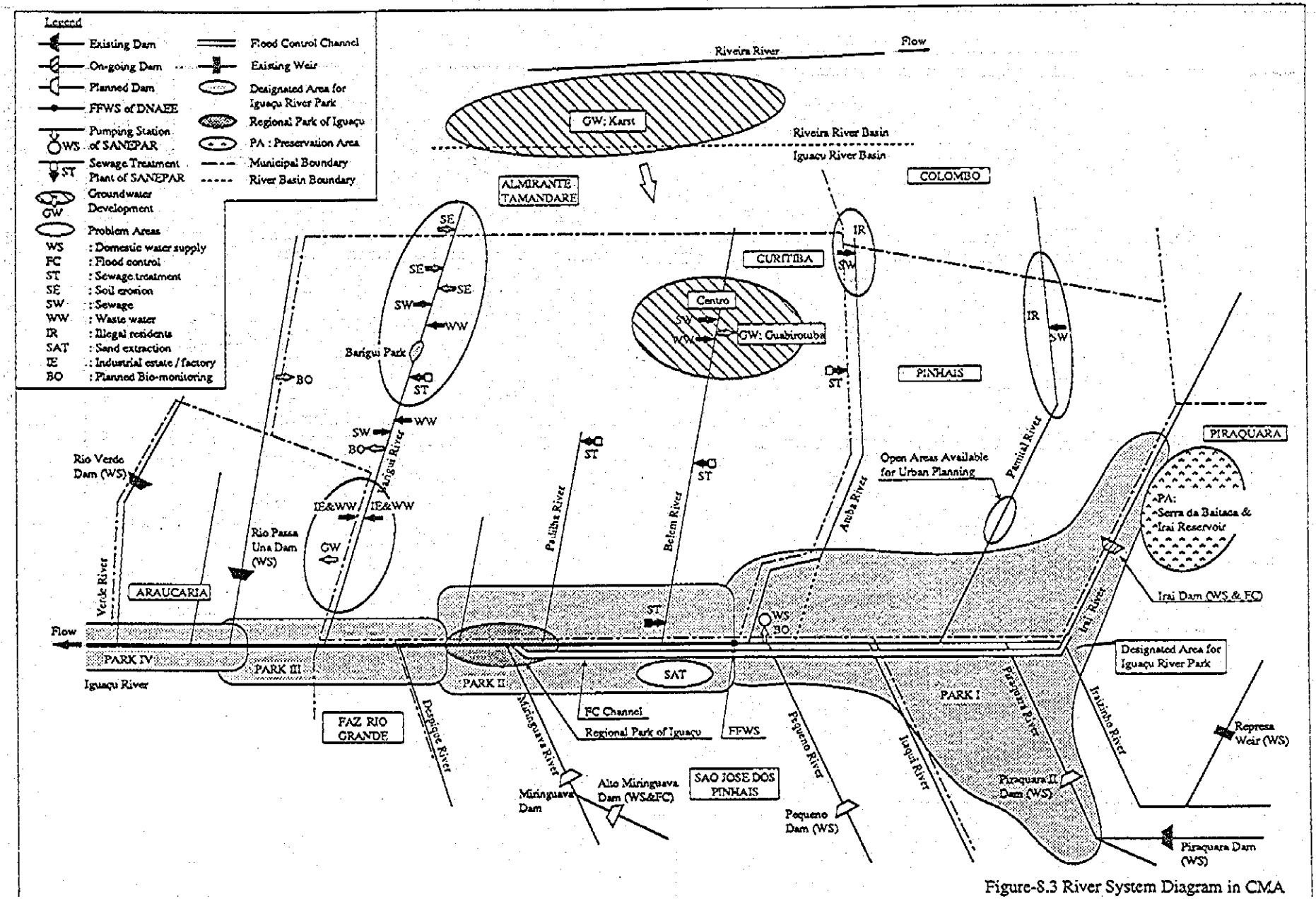


Figure-8.3 River System Diagram in CMA

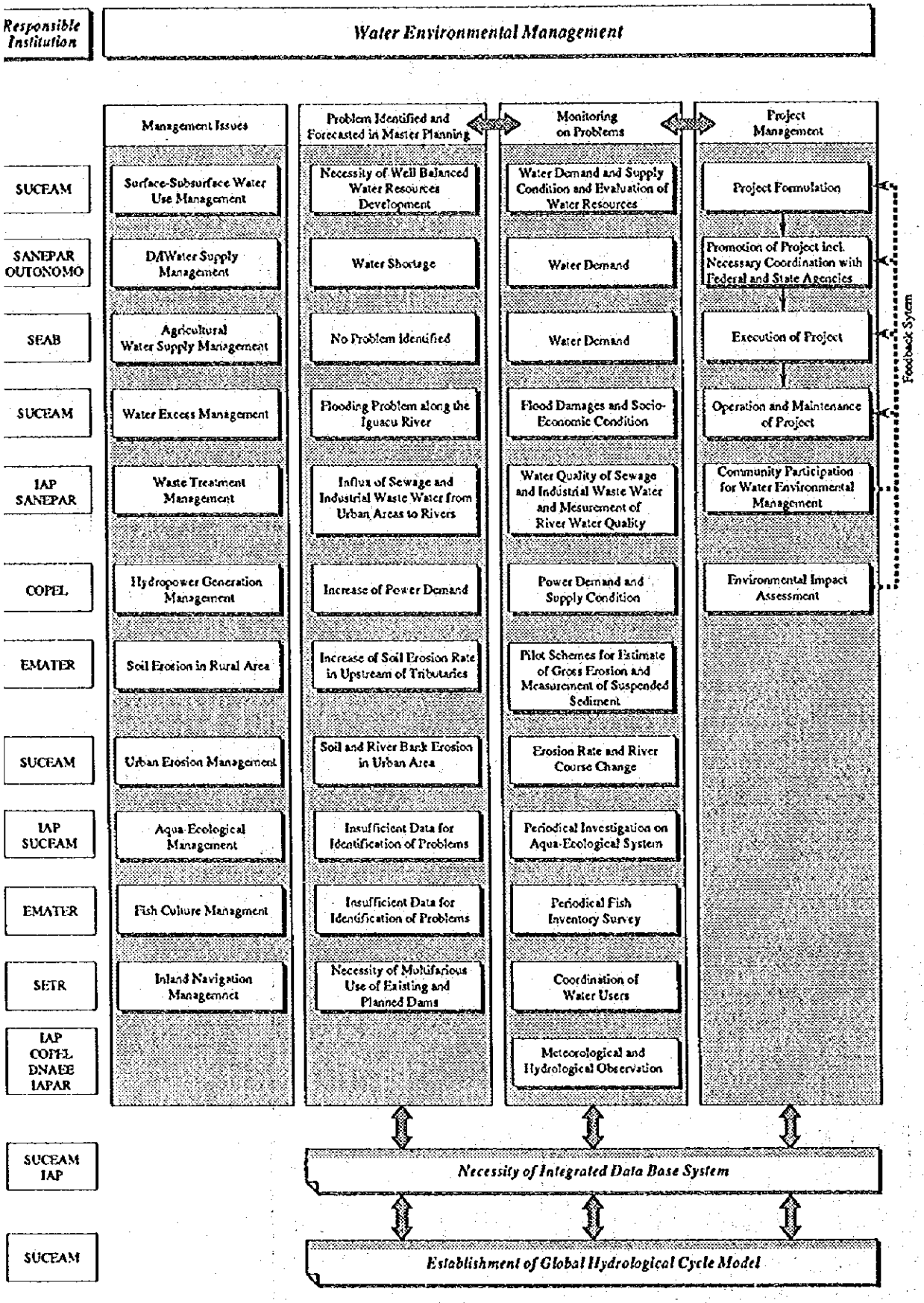


Figure-8.4 Water Environmental Management

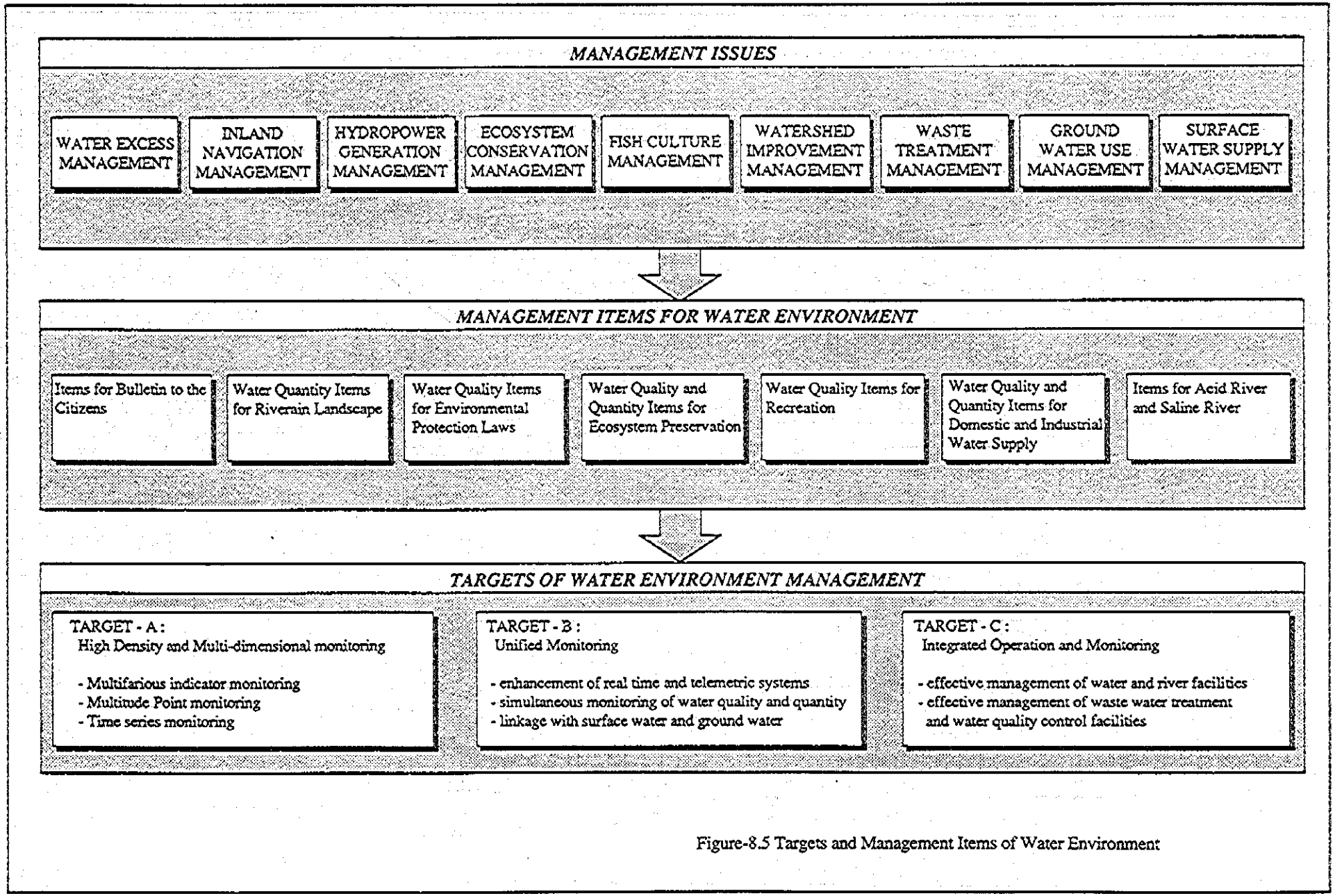


Figure-8.5 Targets and Management Items of Water Environment

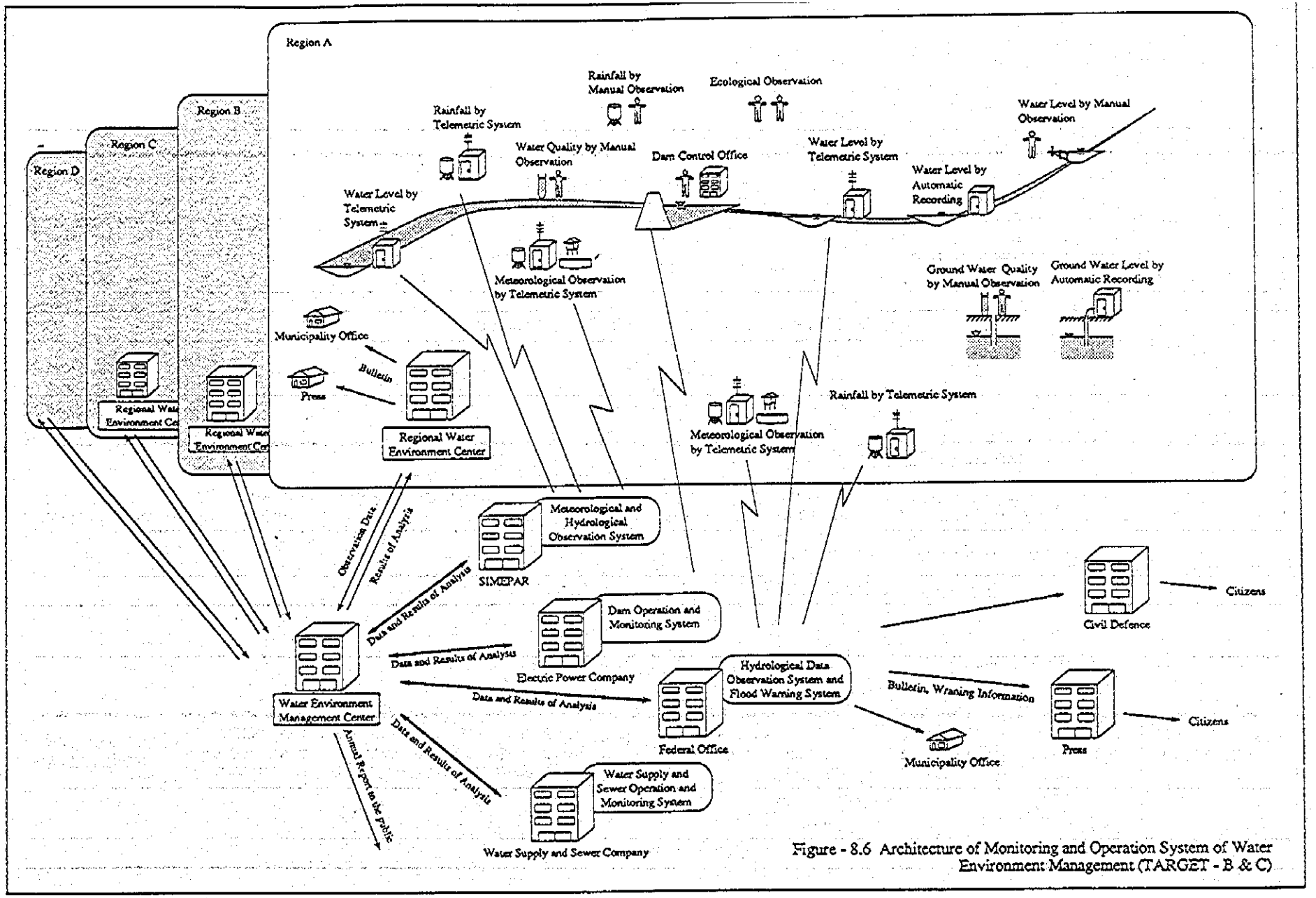


Figure - 8.6 Architecture of Monitoring and Operation System of Water Environment Management (TARGET - B & C)

(2) Provision of new stream flow gauges

The water resources development by providing dam/reservoir or weir structures will require the stream flow data for evaluating the available water resources with high accuracy at the structure sites for managing the project from planning to operation and maintenance. Since the currently proposed development schemes for Cascavel and other urban areas ranked at the type of B are located in the upstream river basin and there are no stream flow gauges at the site, 11 stream gauges are required to be installed in accordance with project implementation.

(3) Strengthening of river water quality observation

Water quality stations have been installed at the major points along the main stream, at the main tributaries and at locations where quality problems are identified or predicted. But, its observation work after 1990 has been interrupted at several stations. Also, water quality in the rivers adjacent to the major cities are predicted to be worsened by the increase of sewage loads discharged by the expanding urban areas. Therefore, the current observation network is required to be strengthened by restarting the observation work at the mentioned stations and by providing new stations in the rivers in the urban areas.

In Curitiba metropolitan area, there are sufficient number of water quality stations but other urban areas with the types of A and B located at the upstream of tributaries have no observation station. The water quality observation at the proposed 11 stations for water use management is also required to be undertaken additionally.

While, the pesticide and fertilizer utilized in agricultural sector are one of the water pollution source. It is necessary to investigate and identify the kind of pesticide and fertilizer currently utilized in agricultural sector and its chemical composition, and degree of influence of those to water environment and human beings firstly, since there are no sufficient data to specify test items for detecting pesticide and fertilizer in the Study. The standards and guidelines for water quality monitoring for pesticide and fertilizer are required to be established on the basis of the investigation result.

(4) Strengthening of sediment observation

Research and investigation work have been made by the IAPAR under the EMATER, and sediment observation has been made mainly by the DNAEE, COPEL, IAP and IAPAR. In order to identify problems and monitor effects due to reforestation and terracing works proposed in the current study, it is necessary to undertake more frequent observation of sediment loads at the existing stations or stations to be newly established in the severe erosion areas. In observation, sediment flow samples at flood time, which occupies the major part of the annual sediment discharge, is necessary to be taken intensively.

Identified severe erosion areas are the tributaries; 1) Santo Antonio, 2) Capanema, 3) Chopim, 4) Cavemoso, 5) Potinga, and 6) Gonçalves Dias and Andrade. In these river basins, the intensive measurement is required to be carried out at the existing stream gauge sites.

(5) Initiation of aquatic ecology monitoring

There has been no integrated aquatic ecology monitoring. It, therefore, is required to initiate the monitoring work so as to provide basic data for establishing the conservation plan of aquatic ecosystem along the rivers.

Aquatic ecology monitoring is required to include bioindicator sampling such as benthos, plankton and nekton and chemical analysis for aquatic biota and water quality as proposed in the ecological improvement study. Also, investigation on vegetation along the river side area using the available Geographic Information System (GIS) and fish inventory survey are recommended to be carried out as proposed by the ecological study.

(6) Establishment of integrated monitoring system for surface and subsurface water resources in Curitiba Metropolitan Area and Expansion to Other Urban Areas

There are many bore holes provided by the SANEPAR and private industrial factories. The surface water resources development is going on in CMA where both water resources is mutually affected in quality and quantity. In order to undertake well balanced development for these water resources, the following monitoring work is required:

a) prediction of domestic and industrial water demands based on population, land use, economic data, and so on,

b) provision of monitoring bore holes for observation of water table and water quality, and additional water level gauge at five (5) rivers for base flow observation in the Karst area,

c) installation of flow meter to the authorized and unauthorized bore holes as well as identification of location of the unauthorized bore holes, and

d) establishment of global hydrological cycle model which enables to estimate potential water resources and to evaluate water demand/supply balance incorporating both water resources and other hydrological components.

The establishment of monitoring system including the model mentioned above is recommended to be made for Curitiba metropolitan area in the 1st stage, where the intensive ground water development has been carried and it is predicted to induce such problems as lowering of ground water table and reduction of intake discharge at the existing bore holes thereby. The 2nd stage will apply the established monitoring method and model to other basins, where occurrence of similar problems are predicted. The required inspection bore holes for the urban areas are as shown in Table-8.3.

Table-8.3 Required Number of Inspection Boreholes

Municipalities	Required Number of Borehold	Total Length of Boreholes (m)
1) Curitiba Metropolitan Area (Karst)	17	1,020
Curitiba Metropolitan Area (Guabirotuba Formation)	20	1,600
2) Cascavel	6	480
3) Foz do Iguaçu	10	800
4) Guarapuava	1	80
5) Other large urban areas (6 municipalities)	11	880

(6) Establishment of integrated data base system under SEMA

There are no integrated data base system for water environmental management in the SEMA. While, the SUCEAM and IAP will require the data base system for planning water resources development and conservation of water environment. The proposed data base system will contain; a) socio-economic data such as economic indices, land use and population, b) meteorological and hydrological data, c) data on ground water, d) water quality records, e) sediment observation data, and f) aquatic ecological data. The data accumulated in the data base system will be used for prediction of water demand, water demand/supply balance analysis incorporating surface and subsurface water resources, simulation of river water quality, and so on.

(7) Data and information network

The proposed State Center is able to collect data and information from the SIMEPAR and DNAEE between their computer systems through the existing telephone cable line. This data transmission system is applied for communication system between the state and regional centers and other related institutions.

8.2.3 Required Cost

(1) Provision of additional meteorological and hydrological observation stations
The required cost for establishing the proposed monitoring system was estimated on the basis of the cost data and information provided by the counterpart personnel. The result is shown in Table-8.4.

Table-8.4 Cost for Monitoring System

Description	Work Items	Required Cost (US$ thousand)
1) SIMEPAR's system	-	35,000
2) Strengthening of monitoring system for meteorological and rainfall observation	• 4 meteorological observatories • 103 rainfall gauges	30 155
3) Provision of new stream gauges for water use management and water quality observation	• 11 stream gauges	110
4) Establishment of integrated monitoring system for surface and subsurface water resources in Curitiba metropolitan area and expansion to other urban areas	• 5 stream gauges • 17 boreholes in the Karst • 20 boreholes in the Guabirotuba • 44 boreholes in other urban areas	50 411 336 634
5) Aquatic ecological monitoring		332
6) Establishment of integrated data base system under SEMA, including data and information network	• 7 sets of computer system and telephone line network	70
Total	-	37,128

The SIMEPAR's project is going on as described in the Main Report I and the total cost of US$ 35 million is scheduled to be disbursed during coming 5 years from 1996. Since this system covers the whole Paraná state including the Iguaçu river basin, the mentioned cost is incorporated into the Master Plan.

(2) Annual observation cost for water quality and sediment loads

The annual cost for water quality analysis is estimated by assuming test items of water and air temperature, dissolved oxygen, coliform fecal, pH, BOD, COD, total nitrogen, total phosphate, turbidity, total solid, heavy metals such as mercury and chrome, and pesticide and fertilizer for identifying the basic condition of river water quality. Assuming that observation frequency is four (4) times a year, and that two (2) samples are taken at one location and analyzed, the required cost for sampling and laboratory test for samples to be taken at the existing and newly provided 64 stations are estimated at US$ 384 thousands.

Sediment sampling and analysis for identification of sediment loads require the annual cost of US$ 120 thousand assuming the frequency of 10 times a year and three (3) samples/location per sampling, and undertaking of observation at the existing 40 stations.

8.2.4 Implementation Schedule

The implementation schedule for the required activities is given as shown in Figure-8.7. The required activities to cope with the problems and needs related to urbanization and industrialization, and the on-going projects and strengthening of the existing monitoring systems are scheduled to be undertaken in the 1st stage during 10 years to 2005. The activities in the 2nd stage are mainly for the expansion or upgrading of monitoring system established in the 1st stage.

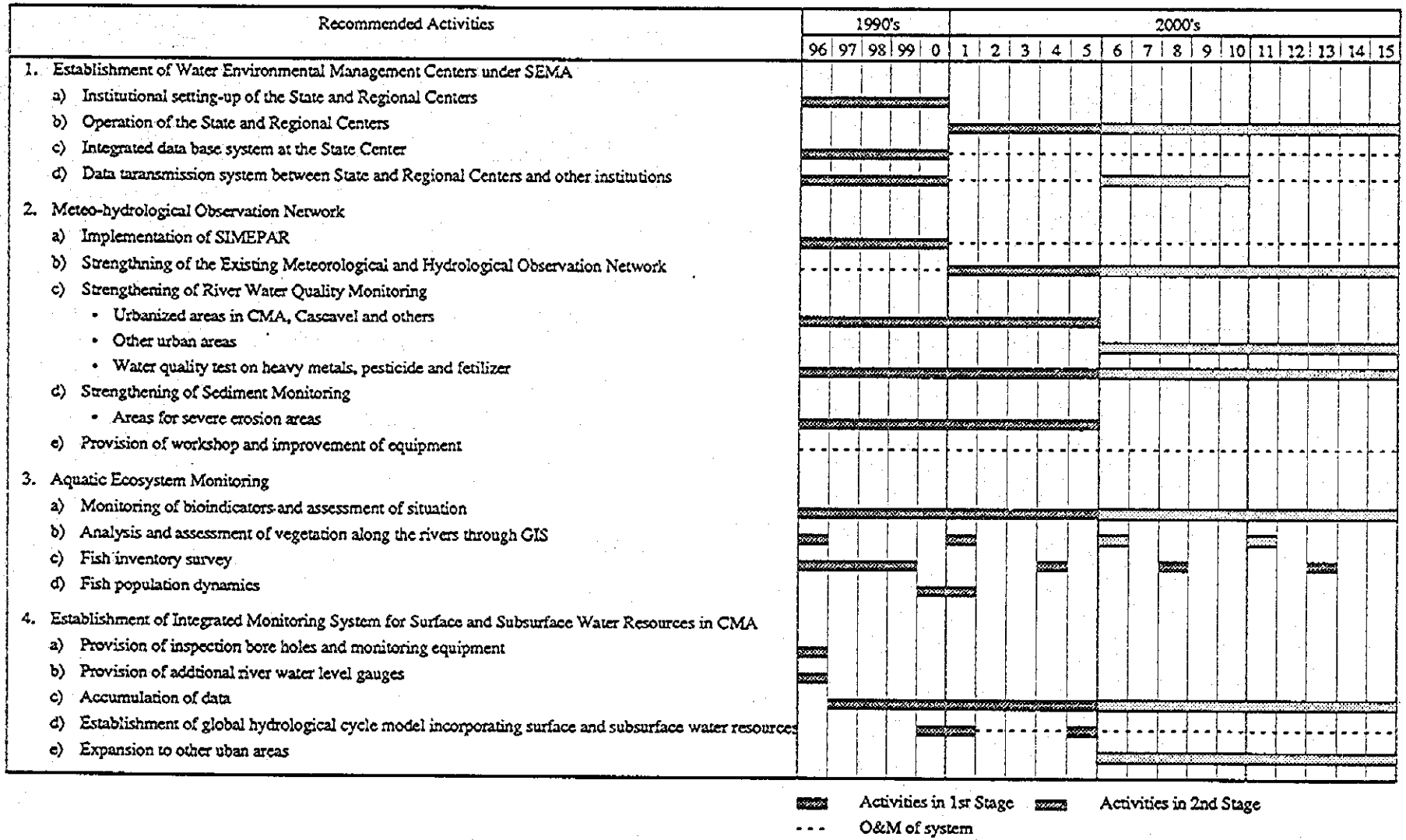


Figure-8.7 Implementation Schedule of Operation and Monitoring System

CHAPTER 9 INSTITUTION

9.1 Current Institutional Framework in the Iguaçu River Basin

9.1.1 Legislation in Force on Water Environment

(1) Ownership and Administration of Water

According to the Constitution, the ownership of main stream water in the Iguaçu River is the property of the Federal Republic, while water of the tributaries and groundwater exclusively situated in the State except hydraulic energy potential is the property of the State.

(2) Use of Water and Water Right

Derivation of water in the Federal or State domain requires concession, authorization or permission, provided that water use for the first necessity of life is free in case that the access to the water is lawful. The State Regulation No. 004/89, 1989, by the SUREHMA (Superintendency of Water Resources and Environment, currently being changed to the SUCEAM-Superintendency of Erosion Control and Environmental Sanitation), gives provisions for the use of water of the State domain, based on the stipulation of the Water Code.

(3) Water Resources Development

The works necessary to derive or store water shall be planned and constructed under the responsibility of a certified professional registered in CREA (Regional Council of Engineers and Architects). Any alternation or any part of alternation and any change in intakes or dikes are subject to the approval of the SUCEAM.

(4) Water Resources Conservation

The Water Codes prohibit degrading or contaminating waters by discharging waste water. The Code orders the entity who causes the nuisance to take remedial actions at the polluter's expense and to compensate for the loss or damage caused by the effluent discharge. In the State domain, the SUCEAM or the IAP (Environmental Institute of Paraná) can demand of the water user to prevent waste of water, to control, or to protect against pollution.

The Federal Law 6766, 1979 prohibits the land allotments for urban purposes in swampy or flood prone areas before taking precautions against water flow, and in land belt along water courses, as well as in areas for ecological preservation, and polluted areas before the recovery. The law requires some portion of land allotment for community facilities, including those for water supply, sewerage, electric power supply and storm water collection. The State Decree No. 2963, 1980 designates areas of the special interest and protection, such as areas contained in the water divisions of surface run-off which contribute as sources of public potable water supply. The State Decree No. 2964, 1980 declares areas of the special interest and protection in the river basins that compose water sources in Curitiba Metropolitan Regions. The Decree assigns the COMEC (Coordination of Metropolitan Region of Curitiba), as the competent agency for previous examination and approval of the land allotment project in Upper Iguaçu River Basin and other ten river basins designated by the Decree.

The State Law No. 8935, 1989, and an additional stipulation by the State Law No. 11055,

1995, prohibits installation, operation, or implementation of highly polluting industries, hospital establishments, waste disposal sites and parcels of land for high population density, in catchment areas of sources for the public water supply.

9.1.2 Current Organizational Framework

(1) Federal Level

(a) Water Resources Administration

Water resources administration at the Federal level is discharged by the National Department of Water and Electric Energy (DNAEE) of the Ministry of Mines and Energy (MME). Although the Constitution provided that the permanent defense against floods is the federal matter, the National Department of Sanitation Works (DNOS), which was the competent organization under the Ministry of Agriculture, was abolished in 1990.

(b) Environmental Entities

The National Council of Environment (CONAMA) and the Brazilian Institute of Environment (IBAMA) administer environmental conservation, preservation of eco-system and pollution control, including water quality management, under the Ministry of Environment and Legal Amazon.

(2) State Level

The prime institute of water environment administration at the State level is the State Secretariat of Environment (SEMA), subordinating the SUCEAM and the IAP. These organs have been in the course of re-organization and strengthening since January, 1995.

The COMEC was established for the coordinated development of the region under the State Secretariat of Urban Development (SEDU), being changed to be placed under the State Secretariat of Planning and General Coordination (SEPL) by the new administration. The duties of the COMEC are as follows:

- promotion, elaboration, approving, obedience and control of the integrated planning of the Metropolitan Region of Curitiba
- execution together with the Sanitation Company of Paraná (SANEPAR) and the City of Curitiba, of the Program of Environmental Sanitation of the Metropolitan Region of Curitiba (PROSAM), assisted by the World Bank.

The PROSAM covers the followings:

- promotion of environmental recovery of the region and preservation of sources for public water supply
- promotion of improvement of physical, chemical and biological characteristics of water resources in the Upper Iguaçu Basin
- promotion of expansion of potable water supply services, with regulation of discharge and quality control of the resources
- minimization of the impacts of urbanization over water resources of the region with suitable land use
- promotion of flood control

- development and implementation of institutional mechanisms and instruments necessary for suitable administration of the environmental resources of the Upper Iguaçu Basin

(3) Municipal Level

Participation in water environment administration by the Municipalities varies according to the level of their establishment and capabilities. Some Municipalities, such as the City of Curitiba, discharge major responsibilities in water environment management, while many of Municipalities have been raised very recently and are still in the courses of their consolidation.

(4) Participation of Non-governmental Organization (NGO)

The Regional Permanent Commission for Flood Prevention of the Iguaçu River (CORPRERI) has been organized as non-profit entity without political purposes, whose major missions are as follows:

- to study and identify the causes of floods
- to give suggestions to the governments in order to gather the efforts of the governments for minimizing the effects of floods
- to promote understanding of issues on floods which involve resettlement of inhabitants

9.2 Institutional Issues of Water Environment

9.2.1 Concepts and Approaches for Institutional Improvement

The following two concepts are employed to formulate institutional improvement programs:

Concept I: *Promotion of Appropriateness, Effectiveness and Efficiency through Remedial Measures against Current Problems*

Concept II: *Responding to Future Needs for Integrated Water Environment Management*

The first concept should be applied everywhere in the world for the improvement every sector of management and government administration. Considering the Concept I, current institutional problems are identified and analyzed for compiling remedial measures to solve the problems.

Since water resources development incurs huge costs and long period for project implementation and the resources conservation will affect future generations, water environment management should cover long term perspectives. Future needs and corresponding institutional responsibilities in government administration are discussed under the Concept II.

Introduction of successful models practiced in other countries, including those in Japan, which might be suitable to Paraná State, is applied as a basic approach in programming institutional improvement measures under both of the two concepts, especially those under the Concept II.

9.2.2 Identified Institutional Problems and Principles to be Followed

The problems to be discussed in the institutional study are selected as follows:

- inappropriate responsibility assignment
- insufficient instructions and training
- insufficient assessment of water resources potential and the existing use
- insufficient detecting capability of polluting sources
- insufficient data and information publication
- unrecovered cost

In order to solve the above problems, the following principles are set to be obeyed under the Concept I.

1) Definite Assignment of Operational and Regulatory Responsibilities and Configuration of Line Responsibilities
2) Enhanced Enforcement of Legislation on Water Environment Management and Administration
3) Establishment of Proper Cost Recovery System
4) Encouragement of Public Participation

9.2.3 Future Needs

Population growth, accompanied by agricultural and industrial development, boosts water demands. Agricultural and industrial expansion will lead to increase in polluting loads as well, reducing available quality water. Raised living standards increase recreational and environmental demands. In order to meet increasing demands with limited budget, water environment management requires much more efficiency. The management at this stage should be integrated in order to achieve optimal use of limited water resources and efficient resources conservation. Responsibilities for water environment administration will largely grow corresponding to socio-economic development.

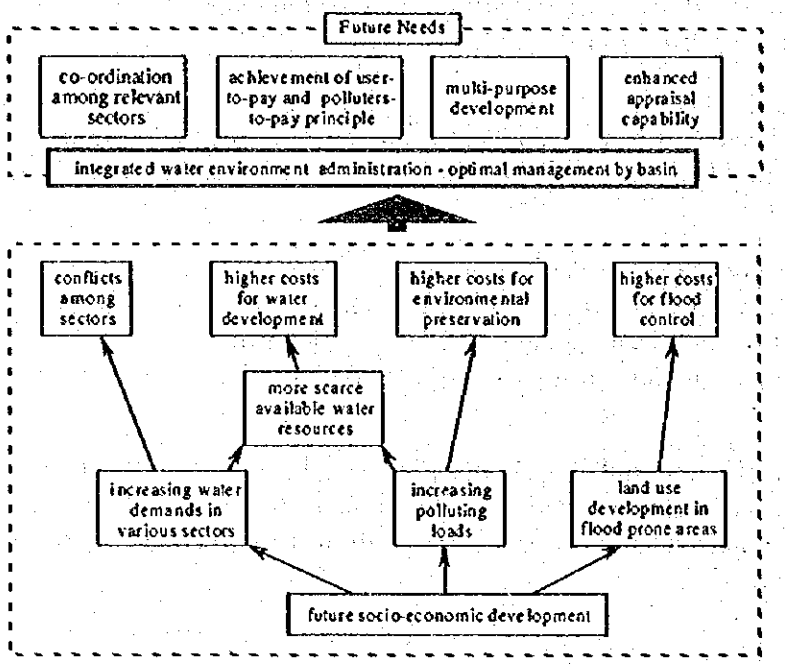


Figure-9.1 Future Needs for Integrated Water Environment Management

Principles to be observed in formulation of institutional improvement programs to meet the future needs in water environment management are set as follows:

5) Introduction of Basin Management and Establishment of the Competent Entity
   - Equitable and Definite Policy Formulation on Water Allocation and Water Quality Control
   - Comprehensive Planning, Evaluation and Regulation
6) Coordinated Administration and Management among Relevant Administrative Sectors
   - Linkage of Water- and Land-use Management
   - Linkage of Quantity and Quality Management
   - Linkage of Surface Water Management and Groundwater Management
7) Equitable Water Pricing

9.3 Master Plan for the Iguaçu River Basin

9.3.1 Phased Development of Institutional Improvement

The programs under the Concept I are recommended for ***immediate*** implementation, while the programs under the Concept II are generally proposed for longer term implementation ***after*** the programs under the Concept I. Generally, the completion of the programs under the Concept I would be a prerequisite for the implementation of the programs under the Concept II. Continuous upgrade of water environment management could be achieved through the introduction and implementation of the programs under the Concept II.

9.3.2 Recommended Institutional Programs under the Concept I

The following programs are recommendable to solve the current problems. These programs are proposed to be implemented, covering the whole State. Detail contents are given in Chapter 10 of the Main Report I.

<Program 1 Organizational Strengthening through Implementation of the Current Re-organization>

After the analysis of the required tasks, adequate staff allocation, examination of required budget and the consequent appropriation would be necessary. Re-organization of the branch offices should follow, coupled with training and re-training, especially for the transferred staff and the staff in charge of field or extension services with elaborated instructions and manuals.

<Program 2 Strengthened Groundwater Management>

Potential assessment of the groundwater, applying the methodology shown in the Study, is recommended as the first necessity. Strengthened inspection of water use and promotion of registration would be necessary through organizing a team for the duty. Registration or licensing the professional drillers and a system to control of them are recommendable. Establishment of procedures for granting groundwater development and use is recommended. Regulations of surface water conservation through land use control in catchment areas of the sources to the public supply would better be expanded to recharging areas of the aquifers as well.

<Program 3 Enhancement in the Enforcement of Environmental Regulations>

The following five sub-programs are recommended.

1) establishment and enforcement of reporting obligation of operation and accidents by water user to the competent entity
2) effluent standards by scale and by type of industry
3) phased enhancement of detecting capability of problems and inconformity to the effluent and the water quality standards
4) prohibition of effluent infiltration to the ground,
5) enhanced control of agrotoxic use

Establishment of a regulation on the obligations to monitor effluent and to report by industries themselves are recommended, so that pollution control could be more effective if the regulation is enforced adequately. Strict enforcement of the effluent standards requires examination of availability of treatment technology of the industries. Effluent standards by scale and by type of industries might be necessary. With the limited capability of the responsible entity, nomination of harmful substances out of those designated in effluent and water quality standards for continuous monitoring activities would be required after investigation and examination of conditions of industrial and agricultural production as well as the magnitude of harmful effects caused by the items designated in effluent and water quality standards. Guidance for appropriate use of agrotoxic use to the farmers and encouragement of coordinated use among neighboring farmers are recommended.

<Program 4 Legal Arrangement for the Control of Soil, Sand and Stone Taking in River Areas>

Some granting procedures for soil, sand and stones taking in river areas are recommendable in order to maintain normal functioning of water courses including flood control.

<Program 5 Cost Recovery of Water Environment Management>

(1) Cost Recovery of Resources Assessment and Environmental Monitoring

Fee charging according to the volume of water granted is recommended not only for demand control but also for supplemental funds for resource assessment and environmental monitoring activities.

(2) Cost Recovery of Water Supply and Sanitation

Continuous revision of tariff tables is recommended based on long run marginal cost (LRMC) pricing and progressive block tariff to achieve the cost recovery, equitable demand control and optimal investment. In order to reduce 40% of the current leakage, leak detection by organizing an inspection team would be recommendable for cost saving of water supply services.

<Program 6 Promotion of Residents Participation through Information Publication>

Periodical publication of report on data collected and analyzed, current issues, and government policies would contribute to public awareness and to encourage sound residents

participation to water environment management.

9.3.3 Recommended Institutional Programs under the Concept II

<Program 7 Introduction River Basin Management and Establishment of Competent Entities>

River basin management, a management of river basin as a unit of water resources management, has been found equitable and efficient for comprehensive water resources management. Besides, the Constitution, 1988, has the clear definition of ownership of water by river and hydraulic energy potential in all rivers, which might not accord to river basin management. As stipulated in the Constitution, the Federal Republic has the exclusive power to legislate on waters, energy and the regime of lake or river navigation. The policy, the instruments to achieve the policy, the system and the organization of river basin management must be discussed, enacted and enforced within the legal frame of the federal administration. The participation of the State to the river basin management for preservation of its property, environmental conservation, registry and control of concession of water use in its domain shall be carried out within the policy frame of the federal legislation.

(1) Establishment of the Competent Entity

Hydrographic characteristics of the Iguaçu River Basin, to be noted for organizing river basin management, can be summarized as described below. The competency of the river management entity, such as a Basin Committee (Sub-basin Committee) and a Basin Agency (Sub-basin Agency), could be proposed as the following two options.

1) All rivers in the Pilot River Basins finally belong to the Paraná River Basin, and form a complicated hierarchy of flow system (according to the current discussion on river basin management at the federal level, the Iguaçu River Basin is classified as a sub-basin of the Paraná River Basin)

2) Rivers in the Iguaçu River Basin comprise of federal rivers, and state rivers whose water is the property of the Federal Republic and the State, respectively.

<Option A>

The most common type of inter-jurisdictional basin entities, in the federative system, is a committee with functions to coordinate basin planning, operation and regulatory activities of the political jurisdictions, or to issue some guidelines or recommendation to be approved and followed by the jurisdictions. These committees are governed by high officials from the affected jurisdictions, forming board of directors, with some participation of users and other stakeholders, while staff assigned by the jurisdictions conduct day-to-day work.

In this option, basin agencies are not necessary to be established. In the case that a multi-purpose facility development is found efficient for water use, conservation or flood control, some joint venture agency can be organized for planning, design, construction, operation and maintenance of the facilities, with shareholdings by jurisdictions, public agencies or utility companies under the supervision of competent entities assigned by jurisdictions.

<Option B>

Recommended structure and competency Basin Committees (Sub-basin Committees) and Basin Agencies (Sub-basin Agencies) in Option B are illustrated in Figure-9.2.

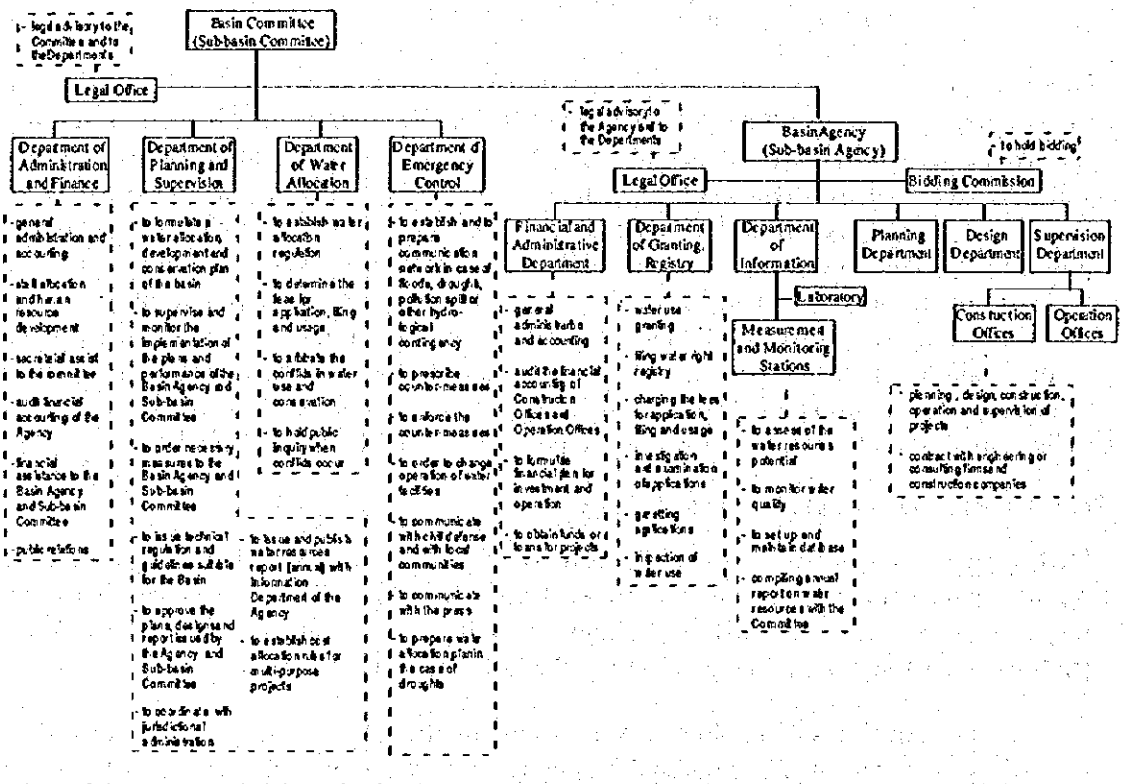


Figure-9.2 Recommended Organization Structure and Competency of Basin Management Entities (Option B)

Option A can be recommendable under the current legal frame, while in order to achieve the principles to respond to the future needs, or to attain optimal management, especially in Upper Iguaçu Basin, which could be defined as a part of the Iguaçu River Basin down to the conjunction with the Negro River, water allocation and development as well as the resources conservation should be comprehensively planned, appraised, implemented and monitored. Scope of the competency of the basin management entities should be wider and stronger than those described as Option A. Encouragement of agreements with the Federal Government would be highly necessary, if river basin management of Option B is not adopted in the current law project.

<Program 8 Promotion of Coordination for Comprehensive Management>

(1) Establishment of an "Inter-sectoral Committee"

Water resources allocation, development and conservation should be conducted harmoniously as measures to attain the objectives of the socio-economic development plan and sector development plans. Before the formulation of water environment management policy, information exchange on each sectoral development plan is necessary, so that the policy can serve an instrument of optimal socio-economic development.

An "State Inter-sectoral Committee" attended by high officials, chaired by the General Director of the State Secretariat of Planning and General Coordination (SEPL) and attended

by high officials of the relevant State Secretariats, Public Agencies and other relevant entities, and a few "Sub-committees", such as on development policy formulation, water pricing and tariff revision, whose subjects would be designated by the Committee, attended by the officials of director level of the relevant sector, might be recommendable. "Working-group" activities by middle management level or group studies might also be encouraged.

(2) Further Close Coordination with Land Use Management

Water environment administration and management have linkages with regional development and consequent changes in land uses. Water supply and sanitation programs should cover the urban expansion. Development of flood prone areas would necessitate flood plain management and flood control. Water quality conservation at the sources for public supply would require land use restriction or control, as currently enforced. Hydrological potential would be a tight constraint for city planning. More close coordination with the SEDU should be promoted.

<Program 9 Establishment of Public Hearing System into the Water Use Granting Procedure>

Currently before the water use granting, gazetting procedure is due, lacking consequent procedure for notification of objections to the application by prospectively affected parties and adjusting system upon which the discretion of the public entity or the Basin Committee can be made. Preliminary adjustment before the granting through the procedure recommended would prevent conflict among individuals. A model of the procedure is discussed in the Sectoral Report Vol. M, Institution.

<Program 10 Comprehensive Water Quality Management by River Basin>

(1) Effluent Standards by River Basin

The objective of the effluent standards can be regarded as the achievement of the water quality standards to meet the minimum environmental requirements of the society along the basin. In this sense, the effluent standards can be set for each basin, examining the current and prospective total volume of effluent along the river, as well as the diluting and self-cleaning capacity of the basin. Some stricter effluent standards may be necessary to be drafted by the SEMA or the Basin Committee and discussed in the State Environmental Council and established through legislative process, especially for the Upper Iguaçu River Basin. The capability of the SUCEAM, or the Upper Iguaçu Basin Agency, for research and development of effluent treatment technology, and for guiding and supervising industries should be much strengthened for the implementation of the plans for the reduction of total pollution loads.

(2) Introduction of Sewerage Scheme and Management by a River Basin

Conventionally, sewerage systems are constructed and managed for the improvement of sanitary conditions of municipal areas. With the expansion of urban areas and growing pollution loads from the treatment facilities to rivers, sewerage schemes should be programmed in the viewpoint of the water quality conservation of the river. The developments of sewerage systems under a scheme formulated by river basin would be programmed as a whole taking into account of the socio-economic and hydrological conditions of the basin. The program could be worked out with technical section the SUCEAM with a collaboration of the IAP under the control of the SEMA, or Sub-basin

Agency, while implementation would be discharged by the SANEPAR.

<Program 11 Enhanced Administration of Water Resources Development>

(1) Strengthened Management of Water Resources Development

Currently, major works and facilities are constructed for hydro-power generation throughout the State and for municipal water supply in the Curitiba Metropolitan Area. Management for existing facilities seems to be well conducted with intensive efforts by the sector entities, including those for regulatory functions. In the future, however, major construction would be required to meet the increasing demands, and especially multi-purpose facilities would be necessary and recommendable for efficient investment and optimal use of the resources.

(a) Strengthening of Capability of Technical Appraisal and Control

Current regulations of water resources development are considerably weak, despite that the safety of large scale water works is extremely important and their development will potentially cause huge negative impacts on the society. Application, appraisal, permission and control procedure should be established. Forms for the application and guidelines for the appraisal would be necessary to be prepared. Procedures and guidelines for adequate and optimal operation of the facilities and reporting of the operation to the regulatory entities, as well as command lines and warning system in accidental conditions and in hydrological events, such as extraordinary flood or severe drought, should also be elaborated. Hydro-power sector, where technical appraisal is assumed by the ELTROBRÁS, could be a model for the preparation.

(b) Environmental Impact Assessment and Measures to be taken for Resettlement

A great deal of impacts could occur by water facility development, especially by those with reservoir development, while environmental requirements are escalating. "Plano Diretor de Meio Ambiente do Setor Elétrico, 1991/1993" could also be a good model for other sectoral water resources development and multi-purpose facility projects.

Resettlement might often damage, sometimes seriously, the living conditions of resettlers, and in some cases, of those of inhabitants who accept the resettlers near their living areas. Preparation for defining the procedure of implementation of lands acquisition and subsequent resettlement would be necessary prior to the planning of major water resource development. Planning a resettlement scheme should be combined into the project planning. The cost of resettlement should also be included in the cost of the project.

(c) Examination of Compensation Discharge

A reservoir development affects on run off in down stream, which might damage some functions of the river, such as navigability, or fishery and eco-system preservation. Full use of reservoir storage and assuring compensation discharge for normal functioning of the stream would be a controversial trade off with the demand increase in quantity and quality. Compensation discharge should be tightly determined by basin by basin, taking into account of the needs and the priority among them.

(2) Cost Allocation for Construction, Operation and Maintenance

Construction of multi-purpose water facilities including flood control functions is found

efficient investment corresponding to socio-economic development when and where natural flow cannot meet the demands, and the cost for sectoral development and for protection of valuable properties and assets located in flood prone areas will increase. Multi-purpose facilities should be promoted to meet the requirement for increasing investment with limited financial resources. A method of cost allocation might necessary to be elaborated. The Japanese cost allocation method, as described in the Sectoral Report Vol. M, Institution, can be introduced as a model.

These calculations should be conducted by the entity in charge of the water resources management (SUCEAM under the control of SEMA or a Basin Agency under the guidance of Basin Committee), with the unified cost estimation standards. The cost allocated to each sector, such as hydro-power, water supply or irrigation, could be charged on consumers of the service through respective tariff collection system. The cost allocated for flood control purpose could be covered by the tax collection imposed on the assets of the area.

<Program 12 Water Pricing and Charging for Optimal Water Allocation and Demand Control >

Water would be transformed into an economic good when the water resources as considered as limited resources corresponding to the demand escalation. Principle of opportunity cost pricing would be recommendable to be introduced, especially in the Upper Iguaçu River Basin. Opportunity cost includes the following three components: i) resource use cost: the economic value of goods or service forgone by the commitment of construction and operation for the use, ii)natural resource depletion cost in terms of quantity and quality, and iii) damage cost incurred by the use.

As for the resource use cost, the discussions are given above and Chapter 10 of the Main Report I. The natural resource cost might vary according to; i) volume of intake, ii) location of intake, ii) season of intake, iii) ratio of return flow iv) quality of natural water and required for the use. Damage cost should be discussed as compensation or fine. Cost for natural resource depletion in practice might lead to charging; i) by quantity, ii) by basin, iii) by purpose of use, and for iv) effluent discharge by volume and by quality. Even though actual modifications of the pricing can be made as social or industrial promotion subsidy or income re-distribution, opportunity cost should be analyzed by basin and for each type of use, and modifications should be made explicitly with statement of the reason and amount of modification in pricing drafting. Charging for effluent discharging can be separately be discussed from damage compensation or fines against disobedience of the standards.

Establishment of a unit or staff enhancement for the investigation and policy drafting for water pricing would be necessary in the SUCEAM or a Basin Committee, coupled with strengthened coordination with economic planning and statistics section of the Government. This unit or enhanced staff could also be responsible for regulatory functions on water supply and sanitation tariff from point of economic view as well.

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CHAPTER 10 COST ESTIMATE, AND ECONOMIC AND FINANCIAL EVALUATION

10.1 Cost Estimate

The project costs required for the implementation of major sectors in Master Plan were roughly estimated and summarized as shown in Table-10.1. The cost estimate was carried out considering the following items.

1) The cost consists of preparatory work, main construction cost, direct cost of equipment, land acquisition, administration, engineering service and contingency.

2) The cost was estimated based on the price level and exchange rate, 1 US$ = 0.89 R$, as of August 1994.

3) Unit prices for construction works are based on "Table of Composite Unit Price July 1994, SANEPAR".

4) Administration and engineering service cost is assumed to be 15 % of the total of direct construction cost and preparatory work cost, while preparatory work cost is assumed to be 10 % of direct construction cost.

5) The cost for water supply sector was estimated by modifying the cost estimate in the document "The Master Plan of Water Supply in the Metropolitan Region of Curitiba, June, 1991 - SANEPAR".

6) The cost for sewage treatment sector was estimated by modifying the cost estimate in the document "The Master Plan of Sewage Treatment in the Metropolitan Region of Curitiba, September, 1993 - SANEPAR".

7) The cost for terracing was estimated based on the data of EMATER.

8) The cost for non-tillage was estimated by assuming machinery cost, it's durability, capacity, etc.

9) The cost for hydroelectric power generation was estimated by converting the cost estimated by COPEL to 1994 price level.

Table-10.1 Rough Project Cost for Iguaçu River Basin

Sector		Scale of Sector	Project Cost (10^6US$)
Domestic and Industrial Water Supply	Curitiba M.A.	625,000 m^3/day	760.0
	Other Area	289,000 m^3/day	198.0
	Sub-total	914,000 m^3/day	958.0
Agricultural Water Supply		33,000 m^3/day	5.0
Sewage Treatment	Curitiba M.A.	420,000 m^3/day	294.0
	Other Area	45,000 m^3/day	50.0
	Sub-total	465,000 m^3/day	344.0
Flood Control			97.0
Soil Erosion Protection	Terracing with Farm Road	10,781 km^2	108.4
	Non Tillage	7,520 km^2	35.5
	Sub-total	18,301 km^2	143.9
Afforestation		2,800 km^2	168.0
Total			1,715.9
Hydroelectric Power Generation		1,400 MW	1,193.9
Grand Total			2,909.8

10.2 Economic Analysis

10.2.1 Objectives and Target Areas

This section presents an outline of an economic analysis carried out for the proposed Master Plan for the Iguacu River Basin. The objective of the analysis is to assess the magnitude of economic return to the proposed Master Plan by sector from the perspective of overall economy.

The result of the economic analysis would serve as the basis for making a judgment in promoting each component to the feasibility study stage and making a comparison among each of the Master Plan components. A cost-benefit analysis derived economic internal rates of return (EIRRs), benefit - cost ratios and net present values for each component.

The target areas of the economic analysis are the following. The selected target areas are those for which economic benefits could be quantified.

- water supply
- sewerage
- flood mitigation
- soil erosion
- ecological preservation area
- hydropower

10.2.2 Results of the Analysis

(1) Common Assumptions

The following are the assumptions underlying all the sectors.

a) An evaluation period of each sector are determined based on such factors as the life of the facilities and present practice of the related organizations.

b) A construction period of each sector is determined based on the average length needed for constructing the facilities of each sector.

c) A conversion factor of 0.85 is applied to adjust the investment and operation and maintenance costs in order to correct for price distortion. The total cost was adjusted using the conversion factor based on the judgment that the proportion of foreign currency in the investment cost of the past projects in Paraná was marginal.

d) The exchange rate applied is R$0.89 = US$1.0.

(2) Water Supply

Assumptions

A cost-benefit analysis for water supply sector was conducted based on the following assumptions.

a) An economic analysis was conducted for the urban water supply component. The rural water supply component was not included in the analysis since the magnitude of investment is marginal.

b) A construction period of 4 years and an evaluation period of 30 years are assumed.

c) The volume of water to be supplied by the proposed system is divided into domestic and industrial uses based on the proportions derived in the water demand projection for each city.

d) Economic benefit was estimated to be 0.93 US$/m^3 for domestic water composed of 0.62 US$/m^3 as the present average tariff level collected by SANEPAR and 0.31 US$/m^3 as the assumed consumer surplus. Industrial water supply benefit is estimated to be 0.56 US$/m^3, the average of SANEPAR's tariff on industrial water and unit water cost of direct abstraction.

e) Water losses are assumed to be 25% for domestic water and 10 % for industrial water. Benefit, therefore, is estimated for the volume measured at the point of consumers.

Results

The following EIRRs were derived.

- Curitiba MA (A): 10.29 %
- Cascavel (A): 21.49 %
- Foz do Iguaçu (A): 77.81 %
- Guarapuava (A): 38.16 %
- Medianeira (B): 37.54 %
- Dois Vizinhos (B): 18.42 %
- Francisco Beltrao (B): 51.19 %
- Pato Branco (B): 17.02 %
- Palmas (B): 18.76 %
- União da Vitoria (B): 10.27 %
- Total of Type A Cities excluding Curitiba M.A.: 40.79 %
- Total of Type B Cities: 25.92 %
- Total of Type C cities: 8.20 %

Note : (A) ; type A cities (those with a population of more than 100,000 in 2015) , (B) ; type B cities (population between 50,000 and 100,000 in 2015), (C); other cities than (A) and (B).

Various information in Paraná and Brazil indicates that the opportunity cost of capital (OCC), which is a criterion against which an EIRR can be compared, is somewhere between 10% and 12%. The derived EIRRs of the type A and B cities range between the highest in Foz do Iguaçu at 77.8% and lowest in União da Vitoria at 10.3%. Overall the EIRRs for all the type A and B cities in the Iguaçu River Basin are calculated at 40.8% and 25.9% respectively, implying sufficient economic return to investment. The EIRR of the type C cities is 8.2% on average indicating lower return, which would be a reflection of more dispersed settlement pattern in smaller cities.

For the Curitiba Metropolitan Area, which accounts for 67% and 79% of the total water supply volume and the investment cost of all the type A and B cities in the Iguacu River Basin respectively, an EIRR was derived at 10.3%, almost equal to the OCC. The relatively low EIRR for the Curitiba MA compared with other cities would be due to severe water balance condition in the Curitiba MA and resultant higher investment cost per unit water volume. The needs for constructing dams and conveying water from more distant sources lead to lower investment efficiency.

Conclusion

It is concluded that the urban water supply component of the Iguaçu River Basin, in general, shows sufficient economic return to investment. It is judged that all the cities are worth promoting to the feasibility study stage for further detailed analysis. In order to be able to make a more rigid judgement on investment justification, the following aspects should be refined and incorporated into an economic analysis in the feasibility analysis stage.

a) a detailed estimate of investment cost and operation and maintenance cost

b) an estimate of benefit reflecting economically optimum tariff level and consumer surplus

Special consideration should be given to water supply planning in the Curitiba Metropolitan Area such as follows.

a) Demand side measures such as charging on direct abstraction as proposed for the Strategy should be taken into consideration. Total demand would fall as a result reducing the burden for supply side measures.

b) A new tariff system would be worth considering. Regional variation in the tariff level is inevitable based on the marginal cost pricing or from the cost recovery perspective. In the Curitiba Metropolitan Area where water is more expensive and the economic level is higher than other areas, a higher level of tariff would be acceptable.

c) The present study assumes that both domestic and industrial water demand are to be met by facilities of the same standard. In reality, separation of domestic water supply system and industrial water supply system would be necessary. For the part of industrial water demand to be met by public water supply system, facilities of lower cost would be suitable since the quality of water demanded by industries would be lower. On the ground that systems are separated for domestic and industrial purposes, an EIRR solely for domestic water supply would be higher than derived as above due to the higher economic benefit of domestic water than that for industrial use.

(2) Sewerage

Assumptions

A cost-benefit analysis for the sewerage component was carried out based on the following assumptions.

a) A construction period of 4 years and an evaluation period of 30 years are assumed.

b) Present average tariff level of SANEPAR at US$ 0.58 /m^3 is used as the economic benefit as a proxy of the wiliness-to-pay of customers.

Results and Conclusion

The following EIRRs were derived.

- Curitiba : 24.27 %
- Cascavel : 16.57 %

Both Curitiba and Cascavel show high economic return to investment largely surpassing the OCC at 10 %. Real EIRRs would be higher than the above figures since the benefit applied captures only part of actual willingness-to-pay of customers and do not reflect improved water quality affecting non-customers. The different level of EIRRs between the two cities would be due to different proportions of costs for pipe works. Curitiba shows higher investment efficiency reflecting a more dense settlement pattern.

In the feasibility analysis stage, a more detailed analysis should be made covering the following items.

a) a detailed estimate of investment cost and operation and maintenance cost

b) an estimate of benefit reflecting :

- economically optimum tariff level and consumer surplus, and
- quantification of external effect (economic impact of water quality improvement for non-customers).

(3) Ecology

Objective and methodology

A number of approaches have been introduced to quantify economic benefit of ecological preservation such as focusing on genetic resources as a pharmaceutical resource and a contingent valuation method to clarify peoples' willingness-to-pay for preservation. The present analysis, however, adopted a simplified approach due to the limitation in data availability. The objective of the analysis is rather to show a method of quantifying environmental benefits than to present a result of an in-depth economic analysis, taking up the Serra da Baitaca Preservation Area Project as an example.

The methodology adopted for benefit quantification is based on the travel cost approach, which is often applied to measuring economic benefit of recreational resources. The idea is that the costs people pay for spending a certain length of time for recreational activities reflect the value of the recreational resource. Theoretically, the costs are broken down into travel cost to reach the place and time cost, which is the income lost due to spending the time for recreation. Consumer surplus can be measured once a demand function for the recreational asset is derived.

In the present analysis, a simplified method is adopted. Two basic assumptions are set : the aspects of the travel cost and the opportunity cost of preserving the area. The latter means the economic growth lost due to prohibiting the commercial use of the area other than recreational activities.

Assumptions

The following assumptions are set for the analysis.

a) Investment cost is estimated to be 1,170,000 US$, US$ 585,000 for various program cost as estimated in the Section-7.4 plus another US$ 585,000 assumed as costs for constructing various facilities. Operation and maintenance cost is assumed to be 5% of the investment cost annually.

b) Travel cost is estimated based on the following assumed factors :

- population in Curitiba : 1,315,000,
- 10 % of the population visit the place (131,500 people),
- the frequency of the visit is once a year on average, and
- travel cost between Curitiba and the place is US$ 10/round trip.

Annual travel cost is, thus, derived at 1,315,000 US$. This value can be regarded as the minimum level of economic benefit. Actual benefit would be higher by the portion of consumer surplus.

c) Opportunity cost of preservation is estimated based on an information on the ecological ICMS. The total amount to be used for preservation under the ecological ICMS system in 1996 would be around US$ 30 million for 30 preservation areas or 1 million US$ per one preservation area on average. The opportunity cost is, therefore, assumed to be US$ 1 million per year.

Results and Conclusion

An economic internal rate of return for the Serra da Baitaca Preservation Area Project is derived at 12.4% based on the above assumptions. It should be emphasized, however, that this calculation is preliminary based on assumptions. The following aspects should be surveyed in the feasibility study stage as the basic factors for benefit estimation.

- number of visitors to the area and frequency of visits
- willingness-to-pay of potential visitors
- a detailed estimate of opportunity cost of preservation
- an estimate of benefit from a wider perspective (preservation of genetic resources, peoples' valuation of preservation etc.)

(4) Flood Protection

An economic analysis was carried out for the União da Vitoria Flood Protection Project.

Assumptions

a) An evaluation period is set at 50 years.

b) A construction period of 5 years is assumed.

c) Annual operation and maintenance cost is assumed to be 0.5% of the investment cost.

d) Probable flood damage is estimated to be US$ 9,779 thousand annually. This damage value is assumed to grow by 5% per year in accordance with economic growth of the affected area.

Result and Conclusion

An EIRR is calculated to be 14.65 % indicating economic viability of the União da Vitoria Flood Control Project. The project is judged to be worthwhile to be promoted to the feasibility study stage.

(5) Soil Erosion Prevention

The Master Plan proposes soil erosion prevention measures for an area of 1.3 million ha in total in the Iguaçu River Basin. There are altogether 10 locations planned under the Master Plan. An economic analysis was conducted for the total of all the ten components.

Assumptions

a) An evaluation period of 30 years is assumed.

b) A construction period of 1 year is assumed.

c) The cost of fertilizers to be saved by the project is employed as the economic benefit.

Result and Conclusion

An EIRR is derived at 8.63%. This EIRR shows the minimum level of EIRR expected. Actual EIRR would be much higher than this level since a number of expected benefits were not included in the present analysis due to the limited availability of data needed for quantification. They would include the rise in agriculture productivity, reduction in the water treatment cost due to the fall in sedimentation volume and reduction in fertilizer use leading to improved water quality. A higher EIRR would be expected once a more detailed economic analysis in the feasibility study stage succeeds in quantifying these benefits.

(6) Hydropower

Project to be Analyzed

There are 3 hydropower projects planned to start operation by the year 2015 in the Iguacu River Basin. Out of these, the construction of the Jordao Diversion Project and the Salto Caixias Project have already started. The present analysis, therefore, focuses on the remaining 1 hydropower project which have not been committed yet, the Fundão project.

Assumptions

The following assumptions are set.

a) An evaluation period of 50 years is set.

b) A construction period of 5 years is assumed.

c) The operation and maintenance cost is assumed to be 0.5% annually of the investment cost.

d) Economic benefit from consumption is set at 72 US$/MWh. Benefit from demand

both in the peak and out-of-peak time is assumed to be 17% of the consumption benefit.

Result and Conclusion

An EIRR of the Fundão hydropower project is derived at 19.7%, indicating a high economic return to investment.

10.3 Financial Analysis

10.3.1 Objective

A financial analysis was conducted for the water supply component and sewerage component. The objective of the financial analysis is to evaluate the return to investment from the perspective of implementing agency.

10.3.2 Water Supply

Methodology and Assumptions

Financial internal rates of return (FIRR) were derived for each component of the water supply sector. The following are the assumptions.

a) The investment cost presented in section 10.1 is applied. Operation and maintenance costs are assumed to be 9% of the investment cost.

b) Revenue is estimated based on the present average revenue per cubic meter collected by SANEPAR : US$ 0.62/m^3 for domestic use and US$ 1.10/m^3 for industrial use.

c) The volume of water to be supplied by the proposed system is divided into domestic and industrial uses based on the proportions derived in the water demand projection for each town.

d) Water losses are assumed to be 25% for domestic water and 10 % for industrial water. Revenue, therefore, is estimated based on the amount measured at the point of consumers.

Result and Conclusion

The following FIRRs are derived.

Unit: %

Area	Industry + Domestic	Domestic only
Type A		
Curitiba M. A.	9.51	3.99
Cascavel	13.50	11.55
Foz do Iguacu	62.16	58.31
Guarapuava	33.30	27.22
Type B		
Medianeira	27.57	24.77
Dois Vizinhos	20.38	12.80
Francisco Beltrao	47.21	39.02
Pato Branco	11.15	8.33
Palmas	14.37	10.49
Uniao da Vitoria	8.73	3.63
Total of Type A cities excluding Curitiba M.A.	28.85	26.89
Total of Type B cities	22.71	17.23
Total of Type C cities	4.75	—

Note: "—" means negative

FIRRs are derived for two cases : the first case of industrial use and domestic use combined and the second case of domestic use only. The first case assumes that all the industries would pay the industrial water tariff at US$ 1.10/m^3. The second case focuses only on domestic water supply defined.

Since data on real interest rates in Paraná was not available, it is difficult to make a straight judgment on these FIRRs. In general, however, it can be judged that most of the components will generate sufficient return to operate the system in a sound manner. The derived FIRRs would also serve as a criterion for the following objectives.

- loan procurement for implementing organizations such as SANEPAR
- adjustment of tariff level reflecting different level of cost efficiency among different regions
- decision on investment in water supply project by the private sector

10.3.3 Sewerage

Methodology and Assumptions

Financial internal rates of return (FIRR) were derived for the sewerage components in Curitiba and Cascavel. The following are the assumptions.

a) The investment cost presented in section 10.1 is used. Operation and maintenance costs are estimated based on the data supplied by SANEPAR.

b) Revenue is estimated based on the present average revenue per cubic meter collected by SANEPAR : US$ 0.58/m^3.

Results and Conclusion

The following FIRRs are derived.

- Curitiba : 21.34 %
- Cascavel : 14.27 %

It is judged that these levels will be sufficient for a sound financial management of the sewerage system. These FIRRs can be referred to in making various judgments in the same manner as mentioned for the water supply component.

CHAPTER 11 RECOMMENDATIONS

11.1 Studies for Urgent Implementation

Such studies as described below are recommended to be conducted urgently, following this Study.

(1) Study on Comprehensive Regional Plan on Water Environment for the Curitiba Metropolitan Region

The following issues regarding water environment are identified and clarified throughout the Study in Curitiba Metropolitan Region.

1) water supply by dam development
2) water supply by groundwater development
3) water quality control and sewerage development
4) flood control

A study on comprehensive regional plan on water environment should be conducted with more preciseness, containing the above issues. Feasibility studies should follow, after selection of programs or projects of priority regarding the above four issues.

(2) Feasibility Study on Flood Control in Uniao da Vitoria

A feasibility study on flood control is recommendable for Uniao da Vitoria, where the largest damage over the State by flood occurs.

(3) Feasibility Study on Water Supply and Sanitation in Cascavel

Water demand in Cascavel will grow rapidly corresponding to the urban development. Although the Study proposes the sources of water supply from surface and underground water, a feasibility study for more precise plans is required. A feasibility study on sewerage development to prevent water contamination in downstream rivers would be necessary because of the similar geographical conditions to Londrina.

11.2 Master Plan Study for Other River Basins than the Pilot River Basins of the Study

The Study formulates the Strategy to cover the whole state, and the Master Plan for Iguaçu and Tibagi River Basins, after the selection of the two basins as the Pilot River Basins. For other seven (7) river basins, master plan studies should be conducted as soon as possible. The Steering and the Technical Committees established for the Study are expected to facilitate those master plan studies.

11.3 Review of Other Development Plans

The Strategy and the Master plan proposed in the Study are formulated from the viewpoint of water environment applying various assumptions and estimates on socio-economic conditions. In other development plans, such as those for socio-economic development, regional development, industrial development of various sectors, and transportation and road

network development, programs and projects should be planned taking into account of the proposals made in the Study from the viewpoint of water environment. For example, in order to restrain the population concentration occurred in the Curitiba Metropolitan Region and to distribute the population and industries to regional poles, concrete schemes should be examined and programmed in regional development plans.

11.4 Implementation and Review of the Proposed Projects

In order to promote socio-economic development and to raise the living standards and to enjoy conserved or improved water environment, projects and programs proposed in the Study should be implemented steadily. Since the projects and programs are planned based on the estimated socio-economic framework in target years of 2005 and 2015, the plans should be reviewed every five years or when necessary, according to the changes in socio-economic conditions.