CHAPTER 10

WATER QUALITY AND HYDROLOGICAL MONITORING PLAN COMPONENT (6)

CHAPTER 10 WATER QUALITY AND HYDROLOGICAL MONITORING PLAN COMPONENT(6)

10.1 Basic Policy

The basic policies for the formulation of the master plan for water quality and hydrological monitoring are as follows.

- 1. Monitoring of the water level and meteorological conditions around the Patos Lake, the water quality distribution in the Lake, the flow and load from main inflow rivers, and the discharge load from main pollution sources, to conserve and effectively exploit the various benefits that can be derived from the Lake in a long term basis.
- 2. Meteorological and hydrological conditions in the basin directly affect lake and river water environment. In view of the significant annual and seasonal fluctuations, monitoring should be regularly and concurrently carried out as much as possible.
- 3. Since monitoring covers a wide area, the selection of the monitoring stations will consider water quality distribution characteristics, use of the water area, and load inflow points ascertained from the Study results, as well as the time and expenses each monitoring activity would incur.
- 4. The monitoring of main pollution sources will target factories and enterprises discharging significant amount of sewage/wastewater, and sewer outlets.
- 5. With emphasis on the continuity of data, existing monitoring stations of relevant agencies will be used as much as possible.
- 6. To carry out monitoring activities according to the budget and personnel that can be provided, monitoring stations and items should be prioritized and any increments should be carried out gradually.
- 7. Current monitoring activities are mainly carried out by FEPAM. In consideration of ease in accessing the monitoring stations, strong interest in surrounding environments, use of data, etc., the activities will be gradually transferred to the

municipalities of monitoring stations where measurements and sampling are carried out.

- 8. A committee to standardize monitoring techniques will be established and a manual will be prepared in view of the delegation of the monitoring activities to the municipalities.
- 9. An automatic observation system with exorbitant operation and maintenance costs will not be introduced.
- 10. A system for the joint use of monitoring data among relevant agencies should be promoted.

10.2 Monitoring System for Patos Lake

10.2.1 Monitoring Items

Monitoring in the Patos Lake and its coastal area should extensively cover items such as water quality, bottom materials and aquatic organisms, as well as the meteorological and hydrological conditions that affect the distribution of these items. There are a great variety of items that may be used for the detailed analysis and observation of these monitoring items. With this monitoring plan, however, the items were, to a possible extent, restricted to a few as emphasis was placed on the ability to monitor them continuously.

The monitoring items proposed for this master plan are as shown below.

(1) Water Quality

In-situ Observation:	Transparency, Oil-film, Floatage, Water color, Odor,	
	Water temperature, Salinity, Conductivity, pH, Turbidity	

Items for the Analysis of Water Samples:

BOD, COD(Cr), DO, T-N, NH₄-N, NO₂-N, NO₃-N, T-P, PO₄-P, Chl-a, Coliform(fecal), T-S, Cd, Pb, Cr⁺⁶, Cu, Ni, Zn, Hg, As, CN, Agricultural chemicals

(2) Bottom Materials

In-situ Observation: Color, Odour, pH, ORP

Items for the Analysis of Bottom Samples:

COD, T-S, T-N, T-P, Ig-loss, Cd, Pb, Cr⁺⁶, Cu, Ni, Zn, Hg, As, CN, Agricultural chemicals

(3) Aquatic Lives

In-situ Observation:	Biotic Community	
Items for the Analysis	of Water Samples:	Phytoplankton
Items for the Analytis	is of Bottom Samples:	Benthos

(4) Meteorological/Hydrological Conditions at shoreline stations

Meteorology:	Temperature, Precipitation, Wind (velocity & direction),
	Amount of insolation
Hydrology:	Water level

Also, in consideration of the budget and personnel that will be dispensed for this undertaking, the monitoring items including the supplementary ones were ranked in order of priority as shown in **Table 10.2-1**.

Priority	Monitoring Items	Parameters	
	Water Quality	Transparency, Color,	
		Temperature, Salinity, pH,	
٨		BOD, COD, DO, T-N, NH ₄ -N, NO ₂ -N,	
(High Priority)		NO ₃ -N, T-P, PO ₄ -P, Chl-a, Coliform	
(Ingli I nonty)	Meteorological and	Temperature, Precipitation,	
	Hydrological Conditions	Wind (velocity & direction),	
		Water level	
	Water Quality	Odor, Oil Film, Floatage,	
		Conductivity, Turbidity,	
P		T-S, Cd, Pb, Cr^{+6} , Cu, Ni, Zn, Hg, As, CN	
D	Bottom Materials	Color, Odor, pH, ORP,	
		COD, T-S, T-N, T-P, Ig-loss	
	Aquatic Lives	Biotic community, Phytoplanktons	
	Water Quality	Agricultural chemicals	
С	Bottom Materials	Cd, Pb, Cr^{+6} , Cu, Ni, Zn, Hg, As, CN,	
		Agricultural chemicals	
	Aquatic Lives	Benthos	
	Meteorological and	Amount of insolation	
	Hydrological Conditions		

 Table 10.2-1
 Prioritization of Monitoring Parameters

10.2.2 Monitoring Stations

In the selection of monitoring stations, every water area should at least have 1 station (the Master Plan will detail 34 water areas: see **Fig. 4.5-1**). Nonetheless, due to limitations in budget and personnel, the number of stations may be kept to a few, as long as observations can be continued for a longer period of time.

For the Master Plan, the following items were taken into account for the selection of monitoring stations.

- 1) Selection of the central water section as a representative station of the water area
- 2) Use of existing monitoring stations
- 3) Ecologically significant stations
- 4) Recreation areas (areas designated for swimming)
- 5) Topographically highly enclosed area; indicating a degree of independence as a water area.
- 6) Water area whose water quality and utilization differ from the rest.
- 7) Monitoring efficiency

The monitoring stations selected within the Patos Lake based on the above-mentioned factors are as shown in **Figs. 10.2-1** and **10.2-2**, and **Tables 10.2-2** and **10.2-3**. For this master plan, the most ideal situation is represented as Case 1 and that which has the lowest need for implementation as Case 2.

Number of Stations:	Case 1	22 stations
	Case 2	9 stations

Number of Layers: 1 layer (surface) for sampling

Stations No. 4, 7, 11 and 17 for Case 1 (see **Fig. 10.2-1**) and stations No. 3, 4, 5 and 7 (see **Fig. 10.2-2**) for Case 2 will be used in place of the monitoring stations for coliform used by FEPAM in summer in the coasts of Tapes, Arambare, Sao Lorenco do Sul and Pelotas (see Chapter 3.4-2).

For meteorological and hydrological monitoring at the coast of the Patos Lake, continuous observations aforecited in Chapter 3.4-1 in Santa Rita, Sao Lourenco do Sul, Barra Falsa, Cristovao Pereira, Pelotas, Rio Grande (pilot station), Farol de Itapua are desired (see **Fig. 3.4-1**).





Station		Location	Remarks
1	Guaiba Lake:	Rio Guaiba	Inflow quality
2	Northern Area:	Lagoa do Casmeto	Irrigation
3		Central part (north)	
4		Saco de Tapes	Inner Bay
5		Central part (south)	
6		Coastal part (east)	Coastal area
7	Central Area:	Offshore area of Arambare	Coastal area
8		Central part (north)	
9		Estuary of Rio Camaqua	Coastal area
10		Central part (center)	
11		Offshore area of S.Lourenco	Recreation
12		Central part (south)	
13	Southern Area:	Lagoa do Pequena	Fishery
14		Central part (north)	
15		Central part (center)	
16		Saco do Rincao	Recreation
17		Offshore area of Laranjal	Recreation
18		Estuarine part (north)	
19		Saco do Arraial	Aquatic life
20		South of Ilha dos Marinheiros	Aquatic life
21		Saco da Mangueira	Aquatic life
22		Canal de Rio Grande	

 Table 10.2-2
 Proposed Monitoring Stations in Patos Lake (Case 1)

Table 10.2-3	Proposed Monitoring Stations in Patos Lake (Case 2)
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Station]	Location	Remarks
1	Guaiba Lake:	Rio Guaiba	Inflow quality
2	Northern Area:	Central part	Representative station
3		Saco de Tapes	Recreation
4	Central Area:	Offshore area of Arambare	Representative station
5		Offshore area of S.Lourenco	Recreation
6		Central part (south)	Representative station
7	Southern Area:	Offshore area of Laranjal	Recreation
8		Estuarine part	Representative station
9		Saco do Arraial	Aquatic life

10.2.3 Monitoring Frequency

Meteorological and hydrological conditions affect the water quality of the Patos Lake, resulting in great seasonal and annual fluctuations. Due to these significant fluctuations, water quality monitoring should be carried out at least every season, and to understand annual fluctuations, long-term continuous monitoring should be carried out.

The items to be monitored are prioritized in **Table 10.2-1**. In consideration of seasonal changes in the environment and the priority ranking of monitoring items, the monitoring frequency proposed for this master plan is as shown below.

(1) Water Quality

4 times a year (once in every season):

	Transparency, Color, Temperature, Salinity, pH, BOD,
	COD, DO, T-N, NH ₄ -N, NO ₂ -N, NO ₃ -N, T-P, PO ₄ -P, Chl-a,
	Coliform, Odor, Oil film, Floatage, Conductivity, Turbidity
once a year (summer):	T-S, Cd, Pb, Cr ⁺⁶ , Cu, Ni, Zn, Hg, As, CN
every 2 years:	Agricultural chemicals

(2) Bottom Materials

once a year (summer): Color, Odor, pH, ORP, COD, T-S, T-N, T-P, Ig-loss, Cd, Pb, Cr+6, Cu, Ni, Zn, Hg, As, CN

every 2 years: Agricultural chemicals

(3) Aquatic Lives

once a year (summer): Biotic community, Phytoplankton, Benthos

(4) Meteorological and Hydrological Conditions

every hour: Temperature, Precipitation, Wind (velocity & direction), Amount of insolation, Water level

10.2.4 Monitoring Method

In consideration of the significant meteorological and hydrological influences on water quality distribution in the target water area, simultaneous monitoring is desired for Patos Lake. This is difficult, however, because the target water area is very big and because there are only a limited number of monitoring units. It is proposed, therefore, that several monitoring units will be assigned to the monitoring work, to enable simultaneous monitoring activities. To attain uniformity in the monitoring results, the following minimum conditions are given.

1) Transfer of monitoring techniques to relevant agencies

- Creation of a monitoring and sampling manual
- Creation of a manual for analysis
- Transfer of monitoring and sampling techniques to relevant agencies
- Transfer of techniques for analysis to relevant agencies

2) Provision of monitoring equipment and materials and facilities for analysis

- Provision of surveying and measuring equipment
- Provision of facilities for analysis
- Provision of data processing machinery

It is proposed that under the supervision and guidance of FEPAM, observations and sampling at the site, including river monitoring data, will be divided among the university and relevant agencies as well as the concerned municipalities. In addition, the analysis of collected samples will be divided into about three laboratories of FEPAM, FURG, DMAE, CORSAN etc. with due consideration of area distribution.

The analysis of the samples will be based on the "Standard Methods for the Examination of Water and Wastewater" (prepared and published jointly by the American Public Health Association, the American Waterworks Association and the Water Pollution Control Federation).

10.3 Monitoring System for Rivers

As previously mentioned in Chapter 3.4-1, the monitoring of the water quality of rivers flowing into the Patos Lake and the hydrological conditions in the Patos Lake basin were carried out by the agencies concerned in accordance with their respective objectives (see **Table 3.4-1**).

The river water quality monitoring items to be proposed in respect of the future monitoring system are as shown below.

(1) **Basic items**

1) Importance of monitoring activities

Study and analysis of the classification of the water area by use

Application of the designated types of water areas

Establishment of water quality standards

Selection of monitoring stations

2) Clarification of the roles of every agency concerned

Roles of FEPAM, DMAE, CORSAN, and FURG etc.

Involvement and roles of concerned municipalities in the monitoring activities

3) Coordination of the monitoring activities of every agency

Unify and coordinate the monitoring period, items, frequency, and method of analysis

Preparation of a manual for survey, monitoring, and analysis

Provision of equipment and materials for the survey and monitoring activities, and facilities for the analysis.

4) Standardization and publication of results of the monitoring and analysis work

Construction and standardization of database

Publishing of data

5) Continuous implementation of monitoring activities

Personnel training and budgetary measures

(2) Items to be monitored and analyzed

- 1) Monitoring of river flow to determine water quality and load
- 2) Reconsideration of and additions to the items to be analyzed

Parameters for eutrophication (T-N, T-P) Harmful substances, e.g. agricultural chemicals Parameters for living organisms

(3) Target rivers and monitoring frequency (Fig. 10.3-1)

1) Once a month monitoring in the following 7 principal rivers:

Rio Jacui, Rio Taquari, Rio Cai, Rio dos Sinos, Rio Gravatai, Rio Camaqua, Canal do Sao Goncalo

2) Four times a year monitoring in 9 small to medium size rivers:

Arr. Diluvio, Arr. do Salso, Arr. Velhaco, Arr. Sao Lourenco, Arr. Grande, Arr. Pelotas, Can. Pepino, Arr. Santa Barbara, Arr. Fragata

(4) Monitoring method

- 1) Involvement and roles of concerned municipalities in the monitoring activities
- 2) Analysis of collected samples in laboratories of FEPAM, FURG, DMAE, CORSAN etc. with due consideration of area distribution

- 3) Preparation of a manual for survey, monitoring, and analysis
- 4) Provision of equipment and materials for the survey and monitoring activities, and facilities for the analysis.

Basically, the monitoring of basin hydrological conditions by existing observation stations will be continued. However, due to a huge number of missing data and the fact that many of the existing observation stations are not working, the provision of appropriate equipment/facilities and the establishment of a monitoring system for the continuous implementation of monitoring activities are strongly desired. Further, as valuable data are not organized and left unattended, an easy to use database will be constructed to facilitate data access.



10.4 Wastewater Monitoring for Industries and Enterprises

As previously mentioned in Chapter 3.4-3, the monitoring of the quality of sewage from the factories and enterprises in the Guaiba river basin is regularly carried out by the SEDAPI of the Industrial Pollution Control Division of FEPAM.

Nonetheless, because there are quite a number of issues at present to be dealt with, the following were proposed in respect of the future monitoring system.

1) Expansion and provision of FEPAM employees and equipment

- to increase the number of enterprises subject to this study
- to enable continuous monitoring activities

2) Monitor sewage volume along with water quality

The monitoring of wastewater from factories and enterprises in the Guaiba River basin have been carried out, to a certain degree, by FEPAM. On the other hand, in the Mar de Dentro area, not only is wastewater not monitored but basic data such as the process for manufacturing goods, amount of water consumed, and wastewater treatment facilities, are unknown. Based on this, an inventory of the factories and enterprises in Rio Grande and Pelotas will first be prepared, followed by the selection of entities that would represent the types of factories and enterprises in the area, in order to carry out monitoring for the calculation of the effluent load per unit production.

10.5 Structure for the Execution of Monitoring Works

To preserve the multilateral values of the Patos Lake and effectively exploit these in a long term basis, the following factors should be monitored regularly: water quality distribution, hydrological and meteorological conditions in the surrounding lake area, water quality and pollutant load of inflow rivers, discharge load from main pollution sources. Also, countermeasures should be adopted when the need arises.

At present, the water quality monitoring activities at the shore and basin of Patos Lake are mainly carried out by FEPAM. The activities, however, are not satisfactory due to shortage in staff, equipment and materials, and funds. Since continuous implementation and the acquisition of reliable data are important for the monitoring activities mentioned herein, establishing an implementation system and clearly identifying the roles of the parties concerned are essential.

Monitoring activities, on their own, do not guarantee the improvement of environmental conditions, e.g. water quality. There is a need to conduct an efficient study to determine the means to as much as possible reduce operation and maintenance costs. In this regard, gaining the cooperation of municipalities with monitoring stations and relevant NGOs would be an effective means of instilling interest in participating in water quality improvement activities.

On the other hand, to enhance the residents' interest in water quality and its effect on the environment, showing the results of the monitoring activities to the public and promoting the joint use of data among the relevant agencies would prove to be very useful.

Based on these aforementioned points of view, the following items are proposed for the organization of the implementation system for the water quality monitoring activities in the Patos Lake and its inflow rivers (see Fig. 10.5-1).

(1) Establishing an Implementation System

1) Preparation and establishment of an organization

• Strengthening of FEPAM's organizational structure

Specialization: Formulation of plans, Technical supervision and

guidance, Observation and analysis, Data management

• Establishment of a water quality monitoring technical committee

Supervising Division: FEPAM

Main Services:	Formulation of water quality monitoring plans		
	Formulation of technical manuals (observation,		
	sampling, and analysis)		
	Transfer of technology to relevant agencies		
Members:	FEPAM, CORSAN, DMAE, FURG, UNISINOS,		
	UFRGS, EMBRAPA etc.		

• Preparations for an Implementation System

Study and Monitoring Implementing Agencies:

Division of responsibilities among relevant agencies, the municipalities, and NGO Persons in charge of every monitoring station(from about 20 agencies)

Agency for analysis: Division of responsibilities of analysis work

[For example]

FEPAM: Sewage from factories and enterprises

CORSAN: Freshwater (rivers and northern water area of Patos Lake)

FURG: Brackishwater (southern water area of Patos Lake)

2) **Provision of equipment and materials**

- Provision of equipment and materials for surveying and observations: about 20 agencies
- Provision of facilities and machinery for analysis: about 3 agencies

3) Budgetary measures

- Expenses for the establishment of an organization
- Expenses for the provision of equipment and materials
- Expenses for personnel training
- Expenses for the construction of a database

(2) Personnel Training

- 1) Education and training of staff for surveying and observations
- 2) Education and training of staff for analysis work

(3) Database Construction and Joint Use of Data

- 1) Provision of data processing equipment
- 2) Establishment of the functions of the data center

Succeeding section states the details involved in the provision of the equipment and materials for the establishment of the water quality monitoring implementation system. The staff required for regular monitoring are as shown below.

1) Planning and administration

Chief for water quality monitoring:	1 person (FEPAM)
Monitoring plan formulation:	1 person (FEPAM)
Technical management and guidance	
(monitoring and sampling):	1 person (FEPAM)
Technical management and guidance (analysis):	1 person (FEPAM)

2) Monitoring and Sampling

Sewage from factories and enterprises: 3 persons (FEPAM)

Rivers: 2 persons x about 20 agencies (including municipalities, NGOs, etc.)

Patos Lake: 3 persons x about 6 agencies (FURG, DMAE, Municipality, NGOs) Other living organisms and bottom sediments: 4 persons

3) Analysis of Samples

Sewage from factories and enterprises: 3 persons (FEPAM) Freshwater (rivers and northern water area of Patos Lake): 3 persons (CORSAN) Brackishwater (southern water area of Patos Lake): 3 persons (FURG)

4) Data Management

Monitoring data management: 2 persons (FEPAM)



10.6 Expansion Plan for Observation Equipment and Laboratory for Analysis

To continue the water quality monitoring activities for a longer period of time in the Patos Lake and its basin would not only require an implementation system, but also the provision of equipment and materials necessary for the work. These equipment and materials will be largely divided between those for surveying and monitoring and those for the analysis of samples. Aside from these, equipment for data management will also be required.

(1) Equipment and materials for surveying and monitoring

The type and number of equipment and materials for surveying and monitoring depend on the monitoring items and the implementation system. Since this study has not arrived to the point of proposing the river monitoring stations in the basin, detailed studies such as the required number of monitoring units have not been carried out. However, in consideration of the extensiveness of the study area and the numerous municipalities involved, the previously mentioned participation and cooperation of about 20 relevant agencies (municipalities, NGO, etc.) would require at least 20 sets of the following materials and equipment for surveying and monitoring.

- 1) Secchi disk
- 2) Salinometer
- 3) pH meter
- 4) Turbidity meter
- 5) Sampler for water
- 6) Sampler for bottom materials
- 7) Ropes, etc.

(2) Equipment and materials for the analysis work

The analysis equipment to be provided for the laboratory should be decided by first determining the monitoring items and number of samples as well as the detailed study of the roles of existing laboratories and the facilities to be provided this time. The

analysis work will be divided among FEPAM, CORSAN FURG and EMBRAPA, and the responsibilities of each organization are assumed below.

FEPAM: Sewage from factories and enterprisesCORSAN: Freshwater (rivers and the northern water area of Patos Lake)FURG: Brackishwater (southern water area of Patos Lake)

Below are the analysis equipment requested to be mainly installed in the laboratory of each agency:

1) FEPAM

• Spectrophotometer atomic absorption analyzer (1 set, heavy metal analysis)

2) CORSAN

- Utermohl chamber with capacity of 5, 10, 50, 100ml (2 sets, plankton count)
- Sedgwick rafter chamber (3 sets, plankton count)
- Sebelin digester with 6 mouths (1 set, COD analysis)
- Electronic heater of 300 x 400mm with 50-300 temperature regulator (2 sets, NH₄-N, T-N analysis)
- Water bath with 6 mouths (1 set, solid determination)
- TOC auto-analyzer (1 set, total organic carbon)

3) FURG

- Vacuum pump for water sample filtering (2 sets, Chl-a determination)
- Fluorimeter TURNER : TD-700 (1 set, Chl-a determination)
- Radioactive scintillation counter (1 set, C14 measurement)
- Portable water quality checker : Horiba U-10 (1 set, in-situ observation)
- Irradiancemeter : Li-Cor 100 spheric sensors (2 sets, solar radiation)

- Portable DO meter with agitator in sensor(3 sets, DO measurement)
- Portable thermo-salinometer (4 sets, temperature, salinity measurement)
- Portable wind meter (1 set, wind measurement)
- Current meter : AANDERAA (2 sets, current measurement)
- Tide gauge : pressure sensor (3 sets, tidal measurement
- Spectrophotometer atomic absorption analyzer (1 set, heavy metal analysis)
- Spectrophotometer : UV-visible (1 set, PO₄-P, NO₂-N, NH₄-N analysis)
- CHNS analyzer (1 set, C, N, S analysis in sediment)
- Mercury analyzer with fluorescence detector/generator (1 set, Hg analysis)
- Ion chromatograph system (1 set, Cr, CN determination)
- Microwave oven digester (1 set, metal analysis in aquatic organisms)

(3) Data Management Equipment

Since monitoring will be continuously carried out for a longer time period, tremendous amount of data will be accumulated. These monitoring data will be widely used for environmental policy formulation and as a basis for the preparation of necessary countermeasures.

On the other hand, the results of the monitoring activities should be published as a means of improving the residents' interest in water quality and its adverse environmental impacts. In addition, it is also important to promote the joint use of data among relevant agencies, especially since these data are very valuable. Based on this concept, a database will be constructed to make full use of the results of the monitoring activities.

CHAPTER 11

ORGANIZATIONAL STRENGTHENING AND JOINT INFORMATION USE PLAN COMPONENT (7)

CHAPTER 11 ORGANIZATIONAL STRENGTHENING AND JOINT INFORMATION USE PLAN COMPONENT(7)

11.1 Basic Policy

For the preservation of the aquatic and wetland ecosystem, it is requested that the problems encountered by each state government sector should be dealt with by basin. In this regard, the agency that coordinates the sectors plays a major role. As project planning and implementation would require various information, a system that would efficiently utilize the information held by every sector is very essential. In consideration of the problems in the present environmental management system specified in Chapter 3, the basic policies for the organizational strengthening and joint information use plan are established as follows.

(1) Master Plan Implementation System

The executing secretariat for the Mar de Dentro Program (SEPMD) is established within the SCP of the state of Rio Grande do Sul. The department promotes the PRO-MAR program by establishing contacts with every sector, municipality, university and NGO. Three committees will be organized to provide SEPMD technical and financial assistance as well as assistance in policy making, in order to establish a strong implementation system.

(2) Strengthening of the SEPMD

SEPMD does not have the sufficient number of staff to efficiently cope with its designated functions. In view of this situation, more employees will be assigned to the department as a means of strengthening its functions.

(3) Strengthening of FEPAM

SEMA-FEPAM are mainly responsible for solving the environmental problems of the state. However, staff shortage makes it difficult for FEPAM to effectively carry out monitoring activities in the Mar de Dentro area which also brings about outstanding delays in licensing and approval services. To solve this particular situation, SEMA is considering transferring a part of the services to the municipality, eliminate functions that are unnecessary and strengthen those that are of importance.

(4) **Promote Joint Use of Information**

The type and whereabouts of information required for the implementation of the Master Plan, which are presently unknown, will be confirmed. A database will be constructed and a map will be produced, and both will be entered in the web site of every agency. In addition, SEPMD will also put the implementation process and relevant information on the web site to encourage the residents to trust the government, and foster a sense of responsibility among government employees.

11.2 Master Plan Implementation System

For the PRO-GUAIBA program, which covers the Guaiba River basin, the executing secretariat was organized within SCP. The department coordinates with the state government sectors and other relevant agencies and promotes a comprehensive environmental preservation project with funding from IDB. Using the PRO-GUAIBA implementation system as a reference, the master plan implementing system, with SEPMD as the executing secretariat, is as shown in **Fig. 11.2-1**.

SEPMD would need a staff of around 10 to carry its various functions described in **Table 11.2-1**. The following committees will also be established to support SEPMD: policy making committee, technical committee, financial committee.

To support the SEPMD, the following committees will be organized: policy making committee, technical committee, and financial committee. **Table 11.2-1** shows the functions of each committee and the responsible agencies.



Table 11.2-1Functions of the Mar de Dentro ProgramExecuting Secretariat

Name (Responsible Agency)	Functions	Agency in Charge
Agency responsible for administrative work for the project (SEPMD/SCP)	Instructions to and coordination of relevant agencies Collection and management of information Summary of environmental management plan Summary of the project plan Summary of legal amendments Promotional campaigns, web site management	SEPMD/SCP
	Summary of fund procurement and repayment plan Management and application of PRO-MAR funds	DSP/SCP
Policy making committee (SEMA)	Decide the zoning of water areas and basin areas Deciding the water area and land use plan Deciding the environmental management plan Deciding the project plan Deciding the priority ranking for projects to implement Deciding the fee collection system	Basin committee (consist of representatives from government agencies, water users, and residents)
Technical committee (FEPAM)	Study the zoning of water areas and basin areas (draft) Study the aquatic environmental management plan (draft)	FEPAM FEPAM
	Study the water resource management plan (draft)	DRM
	(draft) Sewage treatment techniques	FZB, NGO, university) CORSAN, SANEP, DMAE
	Solid waste management techniques Monitoring techniques	SANEP Committee for the standardization of monitoring techniques (FEPAM, university, municipality, NGO)
	River and lake water quality monitoring	FEPAM, FURG, DMAE, university
	Monitoring of effluents of enterprises Environmental conservation oriented agriculture	FEPAM EMATER, (EMBRAPA)
	River management Database, GIS, and information processing	EMATER, DRMDatabasemanagementcommittee
	Environmental education and personnel capacity building	SE, university, NGO
Financial committee (DSP/SCP)	Study the project scale Approval of the fund procurement and repayment plan Request revenues from the state financial department	SF, SOPS, SCP

The basin committee has been appointed as the committee in charge of the formulation of policies for water resource management. However, for the implementation of the master plan, SEPMD will be responsible for the formulation of the policies. With the assistance of SEMA, SEPMD will prepare a draft and will explain the context to the basin committee. The technical committee will provide SEPMD with technical advice and information, and even conduct studies when necessary. The wetland committee and the committee for the standardization of monitoring techniques proposed in Chapters 9 and 10 will be established as a part of the technical committee. With assistance from the Special Project Department of the SCP, the financial committee will conclude the appropriateness of the budget proposed by SEPMD. The money for the implementation of the priority projects will be pooled from the PRO-MAR funds, including foreign reserves, and will be managed by the Special Project Department of SCP.

11.3 System for the Joint Use of Information

The information required for the implementation of the master plan are summarized in **Table 11.3-1**. Although the whereabouts and details of these information have been partly confirmed through this study, many of the information are still unknown. Clarifying these points should be given priority.

As mentioned in Chapter 3, water quality data that has been monitored vary by agency in terms of parameters, monitoring frequency, and accuracy of results. These differences are considered inevitable as the agencies carry out the monitoring work under differing objectives. The data will be placed in a database in specific form and placed in the web site to allow mutual use; this will increase the rate of use of these data. The same can be said about the results of the monitoring activities of NGOs on living organisms, thereby increasing the possibility that these results will be reflected in the plans of government agencies.

Producing a map containing some of the information would also prove to be convenient. The GIS using ArcInfo (ArcView) that had been introduced to the state is being used for the PRO-GUAIBA program. Utilizing this system for the master plan would eliminate the need for new investments for facilities and allow the accumulation of topographic/mapping information. **Fig. 11.3-1** shows the process for the construction of the system for the joint use of information.

This system will be a client/service oriented distribution processing system. A database

will be constructed for the data of every sector of the state, municipality, university, and NGOs which will be arranged in a specified format and be made accessible through the network. Agreements regarding the database structure, construction and use will be decided by the database management committee to be organized within the technical committee.

Table 11.3-1Information for Environmental Management and the
Agency Responsible for Collection and Management

Major Category	Minor Category	Agency Responsible for Information Collection and Management
Mapping	Topographic map	Ministerio do Exercito
information	Slope classification map	(IBGE)
	Geological map	DNPN
	Soil distribution map	MA/EMBRAPA/CPACT
	Vegetation map	(IBGE)
	Land use map	(IBGE)
	Water use map	None
	Nautical chart	DEPRC, (DHN)
Remote sensing	Satellite images (LANDSAT, SPOT, etc.)	CEPSRM
information	Aerial photos	None
Statistics	Population	(IBGE)
	Statistics on water resources (water demand by use)	DRM
	Industrial statistics (production output by industry)	None
	Land use statistics (area by land category)	SAA
	Statistics on livestock raising (number of heads by type of livestock)	SAA, LARA
	Statistics on fisheries (catch by species)	SAA
	Agricultural statistics (cropping area, agro-chemical consumption, etc.)	SAA, EMATER
	Statistics on health and sanitation (water supply diffusion rate,	
Essility Inventory	Severage diffusion rate, no. of patients with water-borne diseases)	DDM
Ginetallation point	Dellution facilities (induction and provide and provid	
(Instantation point,	Pollution source (industrial, public, etc.)	FEPAM CODSAN
functions	sewage treatment facility (puriying tank, sewage treatment plant,	CORSAN
performance cost)	industrial wastewater treatment plant)	
Inventory of living	Bird species	FZB NGO
organisms	Wetland vegetation	FZB NGO
Wetland inventory	Welding Vegetition	IICA study results
Monitoring data	Meteorology (rainfall, wind conditions, temperature, evaporation,	INMET DNAEE
into mig unu	etc.)	
	River flow	INMET
	River water quality and bottom sediment quality	INMET, CORSAN
	Water level (lake water level, tidal level)	IPH-UFRGS
	Conditions in the lake	JICA study results
	Water quality and bottom sediment quality of area in the lake.	ALM (Mirim Lake)
	Living organism	FZB, NGO
Generation per unit	Domestic wastewater (water amount and water quality by type of use)	CORSAN, SANEP
data (required	Industrial wastewater (water amount and water quality by type of	FEPAM
water amount,	industry	
sewage amount,	Non-point source	None
generation load)		
Water quality	Environmental standards	SEMA
standards	Wastewater standards	SEMA
Development	Regional development plan (including urban planning)	SOPS
conservation plans	Water resource development plan	DRM
(tederal, state, and	Natural resource protection plan	FEPAM, FZB
district levels)	Environmental facility construction plan (water supply, sewerage, solid waste disposal site)	CORSAN, SANEP
Research paper on every field		



11.4 Information and Database Necessary to Promote the Plan

An environmental information database with emphasis on following points is proposed to promote the Plan.

Data items based on user-side needs: There are often discrepancies between the demands of data users and items of existing data. At the initial stage of the project, thorough dialogue is necessary between data users and suppliers on data items included in the database.

Step by step progress: To make the data-base actually useful, scrap-and-build of monitoring items as well as database system should be made at later stages.

Small costs: Database becomes reliable only when it is steadily updated for many years. Due to the difficulty in securing a stable and sufficient budget for such activities, the database should be low-cost system. Use of Internet can be a solution. Although GIS database is foreseen in the later stage, data items that need GIS should be carefully selected.

Use of Internet: It is difficult for potential users to locate what sorts of data exist in which organizations. It is not only the case with general public, but also government agencies experience same difficulties in allocating existence and availability of data possessed by other organizations.

Information dissemination: Data items should be classified to the following categories: 1) free access on Internet, 2) limited access to intra-governmental users, and 3) available by permission. Items 3) should be made minimum and a classification list of items should be prepared.

Need for printed materials: Website data, however, presently have not been admitted as bibliographic materials. It is necessary to print out and publish them for example in the form of annual reports so that they have reference value.

Incentives to supply side organizations: Supply-side agencies tend to be one-side collaborators just only to provide data, and they are apt to lose motivations of cooperation in the long run, and this makes long-term collaboration difficult. Although monetary incentive is one of the answers, more appropriate is to clearly credit them among implementing bodies. In particular, their collaboration has to be counted on official achievements of respective organizations.

Involvement of supply-side organizations and decentralized compilation works: In is often the case that supply-side agencies cannot touch the data once they hand over the data to the processing side. When the original data is modified in the database, responsibility and copyright to those data tend to be noncommittal. To prevent this, supply-side agencies should be continuously responsible from data collection to dissemination. The responsibility and work of the adtabase secretariat should be limited to: 1) coordination of collaborating agencies, 2) advice on data format, and 3) publication of annual report.

Implementation:

SCP and FEPAM

In collaboration with

Agencies of State government, Municipalities, Universities and NGOs, And Wetland committee (on ecological items)

Outputs:

(Preparation Phase)

1. Network of data-supplying organizations.

(Existing Data Phase)

- 1. Database (descriptive and tabular) of RS environment on Internet.
- 2. Annual Environmental Data Report of RS

(GIS Data Phase)

- 1. GIS Database of RS environment on Internet.
- 2. Participatory forum on Internet

Workplan:

Preparation Phase (1st year)

- 1. Identification of data possessed by respective organizations.
- 2. Determination of dissemination standards by respective organization:
- 3. Enforcement of state regulations that justify dissemination of data (including copy right issues for data downloading)
- 4. Exploration of compatibility and overlapping with other databases
- 5. Decision to start up the database and agreement among collaboration organizations.

Existing Data Phase (2nd-4th year, mainly for administration and academia)

- 1. Dissemination of data on the Web sites by respective organizations (standardization of data format is not required at this stage)
- 2. Publication of a booklet introducing the contents of the database.
- 3. Annual publication (in easy DTP style) of Website contents as "Environmental Data Report"
- 4. Data updating annually by supply-side organizations.

GIS Data Phase (5th year and after, mainly for anonymous users)

- 1. Cost/benefit analysis of data standardization and GIS for respective data items. (If the work is too costly and users are limited to researchers, Phase III may not be necessary.)
- 2. Standardization of data format
- 3. Data compilation in GIS format by respective organizations.
- 4. Dissemination of GIS data on the Web sits.
- 5. Opening of Website Forums for public comments.
- 6. Scrap-and-build of monitoring items
CHAPTER 12

ENVIRONMENTAL EDUCATION AND PERSONNEL CAPACITY BUILDING PLAN COMPONENT (8)

CHAPTER 12 ENVIRONMENTAL EDUCATION AND PERSONNEL CAPACITY BUILDING PLAN COMPONENT(8)

12.1 Basic Policy

As repeatedly mentioned in Chapter 10, the cooperation and the participation of the residents are extremely essential to the implementation of the master plan components. In this regard, environmental education becomes a considerably important instrument. In the state of Rio Grande do Sul there are quite a number of educational texts that cover environmental problems in a unique manner. This study attempts to carry out a comprehensive environmental education program using these texts. Environmental education programs (excluding school education programs) was considered, and the basic policies below were established based on the experiences gained from the workshop held under this study.

- (1) A division for popularization and awareness shall be established in FEPAM to promote environmental education as social education in cooperation with NGOs.
- (2) The methods to be adopted for environmental education will focus on those that provide actual learning experiences such as site observations, monitoring, and cleansing work.
- (3) The facilities, equipment and educational materials required for environmental education will be provided gradually.
- (4) Environmental education will be planned in connection with schools and the NGO, and the study team will assist in the implementation.

12.2 Promotion of Environmental Education

12.2.1 Dissemination of Environmental Education Activities

Environmental problems such as urban and living related pollution, and the regional environmental problems are deeply related to people's daily lives and socioeconomic activities. Each person is required to correctly recognize their relation to the environment and change inadequate habits and attitudes so that more consideration is given to the environment. Constant promotion of environmental education is becoming increasingly important to solve the environmental problems that become more complex in various forms, and create a better, more pleasant environment. Therefore, to solve the environmental problems and to achieve a sound and pleasant living environment, it is necessary to disseminate environmental education activities. Environmental awareness campaigns and training workshops are considered the most effective methods to disseminate and promote environmental education activities.

The main objective of environmental awareness campaigns and workshops is to generate environmental concern through the detailed knowledge of lake ecosystem upon observation and experiments, to improve interest, knowledge and capabilities of residents, schoolchildren and administrative personnel to approach environmental problems, to promote common responsibility for sustainable development, and particularly to protect the lake environment in cooperation with the citizens.

(1) Environmental Awareness Campaign

Public cooperation is fundamental for the accomplishment of the goals related to the environmental problems. In that sense, the environmental awareness campaigns are very useful to promote the public participation. Before the implementation of a campaign, a public competition can be carried out to select a campaign logo or mascot. This logo or mascot that symbolizes the campaign, can also be used for the preparation of campaign tools such as stickers, posters, leaflets, banners and other publicity campaign tools.

(2) Training Workshop

Training programs for the community residents are considered an effective means of relaying information to the population. Education workshops are extremely important for adults as well as for children. The relationship between environmental education through workshops at school and the community is important because of the following two points. Firstly, what children learn is expected to increase the opportunity for their whole family and the citizens in the community, including adults, to study the environment and environmental problems. Secondly, if the citizens in the community help children to be interested in environmental problems, more fruitful knowledge and

abilities will be provided to solve these problems.

Generally, residents are not concerned with long effects and consequences and preservation of the environment as long as it does not affect them physically. Therefore, the workshops to be implemented should be focused on topics related directly with the daily lives of the inhabitants. This focus will give better results in the achievement of the proposed goals.

To implement training workshops, it is indispensable to create environmental education programs that satisfy the people's desires (residents or schoolchildren) to understand the environmental circumstances and problems, and to know more about environment. To support the workshop activities, training materials such as textbooks, educational panels, educational video, etc. should be planned and devised.

In the environmental education programs, the purpose of the workshops and campaigns are not only to increase public awareness on environmental issues, but also to promote environmental activities and gain support and participation from the community involved. Below are some examples of points to be explained and discussed in the workshops:

- Benefits of raising public awareness on environmental issues and the subsequent advantages of proper attitudes.
- Relationship between effects (diseases, economical loss, etc.) and environmental degradation.
- The waste and wastewater generated by each individual should be his responsibility, while the environment should be everybody's.
- Need for changes in inadequate habits and attitudes.
- Need for cooperation by the community.
- How many jobs in the region are directly dependent on the water quality?
- How to cooperate with environmental activities.

(3) Environmental Workshop at Schools

The main emphasis of the environmental education directed toward target groups should be directed to children of scholastic age.

In order to construct a society which will allow sustainable development with reduced environmental load, children and youth, who represent the next generation, must be expected to get a deeper understanding of environmental conservation, to voluntarily and actively conduct activities to reduce environmental pollution and to participate in the activities of local communities, volunteer groups, etc. for environmental conservation.

Taking into account the above, the Administration agency must attach importance to the implementation of the following activities:

- 1) In addition to making efforts to enhance events concerning environmental conservation in which children and youth participate, utilizing a variety of opportunities, the Administration agency should improve environmental education in schools and through direct contact with nature.
- 2) The Administration agency should promote the development and dissemination of such programs as environmental surveys, which are easy for children and youth to undertake, and will make efforts to provide assistance to schools for their projects, which supply children and youth with opportunities to express their opinions about environmental conservation.

The younger members, particularly children, of the audience in workshops implemented in Pelotas and Rio Grande were observed to be the most receptive to the video, booklet, and issues discussed. The positive response from the youth during the workshops allow to affirm, with a certain degree of certainty, that the environmental education designed by the Study Team would be very effective in educating schoolchildren.

12.2.2 Building Environmental Education Methods

(1) General

Generally, environmental education methods are divided into programs targeting the general or large segments of the population and those trying to reach limited and confined groups. The first method utilizes mainly mass media or indiscriminate general

campaigns, while the second concentrates on reaching specific groups through customdesigned campaigns, workshops, events, lectures, etc.

The mass media can be used through paid advertising, press releases and other forms of free coverage in television, radio, newspapers and magazines. In the long run this method is very effective because it reaches a considerable number of people at the same time, but the message has to be very vague and general because of the diversity of the audience, and its effectiveness is very difficult to evaluate in the short run. Also, this method is the most expensive and complicated, as large amounts of money and long periods are required to implement an environmental education campaign.

The techniques to reach limited target groups are endless and are generally divided into those targeting area groups, i.e. community centers, neighborhood associations, and so forth, and those targeting social groups determined by such criteria as age, gender and religion, i.e. schools, women's associations, churches, etc.

In targeting area groups, the goal is to focus the issue on its effects on the residents, thus appealing to the sense of community and brotherhood, creating a sense of awareness in which the residents of a certain area influence and control each other to change and/or modify inadequate habits. The problem with this method is finding a proper way to transmit the idea, because the educational level and the attention span of the average citizen vary depending on the social status.

Social groups have the obvious advantage of having very narrow and precise target audiences. Schools particularly present an effective audience because children are very impressionable, curious and idealistic, and it is very easy to transmit the message. However, by the same principle, it is also very easy for them to forget the issue at stake. Therefore, the biggest challenge regarding environmental education at schools is to design the campaign in such a way that they will remember the main points of the campaign.

(2) Methodology

Human activities directly affect the living environment, therefore the residents are responsible for environmental deterioration. Improvement of environmental conditions cannot be carried out without the consent and cooperation of the residents. Accordingly, residents' participation will be encouraged from the planning phase through **pilot** **projects** considering the followings:

- Details and methods of implementation of environmental education programs for schoolchildren.
- Details and methods of implementation of environmental education programs for residents.

Pilot projects aim to raise public awareness about environmental issues such as potential risks of environmental degradation, share of responsibility between state organizations, municipalities and residents for the protection and preservation of the environment through public participation and cooperation.

Pilot projects should be carried out through the activities below:

• Activity-based learning (participation through writing essays and drawing, field trips, etc.)

This method stimulates participants to actively study about environmental conditions and principles. Trainers should develop programs that center around participants' actions both in and out of the workshop. This kind of activities can eventually lead to action plans and implementation to help solve some community problems.

Participation of students from the target areas can be proposed as part of the environmental education campaign through activity-based learning. This participation will consist of writing short essays and illustration on environmental issues.

Field trips to pilot project sites are also proposed as part of learning activities, inviting students, community residents and authorities, before and after the campaign.

• Workshops (community training and environmental education through workshops by local administrative personnel)

As mentioned previously, workshops are very useful to increase public awareness, promote environmental activities and gain support and participation from the community involved.

• **Participation-oriented projects:** (clean-up activities, tree planting, public sector involvement on environmental issues, etc.)

Clean-up operations should be conducted jointly by all administration agencies, residents and school communities at a selected pilot project area. The community residents themselves, with the support of relevant organizations, should do the clean-up activities.

• **Inspection of project sites** (before and after the implementation of pilot projects)

This activity will consist of inspecting and monitoring sites in community areas and schools where pilot projects have been conducted. The inspections should be conducted for the subsequent evaluation of the pilot project achievements and their sustainability.

• Discussions

This method is very important for enhancing judging abilities. Environmental education deals with real-life surroundings or situations which need a lot of discussion.

(3) Promotion of Environmental Education Dissemination Activities by Providing the Necessary Tools and Equipment

1) Educational Campaign Tools

After determining public education methods and techniques, proper campaign tools must be prepared to increase their effectiveness. Besides the obvious background study and preparation of the lecturers, textbooks, educational panels, educational video, etc. can very useful to support the educational activities.

a. Educational Video

A video showing very descriptive images of the present reality to the audience, to illustrate environmental problems related directly to them, can be produced. A general documentary video for the environmental protection of the area of influence of the Patos Lagoon and Mirim Lake titled "A Vida pelas Aguas" (Life from Water) has already been produced by JICA Study Team. Taking this production as a model video, more specific videos can be produced on such topics as protection of the urban living environment, solid waste and wastewater, forest conservation and reforestation, disease prevention measures, etc.

Each video must be effective with as wide a range of the population as possible without losing its usefulness with specific target groups. The goal is to be as specific as possible without excluding a particular segment. The video should complement the textbooks and panels so that they can be used jointly, and it must be more general than the educational text so that its use is not confined to school education or community lectures.

b. Educational Text

The textbook should be designed to fit several purposes. It can be used together with the video and the educational panels. The conclusion of the Study Team is to design a textbook targeting the younger public, because the youth is more susceptible and impressionable, and at the same time it can have a strong influence on the older population. The contents and structure of textbook should be as short as possible, simple, concise and direct, to encourage reading and to arouse interest in the described topics. With this in mind, the textbook should be designed as follows:

- Small, short and simple to avoid initial rejection by readers.
- Colorful and attractive to encourage the youth to keep it and study it.
- Layout with little text and many pictures and illustrations to avoid boredom.
- Impersonal text, with general vocabulary not restricted to any particular age, gender, income, social, religious or interest group.
- Plot supportive of the video, i.e. present situation (harmful consequences, adequate measures to avoid such consequences, benefits of taking the measures).

c. Educational Panels

Educational panels also complement the video and educational text. These panels can display general information, main and important items or show the summarized contents of both educational materials in about 10 panels. These panels can be used in workshops, seminars and other education or cultural events to disseminate environmental education activities.

2) Summary of Education Campaign Tools and Equipment

The educational video, text and panels and other education campaign tools and equipment are summarized in the following **Table 12.2-1**.

No.	Tools and Equipment	Remarks
1	Stickers	The stickers are very effective means of promoting environmental
		campaigns because their handiness facilitates distribution to a
		large segment of the population.
2	Posters	To promote environmental activities, campaigns, etc.
3	Textbook	Complementary tool for use in education programs for schoolchildren and in community lectures. This textbook should be colorful, brief and simple to attract the attention of the readers.
4	Essay and illustration contest by students	Students participation is very important to promote environmental issues. Participation in essays and illustrations is aimed to disseminate environmental education activities among the students.
5	Educational panels	Educational and informative panels with colorful presentations, texts and illustrations showing harmful consequences and their adequate countermeasures, for use in seminars, education workshops and other cultural events to enhance public awareness and encourage public cooperation in environmental issues.
6	Banners	To be located in public areas and promote environmental activities, campaigns, etc.
7	Leaflets	To disseminate information and promote public cooperation in environmental activities.
8	Educational video	Complementary material of the textbook and educational panels. The goal of the video is to be as specific as possible without excluding a particular segment. A video targeting the younger audience is recommended because the youth is more susceptible and impressible than the adults are.
9	TV, video deck	To show educational video on environmental issues.
10	Overhead projector and screen	To transfer technologies pursued under the training program. OHP and screen to be used in seminars, meetings, workshops and conferences.
11	Whiteboard	For use in meetings, conferences, workshops and other multiple purposes.
12	Others	Complementary items such as microphone, speakers, bus tour, T-shirts, caps, etc, according to the necessity.

 Table 12.2-1
 Education Campaign Tools and Equipment

3) Cost of Education Materials and Campaign Tools

The quantities of education materials shown below are estimated amounts. They should be distributed in campaigns and workshops at target areas such as schools, communities, social and environmental promotion departments, etc.

Unit prices are based on the remarked specifications. However, these prices are subject to changes according to particular requirements and quality of the education materials.

Tools & Equipment	Qty.	Unit Price (US\$)	Total (US\$)	Remarks
Stickers (large)	5,000	0.45	2,250.00	Size 18x18cm, 4 colors, vinyl
Stickers (small)	10,000	0.25	2,500.00	Size 12x12cm, 4 colors, vinyl
Poster	5,000	2.00	10,000.00	Size 50x70cm
Textbook	10,000	3.80	38,000.00	Approx. 20 pages, full color
Educational Panel	10	350.00	3,500.00	Size 0.90x1.50m, 4 colors, foam panel, digital printing
Banner	10	200.00	2,000.00	Size 1.00x5.00m, 4 colors, vinyl
Leaflets	2,000	0.30	600.00	4 colors
Pamphlets	2,000	0.50	1,000.00	4 colors
Educational Video	Set		27,000.00	Approx. 10-15 min., includes some animation and computer graphic design
TV, Video Deck	Set		4,000.00	
Overhead Projector and Screen	Set		1,700.00	
Whiteboard	1	100.00	100.00	Size 1.00x1.50m
Others				According to the necessity
TOTAL			92,650.00	

Table 12.2-2Bill of Quantity for Environmental Education

12.3 Personnel Capability Building

12.3.1 Training of Local Administrative Personnel

Local administration agencies should themselves be concerned with the state of the environment and problems of all levels if they want personnel to be active and forward looking in organizing environmental education for community residents and schoolchildren. Policies that promote environmental education include the following attempts:

- Familiarizing personnel with updated information about local and regional environmental situations.
- Encouraging cooperation with other organizations outside the Agency to help with environmental education projects. These organizations may be universities where there are many experts in various fields, local and other national authorities, or non-governmental agencies, etc.
- Monitoring in order to reinforce the personnel's efforts or help solve some problems they may encounter.

The Secretariat of Coordination and Planning (SCP) staff have good organizational structure, which can be very helpful in environmental education campaigns and other matters in need of communal participation. Also, the local organizations are very useful in obtaining public participation in environmental activities, monitoring and evaluation.

(1) Training of Personnel

It is necessary to train government employees to cope with activities that require the residents' participation, by planning and holding a training program that aims at improving the explanation abilities and knowledge of the services.

Every administration agency should open up opportunities for their personnel. Since environmental education has increasingly become one of the most urgent requirement, all administrations should take action in adding on or highlighting their knowledge, so that the community residents are prepared to have environmentally positive behaviors and a good grasp of environmental concepts and concerns needed for meaningful actions. To do so effectively, administration personnel should be trained so they will be acquainted or updated with relevant information and techniques relating to the environment. They can accumulate new ideas and skills to use in their training or provide the residents with more information.

Basic environmental education should be based on the following concepts, ensuring sound environment and cultural life for the present and future inhabitants of the region:

- 1) Ensuring a good environment for the next generation.
- 2) Creating a community with sustainable development.
- 3) Maintaining the balance of the ecosystem to ensure a comfortable environment.
- 4) Promoting preservation of the regional environment under local and regional cooperation by utilizing the experience and technologies of this study.

To protect the environment as previously mentioned, it is essential that every one of the administrative personnel, from regular staff to top management, become aware of environmental problems and work together to solve them. To raise the personnel's abilities and knowledge on environmental issues, the following methods can be designed:

- **Training workshops.** To raise the personnel's knowledge in environmental issues in order to disseminate and promote environmental education activities among the public and gain support and participation from the community involved.
- Environmental paper presentation contest. To facilitate the exchange of environment-related technology and know-how within the administrative personnel, the administration agency should hold an environmental paper contest for the general public. Also, activity-based learning such as essays and illustrations contest can be promoted in schools.
- Environmental forums. Administration agencies must hold regular environmental forums, which include many activities such as special lectures of experts in all environmental fields, panel discussions, and presentations of case studies.
- Environmental awareness month. Designation of an annual environmental awareness month to promote environmental education activities and raise

environmental awareness among the public.



(2) Training Schedule

Time and duration of personnel training can vary according to the scope and details of the experience that the personnel are expected to gain from the training and their available time. If the trainees are already familiar with environmental concepts, they might need only short periods for training. For pilot projects, the training should be conducted before the implementation of the project.

What should be the duration of the training? This depends on the training content to be covered and on the available budget for training management. Planners of the training have to decide and select the possibilities best suited to each target group of personnel.

Resource persons from the community, governmental and non-governmental organizations and experts on environmental education should be invited to expand the trainees' visions and experiences. Issues related to people's life quality must be selected for discussion.

(3) **Preparation of Training**

Before training, besides the general preparation for the venue and necessary equipment, what personnel actually need to attain from the training workshop should be discussed. Prior to the discussion, personnel needs might be surveyed using questionnaires or group discussions. The training organizers then should set up a priority list of such needed content and skills. After consideration of all the specified needs and time availability, they can determine the training schedule, training venues, human resources to contact, materials and equipment to prepare for the personnel.

(4) Recommended Training Strategies

Experience gained through pilot projects implemented in Pelotas and Rio Grande suggested a variety of promising methods and techniques to be used for personnel training.

- 1) Using some illustrative media such as pictures, textbooks, educational panels and videos, and demonstrations to stimulate lectures in order to provide interesting local and regional environmental facts.
- 2) Designing innovative mini-projects or pilot projects selecting appropriate areas or communities to carry out these projects.
- 3) Designing environmental issues based on current news and actual cases.
- 4) Planning for follow-up activities and close monitoring after training workshops, pilot projects, etc. These activities would help lessen practical and experimental problems that occur during the project implementation.

12.4 Environmental Education Program

12.4.1 Guidelines to Develop Environmental Education Program

An educational program is dependent greatly from human activities and other characteristics marked by culture, values and the existent perceptions among the different components of the society. The following guidelines and premises are preliminary, keeping in mind that the environmental education for schools and community, including personnel training will have to be developed in detail by the Administration, with the assistance of governmental and non-governmental organization experts.

(1) General Objectives

To promote an environmental culture in the basin citizens of Patos Lagoon Mirim Lake, keeping in mind that is the people responsibility as generators of pollutants.

(2) Specific Objectives

- 1) To educate appropriate methods of environmental management and specially negative impacts in the health and the environment due to inadequate environmental management.
- 2) To promote the current school education environmental programs emphasizing the negative aspects and benefits of the appropriate environmental management in all education levels.
- 3) To foment the minimization of the generation of pollutants.
- 4) To inform permanently to the community about projects and proposals on environmental topics.
- 5) To train and upgrade Administration personnel and residents on the environmental issues.
- 6) To promote the community participation.

(3) Components

This objective has the purpose to aware the citizens about the environmental degradation and understands that people are the cause of the environmental deterioration and that is each individual's responsibility to manage the environment appropriately.

- Educate on environmental management
- Promote programs of environmental education in schools
- Promote environmental activities
- Foment the minimization of generators that deteriorate the environment
- Inform permanently to the community
- Training
- Promote the community participation

(4) Phases of Environmental Education Program

The different components of the education program would have the following phases:

- **Public awareness phase:** this phase create effective conditions so that the citizens can perceive the situation of the environmental management of the basin like a real problem, of which are part and in whose improvement should participate.
- **Information phase:** this phase diffuses the information to the different users, which are, focused this education program component on environmental management.
- Education phase: this phase seeks behavior changes in people to make environmental management sustainable; the education, training and upgrade of the human resources; the scholastic education; the community participation in various environmental projects; and others.
- Evaluation phase: this phase consists on the annual evaluation and at the

termination of project the fulfillment of its goals.

12.4.2 Executing Unit for the Program

It is proposed that the Administration agency with the cooperation of theSecretariat of Environment, the Secretariat of Public Education and other relevant organizations, to establish an executing unit to plan, delineate goals and strategies, advise the community and evaluate the education program regarding the environmental issues. This unit of central level will coordinate and assure the participation of all the delegation components of the basin.

12.4.3 Environmental Education Plan

The environmental education program presented in the previous Section provides guidelines and premises to develop this component. In this proposal shows objectives, components, phases and the executing unit.

In the following **Table 12.4-1**, environmental education program to be implemented in 2000 - 2010 period is summarized below.

Table 12.4-1

Environmental Education Program

Phase 1	Phase 2	Phase 3	
1999 - 2001	2002 - 2004	2005 - 2010	2011
 Establishment of Executing Unit Preparation of educational projects with the participation of relevant organizations Information to the community Public awareness and discussions Beginning of the educational program for specific areas (waste, wastewater, water pollution, deforestation, agricultural chemicals, etc.) Promotion of environmental education in schools 	 Intensive education in specific areas Training of personnel Promotion of environmental education at school Education through workshops 	 Continuation of training program Continuation of intensive education Follow-up of implemented projects Intermediate evaluation (2005) Intermediate readjustment of program 	 Final evaluation (2011) Readjustment to the environmental education program

12.5 Method for Personnel Capacity Building

This project aims at upgrading following capacity of government officials:

- Rich environmental background knowledge,
- Coordination skills for bringing different opinions to conclusion,
- Overall working efficiency.

Targets:

- Staff members of State government (both environment and development sectors)
- Staff members of municipalities.

Modalities:

On the job training of staff members

1) Staff exchange and secondment system

- Temporal exchange of staff members (ex. 12 months term) between municipalities and state government
- Temporal exchange of staff members between development and conservation sectors within state government.
- Secondment of staff members to international environmental organizations, international NGOs.

2) Knowledge sharing

• Multiplying mechanism of acquired knowledge other members of the division.

3) Site visits

- Opportunities of dialogue with end customers (residents)
- Visits to fields in trouble.

Off the job training of staff members

1) Ad hoc training

- Ad hoc seminars (ex. dialogue skills with residents, new legislation)
- Special training (ex. operation of machineries and computer software)

2) Qualified education

• Opportunities to attend Diploma courses at various levels (domestic and international)

Other measures for staff members

1) Incentive measures

- Incentives (ex. commendation, promotion, salary) to newly acquired qualifications.
- Paid leave for self-upgrading (several days annually with small budget)
- 2) Appropriate personnel allocation
 - Guidelines of required knowledge/skills according to job classification.

Measures for decision- makers

- Knowledge acquisition through personal channels (Advisory actions)
- Meeting opportunities with renowned world professionals (e.g. international conferences)
- Inspection tours (domestic and international)

CHAPTER 13

PROJECT IMPLEMENTATION PLAN

CHAPTER 13 PROJECT IMPLEMENTATION PLAN

13.1 Environmental Restoration and Conservation Plan for the Mar de Dentro Area

In accordance with the basic policies of the master plan components specified from Chapters 5 to 12, the program for the Environmental Restoration and Conservation Plan for the Mar de Dentro area was drawn as shown in **Table 13.1-1**. The program contains 12 sub-programs, each of which consists a selection of important projects and studies (including monitoring) on the restoration and preservation of the aquatic environment and wetland ecosystem (14 projects and 9 studies in total). The reason why there are quite a number of studies planned is because of the extensiveness of the target water area and basin, as well as the bad access conditions. On top of this, even with the combined results of this study and past studies, the environmental conditions in the target area are still not fully known.

The selected projects are what may be called as public works that will be implemented by the state and the municipalities within the limits of their respective budgets. None of these projects will involve investments from private corporations and landowners. For example, the "Cleaner Production Campaign" entails the study of economic measures that would provide private corporations with incentives, e.g. renewal of facilities, and the introduction of and extension of guidance in desirable production processes. Facility renewal, however, will be carried out by the corporation using its own funds. The "Promotion of an Environmental Conservation Oriented Agriculture" entails model project implementation and assessment and the preparation of optimum alternatives. The cost of the application will be the responsibility of the landowner.

Table 13.1-1 E	Environmental	Restoration 8	& Conservation	n Program fe	or the Mai	de Dentro Ar	rea
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Program	Sub-program	[Project Outline (Target Area)	Description & Objectives
1. Point Source	1.1 Domestic Load Reduction	1.1.1	Construction of domestic wastewater	Prevent eutrophication in the southern water section and coliform contamination in
Load Reduction	Measures		collection and treatment system	the southern coast of the Patos Lake through the expansion of municipal sewerage
			(Pelotas, Rio Grande, Sao Lourenco	network and construction of sewage treatment plant.
			do Sul, Tapes, Camaqua)	
	1.2 Industrial Load Reduction	1.2.1	Strengthening of industrial	Understand actual discharge of industrial load by creating an inventory on
	Measures		wastewater monitoring activities	industrial generation sources. Reduce discharge load by establishing the allowable
				discharge load.
		1.2.2	Promotion of Cleaner Production	Introduce desirable production processes by industrial type and extend guidance, to
			program	understand actual production processes. Study economic means that would act as
				incentives to improve production processes.
2. Non-point Source	2.1 Urban Load Reduction	2.1.1	Improvement of domestic solid waste	Reduce litters that become non-point source load in urban areas by establishing a
Load Reduction	Measures		collection and disposal system.	separate collection system, providing collection equipment, and construction a
			(Pelotas, Rio Grande, Sao Lourenco	sanitary landfill site.
			do Sul, Tapes, Camaqua)	
	2.2 Agricultural Load	2.2.1	Promotion Project of an	Establish an agricultural structure geared towards environmental conservation on a
	Reduction Measures		environmental conservation	trial and error basis at the priority area, to determine the effective prevention of the
			oriented agriculture	runoft of soil and type of nutrients, as well as improvements in land productivity, in
		-	(Cangucu area)	order to create a very suitable menu based on different conditions.
		2.2.2	Project for soil erosion and soil	Carry out on a trial and error basis soil runoff prevention works e.g.
			runoff prevention	afforestation/reforestation, in calchment areas considerably profile to soil runoff and
		211	(Sull and Duro rivers)	The river, to create the best menu under different conditions.
3. Wetland	3.1 Education on the Functions	3.1.1	Awareness and expansion project on	Plan and implement activities, hands-on training, etc. effective in promoting
Ecosystem	of a wetland Ecosystem		the functions of a wetland ecosystem	understanding of the use of wetlands and the ecosystem, in concert with the
Restoration &		201		Wetland committee and NGO.
Conservation	3.2 Conservation of wetlands	3.2.1	Conservation of Important wetlands	Convention, regulations will be developed and rouds will be improved
			(Del Rey welland, Camaqua Inverne ferret, San General, Paquena	Convention, regulations with be developed and roads with be improved.
			loke)	
A Establishment of	4.1 Establishment of a	411	Transfer of monitoring techniques	Transfer of techniques to the municipality through the formulation of manuals on
4. Establishment of	4.1 Establishment of a Monitoring System	4.1.1	mansier of monitoring techniques	observation and sampling as well as hands on training
a nyurological	Monitor ing System	412	Monitoring facility expansion project	Increase data reliability to determine the effectiveness of monitoring work by
Ouslity		4.1.2	monitoring facinty expansion project	nerviding the equipment for the surveys and observation works, and constructing
Monitoring				the facilities for analysis
System P				
ystem i		1		L

Program	Sub-program		Project Outline (Target Area)	Description & Objectives
5. Shared Use of	5.1 Shared Use of	5.1.1	Construction of an environmental	Select database items, standardize format, and promote mapping information by
Environmental	Environmental		information database.	GIS. The results will be published in the web site in cooperation with every sector
Information	Information			concerned.
6. Environmental	6.1 Promotion of	6.1.1	Dissemination of environmental	Dissemination of environmental education activities by planning and holding
Education and	Environmental Education		education activities	workshops.
Personnel		6.1.2	Expansion of environmental	Promote environmental education dissemination activities by providing the
Capacity			education facilities	necessary facilities, equipment, and educational texts.
Building	6.2 Personnel Capacity	6.2.1	Training of local administrative	Train government employees to cope with activities requiring resident
	Building		personnel	participation, by planning and holding a training program that aims to improve
				explanation skills and knowledge of the services.
7. Surveys and	7.1 Basic Surveys	7.1.1	Surveys on generation load per unit	Survey sewage discharge at the model area/plant, to determine domestic and
Monitoring		712	production	Industrial (main industries) per unit generation load.
		7.1.2	Surveys on actual contamination by	Analysis of agricultural chemical levels in bottom sediments and living organisms
		717	agricultural chemicals	In the Patos Lake, to determine actual contamination by agricultural chemicals.
		7.1.3	water quality monitoring of Patos	Carry out monitoring works for a long term to grasp water quality fluctuation for
		714	Water quality survey in the couthern	Composition of Palos Lake
1		7.1.4	water quanty survey in the southern	determine actual contamination in the couthern area of the Patos Lake
	7.2 Formulation of Plans	721	Survey for the formulation of the	Analysis of supoff load in the entire Mirim Lake basin including the section within
	7.2 For mulation of Flans	7.2.1	Mirim I ake water quality control	Analysis of funor load in the chine Minim Lake dashi, including the section within Unuquest in cooperation with the Minim Lake complities for the formulation of the
			nlan	Mirim Lake basin water quality management plan
		722	Survey for the formulation of the	Formulate a basin conservation plan for the Camagua River basin to reduce soil
		1.2.2	Camagua River basin conservation	and nutrient runoff into and in the river
			plan	
		7.2.3	Survey for the formulation of the	Formulate a basin conservation plan for the Piratini River basin, to reduce soil and
		1	Piratini River basin conservation	nutrient runoff into and in the river.
			plan	
7. Surveys and	7.2 Formulation of Plans	7.2.4	Survey for the formulation of the	Review the sewage treatment and basin conservation plan of PRO-GUAIBA to
Monitoring			Guaiba River basin water quality	formulate the N, P load reduction plan for Guaiba River basin, which is also
			management plan	considered to be very effective in preventing eutrophication in the Patos Lake.
		7.2.5	Survey for the formulation of the	Prevent contamination of surrounding water area by carrying out leachate
			Leachate prevention at the existing	prevention works at the existing disposal site.
			disposal site in Rio Grande	

Table 13.1-1 (Continuation)

Remarks: Gray column shows priority project and priority survey. Place names in parentheses show priority areas for project implementation.

13.2 Priority Projects

Of the projects outlined in **Table 13.1-1**, the "Cleaner Production Campaign" is very important to the Mar de Dentro area. The campaign however is considered effective if first implemented in the Guaiba River basin where many industrial point sources are situated. The training of government administrators would require that the state of Rio Grande do Sul first develop a standard training program that can be used for all state and municipal environmental administrators, and revise this to suit the Mar de Dentro area.

Of the 9 studies, the study on generation load per unit production is a fundamental study that should be carried out at the federal level. Also the studies for the formulation of the water quality control plan for Mirim Lake basin as well as for Guaiba River basin are both extremely important to the preservation of the water quality of the southern section of Patos Lake. Since Mirim Lake is under the jurisdiction of the federal government and countermeasures for Guaba River are being implemented under the PRO-GUAIBA PROGRAM, these agencies then should be mainly responsible for the planning and implementation of the studies.

Accordingly, the number of projects to be given priority and to be implemented in the Mar de Dentro area total 12, of which 6 are studies. Areas that will have a great impact on the preservation of the Patos and Mirim lake water quality and the wetlands will be given priority in terms of project implementation. The implementation areas of the priority projects are shown in **Fig.13.2-1**.



13.3 Implementation Schedule

Projects that involve facility construction are generally implemented according to the following stages: preparatory stage, master plan study, feasibility study, fund procurement. Of the priority projects selected in the previous section, those that involve facility construction will commence from the feasibility study stage as the master plan is already covered under this study. An implementation schedule most suited to each priority project was studied in consideration of the time each study stage would require and the target year specified in Chapter 4 (see **Fig. 13.3-1**).

Project /Targe	et Area	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1.1.1 Construction of E water Collection	Domestic Waste- and Treatment										
system											
Pelotas											
Rio Grande			I								
Sao Lourenco	do Sul										
Camaqua											
Tapes											
1.2.1 Strengthening of water Monitoring	Industrial Waste- g Activities		• • • •								
2.1.1 Construction of E	Domestic Solid										
Waste Disposal Sy	ystem		1								
Pelotas	•	• • • • • • • •	••••								
Rio Grande											
Sao Loureno	do Sul		* • • •							1	
Camaqua		• • • • • • • •	••••								
Tapes											
2.2.1 Promotion of Env	vironmental										
Conservation Ori Cangucu Dist	ented Agricultute				•						
2.2.2 Prevention of Soi	l Erosion and Soil										
Runoff											
Sutil and Dur	o Rivers		. .		•	-					
3.1.1 Education on the F	unction of a										
Wetland Ecosystem	n			<u> </u>							
3.1.1 Education on the F Wetland Ecosystem •••••• Study Installation etc.)	unction of a n •••• Fin ===== Oper	ancial Preparation & Mai	aration ef	tc.		Project I	mplement	ation (La	nd acquisi	tion, Co	nstructio
					THE STUDY ON THE ENVIRONMENTAL MANAGEMENT OF THE HYDROGRAPHIC BASIN OF PATOS AND MIRIM LAKES		Implem	Fig. 13.3-1			
					JA KOKUSALKO	PAN INTERNAT	FIONAL COOP	ERATION AGEN	CY	of th and Ir	ne Priority Proje

(Continued)

						THE STUDY ON	THE ENVIRONM	ENTAL MANAGE	MENT		Fig.13.3-1
Ii	nstallation etc.)	nancial Prepa ration & Mair	ration e itenance	tc.		roject In	nplementa	uon (Lan	u acquisitio	m, cons	struction,
7.2.5	Study on the Measures against Leachate in Rio Grande				-				,		
7.2.3	Study on the Integrated Management Plan of Piratini			•••••							
7.2.2	Study on the Integrated Management Plan of Camaqua										
7.1.4	Water Quality Monitoring for the Southern Area of Patos Lake			•		-					
7.1.3	Water Quality Monitoring for the Whole area of Patos Lake				• • • • • • •				• • • • • • • • •		
7.1.2	Study on the Contamination by Agricultural Chemicals			•							
6.1.2	Expansion of Environmental Education Facilities										
6.1.1	Promotion of an Environmental Education Activities										
5.1.1	Construction of an Environmental Information Database										
4.1.2	Expansion of Monitoring Facility										
4.1.1	Transfer of Monitoring Techniques										
	Sao Goncalo Canal Pequena Lake			• • • •	• • • •						
	Camaqua riverine forest										
	Dol Rei wetland										

13.4 Project Cost

(1) Generalities

The Project cost notified in the below is the total cost of the 7 components envisaged as priority projects in the environmental management framework of the Master Plan .

In each priority project, the cost is composed of the 3 parts: the initial cost for all related installations, their replacement cost and the annual O.M. cost for the operation and maintenance in each corresponding aspect during the project life.

At this stage of Master Plan, the estimates of these costs for each priority project are mainly made up by the corresponding expert-in-charge, based on the present general conditions and related assumptions for calculations.

All costs are regarded as official/economic prices as of January 2000 prevailing in Brazil, with the exchange rate of U.S. dollar at the following official rate:

$$US \$ 1.00 = R\$ 1.75$$

As for the preliminary reference purpose, at the moment, the costs mentioned below do not include contingencies, compensation measures etc., which will be specified at the stage of location determination for implementing design works.

From these above conditions, the figures on costs obtained from each priority project, therefore, will be correspondingly used in the economic analysis of the Master Plan, assuming that these figures are for the case of "With Project ". This means that, in case of "Without Project ", these figures will be made at zero or no corresponding values.

(2) Initial Costs of Priority Projects

From the conditions mentioned in the above, the initial costs of 7 priority projects were elaborated and summarized as follows:

Priority Project	Study etc. (US\$.000)	Land Acq (US\$.000)	Civil Work (US\$.000)	Equipment (US\$.000)	Initial Cost (US\$.000)
1. Sewage Treatment Project	0	505.0	6,240.0	23,725.00	30,470.00
					(46.14%)
2. Solid waste Disposal Project	205.87	251.13	6,032.66	2,303.07	8,792.73
					(13.32%)
3. Basin Conservation Project	100.00	240.0	10,900.00	800.00	12,040.00
					(18.23%)
4. Wetlands Management	830.00	2,400.0	6,815.00	3,217.00	13,262.00
Project					(20.08%)
5. Monitoring Project	371.59	0	0	968.00	1,339.59
					(2.03%)
6. Information Management	0	0	0	35.00	35.00
Project					(0.05%)
7. Environnemental Education	0	0	0	92.65	92.65
Project					(0.15%)
Total	1,507.46	3,396.13	29,987.66	31,140.72	66,031.97
Iotai	(2.29%)	(5.14%)	(45.41%)	(47.16%)	(100%)

Table 13.4-1	Initial Costs	of Priority Projects
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Source: Documents on project costs from corresponding experts in-charge.

The total initial cost for all 7 Priority Projects in the Master Plan, therefore, is estimated at a preliminary amount of US\$ 66,031,970 or about 66.05 million U.S. dollars. In terms of cost-share by population in the Study area, all 7 priority projects will need a cost of about 6.60 U.S dollars per inhabitant. And in terms of area coverage, a cost of about 123.5 U.S. dollars per square kilometer will be needed for the environmental management in the Study area.

Concerning the figures in the initial cost framework, the two items for equipment purchases (47.16%), and for construction works (45.41%) are found overhemingly predominant. Only these two items cover 92.57% of the total initial cost. At the moment, for land acquisition envisaged in 4 priority projects (Sewage Treatment, Solid waste Treatment, Basin Conservation Project and Wetland Conservation Project), an amount of about 3.4 million US dollars (or 5.14%) of the total initial cost will be used (mostly for the Wetland Conservation Project). And for the initial studies envisaged in 4 priority projects (Wetland Conservation Project, Basin Conservation Project, Solid waste Treatment and Monitoring Project), an amount of 1.51 million US dollars (or 2.29%) is estimated.

In consideration of individual priority projects, the priority project for domestic sewage treatment in 5 cities (Pelotas, Rio Grande, Camaqua, Sao Lorence do Sul and Tapes) is the most expensive one (about 30.5 million US dollars), covering almost one half (46.14%) of the total initial cost. On another hand, the initial cost for solid waste treatment project (sanitary landfill disposal) for these 5 cities would cost about 8.8 million US dollars (13.32 %). Meanwhile, the initial costs for wetland conservation project and basin conservation project are estimated at 13.26 million US dollars (20.08%) and 12.04 million US dollars (18.23%), respectively. These 4 priority projects share 97.77% of the total initial cost. For the remaining 3 priority projects (water quality monitoring, environmental education and information management), their total share is only 2.23% where both projects of environmental education project and information management project share just a tiny amount (about 130,000 US dollars), or only 0.2% of the total initial cost for all 7 priority projects.

(3) Estimation of O.M. Cost and Replacement Cost

Apart from the initial cost to be invested only at the initial stage in a short period, an annual O.M cost will be needed constantly for the operation and maintenance of all related facilities during the project life of 30 years envisaged for the Master Plan. Also a replacement cost will be needed for changing some parts/installations after a certain period of operation envisaged as 10 years for the Master Plan.

The O.M cost is mainly composed of the personnel cost and the costs of applied materials and activities for the operation and maintenance. In the Master Plan framework, some priority projects such as the environmental education program and the information management system, despite of their low initial costs, will have an annual O.M cost far higher than their initial costs.

The annual O.M. costs for 7 priority projects were elaborated and summarized as follows:

Priority Project	Annual O.M. (US\$ 000)	Remarks on O.M.costs
1. Sewage Treatment Project	2,468.00	For 5 sewerage treatment plants
	(37.28%)	
2. Solid waste Treatment Project	2,200.00	OM.cost: O.M for FDS + Recycle
	(33.23%)	For 5 Municipalities
3. Basin Conservation Project	496.00	Calculated as 3 % of Erosion Protect.
	(7.5%)	And 7 persons for basin conservation
4. Wetland Conservation Project	948.60	For 6 conservation projects/programs
	(14.33%)	
5. Water Monitoring Project	207.65	For 6 items of monitoring works
	(3.14%)	
6. Information Management System	150.00	For 4 persons with computer works
	(2.26%)	
7. Environmental Education Program	150.00	For 4 persons with car operations
	(2.26%)	
Total Appual O M. Cost	6,620.25	
Total Annual O.M. Cost	(100%)	

 Table 13.4-2
 Annual O.M. Costs For 7 Priority Project

The O.M. cost for all 7 Priority Projects of the Master Plan, therefore, is estimated at US\$ 6,620,250 or about 6.62 million U.S. dollars to be expended annually.

In comparison to the total initial cost (**about 66.05 million US \$**), the annual O.M cost (**about 6.62 million US \$**) is roughly at the level of 10 %. This level of O.M. cost is considered substantially proper.

Concerning the O.M. cost for each priority project, it is found basically proportional with the corresponding initial cost. The O.M cost for the sewage treatment project (5 plants) covers 37.28% of the total O.M. cost. It is followed by the O.M costs for solid waste treatment project in these 5 cities (33.23%). Due to the application of recycling, the O.M. cost for solid waste treatment is found high. For the wetland conservation project, its share is 14.33%. And the remaining 4 priority projects share only 15.16% of the whole O.M cost.

Apart from the above O.M cost to be expended on annual basis, a replacement cost for equipment will be envisaged during the project life of 30 years. For civil works to be mainly made as R.C.structures, there will be no prevision of replacement cost during the project life of 30 years. For equipment, one half of equipment applied in each priority project will be subjected to change after 10 years of operation.

13.5 Financing Plan

(1) Financing Alternatives

From the above financial figures, there will be two basic considerations on alternatives of financial source: 1) all 7 priority projects for local financial sources or 2) all 7 priority projects made in one package for one foreign financial source. But even in case of foreign financial source, except for very special cases, the annual O.M. cost and replacement costs during the project life, in principle, will be borne by the local side.

For the alternative of financial procurement for the initial cost through foreign source(s) with loan borrowing conditions and repayment terms, this approach will need basic negotiations for endorsement from the Federal Government. From the present situation of heavy repayment of foreign debts by the Federal Government (as notified in Chapter 12 of Supporting Report), the negotiations with the Federal Government for applying foreign loans for implementation would be hard.

For the alternative of domestic financial sources, from the rather large amount of initial investment cost (about 66.05 million U.S. dollars) and annual O.M. cost (about 6.62 million U.S. dollars), it is rather difficult to have all these 7 priority projects of diversified scopes being financed by a sole domestic financial source. Because this would cause a heavy burden for a sole financial source, even with the Federal Budget or State Budget.

In fact, as specified in the budgetary system of 3 layers with financial assistances for project investments in Brazil, there are still governmental budget frameworks to deal with the priority projects of small/medium scale, if so arranged.

The most available financing procedure, therefore, was made with the elaboration of financial procurement for each separate priority project. This is based on the specific characteristics of locality-service and its schedule envisaged for cost allocation of initial cost and O.M.cost etc.for each priority project to determine the possible financial source and, therefore, making the feasibility in financial procurement accordingly.

(2) Proposed Financial Procurement For Project Implementation

From the aforementioned procedure, the financial procurement for the Master Plan formulated by the 7 following components as priority projects with the specific objectives and locality services is elaborayed as follows:

No	Priority Project/Program	For Purpose/Objective	Locality-Service
1.	Sewage Treatment Project	For Treating the domestic sewage	For 5 main cities (Pelota,
			R.Grande,Camaqua, Tapes,
			Sao Lorence do Sul)
2.	Solid Waste Treatment Project	For Treat'g the domestic solid waste	For 5 above main cities
3.	Basin Conservation Project	To Prevent Erosion & Sedimention	For severe land parts only
4.	Wetland Conservation Project	For maintaining eco-resources	For 4 conservation areas
5.	Monitoring Project	To Check Water Quality etc.	For 6 monitorings in Patos
6.	Information Management Proj.	For integrated management of info.	For the whole Study area.
7.	Environmental Educatiom Prog.	For local environmental managm't	For the whole Study area

Table 13.5-1Specific Objectives and Locality Servicesof Priority Projects

Based on the above service scopes of the 7 priority projects, the corresponding financial procurement for each priority project, therefore, is proposed as follows:.

1. For the Sewage Treament Project in 5 Municipalities (Pelotas, Rio Grande, Camaqua, Tapes and Sao Laurence do Sul) and the Solid Waste Treatment System (Pelotas only), due to their specific locality services, this priority project, in principle, will be taken care by the local municipalities. However, due to their high initial costs, a portion i.e. 30% of the initial cost, therefore, is recommended for negotiations for financial assistance by the Federal Budget. The negotiations would be better to be carried out bilaterally between the State Government and the Federal Government.

The remaining portion (70%) of the initial construction cost will be arranged by the corresponding municipalities and SANEP (Pelotas) or CORSAN (for the remaining 4 cities) with their own capitals and moneys borrowed from Brazilian development bank(s). For the O.M. costs of these systems, the fee-collection for sewerage treatment from households subjected to the service is recommended. A sliding fee collection system is recommended.

2. For the priority project of Solid Waste Treatment in 5 main cities as above, the above financial procurement, in principle, will be applied with the main role of SENAP in Pelotas and corresponding Municipalities in other cities. The negotiations for financial assistances from the Federal Budget, if necessary, will be carried out in the same approach as mentioned above. Its cost details are notified in the Main Report and Supporting Report.
- 3. For the Basin Conservation Project, due to its specific environmental management scope for the related basins and private lands in the whole Study area, the basis of cost sharing i.e. in a ratio of 7:3 between the State Government and concerned landowners is recommended. Under this framework, the related Basin Committees will be in close cooperation with the subjected landowners for realizing the erosion protection works. EMATER and EMBRAPA, on another hand, will be engaged in the implementation of eco-agriculture. In case of controlling pollution sources, FEPAM presently under the titular of SEMA has the basic responsibilities as up to now. FEPAM, therefore, is recommended for taking in charge of implementation a strict checking system, particularly for industrial and mining enterprises. The initial cost and O.M. cost of this Project on the basis of cost-sharing are recommended to be borne by State budget or, upon possible negotiations, the financial assistance from Federal budget.
- 4. For the priority project of Wetland Conservation (made in 5 related projects/programs), due to its local scope services, the initial cost as well as the O.M. cost are recommended to be basically financed by the State budget for transferring to SEMA to carry out these projects/programs through the concerned organizations. Lagoa de Peixe, however, should be under the federal management.
- 5. For the Water Quality Monitoring Project, if this causes a great burden for the State Budget, the initial cost for setting monitoring instruments and studies, as well as the annual O.M. cost for its 6 monitoring activities are basically recommended to be mainly borne by the Federal Budget. This is based on its scope of environmental managent for the national largest lagoon-typed lake. This Priority Project, however, would be entrusted to FURG and concerned municipalities for taking in charge of implementation.
- 6. Concerning the Information Management Project, due to its objective of information integration for a better control, the actual Programa Mar de Dentro with its prevailing facilities is recommended to take care of this priority project. The initial cost for installing equipment etc, as well as the O.M. cost for this program, in principle, will be borne by the State accordingly.
- 7. For the Environmental Education Program, due to its scope of operation in State and each Municipality, FEPAM and the Municipalities will be in collaboration for implementation. FEPAM, however, will be in charge of the main position for making materials and sending persons-in-charge to each Municipality to conduct

the program. Municipalities will provide program-persons, meeting /working preparations in localities, room/equipment etc.for proceeding the program.

The financial procurement plan proposed in the above is summarized as follows:

	1			1	
		Estimate	d Costs	Proposed F	Financial Source
	Priority Project/Program	Initial Investment (US\$ 000)	Annual O.M. (US\$000)	Initial Investment	Annual O.M. Cost
1.	Sewage Treatment	30,470.00	2,468.00	Municip + Federal	Municipality (by fee
2.	Project Solid Waste Treatment	8,792.73	2,200.00	financial assist. Municip + Union	collection from users) Municipial tax
3.	Basin Conservation Project	12,040.00	496.00	State > Basin.Com. FEPAM + Landows	State > Basin Com. FEPAM+ Landowners
4.	Wetland Conservation	13,262.00	948.60	State > SEMA>	State > SEMA >
5.	Monitoring Project	1,339.59	207.65	Federal > State > FURG & Municip.	Federal > State > FURG & Related Mun.
6.	Information	35.00	150.00	State (Mar de Dentro)	State (Mar de Dentro)
	Management Project			, , , , , , , , , , , , , , , , , , ,	, , , , , , , , , , , , , , , , , , ,
7.	Environmental	92.65	150.00	FEPAM +Municip.	FEPAM+Municip.
	Education Project				
	Total	66,031.97	6,620.25		

 Table 13.5-2
 Financial Procurement Plan

13.6 Disbursement Schedule

(1) Disbursement Schedule for Initial Cost

Based on the cost documents from the experts-in-charge, the cost allocation or disbursement schedule of the initial cost for all 7 priority projects of the Master Plan was tabulated accordingly.

This disbursement schedule is based on the assumption that the related studies and land acquisitions for all priority projects will be done completely in 2002. As for the basic support of all other priority projects, the establishment of facilities for the 2 priority projects of environmental education and information management system will be completed by the end of this year also.

Except for the basin conservation project (erosion protection works) and the sewage treatment project, the construction/installation works for other priority projects will be done in 2 years, 2003 and 2004. An equivalent cost per year for both civil works and equipment is applied accordingly.

The sewage treatment plants will need a construction period of 4 years, from 2003 to2007, for completion. An equivalent cost per year is applied throughout the 4-year construction/installation period.

The construction works for the basin conservation project will be started from 2003 for the Cangucu portion at first and, after 2 years, from 2005 for the Sutil-Duro portion. Each portion will be constructed in a 4-year period.

Year	Sewage Treatmt	Solid waste	Basin Cons.	Wetland Conserv.	Monitor- ing	Info Manag	Envir Educat.	Sub-total
1. 2002 2. 2003 3. 2004 4. 2005 5. 2006 6, 2007 7. 2008 33. 2034	470 7,500 7,500 7,500 7,500	457 4,168 4,168	340 3,225 2,425 2,500 2,500 525 525	3,230 5,016 5,016	372 484 484	35	93	4,997 20,393 19,593 10,000 10,000 525 525
Total	30,470	8,793	12,040	13,262	1,340	35	93	66.033

 Table 13.6-1
 The Disbursement Schedule for the Initial Cost

Source: Cost documents from corresponding experts in charge.

(2) Disbursement Schedule for Replacement Cost

As mentioned in the above, during the imposed project life of 30 years for all 7 priority projects, the replacement will be occurred for equipment only. The civil works will have no replacement during this period.

For the basin conservation project, however, due to no equipment cost is involved, there is no replacement cost in this project.

As mentioned in the above, the replacement of equipment will be assumingly done with a ratio of 50% after an operation period of 10 years. There will be 2 times of replacement cost during the project life of 30 years. This allocation, however, is made for evenly figuring the depenses in a general table. In fact, some parts of equipment would have a shorter or longer utilization period, or may not need replacement during the project life of 30 years.

Year	Sewage	Solid	Basin	Wetlamd	Monitor-	Info	Envir Educat	Sub-total
	-	waste	manag		ing	manag.	Educat.	
2002						17.5	46.5	64.00
2014 2015 2016 2017 2018 2019 2020 2021 2022	5931.25 5931.25	1151.5	400	1608.5	484			9575.25 5931.25 0 0 0 0 0 0 0 0 0
2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034	5931.25 5931.25	1151.5	400	1608.5	484	17.5	46.5	$\begin{array}{c} 64.00\\ 9575.25\\ 5931.25\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\$
Total	23,725	2,303	800	3,217	968	35	93	31,141

Table 13.6-2 Disbursement Schedule for Replacement Cost

Source: Cost documents from corresponding experts in charge.

(3) Disbursement Schedule for O.M. Cost

The O.M cost will be occurred on annual basis, along with the operation of the corresponding priority project after the completion of construction and installation works.

Except for the 2 priority projects, basin management and solid waste treatment, an equal figure for the annual O.M. cost was applied. For the solid waste treatment, an escalation in O.M cost was applied for the annual increase of treated solid wastes. For the basin management project, due to a implementation-delay of 2 years for the Sutil-Duro portion, there are variations in annual O.M. cost in the first years.

							((US\$ 000)
Year	Sewage	Solid	Basin	Wetland	Monitor-	Info	Envir	Sub-total
	211181	waste	Cons.		ing	manag	Educat.	~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~
2002	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	150	150	300
2004	0	2,200	60	450.0	0	150	150	3,010.00
2005	0	2,200	292	948.6	207.65	150	150	3,948.25
2006	0	2,200	368	948.6	207.65	150	150	4,024.25
2007	2,468	2,200	431	948.6	207.65	150	150	6,555.25
2008	2,468	2,200	447	948.6	207.65	150	150	6,571.25
2009	2,468	2,200	462	948.6	207.65	150	150	6,586.25
2010	2,468	2,200	462	948.6	207.65	150	150	6,586.25
2034	2,468	2,200	462	948.6	207.65	150	150	6,586.25
Total	69,104	68,200	13610	28,908	6,229.5	4,800	4,800	195651.5

 Table 13.6-3
 Disbursement Schedule for O.M. Cost

Source: Cost documents from corresponding experts in charge

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From this disbursement schedule, the O.M.cost per year and the total O.M.cost of each priority project for the whole project life, therefore, are identified respectively. In order to operate each priority project, the proposed organization(s) in charge shall arrange the corresponding amounts for each year to carry out properly the routine operation and maintenance works

CHAPTER 14

PROJECT EVALUATION

CHAPTER 14 PROJECT EVALUATION

14.1 Basic Justification of the Study

(1) Generalities

From the particular characteristics of an environmental management project as for this Project, the project evaluation proceedings will be specifically based on an approach for its ultimate purpose of environmental management. In this case, it will be firstly proceeded by a basic justification of the Study to confirm its essential necessity as well as its significance in environmental management for improving the present local socio-economic conditions. Thus, it will be followed by an economic analysis through the conventional cashflow calculation for economic analysis on related costs and benefits derived from the Master Plan components in order to determine whether the Master Plan implementation has an economic viability or not in the national economic point of view.

Besides, as for an environmental management project of this type, both the proceedings of basic justification and economic analysis will be mutually incorporated in the process for integrating the project justification procedure. The result from economic analysis, as *per se*, is mainly for the purpose of justifying or endorsing the basic justification result, based on the national economic point of view only.

Apart from the basic justification and the economic analysis mentioned above, the technical evaluation and the IEE (Initial Environmental Examination) of the Master Plan are subjected to carry out successively in an order to clearify these respective aspects in the framework of project evaluation, prior to a synthesis of all above evaluation subjects for finally making the Overall Evaluation.

Concerning the necessity of the Project in the present situation of a seriously deteriorated aquatic environment in Rio Grande do Sul, the Chapter 4 (Necessity and Basic Conditions of the Master Plan) has basically dealt with this core issue at large for realizing the disastrous consequences from this deteriorated situation. These adverse conditions in the aquatic environment have obviously inquired an integrated project on the aspect of environmental management for all related domains to be carried out in a large scale and at an early time as possible. The Project, therefore, has a dual purpose, firstly for the recuperation of the basic environmental conditions such as water quality

in Patos Lake etc. and, per consequent, for the final objective of improving the basic socio-economic conditions in the area.

However, in order to confirm whether the Study on Master Plan has sufficiently responded to this imposed necessity or not, a basic justification of the Study is basically needed. This justification, therefore, is carried out, based on the review of the project-components (made as priority projects) proposed in the Master Plan and the opinions on study results from concerned Brazilian organizations through the hearing inquiries carried out to them during the Study periods.

Besides, in the basic justification of the Study, along with the basic justification of the whole Master Plan, the basic justification of each project component (made as priority project) will be carried out orderly. These separate justification results will be used as references for the benefit identification and calculation proceedings for each priority project in the economic analysis to be carried out afterwards.

(2) Results from the Master Plan Study

Based on the identified conditions of natural and socio-economic settings in the Study, the causes of deteriorated aquatic environment in the Study area were confirmed and, in general, sorted out in two types, namely point-sources and non-point sources, accordingly. On this basis, the treatment measures are formulated separately as project components or priority projects to tackle the corresponding aspects.

For the pollution from point sources such as sewerages, solid wastes etc. into the aquatic environment in the Study area, the priority projects of sewerage treatment and solid waste treatment were envisaged accordingly. Meanwhile, for the pollution from non-point sources such as soil erosion, mining, agriculture etc. which is observed as carrying almost 80% of the pollutant loads into the aquatic environment in the Study area, the basin conservation project will mainly deal with this matter.

Depending on the scope and scale of service coverage of each envisaged priority project, the effective areas and the impacts to each aspect will be essentially varied.

In this framework, the Study has made up 7 priority projects for the Master Plan with related descriptions as follows:

Priority Project	For Purpose	Service Coverage
1. Domestic SewageTreatm't	For treating Domestic Sewage	For 5 main cities only
2. Solid waste Treatment	For keep'g Urban Sanitation	For 5 above cities
3. Basin Conservation	For reducing Erosion, Pollution	For severe erosions etc.
4. Wetland Management	For conserv'g Local Wetlands	For 5 conservat. programs
5. Water quality Monitoring	For checking Water Quality etc	For Patos Lake only
6. Information Management	For integrat'g Info. Control	For the whole Project
7. Environment.Education	For improv'g Envir. Knowledge	For the whole Study area

Table 14.1-17 Priority Projects for the Master Plan

(3) Justification of the Study

Firstly, concerning the justification on the formulation of components for the Master Plan, all 7 priority projects envisaged in the framework are considered basically indispensable for incorporatedly and mutually dealing with the imposed issue of environmental management in the Study area.

As the objective of the Study is for the purpose of recuperating the aquatic environment in the Study area, presently found in a very deteriorated situation, the priority projects envisaged in the Master Plan, as per each corresponding objective, shall contribute to the achievement of Master Plan targets. The Master Plan has envisaged 2 target years of 2010 and 2020, as medium-term and long-term, for the 2 main targets as shown in **Table 4.4-5**.

With the implementation of all these 7 priority projects together at the same time, obviously there will be substantial improvements for the following adverse aspects:

- 1. Depletion of fisheries resources
- 2. Shallowing of the navigation route by sedimentation
- 3. Pollution of the beaches
- 4. Degradation of eco system
- 5. Other adverse impacts to the regional socio-economy

The degrees of improvements in these aspects will be promptly identified and, in case of possibilities, tabulated as numeric figures of economic benefits for using in the economic analysis proceedings afterwards. The Master Plan formulation for the whole Project as mentioned above, therefore, is considered appropriate for solving these problems conformably.

As for the basic justification of separate priority projects, the preliminary results for each corresponding project are considered as follows:

- 1) Firstly, for the priority project of sewerage treatment in 5 main cities/ municipalities (Pelotas, Rio Grande, Camaqua, Sao Laurence do Sul and Tapes) of the Study area, the total service area covers more than half of its total population. This is the most basic project dealing with the pollution of point sources with an initial cost of more than 30 million US dollars and an annual O.M. cost of about 2.5 million US dollars. Though the investment cost and the annual O,M. cost for this priority project are considered high, the implementation of this priority project is basically indispensable. This project will definitely make a high impact in the recuperation of aquatic environment in Patos Lake and in the improvements of local socio-economic conditions in the area. The remaining 45 medium/small municipalities in the Study area, however, should be subjected to the scope of another project, i.e. throughout CORSAN, in the near future to cope with the modern living conditions. On another hand, the application of modified septic tank should be gradually promoted in a specific program of large scale for improving the basic living conditions in the rural areas.
- 2) For the priority project of solid waste treatment to be carried out through a combination of Sanitary Landfill with Recycling Center in 5 Municipalities (Pelotas, Rio Grande, Camaqua, Sao Lorence do Sul and Tapes) and an "Adopt a School" Program in Pelotas, this project is formulated in a proper direction of modern waste management. For this priority project, the initial cost is projected at about 8.8 million US dollars with an annual O.M cost of average 2.2 million US dollars. Its service area of 5 main cities covers a population of 600,000 in the Study area. On the aspect of costs and handling conveniences, it is still unknown for a comparison with the case of introduction of sorting machine(s) and a primary selection at home as being applied in some countries like Japan etc.. Besides, with the present situation of waste dumping grounds located very near resident areas in other municipalities in the Study area, their deplacement and proper re-construction are considered necessary also. Due to its rather small work scope, corresponding local municipalities are recommended to take care of this matter in their capabilities accordingly.
- 3) For the **priority project of basin conservation**, this project, in grosso modo, is composed of 2 demarcated parts with different tasks: 1) the protection works for areas of serious erosion and 2) the basin management program for pollution

controls in the remaining areas.

For the protection works in areas of serious erosion, the two works of Cangucu and Sutil-Duro for a total area of 50,000 ha, selected as the most erosion-affected area, will be carried out in the Study area. The main works are envisaged in terracing, farmland construction and no-tillage plantation. The initial cost is estimated at 10.8 million US dollars (or 216 US dollars per ha) with an annual O.M. cost of 328,000 US dollars (or about 6.6 US dollars per ha). In comparison to its high initial cost, the annual O.M cost is observed very low. This priority project is for the main purpose of preventing an annual amount of 1.15 million ton of erosion soil, assumingly causing the sedimentation and pollution as non-point source in Patos Lake. In comparison with the present amount of about 66 million tons of erosion soil per year calculated in the Study area, the priority project, therefore, is envisaged to solve this problem at the level of about 2 percents. On contrary to the inferiority on the aspect of sedimentation/pollution reduction, these protection works, however, can make a large profit by making 50,000 ha for a higher agricultural productivity.

In the framework of basin conservation project, the pollution control in the remaining areas shall be intensively carried out in 2 aspects, the control in urban areas as for point sources and the control in rural areas as for non-point sources. This program is made by a combination of strengthening both the institutional measures and the civil works/installations. For the control of point sources, along with the envisaged installation of domestic and industrial sewerage treatment plants, the systematic measures for a proper investigation program of the industrial effluents are envisaged. For the control of non-point sources, along with the construction of riparian buffer strips in subjected agricultural lands, the application of tillage system and a proper water management system will be properly realized. It is said that, in average, about 80% of the pollutant loads in Patos Lake are originated from the pollution of non-point sources, sharing a high percentage of TP. This priority project/program is envisaged to reduce 20% of the TP pollutants by promoting a policy for eco-agriculture by planting plants with less use of agro-chemicals in the agricultural land of the Study area. This program itself is very important and interesting in the scope of environmental conservation in the Study area. Through its planned scope, the initial cost of related works for this part is estimated at only 1.2 million US dollars. A corresponding amount of 172,000 US dollars is envisaged as annual O.M. cost for this important issue.

The total initial cost for the priority project of basin conservation, therefore, is 12.04 million US dollars with an annual O.M. cost of 496,000 US dollars. From its

basic importance in the task of environmental management in the whole Study area, this priority project is basically considered indispensable and, considering its work-scope and objectives, the related costs are considered not high.

- 4) For the priority project of wetland conservation in the Study area, 5 captioned conservation programs/projects are envisaged at local level. The related costs are envisaged at about 13.2 million U.S dollars as for the initial cost and about 950,000 US dollars as for the annual O.M.cost, respectively. This priority project envisages many related installations and operation-equipment in these subjected areas. These installations and operation equipment, if so being installed, can perform a significant support to the local conservation of natural properties and, at the same time, to the promotion of eco-tourism in the area. The profits from eco-tourism etc. in each conservation area could be revolved for using in the annual O.M. cost.
- 5) For the **priority project of monitoring water quality etc.**, this project, in a whole, is considered basically important for a periodical check of the aquatic environment mainly in Patos Lake in order to have a prompt protection from any pollution sources. The initial cost of this project is envisaged at about 1.35 million US dollars with an annual O.M. cost of 207,650 US dollars. The project, therefore, has an essential effect in eventually preventing the damages caused by various pollution sources to the local marine resources, beaching resorts, agriculture, wetland properties and the eco-system in Patos Lake as being frequently happened up to now.
- 6) For the priority project of information management, this project is considered indispensable for an integrated control of information and data on environmental management in the Study area. With the availability of working facilities of Programa Mar de Dentro, the project will be basically introduced in this program. A low initial cost of only 35,000 US dollars, therefore, is envisaged for the purchase of a working station (computer system) with related accessories, but an annual O.M. cost of 150,000 US dollars is considered necessary for a working staff of 4 persons. With the implementation of this priority project, the actual situation of uncontrolled data from various sources will be gradually solved and, as a matter of fact, the management of all data and information related to the environmental management and conservation in the Study area will be performed systematically and properly.

7) For the priority project of environmental education, despite of its coverage for the whole Study area of 50 municipalities, the initial cost of 92,650 US dollars for making related materials and an annual O.M. cost of 150,000 US dollars for a core working staff of 4 persons are needed. This program will substantially enhance the basic environmental knowledge in local inhabitants for an improvement in public health as well as in their daily living conditions.

The Study, however, has also other aspects to be taken into account at the stage of Project implementation as follows:

- (1). Initially, the Study framework is formulated to deal with the environmental conditions in both Patos and Mirim Lakes, but due to the implication of Mirim Lake to basins in Uruguai, the related studies were finally limited to Patos Lake only. The studies as well as measures for Mirim Lake, therefore, were not carried out to know the environmental impacts in order to envisage the related measures for the implications to the Study area.
- (2). As per the initial study-scope, the Master Plan of the Study was formulated for making up an environmental management plan in the Study area. Meanwhile, local inhabitants and concerned organizations in the Study area, through the related reporting sessions and seminars of the Study, have voiced their support for a Study plan with concrete measures for improving local basic living conditions. This matter, therefore, should be concerned in the following stage of related studies,
- (3). As for the linkage between the Study and Programa Mar de Dentro, both have been being developed in the same area of Southern Rio Grande do Sul. Basic collaborations have been mutually done between the two technical working groups for the ultimate purpose of improving the local environmental conditions recognized as seriously deteriorating at the moment. The local entities in the Study area, therefore, are reportedly expecting for the implementation of the priority projects.
- (4). Since the environmental implication to Patos Lake from the Northern part of Rio Grande do Sul is very large, assumingly supplying more than 2/3 of the pollutant load into Patos Lake. Therefore, the project of Pro Guaiba, on another hand, should achieve its objective of environmental management in this part for ensuring a proper aquatic environment in Guaiba Lagoon situated on the upper part of Patos Lake. Unless this fundamental condition on environmental management is

properly ensured, the execution of priority projects of the Master Plan for the Southern part alone will not be able to recuperate the aquatic environment in Patos Lake.

- (5). Basically, the priority projects of the Master Plan are mainly subjected to prevention measures for the pollution sources coming to Patos Lake such as effluents of domestic sewerages, erosion land and chemicals from agriculture, mining areas etc. Therefore, in the present framework of the Study, the matter of sludge precipitated up to now in Patos Lake was not taken into account. If an intensive clearing of precipitated sludge in Patos Lake is steady done along with the implementation of above priority projects, the pace of recuperation for the aquatic environment in Patos Lake will be definitively faster.
- (6). Besides, on the institutional aspect, there are indications on the inferiority in environmental management in the area at the moment. For instance, as per the present aspect of controlling navigation-security in Patos Lake, the Port Authority in Porto Alegre has been assigned for the task of management and maintenance of Patos Lake including the annual dredging of sediments for facilitating the navigation in this inland water area. This institutional framework, however, has caused the consequences in difficulties for other related public organizations to participate in the environmental management and conservation works for this water area. Concerning this aspect, the establishment of a proper institutional framework for the management of Patos Lake etc., therefore, is basically considered very necessary.
- (7). Patos Lake is the largest lagoon-typed lake in Brazil, largely influencing the salient features of ecology and socio-economy in this part of Rio Grande do Sul. According to the results of economic analysis showed in the below, its present utilization in navigation (500-600 ships per year) has only made a small economic contribution. Meanwhile, with the projected targets for improving its aquatic environment, other economic activities such as marine resources, beaching resorts, eco-tourism etc, will be steadily developed, offering huge economic contributions as evaluated in the economic analysis. The system of controlling water pollution in Patos Lake from the concerned sources, therefore, should be strictly proceeded accordingly.

14.2 Economic Evaluation

(1) Economic Evaluation Methodology

For the economic evaluation, the conventional economic analysis through proceedings of calculated project costs and benefits will be performed on the basis of an environmental management project. With the formation of a cashflow analysis for an essential project life of 30 years considered properly as for the full utilization period for civil works/structures and benefits in the Project, the figures of IRR, B/C and NPV will be obtained accordingly.

For the figures of costs, as mentioned in the previous chapter, these figures are basically obtained from the corresponding experts in charges. Meanwhile, for the figures on economic benefits to be used in the economic analysis, they are made up **through a simplified process of multi-criteria method with consensus-maximizing techniques** (ref. Environmental Economics , WB series 3) based on data/information collected from concerned officials/persons during the field surveys.

This valuation, in principle, is basically applied for this case of a large number of decision variables and complex causal interrelationships based on all the related basic factors and the assumption of a recuperation level of the water quality for securing a proper aquatic environment in Patos Lake as specified for the target years of 2010 and 2020, as well as the actual conditions of incomes or expenses derived from the related items.

Due to various limited circumstances in the basic surveys during the field studies for collecting sufficient data of the diversified benefit items as for this case, the valuation of the identified economic benefits by constructing a corresponding economic model for each benefit item for a more reliable numeric figure, therefore, was not possibly carried out.

The economic internal rate of return (IRR) is calculated by using the tabulated annual average benefits and the annually demarcated project costs, and used as an index in case of considering the economic viability. The IRR is defined by the following formula:

$$\sum_{t=1}^{t=T} \frac{C_t}{(1+R)^t} = \sum_{t=1}^{t=T} \frac{B_t}{(1+R)^t}$$

Where, T=	the last year of the project life,
Ct=	the annual economic cost flow of the project in year t,
Bt=	the annual benefit flow derived from the project in year t, and
R=	the economic Internal Rate of Return (IRR)

For the B/C (Benefit/Cost), this ratio is defined by the following formula:

$$B_{C} = \frac{\sum_{t=1}^{t=T} \frac{B_{t}}{(1 + R_{d})^{t}}}{\sum_{t=1}^{t=T} \frac{Comr}{(1 + R_{d})^{t}}}$$

Where, T=	the last year of the project life,
Com <i>r</i> =	the annual OM cost and replacement cost in year t,
Bt=	the annual benefit in year t, and
Rd=	a specific discount rate

For the NPV (Net Present Value), this figure shows the cash balance at the end of the project life calculated with a specific discount rate through the cashflow, normally at 10 % as applied in the basic case of economic analysis for this project.

Due to its mutually incorporated relation among all 7 subjected priority projects for making a whole project of environmental management in the Study aea, the economic analysis for separate priority projects, therefore, is considered basically nonsense. As a matter of fact, in this case, instead of separate economic evaluations for each priority project, the economic analysis of all 7 priority projects in the Master Plan as one unity is carried out accordingly.

As specified in the above, the figures resulted from the economic analysis for this project of environmental management, however, are generally used only for reference purposes in the national economic point of view. On this basis, even with their viability in impacts to the socio-economy, if so happened, they will not serve as decisive criteria figures for appraising the necessity of the project based on the opportunity cost in national economy as for other economic development–oriented projects.

The project costs and benefits of the Project are assumingly made for the case of

"With Project". This means, in case of "Without Project ", all these figures are set at nil (zero). The project costs mentioned in Chapter 13 are used as for the case of "With Project ", assuming the related project costs for "Without Project " are at nil (zero) also. Also for the figures of benefits used in the below evaluation proceedings, they are assumingly made as economic benefits, after the deduction of all related costs. At the end of project life of 30 years, there will be no salvage costs and benefits to be considered thereof.

(2) Identification of Economic Benefits

As for the economic benefits obtained from the implementation of the 7 priority projects of the Master Plan, the identification and valuation of the subjected economic benefits are subjects to be carried out accordingly.

As for the economic analysis of an environmental management project, the 2 following kinds of benefits are basically taken into account:

- 1. benefits from increased natural resources, and
- 2. benefits for decreasing expenses due to negative impacts.

Besides, the economic benefits are classified into 2 categories, the direct benefits and the indirect benefits. The direct benefits are benefits obtained directly from a priority project. And the indirect benefits are benefits come through a direct benefit or, in case of some institutional development projects, by assisting another priority project to achieve that benefit in direct type.

Based on these conditions, the scope of economic benefits covered by the implementation of the 7 priority projects, therefore, is firstly elaborated as follows:

- 1. Increase of marine resources incomes
- 2. Increase of beaching resorts incomes,
- 3. Increase of incomes from eco-tourism,
- 4. Increase of farmland incomes
- 5. Increase of land value and price of real estates
- 6. Increase of regional economic production

- 7. Increase of labor utilization
- 8. Decrease of annual cost for dredging sedimentation
- 9. Decrease of annual cost of caring public health
- 10. Decrease of financial assistances to marginal fishing families etc.

With the further elaboration of direct and indirect benefits in these aspects as per each corresponding priority project, the obtained results are summarized in the following table.

	1. Sewage	2.Solidwaste	3.Basin	4.Wetland	5.Monitor	6.Info.	7.Envir.
ProjectBenefit	Treatment	Treatment	Conservat'n	Conservat'n	Project	Managem't	Education
1.Marine							
Resources	DIRECT	DIRECT	DIRECT	DIRECT	Indirect	Indirect	Indirect
2.Beaching							
Resorts	DIRECT	DIRECT	DIRECT	DIRECT	Indirect	Indirect	Indirect
3.Eco-							
Tourism	DIRECT	DIRECT	DIRECT	DIRECT	Indirect	Indirect	Indirect
4.Farmland							
Income	na	Na	DIRECT	na	Indirect	Indirect	Indirect
5.Land & Real							
estates	Indirect	Indirect	Indirect	Indirect	Indirect	Indirect	Indirect
6.Regional							
Economy	Indirect	Indirect	Indirect	Indirect	Indirect	Indirect	Indirect
7.Job							
Generation	Indirect	Indirect	Indirect	Indirect	Indirect	Indirect	Indirect
8. Reduction							
of Dredg.cost	DIRECT	Indirect	DIRECT	Indirect	Indirect	Indirect	Indirect
9. Reduction							
of Health care	DIRECT	DIRECT	DIRECT	Indirect	Indirect	Indirect	Indirect
10. Reduction							
Finan. Assist.	DIRECT	Indirect	DIRECT	DIRECT	Indirect	Indirect	Indirect

Table 14.2-1Results on Direct and Indirect Benefits from the
Implementation of Priority Projects

From the above results, the 4 priority projects (sewage treatment, solid waste treatment, basin conservation and wetland conservation) are virtually found with the direct benefits; meanwhile, the 3 other priority projects of institutional development (monitoring project, environmental education and information management) have only indirect benefits.

Based on the aggregation analysis, the major direct benefits, therefore, are identified as follows:

- 1. Increase of marine resources
- 2. Increase of beaching resorts incomes,
- 3. Increase of incomes from eco-tourism,
- 4. Increase of agricultural production
- 5. Reduction of annual cost for dredging sedimentation
- 6. Reduction of annual cost for healthcare
- 7. Reduction of financial assistances to fishermen families

(3) Valuation of Economic Benefits

In this economic analysis, only the direct benefits are taken into account for the calculation of numeric figures to be used in the economic analysis. The calculation of these subjected economic benefits is based on the assumption of a projected recuperation level in the water quality of Patos Lake to be achieved by the target years of 2010 and 2020, and the actual and future conditions of incomes or expenses of the related items.

As mentioned in the above, the principle applied for deciding the numeric figures of economic benefits in this project is based on the multi-criteria method of consensus maximizing technique.

So far, there are five main forms of multi-criteria evaluation methods: aggregation, consensus-maximizing, lexicographic, graphical and concordance techniques (ref. Environmental Economics, WB series 3). In this case of a very large area to estimate the subjected figure, the technique of consensus maximization is helpful in attempting to globally estimate the objective by taking into account preferences across the different related groups for a large number of decision variables and complex causal inter-relationships.

This process is generally applied through a method ranking specific criteria in term of importance order to reveal the most overall index of importance. In this case, a simplified process for deciding the estimation on a benefit item is made up by the aggregation of individual preferences to form the most group consensus based on discussions about the present situation and the envisaged future based on the recuperation level of the aquatic environment etc. as defined by the target years of 2010

and 2020.

The preliminary results from this valuation process for the subjected benefit-items are observed as follows

For the increased economic benefits from marine resources, beaching resorts and eco-tourism (as direct benefits from 4 priority projects), based on the consensus maximization of different related groups (concerned officials e.g. IBAMA, Secretaria de Turismo and persons/groups e.g. local fishermen association, hotel persons, tourist officers), a double increase from the present situation in these aspects would be obtained after 20 years of project operation. This means that, in satisfaction of all projected factors, an annual increase rate of 5% from the present situation is possibly obtained.

- (1) For marine resources, this estimation is made up that, in condition of the projected recuperation pace of aquatic environment, the volume of marine resources after 20 years of project operation would be equivalent to the lowest annual catch in the timing of 20 years ago. The annual amount of fish catch in Patos Lake is presently estimated at 15,000 tons with an envisaged economic net profit of 1,000 US dollars per ton.
- (2) For the benefits on beaching resorts, based on the projection of sewage treatment plants and solid wastes sanitary disposals in the 5 resort municipalities and the local capacities for reception, the number of beaching visitors after 20 years of project operation would be double from the present situation. At present, according to statistical records, an estimated number of 200,000 persons are presently staying in resort hotels in the area for beaching through the year, offering a net economic profit of 40 US dollars per person.
- (3) For the benefit of eco-tourism, based on the projected frameworks of related priority projects (related promotion programs for eco-tourism i.e. one more person from each family in the Study area to participate into the eco-tourism at the target year of 2020) and the projection of improving local eco-tourist sites i.e. wetlands etc., a double volume of visitors from the present situation, therefore, would be obtained after 20 years of project operation. At present, an annual number of 400,000 persons are coming into the Study area as visitors, offering a net economic profit of 20 US dollars per person.

On another hand, for the economic benefits from **decreasing the present public healthcare cost and financial assistance to fishermen families** (as direct benefits from 3 priority projects), based on the consensus maximization of different related groups (concerned officials e.g. Secretaria de Saude and persons/groups e.g. local fishermen association) , in satisfaction of the projected environment, a half decrease from the present situation in these aspects would be obtained after 25 years of **project operation**. This means an annual rate of 2% from the present situation is elaborated.

- (1) For the benefit on reducing expenses for healthcare, the beneficiary population is estimated at 600,000 persons (for the 5 subjected municipalities in the Study area) along with an average annual cost of 10 US dollars for healthcare per person at present.
- (2) For the benefit on reducing the financial assistance to marginal fishermen families, the present financial assistance to marginal fishermen families is carried out for a number of 5,000 families with a financial assistance at 1,000 US dollars/family/year.

For the cost reduction of dredging sedimentation on navigation route, based on the scope of the Priority Project for erosion prevention and the present conditions of erosion in the area, only about 1.5% of the total erosion soil volume is subjected to prevention. An assumption of only 1.5 % decrease per year from the actual dredging cost (R\$ 3 million or roughly US \$ 1.5 million) is elaborated accordingly.

For the generation of economic benefits from a higher agricultural production, as the full economic benefit of agricultural productivity of a farmland unit is envisaged after 30 years of the project implementation, , an annual increase rate of 3.5% is possibly obtained.

From these above assumptions and elaborations, the related figures, therefore, are summarized as follows:

Economic Benefit	Present Conditions	Actual annual EcoSituation	Envisaged annual Increase rate
1.Marine Resources		@ 1,000 U\$/t	
	15,000 ton/year	15,000,000 US\$	5 %
2.Beaching Resorts		@ 40 U\$/person	
-	200,000 pers/y.	10,000,000 US\$	5 %
3.Eco- Tourism		@ 20 U\$/person	
	400,000 pers/y.	10,000,000 US\$	5 %
4. Farm Income	Nil	@300 US\$/ha	
(50,000 ha)		15,000,000 US\$	3.5%
4. Sediment. Reduction			
	R\$ 3 million/y.	1,5000,000 US\$	1.5 %
5. Medicinal cost. Reduction		@ 10 U\$/person	
	600,000 pers/y.	6,000,000 US\$	2 %
6.Financial AssistReduction		@ 1,000 U\$/fam.	
	5,000 families	5,000,000 US\$	2 %

Table 14.2-2 Conditions for Economic Benefits Calculation

On this basis, the economic benefits are made up for a start from 2005, after 2 years of project-implementation, in the cashflow of economic analysis for a project life of 30 years until 2034.

(4) Economic Analysis of the Project

The economic analysis judges the project viability in terms of direct contribution to the national economy by the project implementation.

From the annual disbursement of project costs and economic benefits mentioned in the above, the Basic Internal Rate of Return (IRR) was obtained at 13.10 % along with the ratio of B/C at 1.31 and the NPV at 31,735,700 (with the discount rate of 10%).

For the sensitivity analysis to cope with the risks would be happened when implementing the project, the three following typical cases are basically notified for the economic justification. (For other drastic cases, the analysis was also performed in the concerned file, but for reference purposes only)

- 1. Case 1: An increase of 10 % in costs
- 2. Case 2: A decrease of 10 % in benefits

3. Case 3: A combination of an increase of 10 % in costs and a decrease of 10 % in benefits

In these three cases of sensitivity analysis, the results are observed as follows:

Case 1: IRR= 11.99 %; B/C= 1.19; NPV= 21,586,040 Case 2: IRR= 11.88 %; B/C= 1.18; NPV= 18,412,470 Case 3: IRR= 10.80 %; B/C= 1.07; NPV= 8,262,810

The above economic analysis results are showed in the following **Tables 14.2-3** to **14.2-6**.

From the above results of economic evaluation, the Master Plan which covers the 7 subjected priority projects showed basically an economic viability for implementation. In the sensitivity analysis for the three above cases, the corresponding IRR figures implied also an economic viability, even for the worst case of 10-percent increase of costs combined with 10-percent decrease of benefits, a considerable IRR of 10.80 % could be obtained.

Table 14 2-3	Calculation of Economic Internal Rate of Return (Basic Case
	Calculation of Leonomic internal nate of neturn (Dasic Case

														(US\$ 000)
Project			Co	ost					Ben	etīt				
Year	Year	Initial Cost	Banl Cost	OMCant	Total	Marine	Beaching	Ecoturist	Farmland	Reducing	Health	Reducing	T . 1	Balance
Tear		initiai Cost	Rept. Cost	OMCOS	rotar	Resour.	Business	Income	Income	Sediment	Care	Subsidy	Total	
(Base	year)													
1	2002	4,997.00	0.00	0.00	4,997.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-4,997.00
2	2003	20,393.00	0.00	300.00	20,693.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-20,693.00
3	2004	19,593.00	0.00	3,010.00	22,603.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-22,603.00
4	2005	10,000.00	0.00	3,948.25	13,948.25	750.00	400.00	200.00	450.00	30.00	120.00	100.00	2,050.00	-11,898.25
5	2006	10,000.00	0.00	4,024.25	14,024.25	1,500.00	800.00	400.00	900.00	60.00	240.00	200.00	4,100.00	-9,924.25
6	2007	525.00	0.00	6,555.25	7,080.25	2,250.00	1,200.00	600.00	1,350.00	90.00	360.00	300.00	6,150.00	-930.25
7	2008	525.00	0.00	6,571.25	7,096.25	3,000.00	1,600.00	800.00	1,800.00	120.00	480.00	400.00	8,200.00	1,103.75
8	2009	0.00	0.00	6,586.25	6,586.25	3,750.00	2,000.00	1,000.00	2,250.00	150.00	600.00	500.00	10,250.00	3,663.75
9	2010	0.00	0.00	6,586.25	6,586.25	4,500.00	2,400.00	1,200.00	2,700.00	180.00	720.00	600.00	12,300.00	5,713.75
10	2011	0.00	0.00	6,586.25	6,586.25	5,250.00	2,800.00	1,400.00	3,150.00	210.00	840.00	700.00	14,350.00	7,763.75
11	2012	0.00	0.00	6,586.25	6,586.25	6,000.00	3,200.00	1,600.00	3,600.00	240.00	960.00	800.00	16,400.00	9,813.75
12	2013	0.00	64.00	6,586.25	6,650.25	6,750.00	3,600.00	1,800.00	4,050.00	270.00	1,080.00	900.00	18,450.00	11,799.75
13	2014	0.00	9,575.25	6,586.25	16,161.50	7,500.00	4,000.00	2,000.00	4,500.00	300.00	1,200.00	1,000.00	20,500.00	4,338.50
14	2015	0.00	5,931.25	6,586.25	12,517.50	8,250.00	4,400.00	2,200.00	4,950.00	330.00	1,320.00	1,100.00	22,550.00	10,032.50
15	2016	0.00	0.00	6,586.25	6,586.25	9,000.00	4,800.00	2,400.00	5,400.00	360.00	1,440.00	1,200.00	24,600.00	18,013.75
16	2017	0.00	0.00	6,586.25	6,586.25	9,750.00	5,200.00	2,600.00	5,850.00	390.00	1,560.00	1,300.00	26,650.00	20,063.75
17	2018	0.00	0.00	6,586.25	6,586.25	10,500.00	5,600.00	2,800.00	6,300.00	420.00	1,680.00	1,400.00	28,700.00	22,113.75
18	2019	0.00	0.00	6,586.25	6,586.25	11,250.00	6,000.00	3,000.00	6,750.00	450.00	1,800.00	1,500.00	30,750.00	24,163.75
19	2020	0.00	0.00	6,586.25	6,586.25	12,000.00	6,400.00	3,200.00	7,200.00	480.00	1,920.00	1,600.00	32,800.00	26,213.75
20	2021	0.00	0.00	6,586.25	6,586.25	12,750.00	6,800.00	3,400.00	7,650.00	510.00	2,040.00	1,700.00	34,850.00	28,263.75
21	2022	0.00	0.00	6,586.25	6,586.25	13,500.00	7,200.00	3,600.00	8,100.00	540.00	2,160.00	1,800.00	36,900.00	30,313.75
22	2023	0.00	64.00	6,586.25	6,650.25	14,250.00	7,600.00	3,800.00	8,550.00	570.00	2,280.00	1,900.00	38,950.00	32,299.75
23	2024	0.00	9,575.25	6,586.25	16,161.50	15,000.00	8,000.00	4,000.00	9,000.00	600.00	2,400.00	2,000.00	41,000.00	24,838.50
24	2025	0.00	5,931.25	6,586.25	12,517.50	15,750.00	8,400.00	4,200.00	9,450.00	630.00	2,520.00	2,100.00	43,050.00	30,532.50
25	2026	0.00	0.00	6,586.25	6,586.25	16,500.00	8,800.00	4,400.00	9,900.00	660.00	2,640.00	2,200.00	45,100.00	38,513.75
26	2027	0.00	0.00	6,586.25	6,586.25	17,250.00	9,200.00	4,600.00	10,350.00	690.00	2,760.00	2,300.00	47,150.00	40,563.75
27	2028	0.00	0.00	6,586.25	6,586.25	18,000.00	9,600.00	4,800.00	10,800.00	720.00	2,880.00	2,400.00	49,200.00	42,613.75
28	2029	0.00	0.00	6,586.25	6,586.25	18,750.00	10,000.00	5,000.00	11,250.00	750.00	3,000.00	2,500.00	51,250.00	44,663.75
29	2030	0.00	0.00	6,586.25	6,586.25	19,500.00	10,400.00	5,200.00	11,700.00	780.00	3,120.00	2,600.00	53,300.00	46,713.75
30	2031	0.00	0.00	6,586.25	6,586.25	20,250.00	10,800.00	5,400.00	12,150.00	810.00	3,240.00	2,700.00	55,350.00	48,763.75
31	2032	0.00	0.00	6,586.25	6,586.25	21,000.00	11,200.00	5,600.00	12,600.00	840.00	3,360.00	2,800.00	57,400.00	50.813.75
32	2033	0.00	0.00	6,586.25	6,586.25	21,750.00	11,600.00	5,800.00	13,050.00	870.00	3,480.00	2,900.00	59,450.00	52,863.75
33	2034	0.00	0.00	6,586.25	6,586.25	22,500.00	12,000.00	6,000.00	13,500.00	900.00	3,600.00	3,000.00	61,500.00	54,913.75
To	tal	66,033.00	31,141.00	195,651.50	292,825.50	348,750.00	186,000.00	93.000.00	209.250.00	13,950.00	55,800.00	46,500,00	953,250,00	660,424,50

In the condition of discount rate at 10 %: Net Present value (NPV):

Internal rate of return (EIRR):

B/C

Cost	Benefit									
-	Base	-10 %	-20 %	-30 %						
Base	0.13	0.12	0.11	0.09						
+10 %	0.12	0.11	0.09	0.08						
+20 %	0.11	0.10	0.09	0.07						
+30 %	0.10	0.09	0.08	0.06						

101,496.58

1,906,500.00

1100 10

133,232.28 31,735.70 13.10%

1.31

														(US\$ '000)
Drojaat			Cu	ost		Benefit								
Voor	Year			014.0	The sector	Marine	Beaching	Ecoturist	Farmland	Reducing	Health	Reducing	Trad	Balance
reat		Initial Cost	Repl. Cost	UM Cost	Totai	Resour.	Business	Income	Income	Sediment	Care	Subsidy	rotai	
(Base	e year)													
1	2002	5,496.70	0.00	0.00	5,496.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-5,496.70
2	2003	22,432.30	0.00	330.00	22,762.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-22,762.30
3	2004	21,552.30	0.00	3,311.00	24,863.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-24,863.30
4	2005	11,000.00	0.00	4,343.08	15,343.08	750.00	400.00	200.00	450.00	30.00	120.00	100.00	2,050.00	-13,293.08
5	2006	11,000.00	0.00	4,426.68	15,426.68	1,500.00	800.00	400.00	900.00	60.00	240.00	200.00	4,100.00	-11,326.68
6	2007	577.50	0.00	7,210.78	7,788.28	2,250.00	1,200.00	600.00	1,350.00	90.00	360.00	300.00	6,150.00	-1,638.28
7	2008	577.50	0.00	7,228.38	7,805.88	3,000.00	1,600.00	800.00	1,800.00	120.00	480.00	400.00	8,200.00	394.12
8	2009	0.00	0.00	7,244.88	7,244.88	3,750.00	2,000.00	1,000.00	2,250.00	150.00	600.00	500.00	10,250.00	3,005.13
9	2010	0.00	0.00	7,244.88	7,244.88	4,500.00	2,400.00	1,200.00	2,700.00	180.00	720.00	600.00	12,300.00	5,055.13
10	2011	0.00	0.00	7,244.88	7,244.88	5,250.00	2,800.00	1,400.00	3,150.00	210.00	840.00	700.00	14,350.00	7,105.13
11	2012	0.00	0.00	7,244.88	7,244.88	6,000.00	3,200.00	1,600.00	3,600.00	240.00	960.00	800.00	16,400.00	9,155.13
12	2013	0.00	70.40	7,244.88	7,315.28	6,750.00	3,600.00	1,800.00	4,050.00	270.00	1,080.00	900.00	18,450.00	11,134.73
13	2014	0.00	10,532.78	7,244.88	17,777.65	7,500.00	4,000.00	2,000.00	4,500.00	300.00	1,200.00	1,000.00	20,500.00	2,722.35
14	2015	0.00	6,524.38	7,244.88	13,769.25	8,250.00	4,400.00	2,200.00	4,950.00	330.00	1,320.00	1,100.00	22,550.00	8,780.75
15	2016	0.00	0.00	7,244.88	7,244.88	9,000.00	4,800.00	2,400.00	5,400.00	360.00	1,440.00	1,200.00	24,600.00	17,355.13
16	2017	0.00	0.00	7,244.88	7,244.88	9,750.00	5,200.00	2,600.00	5,850.00	390.00	1,560.00	1,300.00	26,650.00	19,405.13
17	2018	0.00	0.00	7,244.88	7,244.88	10,500.00	5,600.00	2,800.00	6,300.00	420.00	1,680.00	1,400.00	28,700.00	21,455.13
18	2019	0.00	0.00	7,244.88	7,244.88	11,250.00	6,000.00	3,000.00	6,750.00	450.00	1,800.00	1,500.00	30,750.00	23,505.13
19	2020	0.00	0.00	7,244.88	7,244.88	12,000.00	6,400.00	3,200.00	7,200.00	480.00	1,920.00	1,600.00	32,800.00	25,555.13
20	2021	0.00	0.00	7,244.88	7,244.88	12,750.00	6,800.00	3,400.00	7,650.00	510.00	2,040.00	1,700.00	34,850.00	27,605.13
21	2022	0.00	0.00	7,244.88	7,244.88	13,500.00	7,200.00	3,600.00	8,100.00	540.00	2,160.00	1,800.00	36,900.00	29,655.13
22	2023	0.00	70.40	7,244.88	7,315.28	14,250.00	7,600.00	3,800.00	8,550.00	570.00	2,280.00	1,900.00	38,950.00	31,634.73
23	2024	0.00	10,532.78	7,244.88	17,777.65	15,000.00	8,000.00	4,000.00	9,000.00	600.00	2,400.00	2,000.00	41,000.00	23,222.35
24	2025	0.00	6,524.38	7,244.88	13,769.25	15,750.00	8,400.00	4,200.00	9,450.00	630.00	2,520.00	2,100.00	43,050.00	29,280.75
25	2026	0.00	0.00	7,244.88	7,244.88	16,500.00	8,800.00	4,400.00	9,900.00	660.00	2,640.00	2,200.00	45,100.00	37,855.13
26	2027	0.00	0.00	7,244.88	7,244.88	17,250.00	9,200.00	4,600.00	10,350.00	690.00	2,760.00	2,300.00	47,150.00	39,905.13
27	2028	0.00	0.00	7,244.88	7,244.88	18,000.00	9,600.00	4,800.00	10,800.00	720.00	2,880.00	2,400.00	49,200.00	41,955.13
28	2029	0.00	0.00	7,244.88	7,244.88	18,750.00	10,000.00	5,000.00	11,250.00	750.00	3,000.00	2,500.00	51,250.00	44,005.13
29	2030	0.00	0.00	7,244.88	7,244.88	19,500.00	10,400.00	5,200.00	11,700.00	780.00	3,120.00	2,600.00	53,300.00	46,055.13
30	2031	0.00	0.00	7,244.88	7,244.88	20,250.00	10,800.00	5,400.00	12,150.00	810.00	3,240.00	2,700.00	55,350.00	48,105.13
31	2032	0.00	0.00	7,244.88	7,244.88	21,000.00	11,200.00	5,600.00	12,600.00	840.00	3,360.00	2,800.00	57,400.00	50,155.13
32	2033	0.00	0.00	7,244.88	7,244.88	21,750.00	11,600.00	5,800.00	13,050.00	870.00	3,480.00	2,900.00	59,450.00	52,205.13
33	2034	0.00	0.00	7,244.88	7,244.88	22,500.00	12,000.00	6,000.00	13,500.00	900.00	3,600.00	3,000.00	61,500.00	54,255.13
Т	otal	72,636.30	34,255.10	215,216.65	322,108.05	348,750.00	186,000.00	93,000.00	209,250.00	13,950.00	55,800.00	46,500.00	953,250.00	631,141.95
In the c	ondition	of discount ra	ate at 10 %:											
Net Present value (NPV): 111,646.24 133,232.28 21,586.04										21,586.04				

Table 14.2-4	Calculation of Economic Internal Rate of Return (Case 1 of 10 % Increase of Cost	t)
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Net Present value (NPV):

Internal rate of return (EIRR): B/C

133,232.28 21,586.04 11.99% 1.19

14-19

								····						(US\$ '000)
Project		Cost Benefit												
Year	Year	Initial Cost	Repl. Cost	OM Cost	Total	Marine	Beaching	Ecoturist	Farmland	Reducing	Health	Reducing	Total	Balance
						Resour.	Business	Income	Income	Sediment	Care	Subsidy	TOTAL	
(Base	year)													
1	2002	4,997.00	0.00	0.00	4,997.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-4,997.00
2	2003	20,393.00	0.00	300.00	20,693.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-20,693.00
3	2004	19,593.00	0.00	3,010.00	22,603.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-22,603.00
4	2005	10,000.00	0.00	3,948.25	13,948.25	675.00	360.00	180.00	405.00	27.00	108.00	90.00	1,845.00	-12,103.25
5	2006	10,000.00	0.00	4,024.25	14,024.25	1,350.00	720.00	360.00	810.00	54.00	216.00	180.00	3,690.00	-10,334.25
6	2007	525.00	0.00	6,555.25	7,080.25	2,025.00	1,080.00	540.00	1,215.00	81.00	324.00	270.00	5,535.00	-1,545.25
7	2008	525.00	0.00	6,571.25	7,096.25	2,700.00	1,440.00	720.00	1,620.00	108.00	432.00	360.00	7,380.00	283.75
8	2009	0.00	0.00	6,586.25	6,586.25	3,375.00	1,800.00	900.00	2,025.00	135.00	540.00	450.00	9,225.00	2,638.75
9	2010	0.00	0.00	6,586.25	6,586.25	4,050.00	2,160.00	1,080.00	2,430.00	162.00	648.00	540.00	11,070.00	4,483.75
10	2011	0.00	0.00	6,586.25	6,586.25	4,725.00	2,520.00	1,260.00	2,835.00	189.00	756.00	630.00	12,915.00	6.328.75
11	2012	0.00	0.00	6,586.25	6,586.25	5,400.00	2,880.00	1,440.00	3,240.00	216.00	864.00	720.00	14,760.00	8,173.75
12	2013	0.00	64.00	6,586.25	6,650.25	6,075.00	3,240.00	1,620.00	3,645.00	243.00	972.00	810.00	16,605.00	9,954,75
13	2014	0.00	9,575.25	6,586.25	16,161.50	6,750.00	3,600.00	1,800.00	4,050.00	270.00	1,080.00	900.00	18.450.00	2.288.50
14	2015	0.00	5,931.25	6,586.25	12,517.50	7,425.00	3,960.00	1,980.00	4,455.00	297.00	1,188.00	990.00	20.295.00	7.777.50
15	2016	0.00	0.00	6,586.25	6,586.25	8,100.00	4,320.00	2,160.00	4,860.00	324.00	1,296.00	1.080.00	22.140.00	15.553.75
16	2017	0.00	0.00	6,586.25	6,586.25	8,775.00	4,680.00	2,340.00	5,265.00	351.00	1,404.00	1,170.00	23,985,00	17 398 75
17	2018	0.00	0.00	6,586.25	6,586.25	9,450.00	5,040.00	2,520.00	5,670.00	378.00	1.512.00	1.260.00	25 830 00	19 243 75
18	2019	0.00	0.00	6,586.25	6,586.25	10,125.00	5,400.00	2,700.00	6.075.00	405.00	1.620.00	1.350.00	27 675 00	21.088.75
19	2020	0.00	0.00	6,586.25	6,586.25	10,800.00	5,760.00	2,880.00	6.480.00	432.00	1.728.00	1.440.00	29,520,00	22,000.15
20	2021	0.00	0.00	6,586.25	6,586.25	11,475.00	6,120.00	3,060.00	6.885.00	459.00	1.836.00	1.530.00	31 365 00	24 778 75
21	2022	0.00	0.00	6,586.25	6,586.25	12,150.00	6,480.00	3,240.00	7,290.00	486.00	1.944.00	1.620.00	33,210,00	26,623.75
22	2023	0.00	64.00	6,586.25	6.650.25	12,825.00	6.840.00	3.420.00	7.695.00	513.00	2 052 00	1 710 00	35,055,00	28,023.75
23	2024	0.00	9,575.25	6,586.25	16.161.50	13,500.00	7,200.00	3,600.00	8,100.00	540.00	2 160 00	1,800,00	36,900,00	20,404.75
24	2025	0.00	5,931.25	6,586.25	12.517.50	14,175.00	7.560.00	3.780.00	8,505.00	567.00	2,768,00	1,000.00	38 745 00	26,758.50
25	2026	0.00	0.00	6,586.25	6.586.25	14,850.00	7.920.00	3.960.00	8,910.00	594.00	2,200.00	1,020.00	40 590 00	34 003 75
26	2027	0.00	0.00	6.586.25	6 586 25	15,525,00	8,280,00	4 140 00	931500	621.00	2,376.00	2 070 00	40,370.00	35 848 75
27	2028	0.00	0.00	6.586.25	6,586,25	16.200.00	8,640.00	4 320 00	9 720 00	648.00	2,404.00	2,070.00	42,433.00	33,646.75
28	2029	0.00	0.00	6.586.25	6,586,25	16,875.00	9,000,00	4 500 00	10 125 00	675.00	2,392.00	2,100.00	44,280.00	20 528 75
29	2030	0.00	0.00	6.586.25	6 586 25	17 550 00	9 360 00	4 680 00	10,530,00	702.00	2,700.00	2,250.00	40,125.00	11 292 75
30	2031	0.00	0.00	6.586.25	6 586 25	18,225,00	9 720 00	4 860 00	10,935.00	729.00	2,000.00	2,340.00	47,970.00	41,303.73
31	2032	0.00	0.00	6 586 25	6 586 25	18 900 00	10,080,00	5 040 00	11 340 00	729.00	2,910.00	2,430.00	49,013.00 51.660.00	43,228.73
32	2033	0.00	0.00	6 586 25	6 586 25	19 575 00	10,000.00	5,040.00	11 745 00	783.00	3 132 00	2,520.00	53,505,00	43,073.73
33	2034	0.00	0.00	6 586 25	6 586 25	20 250 00	10,440.00	5 400 00	12 150 00	810.00	3,152.00	2,010.00	55,503.00	40,918.73
 	<u></u> tal	66 033 00	31 141 00	195 651 50	292 825 50	313,875,00	167 400 00	83 700 00	188 325 (0)	12 555 (1)	50 220 00	41.850.00	23,330.00	40,703.75
In the co	ndition	of discourt r	ate at 10 %	175,051.50	2,2,023.30	515,075.00	107,400.00	35,700.00	100,525.00	12,353.00	50,220.00	41,000.00	637,923.00	
Net Pres	ent valu	e (NPV)	ac ut 10 /0.		101 496 58								110.000.05	18 413 47
	one rutu	·• (+ 14 + <i>j</i> -			101,70.00								113,303,03	18.412.47

Table 14.2-5 Calculation of Economic Internal Rate of Return (Case 2 of 10 % Decrease of Cost)

Net Present value (NPV):

Internal rate of return (EIRR): B/C

119,909.05 18,412.47 11.88%

1.18

														(US\$ '000)
Project			Co	ost	<u> </u>	Benefit								
Vear	Year	Initial Cost	Bank Cost	OM Cost	Total	Marine	Beaching	Ecoturist	Farmland	Reducing	Health	Reducing	T !	Balance
i cai		initiai Cost	Repi. Cost	OM COS	TOTAL	Resour.	Business	Income	Income	Sediment	Care	Subsidy	Total	
(Base	year)													
1	2002	5,496.70	0.00	0.00	5,496.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-5,496.70
2	2003	22,432.30	0.00	330.00	22,762.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-22,762.30
3	2004	21,552.30	0.00	3,311.00	24,863.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-24,863.30
4	2005	11,000.00	0.00	4,343.08	15,343.08	675.00	360.00	180.00	405.00	27.00	108.00	90.00	1,845.00	-13,498.08
5	2006	11,000.00	0.00	4,426.68	15,426.68	1,350.00	720.00	360.00	810.00	54.00	216.00	180.00	3,690.00	-11,736.68
6	2007	577.50	0.00	7,210.78	7,788.28	2,025.00	1,080.00	540.00	1,215.00	81.00	324.00	270.00	5,535.00	-2,253.28
7	2008	577.50	0.00	7,228.38	7,805.88	2,700.00	1,440.00	720.00	1,620.00	108.00	432.00	360.00	7,380.00	-425.88
8	2009	0.00	0.00	7,244.88	7,244.88	3,375.00	1,800.00	900.00	2,025.00	135.00	540.00	450.00	9,225.00	1,980.13
9	2010	0.00	0.00	7,244.88	7,244.88	4,050.00	2,160.00	1,080.00	2,430.00	162.00	648.00	540.00	11,070.00	3,825.13
10	2011	0.00	0.00	7,244.88	7,244.88	4,725.00	2,520.00	1,260.00	2,835.00	189.00	756.00	630.00	12,915.00	5,670.13
11	2012	0.00	0.00	7,244.88	7,244.88	5,400.00	2,880.00	1,440.00	3,240.00	216.00	864.00	720.00	14,760.00	7,515.13
12	2013	0.00	70.40	7,244.88	7,315.28	6,075.00	3,240.00	1,620.00	3,645.00	243.00	972.00	810.00	16,605.00	9,289.73
13	2014	0.00	10,532.78	7,244.88	17,777.65	6,750.00	3,600.00	1,800.00	4,050.00	270.00	1,080.00	900.00	18,450.00	672.35
14	2015	0.00	6,524.38	7,244.88	13,769.25	7,425.00	3,960.00	1,980.00	4,455.00	297.00	1,188.00	990.00	20,295.00	6,525.75
15	2016	0.00	0.00	7,244.88	7,244.88	8,100.00	4,320.00	2,160.00	4,860.00	324.00	1,296.00	1,080.00	22,140.00	14,895.13
16	2017	0.00	0.00	7,244.88	7,244.88	8,775.00	4,680.00	2,340.00	5,265.00	351.00	1,404.00	1,170.00	23,985.00	16,740.13
17	2018	0.00	0.00	7,244.88	7,244.88	9,450.00	5,040.00	2,520.00	5,670.00	378.00	1,512.00	1,260.00	25,830.00	18,585.13
18	2019	0.00	0.00	7,244.88	7,244.88	10,125.00	5,400.00	2,700.00	6,075.00	405.00	1,620.00	1,350.00	27,675.00	20,430.13
19	2020	0.00	0.00	7,244.88	7,244.88	10,800.00	5,760.00	2,880.00	6,480.00	432.00	1,728.00	1,440.00	29,520.00	22,275.13
20	2021	0.00	0.00	7,244.88	7,244.88	11,475.00	6,120.00	3,060.00	6,885.00	459.00	1,836.00	1,530.00	31,365.00	24,120.13
21	2022	0.00	0.00	7,244.88	7,244.88	12,150.00	6,480.00	3,240.00	7,290.00	486.00	1,944.00	1,620.00	33,210.00	25,965.13
22	2023	0.00	70.40	7,244.88	7,315.28	12,825.00	6,840.00	3,420.00	7,695.00	513.00	2,052.00	1,710.00	35,055.00	27,739.73
23	2024	0.00	10,532.78	7,244.88	17,777.65	13,500.00	7,200.00	3,600.00	8,100.00	540.00	2,160.00	1,800.00	36,900.00	19,122.35
24	2025	0.00	6,524.38	7,244.88	13,769.25	14,175.00	7,560.00	3,780.00	8,505.00	567.00	2,268.00	1,890.00	38,745.00	24,975.75
25	2026	0.00	0.00	7,244.88	7,244.88	14,850.00	7,920.00	3,960.00	8,910.00	594.00	2,376.00	1,980.00	40,590.00	33,345.13
26	2027	0.00	0.00	7,244.88	7,244.88	15,525.00	8,280.00	4,140.00	9,315.00	621.00	2,484.00	2,070.00	42,435.00	35,190.13
27	2028	0.00	0.00	7,244.88	7,244.88	16,200.00	8,640.00	4,320.00	9,720.00	648.00	2,592.00	2,160.00	44,280.00	37,035.13
28	2029	0.00	0.00	7,244.88	7,244.88	16,875.00	9,000.00	4,500.00	10,125.00	675.00	2,700.00	2,250.00	46,125.00	38,880.13
29	2030	0.00	0.00	7,244.88	7,244.88	17,550.00	9,360.00	4,680.00	10,530.00	702.00	2,808.00	2,340.00	47,970.00	40,725.13
30	2031	0.00	0.00	7,244.88	7,244.88	18,225.00	9,720.00	4,860.00	10,935.00	729.00	2,916.00	2,430.00	49,815.00	42,570.13
31	2032	0.00	0.00	7,244.88	7,244.88	18,900.00	10,080.00	5,040.00	11,340.00	756.00	3,024.00	2,520.00	51,660.00	44,415.13
32	2033	0.00	0.00	7,244.88	7,244.88	19,575.00	10,440.00	5,220.00	11,745.00	783.00	3,132.00	2,610.00	53,505.00	46,260.13
33	2034	0.00	0.00	7,244.88	7,244.88	20,250.00	10,800.00	5,400.00	12,150.00	810.00	3,240.00	2,700.00	55,350.00	48,105.13
То	tal	72,636.30	34,255.10	215,216.65	322,108.05	313,875.00	167,400.00	83,700.00	188,325.00	12,555.00	50,220.00	41,850.00	857,925.00	535,816.95
In he co	ndition	of discount ra	ate at 10 %:											
Net Present value (NPV): 111,646.24 119,909.05 8,262.81										8,262.81				

Table 14.2-6 Calculation of Economic Internal Rate of Return (Case 3 of 10 % Increase of Cost & 10 % Decrease of Cost)

Internal rate of return (EIRR):

B/C

10.80%

1.07

(5) Observations from Results of Economic Analysis

Through the results from economic evaluation, the observations are found as follows:

- (1) In general, a project of environmental management is often found in difficulty for offering an economic viability in implementation. However, thanks to the significant increases in economic benefits for marine resources, beaching resorts, eco-tourism etc. expected from the recuperated targets in aquatic environment of Patos Lake, the Master Plan, therefore, could offer an economic viability in implementation.
- (2) The share of economic benefits in marine resources is found as the highest. Meanwhile, the economic benefit for dredging sedimentation, on the contrary, is observed as the lowest. Besides, the economic benefits from a higher agricultural productivity, beaching resorts, eco-tourism, healthcare and reduction of fishermen subsidies showed high figures, respectively. This implies the order in economic importance come from these related sectors, where the developments for fishery and tourist activities should be regarded with high priorities. Along with the Master Plan implementation, preparations for these developments in private sector or third sector, therefore, are considered necessary also.
- (3) From the results of economic evaluation, the utilization for navigation in Patos Lake showed a low contribution to the regional economy in the Study area. Therefore, the navigation could be kept at the present conditions with more concerns on environmental conservation measures on this channel. From the envisaged erosion protection works, the present cost of dredging sedimentation could be reduced for only a very small amount i.e. 1 % per year as notified in the calculation.

Finally, it should be acknowledged that the results from the above economic analysis are merely made to justify the implementation of the Master Plan in the national economic point of view. With its implementation along with a proper project management, the intangible impacts in the socio-economic aspect come from a healthy society as resulted from the Master Plan implementation, could also make large contributions to the steady growth of regional economy in Rio Grande do Sul. These contributions, however, are not being showed in the above economic analysis.

14.3 Technical Evaluation

Brazil and the state of Rio Grande do Sul have actual experience in the technologies (both hard and soft) necessary for the implementation of the projects proposed in the master plan, hence no problems are expected to arise in terms of safety, reliability, and feasibility. As for the sewage treatment plant (oxidation ditch + wetland) and the sanitary landfill site, however, sufficient research on relevant conditions internally and abroad should be carried out during the feasibility study, in order to create a design that suits prevailing conditions in the area, as neither of these facilities have ever been constructed in Mar de Dentro.

As a non point source countermeasure consisting both mechanical and agronomical methods, "environmental conservation oriented agriculture" should be popularized in the whole basin area. Although the former method is already being practiced by the farmers, the latter still has and needs to be developed with due consideration of the conditions suitable to the area and production efficiency. The cooperation of relevant agricultural agencies in the state is strongly expected for the implementation of this countermeasure.

14.4 Environmental Impact Assessment

Since the projects proposed in the master plan were devised in the aim to restore and conserve the aquatic environment and the wetland ecosystem, there is a need to mitigate whatever adverse environmental impact they are expected to incur. However, for the sewage treatment project and solid waste disposal project for urban areas, localized adverse environmental impacts are likely if the management of the sewage treatment and solid waste disposal systems is inadequate, as these systems target to treat and dispose sewage and solid waste from numerous point sources at a designated area.

What is most feared that would result from the construction of the sewage treatment plant (oxidation ditch + wetland) proposed in the master plan is the generation of foul odor and insects. Accordingly, considerations should not only focus on the location of the facilities, but also the regular pump inspection, cleaning of wetlands, and cutting down of dead vegetation.

It is also highly likely that a waste disposal site would generate foul odor, leachate and litter, cause fire outbreaks, and breed large numbers of rodents, birds and insects, and is

therefore feared to ruin the scenery. The development is also considered to bring about noise and dust from the waste collection vehicles and the landfill equipment.

The master plan proposes the installation of gas removal and leachate treatment facilities in the landfill site. Although it is possible to control the adverse impacts to a minimum by selecting the site for the construction properly, appropriate implementation and management of construction work, it would also be necessary to plant trees outside the landfill site to act as a buffer zone and the frequent application of cover soil and spraying of insecticide.

14.5 Overall Evaluation

From the results of the aforementioned economic, technical and environmental evaluation activities, it is concluded that the implementation of the proposed master plan would be of considerably importance.

CHAPTER 15

RECOMMENDATIONS AND SUGGESTIONS

CHAPTER 15 RECOMMENDATIONS AND SUGGESTIONS

- (1) The master plan for water quality control in the Patos and Mirim lake area was formulated under this study, and mainly entails the strengthening of water quality monitoring activities and wetland preservation to attain the specified goals. The water quality control plan was originally intended to be formulated parallel with the water area/wetland/basin use plan and the regional economy development plan. None of these plans, however, have taken shape in the Mar de Dentro area. The state of Rio Grande do Sul should, as soon as possible, formulate a development plan in harmony with the master plan proposed herein in accordance with the basic policies of the Mar de Dentro Program, which was implemented to develop the characteristics and potential of the area in order to increase the income of and create job opportunities for the residents. The water quality standards, allowable inflow load and target reduction load stipulated in the master plan.
- (2) As over 80% of the inflow load in the Patos and Mirim lakes originates from non-point sources, a long term basin conservation measure for a vast area should be taken; the cooperation of the landowners is indispensable to the implementation of these measures. Under the traditional land ownership system in the state of Rio Grande do Sul, many areas are careless with the use of the land and landowners are really not that concerned about developing an environmental conservation oriented agriculture and soil erosion and runoff prevention measures. But for the implementation of non-point source countermeasures landowners should be made to understand that these will improve land productivity in the long run, and their cooperation in the implementation of the measures should be acquired
- (3) The actual production activities and wastewater and solid waste management conditions in the industrial point sources in the Mar de Dentro area are hardly determined. The industrial production output of the Mar de Dentro area is only about 1/10 of the entire state. In Rio Grande, there are large scale factories, therefore, wastewater is estimated to have quite an impact on the surrounding water area. Based on this, the actual production activities and wastewater and solid waste management conditions in the industrial point sources will be determined, and monitoring will be carried out to determine the water quality in surrounding water areas.

- (4) In the master plan, the concept adopted for the sewage treatment plan for Pelotas and Rio Grande and the solid waste management plan for Pelotas is very basic. To come up with concrete schemes, the implementation of a feasibility study is required. For the municipalities that were not covered, the state government is expected to formulate a basic plan using this master plan as a reference.
- (5) The runoff load from the Guaiba River basin makes up about 60% of the Patos Lake inflow load, and this is particularly evident in the northern half of the lake where eutrophication is reaching a critical level. At present, the runoff load from Guaiba River basin does not impact the southern water section. However, it is forecast to affect the area in the future and immediately raise the level of eutrophication as a result. Although this underscores the extreme importance of reducing nutrient salt loads in the Guaiba River basin, this is not covered at all in the PRO-GUAIBA Program. In the future, it is necessary to incorporate into the PRO-GUAIBA Program sewage treatment and basin conservation measures that would affect nutrient salt reduction.
- (6) For the implementation of the master plan proposed herein, the following should be simultaneously carried out: organizational strengthening, fund procurement, continuous studies and monitoring activities, effective use of available data, educational activities for the residents. The state of Rio Grande do Sul should hasten the implementation of the policies proposed in the master plan based on the experiences gained from the preceding PRO-GUAIBA Program. In addition, the state should also expedite the strengthening of the planning and coordinating functions of SEPMD, the executing secretariat for the Mar de Dentro Program.
- (7) The socio-economic conditions in the basin are subject to changes every year changes that are immediately reflected in the conditions of the water areas and the wetlands. The results of calculations using the runoff load simulation model, the hydraulic and water quality simulation model developed in this study, and the water quality monitoring results should be compared incessantly, to clearly identify the reasons for the changes in lake water quality and to establish more effective countermeasures.

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2-c2	P.Baisch	Heavy metals transport and accumulation in fluvial system	1999	FURG
		of subtropical zone (Sinos river, Southern Brazil)		
2-c3	FEPAM	Qualidade das Águas do Rio Caí – Período 1992/1997	1998	FEPAM
		Water Quality of Caí River – Period 1992/1997		
2-c4	GERCO/FEPAM/	Qualidade das Águas do Rio Gravataí – Período 1992/1994	1996	FEPAM
(P9-8)	GTZ	Water Quality of Gravataí River – Period 1992/1994		
2-c5	Haase, Janine and	Avaliação da qualidade dos recursos hidrográficos do	1998	FEPAM
	Vecchio, Gracianine	Guaíba, através da aplicação de um Índice de Qualidade da		
	Rocca	Água		
		Evaluation of the Guaíba hydrographic resources quality		
		through the application of a Water Quality Index		

2. Generation/Runoff Pollution Loads and Load Reduction Measures

No.	Author/Editor	Title	Year	Published by / Printed in
2- c6	FEPAM	Avaliação da Poluição Hídrica e Atmosférica em Áreas de	1998	FEPAM
		Mineração e Utilização de Carvão do Baixo Jacuí, RS		
		(Relatório Final)		
		Evaluation of Hydrological and Atmospheric Pollution in		
		Charcoal Mining and Utilization Areas in the Baixo Jacuí,		
		RS (Final Report)		
2-c7	FEPAM	Avaliação da Poluição Hídrica e Atmosférica em Áreas de	1997	FEPAM
(P9-1)		Mineração e Utilização de Carvão do Baixo Jacuí, RS, II		
		Parte		
		Evaluation of Hydrological and Atmospheric Pollution in		
		the Charcoal Mining and Utilization Areas of the		
		Downstream of Jacuí, RS, Part II		
2-c8	FEPAM	Avaliação da Poluição Hídrica e Atmosférica em Áreas de	1995	FEPAM
(P9-2)		Mineração e Utilização de Carvão do Baixo Jacuí, RS (III		
		Parte)		
		Evaluation of Hydrological and Atmospheric Pollution in		
		Charcoal Mining and Utilization Areas in the Downstream		
		of Jacuí, RS (Part III)		
2-c9	UFRGS	Avaliação Preliminar das Condições Ambientais da Bacia do	1995	UFRGS
		Arroio Dilúvio, em Porto Alegre/RS, com ênfase na		
		Qualidade da Água		
		Preliminary Evaluation of the Environmental Conditions of		
		the Dilúvio River Basin, in Porto Alegre/RS, focusing on the		
		Water Quality		
2-c10	UNISINOS/FURG/	Caracterização, Diagnóstico e Planejamento da Bacia de	1996	Ministério de Ciência e Tecnologia,
(P5-15)	UCPEL	Drenagem do Rio Camaquã, Relatório Final, Vol. I, Terceira		RS
		Parte		
		Characterization, Diagnosis and Planning of the Camaquã		
		River Drainage Basin, Final Report, Vol. I, Third Part		

No.	Author/Editor	Title	Year	Published by / Printed in
2-c11	Prefeitura do Porto	Programa Guaiba Vive	1997	Prefeitura do Porto
	Alegre			Alegre
2-c12	FEPAM	Qualidade das Águas da Bacia Hidrografica do Rio das	1999	FEPAM
		Antas & Rio Taquari – Período 1992/1997		
		Water Quality of Antas & Taquari River – Period 1992/1997		
2-c13	FEPAM	Qualidade das Águas do Rio dos Sinos – Período 1992/1997	1999	FEPAM
		Water Quality of Sinos River – Period 1992/1997		
2-c14	DMAE	Sistema Hidrico de Simulacao para a Propagacao de	1998	DMAE
		Poluentes Desenvolvio para Atender o Plano Diretor de		
		Esgotos de Porto Alegre		
(d) Mo	nitoring Network			
2-d1	SCP/FEPAM	Rede de Monitoramento Ambiental, Monitoramento das		SCP-RS
(P5-12)		águas Superficiais, Rio Gravataí		
		Environmental Monitoring Network, Monitoring of		
		Superficial Waters, Gravataí River		
2-d2	DMAE	Mapa dos Pontos de Coleta do Departamento Municipal de		
(P9-25)		Águas e Esgotos, Escala 1:100,000, com tabela do Guaíba,		
		trecho inferior com controle de qualidade da água		
		Map of the Collection Points of the Municipal Department		
		of Water Supply and Sewerage, Scale 1:100.000, with a		
		table of Guaíba, lower section with water quality control		

3. River and Basin Conditions

No.	Author / Editor	Title	Year	Published by / Printed in
(a) Bas	in Division			
3-a1	UNDP/FAO/CLM	Mapa com a Lagoa Mirim e seus afluentes (contribuintes)	1969	
(P6-2)		Escala 1:500.000		
		Map of the Mirim Lake and its tributaries		
		Scale 1:500,000		
3-a2	SCP	Proposta de Sub-divisão das Regiões Hidrográficas do	1996	SCP
(P6-3)		Estado, Criadas pela Lei Estadual 10350/94,		
		Escala 1:100.000		
		Proposal for the Sub-division of the State Hydrographic		
		Regions, Created by the State Law no. 10350/94,		
		Scale 1:100,000		
(b) Geo	ology		-	
3-b1	Departamento	Mapa Geológico do RGS (Escala 1:1.000.000)	1989	DNPM
(P6-6)	Nacional de	e parte do Escudo Sul – Riograndense, Escala 1:600.000		
	Produção Mineral	Geological Map of RGS (Scale 1:1,000,000) and part of the		
	National Department	South – Riograndense (Scale 1:600,000)		
	of Mineral			
	Production			
(c) Soil				
3-c1	N. GP. Cunha,	Geomorfologia, Solos e Capacidade de Uso das Terras do	1995	MA/EMBRAPA/CPACT
	R. J. C. Silveira	Município de Pedro Osório		
		Geomorphology, Soils and Capacity of Land Use of the		
		Pedro Osório Municipality		
3-c2	N. GP. Cunha,	Estudo dos Solos do Município de Arroio Grande	1996	MA/EMBRAPA/CPACT
	R. J. C. Silveira	Study of Soils of the Arroio Grande Municipality		
3-c3	N. GP. Cunha,	Estudo dos Solos do Município de Capão de Lero	1996	MA/EMBRAPA/CPACT
	R. J. C. Silveira	Study of Soils of the Capão de Lero Municipality		

No.	Author / Editor	Title	Year	Published by / Printed in
3-c4	N. GP. Cunha,	Estudo dos Solos do Município de Pelotas	1996	MA/EMBRAPA/CPACT
	R. J. C. Silveira	Study of Soils of the Pelotas Municipality		
3-c5	N. GP. Cunha,	Estudo dos Solos do Município de Herval	1996	MA/EMBRAPA/CPACT
	R. J. C. Silveira	Study of Soils of the Herval Municipality		
	C. R. S. Severo			
3-c6	N. GP. Cunha,	Estudo dos Solos do Município de Jaguarão	1996	MA/EMBRAPA/CPACT
	R. J. C. Silveira	Study of Soils of the Jaguarão Municipality		
	C. R. S. Severo			
3-c7	N. GP. Cunha,	Estudo dos Solos do Município de Rio Grande	1996	MA/EMBRAPA/CPACT
	R. J. C. Silveira	Study of Soils of the Rio Grande Municipality		
	C. R. S. Severo			
3-c8	N. GP. Cunha,	Estudo dos Solos do Município de Piratini	1998	MA/EMBRAPA/CPACT
	R. J. C. Silveira	Study of Soils of the Piratini Municipality		
	C. R. S. Severo			
3-c9	N. GP. Cunha,	Estudo dos Solos do Município de Canguçú	1998	MA/EMBRAPA/CPACT
	R. J. C. Silveira	Study of Soils of the Canguçú Municipality		
	C. R. S. Severo			
3-c10	N. GP. Cunha,	Caracterização dos Solos de São José do Norte, Tavares e	1997	MA/EMBRAPA/CPACT
		Mostarda		
		Characterization of Soils of São José do Norte, Tavares e		
		Mostarda		
3-c11	N. GP. Cunha,	Caracterização dos Solos de Morro Redondo	1997	MA/EMBRAPA/CPACT
	R. J. C. Silveira	Characterization of Soils of Morro Redondo		
	C. R. S. Severo			
3-c12	N. GP. Cunha,	Caracterização dos Solos de Santa Vitória do Palmar	1997	MA/EMBRAPA/CPACT
	R. J. C. Silveira	Characterization of Soils of Santa Vitória do Palmar		
	C. R. S. Severo			
3-c13	IBGE	Mapa Exploratorio de Solos (Escala 1:1,000,000)	1986	
		Explanation Map of Soil (Scale 1:1,000,000)		

No.	Author / Editor	Title	Year	Published by / Printed in
(d) Met	teorology			
3-d1	EMBRAPA	Médias Anuais Agroclimatológicas de Pelotas, 1961-1990		EMBRAPA
(P10-1)		Annual Average Agro-climatological Data of Pelotas,		
		1961-1990		
3-d2	DISME INMET	Registros Climatológicos de Superfície	1997	INMET
(P10-2)		Surface Climatological Records		
(e) Hyd	lrology			
3-e1	DNAEE	Inventario das Estações Pluviométricas	1996	DNAEE
(P9-22)		List of Rainfall Stations		
3-e2	DNAEE	Mapa (Location of Hydrographic Observation Stations)		DNAEE
(P9-24)		Map		
3-e3		O Descarregador de Cheias na Lagoa Mirim		
		The Flood Discharger in Mirim Lake		
(f) Lan	d-use			
3-f1	FEPAM	Mapa de Uso e Cobertura do Solo da Bacia Hidrográfica do	1996	PROJETO FEPAN/FNMA
(P6-8)		Rio Camaquã, Escala 1/250.000		
		Map of Land Use and Soil Coverage of the Camaquã River		
		Hydrographic Basin, Scale 1/250,000		
3-f2	FEPAM	Mapa de Uso e Cobertura do Solo da Bacia Hidrográfica do	1996	PROJETO FEPAN/FNMA
		Rio Camaquã		
		Map on Land Use and Soil Coverage of the Camaquã River		
		Hydrographic Basin		
3-f3	IBGE	Mapa de Capacidade de Uso dos Recursos Naturais	1986	IBGE
		Renovaveis		
		Map of Utilization Capacity of Natural Resources		

No.	Author / Editor	Title	Year	Published by / Printed in			
(g) Ag	(g) Agricultural Chemicals						
3-g1	PRO GUAIBA	Sistemas de Manejo e Controle da Contaminação por	1995	EMATER-RS			
		Agrotóxicos (Pro-Guaíba)					
		Systems of Management and Control of Contamination by					
		Agricultural chemicals					
(h) Ins	titutional Framework						
3-h1	Conselho de	Comites Instalados (Note)	1999				
	Recrusos						
	Hidricos-RS						
(i) Soil	Erosion						
3-i1	J.H. Stallings	Soil Conservation	1959				
3-i2	JICA	Final Report of the Feasibility Study on the Irrigation Project	1995				
		in Ruginesti-Pufesti-Panciu District Vrancea, Romania					
3-i3	JICA	Final Report of the Master Plan Study on Utilization of	1995				
		Water Resources in Parana State, Brazil					
3-i4	Ago Hideo and K.C.	The Proposal of Integrated Land Management with	1998	Journal of the Japanese Society of			
	Adriaan	Participatory Approach in Latin America (I),		Irrigation, Drainage and			
				Reclamation Engineering			
				(English version)			
3-i5	Ago Hideo and	The Proposal of Integrated Land Management with	1999	Journal of the Japanese Society of			
	Ogino Yoshihiko	Participatory Approach in Latin America (II) and (III)		Irrigation, Drainage and			
	_			Reclamation Engineering			
				(English version)			

4. Ecosystem and 5. Wetlands

No.	Author/Editor	Title	Year	Published by / Printed in
(a) Itap	ouã National Park			
4- a1	Bueno, O.L.	Fitossociologia e Florística da Vegetação Herbáceo-arbustiva da Praia de Fora. Parque Estadual de	1996	Ser. Bot., Porto Alegre, 47
		Itapuã, RS		
		Phytosociology and Floristics of the Herbaceous-shrubby		
		Vegetation of the Praia de Fora. Itapuã State Park, RS.		
4- a2	Silveira, N.	Flora da Restinga de Itapuã, Viamão, RS		Myrtaceae
		Itapuã Sandbank Flora, Viamão, RS		
4- a3	Bonotto, A.L.	Flora da Restinga de Itapuã, Viamão, RS		Rubiáceae
		Itapuã Sandbank Flora, Viamão, RS		
4- a4	Oliveira, M.A.A.	Flora da Restinga de Itapuã, Viamão, RS		Leguminosae
		Itapuã Sandbank Flora, Viamão, RS		
4- a5	Volkmer-Ribeiro, C.	Limnologia e a Vegetação de Macrófitas na Lagoa Negra,	1981	Ser. Bot., Porto Alegre, 27
		Parque Estadual de Itapuã, RS		
		Limnology and the Macrophyto Vegetation in the Lagoa		
		Negra, Itapuão State Park, RS		
4- a6	Callegaro, V.L.	Fitoplâncton da Lagoa Negra e de outras Lagoas e Lagunas,	1984	1º Seminário sobre Pesquisa da
		na Faixa Costeira do RS.		Lagoa dos Patos
		Phytoplankton of the Lagoa Negra and other Lakes and		
		Lagoons in the Coastal Area of RS		
4- a7	Oliveira, M.A.A.	Florística e Fitossociologia do Estrato Arbóreo-arbustivo da		
		Restinga da Praia de Fora, Parque Estadual de Itapuã,		
		Viamão, RS		
		Floristics and Phytosociology of the Arboreous-shrubby		
		Stratum of the Praia de Fora Sandbank, Itapuã State Park,		
		Viamão, RS		

No.	Author/Editor	Title	Year	Published by / Printed in
4- a8	Callegaro, V.L.M.	Diatomáceas da Lagoa Negra, Parque Estadual de Itapuã, RS, BR	1981	Ser. Bot., Porto Alegre, 27
		Diatomaceae of the Lagoa Negra, Itapuã State Park, RS, BR		
(b) Tai	m Ecological Station			
4- b1	Buckup, P.A.	A list of the fishes of the Taim Ecological Station, RS, Brazil.	1983	Ser. Zool., Porto Alegre, 63
4- b2	Gastal, H.O.	Entomofauna Terrestre da Estação Ecológica do Taim, RS <i>Terrestrial Entomofauna of the Taim Ecological Station, RS</i>	1991	Aeta Biologic Leopoldensia, 13-1
4- b3	Grosser, K.M.	Ocorrência e Distribuição de Peixes na Estação Ecológica do Taim, RS, Brasil Occurrence and Distribution of Fishes in the Taim Ecological Station, RS, Brazil	1994	Ser. Zool., Porto Alegre, 77
4- b4	Mansur, M.C.D.	Moluscos Bivalves Límnicos da Estação Ecológica do Taim e Áreas Adjacentes, RS Limnical Bivalved Shellfishes of the Taim Ecological Station and Neighboring Areas, RS	1991	Ser. Zool., Porto Alegre, 71
4- b5	Veitenheimer-Mende s, I.L.	Distribuição dos Moluscos Gastrópodes Límnicos na Estação Ecológica do Taim, RS, BR Distribution of Limnical Gastropod Shellfishes in the Taim Ecological Station, RS, BR		Zoologia
4- b6	Lopes-Pitoni, V.L.	Moluscos Terrestres na Estação Ecológica do Taim, RS, BR Terrestrial Shellfishes in the Taim Ecological Station, RS, BR		Zoologia
4- b7	Mansur, M.C.D.	Ocorrência e Densidade de <i>Corbicula fluminea</i> e <i>Neocorbicula limosa</i> na Estação Ecológica do Taim e Áreas Adjacentes, RS, BR Occurrence and Density of Corbicula fluminea and Neocorbicula limosa in the Taim Ecological Station and Neighboring Areas, RS, BR	1988	Ser. Zool., Porto Alegre, 68

No.	Author/Editor	Title	Year	Published by / Printed in
4- b8	Lobo, E.A.	Análise e Estrutura da Biocenose de Diatomáceas em	1992	Aeta Limnol. Brasil, IV
		Lagoas da Estação Ecológica do Taim, RS, BR		
		Analysis and Structure of the Diatomaceae Biocoenosis in		
		Lakes of the Taim Ecological Station, RS, BR		
4- b9	Werner, V.R.	Cyanophyceae da Estação Ecológica do Taim, RS, BR		Rev. Brasil. Biol., 52
		Cyanophyceae of the Taim Ecological Station, RS, BR		
4-b10	Silva, S.M.A.	Euglenaceae Pigmentadas da Estação Ecológica do Taim,	1988	Ser. Bot., Porto Alegre, 38
		RS, BR		
		Pigmented Euglenaceae of the Taim Ecological Station, RS,		
		BR		
4-b11	Rosa, Z.M.	Chrorococcales da Estação Ecológica do Taim, RS, BR	1989	FZB
		Chrorococcales of the Taim Ecological Station, RS, BR		
4-b12	Melo, M.T.Q.	Dieta de Caiman latorostris na Estação Ecológica do Taim,		Tese de Mestrado (Master Thesis)
		RS		
		Diet of the Caiman latorostris in the Taim Ecological		
		Station, RS		
4-b13	Verdade, L.M.	II Workshop sobre Conservação e Manejo do Jacaré-do-	1992	
		papo-amarelo (Caiman latirostris). Piracicaba.		
		II Workshop on the Conservation and Management of the		
		Jacaré-do-papo-amarelo (Caiman latirostris). Piracicaba.		
4-b14	Volkmer-Ribeiro, C.	Anheteromeyenia sheilae sp. n. e outras Esponjas	1988	Ser. Zool., Porto Alegre, 68
		Dulciaquícolas da Região Costeira do RS		
		Anheteromeyenia sheilae sp. n. and other Dulciaquicolous		
		Sponges of the RS Coastal Region		
4-b15	Reis, R.E.	Rineloricaria longicauda e R. quadrensis, Duas Novas	1983	Ser. Zool., Porto Alegre, 68
		Espécies de Loricariinae do Sul do Brasil		
		Rineloricaria longicauda and R. quadrensis, Two New		
		Loricariinae Species of the Southern Brazil		

No.	Author/Editor	Title	Year	Published by / Printed in
4-b16	Callegaro, V.L.M.	Diatomáceas das Lagoas do Jacaré, do Nicola e Mangueira,	1988	Ser. Bot., Porto Alegre, 38
		Estação Ecológica do Taim: Novas Ocorrências para o RS		
		Diatomaceae of the Jacaré, Nicola and Mangueira Lakes,		
		Taim Ecological Station: New Occurrences for RS		
4-b17	Azevedo, V.G.	Aspectos Ambientais Sistêmicos na Estação Ecológica do	1995	FURG
		Taim – RS, voltados a Ações de Modelagem Ecológica e		
		Manejo		
		Systemic Environmental Aspects in the Taim Ecological		
		Station - RS, oriented to Ecological Modeling and		
		Management Actions		
4-b18		Banhado do Taim: Sinfonia da Natureza		
		Taim Swamp: Symphony of Nature		
(c) Lag	una do Peixe			
4-c1	Danileviez, E.	Flora e Vegetação de Restinga na Barra da Laguna do	1989	Ser. Bot., Porto Alegre, 39
		Peixe, Tavares, RS: levantamento preliminar		
		Sandbank Flora and Vegetation in the Peixe Lagoon		
		Border, Tavares, RS: Preliminary Survey		
4-c2	CEMAVE/ IBAMA	Relatório das Atividades Desenvolvidas no Parque Nacional		
		da Lagoa do Peixe, RS. Anos 1993-1997		
		Report on the Activities Developed in the Peixe Lake		
		National Park, RS. Years 1993-1997		
4-c3	Werner, V.R.	Morphological Variability in <i>Gloeotrichia natans</i>		Rev. Brasil. Biol., 58
		rabenhorst		
		ex. Bornet et flahaut from Southern Brazil		
4-c4	Antas, P.T.Z.	Muda e Peso de Scolopacidae e Charadriidae Capturados na	1988	Anais do III ENAV
		Lagoa do Peixe, Tavares, RS, entre 1985 e 1987		
		Moulting Season and Weight of the Scolopacidae and		
		Charadriidae Captured in the Peixe Lake, Tavares, RS,		
		between 1985 and 1987		

No.	Author/Editor	Title	Year	Published by / Printed in
4-c5	Antas, P.T.Z.	Análise dos Dados de Anilhamento de Sterna hirundo na	1988	Anais do III ENAV
		Lagoa do Peixe, Tavares, RS		
		Analysis of "Anilhamento" (related to rings) Data of the		
		Sterna hirundo in the Peixe Lake, Tavares, RS		
4-c6	Cordeiro, P.H.C.	Trinta-reis-boreal (Sterna hirundo): Uma Análise das		PROAVES
		Recuperações entre 1980 e 1994		
		Trinta-reis-boreal (Sterna hirundo): An Analysis of the		
		Recoveries between 1980 and 1994		
4-c7	Macedo-Flôres, J.	Censos de Aves Migratórias Neárticas na Região Costeira		VII Congresso Brasileiro de
		do RS		Ornitologia
		Census of Neartic Migratory Birds in the Coastal Region of		
		RS		
4-c8	Danieleviez, E.	Flora e Vegetação de Restinga na Barra da Laguna do	1989	Ser. Bot. Porto Alegre, 39
		Peixe, Tavares, RS: Levantamento Preliminar		
		Sandbank Flora and Vegetation in the Peixe Lagoon		
		Border, Tavares, RS: Preliminary Survey		
(d) Lar	ni Biological Reserve			
4-d1	UFRGS	Levantamento Florístico Preliminar da Reserva Biológica	1979	
		do Lami, Porto Alegre, RS		
		Preliminary Floristic Survey of the Lami Biological		
		Reserve, Porto Alegre, RS		
(e) Tap	es and Arambaré			
4-e1	Malabarba, L.R.	Levantamento Preliminar da Abundância e Diversidade da	1984	1º Seminário sobre Pesquisa da
		Ictiofauna do Saco de Tapes, Laguna dos Patos, RS		Lagoa dos Patos.
		Preliminary Survey of the Abundance and Diversity of the		
		Ichthyofauna of the Tapes Bay, Patos Lagoon, RS		

No.	Author/Editor	Title	Year	Published by / Printed in
4-e2	Martin, E.V.	Estrutura das Comunidades de Aves Aquáticas no	1997	Tese de Mestrado(Master Thesis)
		Complexo de Areas Umidas de Tapes e Arambaré, Planície		
		Costeira do RS		
		Structure of the Aquatic Birds Communities in the Humid		
		Areas Complex of Tapes and Arambaré, Coastal Plain of RS		2
4-e3	Franciosi, M.B.B.	Variações Espaciais e Temporais das Populações de	1984	1º Seminário sobre Pesquisa da
		Cladocera no Saco de Tapes, Lagoa dos Patos, RS		Lagoa dos Patos.
		Spatial and Temporal Variations of the Cladocera		
		Populations in the Tapes Bay, Patos Lake, RS		
4-e4	Vélez, E.	Estrutura das Comunidades de Aves Aquáticas em Açudes	1996	3º Congresso de Ecologia do Brasil
		dos municípios de Tapes e Arambaré, Planície Costeira do		
		RS		
		Structure of Aquatic Birds Communities in Weirs in the		
		municipalities of Tapes and Arambaré, Coastal Plain of RS		
(f) Gen	eral			
4-f1	Lema, T.	Contribuição ao Conhecimento dos Testudines do RS -	1990	Acta Biological Leopoldensia, 12
		Lista Sistemática Comentada (reptila).		
		Contribution to the Knowledge of Testudinidae in RS –		
		Commented Systematic List (reptile).		
4-f2	FAURGS/IBAMA/	Relatório Final do Projeto de Pesquisa e Monitoramnto de	1996	
	FEPAM	Fauna Sinergética	1997	
		Final Report of the Research and Monitoring Project of the	1998	
		Synergetic Fauna		
4-f3	Burger, M.I.	Os Efeitos de Habitat e Caça Amadorista na Densidade de	1996	Tese de Doutorado (Doctor Thesis)
		Dendrocygna viduata (aves, Anatidae) no RS		
		The Effects of Habitat and Amateur Hunting in the Density		
		of Dendrocygna viduata (birds, Anatidae) in RS		

No.	Author/Editor	Title	Year	Published by / Printed in
4-f4	Bernardes, A.T.	Fauna Brasileira Ameaçada de Extinção	1990	Ed. Fundação Biodiversitas para a
				Conservação da Diversidade
		Brazilian Fauna Threatened of Extinction		Biológica.
4-f5	Menegheti, J.O.	Setting Hunting Regulations for Netta peposaca in South	1992	Proc. of IWRB Symposium,
		Brazil		St. Petersburg Beach, Florida, USA
4-f6	Menegheti, J.O.	Status of Cygnus melancoryphus in the Southern Brazil	1991	II International Congress,
		Gestion en Recursos Naturales		Valdívia, Chile
		Management on Natural Resources		
4-f7	Menegheti, J.O.	Efeito da Caça Seletiva na Razão de Sexo de Netta	1993	III International Congress,
		peposaca (aves, Anatidae). Gestion en Recursos Naturales		Pucón, Chile
		Effect of the Selective Hunting in the Proportion of Sex of		
		Netta peposaca (birds, Anatidae). Management of Natural		
		Resources		
4-f8	Rosa, Z.M.	O gênero Pediastrum Meyen (Chlorococcales-	1988	Ser. Bot., Porto Alegre, 38
		Hydrodictyaceae) do Sistema Lagunar da Região Litorânea		
		do RS, BR		
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		species of the Lagoon System of the Coastal Region of RS,		
		BR		
4-f9	Melo, M.T.Q.	Resultados Preliminares de Levantamento das Populações	1997	VIII Congreso Ibero-americano de
		de Caiman latirostris em Ambientes de Áreas Úmidas no		Biodiversidad y Zoologia de
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4-f10	Burger, M.I.	A Caça Esportiva de <i>Dendrocygna viduata</i> no Sul do Brasil (1984-1991): Formas de Avaliação e Efeitos da Caça de outras Espécies de Mudanças na Legislação <i>The Sportive Hunting of Dendrocygna viduata in Southern</i> <i>Brazil (1984-1991): Evaluation Manners and Effects of</i> <i>Hunting on other Species and Changes in the Legislation</i>	1997	VIII Congreso Ibero-americano de Biodiversidad y Zoologia de Vertebrados, Chile.
4-f11	Guadagnin, D.L.	Estandardização de Contagens de Columbideos para Monitoramento da Caça no RS Standardization of Columbidae Counting for Hunting Monitoring in RS	1997	VIII Congreso Ibero-americano de Biodiversidad y Zoologia de Vertebrados, Chile.
4-f12	Burger, M.I.	Efeito do Habitat na Distribuição de <i>Dendrocygna viduata</i> no RS <i>Effect of the Habitat in the Distribution of Dendrocygna</i> <i>viduata in RS</i>	1996	3º Congresso de Ecologia no Brasil.
4-f13	Taborba, W.Q.	Censo Aéreo de alguns Anatídeos no RS Aerial Census of some Anatidae in RS	1996	Resumo do XXI Congresso Brasileiro de Zoologia.
4-f14	Oliveira, K.P.A	Distribuição Geográfica de Seis Famílias (Capromydae, Caviidae, Dasyproetidae, Erethizontidae, Hydrocharidae, Sciuridae) de Rodentia no Estado do RS Geographical Distribution of Six Families (Capromydae, Caviidae, Dasyproetidae, Erethizontidae, Hydrocharidae, Sciuridae) of Rodents in the RS State	1996	Resumos do XXI Congresso Brasileiro de Zoologia.
4-f15	Nascimento, J.L.X.	Biologia e Situação Atual da Marreca-Parda Anas georgica no BR Biology and Present Situation of the Marreca-Parda (Pard- Duck) Anas georgica in BR		

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4-f18	Nascimento, J.L.X.	Análise dos Dados de Anilhamento de Amazonetta brasiliensis no Brasil Analysis of "Anilhamento" (related to rings) Data of the Amazonetta brasiliensis in Brazil	1990	Ararajuba 1
4-f19	Lema, T.	Contribuição ao Conhecimento dos Testudines do RS – Lista Sistemática Comentada (Reptila) Contribution to the Knowledge of Testudinidae in RS – Commented Systematic List (reptile)	1990	Acta Biologica Leopoldensia , 12
4-f20	Valentini, H.	Análise da Pesca do Camarão-rosa (<i>Penaeus brasiliensis e</i> <i>P. paulensis</i>) nas Regiões Sudeste e Sul do BR <i>Analysis of the Pinky-Shrimp (Penaeus brasiliensis and P. paulensis) Fishery in the Southeast and South Regions of</i> <i>BR</i>	1991	Atlântica, Rio Grande, 13-1
4-f21	Vooren, C.M.	Guia das Aves Comuns da Costa do RS. Projeto Asas Polares. Guide of Common Birds of the RS Coast. Polar Wings Project	1995	IMAGO MARIS, 2
4-f22	Silva, K.G.	Monitoramento da Ocorrência de Tartarugas Marinhas no Litoral do RS Monitoring of the Occurrence of Marine Turtles in the RS Coast	1996	XI Semana Nacional de Oceanografía.

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		Diatomaceae of the Guaíba Beaches, RS		
(h) Lag	guna dos Patos Estuary	y		
4-h1	Koch, E.M.	Transplante de Ruppia marítima L. no Estuário da Lagoa dos Patos – RS	1984	1º Seminário sobre Pesquisa da Lagoa dos Patos
		Transplant of Ruppia maritime L. in the Patos Lake Estuary $-RS$		
4-h2	Chao, L.N.	BELAP – Bioecologia dos Peixes do Estuário da Lagoa dos Patos – RS BELAP – Bioecology of Fishes of the Patos Lake Estuary – RS	1984	1º Seminário sobre Pesquisa da Lagoa dos Patos.
4-h3	Topin, L.O.	Biologia do Siri <i>Callinectes sapidus</i> na Área Estuarine da Lagoa dos Patos - Rio Grande – RS Biology of Callinectes sapidus crab in the Estuary Area of the Patos Lake – Rio Grande – RS	1984	1º Seminário sobre Pesquisa da Lagoa dos Patos.
4-h4	D`Incao, F.	Crescimento e Mortalidade do Camarão <i>Penaers paulensis</i> na Lagoa dos Patos, RS <i>Growth and Mortality of Penaers paulensis Shrimp in the</i> <i>Patos Lake, R</i>	1984	1º Seminário sobre Pesquisa da Lagoa dos Patos.
4-h5	Marchiori, M.A.	Repovoamento do Camarão Rosa <i>Panaeus paulensis</i> no Estuário da Lagoa dos Patos - Rio Grande – RS <i>Repopulation of the Pink Shrimp Penaers paulensis in the</i> <i>Estuary of the Patos Lake – Rio Grande – RS</i>	1984	1º Seminário sobre Pesquisa da Lagoa dos Patos.
4-h6	Bemvenuti, C.E.	Efeito da Predação sobre a Macrofauna Bentônica de uma Enseada Estuarina da Lagoa dos Patos Predatory Effects over the Bottom Macrofauna of an Estuarine Inlet of the Patos Lake	1984	1º Seminário sobre Pesquisa da Lagoa dos Patos.

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		maritima no Estuário da Lagoa dos Patos, RS		Lagoa dos Patos.
		Structure of the Community Associated to the Ruppia		
		maritime Prairie in the Patos Lake Estuary, RS		
4-h8	Amus, M.L.	Levantamento e Modificações Ambientais do Ecossistema	1984	1º Seminário sobre Pesquisa da
		Esturial da Lagoa dos Patos		Lagoa dos Patos.
		Environmental Survey and Modifications of the Estuarine		
		Ecosystem of the Patos Lake		
4-h9	Itussarry, M.E.	Aspectos Biogeográficos dos Ostracodes deteminados por	1984	1º Seminário sobre Pesquisa da
		Parâmetros Ambientais na Porção Esturial da Lagoa dos		Lagoa dos Patos.
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		Environmental Parameters in the Estuarine Portion of the		
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4-h10	Niencheski, L.F.H.	Monitoria de Ambientes por Balanus	1984	1º Seminário sobre Pesquisa da
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4-h11	Bemvenuti, M.A.	Hábitos Alimentares de Peixe-rei (Atherinidae) na Região	1990	Atlântica 12-1
		Estuarina da Lagoa dos Patos, RS, BR		
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4-h12	Bemvenuti, M.A.	Abundância, Distribuição e Reprodução de Peixes-rei	1987	Atlântica 9-1
		(Atherinidae) na Região Estuarina da Lagoa dos Patos, RS,		
		BR		
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4-h14	Capitoli, R.R.	Occurrence and Bio-ecological Observation on <i>Metasesarma rubripes</i> (crab) in the Estuarine Region of Patos Lake	1977	Atlântica 2-1
4-h15	Weiss, G.	Development and Metamorphosis Characteristics of <i>Lycengraulis olidus</i> (Engraulidae) and <i>Brevoortia pectinata</i> (Clupeidae) in the Patos Lake Estuary	1977	Atlântica 2-1
4-h16	Reis, E.G.	Reproduction and Feeding Habitats of the Marine Catfish <i>Netuma barba</i> in the Estuary of Patos Lake, BR	1986	Atlântica 8
4-h17	D`Incao, F.	Pesca e Biologia de <i>Penaeus paulensis</i> na Lagoa dos Patos, RS Fishery and Biology of Penaeus paulensis in the Patos Lake, RS	1991	Atlântica 13-1
4-h18	Bemvenuti, C.E.	Impacto da Predação sobre <i>Heteromastus similis</i> southern, 1921 e <i>Nephtys fluviatilis</i> monro, 1937 em Fundos Moles Estuarinos <i>Predatory Impact over Heteromastus similis southern,</i> 1921 and Nephtys fluviatilis monro, 1937 in Estuarine Soft Bottom	1988	Atlântica 10-1
4-h19	Costa, C.S.B.	Distibuição, Função e Valores das Marismas e Pradarias Submersas no Estuário da Lagoa dos Patos, RS, BR Distribution, Function and Values of Submerged Marshy Areas and Prairies in the Patos Lake Estuary, RS, BR	1997	Atlântica 19

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4-h20	Silva, K.G.	Os Pinipedes no Litoral do RS – Monitoramento, Pesquisa e	1997			
		Educação Ambiental				
		The Pinnipedian in the RS Coast – Monitoring, Research				
		and Environmental Education				
(i) Paln	nares do Sul					
4-i1	Ramos, R.A.	Comportamento Reprodutivo de Algumas Espécies de	1997	VIII Congreso Ibero-americano		
		Anatidae em Cultivo de Arroz Irrigado no município de		de Biodiversidad y Zoología de		
		Palmares do Sul, RS, BR		Vertebrados, Chile.		
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		Irrigated				
		Rice Cultivation of the municipality of Palmares do Sul, RS,				
		BR				
(j) Sant	(j) Santa Vitória do Palmar					
4-j1	Ataguile, B.S.	Levantamento Preliminar da Avifauna em Região Natural				
-		de Banhado, na Estância Ipiranga, RS				
		Preliminary Survey of Avifauna in the Swamp Natural				
		Region, in the Ipiranga Farm, RS				
4-j2	Nascimento, J.L.X.	Aninhamento de Dendrocygna spp. no Brasil entre 1973 e	1995			
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4-j3	Bretschneider, D.S.	Nota sobre a Alimentação do Marrecão (<i>Netta peposa</i>) em	1981	Ser. Zool., Porto Alegre, 58		
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(k) Ot	(k) Others						
4-k1		Caracterização Sócio-Econômica e Fundiária do Parque					
		Nacional da Lagoa do Peixe - RS					
		Socio-Economic and Land Ownership Characterization of					
		the Lagoa do Peixe National Park - RS					
4-k2		II Simpósio de Ecossistemas da Costa Sul e Sudeste	1990				
		Brasileira					
		II Symposium of Ecosystems of the Brazilian Southern and					
		Southeast Coast					
4-k3	SCP	Comercio e Turismo -Projeto RS 2010 -	1998	SCP			
4-k4		Polictica Nacional de Ecoturismo					
4-k5	Progrma Mar de	Eco-Turismo Pro-Mar de Dentro	1999	SCP			
	Dentro, SCP						

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(a) Cha	art and Map						
6-a1	UNDP/FAO/CLM	Mapas com Batimetria da Lagoa Mirim, Escala 1:133.406	1968				
(P6-1)		Bathymetric Map of the Mirim Lake, Scale 1:133,406					
6-a2	Marinha do Brasil	Cartas Náuticas do Porto do Rio Grande (no. 2101)	1990	Hidrografia e Navegacao			
(P6-4)		Escala 1:25.000					
		Navigation Map of the Rio Grande Harbor (no. 2101) Scale					
		1:25,000	10.10				
6-a3	Marinha do Brasil	Cartas Náuticas da Lagoa dos Patos (no.2140)	1968	Hidrografia e Navegacao			
(P6-7)		Escala 1:2/1.653					
<i>.</i>		Navigation Map of the Patos Lake, Scale 1:2/1,653					
6-a4	Marinha do Brasil	Cartas Náuticas de Rio Grande a Feitaria (no.2112)		Hidrografia e Navegacao			
		Escala 1:80,000					
		Navigation Map of the Rio Grande and Feitaria (no. 2112)					
- -		Scale 1:80,000	1005				
6-a5	FEPAM/GERCO	Carta de Batimetria da laguna dos Patos, Escala 1:100.000	1995				
(P6-9)		Bathymetric Chart of the Patos Lagoon, Scale 1:100,000	100-				
6-a6	FEPAM/GERCO	Carta de Faciologia da Laguna dos Patos, Escala 1:100.000	1995				
(P6-10)		Bathymetric Map of the Patos Lagoon, Scale 1:100,000					
6-a7	Carlos A. E. G.	Caderno de Cartas da Lagoa dos Patos	1995	Programa de Gerenciamento			
(P9-12)	Glauber A. G.	Atlas of the Patos Lake		Costeiro FURG/FEPAM			
6-a8	Carlos A. E. G.	Caderno de Cartas da Costa do Rio Grande do Sul	1995	Programa de Gerenciamento			
(P9-13)	Glauber A. G.	Atlas of the Rio Grande do Sul Coast		Costeiro FURG/FEPAM			
(b) Tid	(b) Tide and Wave						
6-b1	Toldo E. E. Jr.	Wave Cllimate along the Shoreline of the Lagoa dos Patos,	1998	CECO-UFRGS			
(P7-24)	Almeida, L.E.S.B.	Brazil					
	Correa I.C.S.	(Quaternary of South American & Antarctic Peninsula)					
	Ferreira E.R.						

6. Hydrological Conditions of Patos Lake

No.	Author / Editor	Title	Year	Published by / Printed in
6-b2	IPH-UFRGS	Banco de Dados de Niveis e Ventos da Lagoa dos Patos		Fundacao de Amparo a Peaquisa do
(P7-24)		Data Bank of Water Level in Patos Lake		Estado do Rio Grande do Sul
6-b3	Marinha do Brasil	Tábuas das Mares para 1998, 1997 (35 ^a , 36 ^a edição)	1997	Diretoria de Hidrografia e
(P9-6)	Navy of Brazil	Tide Table for 1998, 1997 (35th edition)	1998	Navegacao
6-b4		Cartas Temáticas de Parâmetros Oceanográficos, Relatório	1995	FURG/FEPAM
(P9-14)		Técnico		
		Thematic Maps of Oceanographic Parameters, Technical		
		Report		
(c) Hyd	Irodynamics			
6-c1	Osmar	Hydrodynamique de la Lagune dos Patos (30S, Bresil),	1996	These presentee a L'UNIVRRSITE
(P9-11)		"Mesures et Modelisation"		BORDEAUXI
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		Modeling (30S, Brazil)		
6-c2	Osmar O. Moller, Jr,	Facteurs et Mecanismes de la Circulation des Eaux dans	1991	Bull. Inst. Geoo. Bassin d'Aquitaine,
(P7-15)	Paim Paulo S. G.	L'estuaire de la Lagune dos Patos		Bardeaux
	Soares Ivan Dias	Effects and Mechanisms of Water Circulation in the Patos		
		Lake Estuary		
6-c3	Osmar O. Moller, Jr,	Hydrographical Characteristics of the Estuarine Area of	1997	Estuaries of South America,
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6-c4	Niencheski, L. F.	Caracterizacao Hidrologica de Tres Regioes Distintas no	1986	Laboratorio de Hidroquimica, FURG
	Baptista, J. R.,	Estuario da Lagoa dos Patos – RS		
	Hartmann, C.,	Hydrologic Characterization of Three Different Areas in the		
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6-c5	Bordas M.P.	Circulacao e Dispersao em Systemas Costeiros e Oceanicos	1984	11 Simposio Brasileiro Sobre
	Borche C.A.	(Caso da Lagoa dos Patos),		Recursos do Mar
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	Goncalves M.R.R.	Circulation and Dispersion in the Coastal and Ocean		
		System Project CIRM/UFRGS 70/27/84		

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6-c6	Borche C.A.	Water Circulation and Dispersion Capacity in the Lagoa	1989	Proc. SIUEC vol.2
	Salomon J.C.	Patos – Guaiba Coastal System		
	Bordas M.P.			
6-c7	SOPSH	Prestacao de Servicos de Consultoria para o	1998	Governo do Estado do Rio Grande
	DRHS	Desenvolvimento de Estudos Visando a Caracterizacao do		do Sul
	FRH/RS	Comportamento Hidraulico-Hidrologico do Sistema Hidrico	1999	Magna Engenharia Ltda.
		Guaiba-Lagoa dos Patos, Localizado no Estado do Rio		
		Grande do Sul		
		1. Relatorio de Andamento Nº03 (RA-03)	Nov.	
		2. Relatorio de Instalacao das Estacoes Hidrometeoro-	Dez.	
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		Seguimento de Flutuadores a Deriva		
		4. Relatorio da 2 ^ª Campanha de Medicoes de Correntes e	Abr.	
		Seguimento de Flutuadores a Deriva		
		5. Relatorio da 3 ^ª Campanha de Medicoes de Correntes e	Jul.	
		Seguimento de Flutuadores a Deriva		
6-c8	DNAEE, MME	Bacia do Guaiba	1983	Ministerio das Minas e Energia
		Mecanica de Correntes do Guaiba (Relatorio Sintese)		Departamento Nacional de Aguas e
		Guaiba Basin		Energia Eletrica
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(d) Sed	imentation			
6-d1	Toldo Jr. E. E.	Producao de Sedimentos no Sistema Lafunar da Lagoa dos		DECO-UFRGS
(P7-2)	Dillenburg S, R	Patos, RS		
	Correa I.C	Sediment Yield in the Patos Lake System		
	Almeida L. E. B			
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	Gruber N. L. S.			

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(P7-18)	Thierry Long	Estuarina da Lagoa dos Patos		
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6-d4	CECO-UFRGS	Morphology and Sedimentology of the Southwest Atlantic	1996	
(P6-12)		Coastal Zone and Continental Shelf from Cabo Frio (Brazil)		
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		Production and Suspended Material		
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		Phytoplankton of the Patos Lagoon Estuary, Southern Brazil		(1995) 40, 219-229.
7-a3	Auer, M. T. et al.	Measurement and Verification of Rates of Sediment	1993	Hydrobiologia 253: 301-309, 1993.
		Phosphorus Release for a Hypereutrophic Urban Lake		
7-a4	Austin, E. R. & Lee,	Nitrogen Release from Lake Sediments	1973	Journal WPCF, Vol.45, No. 5, May
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7-a5	Baisch, P.	Heavy Metals Transport and Accumulation In Fluvial	1998	Ecological Chem. 1998, 7(1):48-54.
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7-a6	Baisch, P. &	Evolução do Impacto dos Metais Pesados e Matéria Orgânica	1997	Anais Congres. Bras. Geoquímica
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		Brazil		
7-a8	Baisch, P. et al.	Flux of Particulate Organic Matter Components and Heavy		personal communication
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		conditioning of heavy metals in the versant of Camaquã river		
		basin		

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		associated with suspended matter		
7-a11	Baumgarten, M. G.	Qualidade das Águas Estuarinas que Margeiam o Município	1995	Atlântica, Rio Grande, 17: 17-34,
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		Dissolvidos		
		Water quality of estuarine site around of Rio Grande		
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/-a12	Bertuzzi, A. et al.	Benthic Fluxes of Dissolved Inorganic Carbon, Nutrients and	1997	water and Soil Pollution 99:
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7-a16	Danen-Louwerse, H	Iron Content of Sediment and Phosphate Adsorption	1993	Hydrobiologia 253: 311-317, 1993
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7-a20	Fillos, J. & Molof,	Effect of Benthal Deposits on Oxygen and Nutrient	1972	Journal WPCF, Vol.44, No.4, April
	А. Н.	Economy of Flowing Waters		1972.
7-a21	Fillos, J. & Swanson,	The Release Rate of Nutrients from River and Lake	1975	Journal WPCF, Vol.47, No.5, May
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7-a23	Hassett, R P. et al.	Ecological Stoichiometry of N and P in Pelagic Ecosystems:	1997	Limnol. Oceanogr., 42(4), 1997,
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7-a24	Kelly, M. G. &	Phytoplankton Algae: Nutrient Concentrations and Growth		Science, Vol. 180.
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7-a25	Kleeberg, A. &	In situ Phosphours Release Experiments in the Warnow	1993	Hydrobiologia 253: 263-274, 1993.
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7-a26	Moustafa, M. Z. et	The Response of a Freshwater Wetland to Long-term 'Low	1998	Hydrobiologia 364: 41-53, 1998.
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7-a30	Pestana, M. H. D. et	Study of Heavy Metals in Gold and Cooper Mining Areas of	1993	International Symposium on
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7-a31	Portielje, R. &	Sorption of Phosphate by Sediments as a Result of Enhanced	1993	Hydrobiologia 253: 249-261, 1993.
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7-a32	Rosa, F.	Sedimentation and Sediment Resuspension in Lake Ontario	1985	J. Great Lakes Res. 11(1): 13-25.
7-a33	Salas, H. J. &	Metodologias Simplificadas para la Evaluacion de	1990	CEPIS / HPE / Organizacion Mundial
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		lakes in tropical region		
7-a34	Santos, E. D. dos et	Poluição Orgânica e Condições Sanitárias das Águas	1997	Atlântica, Rio Grande, 19: 5-18,
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		1996)		
		Organic pollution and sanitary condition of water near Rio		
		Grande Municipality – Rio Grande do Sul State, Brazil		
7-a35	Seelieger, U. et al.	Subtropical Convergence Environments: Energy Flow and	1997	Springer-Verlag 1997.
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7-a36	Søndergaard, M. et	Eight Years of Internal Phosphorus Loading and Changes in	1993	Hydrobiologia 253: 345-356, 1993.
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7-a37	Tartari, G. & Biasi,	Trophic Status and Lake Sedimentation Fluxes	1997	Water, Air and Soil Pollution 99:
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		Sediment Yield in the Lagoa dos Patos System		
7-a40	UFPEL / ETFPEL /	Monitoramento da Qualidade das Aguas da Bacia da Lagoa		UFPEL / ETFPEL / Agência da
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	Mirim	Plan of water quality monitoring on Mirim lake basin		
7-a41	Ward, G. H.	The Measurement of Benthal Oxygen Demand in the	1984	Journal WPCF, Volume 56, Number
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No.	Author/Editor	Title	Year	Published by
7-a42	Yunes, J. S. et al.	The Effect of Nutrient Balance and Physical Factors on the	1996	A Report to the European Economic
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7-a43	Yunes, J. S. et al.	Toxic Blooms od Cyanobacteria in the Patos Lagoon	1996	Journal of Aquatic Ecosystem Health
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7-a45		Environmental Health Criteria	1986	World Health Organization, Geneva
7-a46	Boney, H. D.	Phytoplankton	1989	Edward Arnold
7-a47	Harris, G. D.	Phytoplankton. Ecology	1986	Chapman and Hall
7-a48	Baisch, P.	Les oligo-elements metalliques du systeme fluvio-lagunaire dos Patos (Brezil) – Flux et devenir	1994	These (Docteur es Sciences)
7-a49	Hosomi, M.	Study about elution and control of nitrogen and phosphorous from sediments of lake	1987	Environmental Chemical Engineering Lab. Tokyo Univ. of Agriculture and Tecnology
7-a50	Smith, S. L. et al.	The development and implementation of Canadian Sediment Quality Guidelines	1996	Development and Progress in Sediment Quality Assessment: Rationale, Challenges, Techniques & Strategies, p.p.233-249
7-a51	United States Environmental Protection Agency	Current Drinking Water Standards	1998	
7-a52	IPCS – International	The WHO Recommended Classification of Pesticides by		World Health Organization
	Programme on	Hazard and Guidelines to Classification 1996-1997		
	Chemical Safety			
7-a53		Guidelines for drinking-water quality	1993	World Health Organization

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No.	Author/Editor	Title	Year	Published by		
(b) Wat	(b) Water Quality of Mirim Lake					
7-b1	Agência da Lagoa	Monitoramento da Qualidade das Águas da Bacia da Lagoa	1995			
(P9-4)	Mirim.	Mirim (2 volumes em Disquetes)				
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No.	Author/Editor	Title	Year	Published by / Printed in				
(a) Hyd	(a) Hydrodynamic Model							
8-a1	Osmal O. Moller, Jr, Patrice Castaing, Pascal Lazure	The Analysis of Mixing, Circulation and Estuarine/Shelf Exchange Processes in Patos Lagoon from a 3D Model	1997					
8-a2	Osmal O. Moller, Jr, Mauricio M.Mata, Joao A. Lorenzzentti, Jose L. Stech	The Patos Lagoon Summertime Circulation and Dynamics	1996	Continental Shelf Research, Vol.16 No.3				
8-a3	Fernandes, E. H. L. Niencheski, L. F. H.	Um Model de Caixas Simplificado para o Estudo dos Processoes de Transporte na Regiao Estuarina da Lagoa dos Patos (RS-Brazil) A simple Box Model to Evaluate the Transport Processes in the Patos Lagoon Estuarine Region	1997	REVISTA ATLANTICA/FURG/RIO GRANDE				
8-a4 (P9-6)	Alejandro Borche	IPH-A Aplicativo para Modelacao de Estuarios e Lagoas "Manual de Uso"	1996	IPH-UFRGS				
(b) Dif	fusion Model		•					
8-b1		Sistema Hídrico de Simulação para a Propagação de Poluentes Desenvolvido para Atender o Plano Diretor de Esgotos de Porto Alegre Hydrologial Simulation System for the Propagation of Pollutants Developed to the Porto Alegre Sewerage Master Plan	1998	DMAE				

8. Hydraulic and Water Quality Simulation Models for Patos Lake

No.	Author/Editor	Title	Year	Published by / Printing in
(a) Ger	neral			•
9-a1		Sistema de Tratamento e Destinação Final		CORSAN
		Treatment and Final Destination System		
9-a2		Estudo de Concepcao (E.C.) Para Ampliacao Do Sistema de		
		Abastecimento da Cidade de Pelotas/RS, Volume I,		
		MMMemorial Descrotivo e Pecas, Graficas		
9-a3		Water Quality, Prevention, Identification, and Management		
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9-a4		Guidance Specifying Management Measures for Sources of		
		Nonpoint Pollution in Costal Waters, Issued Under the		
		Authority of Section 6217(g) of the Coastal Zone Act		
		Reauthorization Amendments of 1990, United States		
		Environmental Protection Agency Office of Water,		
		Washington, DC		
9-a5		Cartilha de Educacao Ambiental, Governo Do Estado Do		
		Rio Grande Do Sul		
(b) Pel	otas			
9- b1	Marco	Plano Integrado de Saúde e Ambiente, Município de Pelotas,	1998	Secretaria Municipal de Saúde e
		RS		Bem Estar Social do Município de
		Integrated Plan of Health and Environment, Municipality of		Pelotas
		Pelotas, RS		
9- b2		SANEP (Introduction Papers of SANEP)		SANEP
9- b3		Estudo de Concepção (E.C.) para Ampliação do Sistema de	1998	SANEP
		Abastecimento da Cidade de Pelotas, RS. Vol.1, Memorial		
		Descritivo - Peças Gráficas		
		Conception Study for the Enlargement of the Water Supply		
		System of Pelotas City, RS. Vol.1, Description Records –		
		Graphical Pieces		

9. Sewage Treatment in the Urban Areas

No.	Author/Editor	Title	Year	Published by / Printing in
9-b4		Primer Simposio sobre Municipio y Medio Ambiente	1994	ACTAS, San Luis.
		First Symposium on Municipality and Environment		
9-b5		Water Quality Analysis Results of Several Existing Factories		SANEP
		in Pelotas City		
9-b6		Sistemas de Esgotos Sanitários, Areal/Baronesa, Estação de		SANEP
		Tratamento, Planta Baixa Geral		
		Sewerage Systems, Areal/Baronesa, Treatment Station,		
		General Drawing		
9-b7	SANEP	Serviço Autônomo de Saneamento de Pelotas	1997	Município de Pelotas
(P5-20)	Município de Pelotas	Autonomous Service of Sanitation of Pelotas		
9-b8	Município de Pelotas	Plano Integrado de Saneamento da cidade de Pelotas,	1998	Município de Pelotas
(P5-21)		Volume I		
		Sanitation Integrated Plan of Municipality Pelotas, Volume I		
9-b9	Município de Pelotas	Plano Integrado de Saneamento da cidade de Pelotas,	1998	Município de Pelotas
(P5-22)		Volume II		
		Sanitation Integrated Plan of Municipality Pelotas, Volume		
		II		
9-b10		Organization Chart of SANEP.		SANEP
9-b11		Cadastro Industrial, Departamento de Tratamentto		SANEP
(c) Rio	Grande			
9- c1		Identificação das Possíveis Fontes de Contaminação das	1993	FURG
		Águas que Margeiam a Cidade do Rio Grande – RS		
		Identification of Possible Contamination Sources of the		
		Waters Surrounding the Rio Grande City – RS		
9-c2		Water Quality Analysis Results of the Existing Water	1999	CORSAN
		Treatment Facility in Rio Grande City		

No.	Author/Editor	Title	Year	Published by / Printing in
9-c3		Projeto do Sistema de Tratamento, Cassino (Descrição Geral		CORSAN
		do Projeto da Rede de Esgotos)		
		Treatment System Project, Cassino (General Description of		
		Sewerage Project)		
9-c4		Projeto Executivo de Esgotamento Sanitário da Cidade de		CORSAN
		Rio Grande – RS, Planta Geral do Sistema (Escala 1:20.000)		
		Detail Design of the Sewerage System of Rio Grande City –		
		RS, General Plant of the System (Scale: 1:20,000)		
9-c5	Município de	PROHARG - Programa Habitacional do Rio Grande	1998	Município de Rio Grande
(P5-23)	Rio Grande	PROHARG – Housing Program of Rio Grande		
(d) Sao	Lourenco do Sul			
9-d1	Municipio de	General Planning Map of Sao Lourenco do Sul	1998	CORSAN, Sao Lourenco do Sul
	Sao Lourenco do Sul			
9-d2	Municipio de Sao	Monitoramento de Sao Lourenco do Sul/Companhia	1999	CORSAN, Sao Lourenco do Sul
	Lourenco do Sul	Riograndense de Saneament /Data on Water Quality		
		Analyses of Caraha and Sao Lourenco Rivers		
(e) Can	naqua			
9-e1	Municipio de	General Planning Map of Camaqua	1998	CORSAN, Camaqua
	Camaqua			
9-e2	Municipio de	Companhia Riogdandense de Saneament /034-Camaqua,	1999	CORSAN, Camaqua
	Camaqua	1999/Monthly Expenditure of Drinking Water Section in		
		Сатадиа		
(f) Tap	es			
9-f1	Municipio de Tapes	Planta Cadastral da Cidade de Tapes, Escala:1/4,000,	1997	CORSAN, Tapes
		Nov.97/General Planning Map of Tapes		_
9-f2	Municipio de Tapes	Vazoes Totais de Contribuicao a ETE/Paper	1997	CORSAN, Tapes
9-f3	Municipio de Tapes	Estrutura Sintelica das Tarifas da CORSAN Receita Direta	1999	CORSAN, Tapes
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No.	Author/Editor	Title	Year	Published by / Printing in			
(g) Otł	(g) Others						
9-g1	CORSAN	Rede Coletora de Esgosto Sanitarios (Divisao de Bascias),	1994	CORSAN, Porto Alegre			
		Sao Lourenco do Sul-RS/Drawing					
9-g2	CORSAN	Rede Coletora de Esgotos Sanitarios (Rede Coletora Bacia	1994	CORSAN, Porto Alegre			
		-2),Sao Lourenco do Sul/Drawing					
9-g3	CORSAN	Rede Coletora de Esgotos Sanitarios (Rede Coletora Bacia	1994	CORSAN, Porto Alegre			
		-5),Sao Lourenco do Sul/Drawing					
9-g4	CORSAN	Estacao de Tratanento de Esdotos (Implantacao e Localizacao	1994	CORSAN, Porto Alegre			
		da ETE), Sao Lourenco do Sul-RS/Drawing					
9-g5	CORSAN	Estacao de Tratanento de Esdotos (Lagoas de Estabilizacao	1993	CORSAN, Porto Alegre			
		Planta General), Tapes-RS/Drawing					
9-g6	CORSAN	Estacao de Tratanento de Esdotos (Projeto Paisagistico	1993	CORSAN, Porto Alegre			
		Implantacao), Tapes-RS/Drawing					
9-g7	CORSAN	General Organization Chart of CORSAN	1999	CORSAN, Porto Alegre			
9-g8	CORSAN	Precos Compostos 08/09, Porto Alegre/A List of Unit Costs	1999	CORSAN, Porto Alegre			
		for Sewage Related-Works					
9-g9	CORSAN	Insumos 08/09, Porto Alegre/Alfabetisca / A List of Unit	1999	CORSAN, Porto Alegre			
		Costs for Sewage Related-Works					
No.	Author / Editor	Title	Year	Published by / Printed in			
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(a) General							
10-a1	Eng. Edson Plá Monterosso (SANEP)	Pesquisa sobre Compostagem Research on Composting	1998				
10-a2		Descrição da Usina de Compostagem Description of the Recycling/Composting Plant	1998	Departamento de Processamento de Resíduos Sólidos da SANEP (Pelotas)			
10-a3		Lei no. 9921 (27/Julho/1993) Law no. 9921 (July, 27/1993	1993	Governo do Estado do RS			
10-a4		Projeto de Lei no. 3733/97 (revisão e emendas) Project of Law no. 3733/97 (revision and amendments)	1998	Conselho Municipal de Proteção ao Meio Ambiente de Pelotas			
10-a5	Pro-Guaiba	Diagnóstico do Lixo Domiciliar na Bacia do Guaíba Diagnosis on Domestic Solid Waste in Guaíba Basin	1997	SCP-RS			
10-a6	Schalch, Valdir	Produção e Características do Chorume em Processo de Decomposição de Lixo Urbano Production and Characteristics of Leachate in Municipal Waste Decomposition Process	1984	University of São Paulo (Master's Degree thesis)			
10-a7	Arruda A. et alli	Sistema de Tratamento de Líquidos Percolados Implantado no Aterro Sanitário de São Giácomo, Caxias do Sul – RS Leachate Treatment System installed in the Sanitary Landfill, Caxias do Sul – RS	1996	International Symposium of Environmental Quality			
10-a8	R. Stegman	The pollution potential of sanitary landfill	1982	Proceedings of the Exeter Symposium			
10-a9	Waquil D.D., Freitas A.R	A Problemática do Tratamento de Lixívia de Aterros Sanitários The Problem of Leachate Treatment of Sanitary Landfills	1983	12 nd Brazilian Congress of Sanitary and Environmental Engineering			
10-a10		Law no. 6.938 (Aug 31 st , 1981)	1981	Governo da República Federativa do Brasil			

10. Solid Waste Management System in the Urban Areas

No.	Author / Editor	Title	Year	Published by / Printed in		
10-a11		Decree no. 99.274 (June 6 th , 1990)	1990	Governo da República Federativa do		
				Brasil		
10-a12		Resolution CONAMA* no. 001 (Jan 23 rd , 1986)	1986	Governo da República Federativa do		
		*National Council of Environment		Brasil		
10-a13		Resolution CONAMA no. 005 (Aug 5 th , 1993)	1993	Governo da República Federativa do		
				Brasil		
10-a14		Resolution CONAMA no. 237 (Dec 19 th , 1997)	1997	Governo da República Federativa do		
				Brasil		
10-a15		Law no. 9.921 (July 27 th , 1993)	1993	Governo do Estado do RS		
10-a16		Decree no. 38.356 (April 1 st , 1998)	1998	Governo do Estado do RS		
10-a17		Law no. 10.009 (Feb 7 th , 1994)	1994	Governo do Estado do RS		
10-a18		Regulation no. 012/95	1995	Secretaria Estadual de Saúde e Meio Ambiente do RS		
(b) Pelo	tas		1			
10-b1		Plano Integrado de Saúde e Meio-Ambiente do Município de Pelotas	1998	Secretaria Municipal de Saúde e		
		Integrated Health and Environment Plan of the Municipality of Pelotas		Bem-Estar Social		
10-b2		Relatório sobre as atividades da COORECICLO em Pelotas	1999	COORECICLO (Cooperativa de		
		Report on COORECICLO activities in Pelotas		Trabalho e Reciclagem de Lixo)		
10-b3		Lei no. 4.354 – Dispõe sobre o Código Municipal de Limpeza Urbana de	1999	Municipal Chamber of		
		Pelotas e dá outras providências		Representatives of Pelotas		
		Law no. 4.354 – Establishes the Municipal Code of Urban Cleaning in		-		
		Pelotas				
10-b4		Analysis sheet on the Pelotas Landfill leachate	1998	SANEP		
(c) Rio ((c) Rio Grande					
10-c1		Resíduos Sólidos Industriais: Geração e Disposição no Rio Grande do	1997	FEPAM – Fundação Estadual de		
		Sul		Proteção ao Meio Ambiente		
		Industrial Solid Waste: Generation and Disposal in Rio Grande do Sul				
		State				

No.	Author / Editor	Title	Year	Published by / Printed in
10-c2		Contrato dos Serviços de Coleta de Resíduos Sólidos do Município de	1998	Prefeitura do Município de Rio
		Rio Grande		Grande
		Contract on Solid Waste Collection Services for Rio Grande		
10-c3		Relatório sobre as atividades da ASCALIXO (Associação de Catadores	1998	ASCALIXO e Secretaria Municipal
		de Resíduos Sólidos)		de Serviços Urbanos – Rio Grande
		Report on ASCALIXO (Association of Solid Waste Collectors) activities		
10-c4	PROJESUL	Relatório sobre o Impacto Ambiental do Sistema de Disposição Final dos	1999	
	Consultoria	Resíduos Sólidos Urbanos para RIO GRANDE		
		Report on Environmental Impact of the Urban Solid Waste Final		
		Disposal System for RIO GRANDE		
(d) Sao	Lourenco do Sul			
10-d1		Law no. 03/91 "Municipal Code of Urban Cleaning"	1990	Municipal Chamber of
		(Nov 19 th , 1990)		Representatives of S. Lourenço do
				Sul
10-d2		Law no. 1.646 - creates the Municipal Council of Environment Protection	1990	Municipal Chamber of
		(May 29 th , 1990)		Representatives of S. Lourenço do
				Sul
(e) Cam	aqua			
10-e1	Geologist Luis	Licença de Instalação (LI) – Aterro Sanitário do Bonito – Camaquã, RS	1999	GEO-AMBIENTE
	Carlos Evangelista	Installation License – Sanitary Landfill of Bonito – Camaquã, RS		
10-e2		Law no. 19 (1949) - "Code of Dispositions"	1949	Municipal Chamber of
				Representatives of Camaquã
10-e3		Law no. 005 – creates the Municipal Council of Environment Protection	1983	Municipal Chamber of
		(June 2 nd , 1983).		Representatives of Camaquã
10-e4		Inquérito Civil Público no. 008/98 – Depósito de Lixo de Camaquã	1998	2 nd Public Attorney Office of
		Public Civil Trial no. 008/98 – Camaquã Dumping Site		Camaquã
(f) Tapes				
10-f1		Law no. 1312 (Nov 9 th , 1990) - "Code of Dispositions"	1990	Municipal Chamber of
				Representatives of Tapes

No.	Author / Editor	Title	Year	Published by / Printed in	
(g) Porto Alegre					
10-g1	Pro-Guaíba,	Plano Diretor de Resíduos Sólidos da Região Metropolitana de Porto	1998	SCP-RS	
(P5-11)	SCP/METROPLA	Alegre (excerpts)			
	Ν	Solid Waste Master Plan of the Metropolitan Region of Porto Alegre			
10-g2	LABORQUÍMICA	Analysis sheet on the Porto Alegre (Extrema) Sanitary Landfill leachate	1999	DMLU – Municipal Dept. of Urban	
				Cleaning of Porto Alegre	

11. Environmental Education

No.	Author / Editor	Title	Year	Published by / Printed in
11-1		Cartilha de Educação Ambiental		CORSAN
		Environmental Education Promotion Book		
11-2		Ambiente e Educação.	1995	RS
		Environment and Education		