GLOBAL INTERNATIONAL WATERS ASSESSMENT
GIWA UNEP/GEF

LATIN AMERICA AND THE CARIBBEAN

Subregion 38 Patagonian Shelf

DETAILED ASSESSMENT

PRELIMINARY REPORT

Instituto Argentino de Recursos Hídricos IARH

Buenos Aires, Argentina, October 2002

TABLE OF CONTENTS

1. BACKGROUND

1.1 Objectives

1.2 Outputs from the First Subregional Workshop (August 16-18, 2001)

1.3 Initial conceptual framework

1.4 GIWA Methodology and the Subregion 38: Patagonian Shelf.

1.4 Organization.

2. CONSULTATION PROCESS

2.1 Background

2.2 Report sheets

2.3 Process

2.4 Outputs

3. DETAILED ASSESSMENT

3.1 Methodology

3.2 Adopted organization

3.3 Outputs

4. SUBREGION 38a: La Plata River Basin

4.1 Brief description of Subregion 38a

4.2 Concern I: Freshwater shortage

4.2.1 Issue 1: Modification of stream flow

4.2.2 Issue 2: Pollution of existing supplies

4.2.3 Issue 3: Changes in the water table

4.3 Concern II: Pollution

4.3.1 Issue 4: Microbiological pollution

4.3.2 Issue 5: Eutrophication

4.3.3 Issue 6: Chemical pollution

4.3.4 Issue 7: Suspended solids

4.3.5 Issue 8: Solid Wastes

4.3.6 Issue 11: Spills

4.4 Concern III: Habitat and community modification

4.4.1 Issue 12: Losses of Ecosystems and ecotones

4.4.2 Issue 13: Modification of structure or communities

4.5 Socioeconomic impacts:

4.5.1 Concern I: Freshwater shortage

4.5.2 Concern II: Pollution

4.5.3 Concern III: Habitat and community modification

5. SUBREGION 38b: South Atlantic Drainage System

5.1 Brief description of Subregion 38b

5.2 Concern I: Freshwater shortage

5.2.1 Issue 1: Modification of stream flow

5.2.2 Issue 2: Pollution of existing supplies

5.2.3 Issue 3: Changes in the water table

5.3 Concern II: Pollution

5.3.1 Issue 4: Microbiological pollution

5.3.2 Issue 5: Eutrophication

5.3.3 Issue 6: Chemical pollution

5.3.4 Issue 7: Suspended solids

5.3.5 Issue 8: Solid Wastes

5.3.6 Issue 11: Spills

5.4 Concern III: Habitat and community modification

5.4.1 Issue 12: Losses of Ecosystems and ecotones

5.4.2 Issue 13: Modification of structure or communities

5.5 Concern IV: Unsustainable exploitation of living resources

5.5.1 Issue 14: Over-exploitation

5.5.2 Issue 15: Excessive by-catch and discards

5.5.3 Issue 16: Destructive fishing practices

5.6 Socioeconomic impacts:

5.6.1 Concern I: Freshwater shortage

5.6.2 Concern II: Pollution

5.6.3 Concern III: Habitat and community modification

5.6.4 Concern IV: Unsustainable exploitation of living resources

6. PREDICTIVE ANALYSIS

6.1 SR38a: La Plata River Basin

6.1.1 Demography

6.1.2 Economy

6.1.3 Technical and other type of changing

6.1.4 Environment

6.1.5 Socio economic

6.2 SR38b: South Atlantic Drainage System

6.2.1 Demography

6.2.2 Economy

6.2.3 Technical and other type of changing

6.2.4 Environment

6.2.5 Socio economic

7. CONCLUSIONS

7.1 SR38a: La Plata River Basin

7.1.1 Concern I: Freshwater shortage

7.1.2 Concern II: Pollution

7.1.3 Concern III: Habitat and community modification

7.1.4 General conclusion

7.2. SR38b: South Atlantic Drainage System

7.2.1 Concern I: Freshwater shortage

7.2.2 Concern II: Pollution

7.2.3 Concern III: Habitat and community modification

7.2.4 Concern IV: Unsustainable exploitation of living resources

7.2.5 General conclusion

7.3 Lessons learning

7.4 Recommendations

BOXES

Box 1 SR38a. Modification of the stream flow: Cuareim or Quaraí River

Box 2 SR38a. Pollution of freshwater supplies: Metropolitan area of São Paulo, Brazil.

Box 3 SR38a. Changes in the water table: Overexploitation and pollution of Puelche aquifer.

Box 4 SR38a. Microbiological pollution: Pollution in the La Plata River

Box 5 SR38a. Eutrophication pollution: Barra Bonita Reservoir, Tietê River Basin, Brazil

Box 6 SR38a. Chemical pollution: Mercury accumulation in sediment cores and along food chains in two regions of the Brazilian Pantanal.

Box 7 SR38a. Chemical pollution: Long-term accumulation of individual PCB's, dioxins, furans and trace metals in Asiatic clams from the La Plata River Estuary, Argentina.

Box 8 SR38a. Spills: Mine tailings spill in the Upper Pilcomayo Basin.

Box 9 SR38a. Loss of ecosystems or ecotones: Iguazú River system in La Plata River Basin.

Box 10 SR38a. Modification of structure or communities: Impacts of reservoirs on fisheries.

Box 11 SR38a. Infantile mortality rate for water diseases in São Paulo State (Brazil)

Box 12 SR38b. Modification of stream flow: Reduction of the Colhue Huapi Lake.

Box 13 SR38b. Pollution and changes in the water table level: Groundwater supply to Río Gallegos city (Argentina)

Box 14 SR38b. Pollution in Limay, Neuquén and Negro Rivers

Box 15 SR38b. Eutrophication in Pellegrini Lake, Río Negro, Argentina

Box 16 SR38b. Unsustainable exploitation of fisheries and other living resources

ANNEXES

ANNEX I: **Subregion 38a La Plata River Basin.** Report Sheets

ANNEX II: **Subregion 38b: South Atlantic Drainage System.** Report Sheets

ANNEX III: Information Request Forms

ANNEX IV: Information Request Forms submitted by Subregional Experts

ANNEX V: Key informants

DETAILED ASSESSMENT
PRELIMINARY REPORT

1 BACKGROUND

This report describes briefly the development and outputs of the Detailed Assessment corresponding to the Scaling and Scoping, Component 1 of the current GIWA Methodology (version 3.5 May 2002). This report has been labeled as "Preliminary" since the final document will come out at the end of the process, when subsequent additions, reviews and updatings accomplished during the forthcoming remaining stages will render a final, comprehensive and improved version of this report.

The Detailed Assessment is presented in this report following the guidelines of the current Version 3.5 of GIWA Methodology. Section 1.1 describes the objectives there stated for this component.

SR38 Patagonian Shelf activities started in early July 2001, with the establishment of the coordination unit and the recruitment of experts to integrate the Subregional Expert Team. Soon afterwards, following methodological criteria prevailing at that time, the Scaling and Scoping Subregional Workshop was convened in Buenos Aires. Over 25 experts from representative areas of the Subregion and covering the various fields related to water resources and environment assessed and scored GIWA issues and selected priority concerns on the basis of their expert judgment. Section 1.2 summarizes the outputs of this Workshop. More detailed information may be found in the corresponding full Final Report displayed in GIWA web site (www.giwa.net).

The Detailed Assessment was conceived at that time as a self contained component, devoted to substantiate or review the output of the S&S exercise, based on documented information. A Second Subregional Workshop, was originally scheduled to allow the experts the opportunity of reviewing, discussing and validating the findings of the detailed assessment, thus establishing sound basis for the development of the causal chain analysis, which was the intended final output of the third and last Subregional Workshop. Section 1.3 refers explicitly to this initial conceptual framework.

Such methodological approach has been since those days subject to further elaboration, improvements and changes. The current Version 3.5 of GIWA Methodology presents substantial changes as compared to the starting one. The most relevant differences are the elimination of the 2nd. Workshop and the corresponding validation of the S&S Detailed Assessment, which became a not self contained component operating at all stages of the process, and the incorporation of the Policy Option Analysis as a main component of the project and the final output of second and last Subregional Workshop. Section 1.4 briefs this current approach.

Therefore this Report reflects this process of change, which lasted, as regards the Detailed Assessment and Causal Chain Analysis components, until last May 2002, when the updated GIWA Methodology was issued. In the meantime, since the S&S Workshop was completed in August 2001, SR38 activities were carried out trying to adapt to an evolving environment, moving from the original DA approach based on an extensive list of indicators, to the current one, a more descriptive and inventory type of output. As a consequence of this process, some methodological gaps have become apparent, particularly in relation with the need to review some of the outputs of the First Workshops on the light of the collected information. It is intended that said gaps and adjustments will be addressed during the remaining stages and consolidated in the context of the Final Workshop.

1.1 Objectives

Within the general framework of current GIWA methodology, the Detailed Assessment is an integral activity associated to all the methodological components of the assessment process which operates at several stages in said process. It is designed to prove and support with actual facts and information the conclusions of the Scoping exercise. In this context, the purpose of the Detailed Assessment is to document with existing information the scoring given to the impacts of the selected priority Major Concerns and Issue(s). Such information may come from various sources including former assessments, research papers, scientific publications, surveys, government reports, status reports, EIA reports, economic reviews, etc.

The aims of the Detailed Assessment at this stage of the process are:

1. To substantiate the conclusions of the Scoping based on the expert judgments by actual quantitative information; and
2. To identify and document the nature and availability of information related to the selected priority Major Concern and priority GIWA Issue(s) within the Major Concern.
3. To quantify the severity of the impacts of the selected priority Major Concern and priority GIWA Issue(s) within the sub-region.

1.2 Outputs from the First Subregional Workshop

During August 16-18, 2001, the First Subregional Workshop was convened in Buenos Aires. A number of experts representing various regions and fields of expertise participated in the discussions and assessed each of the GIWA issues and concerns, in present and future conditions to come out with their scoring and, consequently, the definition of the priority concerns and issues to be further analyzed in the remaining stages.

1.2.1 Scaling

The group agreed on the external limits of Subregion 38, Patagonian Shelf, which correspond to the to the officially accepted geographical limits of the La Plata River Basin and the boundaries of watersheds in the Argentinean continental territory. There was an objection, substantiated by the experts, as regards the northern limit of the coastal fringe in the Atlantic Ocean proposed by LME and GIWA. However, the subregional task teams of SR 38 and SR 39 agreed, after holding their respective First Workshops, to maintain the current division between both Subregions, subject to further analysis and subsequent studies of the South Atlantic Convergence.

Subregion 38 was divided in two systems (**Figure 1**): SR38a La Plata River Basin and SR38b South Atlantic Drainage System. For the purpose of the Detailed Assessment both systems were separated into subsystems/subbasins comprising international reaches or subnational intejurisdictional waters. They are listed in **Table 1**.

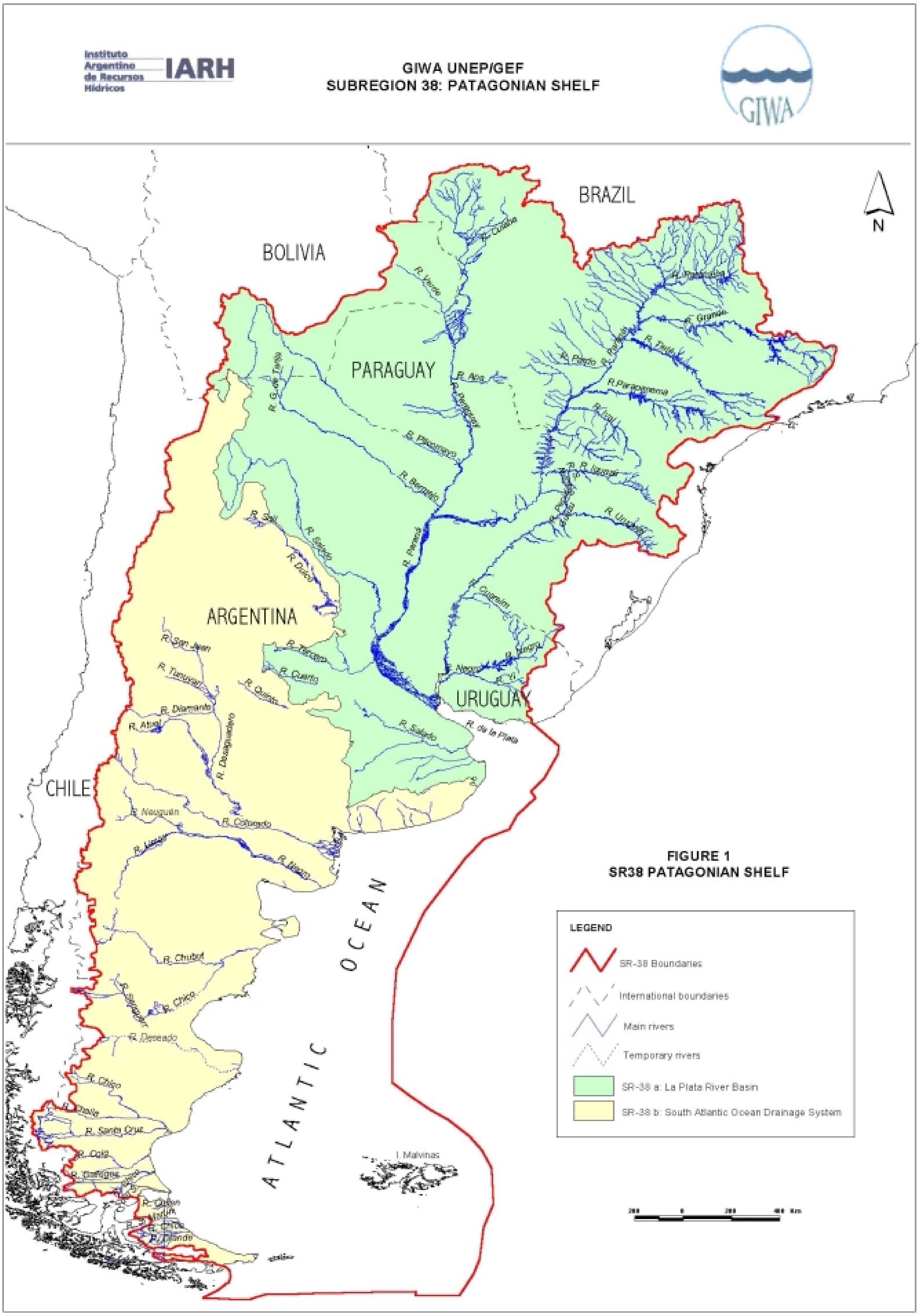

Instituto Argentino de Recursos Hídricos
IARH
GIWA UNEP/GEF
SUBREGION 38: PATAGONIAN SHELF
GIWA
N
BRAZIL
BOLIVIA
PARAGUAY
ARGENTINA
URUGUAY
CHILE
ATLANTIC OCEAN
I. Malvinas
R. Cuiaba
R. Verde
R. Paranaiba
R. Grande
R. Tiete
R. Pardo
R. Paranapanema
R. Iguazu
R. Uruguay
R. Apa
R. Pilcomayo
R. Bermejo
R. Paraná
R. Salado
R. Dulce
R. Sali
R. Cuareim
R. Negro
R. Yi
R. de la Plata
R. Tercero
R. Cuarto
R. Quinto
R. San Juan
R. Tunuyan
R. Diamante
R. Atuel
R. Desaguadero
R. Neuquén
R. Colorado
R. Limay
R. Negro
R. Chubut
R. Senguerr
R. Chico
R. Deseado
R. Chico
R. Santa Cruz
R. Coig
R. Gallegos
R. Grande
FIGURE 1
SR38 PATAGONIAN SHELF
LEGEND
SR-38 Boundaries
International boundaries
Main rivers
Temporary rivers
SR-38 a: La Plata River Basin
SR-38 b: South Atlantic Ocean Drainage System

Table 1 Subsystems selected for SR 38

Name of the shared surface or groundwater subsystem	Countries
SR38a La Plata River Basin	
Apa (Paraguay river system)	Brazil and Paraguay
Bermejo (Paraguay river system)	Argentina and Bolivia.
Pilcomayo	Argentina, Bolivia and Paraguay.
Paraguay	Argentina, Bolivia, Brazil and Paraguay.
Iguazú (Paraná river system)	Argentina and Brazil.
San Antonio (Iguazú river system)	Argentina and Brazil
Paraná	Argentina, Brazil and Paraguay.
Uruguay	Argentina, Brazil and Uruguay.
Cuareim (Uruguay River System)	Brazil and Uruguay
Negro (Uruguay River System)	Brazil and Uruguay.
Pepiri Guazú (Uruguay River System)	Argentina and Brazil
de la Plata	Argentina and Uruguay
Guaraní Aquifer	Argentina, Brazil, Paraguay and Uruguay
SR38b South Atlantic Ocean Drainage System	
Alfa	Argentina and Chile
Chico del sur	Argentina and Chile
Cullen	Argentina and Chile
Chico	Argentina and Chile
Ch Gamma	Argentina and Chile
Gallegos	Argentina and Chile
Grande	Argentina and Chile
San Martín	Argentina and Chile
Tierra del Fuego	Argentina and Chile
Colorado	Argentina
Chubut and Chico	Argentina
Limay, Neuquén and Negro	Argentina.
Santa Cruz	Argentina.

Concern	I: Freshwater shortage			II: Pollution								III: Habitat and community modification		IV: Unsustainable exploitation of fisheries					V: Global Change			
Issue	- Modification of stream flow	- Pollution of existing supplies	- Changes in the water table	- Microbiological	- Eutrophication	- Chemical	- Suspended solids	- Solid wastes	- Thermal	- Radionuclides	- Spills	- Loss of ecosystems or ecotones	- Modification of ecosystems or ecotones	- Overexplotation of fisheries	- Excessive bycatch and discards	- Destructive fishing practices	- Decreased viability of stock	- Impact on biological and genetic diversity	- Changes in hydrological cycle	- Sea level change	- Increased UV-B radiation	- Changes in ocean CO_2 source/sink function
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Environmental issue	1	2	1	1	2	2	2	2	1	0	2	3	2	3	2	2	1	2	2	0	0	1
Present impact	1.4			1.75								2.5		2					1			
Future impact	2			1.5								3		2.5					2			

Socioeconomic impact	Economic	Health	Social	Economic	Health	Social	Economic	Health	Social	Economic	Health	Social	Economic	Health	Social
Present impact	3	1.6	1.9	3	1.6	2.3	2	0	2	2.2	0	2.2	2.7	2.4	2
Future impact	3	2	2.5	3	1.5	2	2.5	0	2.5	2.5	0	2.5	3	3	2.5
Weighted impact	1.94			1.91			2.01			1.8			1.98		

Ranking	**3**	**2**	**1**	**4**	**5**

0 = No impact; 1 = Slight impact; 2 = Moderate impact; 3 = Severe impact

Table 2. Subregion 38 a: La Plata River Basin

Concern	**I: Freshwater shortage**			**II: Pollution**								**III: Habitat and community modification**		**IV: Unsustainable exploitation of fisheries**					V: Global Change			
Issue	- Modification of stream flow	- Pollution of existing supplies	- Changes in the water table	- Microbiological	- Eutrophication	- Chemical	- Suspended solids	- Solid wastes	- Thermal	- Radionuclides	- Spills	- Loss of ecosystems or ecotones	- Modification of ecosystems or ecotones	- Overexplotation of fisheries	- Excessive bycatch and discards	- Destructive fishing practices	- Decreased viability of stock	- Impact on biological and genetic diversity	- Changes in hydrological cycle	- Sea level change	- Increased UV-B radiation	- Changes in ocean CO2 source/sink function
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Environmental issue	1	1	3	1	1	1	2	2	1	0	2	2	2	3	2	2	1	1	+1	0	1	1
Present impact	1.8			1.5								2		1.95					0			
Future impact	2			1.2								3		2.5					0			

Socioeconomic impact	Economic	Health	Social	Economic	Health	Social	Economic	Health	Social	Economic	Health	Social	Economic	Health	Social
Present impact	2.3	0	2.3	2.3	2	1	2.3	0	2	2.2	2.2	2.2	+1,4	0	+1,6
Future impact	2.5	1	2.5	2.5	1.5	1	3	0	3	2.5	2.2	2.5	+1	0	+1,67
Weighted impact	1.93			1.55			2.2			2.01			-0.59		

Ranking	**2**	**4**	**1**	**3**	**5**

Table 3. Subregion 38 b: South Atlantic Drainage System

0 = No impact
1 = Slight impact
2 = Moderate impact
3 = Severe impact

1.2.2 Scoping

As **Tables 2** and **3** show, the scoring exercise did not resulted in clear identification of priorities in Subregion 38, except for the Major Concern 3: Habitat and Community Modification, that was given the largest score in both subregions. The group considered that numerical differences were not significant enough to establish priorities for the rest of the Concerns based on them. These priorities were finally assigned on the basis of common expert judgment built through intense discussion and further assessment of the individual scores.

Table 4 shows priorities assigned to the Major Concerns for SR38a and SR 38b individually and for Sub region 38 as a whole.

Priority	**SUBREGION**		
	La Plata River Basin	South Atlantic Drainage System	**Patagonian Shelf**
1	III. Habitat and Community Modification	III. Habitat and Community Modification	**III. Habitat and Community Modification**
2	II. Pollution	I. Freshwater Shortage	**I. Freshwater Shortage**
3	I. Freshwater Shortage	IV Unsustainable exploitation of fisheries and other living resources.	**II. Pollution**
4	IV Unsustainable exploitation of fisheries and other living resources.	II. Pollution	**IV Unsustainable exploitation of fisheries and other living resources.**
5	V. Global Change	V. Global Change	**V. Global Change**

Table 4 Priorities assigned in the S&S Workshop

The linkages between major concerns for Subregion 38 Patagonian Shelf as a whole (Figure 2) resulted from the aggregation of the analysis made for SR38a and 38b. Pollution of water sources has been identified as the main issue concerning water shortages in La Plata River Basin while in SR38b habitat modifications due to anthropic activities aggravate natural water deficits characteristic of said mostly arid region. As regards marine resources and ecosystems, pollution and unsustainable fishing practices affect aquatic habitats. Global changes, in terms of large climate variability and changes in the water balance, will affect aquatic ecosystems, habitat and community structures.

Given the significant differences in terms of physiographic, environmental and socioeconomic that exist between both systems SR38 a La Plata River Basin and SR38b, South Atlantic Drainage System, it was decided that the Detailed Assessment should be carried separately for each of them. Therefore Major Concerns III Habitat and Community Modification and II Pollution were decided for SR38a, keeping I Freshwater shortage as a relevant concern, mainly related to pollution of water sources. Major Concerns III Habitat and Community Modification and I Freshwater Shortage were adopted for SR38b, keeping II Pollution and IV Overexploitation of Living Resources as relevant concerns, closely linked to the priority ones.

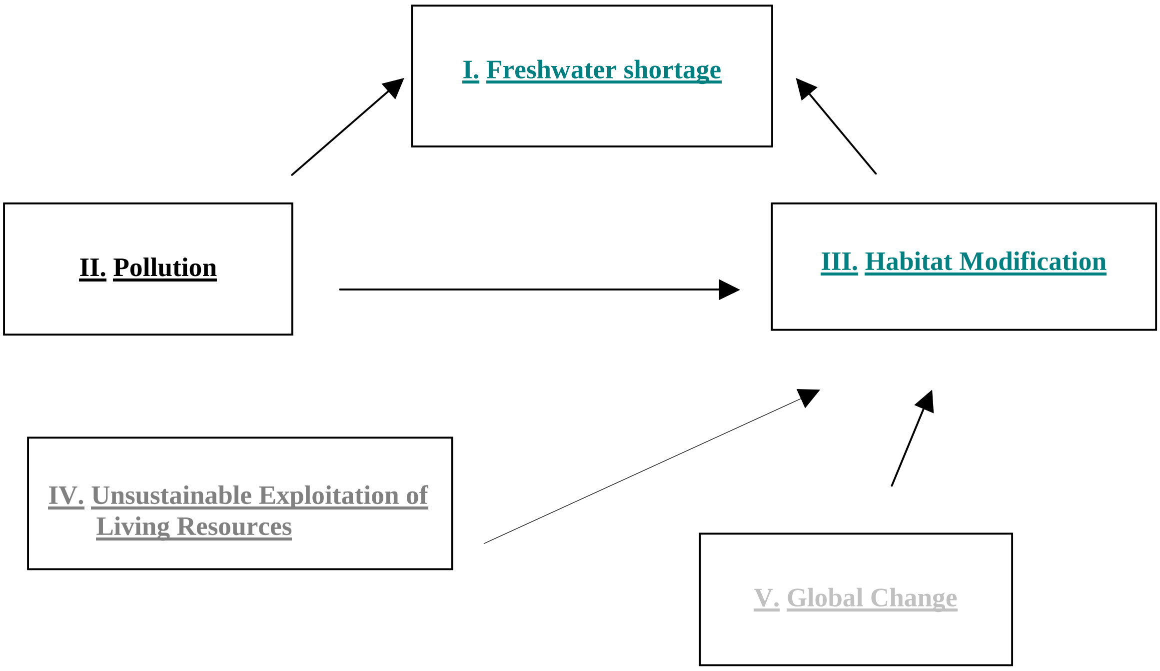


Figure 2 Linkages between Major Concerns

1.3 Initial conceptual framework

On July 1, 2001, an agreement between GIWA-UNEP, represented by Kalmar University, Sweden and the Argentine Water Resources Institute (IARH), Argentina, became operative with the objective of carrying out Phase II of the Global International Assessment Program in Subregion 38, Patagonian Shelf. IARH was appointed as the Subregional Focal Point.

According to the GIWA Methodology for Stage 1 (June, 2001), which served as the basis for the agreement, Phase II of GIWA was organized into three main stages:

- Stage I comprised Scaling and Scoping component, to be carried out mainly on the basis of expert judgments from subregional experts during a First Workshop (August, 2001). The outputs, summarized in Section 1.2, were reported in September, 2001.
- Stage 2 involved the Detailed Assessment of impacts prioritized during Stage 1. By the time the Workshop was held, such approach consisted in the systematic allocation of value to indicators given in a database to be provided by GIWA. A second Subregional Workshop was to be convened to review and validate the results of the Detailed Assessment.
- Stage 3, the final one of the Protocol for Phase II, identified as Causal Chain Analysis of the prioritized impacts, was to be set out on the basis of a preliminary scheme prepared by the Subregional Focal Point and validated at a Third Subregional Workshop.

According to the above mentioned agreement, Phase 3 of GIWA, the predictive and policy options phase was planned to be executed at the mega-regional level with input from the sub-regional task teams. Consequently these teams became committed their availability and participation in this phase of the project as well as to provide input to the predictive and policy option task force as required.

1.4 GIWA Methodology and the Subregion 38: Patagonian Shelf.

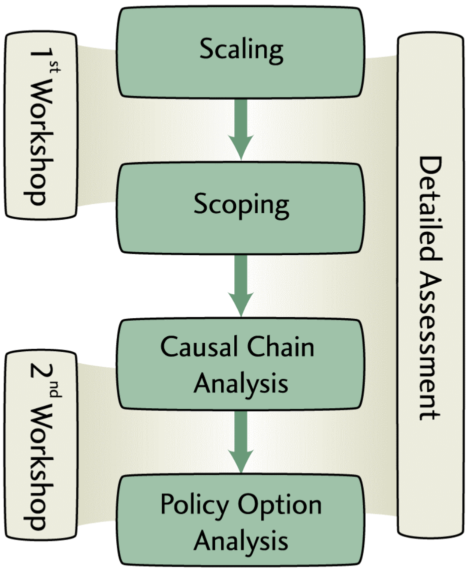
Due to the intrinsic nature of the project, the Methodology for Remaining Stages of the GIWA Project suffered changes that progressively modified the scope of the work that the subregional focal points would have to carry out.

The draft version of the Methodological Guidance for the Remaining Stages of the GIWA Project (October, 2001) established five components and the carrying out of two workshops. The first Component (Scoping and Scaling) and the 1st Workshop remained with their original structure. Component 2 (Detailed Assessment) methodology was changed strongly from the previous one, and the Subregional Workshop designed to validate its findings, was suppressed. The Causal Chain Analysis was identified as a particular activity (Component 3) and two more components were added: Predictive Analysis (Component 4)[1], and Policy Options (Component 5). The scope of this last component was defined as the preparation of an appendix with a draft list of alternative measures for remedial actions (that would be prepared during the 2nd Workshop, designed to covered components 3 to 5).

The methodology continued to evolve further. An updated version in January 2002, submitted to discussion a proposal for the Causal Chain Analysis which continued to be foreseen at that time as the major output of the process, supplemented by an approach to a set of policy options based on the findings of the CCA.

The outline of the, currently, final methodology version (Version 3.5, May 2002), is illustrated in Figure 3. The Scaling and Scoping Stage have kept its scope, with an emphasis in the collection of supporting evidence and information prior to the convening of the 1st. Workshop. The most significant changes take place in the subregional focal point tasks for the remaining stages (Components 3 to 5), which are outlined as follows:

Figure 3. Outline of currently methodology.



Detailed Assessment

- is not a self contained component which is confined to one stage in the assessment process;
- is an integral activity within the other components and, therefore, is carried out at several stages in the assessment process;
- substantiates the experts conclusions in the other components;
- identifies and documents the nature and availability of information related to the selected priority concerns and issues;
- quantifies the severity of the impacts of the selected concerns and issues.

Causal Chain Analysis

- traces the proximate to the root causative factors behind the selected GIWA concerns and issues;
- is conducted to serve as the foundation of the selection of policy options.

[1] Involving the construction of two future scenarios in addition to the most likely one considered during 1st Stage

Policy Option Analysis

- indicates potential policy interventions, based on the identification of the root causes conducted in the Causal Chain Analysis;
- includes the evaluation of alternative scenarios, developed on the basis of projected actions taken to addresses the identified root causes of environmental degradation.

Particularly, the most important change concerning the Detailed Assessment is related to its transformation in a continuous process incorporated to all stages of the GIWA, which begin with the Scoping. Within this context, the present Detailed Assessment Preliminary Report for Subregion 38: Patagonian Shelf, associated to the Scaling and Scoping Stage, provides a more in depth analysis and complements the information about the prioritized major concerns and issues presented in the Final Report of the 1st Subregional Workshop: Scaling and Scoping (IARH 2001). On the basis of the collected data, such prioritization has been checked, justified or reviewed. The effort also advances providing substantial information on which the Causal Chain Analysis will be based.

As previously stated, the Detailed Assessment will proceed forwards to support the Causal Chain Analysis and will provide information to substantiate the Policy Option Analysis Stage. Consequently, the findings of the DA for these above mentioned stages will be incorporated as appendices of the corresponding reports and integrated to this one in order to constitute the Final Detailed Assessment Report.

1.5 Organization

The Argentine Water Resources Institute (IARH) is the Focal Point for Subregion 38: Patagonian Shelf, responsible for the conduction of all necessary activities to fulfill the objectives and terms o reference agreed with GIWA Core Team and Kalmar University. For this purpose IARH has designated a Coordinating Team, integrated by Mr. Alberto Calcagno (coordinator) and Ms Ana Mugetti (co-coordinator), which is technically assisted by Ms. Silvia Gonzalez. Project activities are closely followed up by IAHR´s Board which meets on a monthly basis.

The Coordinator Team has adopted a flexible organization, capable of adapting to the changes required by the development of the different stages. Following GIWA guidelines, a Regional Expert Team and Network was first implemented, integrated by over 50 specialists from various regions and covering the various fields of expertise required by the process. The composition of the Expert Team and the level of involvement of its members will be adapted to the needs of the different stages. In order to support more efficiently the CCA and POA, a stronger participation of experts in socioeconomic and public policy fields will be procured.

A Subregional Core Team has also been appointed to support the Coordinating Team during the DA stage, integrated by four senior experts and junior associates. This team has been responsible for conducting the survey and collection of existing information, making the linkage with the members of the Expert Teams and other information suppliers, and carrying out the activities leading to the elaboration of the DA. To this end, responsibilities for each Concern and GIWA issues were distributed among the Core Team members.

It is envisaged that the Composition of the Core team will also be adapted to the requirements of the next stages of the Project.

2. CONSULTATION PROCESS

2.1 Background

Due to the fact that the methodology for the remaining stages of GIWA project, issued in October, 2001, did not provide concrete guidelines to proceed with the Detailed Assessment, the SR38 Core Team decided to undertake a subregional consultation addressing the member of the Expert Team. The consultation was carried out in electronic format, through emailing. Its contents were adapted from the former GIWA's methodology, proposed in April, 2001, which based the Detailed Assessment on the assessment of a series of pre-defined indicators of the environmental and socioeconomic impacts[2].

The adaptation consisted in a gross simplification of the method, characterized by its complexity, the large number of indicators and information gathering effort required, which, in most cases would have resulted ineffective given the foreseen lack of data existing in the region to support many of the extremely detailed pieces of information demanded by the methodology.

A number of forms were designed to request the information, based on the environmental and socioeconomic indicators suggested by the above mentioned methodology, addressing the issues prioritized by the S&S Workshop. A set of forms were elaborated covering each priority issue and the two water systems defined in the Subregion. Effort was devoted to make the design of the forms as friendly and less time demanding as possible, in order to ensure the best positive reaction from the experts to be involved in the consultation.

2.2 Information request forms

In order to gather opinions and information from the members of the Subregion 38 Experts Network information request forms were elaborated for each the 13 issues associated to priority Major Concern that were selected in the First Workshop (Scaling and Scoping) (See Annex III). These concerns are, in numerical order:

I: Freshwater shortage

II Pollution

III Modification of habitat and community.

A set of forms was prepared for each of the two systems defined for the Subregion 38: SR38a, La Plata River Basin and SR38b, South Atlantic Drainage System. To facilitate and organized the response by the different experts, these systems were in turn subdivided in a set of subsystems or major components which resulted from overlapping sub basins, water reaches o regions or maritime zones with the political international limits.

Consequently the subsystems were constructed overlaying the basin or water regions or maritime zones with the political international limits. The subsystems considered for this process of consultation are listed in **Tables 5** and **6**:

[2] This Methodology had been elaborated for GIWA by experts of the University of Plymouth, UK. It was self contained in CD format, which guided the reader through all the sequence of GIWA issues, listed the corresponding indicators, and supported the elaboration of the report sheets.

Table 5. Subregion 38a: La Plata River Basin. Water components

PAR1	Upper Paraná (Brazil)
IGUA	Iguazú and San Antonio (Brazil - Argentina)
URU1	Uruguay (Brazil)
PGY1	Upper Paraguay (Brazil)
PGY2	Paraguay (Paraguay)
PILC1	Pilcomayo (Bolivia)
PILC2	Pilcomayo (Argentina - Pararaguay)
BER1	Bernejo (Bolivia)
BER2	Bermejo (Argentina)
PAR2	Upper Paraná (Argentina - Pararaguay)
PAR3	Middle Paraná .(Argentina)
URU2	Upper Uruguay and Pepiri Guazu (Argentina - Brazil)
CUAR	Cuareim (Brazil - Uruguay)
URU3	Low Uruguay (Argentina - Uruguay)
NEGR	Negro (Brazil - Uruguay)
SAG	Guarani Aquifer (Argentina- Brazil- Paraguay- Uruguay)
PAR4	Low Paraná and Delta (Argentina)
RDLP	La Plata (Argentina - Uruguay)
ZCLP	Maritime front and coastal zone (Argentina. - Uruguay)

Table 6. Subregion 38b: South Atlantic Drainage System. Water components

COLO	Colorado (Argentina)
NEGR	Negro (Argentina)
CHUB	Chubut (Argentina)
SCRZ	Santa Cruz (Argentina)
GALL	Alfa, Chico del Sur, Cullen, Chico, Gamma, Gallegos (Argentina - Chile)
TFUE	Grande, San Martín, Tierra del Fuego (Argentina)
ZCAS	South Atlantic Coastal zone

As Annex III shows, the forms consisted of the following four parts:

PART I: GENERAL INFORMATION, comprising the issue concerned, the particular proposed water subsystem(s) to be assessed, personal data of the expert addressed, identification of the unit in charge of receiving the information and completed forms and of the member of the Core Team that would be in charge of the preliminary integration, at the corresponding issue level, of the collected information.

PART II: EXPERT´s OPINION REPORT. The expert was asked to provide his opinion about the situation and impacts of the issue, including its relation to the Major Concern involved, in about 500 words. In order to facilitate the elaboration, it was stressed that said opinion would be formulated mainly on the basis of his personal knowledge and information at hand, on the water system and influence region that he had indicated in Part I, of the form. Notwithstanding, it was also stressed the convenience of supporting said opinion with the information sources that the expert would be identifying in Part III.

PART III: LIST OF SUGGESTED INDICATORS AND INFORMATION SOURCES. In order guide the elaboration of the opinion report, the worksheet type of form comprised in the rows a list of suggested environmental and socioeconomic indicators related to the issue of concern. In columns, the expert was asked to broadly assess the situation of the indicators and state bibliographical sources and references to other specialists, who may also contribute with quantitative, general or specific information referred to studies, bodies of water or specific places, for the issue in consideration.

PART IV: MODEL TABLE FOR QUANTITATIVE INFORMATION. A worksheet, based on the format proposed in the former GIWA DA Methodology, was presented to the expert to be used in case he had ready available in his files quantitative information (representative annual values) on any of the indicators listed in Part III or any other one that he might consider appropriate for similar purposes.

2.3 Process

The Technical Core Team, constituted at the end of October, 2001, together with the Coordinating Unit, while waited for further guidelines from GIWA, delineated the strategy to approach the Detailed Assessment, by that time conceived as a one component restricted to the Scaling and Scoping Stage. The Information Request Forms were designed by the team through an iterative process and distributed during late December 2001 and January 2002 to about 45 members of the Subregional Expert Team. Issues and water systems were assigned to the experts on the basis of their thematic and geographical fields of expertise. Therefore, every expert received a personalized forms, one for each issue and system for which information was being requested to him. The deadline for handing the forms was set at the end of April, 2002, and by that time the forms completed by 18 experts had been received.

2.4 Outputs

The information provided by the experts through the forms, established the basis for the elaboration of the DA, and consequently, to improve, extend or eventually rectify, whether necessary, the criteria used to prioritize the 11 GIWA issues and 3 Concerns in the First Subregional Workshop. They also allowed identifying additional information sources and other specialists, who had or would be consulted in later stages of this Assessment. Annex IV shows, as an example, some of the completed forms received, whose information constituted an excellent platform for the assessment detailed in the next section.

A major part of the information obtained during this process was subsequently incorporated into the essays and the report sheets.

3. DETAILED ASSESMENT

3.1 Methodology

The consultation process above described, may be conceived as the first phase of the DA, which was carried out while GIWA Methodology for the Remaining Stages was being elaborated by the GIWA Methodology Task Team. The second phase, addressing specifically the Methodology issued on May 2002, was organized on the basis of a search and collection of information and data realized by the Subregional Core Team. The organization of the team is described in Section 3.2.

The search included publications dealing with studies concerning either the complete systems in which the Subregion 38 had been divided, the subsystems used to request the information in the consultation process or areas of significance within them. As an exception, the Core Team elaborated information for Issue 12, based on the compilation of published data.

As indicated in Section 1.2.2, the Detailed Assessment included in both systems the following issues and concerns:

Concern I Freshwater shortage

- Issue 1: Modification of streamflow
- Issue 2: Pollution of existing supplies
- Issue 3: Changes in the water table

Concern II: Pollution

- Issue 4: Microbiological pollution
- Issue 5: Eutrophication
- Issue 6: Chemical pollution
- Issue 7: Suspended solids
- Issue 8: Solid Wastes
- Issue 11: Spills

Concern III: Habitat and Community Modification

- Issue 12. Loss of Ecosystems or ecotones
- Issue 13. Modification of ecosystems or ecotones, including community structure and/or species composition

Issues 9, Thermal Pollution and 10, Radio nuclides Pollution, were excluded from the assessment, either because of their low weight or scoring.

During the process of collecting information for Subregion 38b: South Atlantic Ocean Drainage System, it was found that there was not available enough supporting evidence to justify the high priority given to Concern I: Freshwater shortage and the Concern II: Pollution. Instead, significant evidence was found supporting the importance of Concern IV: Unsustainable exploitation of living resources. Consequently it was decided to include this Concern and the corresponding issues, with exception of Issues 17, Decreased viability of stock through pollution and disease, and Issue 18: Impact on biological genetic diversity, which were given minimum valuation at the Subregional Workshop.

Concern IV: Unsustainable exploitation of living resources

- Issue 14: Over-exploitation
- Issue 15: Excessive by-catch and discards
- Issue 16: Destructive fishing practices

The criteria that justify the assigned scores are reported in the essays corresponding to each issue. Some relevant situations or hot spots which may be consider outstanding examples supporting those criteria have been incorporated into boxes. Both, environmental and socioeconomic aspects had been analyzed including the consideration of future conditions..

The information collected was incorporated into the report forms, following the guidelines and the definitions established in GIWA Methodology. However, the criterion used for assessing reliability of the information has been modified, given that the Core Team did not feel possible to guarantee a sound objectivity when using GIWA criterion. The following classification was used instead, as a measure of reliability of the information:

1. Proceedings of National and International Symposiums and Congresses.
2. Media Information
3. Reports of National Agencies
4. Reports of International Agencies
5. Books
6. Publications from private organizations
7. Publications from universities and research institutes.
8. International journals with peer review
9. National journals with peer review
10. Journals without peer review
11. Approved Ph. D and M. Sc. Thesis
12. Unpublished

3.2 Adopted organization

As described in Section 1.5, the Subregional Core Team, appointed to support the Coordinating Team during the DA stage, was integrated by four senior experts and junior associates. This team has been responsible for conducting the survey and collection of existing information, making the linkage with the members of the Expert Teams and other information suppliers, and carrying out the activities leading to the elaboration of the DA. They also have been in charge of assembling and selecting the information collected, elaborating the report sheets, essays and boxes To this end, responsibilities for each Concern and GIWA issues were distributed among the Core Team members.

Photo1. Task Group Subregion 38

The task group was integrated by:

Coordinating Team (Photo 1):

Alberto Calcagno

Ana Mugetti

Technical assistant (Photo 1): Silvia González

Core Team Members (Photo 1):

Alberto Calcagno	(Issues 12 to 16)
Carlos Brieva	(Issues 12 to 16)
Marta Faure	(Issues 2,4 and 5)
Ana Mugetti	(Issues 1, 2 and 7)
Silvia Raffaelli	(Issue 7)
Oscar Natale	(Issues 6, 8 and 11)

Assistants:

Catalina Botti	(Issues 2, 4 and 5)
Carlos Brieva	(Issues 1, 2 and 7, concern I)
Mariana Gasparoto	(Issues 12 to 16, concerns III and IV)

Silvia Gonzalez	(Concern II)
Mónica Posse	(Issues 2, 4 and 5)
Alejandra Rodríguez Speroni	(Issues 8 and 11)
Tamara Yunez	(Issue 6)

3.3 Outputs

The products presented in this preliminary report are:

a. Description of the systems 38 to and 38 b: Sections 4.1 and 5.1 respectively.

b. Essays with a descriptive report of the environmental problems under present conditions of priority issues (see Section 3.1). The essays are supported by graphics and illustrations using the information recorded in the worksheets: Sections 4.2 to 4.4 (Subregion 38a) and 5.2 to 5.4 (Subregion 38b).

c. Essays for Issues 14 to 16 under present conditions, Section 5.5.

d. Socioeconomic impacts under present conditions: Section 4.5 (Subregion 38 a) and 5.6 (Subregion 38 b).

e. Boxes with the geographical localization and description of the most significant hot spots of the Subregion.

f. Predictive analysis: Chapter 6

g. Conclusions, including the set of aspects that affect and that imply changes with respect to the findings of the S&S Report, comments on the methodology and the lessons learned.

h. Reports sheets 1 and 2: Annexes I and II, for the subregions 38 to and 38 b, respectively.

i. A list of the key resource persons, which kindly provided information as per requirement of the task group.

Besides, the tasks varied out allowed:

(a) to improve, to extend, and eventually to rectify, the argumentation that sustained the valuation adopted in the Workshop on the base of the expert opinion;

(b) to identify sources of information, including other specialists who could be consulted beyond the initially called for.

(c) to provide sources of quantitative information, at the annual level, about indicators which allowed the quantification of the issue under consideration.

Other results obtained in this period were:

1.- The contributions realized to the preliminary progress report of the GIWA project for the Latin-American region to be disseminated at the World Summit on Sustainable Development (26 August - 4 September 2002, Johannesburg, South Africa).

2.- The presentation (June 6, 2002) of the project and the partial results obtained for the Subregion 38, to the governmental national authorities of Argentina, including Foreign Affairs, the Secretariat of Environment and Sustainable Development and Undersecretary of Water Resources.

4. SUBREGION 38a: LA PLATA RIVER BASIN

4.1. Brief description of the system

4.1.1. Environmental aspects

La Plata River Basin is the second largest watershed in South America, with an area of about 3,100,000 km^2. It spreads across five countries: Argentina, Bolivia, Brazil, Paraguay and Uruguay (**Figure 4.1.1**.). One of its most important characteristics is the high geographic variation of rainfalls[3].

Mean annual precipitation ranges between 1,800 mm along Brazilian coast, subject to marine influence, and 200 mm at the western border of the Basin. The exceptions are some areas associated to the sub Andean ranges, where rainfall increases substantially. Spatial variation of seasonal rainfall regime is also very significant. The Northern area has a distinct seasonal pattern with maximum rainfalls during summer, whereas at the Central the area seasonal distribution is more uniform, with maximum rainfalls in spring and autumn. The amplitude of the annual cycle in rainfalls decreases from north to south both in absolute and in relative terms. Summer rainfalls are almost eight times in the Upper Paraguay and in the Upper Paraná basins, while is only twice in the Middle Paraná and much less to the south. Since the rivers generally run from North to South, this rainfall regime contributes to the attenuation of the seasonal cycle downstream[4].

Paraná and Uruguay Rivers collect almost all waters from the basin, draining them into La Plata River. The Paraná River, formed at the junction of the Paranaiba and Grande Rivers in Brazil, receives waters from a number of large tributaries. Some major sub basins are usually differentiated, like those corresponding to the Paraguay, Paranapanema, Pilcomayo and Bermejo Rivers. Other important sub basins are Tietê and Iguazú watersheds (**Table 4.1.1**).

River (km)	Basin Area (km^2)	Length (km)	Average discharge (m^3/sec)
Uruguay	440,000	1,850	4,500
Paraguay	1,095,000	2,415	3,810(*)
Paraná	1,600,000	2,570	17,140(**)
Iguazú	61,000	1,320	1,540
Bermejo	120,000	1,780	550
Pilcomayo	272,000	1,125	195

Notes: (*) Paraguay at Puerto Bermejo; (**) Paraná at Corrientes (Giacosa, Paoli and Cacik 2000).

Table 4.1.1 SR38a La Plata River basin. Main Rivers

Upper **Paraná River** spreads over the Brazilian southern plateau, while the lower reaches transect an area of plains. The system is characterized by large mean annual flows, resulting from heavy precipitations in the upper basin. Its width and bed morphology varies greatly along the course. Several important wetlands like Iberá Marshes, Submeridional Lowlands, Middle Paraná alluvial valley and Paraná Delta in Argentina are associated to the Paraná River[5].

In Brazil, Paraná River and its main tributaries (Parapanema, Tietê) are mainly used to generate hydroelectric power and a large number of reservoirs have been built in them. Itaipú (Brazil and

[3] Baetghen *et al* (2001): *Climatology and Hidrology of the La Plata Basin.* Document of VAMOS Scientific Study Group in the La Plata Basin.
[4] Baetghen *et al* (2001).
[5] Canevari *et al.* (1999): *Los humedales de la Argentina: Clasificación, situación actual, conservación y legislación.* Buenos Aires, Wetlands International Publ., 46.

Paraguay) outstands among them all, and together with Yacyretá (Argentina and Paraguay), both constitute examples of joint developments by riparian countries in the Basin. In Argentina, middle and lower Paraná River reaches are important waterways and their shores host large urban settlements and major industrial activities. In both countries Paraná River is used for freshwater supply for human and industrial use, fishing, recreational activities, and as a recipient of domestic and industrial effluents.

Uruguay River basin has also its upper areas on the Brazilian plateau and the lower ones on the plains. Uruguay River rises at Serra do Mar (Brazil); its cross section is graded due to its geological formation and presents some significant narrow stretches along its main course[6]. Its flow regime shows a high seasonal variability. Uruguay River is used for various purposes by the countries, which share it. Its main relevant use is Salto Grande hydroelectric power plant (Argentina and Uruguay), completed in early 1980s. It is navigable by about 340 km, downstream of the dam and it supplies water to irrigate rice fields by pumping in Uruguay and Brazil[7]. Cuareim (or Quarai) and Negro Rivers, both of them shared by Uruguay and Brazil, are major left margin main tributaries.

Paraguay River, the main tributary of Paraná River and its basin, spreads over an area of plains. Paraguay River rises to the North, in Parecis Ranges (Brazil), which divides La Plata River Basin and the Amazon River basin. A major feature of the upper Paraguay basin is the Pantanal, the world's largest wetland; it is a huge floodplain 770 km long with an area of about 80,000 km^2 (high waters season), which functions as a reservoir that regulates the Paraguay-Paraná regime. Downstream of the Pantanal, Paraguay River flows between high lateral natural embankments and next to the mouth, it forms multiple meanders. Paraguay River is mainly used in Brazil and Paraguay as a waterway, which also serves Bolivia.

Iguaçú (or Iguazú) River basin develops on the Brazilian plateau. Iguaçú River rises in Serra do Mar (Brazil) and, due to the relief, the riverbed presents sharp changes in slope and narrow valleys. There are many waterfalls and rapids along its course, the most important of which are the renowned Iguaçú Falls. Such features indicate the existence of a large hydropower potential, which has been developed through a cascade of reservoirs. Besides, Iguaçú River supplies water for human and industrial use, being the main water source for Curitiba city in Brazil[8].

Pilcomayo River basin spreads its upper part over a plateau and the lower part over an extended sedimentary plain (Chaco plain). Pilcomayo River has two main characteristics: an exceptional production of sediments that are originating by an erosive processes in upper basin; and a high variability of flows due to seasonal and spatial rainfall variation. Entering the lower basin, the river, heavily loaded with sediments, during the flood season, overflows forming several wetlands (like Patiño Marsh, La Estrella Swamp, Blanca Lagoon, in Argentina), which have a central role in the development of ichthyic fauna. The end section of the river has been progressively receding upstream because of sediment deposition. Groundwater from this basin is the large source of water supply in this part of the Chaco plain, where rainfalls are relatively small. Also, these waters are used for livestock consumption and recreation activities.

Bermejo River basin has sectors with very active natural sediment generation processes, mainly in the upper basin. Bermejo River rises in Real ranges (Bolivia) and in the sub Andean ranges areas of Salta and Jujuy (Argentina). On entering Chaco plain (lower basin), the river reduces dramatically its slope and looses loading capacity, which results in the deposition of part of the suspended sediments. Despite this fact, Bermejo River contributes with over 80% of the suspended sediments transported by the Paraná River into the La Plata River. Its waters are used for irrigation of farming areas and human and livestock consumption, both in Bolivia and Argentina. There are a number of wetlands associated to Bermejo River system, like Quirquincho swamps and Yema Lagoon in Argentina[9].

---

[6] Coimbra Moreira *et al* (n/d): *O estado das aguas na Bacia do Prata.*

[7] Yelpo and C (2000): "Informe Nacional sobre la Gestión del Agua en Uruguay", in GWP: *Agua para el siglo XXI para América del Sur: de la visión a la acción.*

[8] Urban (2000): *A crônica degradação do Rio Iguacu.* Sociedade de Pesquisa em Vida Silvestre e Educação Ambiental.

[9] Canevari, P. *et al.* (1999).

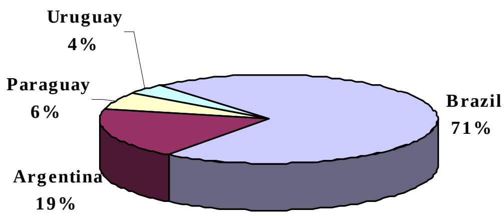
Figure 4.1.1
SR 38a. La Plata River Basin

Note:
Countries names abbreviations:
ARG: Argentina
BOL: Bolivia
BRA: Brazil
PAR: Paraguay
URU: Uruguay

La Plata River is a funnel-shaped coastal plain tidal river. It is oriented in the NW-SE direction. Its mouth, defined by a line joining Punta Rasa (Argentina) and Punta del Este (Uruguay) is about 230 km wide. Based on its hydrodynamics and morphology, La Plata River may be divided in two main areas. The outer area, where the freshwater rich in nutrients, interacts with coastal marine water, is the spawning and nursery area of several important fishery resources[10]. In the Argentinean coast, La Plata River waters are used for human consumption and as a disposal site for urban and industrial wastes in Buenos Aires and its metropolitan area. In the Uruguayan coast, the waters of La Plata River are used for the same purposes. Besides, some Uruguayan tributaries (like Santa Lucía River) are affected by the wastes of agricultural activities (specially fertilizers). Finally, there are recreational uses (such as practice of water sports and fishing) and others activities of relative importance in both coasts.

The **Guaraní Aquifer** is also located in SR38a (**see Figure 4.2.4**). It is one of the biggest groundwater storages in the world, with about 40,000 km^3 of freshwater, spreading below the territories of Argentina, Brazil, Paraguay and Uruguay (**Figure 4.1.2**). Its average thickness is about 250 m, ranging from a few meters at the borders of the basin to about 600 m in the central areas. The aquifer recharge areas, which also are the most vulnerable, coincide with its outcropping areas, generally next to the boundaries of the groundwater basin. The aquifer roof deep up to over 1,000 meters, as it occurs next to the Uruguay River in Argentina. In such regions, thermal water flows naturally from deep wells with temperatures between 33 C and 50 C, and average flows of about 100 m^3/hour. Currently, the thermal waters are used for health and tourism purposes, although it could be potentially used as a heat source for industrial uses[11].

Figure 4.1.2
Guaraní Aquifer
Area by country (%)



Source: SSRH, CODEVASF, DGRH and DNH (2002)

4.1.2. Socioeconomic Aspects

Spatial distribution of population in the five countries (Argentina, Bolivia, Brazil, Paraguay and Uruguay), which integrate the SR38, is very unequal. With the exception of Uruguay, population density is relatively low in all countries. The rate of increase the population, as it results from the two last Censuses, exhibits large variations among them (**Table 4.1.2**).

In general, the major concentrations of population are located in La Plata Basin, which is inhabited by about 50% of the combined population of the five countries. The main industrial belt of Argentina (between Santa Fe and La Plata), including the two biggest urban settlements (Metropolitan Area of Buenos Aires and Great Rosario) is located in this region. Something of the sort happens in Brazil, where the most densely populated areas in the South and Southeast of Brazil, including the large metropolitan areas of São Paulo and Curitiba, also belong to La Plata River Basin.

[10] Framiñan and Brown (1996): "Study of Río de la Plata turbidity front, Part I: spatial and temporal distribution", in *Continental Shelf Research,* 16 (10): 1259-1282. London, Elsevier Sciencie Ltd.
[11] SSRH, CODEVASF, DGRH and DNH (2002): *Project for the Environmental Protection and Sustainable Development of the Guaraní Aquifer System*. Annex 6: Description of Guaraní Aquifer System. http://www.aaas.org/international/lac/plata/rocha.shtml.

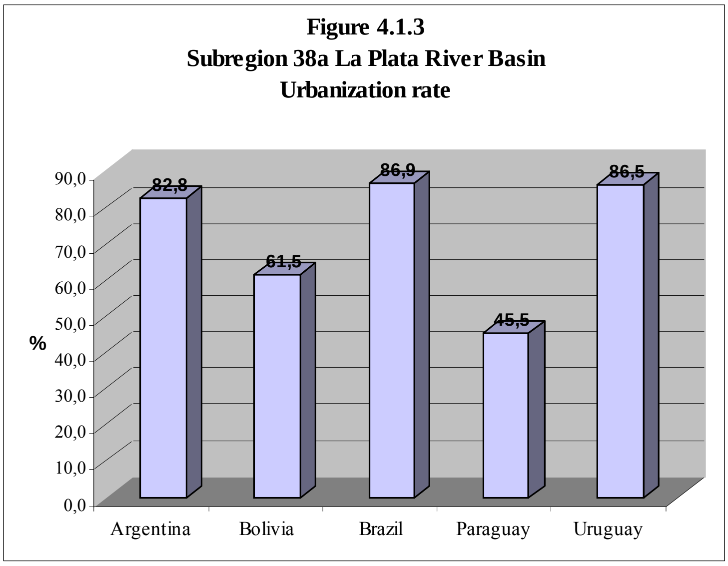
Country	**Total population**[12]	**Area (km^2)**	**Density (pop/km^2)**	**Inter census Population Growth (%)**
Argentina	27,740,527	1,176,840	23.6	9.2
Bolivia	3,661,232	577,986	6.3	32.8
Brazil	91,668,241	3,026,539	30.3	8.1
Paraguay[(1)]	5,496,450	406,752	13.5	32.4
Uruguay	3,198,147	154,936	9.6	4.9

Notes: [(1)] Projected to year 2000

Source: INDEC 2001; INE-Bolivia 2002; IBGE 2000; DGEEC 2002; INE-Uruguay 2002.

Table 4.1.2. SR38a. La Plata River Basin. Total population, area, density, and growth per country

With the exception of Paraguay and Bolivia, urban population largely exceeds rural population in the rest of the countries. High urbanization rates in Argentina, Brazil and Uruguay reflect the importance of the large metropolitan areas of the region, especially the Argentinean and Brazilian ones (**Figure 4.1.3**). The growth of intermediate cities has been also important in the last decades. All great cities have, in general, a good coverage of drinking water supply and sanitation systems. However sewage treatment is still quite low.



Besides domestic water supply, there is an important use of water by industry, especially in Argentina and Brazil. However, agriculture is by far the major water-demanding sector, being the most important activity in La Plata River Basin (**Table 4.1.3**).

Cereals, soybean and oleaginous are grown in Argentinean Pampas, soybean and sugar cane in Southern Brazil, soybean, cotton and grains in Paraguay, cereals and forage in Uruguay. In all of these areas, farming is complemented with cattle raising and milk industry[13].

Country	**Domestic (%)**	**Industry (%)**	**Agriculture (%)**
Argentina	9.0	18.0	73.0
Bolivia	10.0	5.0	85.0
Brazil	22.0	19.0	59.0
Paraguay	15.0	7.0	78.0
Uruguay	6.0	3.0	91.0

Source: GWP 2000

Table 4.1.3. SR38 Patagonian Shelf: Annual Extraction of water by economic sector

[12] To analyze the variations of population there was selected the provinces in Argentina, the states in Brazil and the departments in Uruguay and Bolivia, which are partially or totally included in La Plata River Basin.
[13] GWP (2000) *Agua para el Siglo XXI en América del Sur: de la visión a la acción.* GWP-SAMTAC.

Water of the large rivers and their main tributaries is used, also, to generate hydroelectric power. There are a large number of reservoirs in the whole Subregion, the major ones being located in the upper Paraná basin (Itaipú 12,000 Mw, Yacyretá 3,000 Mw, Ilha Solteira 3,500 Mw). Salto Grande (1,900 Mw), in Uruguay River basin also outstands.

As the economic profile of these five countries regards, the data show a decrease of GDP between 1998 and 1999 in all the countries in the Subregion 38, following a period of growth (**Table 4.1.4**). The participation of the different economic sectors in the GDP reflects the relevance of services and private consumption associated especially to the main urban centers (**Table 4.1.5**). La Plata River basin is also an important center of the regional economy: about 70% of global GNP of Argentina, Brazil, Uruguay, Bolivia and Paraguay is produced within the basin[14].

Countries	Average annual rates					
	1990	1995	1996	1997	1998	1999
Argentina	-2.0	-2.9	5.5	8.0	3.8	-3.4
Bolivia	4.4	4.7	4.5	4.9	5.4	0.8
Brazil	-4.6	4.2	2.5	3.1	0.1	1.1
Paraguay	3.0	4.5	1.1	2.4	-0.6	-0.1
Uruguay	0.4	-2.3	5.0	5.0	4.3	-3.8

Source: http://www.eclac.org.cl

Table 4.1.4. Subregion 38 Patagonian Shelf. Growth of Gross Domestic Product (GDP) at constant market prices

Sectors	Countries				
	Argentina	Bolivia	Brazil	Paraguay	Uruguay
Agriculture	5.7	15.4	8.4	24.9	8.5
Industry	28.7	28.7	28.8	26.2	27.5
Manufacturing	19.1	16.5	22.7	14.8	17.8
Services	65.6	55.9	62.8	48.9	64.0
Private consumption	70.7	75.2	63.6	72.9	71.0
General government consumption	11.9	14.0	17.8	10.5	13.7
Imports of goods and services	12.9	28.9	10.1	49.4	22.5

Source: World Bank 2000

Table 4.1.5. Subregion 38 Patagonian Shelf. Structure of economy (% of GDP) by country

In La Plata Basin, floods are the main natural risk. It impacts over a large number of population who live in cities and rural areas near to Paraná River littoral, and causes enormous economic losses. Last three main catastrophic floods occurred in 1982-83, 1992 and 1997-98, and they were associated with ENSO phenomenon. In 1997-98, ENSO also affected Uruguay River regime and the consequent flood impacted on several urban settlements[15]. These catastrophic floods caused economic losses to some industries, businesses and homes, creating a depression and psychological impact on most of the population[16] (C. Tucci 1998).

[14] Tucci and Clarke (1998): "Environmental Issues in the La Plata Basin", in *Water Resources Development*, 14 (2): 157-173.
[15] Goniadzki *et al.* (1998): *Uso de la información espacial para la confección de cartografía de vulnerabilidad por inundaciones en la Cuenca del Plata.* http://www.conae.gov.ar/ninio/ninio2/ina_inta.htm
[16] Tucci C. (1998): *Dams and flood control*. Porto Alegre, Institute of Hydraulic Research.

4.2 Concern I: Freshwater shortage

This concern was ranked as second priority in Sub Region 38 as a whole, being assigned priority 3 in SR38a La Plata River Basin System.

Freshwater Shortage - Environmental Impacts by Issue: Present Conditions	*
1. Modification of stream flow	1.0
2. Pollution of existing supplies	2.0
3. Changes in the water table	1.0
Overall Impact	1.9

* Weighted score

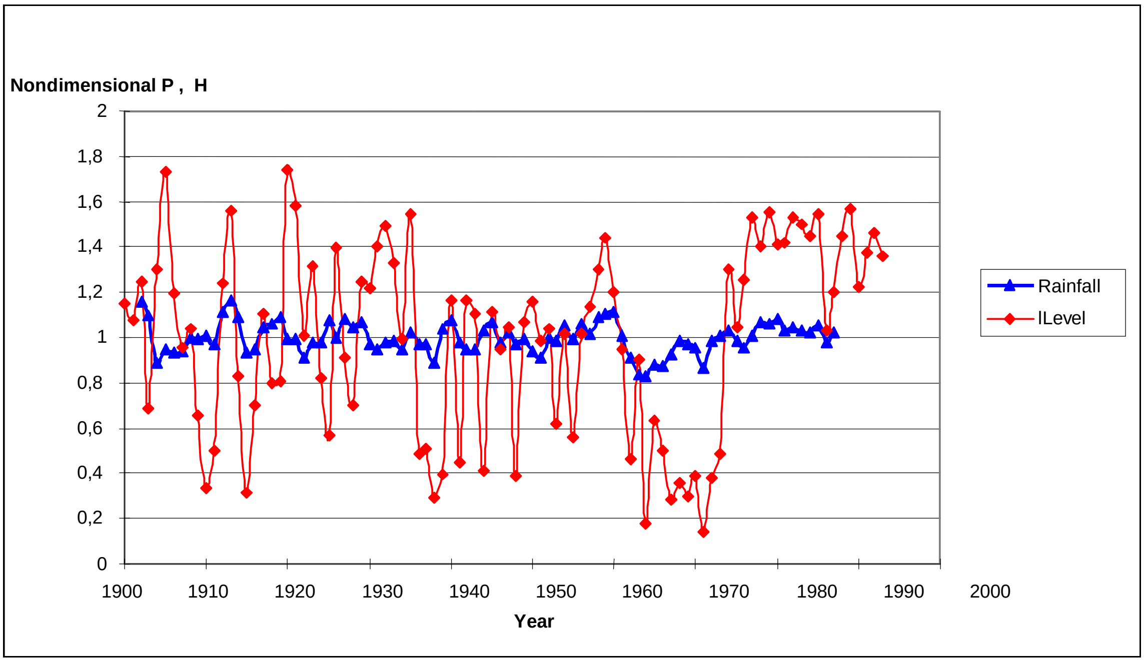
As regards Issue 1, slight impact score was assigned given some localized evidences of significant discharge decrease due to intensive water extraction in the Quarai/ Cuareim region. Changes in low water flows and to some extent in high water flows due to land use and reservoir operation occur in the Paraná River system. Pollution of fresh water sources was considered the more relevant cause of fresh water shortage in SR38a, based on reports of fish kills, extended bacteriological contamination due generalized discharge of raw sewage into rivers, very high levels of pollution in some urban and industrial areas (Tieté River, Paraguay River, Lower Paraná -La Plata River coastal fringe, Pilcomayo River during peak flows, etc.), including evidence of toxic substances. There is also evidence of contamination of aquifers (Buenos Aires Metropolitan Region, Paraná coastal region, Guarani aquifer recharge areas), used as urban and industrial water supplies, due to domestic and industrial pollution and intensive agriculture and cattle raising activities. Issue 3 received score 1 given some evidences of water table lowering, well's deepening, overexploitation of aquifers and presence of salinization in some hot spots in Brazil, Uruguay and Argentina- Buenos Aires Metropolitan Region.

4.2.1. Issue 1: Modification of stream flow

As regards Expert Group, there are some evidences of changes in downstream discharges due to changes in land use and reservoirs operation.

In the Upper Paraná River Basin, stream flow increasing of about 20% - 45% were observed in several tributaries upstream of Itaipú Reservoir compared with the same measures in the 60-70 years (Müller 1998)[17]. Similar trends were found in the Paraguay River Basin (**Figure 4.2.1**) and Uruguay River Basin (Tucci and Clarke 2001). Such stream flows changes can not be explained only by the increasing in rainfall during the same period, therefore, other factors such as changes in land use and land cover affect this process (Müller 1998).

[17] Complete bibliography and source references are in the Annexes of report sheets



Source: (Tucci and Clarke 1998)

Figure 4.2.1 Variation in annual water level at Ladário, (Upper Paraguay) and rainfall (three year moving average) at Cuiabá, River Paraguay

Taking into account the historical series of the river discharges it is possible to identify three periods within the Middle and Lower Paraná River basin. The first one from the beginning of the XX century to 1930 with a positive trend, the second one from 1930 to 1970 with the lowest flows of the century and a negative trend, and finally the last one from 1970 to 1998 with higher flows and more frequent outstanding peak flows. There is also in the last period a different distribution of monthly discharges (Giacosa, Paoli and Cacik 2000).

The lack of a theory which explains the climate changes and seasonal anomalies make it difficult to assess the influence of the human activities on these issues. However, it is well known that the human activities have modified the environment by changing the land cover (deforestation, annual crops that increase runoff and decrease infiltration, etc.) and building reservoirs and dams for hydroelectric power generation and irrigation. Dam operation changes the hydrological regimen downstream since it originates both, a decrease in peak flows and an increase in minimum flows (**Figure 4.2.2**).

In summary it is possible to say (i) that flow has increased in the Upper Paraguay, Paraná and Uruguay River basins; and (ii) rainfall and land-use changes have both contributed to cause the flow increase, although there is not yet a clear answer as to the relative magnitudes of the two contributory causes (Tucci and Clarke 2001).

Despite the fact that demand for water supply and irrigation historically used to be both met within La Plata River basin, today in some areas, urban water supply and irrigation compete for available water, especially during low flow periods, when demand increases (Arcelus et al. 1999; ANA 2001)

In the Uruguay River basin there are some private developments for rice production. This irrigation occurs mainly along the Ibicuí River in Brazil and the Cuareim River shared by Uruguay and Brazil, both tributaries of the Uruguay. In these areas there are some conflicts between the requirements for water supply and for irrigation during dry months. The present demand is about 13% of the mean flow of the Ibicuí River (Tucci and Clarke 1998).

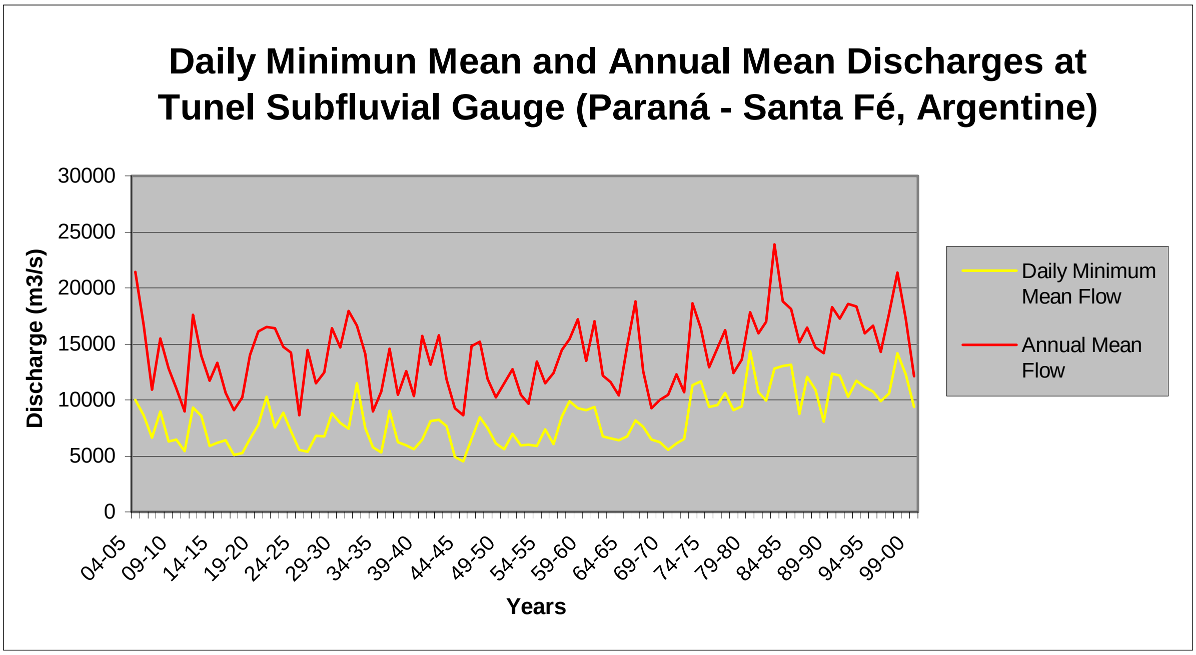


Figure 4.2.2: Changes of the daily minimum mean discharges and annual mean discharges of the Paraná River (Paraná – Santa Fé cities)

In the Cuareim River Basin rice started to be grown over 25 years ago near Artigas and Quaraí cities, based on the supply of irrigation water from November to February (**Box 1**). Since 1986-87 cultivated areas have strongly increased and water availability soon became a barrier to such growing trend. Improved water management by means of storage reservoirs (60% of water source) allowed the addition of new lands for rice crops. Just in Salto-Artigas area, Uruguay, over 26,000 ha have been added in the last 10 years, reaching about 30,000 ha (CRC 2002).

In several areas within Tiete River basin and Grande River basin in Sao Paulo State irrigation can not be expanded since there are some conflicts between domestic water supply and irrigation due to freshwater shortage. Similar conflicts between industrial and domestic water supply have been found in the region of Baxio Pardo - Mogi (Sao Paulo) where sugar cane and alcohol industries use about 22% of the industrial water consumption (Tucci 2001).

Box 1 SR38a - Modification of the stream flow: Cuareim or Quaraí River

Cuareim River basin is about 14,900 km^2 and it is shared by Brazil (55.6%) and Uruguay (44.4%). It is located in Southern part of Brazil and Northwestern of Uruguay (**Figure 1**). The Cuareim River is one of the main tributaries of Uruguay River.

Figure 1. Location of the Cuareim River basin

Climate is temperate and mean annual rainfall is about 1,270 mm. Precipitation pattern and soil features determine water deficit during summer months.

Water supply for Artigas (Uruguay, 40,000 inhabitants) and Quaraí (Brazil, 29,000 inhabitants) cities, and irrigation, of high economic importance, are the main water uses.

Rice started to be grown over 25 years ago near Artigas and Quaraí cities, based on the supply of irrigation water from November to February. Since 1986-87 cultivated areas have strongly increased and water availability soon became a barrier to such growing trend (**Figure 2**). Improved water management by means of storage reservoirs (60% of water source) allowed the addition of new lands for rice crops. Just in Salto-Artigas area, Uruguay, over 26,000 ha have been added in the last 10 years, reaching about 30,000 ha (CRC 2002).

Although demand for water supply and irrigation historically used to be both met, today urban water supply and irrigation compete for available water, especially during low flow periods, when demand increases (Arcelus et al. 1999). Critical values of water availability during summer months become evident, when the long term minimum discharge for 1980-1993 period is analyzed (Figure 3) (DNH 1994).

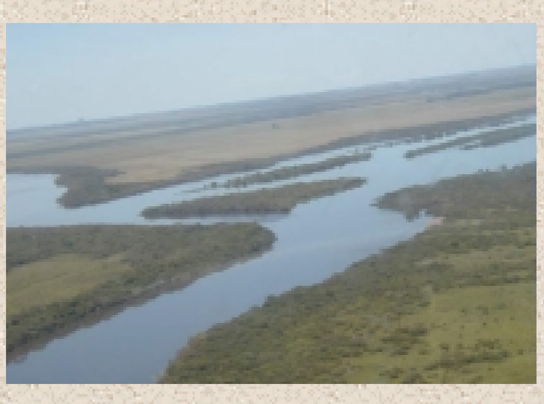


Figure 2. Cuareim River and irrigated rice crops

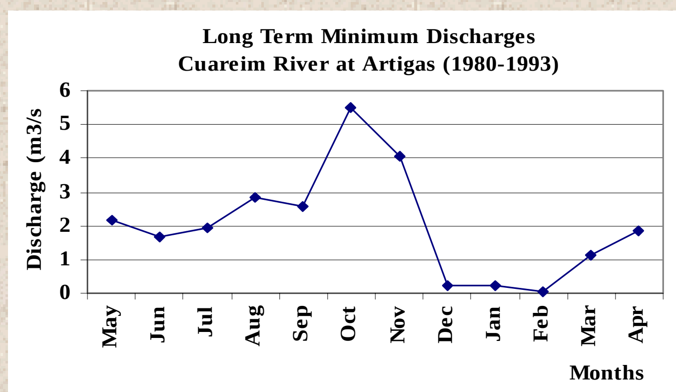


Figure 3. Cuareim River minimum discharges

4.2.2. Issue 2: Pollution of existing supplies

Pollution of surface and ground water bodies used in most cases as sources for human consumption, industrial use and irrigation is becoming an extended problem with growing trends in the region. As a consequence water supply is becoming affected by increase treatment costs and the need of searching for alternative sources to cope with growing and unsatisfied demand. In some hot spots within SR38a, this problem has already become stringent and it is foreseen that it will become worse in the future as urbanizations trends remain unchanged. Supporting evidence of pollution of water sources has been found and some of them are briefed below.

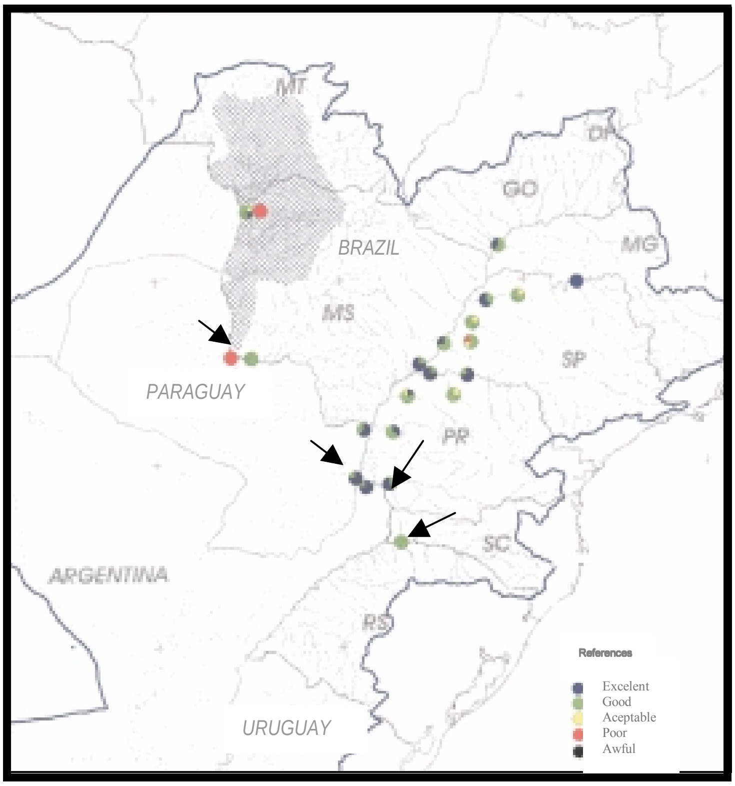
The waters from Pilcomayo and Bermejo Rivers, as well as their tributaries, are important sources of domestic water supply. Systematic information on water quality and its impact on water supply and human health is generally lacking or poor. In general it is considered that water quality is good except in the vicinity of human settlements. However, the increase in turbidity due to large sediment loads carried by these systems during the summer rainy season obliged to add water pre - treatment to the conventional one. Evidence of water pollution has resulted from the Water Monitoring Program that the Department of Tarija (Bolivia) has been carrying out since 1998, by the Natural Resources and Environment Departmental Direction, in order to assess the water quality in nine points in those basins in Bolivian territory. Concentration levels of As, Pb, Cd, Ni, Zn, Mn CN, P, Fe and B over the allowed ones by the Bolivian environmental legislation, have been found.

Additionally, incidental pollution events have been recorded, such as the cases of mining spill at Porco in the Upper Pilcomayo River in 1996 and hydrocarbon spill at Bloque de los Monos that affected the Pilcomayo River 5 km upstream of Villamontes in 1998. They indicate the existence of risks for direct human water consumption and of accumulation in biota.

In the Upper Paraguay River the main pollution risk drive from mining (Mato Grosso), sediment loads from erosion due to soil fragility and overgrazing mainly in the Taquarí River basin (Mato Grosso do Sul) and untreated discharges. In general water quality is good except near the cities. There have been reported fish kills but from natural origin due to a lowering in the dissolved oxygen as a consequence of higher load of organic matter contents during the rainy season.

The **Figure 4.2.3** presents graphically the results of a short term diagnostic of the water quality in selected stations associated to international river reaches in the Brazilian area of the La Plata River Basin. Graphs are based on a water quality index derived from one year long periodic measurement of a certain number of parameters.

The Upper Paraná basin in Brazil is about 1,000,000 km^2 and its population is 46.7 millions of inhabitants spread in 5 States and 1 Federal District. A major part of the industries and many of the greatest cities of the La Plata basin are located in this region. Also a number of reservoirs for hydroelectric generation have altered the natural flow conditions. Pollution of water supply sources is a generalized but localized problem in many urban settlements. São Pablo city has 16



Note: ➔ Stations mentioned in Table 4.2.1

Figure 4.2.3. Quality water in the Brazilian area of the La Plata River Basin.

millions of inhabitants and water pollution is a high concern since domestic and industrial discharges are thrown to the rivers and reservoirs without treatment polluting the water sources (**Box 2**). Tamanduateí, Pinheiros and Tietê Rivers (Upper Metropolitan Zone) have a high pollution load with extremely low, or even zero, dissolved oxygen levels (CETESB 2000). The water treatment costs are increasing and with such pollution trends the availability of the water sources are also at risk. High algal growth and low efficiency of its control in the Guarapiranga Reservoir have originated problems with the water treatment (Beirut 2001). Although there exist several restoration plans in place, their outputs are expected to become evident in about 20 years given the current pollution condition. In the Upper Paraná River basin the organic matter discharge is estimated in 730,000 tons BDO/year.

As regards groundwater sources, there exist a water quality monitoring network of 142 wells widely spread in the Guaraní, Bauru, Serra Geral, Taubate and Cristalino aquifer systems, operated by CETESB. Thirty one physical – chemical and bacteriological parameters are analyzed every semester. In some wells pollution from nitrate and coliforms bacteria have been found. As indicated by groundwater vulnerability studies, the major environment concern areas are Ribeirao Preto/Franca, Bauru, Campinhas and the recharge zone of the Guaraní aquifer.

A similar situation of stress waters sources occurs in Curitiba region, in the upper watershed of the Iguazú River. According to ANEEL (2001), in general, the water quality of the system is good. However there are local cases of high pollution such as the main reach of the Iguazú River and Iraí Reservoir that originates problems in the water supply for Curitiba, given its ongoing eutrophication process (ANEEL 1998). In the Iguazú River sewage discharges are thrown without treatment. The potential pollution load is estimated in about 140,000 kg BOD_5/day. Only 29% of urban population is served by sewage network.

Additionally, other sources of pollution are runoff from rural and urban area. In effect, this region there was an accelerated growth of agriculture as of the decade of the 60, replacing forests by intensively mechanized agriculture areas. This process resulted in an intensive use of the natural resources that caused serious problems of erosion with economic implications for agrosystems and for the environment. Among them outstands the increase of turbidity in the water uptakes with consequent increase in operation costs of the water purification services. (FAO 1992).

Table 4.2.1 shows the main parameters of water quality measured in the transboundary reaches of the Brazilian rivers. The Brazilian guidelines about physical-chemical and bacteriological parameters of water quality used in supplying with conventional treatment are different from those proposed by Argentine guidelines. While Brazilian guidelines take into account water uses and aquatic life supporting variables together, Argentine ones take them separately.

Impacts of BOD contents in the waters of the Paraná River (Middle, Lower and Delta), Lower Uruguay River and La Plata River, as regards proposal national guidelines of water quality for domestic water supply, might be consider between medium and low. The impacts of nutrients and pathogens contents in water might be classified as moderate. In Río Tercero Reservoir, located in the Tercero River (tributary of the Paraná River) problems of water treatment due to eutrophication have been recorded.

In the Lower Paraná River near Rosario city algae concentration is about 15,000 and 300,000 org/l, and turbidity is about 30 – 230 NTU. It is a particular case of water with a medium turbidity and moderate concentration of plankton microorganisms. Although the plant of conventional water treatment guarantee the absence of pathogen agents in the treated water, it can not guarantee the absence of algae even with the improvements done on several treatment steps. As a consequence there are operative problems, worsening of treated water features, possible increasing in tri-halo-methane (THM), and nutrients such as organic matter which might cause microorganisms growing in the water supply network (Cepero *et al.* 2000; Vazquez *et al.* 1997).

Parameter	MVA*	Unit	Foz do Iguazu		Iguazu National Park		Murtinho Port		Iraí	
River			Paraná		Iguazú		Paraguay		Uruguay	
			1998	1993-1997	1998	1993-1997	1998	1993-1997	1998	1993-1997
Arsenic	0.05	mg/L	0.005	0.02	0.005	0.02	0.01	0.02	-	-
Cadmium	0.001	mg/L	0.004	0.001	0.004	0.001	ND	0.001	ND	0.001
Lead	0.03	mg/L	0.04	0.03	0.04	0.03	0.02	0.02	0.01	0.02
Cyanide	0.01	mg/L	0.01	0.01	0.007	0.01	0.01	0.008	-	-
Chloride	250	mg/L	2.2	2	1.3	2	5.5	3.5	3.5	1.5
Copper	0.02	mg/L	0.01	0.01	0.009	0.01	0.003	0.007	ND	0.02
Fecal coliforms	1,000	# /100mL	25	110	320	210	20	110	-	-
Total coliforms	5,000	# /100mL	10,000	700	3,200	1,300	650	4,000	10,300	12,100
Colour	75	mgPt/Co	70	40	85	50	85	60	-	135
Total Cromium	(0.05)	mg/L	0.05	0.01	0.05	0.01	0.005	0.005	ND	0.01
BOD	5	mg/L O_2	1	1	1	1	5	7	0.5	1
Detergents	0.5	mg/l LAS	0.02	0.05	0.03	0.05	0.07	0.04	0.04	0.08
Total Phosphate	0.025	mg/L P	0.02	0.015	0.036	0.03	0.12	0.074	0.09	0.14
Phenol Index	0.001	mg/LC_6H_5OH	0.001	0.005	0.001	0.005	0.003	0.001	0.002	0.007
Mercury	0.0002	mg/L	0.0002	ND	0.0002	ND	0.0002	0.0002	ND	0.0002
Nitrates	10	mg/L	0.33	0.23	0.49	0.47	0.15	0.17	0.6	1.6
Nitrites	1	mg/L	0.008	0.005	0.003	0.005	0.001	0.003	0.007	0.02
NH_4^+	0.02	mg/L	0.03	0.03	0.04	0.03	0.35	0.23	0.1	0.1
Oils and grease	Absent	mg/L	5	4	5	4	ND	0.25	-	-
Dissolved Oxygen	≥ 5	mg/L O_2	9.6	9	9.6	9.2	3	4.6	6.1	7.8
PH	6.0 – 9.0	-	7.5	7.5	7.2	7.4	5.8	6.8	7.5	7.5
Turbidity	100	NTU	17	9.5	27	9.2	30	15	35	28
Zinc	0.18	mg/L	0.02	0.06	0.04	0.03	0.06	0.02	0.1	R<0.16<B

Table 4.2.1. Water quality at Brazilian borders

Notes:
* MVA: maximum values allowed by CONAMA 20/1986, Brazil
Data that exceed the guide values of water sources for human consumption with conventional treatment suggested by Technical Argentine Group to the La Plata River Basin Intergovernmental Coordinating Committee (1987).
Data that exceed the maximum values allowed in Brazil.

The coastal area of the La Plata River (**Box 7**), associated to the Buenos Aires Metropolitan Region, is subject to major water quality impacts as a result of intense urban and industrial water uses in a large area along said coast. A systematic water quality monitoring covering a fringe 10,000 meter wide off shore, has been carried on for over a decade. The distribution of the physic, chemical and biological water quality variables in the La Plata River depends to a large extent from hydrodynamic and meteorological conditions. In general, concentrations show a rapid decreasing trend away from the shore. Oxygen demands (BOD_5 and COD) show high values between Riachuelo River and Punta Colorada (**Box 4**). Dissolved Oxygen reaches the lowest values near the coast and the maximum about 3,000 meters off the coast. Such behavior clearly responds to the polluting discharges. High concentrations of Ammonium, Nitrates and Phosphates, as well as heavy metals, agrochemicals and biphenyl poly-chlorines, have been also measured. The highest bacteria concentrations occur within 500 m from the coast, and decreases beyond 3,000 meters. Microbiological parameters such as total coliforms and fecal coliforms are above the values recommended by US EPA. In 1997, geometric mean of about 12,000 of fecal coliforms /100 ml, resulted from measurements in the Riachuelo River

In the Salado River basin, a tributary of the outer La Plata River, concentrations of nitrate well above the accepted guidelines values have been found (N/NH4 max. 5,4 mg/l, N/Nitrate max. 2,1 mg/l, P/Phosphate max. 1,7 mg/l).

In Uruguay, water supply for Maldonado and Punta del Este were affected by eutrophication problems in Laguna del Sauce. At the same time in the littoral of the La Plata River, pollution is related to discharges of Saint Lucia River and other small streams that flow into Montevideo´s bay.

Box 2 SR38a Pollution of freshwater supplies: Metropolitan area of São Paulo, Brazil

Despite the fact that available fresh water resources in the la Plata River basin exceeds by far existing aggregated demand, uneven temporal and spatial distribution of flow in watershed headwaters and water quality degradation of sources are posing problems of freshwater shortage in some areas , like in the metropolitan areas of São Paulo and Curitiba. São Paulo city is an emblematic case of such situation which may become more frequent in this apparently water rich basin.

The city of São Paulo, which lies on the Upper Tietê River basin, demands about 60 m^3/s of safe drinking water. Presently, 33 m^3/s are imported from neighboring basins, since the Tietê system is lacking water of a sufficiently high quality (Tucci and Clarke 1998).

The population of São Paulo Metropolitan Region (RMSP) is about 17 millions inhabitants, divided into 39 municipalities. The main water and sanitation supplier is SABESP which operates the Metropolitan System that is fed from 8 major systems (**Figure 1**) (Cantareira, Guarapiranga, Alto Tietẽ, Grande River, Claro River, Alto Cotia, Baixo Cotia y Ribeirao da Estiba) (CETESB 2001).

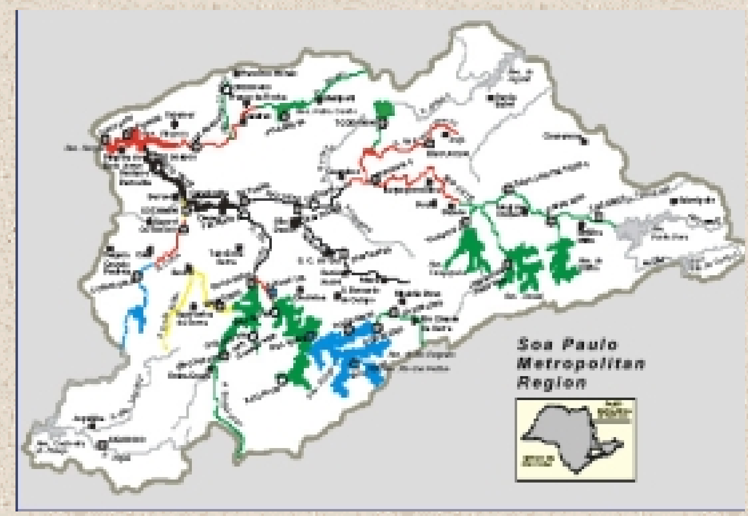


Figure 1 SR38a Map of the Metropolitan region of São Paulo State.

Cantareira system supplies about 50% of the metropolitan area requirement, while additional 20%, is supplied by Billings - Guarapiranga Reservoirs system, mainly to the southern part of SPMR. Billings is the biggest reservoir and was built in 1927. The water quality of the Billings - Guarapiranga system is presenting an environmental alert condition for domestic water supply due to: eutrophication, toxic algal growing, and water color and taste nuisances that require a larger economic and technological effort to treat water up to acceptable drinking standards. According to the Water Quality Report of Inland Waters in São Paulo State (CETESB 2001), both reservoirs exhibit generalized eutrophic conditions based on phosphorous and chlorophyll “a” indices, with an increase with relation to 1999 in Guarapiranga Reservoir.

Figure 2 View of São Paulo city, Brazil

A rapid and intense occupation (so called “informal city”) of the watershed areas draining into the reservoirs has altered significantly the natural water cycle in terms of quantity and quality, by reducing infiltration rates, modifying flow regimes and incorporating point and diffuses pollution sources. These areas, which amount to 54% of São Paulo Metropolitan Region, exhibit the highest rates of demographic growth in the region (**Figure 2**). Main point and non point sources of pollutant, like organic matter (BOD input was estimated in about 10.7 ton/day in Billings Reservoir watershed in 1996), nutrients, heavy metals and biocides, come from urban and industrial wastes, rural runoff, uncontrolled solid waste disposal and leakage from surface or underground storages. Although a large part of the watershed still exhibits acceptable conservation status, trends during the last years indicate that higher rates of urban expansion in said vital areas are taking place as a consequence of various regulatory, economic, institutional and social circumstances. Thus, freshwater shortage as a consequence of pollution of sources is becoming a major issue in highly developed upper watershed areas of the La Plata Basin.

4.2.3. Issue 3: Changes in the water table

There is evidence of the water table lowering, wells deepening, over-exploitation of aquifers and groundwater salinization within La Plata basin. Experts pointed out that isolated cases had been reported in Brazil.

Information about quantity, availability and exploitation of groundwater in the Subregion 38a is still incomplete and variable. However, the province of Buenos Aires is considered an emblematic case of overexploitation of aquifers within La Plata River basin (**Box 3**).

Groundwater overexploitation due to domestic water supply has been observed in urban belt of Buenos Aires City, the more densely inhabited area in Argentina with about 12 million inhabitants. It extends from Zárate city to La Plata city. La Plata, historically is the first important city of Argentina being supplied from groundwater (1885). This source has undergone overexploitation since before 1950, when 15 wells had to be abandoned due to salt intrusion from the saline strata which underlies the coastal plain of the La Plata River (World Bank 2000).

During 1970 the salt intrusion rate was 70 m per year towards the city center, but the trend has now decreased because many wells have been abandoned and others reduced their rates. At the same time, such intensive exploitation resulted in the decrease of the hydraulic potential of the good quality semi-confined aquifer which supplies the city; favoring the downward flow of water polluted with nitrates from the upper free aquifer (CYTED 2000).

Nowadays, an increase in the water table in the Buenos Aires Metropolitan Region aquifer is taking place, mainly due to: (i) rainfall increasing in the aquifer recharge area, (ii) decreasing of the industrial activity and water use, and (iii) substitution of groundwater by surface water supply and the expansion of the water supply network without providing sewage network at the same time. In Buenos Aires urban belt, 55% of the population is supplied by freshwater network while only 33% is served by sewage collection systems (FI UNLP 1996).

In the Northwestern part of Buenos Aires irrigation and domestic water supply uses compete for the same groundwater sources. Salinization processes due to lowering of the water table makes this conflict more serious by diminishing water availability, particularly during summer months when domestic and crop requirements are higher (Gonzalez and Hernández 1998)

Guaraní Aquifer System (SAG) is the greatest aquifer of the region and will be subject to a joint regional appraisal and definition of common management approaches for sustainable use and conservation by means of a GEF Project starting in 2002 (**Figure 4.2.4**). Preliminary studies indicate that there are not evidences of overexploitation at regional level of the Guaraní Aquifer System by the four countries that share this water resource. SAG use in Argentine is minimal regarding its installed pumping capacity (about 3.00 m^3/h). A similar situation is found in Uruguay. In Brazil the installed pumping capacity is about 111,000 m^3/h representing 1/30 of the recharge rate, which is considered to be a sustainable exploitation. In Paraguay extraction rates are similar to estimated recharge rates (Gregoraschuk 2001). However, at local level mainly in recharge areas or natural spring areas with urban development, there are evidences of overexploitation and risk of pollution from human activities.

In the State of Sao Paulo, Brazil, groundwater sources are not too much exploited. Extraction rate is about 60 m^3/s, representing only 18% of the available recharge, estimated in 336.1 m^3/s. However, in local areas at municipal level such as do Pardo, (Ribeirão Preto); Turvo/Grande (São José do Rio Preto); Paraíba do Sul (São José dos Campos); Tietê/Jacaré (Bauru), a lowering of the water table is taking place due to overexploitation (CETESB 2001).

In the Upper Tietê River basin extraction rates from the sedimentary aquifer are higher than recharge rates. This negative balance is somehow supplied by the losses from the freshwater and sewage networks. However, lowering in the water table due to aquifer overexploitation is inverting the natural underground flow from the river towards the aquifer, reducing the basic discharge of the river (CETESB 2001).

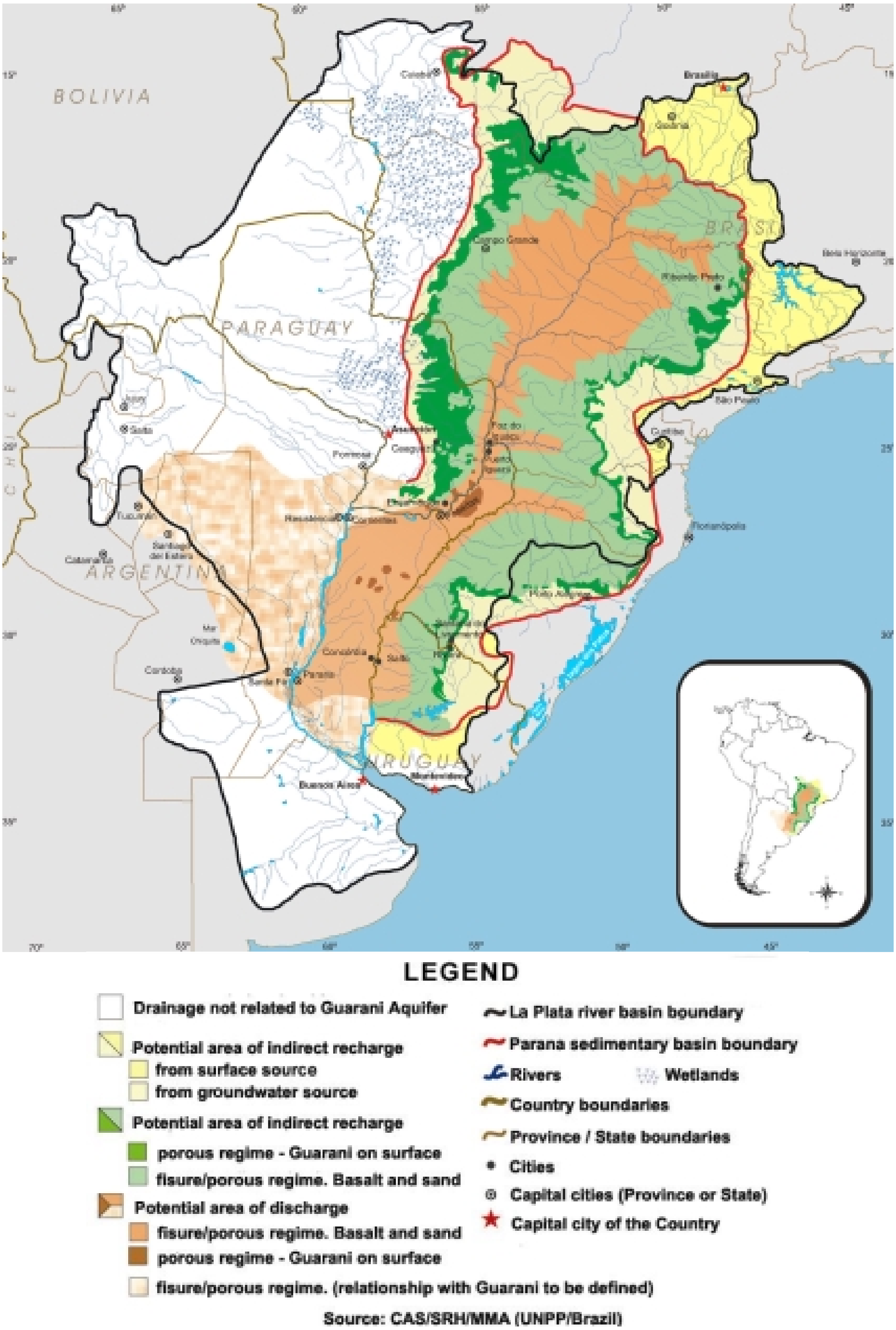


Figure 4.2.4: Guaraní Aquifer System location and features

Box 3 SR38a Changes in the water table: Overexploitation and pollution of Puelche aquifer

Puelche aquifer is located in Argentine, extending from the province of Santa Fe in the north to the Samborombón bay (province of Buenos Aires) in the South (**Figure 1**).

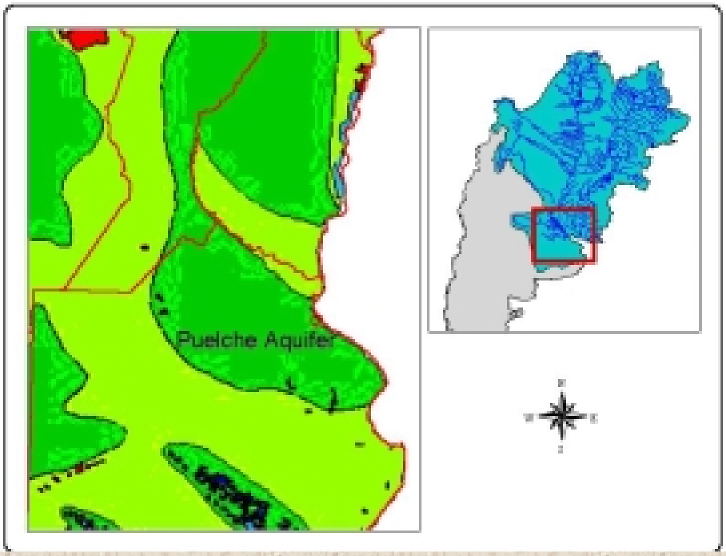


Figure 1 Location of the Puelche Aquifer in SR38a

Groundwater overexploitation due to domestic water supply has been observed in urban belt of Buenos Aires City, the more densely inhabited area in Argentina with about 12 million inhabitants. It extends from Zárate city to La Plata city.

La Plata (**Figure 2**), historically is the first important city of Argentina being supplied from groundwater (1885). The groundwater source, has undergone overexploitation since before 1950, when 15 wells had to be abandoned due to salt intrusion from the saline strata which underlies the coastal plain of the La Plata River.

During 1970 the salt intrusion rate was 70 m per year towards the city center, but the trend has now decreased because many wells have been abandoned and others reduced their rates. At the same time, such intensive exploitation resulted in the decrease of the hydraulic potential of the good quality semi-confined aquifer which supplies the city; favoring the downward flow of water polluted with nitrates from the upper free aquifer .The underground water balance is negative. A deficit of 11 hm^3/year results from an extraction of about 50 hm^3/year for freshwater domestic supply while the recharge is only 39 hm^3/year. Water quality presents a poor condition: nitrates concentration is above 45 mg/liter in the entire city, but it is as much 90 mm/liter in about 2/3 of its area. Pollution is caused by non point sources, mainly leakages from sewer network, abandoned sanitation wells and an old solid wastes dumps (CYTED 2000).

Figure 2 View of La Plata City, Argentina

Other places around Buenos Aires city (**Figure 3**) have similar pollution problems, even more significant than La Plata city. The Puelche semi confined aquifer turned into a free one due to the lowering of piezometric level below the roof of the semi confined aquifer because of overexploitation (Quilmes and Berazategui cities). At the same time pollution by nitrates increased sharply. Also Lanús, Lomas de Zamora, San Martín, Olivos, Tigre and other cities in the Buenos Aires Metropolitan region have experienced salt intrusion problems (World Bank 2000).

During the last 10 years, many wells were abandoned because of pollution, salinization and the substitution of groundwater to surface supply sources, originating the raising of the hydraulic level, in some cases up to the land surface. Buildings and urban infrastructure are being affected and. human health risk and other environmental impacts occur as a consequence of polluted out flowing waters. Recently new industries, like breweries, have set up in the northern area of the RMBA (Zárate) and negative impacts related to water availability, in both quantity and quality, are expected in the near future (FI UNLP 1996).

Figure 3 Cities location. SAC-C space image

4.3 Concern II: Pollution

This concern was ranked as second priority in Sub Region 38 as a whole, being assigned priority 2 in SR38a La Plata River Basin System:

Pollution - Environmental Impacts by Issue: Present Conditions	*
4. Microbiological	1.0
5. Eutrophication	2.0
6. Chemical	2.0
7. Suspended Solids	2.0
8. Solid Wastes	2.0
9. Thermal	1.0
10. Radionuclides	0
11.Spills	2.0
Overall Impact	1.9

* Weighted score

In Sr38a region, there are numerous indications of bacteriological contamination. Score was given based on GIWA criteria, which only takes in account registered cases of gastroenteric diseases due to fish consumption, that are no significant in the region. However, water quality measurements, health records and bathing advisories indicate that the impact may deserve a higher score. There is evidence of eutrophication in localized areas of large reservoirs on the international rivers and has a more generalized and higher incidence in a number of man made lakes in their tributaries.

Industrial contamination is particularly important as a result of the limited treatment of industrial wastes and revamping of industrial processes. Lack of control on oils used by cars and engines in general also contributes to the situation. Contaminated rain runoff waters, which wash out debris and solid wastes into the receiving surface waters, are a fair common urban source of organic and chemical pollution. There is high fish mortality near effluent discharges, and pesticides are widely use in agriculture all over the Basin, including those banned by legislation. Finally mining waste discharges are present in the Upper Pilcomayo River basin.

There are indications of increases in turbidity due to erosion processes caused by changes in land use and unsustainable agricultural practices. This occurs in particular in humid areas subject to deforestation for agricultural purposes, in various regions in the Basin. Suspended sediments are particularly high in the Bermejo and Pilcomayo Rivers, most of it originated in natural land slides and soil erosion processes.

There is a widespread presence of solid wastes from urban and industrial refuse in shores and banks of water bodies, mainly in urban watersheds, like the large metropolitan areas located in the Basin. Storm events contribute to solid waste transport and spreading. There are also open uncontrolled urban dumping sites in the vicinity of main rivers and tributaries.

Important occasional oil spills in rivers like in La Plata River (Magdalena, 1999, 250 tons of crude oil), Iguazú River (Curitiba, 2000, Petrobrás, 1,300 m^3 of oil) support the score given to this issue. Particular relevance has had the heavy metal spill from the tailing pond of COMSUR Mine, Pilcomayo River (Porco, 1996, 300,000 tons).

Issues 9, Thermal Pollution and 10, Radionuclides Pollution, were excluded from the assessment, either because of their low weight or scoring.

4.3.1. Issue 4: Microbiological pollution

GIWA valuation criteria for microbiological pollution is based on impacts on Human health, mainly gastrointestinal disorders related to fish consumption. Since there were no significant evidences of such impact in the region, a score of 1 (low impact) was assigned to this issue by the expert group during Workshop I. However it was considered that Fecal Coliforms (MLN/100 ml) should better be considered as indicator of water quality related to microbiological pollution. As result of a preliminary analysis of the information available related to microbiological pollution in the Subregion 38a, it was possible to assess the situation of some water components. The importance of the impact was determined using the Guidelines of Water Quality for La Plata River Basin proposed by the Argentine Technical Counterpart to the CIC – Intergovernmental Coordinating Committee for the La Plata River basin countries and similar values established by Brazilian legislation, as follows: a) water for domestic supply with conventional treatment – FC = 1000 MLN/100 ml; b) water for leisure activities with direct contact - FC = 200 MLN/100 ml (FC = 1000 MLN/100 ml for Brazilian legislation). According to the Brazilian Norm CONAMA 20/86, it should have to consider that the water indication for consumption previous conventional treatment is apt for recreation with primary contact in Brazilian Guidelines.

In the São Paulo Metropolitan Region (Brazil), the Upper Tietê River system is completely anaerobic due to discharge of untreated industrial effluent and sewage and supports no fish life, emits foul odors most of the year, and serves as a sewage dump. It receives permanent discharges of waste water, at a rate of about 40m3/s, representing 60% of the river's mean dry-weather flow. This pollution affects some 8 million people and it is the cause of the water quality deterioration in the reservoirs downstream (IDB, 1995). In this case the impact is evaluated as severe. The Paranoa Lake receives the treatment effluent of Brasilia city and exhibits water quality problems (**Figure 4.3.1**), when reference is made to Brazilian guidelines.

There is a generalized lack of sewage treatment in the sub-region 38a, that impacts on the water quality of many rivers, mainly in the vicinity of cities. In the Upper Uruguay, Peixe, Cuareim and Lower Uruguay Rivers the microbiological pollution can be considered as severe. Similar situation is found in the Upper Paraguay River, but it might be considered as moderate because of the dilution capacity of the river. Finally, in the Negro River the microbiological pollution is considered as low.

The impact of microbiological pollution related to leisure activities in the La Plata basin might be considered between moderate and severe. In the Middle Paraná River the Fecal Coliforms measured in 1994 presented an average of 609 MLN/100 ml and a median of 210 MLN/100 ml, both values exceeding the standard. The same situation for average and median measures have been found in the Paraguay River, 651 MLN/100 ml and 218 MLN/100 ml, respectively. Although in the Lower Uruguay River the average and median of Fecal Coliforms concentration measured has been below the guidelines, there are values in the range 4–480 MLN/100 ml, higher than the standard. That has determined the interdiction of the human recreation with primary contact in fringe coastal of considerable extension.

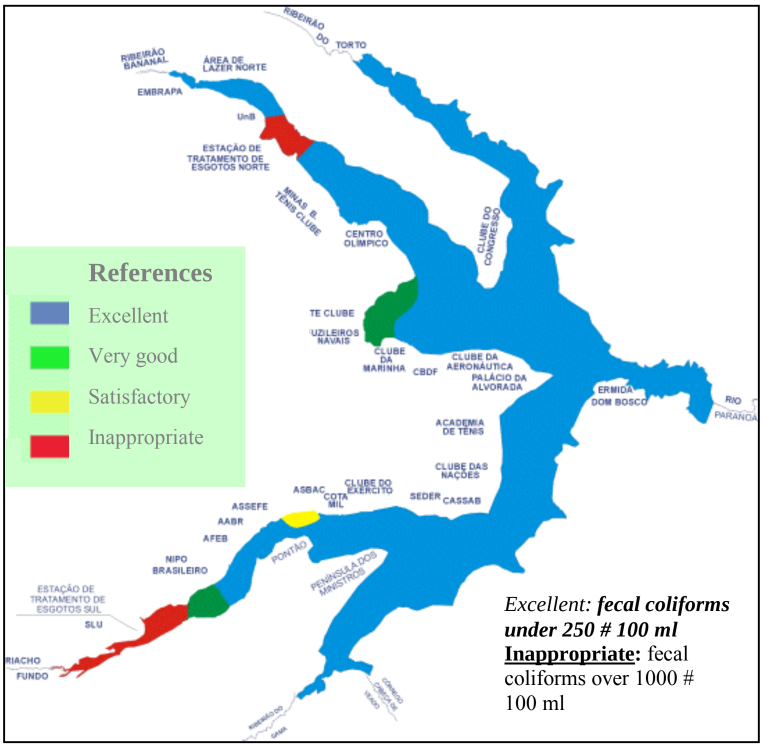


Figure 4.3.1. Water quality for leisure use in Paranoa Lake, Brasilia (Brazil). Source: CAEBS, 2002

The impact of microbiological pollution related to water supply in the La Plata River (**Box 4**) and its Southern shoreline can be classified as moderate. Although in 1994-95 the median of Fecal Coliforms concentration measured has been below the guidelines, the values are in the range 13–630957 MLN/100 ml, the higher exceeding by far the accepted standards. Such high values are due to sewage discharges at Berazategui as well as Riachuelo River, Santo Domingo and Sarandí streams.

There is not information gathered about *Vibrio Colerae* in the La Plata River basin except an event of cholera in the 1994 in the Tarija River, tributary of the Bermejo River. Few cholera cases were reported in the same area in later years.

Box 4 SR38a. Microbiological Pollution: Pollution in the La Plata River

La Plata River is a large estuary shaped freshwater body of about 30,000 km^2, limited to the northwest by the Delta of the Paraná River and Uruguay River mouth and by the sea, to the Southeast, by the imaginary line that joins Punta del Este city in Uruguay with Punta Rasa in Argentine. La Plata River has a mean annual flow above 22,000 m^3/s from both the Paraná River (about 18,000 m^3/s) and the Uruguay River (about 4,500 m^3/s). Suspended solids vary between 150 and 300 mg L^{-1} (Boneto and Hurtado 1998).

Buenos Aires Metropolitan Region, is supplied by two very important water treatment plants: San Martin (2,500,000 m^3/d) and Belgrano (1,100,00 m^3/d). San Martin plant is located in Buenos Aires city, 30 km downstream of the Reconquista River mouth and of a number of smaller and very contaminated creeks and streams (Medrano, White, Vega and Maldonado). Until 1976, its water intake was located some 600-700 meters off the coast. Because of the high pollution levels, the intake had to be moved up to 1050 meters away from coast (World Bank 1995). Moving the water intake point was clearly a direct cost attributable to pollution, which today must be considered a sunk cost. The fact that currently, said pollution sources upstream of the water intake still remain active, renders the city supply system highly vulnerable to higher water treatment costs if pollution increases in future (World Bank 1995).

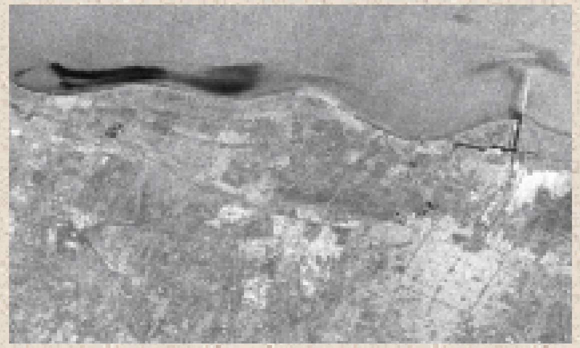


Figure 1: Sewage discharge at Berazategui

Table 1. Source: ETOSS 1997

Table 1 Characteristic parameters of the sewer water discharged in La Plata River	
Parameters (unit)	**Daily average**
BOD_5 (mg L^{-1})	120
COD (mg L^{-1})	310
Nitrates (mg L^{-1})	21
Total phosphorus (mg L^{-1})	4
Total coliforms (MLN/100 ml)	5 E7
Fecal coliforms (MLN/100 ml)	1 E7

Dissolved Oxygen reaches the lowest values near the coast and the maximum about 3,000 meters off the coast. Such parameters clearly respond to the polluting discharges, exhibiting high concentrations of Ammonium, Nitrates and Phosphates, as well as heavy metals, agrochemicals and biphenyl poly-chlorines. The highest bacteria concentrations occur within 500 m from the coast, and decreases beyond 3,000 meters. Microbiological parameters such as total coliforms and fecal coliforms are above the values recommended by US EPA. In 1997, geometric mean of about 12,000 of fecal coliforms /100 ml, resulted from measurements in the Riachuelo River. As a consequence, direct contact recreational activities are interdicted in many areas along the coast, which indicates that the impact associated to microbiological pollution, should be qualified between moderate and severe in this region (CIC La Plata basin1987). Phytoplankton higher concentrations occur near the coast, although they have been decreasing during the last 50 years probably due to chemical pollution. The analysis of main algal species distribution and their ecological features help in identifying the areas whether the human impact is higher such as the mouth of the Luján and Riachuelo - Matanza Rivers and the sewage discharge at Berazategui (**Figure 1**).

4.3.2. Issue 5: Eutrophication

As a result of the analysis of the available information on Eutrophication, some water components of Subregion 38a, could be evaluated, in order to discuss and support the findings of the First Workshop.

In South Coastal Fringe of La Plata River (**Box 4**) the nutrients constitute one of the important contributions originating from different sources, like industries, domestic effluents, etc. The most affected zone comprises a 500 ms width band from the shore, which may extend up to 1,500 ms in some specific zones, like Berazategui. The river dynamics influences the distribution of the nutrients concentrations. The phytoplanctonics species found in South Coastal Fringe are characteristic of a freshwater environment, with predominance of mesosaprobics, and eutrophic species. The larger concentrations are near the coast. The more numerous algae groups are: bacilariophytae, clorophytes and cyanogenic bacteria, indicating lower complexity, and denoting a fluctuating and unstable environment. It was observed a diminution of the algal density in the last 50 years; this could be due to chemical contamination (heavy metals, biocides, hydrocarbons). The low algae density and the reduced chlorophyll concentration demonstrate that the SCF is little productive. The analysis of main algae species distribution and their ecological features help in identifying the areas where human impact is higher such as the mouth of the Luján and Riachuelo-Matanza Rivers and the sewage discharge at Berazategui. Problems in water purification for human consumption in the city of Buenos Aires have taken place.

In the Province of Buenos Aires, there exists a significant number of lagoon ecosystems, characterized by non permanent thermal stratification and high suspended solids concentration that determines a low transparency (Secchi disc < 40 cm). These lagoons have features of a eutrophicated ecosystems and as such, they are alkaline water bodies, with high concentration of nutrients and algal biomass. The abundance of nutrients is related to the contributions of urban and domestic effluents, and agricultural and cattle raising activities. There are evidences of damages caused by water quality to the ichthyic fauna. These water bodies are of importance for tourist, sport and recreational activities. In the basin of the Salado River, nutrient concentrations exceeded guidelines (N/NH4 max. 5.4 mg/l, N/Nitrate max. 2.1 mg/l, P/Phosphate max. 1.7 mg/l).

In the Negro River basin (Uruguay), the Bonete (1,070 km^2), Baygorria (100 km^2) and Palmar (320 km^2) reservoirs were constructed for electric generation (600 MW), but currently they are used for multiple purposes. Deterioration of water quality became evident by the increase of their trophic state (mesotrophic-eutrophic), the increase of the corrosive potential, toxic algal blooms, weeds and colonization by exotic species. The phytoplankton community has been dominated by nanoplanktonic phytoflagellate, diatoms (Aulacoseira) and cyanogenic bacterias (Microcystis accompanied by Anabaena). The last ones, most abundant during the summer, presented toxic blooms between January and March (maximum of chlorophyll a = 37 µg/l) in the intakes near the dams. The maximum concentration of Hepatotoxina (microcystina) was registered in January in the Yí River (2,879 µg/l) while the density of cyanogenic bacterias was not that important. Such Hepatotoxina concentration is considered high with respect to other regional environments (Gorga et al. 2001).

In the Brazilian territory of the Paraná River basin, the contribution of organic matter for the whole basin is estimated in 730,000 tons BDO/year. Serious problems of water treatment affects water supply of Sao Paulo from Billings- Guarapiranga Reservoir system due to the excessive algal blooms. The methods in use (massive applications of copper sulfate in the dam) to control algae growth are diminishing their efficiency and becoming risky for human health. (Beiruth, 2001). The series of reservoirs in the middle Tiete River, Brazil, receive inputs from sugar cane processing plants and upstream discharges from the city of Sao Paulo. Hence the first reservoir in the cascade, Barra Bonita is the most polluted **(Box 5)**.

The maximum trophic conditions (hipertrophic, as regards phosphorus) were found in Barra Bonita Reservoir, and in Tietê , Sorocaba , Piracicaba, Capivari and Cotia Rivers. Grande River basin had the lower phosphorus concentration. As regards clorophill parameter, the worse situation occurred in the central sector – Bororé- of Billings Reservoir (hipertrophic) (CETESB 2001).

Cabra Corral Reservoir (Pasaje- Salado River) located in the Paraná River basins shows evidences of eutrophication. In the water intake of the water supply system for Rosario City (Lower Paraná River) the algae concentrations ranged between 1,000 and 45,000 org/l between years 1998-2000. (Waters Provincial Laboratory of Santa Fe 2001) causing problems in the water treatment steps.

Nutrient concentrations in Itaipú Reservoir associated to poor management of agriculture lands in the watershed is shown in **Figure 4.3.2** (FAO 1992).

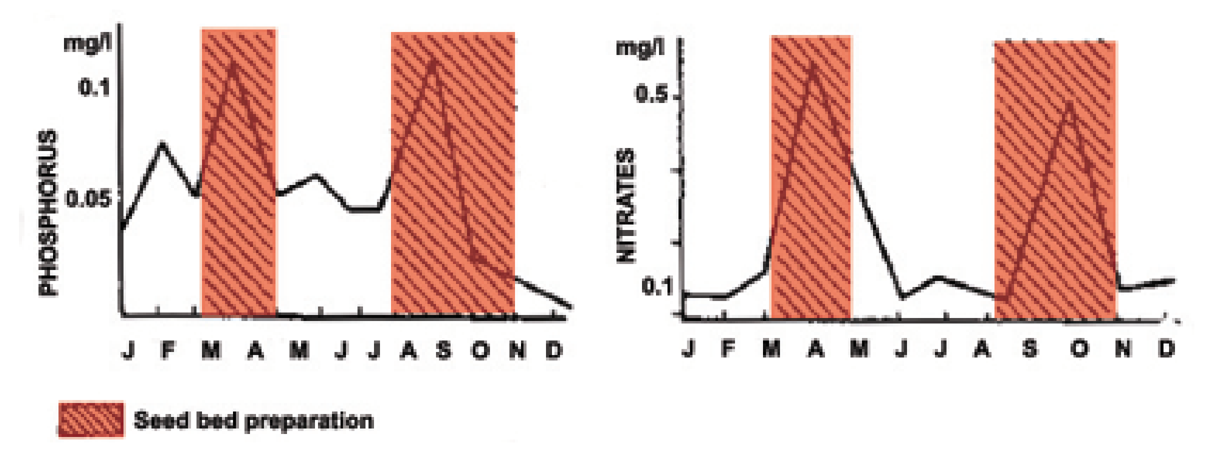


Figure 4.3.2: Nutrients concentration in the Itaipú Reservoir related to agriculture practices

In the Lower Paraná River basin there are evidences of eutrophication and algal bloom in the Río Tercero and Piedras Moras Reservoirs. Since 1977 a limnology study has been carried out by the Limnology Institute of La Plata. Water samples have been systematically taken from the reservoir. Phytoplankton biomass – as chlorophyll “a”- between 1977 and 1982 was about 11 mg/m^3, while it was 6.3 mg/m^3 between 1983 and 1996. Such decrease of about 50% in Chlorophyll ”a” concentration, as well as in Total Nitrogen and Total Phosphorous has been due to reservoir operation. (Mariñelarena 1999)

In 1999 there have been two algal bloom processes. The first one, in February and March produced by *Anabaena spiroides* which caused fish kills (Mancini 1999), and the second one, in October and November produced by *Ceratium hirundinella*. Such algal bloom caused problems in the treatment of water supply to Río Tercero city. Further algal bloom are expected since there have been found resistant types of *Ceratium hirundinella*, given the existence of optimal conditions for their growing.

Box 5 SR38a Eutrophication Pollution: Barra Bonita Reservoir, Tietê River Basin, Brazil.

The series of reservoirs (**Figure 1**) in the middle Tiete River, Brazil, receive inputs from sugar cane processing plants and discharges from the city of Sao Paulo at their upstream end, hence the most polluted is the first reservoir in the cascade, Barra Bonita.

Barra Bonita Reservoir (**Figure 2**), completed in 1963, has approximately 325 km^2 of surface area and a maximum depth of approximately 25 m. Studies beginning in the late 1970s have demonstrated a rapid eutrophication of the reservoir and the importance of flushing rate and winds on water quality. Thermal stratification is transient throughout the year, and the water column remains oxygenated. These conditions, in combination with high concentrations of iron entering via tributaries, tend to maintain low phosphate levels in the water, while the sediments have elevated concentrations. In contrast, nitrate concentrations are high, and enrichment experiments do not detect nitrogen limitation (UNEP).

Figure 2: Barra Bonita Reservoir

Other characteristics are: Catchment area: 32,330 m^2; volume of 2,566,000,000 m^3; and residence time 0.2 year.

The more important tributaries are Tietê and Piracicaba Rivers. The principal source of nutrients to Barra Bonita Reservoir is the Tiete River (0.361 mg Total Phosphorus/l, mean 1989/2000). The central part of reservoir had the major levels of chlorophyll "a". 25.65 mmg/l (mean 1989-2000) (CETESB 2001).

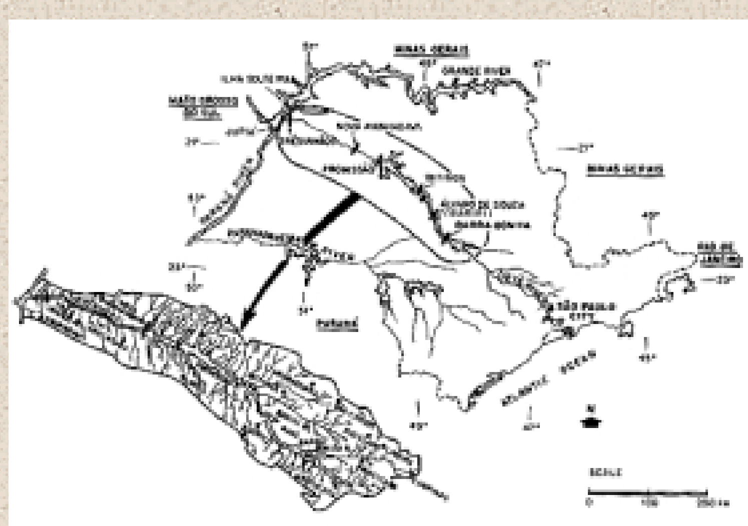


Figure 1: Reservoirs in the Middle Tietê River

4.3.2. Issue 6: Chemical pollution

As regards the Paraná River, heavy metal concentrations in the water column exceeding brazilian guidelines (CONAMA 20/86) for Fresh Water Aquatic Life were found in São Paulo metropolitan zone, Alto Tietê: Rivers Thiete, Tamanduatei and Pinheiros all exceeded zinc (0.18 mg/L), nickel (0.025 mg/L), mercury (0.0002 mg/L), copper (0.02 mg/L) and lead (0.03 mg/L) allowable levels. Tamanduatei River presented the highest concentrations for zinc (0.64 mg/L), mercury (0.00039 mg/L), copper (0.12 mg/L) and lead (0.13 mg/L) whereas Tietê River registered the highest levels of nickel (0.07 mg/L) for this area. Allowable phenol standard (0.0001 mg/L) was exceeded in all these water bodies plus Juqueri River, especially by Tamanduatei River which presented a critical value of 0.35 mg/L. Pardo and Batalha Rivers reported moderately high cadmium concentrations (0.002 mg/L) exceeding guidelines (0.001 mg/L) (CETESB 2002).

Bioaccumulated persistent organic pollutants such as DDT and Hexachlorocyclohexane had been detected in fish: *Pseudoplatystoma fasciatum, Salminus maxillosus, Colossoma mitrei, Luciopimelodus pati, Trachycorystes albricrux* and *Serrasalmus aureus* while lindane was only found in *Pseudoplatystoma fasciatum* (ENAPRENA 1995). Commercial and tourist activities are potentially affected since fish populations seem to be reduced due to pesticide presence in the water column.

The Upper Paraguay River basin has been subjected to intensive economic activities such as gold mining **(Box 6)** and agriculture exploitation. A common problem relative to mining exploitations is mercury pollution from mining operations. This is particularly significant in the State of Mato Grosso. Mercury is used to concentrate placer gold, often at concentrations approaching three grams of mercury for every gram of gold mined (Banks 1991). High levels of mercury have been found in fish and in fish-eating birds. Agrochemicals, including heavy use of fertilizers, herbicides and insecticides, constitute another significant problem as they are washed into streams and Rivers.

Agricultural and industrial activities are the major threats concerning the Paraguay River in Paraguay. Traces of heavy metals and pesticides are likely to be found in both surface and deep waters. Lead, chromium, cadmium, iron and mercury concentrations from samples taken at Pilcomayo and Formosa ports in the period 1988-1995 exceeded international water quality guidelines for fresh water aquatic wildlife.

Heavy metal concentrations in sediments were analysed in different points at Asunción bay. Levels reported at 300 metres NE (Brugada River) were higher than those from Club Mbiguá, a sampling point distant from industrial activity areas (Facetti *et al.* 1994; ENAPRENA 1995). Chromium and Zinc concentration in sediments exceeded those reported for moderately polluted world rivers.(Cr: 103 mg/Kg vs 16-27mg/Kg; Zn: 163.2 mg/Kg vs 26-99 mg/Kg).

Persistent organic pollutants such as DDT and hexachlorocyclohexane were detected bioaccumulated in fishes, like *Pseudoplatystoma fasciatum, Salminus maxillosus, Colossoma mitrei, Luciopimelodus pati, Trachycorystes albricrux* and *Serrasalmus aureus*, while Lindane was only found in *Pseudoplatystoma fasciatum* (ENAPRENA 1995). Pollution in the Paraguay River has both environmental and human health hazards. Commercial and tourist activities are potentially affected since fish populations seem to be reduced due to pesticide presence in the water column.

Heavy metals are the main source of pollution in Pilcomayo River system. Heavy metals content in sediments is particularly important since the predominant fish species (*Prochilodus lineatus* and *Pimelodus albicons*) are detritivorous organisms. High concentrations of lead (0.00026 - 0.002 mg/g), arsenic (0.0005 mg/g), copper (0.0002 - 0.002 mg/g), mercury (0.00011 mg/g), zinc (0.0012 - 0.005) and silver (0.0002 - 0.0005) in sediments were found at Misión La Paz (Salta, Argentina).

Prochilodus lineatus in the Pilcomayo River showed considerable nickel, chromium, arsenic and lead muscle content, higher than those reported for commercial fish in Holland (specially in the case of lead whose mean concentration value is nine times higher than in this country, known to have heavy metal contamination problems). Similarly, *Pimelodus albicons* presented high lead (mean value = 0.572 μg/g), mercury (mean value = 0.628 μg/g) and chromium (mean value = 0.604 μg/g) levels, exceeding guidelines: 0.5 μg/g, 0.5μg/g and < 0.05 respectively.

Heavy metal content in water column was also significant. Lead, arsenic, cadmium, copper, silver, zinc and nickel content presented values, some of which exceeded guidelines for the protection of fresh water aquatic life. At Potosí (Bolivia); lead, cadmium and zinc concentrations were sufficiently high enough to declare water supply inadequate for human consumption and for recreational use with direct contact.

Heavy metal pollution in the Pilcomayo River poses both human and biota hazards. It is well known the occurrence of losses in biodiversity. Bioaccumulation in fish fat and muscles is a major problem. Detritivorous fish are affected mainly and this derives in an economical impact since *Prochilodus lineatus* is a primary source of income. Moreover, pollution in this system encourages migration movements among indigenous populations and enhances even more precarious life style.

The Uruguay River receives organic pollutants from agricultural exploitation. These inputs are generally associated to organic residues from pesticides and to aromatic and aliphatic hydrocarbons from urban activities. Considerable phenol concentrations were found at Iraí station (southern Brazil), where the phenol index reached 0.007 mg/L exceeding CONAMA guidelines (0.001 mg/L) in the period 1993-1998. A similar situation was observed at Monte Caseros site (Argentina Uruguay) where the phenol index reached a critical value of 0.024 mg/L, exceeding CARU guidelines (0.001 mg/L) for fresh water aquatic life.

Further water pollution was reported at El Soberbio sampling station (Brazil-Argentina) where critical metal concentrations were registered for lead (40 µg/L), iron (3150 µg/L), cadmium (6 µg/L) and especially for mercury which reached a value of 5000 µg/L, though this latter might have been referred to an industrial discharge point. CARU guidelines for those heavy metals are: 30µg/L; 300µg/L; 1µg/L and 0.2µg/L respectively.

Persistent organic pollutants are also a significant agent impairing water quality of the southern reach of the Uruguay River. Heavy use of agrochemicals is likely to occur as agronomic exploitation is a major economy activity in Uruguay. High concentrations of p-p'DDT (3.2 ng/L) and aldrin (12.9 ng/L) were found at Monte Caseros station exceeding CARU guidelines: 2ng/L and 10 ng/L respectively. Organic pollution is regarded as an important cause for the diminution of population of migratory fish species in the Upper and Middle course of the Uruguay River (www.fao.org), posing a negative commercial impact.

Water samples taken the Iguazu River at Iguazú National Park station (25° 37' S; 54° 28' W), in its lower reach, in 1998, exhibited high concentrations of cadmium (0.004 mg/L) and lead (0.04 mg/L) exceeding CONAMA guidelines: 0.001 mg/L and 0.01 mg/L respectively. Similarly, significant phenol levels (0.005 mg/L) were reported in 1993 - 1997 period exceeding CONAMA guidelines: 0.001 mg/L.

Protection of environmental conditions in this zone is a priority concern not only because Iguaçu National Park represents a major international tourist resort but because this nature conservation area is the habitat for an important local biodiversity.

La Plata River system receives urban and industrial wastes **(Box 7)**, either directly or through tributaries, which also flow through agricultural areas. Some records of chromium and lead concentrations are over water quality guidelines. Metal concentrations in sediments, bivalves and in suspended particulate matter are comparable to those reported for other moderately polluted world rivers (Bilos *et al.* 1997).

Copper levels in *Corbicula fluminea* are among the highest, similar to those reported for heavily polluted sites (Bilos et al. 1997).

Chromium contents in suspended particulate matter is relatively high; the highest value (408µg/g) doubles the maximum concentration recorded for the Rhine/Meuse Estuary, a well known polluted system (Bilos *et al.* 1997). Suspended particulate matter levels indicate that the La Plata River is a moderately to highly polluted environment (Bilos *et al.* 1997).

Trace metal levels in La Plata River coastal sediments are similar to those reported to for the Shatt al-Arab, Tigris and New River, and lower than those published for the Mississippi, St Lawrence, Brisbane, Gangolli, Southampton Water and Rhine. This suggests a moderate degree of trace metal pollution in this compartment (Bilos *et al.*1997).

Persistent organic pollutants (POP’s) are widely distributed and are concentrated in sediments and biota. Despite its considerable dimensions, the coastal ecosystem of the La Plata River is affected by POP's. These pollutants concentrate in organic sediments and in detritivorous organisms such as *Prochilodus lineatus*, a fatty fish that is an efficient POP’s accumulator.

The risk related to consumption of La Plata River fish is critical when PCB's, dioxins and furans are considered. Toxic bioaccumulation in *Prochilodus lineatus*' tissues from the industrial area present a clear residue hazard ranking: PCB's > 3.7 dioxins > 3.5 chlordane > 8.3 heptachlor epoxide> 3.3 DDT's > lindane ≈ trace metals (Colombo *et al.* 2000). This fish is a clear critical contamination pathway for humans due to its abundance, migrating habits, and its local exploitation and exportation to developing countries in Africa and Asia.

PCB's, PCDD's and PCDF's toxicity equivalents ranged from 0.31 to 39 pg/g fresh weight in *Prochilodus lineatus*, exceeding the U.S Food and Drug Administration guideline of 25 pg/g for human consumption at Quilmes (Colombo *et al.* 2000).

POP's have been analysed in the Samborombón bay biota. Chlorinated pesticides and PCB's were found bioaccumulated in different biota tissues. These results are indicative of water column and sediment pollution.

Box 6 SR38a Chemical Pollution: Mercury accumulation in sediment cores and along food chains in two regions of the Brazilian Pantanal

The Pantanal (**Figure 1**) is a 140,000 km^2 floodplain wetland stretching across western Brazil and parts of Bolivia and Paraguay.

Gold mining with mercury (Hg) amalgamation has thrived since 1980 along its northern rim. Mercury concentrations in surface sediments in the northern Pantanal (45.5 ± 5.5 ng gdry-1) were significantly higher than those in our reference region 200 km deeper into the wetland (Acurizal): 29.1 ± 0.7 ng gdry-1. High mercury levels in primary producers were registered in the northern Pantanal (Leady 2001).

Figure 1. View of the Pantanal

Eichhornia crassipes roots contained 2.7-3.0 times more mercury than shoots in both regions and *Salvinia auriculata*, suggested as a biological monitor for Hg pollution, contained almost four times more mercury in the northern Pantanal (90.7 ± 9.1 ng gdry-1) than in Acurizal (24.5 ± 3.3 ng gdry-1). Plant grazers and scavengers, such as apple snails (*Pomacea* sp.) and adult water beetles (*Fam. Hydrophilidae*), were low in Hg, confirming previous data showing that the channeling of mercury from lower to higher trophic levels along herbivorous links was inefficient compared to transfer along carnivorous links.

Collections of 12-16 individuals of four species of *Characidae* (*Aphyocharax* sp., *Tetragonopterus* sp., *Serrasalmus spiropleura* and *Pygocentris nattereri*) in both regions showed elevated Hg body burdens in both piranhas *S. spiropleura* and *P. nattereri* from the northern Pantanal (149.9 ± 84.2 and 302.2 ± 159.1 ng gdry-1, respectively).

Signals of Mercury use in mining can be quantified in sediment core chronologies and biological tissues, although species at different trophic levels show dissimilar impacts. Mechanisms involved in mercury magnification along food chains deserve more attention, particularly in tropical regions where the threat of chronic exposure to this neurotoxin may have the greatest implications for biodiversity (Leady 2001).

Box 7 SR38a Chemical Pollution: Long-term accumulation of individual PCB's, dioxins, furans, and trace metals in Asiatic clams from the La Plata River Estuary, Argentina

Due to their sedentarism and ability to concentrate xenobiotic compounds, bivalves in have been extensively employed for biomonitoring studies in aquatic ecosystems in both marine and freshwater environments. The long-term accumulation of individual polychlorinated byphenyls (PCB), dioxins (CDD), furans (CDF), and selected trace metals was studied in Asiatic clams of increasing size covering a 0.5-4 year growth period. PCB bioaccumulation was congener-specific and related to compound hydrophobicity and stereochemestry. Penta and hexaCB with log Kow 6-7 were preferentially accumulated.

Total concentrations of the PCB's measured in La Plata River (**Figure 1**) ranged between 446 and 871 ng/g dw (3-5 µg/g lipids) and showed a consistent increase with clam size reflecting the progressive accumulation of these residues (Colombo *et al.*. 1997). PCB's accounted for 83-88% of the total toxic equivalents (TEQ) calculated for the clams. CDD's and CDF's have been measured in four size classes covering the smallest and largest clams of the series.

Figure 1. La Plata River and its relative localization in SR38a

Total concentrations ranged from 136 to 790 and from 70 to 400 pg/g dw for CDD and CDF, respectively. CDD and CDF also increased with size but with much steeper gradients indicating a more rapid equilibration and bioaccumulation kinetics, which is consistent with the almost planar configuration of these compounds. Total TEQ ranged from 7.1 to 13.1 pg/g wet weight for the smallest an largest clams of the series, respectively.

These values are comparable to those reported for fish from the contaminated Saginaw River (5-13 pg/g) but are lower than the Canadian acceptable level in fish for human consumption (15 pg/g). The concentration of trace metals in the Asiatic Clams ranged from 145 to 189, from 22 to 41 and from 3.0 to 4.1 µg/g dw for Zn, Cu, and Ni, respectively.

These values are similar to those reported for bivalves from moderately polluted world rivers. Ni showed rather homogeneous values in six size clases (3.52 ± 0.38 µg/g) whereas Zn showed increasing values from 10 to 22 mm clams and lower levels in larger animals. This suggests that the essential metal, involved in several enzymatic systems (eg., carbonic anhydrase, hydrolases and carboxypeptidases), is being regulated by the clams. A completely different trend is observed for Cu, which is also essential for several basic enzimes like cytochrome oxidase and monooxigenases, but showed a consistent increase with clam size. A trend showing a 85% increase of Cu levels from 10 to 35 mm clams (similar to PCB's) confirmed previous results suggesting a continuous passive accumulation of Cu in clams. This would explain the relatively high Cu values found in La Plata River *Corbicula fluminea* as compared to other freshwater bivalves (Colombo *et al.* 1997).

4.3.4. Issue 7: Suspended solids

Sediments produce several impacts to water quality and availability. Sediments affect hydraulic infrastructure and equipments such as turbines and floodgates, and cause reservoir silting which affect their useful lives. Suspended solids increase the costs of water treatment and usually transport adsorbed pollutants such as metals and agrochemicals.

Erosion due to changes in land use and non sustainable farming practices have originated an increase in water turbidity mainly in areas subject to deforestation for agriculture uses in both humid and semi-arid lands of the La Plata River basin. The development of agriculture and urban settlements resulted in an extensive deforestation in the upper Paraná, Paraguay and Uruguay basins in Brazil. **Table 4.3.1** shows the changes in original cover in the States of Paraná and São Paulo, Brazil, both of which lie in the basin of the Paraná River.

In the State of Rio Grande do Sul, Southern Brazil, which has one third of its area is in the Uruguay basin, the forest cover at the beginning of this century was about 40% of the total area of the State; while nowadays, it is estimated in about only 2.6% (Tucci and Clarke, 1998).

Year	Original cover of São Paulo State %	Year	Original cover of Parana State %	Year	Original cover of Eastern Paraguay %
< 1886	81.8	< 1890	83.4	1945	55
1886	70.5	1890	83.4	1960	45
1907	58.0	1930	64.1	1970	35
1935	26.2	1937	58.7	1980	25
1952	18.2	1950	39.7	1990	15
1962	13.7	1965	23.9		
1973	8.3	1980	11.9		
		1990	5.2		

Source: Tucci and Clarke 1998

Table 4.3.1: Deforestation evolution in the States of São Paulo and Parana in Brazil and Eastern Paraguay

Since 1970 there has been a change in land use within the Upper basins of the Paraná, Uruguay and Paraguay Rivers. In the Brazilian zone, the main perennial coffee crop was substituted by annual crops such as corn and soya. This land use practices increased the soil erosion in rural areas.

The erosion rate and soil loss are variables depending on each region features and their main land use. Erosion rate in the Upper Paraguay is about 4 ton/ha/yr. In the Middle Paraná River erosion rate is lower than 10 ton/ha/yr while in the Lower Paraná River reach it varies between 18 ton/ha/yr, when agriculture–cattle raising annual rotation takes place and 28 ton/ha/yr in the case of continued agriculture. In the Upper Uruguay the erosion rate is about 16-32 ton/ha/yr and in the Bermejo River basin it is between 390 and 2,000 tons/ha/yr (Tucci and Clarke 1998, FECIC 1988, Brea *et al.* 1999).

Figure 4.3.3: Iruya River (Upper Bermejo River basin, Argentina)

The amount of sediment carried out by the Bermejo and Pilcomayo Rivers are usually high. The amount of sediments discharged by the Bermejo River represent about 70% of the total suspended solids of the Paraná River at Corrientes taking into account the historical data series and it reaches up to 80% analyzing just the last years. Such increase of the relative solid discharges may be explained by the construction and operation of reservoirs upstream in the Paraná and Iguazú basins which retain part of the suspended solids. In the Bermejo River 80%

of the total suspended solids measured at El Colorado (106.9 Mt/yr and a long term average discharge of 408.3 m^3/s) comes from the upper Bermejo sub basin while the remaining 20% comes from San Francisco sub basin The most important source of sediment in the Bermejo River sub basin is the Iruya watershed (**Figure 4.3.3**) (Brea 1999).

The amount of sediments carried out by the Upper Pilcomayo basin, measured at Villamontes is about 84 Mt/yr with a long term average discharge as low as 207 m^3/s. Such combination of high solid flow with a moderate water flow determines a mean concentration of solids as high as 12 gr/l. The high amount of sediments from the Andean area of the Pilcomayo is deposited along the river in the Chaco plain reducing its conveyance and increasing the speed at which the deposition front travel upstream in the Argentine and Paraguay territory. Such river receding is estimated at about 5 km/yr between 1940 and 1975, up to 40 km/yr in recent years (**Figure 4.3.4**) (CONAPIBE 1994).

Figure 4.3.4: Pilcomayo River (Arg - Paraguay)

The production and transport of sediment in the Upper Paraguay basin is of great concern, constituting a significant environmental impact of human activities and economic development of the region. In the Planalto, there has been a dramatic increase of the areas planted with annual crops since the 1970s, mainly soya, which has resulted in a significant increase of soil erosion and sediment transport into the Pantanal. At the same time, the short-term increases of annual rainfall in the upper part of the basin have caused soil losses in the Planalto with deposition in some reaches and, in the Pantanal, greater deposition of sediment and reduced channel conveyance (Tucci 2002; Collinschonn 2001).

The suspended sediment dynamics in the Paraná River downstream of the confluence with Paraguay River is directly related to the hydrologic cycle of Bermejo River. The fine suspended materials are transported by the Paraná River and, except in particular situations, find favorable conditions for deposition when entering the La Plata River and in its navigable channels. The rate of increasing in the Delta front is around 100 m/year (Brea 1999).

Figure 4.3.5: Bank erosion downstream of Salto Grande Dam (Uruguay River)

In Salto Grande Reservoir, located in the Lower Uruguay River, the deposition rate anticipated originally as 3.3 $Hm^{3/}$yr is now estimated to be about 11.3 Hm^3/yr, due to the changes in land use in the upper basin as well as the increasing in stream flow during the 1980-92 years (Simonet, Zamanillo and Prendes 1998). At the same time reservoir normal operation originates bank erosion downstream with an increase in the water turbidity (**Figure 4.3.5**).

4.3.5. Issue 8: Solid Wastes

The analysis of the information related to the contamination water resources by solid wastes, either surface or groundwater, corresponding to Subregion 38a, assigned it a score of 2 points: medium impact.

The most important cases that we can mention for Subregion 38a water components are:

- The Pilcomayo River becomes the receiving course of the solid wastes from different human activities in Bolivian territory. Solid wastes water pollution is the result of different factors as urban growth, non sustainable solid waste disposal along streets and rivers, and in open dump sites. Final disposal of solid wastes is around 50% in controlled landfills and 50% in open dump sites.

- In Paraguay, the main environmental impacts are derived from unsatisfactory basic sanitation (drinking water supply, sewage treatment and urban solid waste disposal). The estimated generation of solid wastes is around 3,3 ton/d; less than 20% of this quantity is collected and receive some type engineered ultimate disposal. The ultimate disposal is performed in 6 landfills located in different sites of the country. Some hazardous solids wastes containing heavy metals, toxic organic compounds are dumped in the environment with industrial wastewaters or they go to landfills as solid wastes.
- The La Plata River receives the contribution and influence of coastal cities, Montevideo and Colonia in Uruguay and Buenos Aires Metropolitan Area in Argentina. These cities have large population and the pollution due to open solid wastes dumping is an important issue to be considered. .In the city of Montevideo, one of the most important environmental problem is the dumping of wastes to water courses due to a deficient SW collection system. The dumping is performed by solid wastes scavengers ("hurgadores") concentrating the wastes near the river shores or open dump sites, allowing the development of disease vectors and uncontrolled plagues.

  Regarding to the city of Buenos Aires, more than a third part of the Argentine population is concentrated on Buenos Aires Metropolitan Area. This huge urban settlement determines an important generation of solid wastes: 10,500 ton/d and 0.88 kg/inhabitants/d. In the outskirts of Buenos Aires more than 100 open dump sites were detected affecting 400 ha of soils with 1,200,000 tons of urban and industrial solid wastes.

  Recently, due to a low socio-economic standard of living, the percentage of solid wastes that receive some kind of controlled final disposal has diminished, increasing the number of open dump sites.
- The Upper Paraná River, in Brazil, receives significant loads of solid wastes and wastewaters, coming from riparian cities due to human activities and precarious urban establishments, that decrease the quality of the water course. For example in Sao Paulo's Metropolitan Area the quantity of solid waste generated is 22,100 ton/d with 1,300 Kg/inhabitants/d.

  Almost 71% of the solid wastes generated in Brazil receive some type of final disposal, either landfill or controlled facilities, the remaining 29 % is dumped in open sites.

4.3.6. Issue 11: Spills

Through the analysis of the information linked to the contamination by spills into water resources, both surface and groundwater, corresponding to the Sub-region 38a, we can assign it a score 2 (moderate impact), according to the Approaches of Valuation of the Environmental Impacts agreed in the First Workshop.

A higher score might be assigned, due to the consequences that usually have these accidents in the affected area, but it is important to keep in mind that those effects, in its majority, are of local or regional character. So that considering such factors as, the scale of the analysis, the extension of affected areas, the magnitude of the spilled substances and the measures that contributed to mitigate the potential impacts of the spills, we may arrive to the assigned score.

The main spill events raised in each one of the water components were:

- In the La Plata River basin we can mention 4 events:
  - In June 1996, in the access channel to the port of Buenos Aires the Korean ship Sun Seized collided with the Paraguayan Coast transporting full-oil. The ship tank lost a significant amount of the 2,400 m^3 that transported. Two weeks later, the Prefecture of Colonia discovered full-oil residues in the jetties of the port and in the following days the contamination affected 40 km, between the departments Capital and Juan Lacaze City (BRECHA Newspaper).

- In February 1997, the Panamanian ship San Jorge beached 20 miles from the cost of Punta del East (Uruguay) when she was navigating to Brazil. In the crash one of their deposits broke. The ship was transporting near 58,000 m^3 of raw petroleum. The spill of raw petroleum arrived at the beaches of Uruguay and it affected an extensive coastal area. This oil spill caused an enormous repercussion because it affected beaches of a highly tourist value in high summer season and it also affected places, as the Island of Sea-Wolves, an important habitat of birds and marine mammals. The quantity of petroleum spilled was 2,000 to 3,000 tons of crude oil, affecting 20 Km of coast. As for the Island of the Sea-Wolves, the oil slick impacted in two places contaminating about 500 meters, affecting almost 40% of its perimeter.
- In January 1999, the ship Estrella Pampeana (Shell) collided with the ship Paraná in the Río de la Plata in front of Magdalena's cost, Argentina. The oil tanker transported about 35,000 m^3 of crude oil. The spill impacts on Buenos Aires coast ,in Magdalena's area and Berisso, affected circa 20 Kms. of coast. Shell informed that the spill was of 4,600 m^3, around 4,000 tons (J. C. Villalonga 2000). The spill produced a moderate impact in the coast benthos, in the population of bivalves and it eliminated some species. The habitats of spineless, amphibians, reptilian birds and mammals were affected. The coastal landscape was degraded and recreational activities were affected (sport fisheries and spas) . The soil and terrestrial vegetation were also contaminated.
- In April 2000, the Panamanian oil ship "Pious Princess" spilled 3,000 liters of crude oil in La Plata River, in front of the costs of Berisso, Buenos Aires. The ship had left Caleta Olivia and was transferring its load to other ship. Finished this operation the ship began to leack crude oil, 8 miles off the cost of Berisso. Contingency measures were frustrated due to bad weather conditions, allowing the arrival of hydrocarbon wastes to the cost (J. C. Villalonga 2000).

• In the Iguazú River basin, in July 2000, a spill of 4,000 m^3 of petroleum coming from a Petrobrás refinery, took place in Curitiba, State of Paraná, Brazil. The estimated amount of oil spilled, that reached the river, was of 1,300 m^3. During the period September 2000 - December 2001, INA from Argentina monitored Iguazú River water quality at Puerto Andresito (Argentina). Volatile lineal and aromatic hydrocarbons (BTEX), and PAH were not detected in dissolved and particulate phases. (INA.2002, CTUA, SPA, PNA, EBY, MEyRNR, IMAS, UNAM).

• In the Upper Pilcomayo River basin (Porco, Bolivia); between August and September 1996, a spill of 235,000 m^3 of COMSUR mine tailings took place **(Box 8)**. Due to the rupture of tailings dike containing high concentrations of heavy metals (W Vargas Ballester 1996). Concentrations of heavy metals and suspended solids in this area surpassed Bolivian water quality standards. Immediate remediation measures, along a 10 km reach of the river , were performed. Followed by a water quality monitoring program in the adjacent river basin departments. This spill was of very significant magnitude, in comparison to the historical loads of pollutants from mining origin. The load of heavy metals was transported along the whole basin through particulates, limiting the heavy metals bio-availability. Today a Mining Residues Recovery Program is taking place in Bolivia.

• In the Bermejo River Basin, in Argentine territory, incipient contamination from oil residues were reported (December of 2001). The source of this water pollution is attributed to oil exploration wells, with high salinity (over 120 g/l), temperature (about of 80 C), and hydrocarbons traces. In addition a pollution spill from mine tailings pond breakage was reported in this basin (Aguilar Mine). Water quality and quantity issues are of high concern in the Bermejo River Basin due to the increasing and diversified water uses (CEMA 2002).

• In December 1992 a highway accident took place the municipality of Caieiras, São Paulo, at a Paraná River tributary. A truck-tank transporting 27,780 litres of liquefied phenol crashed, spilling ca. 22,000 litres of phenol on the road side. A part of this material spilled entered the road drainage system driving the waste into Juqueri River. The accident caused serious impacts to the atmosphere, death toll of fish and other animals, also affecting extensively the vegetation. After this accident Juaqueri River phenol concentration surpassed twenty times its mean value (0.061 mg/L); impairing water uses along a two months period.

Box 8 SR38a Spills: Mine tailings spill in the Upper Pilcomayo Basin

A breach of a tailing dam of COMSUR mine at Porco (Bolivia), on August 29th and September 1st. 1996, spilled 235,000 m^3 of mining wastes with high content of particulate heavy metals (**Figure 1**). Rain and snowmelt water entering the dam are believed to have been the main factors contributing to the rupture. The mining spill affected directly the Pilaya-Tumusla reach, within the southern branch of the Upper Pilcomayo River system in the Bolivian Andes. According to the report released by the Bolivian Under Secretariat for the Environment 87% of water pollution occurred in the first 50 km of the river reach.

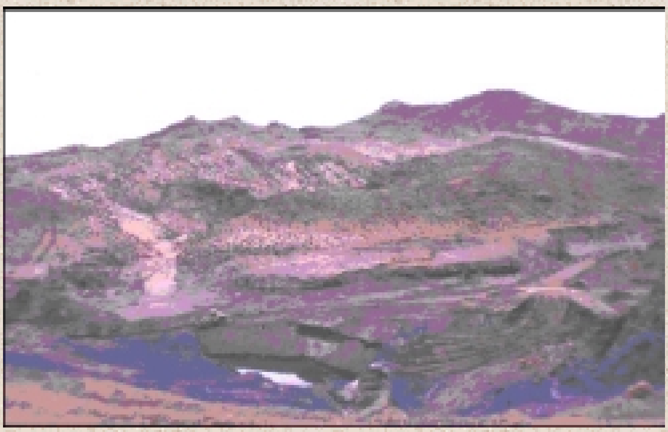


Figure 1: Tailing dam of COMSUR mine at Porco (Bolivia)

It seems likely that a spike of sediments from the COMSUR mine tailings dam might have reached Villamontes (500 km downstream, within de Chaco area). But the efficiency of the wastes recovery program, during the winter -early spring low flow period, allowed the attenuation of the environmental impact. Monitoring of heavy metals concentrations in sediments, immediately after the spill, showed records of lead, cadmium, arsenic and zinc well over reference international sediment standards. This water quality survey brought into focus the broader spatial and temporal scales linked to the heavy metals pollution issue from mining activities in the Upper Pilcomayo Basin (**Figure 2**).

Thus, in this survey the highest heavy metals sediment concentrations were detected near Potosí, upstream from Porco. Where, up today, more than 30 small mines discharge their metal effluents without control into the river. In short, most of the mining activities, performed in the Upper Pilcomayo basin since the early XVII century, have not controlled mining tailings allowing the continuous input of heavy metals into de water system.

Figure 2: Location of the Pilcomayo River basin

The integration of new and old mine tailings discharges and spills turn the heavy metals management issue in the upper basin into a non point and point control approach case. The main water quality impacts associated with the presence of heavy metals from mining effluents and spills are related with the impact on edible fish species (*Prochilodus lineatus, Pimelodus albicans* and *Hoplias malabaricus*).

Fisheries of sábalo (*Prochilodus lineatus*) have both economic and social values in the upper basin, mainly in Villamontes, where a decrease in fishing capture was observed since the late 1980's (Smolders 1998).

At Misión La Paz, Argentina (Lower Pilcomayo River Basin), the water quality monitoring program showed high concentrations of heavy metals in sediments and in the fish bodies. In this area, Native Indian groups use river fish and water as main dietary sources. Further research in mine effluents and spills loads and transport and heavy metals sediment-borne bio-availability will be needed to allow a sustainable development of the Pilcomayo River Basin.

4.4. Concern III: Habitat and community modification

The Concern Habitat and Community Modification was ranked as first priority in SR38 as a whole, as well as in SR38a La Plata River Basin.

Habitat and Community Modification - Environmental Impacts by Issue: Present Conditions	*
12. Loss of Ecosystems or ecotones	3.0
13. Modification of ecosystems or ecotones, including community structure and/or species composition	2.0
Overall Impact	2.0

***** Weighted score

A variety of losses of ecosystems and ecotones, in terms of destruction or transformation into others different types, have taken place in the La Plata River Basins. The construction of a large number of reservoir in the main reaches and its tributaries, have caused the transformation of fluvial lotic systems into lentic or almost lentic ecosystems. Riparian river ecotones into lake ecotones extending considerably their total length and destruction of terrestrial habitats as a consequence of the impoundments turning them into aquatic littoral and pelagic ones. These losses are quite above 30 %. There are also losses of habitats due to heavy pollution, like in Tietê and Riachuelo Rivers. In Uruguay, wetland areas have been desiccated for rice production. In the Paraná River, construction of polders has resulted in disruption of natural delta habitats. Development of large urban settlements along the river shores, like São Paulo, Posadas, Encarnación, the coastal belt of the lower Paraná River and the La Plata River, from Rosario to Ensenada city, have resulted in the destruction of riparian habitats.

Reservoir cascades in the main international stretches (Paraná River) and their tributaries (Grande, Paranaiba, Tietê, Paranpanema, Iguazú) have altered the habitats and interrupted system continuity, affecting community structure and the population dynamics of migratory species of biological and commercial value.

Accidentally introduced exotic species of Asiatic origin, like *Limnosperma Fortunei* and *Corvícula fluminea*, have disseminated in the inner and medium La Plata River, Paraná and Uruguay Rivers, existing evidences of substitution and displacement of autochthonous benthonic species. It is also evident the expansion of carps in the inner La Plata River, Paraná and Uruguay Rivers. Wide distribution of exotic *Tyllapia* is well known in reservoirs and lakes in the subtropical areas of the Basin. As a consequence the ecosystems exhibits species exclusion and changes in the food web.

In the valleys of the Northwest region in Argentina, where an intensive exploitation of natural resources has taken place, drastic changes in ecosystems and ecotones have resulted in community structure and species composition modifications. In the Salado River basin, Province of Buenos Aires, negative impacts on the ecosystems have resulted from the construction of drainage canals.

4.4.1. Issue 12: Losses of Ecosystems and ecotones

SR38a comprises the La Plata River Basin, which has a surface of about 3,100,000 km^2, rating fifth in size in the world and second largest in South America. It is constituted by several subsystems which altogether drain a flow of about 20,500 m^3/s into the La Plata River. The Paraná River is the most significant one, since its watershed, excluded the Paraguay River, is about 50 % of the whole basin.

A major part of the population and annual gross national production of Argentina, Bolivia, Brazil, Paraguay, and Uruguay takes place in said territory. And it is there, where a major loss or transformation of aquatic fluvial and riparian ecosystems has taken place as a consequence of the construction of reservoirs for hydroelectric generation as well as the settlement of large urban areas.

Although published indicators reflecting quantitatively the degree of transformation are not ready available, based on the compilation of graphic and written data from various publications, it is possible to state that over 35 % of the total length of the Paraná River, about 2,570 km, has been altered by the creation of a number of large reservoirs like Ilha Solteira, Jupia and Porto Primavera, in Brazil, Itaipú (Brazil-Paraguay) and Yacyretá (Argentina-Paraguay). To such transformation, it should be added that of the riparian zones, as a consequence of urban settlements built along the river banks, among which it outstands the urban and industrial belt of the Lower Paraná River in Argentina, comprising the cities of Rosario, Zárate and Campana, among others, spanning over a length of more than 100 km (**Figure 4.4.1**).

Source: ANEEL 1999

Figure 4.4.1 La Plata River Basin: Main reservoirs

A large number of reservoirs have been built also in the tributaries of the Paraná River, in Brazilian territory. Even larger transformation rates of lotic environments into lentic and semi-lentic ones, of about 36% in the Tietê and Iguazú Rivers (**Box 9**), 48% in the Grande River, and up to 64% in the Paranapanema River, are found there. Also, the large metropolitan regions of São Paulo and Curitiba have resulted in substantial losses of natural riparian ecosystems in the Tietê and Iguazú systems, respectively.

Reservoir creation transforms fluvial riparian ecosystems into lake type ones, notably increasing their longitudinal development, as well as changes terrestrial ecosystems into aquatic ones. The sum of reservoir areas by sub basin is a proxy indicator of the latter, which, in the case of reservoirs on the Paraná River, amounts to about 6,800 km^2. The total area of the all main reservoirs in the Paraná system, including major tributaries, is over 16,000 km^2, which amounts to about 10% of its watershed.

Another interesting indicator of the transformation produced, is the increase in mean annual residence time of water, in the various water subsystems. **Table 4.4.1** shows, in an indicative way, the situation before and after the construction of the reservoirs, making evident the significant transformations imposed to the natural fluvial environment.

Table 4.4.1 Mean annual residence time of water

River system	Residence time (in days)	
	Natural (1)	Reservoir (2)
Grande	15	695
Paranaiba	14	627
Tiete	12	593
Paranapanema	8	907
Iguazú	15	355
Paraná	30	159

(1) Reference value assuming a mean annual flow of 1 m^3/s.
(2) Calculated on the basis of reservoir volumes

In the Salado River basin, Province of Buenos Aires, negative impacts on the ecosystems have resulted from the construction of drainage canals specially in the Samborombón bay, which is a Ramsar site. In 1997 due to the Channel 15 was made deeper and bigger and it takes all the water from the Salado River, except during floods, some reaches downstream became lentic as a consequent of such interruption (Miretzky *et al.* 2002).

4.4.2. Issue 13: Modification of structure or communities

La Plata River basin is the main continental fishery, in both commercial and sport activities. The sustainability of the fisheries is at risk due to an inadequate management of aquatic resources. Overexploitation, pollution and eutrophication, as well as the building and operation of reservoir are the main human impact over the fisheries (Bonetto 1986).

As regards affectation of the structure and communities dynamic, there are records of fish mortality due to different causes such as agrochemicals discharges, organics discharges, pollution by hydrocarbons, and gas over-saturation due to dams operation (DRIyA - SAyDS).

Habitat modification mainly due to reservoirs building had a direct impact over the aquatic wild life and its biodiversity (**Box 10**) (Agostinho *et al.* 1997). A mortality of about 120,000 fish, that caused an ecological damage on the trophic network, mainly on river bed species which were the most damaged, was related to gas over-saturation of the water (bubble illness) due to floodgate operation of Yacyretá Reservoir (Jacobo, Domitrovic and Bechara 1994).

After construction of Itupararanga Reservoir in the Sorocaba River (tributary of the Tietê River), fish biodiversity might have diminished due to the reduction of spawning and reproduction areas. Such modification originated the decrease and even loss of some species, such as *Apareiodon cf. piracicabae*, *Prochilodus lineatus* and *Salminus hilarii*, which are present in non affected reaches and absent in the reservoir (Smtih and Petrere 2001).

In the Upper Paraná River, the construction of Itaipú dam and reservoir lacking adequate fish passage facilities, have affected migratory species which carried out vital functions upstream such as reproduction or spawning. Such habitat modification originated changes in the community structure and some species became quantitatively more important while others diminished their populations (Canevari *et al.* 1999). Genetic diversity of the migratory species is also affected due to dam barrier.

At the same time, the regulation of flows by the reservoirs affected the species which use the flood plains for spawning. A decrease in the stocks of 6 of the 10 more important species for fishing, has been recorded, being the most effected *Prochilodus lineatus* with a reduction of about 50% (Agostinho and Gomes 2002). *Prochilodus lineatus* is an endemic specie which is ranked fourth as regards its importance as fisheries and is not migrating anymore (Revaldaves *et al.* 1997).

The fish facilities in Yaciretá Reservoir have not favored the migration of important species due to deficient construction features and bad location in the dam. Among the important migratory species the Shad (*Prochilodus lineatus*) was the most abundant of the transferred species (2.5%). However, experimental capture downstream the reservoir resulted in a 30% of Shad suggesting that the fish reach the bottom of the dam but they do not enter into the facilities. The efficiency of transference mechanisms of the dam is too low: only a 1.88% of the total migratory species reach the reservoir and the efficiency is as low as 0.62% taking into account only the most valuables species (Fundación Proteger 2001). Similar impacts in migratory species has been found in Salto Grande Reservoir in the Uruguay River (Canevari *et al.* 1999).

On the other hand, there have been recorded several impacts in the community structure and dynamics due to pollution from point and non point sources. In the Lower Uruguay River have been found pollutant concentrations above the CARU (Management Commission of the Uruguay River) standards for aquatic living.

In the Upper Pilcomayo River the so called “tails” or toxic mud from the mining activity in the Potosí department have negatively impacted several tributaries. There exist a high degree of pollution with heavy metals in both water and sediments and there have been observed a sharply decrease in the benthic fauna as well as fish extinction in some reaches where the water is not useful even for irrigation (FOBOMADE 1996).

In the La Plata River the major source of pollution is the urban belt from the Riachuelo to Berazategui because of the high amount of industries and inhabitants there located. The Persistent Organics Pollutants (POPs) are widely spread and concentrated mainly in sediments and bioaccumulated in debris-feeding organisms such as Shad. Organ-chlorate agrochemicals as well as PCBs are accumulated in the fat tissues of the fish and might kill them by anoxemia (Canevari *et al.* 1999).

Incorporation of exotic species negatively affects the community structure and dynamics. As a consequence the ecosystems exhibits species exclusion and changes in the food web.

As regards higher trophic levels, Carps (*Cyprinus carpio*) introduction in the entire La Plata River basin seriously threat autochthon species such as atherine (*Odotesthes bonariensis*), catfish, yellow catfish, sea catfish and shad (*Prochilodus platensis*), among others. Similar effects produced the introduction of *Plagioscion squamosissimus* and *Oreochromis sp* in the Upper Paraná River, and *Ascipencer baeri* in the Lower Uruguay River and in the Middle and Lower Paraná River (DRIyA - SAyDS).

Two Amazonic predators were captured in Itaipú Reservoir, *Plagioscion squamosissimus* and *Cichla monoculus* which came from upstream reservoirs. In 1997 an accidental introduction of exotic species occurred in the Parapanema River from an aquatic farm due to an extraordinary flood. In additon to the many exotic species spread in the River with the accident, parasite *Laernea cyprinacea* were also introduced (Agostinho and Gomes 2002).

As lower trophic levels are concerned, Asian mollusks have been introduced due to the increase of overseas navigation. Among them, Corbicula (*C. Fluminia and C. Largillerti*) and the mitilidae *Limnosperma Fortunei* have been widely spread in the La Plata River, Lower and Middle Paraná River and Uruguay River originating a strong ecological impact. Autochthon benthic species have been substituted and moved away by these invasive mollusks (Canevari *et al.* 1999). Even more, such mollusk introduction have modified the food web mainly for ox-eyed cackerel, catfish and atherine, all of them economically important species (CARU 2002).

Serious ecosystem affectation due to accidental spills have been reported in the La Plata basin. In Magdalena town, in the province of Buenos Aires, 250 tons of raw oil were spilled affecting mainly the riparian ecosystem. Although impact on fish community were low, invertebrates, amphibian, mammals and bird habitats were highly affected, as well as important economic activities such as tourism, fishing and aquatic sports have been negatively impacted. In 1996 in the Upper Pilcomayo

River at Porco a tail dam from the mining activity was broken, widely affecting the ecosystem due to high concentrations of heavy metals (Preston 1998).

Finally, selective fishing practices in located areas in the La Plata basin might be producing changes in the community structure and dynamics since the most valuable sportive and commercial species are the main target.

In the Brazilian rivers, *Chondrichthyes sp*. is the main endangered specie by overexploitation given its life particular life cycle features (slowly growing, late sexual maturity, low fecundity and high life time). There also are indicators of *Piaractus mesopotamicus* and *Paulicea luetkeni* overexploitation in the Brazilian areas of the Paraná River and Paraguay River basins (Ministério do Meio Ambiente y Programa Nacional do Meio Ambiente II 2001). In the Upper Paraguay River *Hoplias gr. Malabaricus, Serrasalmus marginatus, Serrasalmus spilopleura* and *Pygocentrus nattereri* are the species more searched by the fishermen.

In the Upper Pilcomayo River high inter –annual variation in the capture of valuable species have been reported. Shad fishing is an emblematic case since the average capture decreased from over 1,000 tons/yr in 1980-89 to 400 tons/yr in 1990-98, being some years as low as 100 tons/yr (Smolders, 1999). Despite the fact that there has been a decrease in the Pilcomayo stream flows in the 90´s that might have affected the Shad capture, the lowering in the capture rate might be due to overexploitation as well as the river receding in the lower Pilcomayo that has isolated the upstream population making them more vulnerable (Smolders and Smolders 1999).

In the Upper Paraná River there has been a reduction in the *Rhinelepis aspera* stock and its capture has decreased 70%. Overexploitation of H. edentatus and other such as *P. Granulosus, Paulicea luetkeni* and *Pseudoplatystoma corruscans* has been reported in the Itaipú Reservoir (FUEM, NUPELIA/ITAIPU BINACIONAL 1999).

There are evidences of Shad (*Prochilodus lineatus*) overexploitation in the Middle Paraná River since its capture rate is twice or three times higher than used to be. Because of Shad is a key component in the food web (about 20 species over the 200 recorded in the Middle Paraná, feed on Shad) its loss might cause the extinction of many valuable species (Fundación Proteger 2002). In the San Javier River area the more frequent captures are fish under 4 year old, smaller than the minimum capture allowed affecting the probability of Shad population recuperation (Oldani *et al.* 2001).

Box 9 SR38a. Loss of ecosystems or ecotones: Iguazú River system in La Plata River Basin

The Iguazú River basin, shared by Brazil and Argentina is about 72,000 km^2 which 79% lies in the State of Paraná (Brazil), 19% in the State of Santa Catarina (Brazil) and the remaining 2% in the Province of Misiones (Argentina). Iguazú River is 1,060 km length from its headwaters at Serra do Mar in the East to its mouth at Paraná River in the West.

Regarding the Iguazú River high slope, mainly in its middle zone (Figure 1), several reservoir devoted to hydroelectric power generation have been built in the basin (Table 1) changing the physical, chemical and biological features of the river. Such cascade of reservoir have transformed lotic environments into lentic and semi-lentic ones, of about 36% and it will be over 40% when Salto Caxias start to operate (Agostino and Gomez 1997).

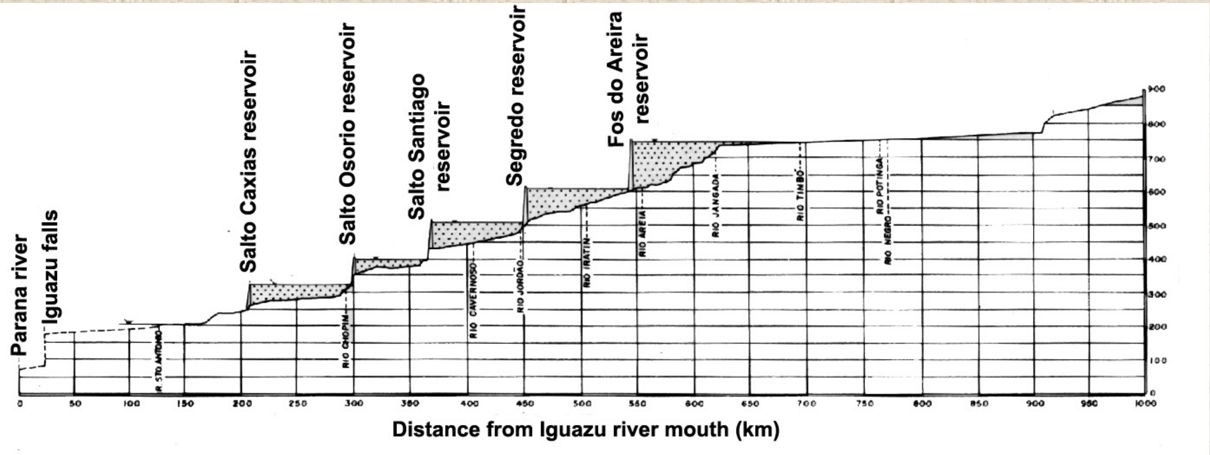


Figure 1: Reservoir cascade in the Iguazú River Basin

Segredo Reservoir (Figure 2) is located second in a cascade of five big reservoirs built in the Iguazú River. It is located about 455 km upstream Iguazú mouth. Before starting to operate Segredo Reservoir, the aquatic vegetation of this reach of the Iguazú River was characterized by root-settle plants used to living in running water and floating plants were extremely rare. Nowadays in a lentic environment, aquatic macrophit and floating plants are favored. As regards aquatic fauna, there were changes in the trophic web and modification of structure. Such changes might have important consequences on the biodiversity not only because of the low amount of species in the Iguazú River but also because of their high endemism. However, fish community was already affected by Foz do Areira Reservoir operation, located upstream (Agostino and Gomez 1997).

Reservoir	Operation beginning (year)	Basin area (sq km)	Reservoir surface (sq km)	Volume (m3. 10^6)
Foz Areira	1980	30000	139	5.8
Segredo	**1992**	**34100**	**82.5**	**3**
S. Santiago	1980	43330	230	6.7
Salto Osorio	1975	46800	62.9	1.2

Table 1 Features of the main reservoirs in the Iguazú River basin

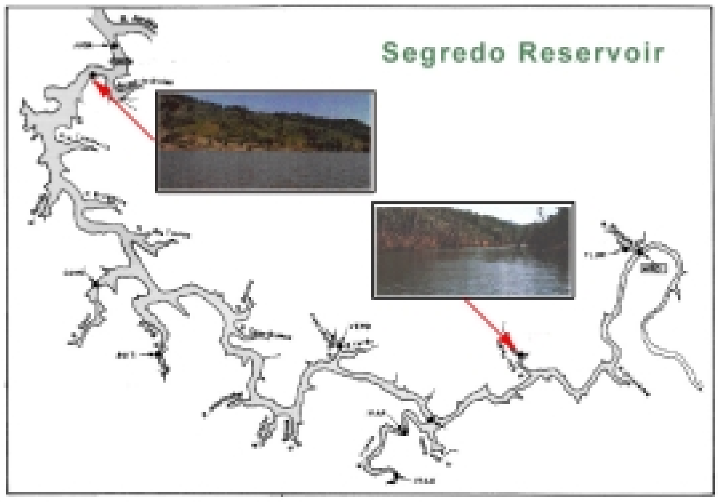


Figure 2: Scheme of Segredo Reservoir

Box 10 SR38a Modification of structure or communities: Impacts of reservoirs on fisheries

The ichthyic fauna has been affected to a large extent by large reservoirs in the Upper Paraná River and its tributaries, due to the number and size of the developments and the absence of passages tending to let migratory species carry out their vital functions (like reproduction). Furthermore, these facilities have had negative impacts on the development of larvae and fingerlings in the alluvial plains (Canevari *et al.* 1999).

The fauna of reservoirs is poorer than the fauna of the rivers due to the decrease of flow velocity and the formation of a great pelagic area.. As regards Itaipú Reservoir, several researchers have described the changes in the fauna after the river closure. Prior to the construction of reservoir (1978 - 1981) there were 113 species of fishes upstream of Saltos de Guayra; while, only 83 species were found during the following years (Agostino *et al* 1994). Only the corbina (*Plagioscion squamosissimus*, an exotic species, imported from the Paranaíba River) kept, after the closure, its importance among the 10 most frequent species before the construction (**Figure 1**). During the first stages of the river closure and impoundment existed a high production of plankton, other invertebrates and small fishes, which meant a significant increment of the fauna predating on said food sources (Canevari *et al*. 1999). The "curimbata" (*Prochilodus scrofa*), the one dominant fish in previous conditions, of high commercial value and central importance large ichthyophagous fisheries, suffered a reduction close to 25% after damming The piranhas (*Senasalmus marginatus*) suffered an important increment in the extensions farthest from the dam site.

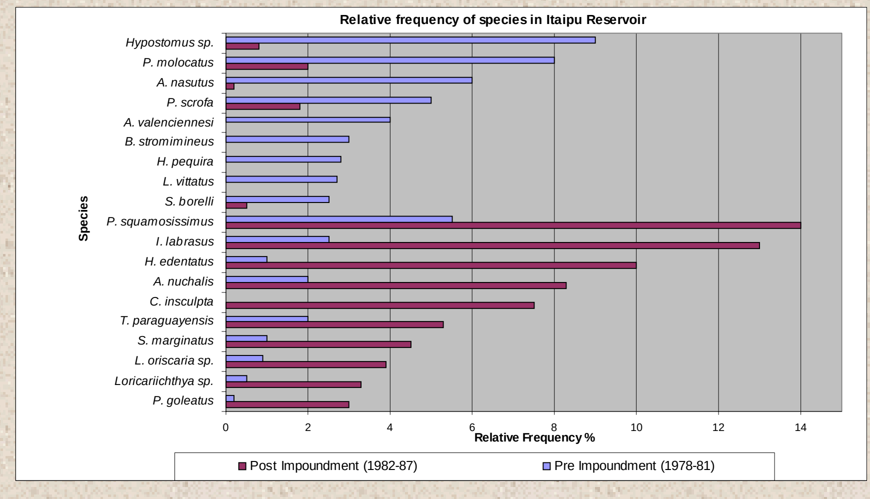


Figure 1 Relative frequency of species in Itaipu Reservoir

Analysis of fish communities with similar food habits revealed that those fishes who feed with mud were more abundant before the impoundment (57% of catchments) and that in the following 6 years presented a moderate participation in catchments (between 8.6% and 19.7%). The insectivorous have proliferated in the reservoir area and, together with fish-eating species, they are the predominant groups in the community. The carnivorous species kept similar levels, but it was observed alterations in their specific composition.

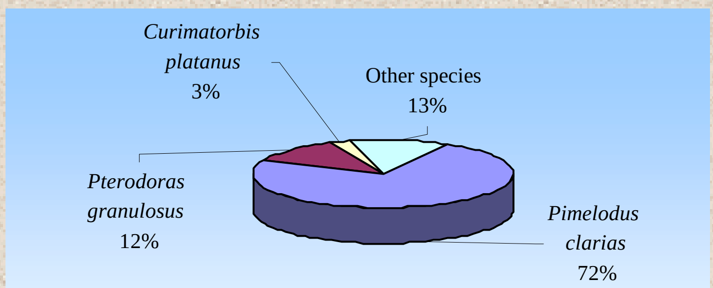


Figure 2. Number of individual transferred in Yacyretá Reservoir (%)

Source: Baigún and Oldani, 2001

The fish passage facilities built in Yacyretá (**Figure 2**), have not facilitated the transference of important migratory species, which constitute the basis of regional fisheries (Baigún and Oldani 2001). Such facilities helped the transferences of small size species, with ubiquitous distribution and very little fishing relevance. Transferences were characterized by a great abundance of yellow catfish (*Pimelodus clarias*) and "armados" (*Pterodoras granulosus*).

4.5 Socioeconomic impacts:

4.5.1. Concern I

Freshwater Shortage - Socioeconomic Impacts Present Conditions	Score
Economic Impact	3.0
Human Health Impact	1.6
Social & Community Impact	1.9

The experts agreed upon the seriousness of the economic impact of freshwater shortage in the region resulting from the loss of drinking water supply sources which leads to increased costs in water treatment or the incorporation of alternative supply sources. São Paulo, Curitiba, Buenos Aires, Rosario metropolitan regions are emblematic cases in the region. Contamination of water supplies was identified as the most relevant cause of economic impact due shortage of freshwater in Sub Region 38a.

Freshwater shortage due to pollution has an relatively major impact in water supply of great urban areas. In Upper Paraná system is outlined the problem of drinking water supply in São Paulo Metropolitan Area, related with pollution of Tietê River. Besides the existence of high costs related to water treatment, pollution caused a considerable investment in sanitation measures. Related to this issue, SABESP started the "Tietê Project", an integrate plan of sanitation which points at the amplification of solid wastes collection and the volume of treated effluents, control of industrial pollution and the improvement of population health (CEPIS-OPS 2000; SABESP 2002). These actions are complemented by the "Projeto de Despolução do Rio Tietê" (SABESP 2002). During its first stage, finished in 1999, was extended the service of sewage network and increased the capacity of effluent treatment from 20% to 60%. It is calculated that approximately 80 tons of effluent stopped being thrown without treatment to the Pinheiros River (Tietê tributary). During the second stage (2000-2004) there is foreseen the amplification of these services, being thought that in approximately 20 years the Tietê River will be completely clean.

Other problems linked to pollution that cause great impacts in water supply in Upper Paraná system are eutrophication of Guarapiranga and Billings Reservoirs (São Paulo metropolitan area) and suspended solids due to land use changes in Paraná State (see Economic Impacts of Pollution).

Several accidents caused the spillage of oil and other substances in various systems of the Subregion. In all cases, these accidents negatively impacted on freshwater resource regarding different uses. These were the cases of oil spills in the Barigüí River (Iguazú system) and La Plata River (in front of Magdalena and Punta del Este coast). In the Pilcomayo River system, mining wastes spilled in Porco produced similar impacts, mostly in local indigenous communities located in river margins (see Economic Impacts of Pollution).

Water pollution is the cause of many health problems in the region, particularly in urban populations in marginal tropical areas, which lack supply of safe water. Microbiological, nitrate and even toxic metals contamination are the recorded main factors affecting the health of the population. Pollution has a direct impact on the population health. In Brazil about 65% of the hospitalised people are from water borne diseases. Such impact is higher in low income people which do not have neither fresch water supply nor sewage infrastructure.

For the whole Subregion 38a a good approach in order to evaluate the problem is to know the percentages of population with access to drinkable water and sewage system. Table 4.5.1 presents the current situation in the countries, which share the Subregion 38a. Given the high concentration of the population in urban areas, it is presented the situation in such areas with regard to both considered indicators.

Countries*	Drinkable water		Sewage system	
	Total (%)	Urban areas (%)	Total (%)	Urban areas (%)
Argentina	63.9	81.7	34.6	53.6
Bolivia (total)	65.3	90.5	65.8	86.4
Brazil	85.2	94.7	97.7	98.0
Paraguay	43.6	70.1	98.2	99.0
Uruguay	93.2	95.9	94.5	95.8

* Provinces of Argentina, States of Brazil and Departments of Uruguay included in La Plata River Basin.
Source: CEPIS-OPS (2000); DGEEC (2001); IBGE (1999); INDEC (1991); INE-Bolivia (2001); INE-Uruguay (1996); SPIDES-ENHOSA (1999).

Table 4.5.1. SR38a. La Plata River Basin: Population with access to drinkable water and sanitary system. Total and urban areas

Data illustrate the existing difference in 1990s between urban and total coverage in the jurisdictions of the Subregion, revealing a relative better situation in cities. However, in all the countries and urban areas of the Subregion 38a an increase of coverage has been observed in the last years of the decade (CEPIS-OPS 2000).

In all the countries of the Subregion 38a the lack of sanitary services coincides with the location of deficit housings areas. In consequence, the lack of access to the basic sanitary services of drinkable water and sewer constitutes a problem that recounts to situations of poverty. There exists information about quantity of population who resides in informal settlements of major cities in the Subregion 38a, information that complements the characterization of sanitary condition. From the five great cities analyzed by CEPIS-OPS's report (2000), Curitiba presents the major percentage of population in marginal settlements, followed by Metropolitan Area of Buenos Aires, Montevideo, São Paulo and Asuncion. Table 4.5.2 presents the information of drinkable water and sewage coverage in these urban areas:

Big cities	Population in marginal settlements (%)	Drinkable water (%)	Sewage (%)
Buenos Aires Metropolitan Area (Argentina)	2.24	78.1	14.8
São Paulo (Brazil)	1.18	99.1	88.9
Curitiba (Brazil)	7.35	90.9	57.2
Montevideo (Uruguay)	1.36	99.9	94.9
Asunción (Paraguay)	0	92.1	51.1

Source: CEPIS-OPS (2000)

Table Nº 4.5.2. SR38a. La Plata River basin: Population with access to drinkable water and sewage in 5 big cities

The percentage of treated effluents presents high variations between a maximum of 76% in Uruguay (the best situation of La Plata River Basin) and the minimum of 8% in Paraguay. Argentina and Brazil have values very near to the latter one, presenting 10% of treated volumes in each case. Bolivia, finally, presents an intermediate situation with a percentage of 30% (CEPIS-OPS 2000). In the case of water disinfection for consumption in urban areas, the situation is much more balanced. Paraguay and Uruguay present 100% of the service with some type of disinfection, followed by Argentina (98%) and Bolivia (95%). The report does not present information for Brazil (CEPIS-OPS 2000).

An environmental evaluation carried out in Montevideo at the beginning of the 1990s identified severe problems of pollution of several sources in the basins that supply the water for different uses. These are the Santa Lucía River basin, which supplies the water for 60% of the population of the country; Laguna del Sauce basin, where problems of eutrophication impede water provision for Maldonado's cities and Punta del Este; and Pando stream basin (OEA-BID-ROU 1992). A study on the departments of the Uruguay located on the coast of La Plata River (Canelones, Maldonado, Colonia and San José) and Montevideo city, presents more detail information (level of censuses section) of population without access to drinkable water and sewage (Cabella *et al* 1999).

In Buenos Aires Metropolitan Area, the presence of clandestine landfills impacts directly on the water availability for human consumption, due to the infiltration of liquids that infiltrated across the residues (N. Virgone 1998; Aguas Argentinas 1997). Besides, Buenos Aires and Rosario (the third urban area of Argentina) discharge sewage and other wastes to La Plata and Paraná Rivers, respectively, without previous treatment. In case of existence of wastes treatment, only a minimal percentage of the whole collected is purified (CEPIS-OPS 2000); as happens in La Plata city.

4.5.2. Concern II: Pollution

Pollution - Socioeconomic Impacts Present Conditions	Score
Economic Impact	3.0
Human Health Impact	1.6
Social & Community Impact	2.3

This group of impacts received the highest valuation (3), due to attributed importance of costs in water treatment by several causes (microbiological pollution, eutrophication), decreases in fish captures, investments in contingency, preventive and emergency measures, losses in properties values and costs of litigation and insurance.

Pollution has an relatively major impact in water supply of great urban areas. In Upper Paraná system is outlined the problem of drinking water supply in São Paulo Metropolitan Area, related with pollution of Tietê River. This problem causes great investments in water treatment and in sanitation measures. “Tietê Project” and “Projeto de Despolução do Rio Tietê” (see Economic Impacts of Freshwater shortage) are two examples of sanitation measures took by SABESP to clean Tietê River and improve quality of life of São Paulo inhabits livelihood.

Another important problem related to pollution in Metropolitan Area of São Paulo is the eutrophication. Guarapiranga Reservoir is affected by algae’s blooms that lead to eutrophication processes and increases the cost of water treatment. There exist several algae species in Guarapiranga Reservoir, which cause problems in dam operating due to their resistance to algaecide and water treatment, because they obstruct the filters and impede the flocculation (Beyruth 2000).

As regards spills, it is outlined the accident occurred in December 1992 in Juquerí River system. This accident mobilized several public and private entities of São Paulo State in the emergency and remediation operations. The total cost of the operations of contingency and prevention measures were estimated in about U$S 150,000 (Hadad and Aventurato 1994).

Problems related with suspended solids of anthropic origin were detected in Paraná State (Brazil), where the erosion caused by land use changes (expansion of the agricultural) causes a considerable increase in rivers turbidity. Suspended solids transported by drainage networks contain, besides, nutrients and pesticides. This fact caused an increase in the costs of water treatment that supplies more than 200 cities of the State (Merten 1993).

Break of a pipeline in January 1999 caused the spill of raw oil in the Barigüí River (tributary of Iguazú), which caused economic costs linked with prevention and monitoring tasks. For example, the governmental entities related to sanitation in the Province of Misiones (Argentina) and Paraná State (Brazil) implemented a line of permanent contact for monitoring the advance of oil spot towards Iguazú River. The analysis of water samples did not indicate pollution in Iguazú River; nevertheless, the "Instituto Misionero de Agua y Saneamiento" (IMAS) put in functioning an old water intake located in the Mbocai stream, tributary of Iguazú. SANEPAR (the Paraná´s sanitation institution), arranged a collection of three daily water samples in Uniao do Victoria, the first Brazilian city that processes Iguazú River's waters for human consumption (IMAS 2000).

Several productive activities cause serious impacts in the Pantanal. Among these impacts is outlined the contribution of chemical pollutants coming from agriculture and mining (heavy metals such as mercury, associated with the exploitation of gold). Also there are processes of eutrophication originated in vegetation burning. All these impacts would generate a major cost in maintenance of navigation in the Paraguay River and significant economic losses due to decreases in commercial and sports fishing (Moiragh de Pérez 2000). On the other hand, the progressive increase of annual cultures (especially soybean) in the Brazilian plateau causes a major contribution of suspended solids towards the Pantanal. The sediments fill channels and river beds progressively, increasing overflows and flooded area and producing decreases in cattle yield and negative economic impacts in cattle raising and in land value (Tucci 1996).

In the Pilcomayo River system, the pollution by heavy metals is related to mining. In the upper Pilcomayo River basin (Bolivian territory), the main problem is mineral tails and effluents discharges without previous treatment. In the first case, mining exploitation around Potosí city has been realizing for more than 500 years without control or prevention measurements. Besides such chronic pollution, it must be added accidents that involve the overturned of residues in major scale. Among these accidents it is outlined, the one was occurred Porco's mine tails, with high impact on indigenous population and the ichthyic resources. In the last case, the accident occurred in the spawning season of shad (*Prochidolus lineatus*) which possibly caused serious impacts on specie reproduction and fishery sustentation (Padilla 1998).

Due to the occurrence of successive accidents in this sector of the basin, the Mining Corporation of Bolivia (COMIBOL) began with environmental actions in 1993. In this context, it was assigned and apportioned an approximate amount of U$S 3.000.000 financed by the World Bank, the Swedish Agency of International Cooperation and the COMIBOL (Veneros 1998). It was negotiated the construction and the financing plans for dikes in Potosí's mines and the assistance in the implementation of a Program of Remediation of environmental passives originated in the past.

An investigation on individuals of shad captured in the proximities of Villamontes (Bolivia) demonstrated the existence of heavy metals in fishes, although not in enough concentration to affect human health. However, the report emphasizes that the pollution of the sediments with heavy metals is a chronic process that affects the populations of shad, impacting on its reproduction and its morphology (Smolders 1998). Between 1980 and 1998, a very important fall was observed in shad catchments in the Pilcomayo River awarded not only to the pollution by mining activity, but also to the increase in the transport of sediments for anthropic causes. This fall in shad fishery represented a decrease of about 66 % in fish sales (Padilla 1998), which affected directly in the local economies, especially the indigenous riverside communities sustained in the shad handcrafted fishing (Castro Arze 1998). The same affirmation was emphasized by the media of Tarija's department (El Diario 18-10-2000).

In the lower basin of the Pilcomayo River (Argentina), there have been done some estimations of the costs needed for water treatment for human and agricultural uses. In both cases it is outlined the necessity to remove heavy metals present in suspended solids, which can be removed by conventional methods of treatment in the case of human consumption and through a pre-treatment in the case of water for irrigation (Lopardo 1998). Other estimations refer to the costs associated to losses of aesthetic values and decreases in shad fisheries. In the first case, the loss of biodiversity and the extinction of species in low basin wetlands would drive to falls in incomes generated by the eco tourism in the area. In the case of fishing, the fall in shad catchments would produce a consistent decrease of fish sales. Also, there are some estimations of the investment needed to do in medical treatments and indigenous population health care. There is an estimation of the reduction of handcrafted products sales that it would take place if the migrations process increases (Lopardo 1998).

Major cities which take water of La Plata River in Argentina (Buenos Aires Metropolitan Area and Great La Plata) have conventional treatment systems. Both principal plants are San Martín (2,500,000 m^3/d) and Belgrano (1,100,000 m^3/d). In the case of the San Martín plant, in 1976 it had changed the location of intake point into the river, as consequence of the high levels of pollution of the coastal waters. The intake point located to 600-700 meters from the coast had to move away up to reaching 1.050 meters. This fact meant an economic cost directly associated with negative impacts of the pollution (World Bank 1995). Despite this change, the same report estimates that the water intake point continues receiving the influence of the discharges of Reconquista River (one of most contaminated in Metropolitan Area of Buenos Aires), which might increase the costs of water treatment. Besides the pollutants of urban-industrial origin discharged by minor tributaries of La Plata river in Buenos Aires, the cost of water treatment in San Martin plant would be influenced by the high concentration of natural origin sediments transported by Paraná and Uruguay Rivers (World Bank 1995). To this respect, the concessionary company of drinkable water service in Metropolitan Area of Buenos Aires (Aguas Argentinas) made many studies that allowed to estimate effects of contribution of Bermejo River’s sediments in water treatment. These studies led to the company to implement, in 2000, a methodology that allows the precise use of storage facilities, as well as to project the volume of chemical inputs and to rationalize the budget of the company (Nociari and López 2001).

In the Uruguayan littoral of the La Plata River, pollution is related to discharges of Saint Lucia River and other small streams that flow into Montevideo´s bay. There also exists a considerable impact caused by discharges of residual waters (domestic, industrial and pluvial), that was partly corrected when there was implemented a collect system which liberates the effluents in a submarine outlet located to 2 km from Punta Carretas. The partial operation of this system (which started in 1995) allowed a decrease in the microbiological pollution in Montevideo’s beaches (Kurucz *et al.*. 1998). Nevertheless, this solution does not allow to solve the problem of heavy rains that exceed the capacity of the pluvial system and overflows in the old system of residual waters. In such opportunities, the authorities recommend not to bath in the Montevideo’s beaches at least for two days.

Another socioeconomic impact linked with pollution in Montevideo’s littoral of the La Plata River is the displacement of valuable species of handcrafted fisheries. In fact, fishermen have indicated that catchments of ¨corbina¨ (*Micropogonias Turnieri*) requires a crescent fishing effort due to pollution by industrial effluent, among other factors. Fishermen aim that currently they must go out with major quantity of nets to capture the same quantity of ¨corbinas¨ that they used to do years ago (Graña and Piñeira 1998). The pollution, which is not homogeneous on the whole coast, not only concerns the bass, but also its principal food, the mussels.

Meanwhile, on the coast of the Province of Buenos Aires, pollution caused by the effluents overturned in Ensenada-Berisso's Petrochemical Pole impacted negatively on the fishing activity (Greenpeace Argentina 2000). Although it has not been found studies that support the prohibition of shad (*Prochidolus platensis*) fishing as consequence of microbiological and chemical pollution in La Plata River, it has found indications of heavy metals in individuals of this specie. This finding caused the prohibition to fish shad in La Plata River.

In relation with pollution caused by spills, two great accidents have taken place in the last years, which affected the Argentine and Uruguayan coasts of La Plata River. In January, 1999, the accident of the “Estrella Pampeana” tanker in front of the Partido of Magdalena’s coast (province of Buenos Aires, Argentina) caused the spill of an approximate 5,500 m^3 of oil in the La Plata River. The spill caused a strong impact on the productive activities of Magdalena: fishing, recollection of rush and tourism in the beaches. Also, there were affected recreational activities and sport fishing due to the closure of beaches and the consistent fall in the number of tourists (INA 2000).

A valuation of environmental passive done in the context of an evaluation of the impact of the spill, estimated the losses caused by the closure of beaches on tourist season (three months), calculating the fall in the revenue of Magdalena's municipality due to the lack of collection of incomes to the resorts, damages to the beaches infrastructure (ways, bicycle-path, signposting, etc), lack of perception of wages of beach maintenance's personnel, lack of tourist activities and closure of the "Club de Pescadores" (Fishermen's Club). There were also estimated the cleanliness costs of the coastal ecosystems affected ("juncales" and "pajonales") and the impacts on the private sector (investments in accommodations, camping, construction of summer housings, etc.). Finally, the report emphasizes the losses derived from suspension of commercial fishing and rush collection and the costs of beach and "juncales" cleanliness tasks. Likewise the possible cost was estimated for three years following the accident. One year after the accident, at the beginning of the summer season of 2000 year, the affected beaches still remained closed, deepening the impact on the Municipality's economy (El Día 15-1-2000).

In February of 1997 there was produced another accident that involved oil spills in front of Punta del Este's coast (Uruguay). In that opportunity, San Jorge ship ran aground and were spilt approximately 58,000 m^3 of crude oil which affected approximately 10 km of beaches. The accident reached a great repercussion due to the high tourist affluence to the beaches (J. Villalonga 2000). Also there were suspended temporarily the fishing activity and the marine food sales (Subrayado Newspaper 12-2-97 and 13-2-97), with the associate economic loss.

Related to pollution by solid wastes in La Plata River subsystem, in Buenos Aires Metropolitan Area deterioration in the quality of life in the informal settlements located in the surroundings of open landfills have been identified. Although an economic quantification does not exist, there is mentioned losses of properties value as consequence of the existence of such landfills (Aguas Argentinas 1997).

A general overview of safe water and sewage services was done in the descriptions of impacts on human health related to Concern I. The same general and introductory description is valid to this Concern.

Despite the absence of information that allows to link explicitly morbidity and mortality with water pollution, there exist reports that indicate the existence of water related diseases in each of the countries. In Argentina, the most frequent diseases are gastrointestinal ones, paratyphoid, typhoid fever, intestinal parasitosis and methemoglobinemia. The diarrhea has a very low effect, with 0.067 episodes per year in five-year-old minor children (CEPIS-OPS 2000). Anywise, the infectious intestinal diseases, added to pneumonia, constitute 60% of the hospitable consultations in the 0-10 age group (OPS-OMS 1998). Between 1992 and 1996 epidemic episodes of cholera were produced in the country, which affected principally to the indigenous communities of the Province of Salta, in the frontline with Bolivia. These outbreaks were linked to the degree of water sources pollution, caused partly by an inadequate disposition of effluents and wastes of many communities and partly by the lack of sewage effluent treatment system in the riverside cities, even those which are beyond the border of the country (CEPIS-OPS 2000). The most important epidemic centers were Pilcomayo, Bermejo and San Martín cities (Berjemo and Pilcomayo Rivers systems), with a peak of 2,080 cases (6.5 for 100,000 inhabitants) and a lethality rate of 1.6% in 1993. After this maximum, the effect went down and during the last years the lethality rate was kept in 1.1% (OPS-OMS 1998). During these epidemics there were also reports of disease cases in the province of Chaco (Norte Newspaper 14-5-97).

In Brazil, the most problematic water related diseases are schistosomiasis, malaria and dengue. There exists a minor quantity of cases of yellow fever and filariosis. It is calculated that there are approximately 10,000,000 persons affected with schistosomiasis, disease caused by baths in waters polluted by *Shistosoma mansoni* (CEPIS-OPS 2000). As regards gastrointestinal infections, information of 1995 indicates that the diarrhea was the second reason of hospitalization and the third reason of death of 1-year-old minors. In this country an epidemic of cholera also was registered at the beginning of the 1990s. Until 1994, it was accumulated approximately 150,000 cases with 1,700 deaths (WHO-OPS 1998); the major part of these cases were located in Northeast Estates, outside of the Subregion 38. In the States of La Plata River Basin, there are records of infantile mortality caused by water related diseases to in the “Unidades de Gerenciamiento de Recursos Hídricos - UGRHI” (Units of Water Resources Management) of São Paulo State (**Box 11**).

In Paraguay, diarrhea is the second reason of morbidity in 0-5 age group (16.1 episodes/child/year). It estimates that the mortality rate due to diarrhea is 14.8 deaths for 1,000 inhabitants (CEPIS-OPS 2000), being the water related disease of major incidence in the country. In fact, diarrhea is one of the main reasons of mortality in children from 0 to 4 years (WHO-OPS 1998) and the third cause of general mortality (Barrera Arraya 1996). The epidemic of cholera registered in the 1990s in the countries of the region also concerned to Paraguay, although the notified cases were relatively smaller (7 in 1993 and 4 in 1996). Although there do not exist studies that associate the appearance of infect contagious and parasitic diseases with solid wastes pollution, it is possible to associate the 1999 epidemic of dengue with the poor wastes management; this epidemic centered principally on Asunción, Central, Alto Paraná and Amambay Departments, spreading to the rest of the country in the year 2000 (BID *et al.* 2001).

According to the information consulted up to the moment, effects of water related diseases is not relevant in Uruguay. Although the diarrhea occupies the second place as reason of consultation in hospitals, it is the eighth cause of mortality in 1-year-old minors. On the other hand, Uruguay is the only country of the Subregion where did not register cases of cholera during the epidemics of the 1990s (OMS-OPS 1998).

Finally, in Bolivia diarrhea appears as main water related disease since it occupies the first place among registered diseases, with a percentage of 64% (PLAMACH-BOL 1996). According to information of 1994, the diarrhea has an effect of 4 cases/child/year and a mortality rate of 7,900 deaths by year (CEPIS-OPS 2000). Despite the lack of statistical information, there exist studies that link the occurrence of diarrheas in Bolivian urban areas with microbiological pollution and deficiency in sanitary services (Barrera Arraya 1996). The same happens in case of the indigenous populations, among which the diarrhea occupies the first place as cause of death during the infancy. The epidemic of cholera reached a maximum peak in 1996, with 2,634 registered cases and a lethality rate of 2.4 % (OPS-OMS 1998), concentrated principally in La Paz and Potosí Departments (the latter partially included in the Subregion).

Going on to the analysis of some selected subsystems, in case of the Tietê River system, there probably exists a relationship between the process of eutrophication in Guarapiranga Reservoir and an increase of diseases due to ingestion of toxins produced by certain species of algae or due to use of cupper sulfate used in algae control (Z. Beyruth 2000). There must be taking into account that this reservoir supplies 20 % of the population of São Paulo Metropolitan Area and its beaches serve, besides, as recreational area. As regards the use of beaches, the “Programa de Balneabilidade das Praias” (executed by CETESB), has qualified these beaches between regular and improper to use in 2001, qualification that evaluates the density of fecal matter and *Escherichia coli* present in coastal waters (CESTEB 2001).

As regards to the pollution caused by spills, the accident that involved the spillage of phenols in the surroundings of the Juquerí River (Upper Paraná system) caused the interruption of the water supply service during several days, which placed the local population in situation of risk (Hadad and Aventurato 1994).

In the Pilcomayo River basin, population health is considered at risk due to the pollution caused by mining residues and effluents of Sucre, Potosí and other cities (Arce *et al.* 1998). The same report emphasizes the high infantile mortality rates of whole Bolivia, indicating a possible relation between this indicator and the lack of access to the health services and basic sanitation. A monitoring realized during 6 months in several localities of Potosí and Chuquisaca Departments (upper Pilcomayo River basin) allowed to qualify the waters as not suitable for domestic consumption, for primary contact recreation, protection of resources, vegetables irrigation and aquiculture. It was also registered poisoning by lead (Sandi 1998). Finally, the accident of Porco's mine, with the overturned of mining residues caused direct impacts on the local economies and affectation of water quality to indigenous populations consumption (Arce *et al*. 1998).

In the Paraguayan tributaries of the Upper Paraná system, there have been detected pollutants from chemical origin (Azodrín 400, Apadrín 60), that have been related to cases of poisoning (Gobierno de la República del Paraguay 2000).

In de la Plata River system, some municipalities of Buenos Aires Metropolitan Area are at high sanitary risk due to water pollution from biological (lecptospirosis and diverse parasitosis) and chemist origin (metahemoglobinemia). These diseases add to the already commented high effect of the diarrhea related to the deficiency of sanitary services, especially in the case of informal settlements (CEPIS-OPS 2000). The occurrence of cases of lectospirosis is related to the recreational use of the waters such as bathing in rivers and ditches and fishing on the coast of La Plata River and the second urban belt of Buenos Aires Metropolitan Area. At the same time, cases of metahemoglobinemia are related to the aquifer pollution by anthropic causes (contribution of organic garbage, industrial effluent, and nitrogenous compounds from cesspits; Aguas Argentinas 1997).

Box 11 SR38a. Infantile mortality rate for water diseases in São Paulo State (Brazil)

Impact of pollution on human health is directly showed by the measurement of infantile mortality rate due to water borne diseases. This rate measures the mortality of under 1-year-old children due to one of the mentioned diseases.

In São Paulo State this indicator is registered taking into account the incidence of diseases such as enteritis, infectious hepatitis and schistosomiasis which are linked not only to the water quality, but also to the sanitary conditions of the housing in which children reside. The analysis was realized in all the UGRHIs of the State (**Table 1**). Data Table shows a gradual improvement in the conditions in the Estate, where mortality rate decreased from 1.18 per 1,000 in 1995 to 0.61 per 1,000 in 1997. In the latter year, the UGRHIs that presented the major rates were Alto Parapanema, Tietê/Batalha, Mogi-Guaçu, Pardo and Mantiqueira. It is observed a sensitive reduction in all the UGRHIs, except in case of Tietê/Batalha and Pardo, that practically supported the same rates.

UGRHI	Water (%)		Sewer (%)		Infantile mortality		
	Supply	Losses	Supply	Treatment	1995	1996	1997
Mantiqueira	80	12	45	2	1,47	0,77	0,75
Paraíba do Sul	96	40	86	25	0,71	0,52	0,45
Pardo	99	42	97	8	0,77	0,51	0,76
Piracicaba/Capivari/Jundiaí	93	33	76	11	0,78	0,46	0,56
Alto do Tietê	98	40	76	28	1,31	0,9	0,64
Sapucai/Grande	98	30	97	63	0,62	0,1	0,48
Mogi-Guaçu	96	39	90	11	1,09	0,59	0,82
Tietê/Sorocaba	95	32	81	12	1,12	1,15	0,53
Baixo Pardo/Grande	92	34	89	12	0,75	0,57	0,62
Tietê/Jacaré	98	36	93	8	0,95	0,79	0,29
Alto Paranapanema	98	32	80	31	3,49	2,87	1,64
Turvo/Grande	98	30	94	17	0,83	0,61	0,37
Tietê/Batalha	94	27	90	29	0,66	0,42	0,84
Médio Paranapanema	88	27	80	21	1,18	0,75	0,58
São José dos Dourados	100	24	90	56	0,88	0,65	0,33
Baixo Tietê	95	30	86	45	1,53	0,66	0,58
Aguapeí	99	29	84	37	1,56	0,89	0,2
Peixe	94	41	79	28	1,02	0,76	0,46
Pontal do Paranapanema	100	36	85	26	0,63	0,26	0,53
Estado de São Paulo	**97**	**38**	**79**	**25**	**1,18**	**0,81**	**0,61**

Table 1: Infantile mortality rate for water diseases in São Paulo State

As regards sanitary conditions, it is outlined that the major infantile mortality rate was observed in those UGRHIs that have a higher percentage of effluent without treating. This fact reveals the close link between both indicators

Among social and community impacts, the experts assembled in the First Workshop emphasized the high effect of the pollution on the tourism and the recreational values, due to, especially, the landscape degradation, the existence of disagreeable smells and the potential impacts on human health. Other negative out-standing effects were the emigration, the possibility of international conflicts (in case of the accidents that involve spillages) and the changes in the food diet. Up to the moment, the report of information and the consultation to the experts allowed to compile evidences of the majority of these impacts. Another identified impacts are loss of biodiversity, affectation on protected areas and existence of complaints as result of the perception of pollution effects.

In Upper Paraná system, severe pollution of Tietê River produced affectation on the urban landscape located on approximately 25 km of its margins (Secretaria Estadual do Meio Ambiente 2002). Guarapiranga basin also presents the same problem. In the latter case, it is observed landscape degradation, loss of vegetable and animal species and loss of ecosystems ecological functions (CETESB 1997). In the Guarapiranga Reservoir's beaches, existence of microbiological pollution impacts on water quality to be used for recreation, affecting negatively in the weekly classification of bathing waters made by CETESB (2002). Finally, a negative additional impact in the reservoir is the disagreeable smells produced by the algae blooms (Beyuth 2000).

Related to the pollution by spills, there was produced fish's death (about 400 carps and "tyllapias") and other animals, as a consequence of the phenol spill in the surroundings of Juquerí River. The same accident caused a disagreeable phenol smell in the air; besides, the contact with this compound caused the loss of vegetation surrounding the industrial lagoon in front of which there took place the accident (Haddad and Aventurato 1994).

In the Pilcomayo River system, the impact of pollution on indigenous communities economy caused the emigration towards urban centers both in Bolivia (Yacuiba or Santa Cruz cities) and in Argentina. Though up to the moment there has not been identified quantitative information that allow to evaluate the magnitude of the phenomenon, it is estimated that the forced migration commits an outrage against the survival of the communities, through loss of identity, communal disintegration and loss of native language (Castro Arze 1998). The accident in Porco mine aggravated temporarily the context of pollution and the process of migration (Condori 1997). In the Group of Work of Indigenous Peoples assembled in Ginebra, it was denounced the death of three indigenous farmers (Condori 1997).

Pollution in Pilcomayo River also affects the biodiversity of the area, both in the upper and in the lower basins. In the first case, the losses are closely related to affectation of heavy metals on the population of "sábalos" (Sandi 1998). In the lower basin, affectation is concentrated on the wetlands, due to contribution of sediments coming from the upper basin. These wetlands have a central role in the development of the ichthyic fauna, since they are the principal site of fish's nourishment due to its great primary productivity. The relation of the ichthyic fauna with these environments is affected increasingly by the sediments contributions of the upper basin and the setback of riverbed (Lopardo *et al.* 1998).

Analysis on solid wastes in Paraguay identified problems related to the pollution in Asunción city (Paraguay River system). The unique qualified dump of the city is located near a wetland on the Paraguay River, causing not only landscape degradation and disagreeable smells, but also wetland pollution due to the infiltration of the lixiviated (BID *et al.* 2001).

Finally, in La Plata River system there have registered negative impacts related with microbiological pollution and accidental oil spills. In the first case, there has been identified loss of aesthetic and recreational values in 21 beaches located between Tigre and Magdalena (Province of Buenos Aires, Argentina), which stop being used by the local population (World Bank 1995). The same happens in the case of the Uruguayan coast of La Plata River, between Colonia and Canelones Departments, where the affectation of beaches is related with the outlet of domestic effluents and with the discharges of La Plata tributaries that are used for overturned of urban and industrial wastes. The area that borders Montevideo city represents the worst situation of beaches bacteriological quality to recreational use. (Andrés *et al*. 1999).

In the case of accidents, the oil spill in front of Magdalena's coasts affected several kilometers of beaches, which had to be closed and caused a direct impact on the aesthetic and recreational values of the resource (Acerbi and J. Barrenechea 1999; FVSA 1999). The arrival of the oil spot to the beaches produced, besides, a direct impact on the biodiversity conservation because the south zone of the coastal reached by the spill fits to the "Parque Costero del Sur", protected area recognized as Reserve of Biosphere for MAB Program (Man and Biosphere) since 1985. The oil also reached creeks and swamps recognized as unique natural habitats (Acerbi and Barrenechea 1999).

On the Uruguayan coast, the spills in front of Maldonado's Department produced equal effect that in Magdalena, this is, the temporary beaches clousure (Subrayado Newspaper 12-2-97). The arrival of the oil spot to the "Isla de los Lobos" struck directly on birds and marine mammals, affecting principally the younger individuals (Villalonga 2000; Brecha Newspaper 1997).

4.5.3. Concern III

Habitat and Community Modification - Socioeconomic Impacts Present Conditions	**Score**
Economic Impact	2.5
Human Health Impact	0
Social & Community Impact	2.5

Compared to the size of the economy, economic negative impacts of habitat destruction and modification are scored as moderate. They become evident mainly in relation to decreases in fishing and to some extent in hunting of commercial interest species in community sectors which feed from or trade them. As a consequence, the impact is higher in regional economies and fishing, sporting and tourism activities. However the majority of the population lives in urban settlements.

In the Itaipú Reservoir fishing effort was 67.5 days in 1987, 120 days in 1993 and 106.5 in 1998 while the optimal recommended is 95.5 day/year (FUEM. NUPELIA/ITAIPU BINACIONAL 1999). Capture per Effort Unit have been decreasing: 21.7 kg captured / day in 1987, 15.5 kg captured / day in 1992 and 11.5 kg captured / day in 1998 (Okada 2001).

Decreasing in fish populations due to overexploitation could have serious impacts on the community that lives on that resource. Some experts believe that if shad resource decrease between 300,000 and 500,000 people who practice survival fishing would move to the cities worsening their livelihood (El Litoral 3/03/2002).

On the other hand, in the Upper Paraná River a prohibition from November 1 to January 31has been established in order to ensure the exit of migratory species towards spawning areas. Although positive impacts on fisheries have not been assessed yet such prohibition causes social and economical problems since many fishers do not have incomes during three months for supporting their families. Thus, many of them begin illegal activities such as stolen cars and drugs traffic through Brazil and Paraguay frontier (Agostinho and Gomes2002)

The cost of controlling invasive species, costs of habitat restoration, loss of educational and scientific values and fundamentally, generational inequity, should be added.

There was no indication of direct impacts on human health as a result of habitat losses, even considering that the creation of lentic littoral ecotones, as a result of reservoir water impoundments, increases the availability of areas prone to the development of vectors of tropical diseases like schistosomiasis, yellow fever, etc.

WHO has estimated in 6 millions the people infected by Schistosoma parasite in Brazil. Originally from the Northeastern part of Brazil this parasite started to expand southwards due to migratory processes and reservoir building. Since 1940 the State of Paraná has been a hyper-endemic area with *Biomphalaria glabrata* as parasite vector (Quintana 2000). The group considered that these vector prone zones are a part of the causal chain process leading to health impacts, where a number of concurrent causes results in them.

There are quite a number of affected communities, directly related to water systems in the Subregion or next to inland or ocean waters, which depend, in a seasonal pattern, upon the characteristics, goods and services that the ecosystems and shoreline ecotones provide to them. Many of these communities carry out craftsmanship activities, very important because of the high social, economic and cultural significance at the local level.

In the Middle Iguazú River, due to the modification of the ecosystem by reservoir building the fisher riparian communities had to change their fishing practices from fish line and fishhook to waiting nets. The adaptation to such new fishing practices is consider an important social impact of reservoir building (Agostino and Gomez, 1997)

Lack of conservation and systematic destruction of the ecosystem, may end their main life strategies, which in many cases are merely survival ones. Resulting changes in traditional ways of living generate economic as well as affective losses, inducing migrations.

5. SUBREGION 38b: SOUTH ATLANTIC DRAINAGE SYSTEM

5.1. Brief description of the System

5.1.1. Environmental aspects

This system comprises the basins located between the Andean ranges and the Atlantic Ocean coast, which drain across extended arid areas of Argentina into the sea (**Figure 5.1.1**). Colorado, Negro, Chubut and Santa Cruz Rivers are the main systems crossing the area from West to East. Gallegos and Chico del Sur Rivers (Santa Cruz province) and Alfa, Cullen, San Martín, Ch Gamma, Chico y Grande Rivers (Tierra del Fuego province), located in the extreme Southern part, are water systems shared with Chile (**Table 5.1.1**). All of these rivers rise in the Andean Ranges and feed their flows from snow melting and rainfall. On their way to the ocean, in general, these rivers do not receive relevant tributaries[1].

Rivers	Basin area (km^2)	Length (km)	Average discharge (m^3/sec)
Colorado	50,236	923	1,301
Negro	19,778	637	846
Neuquen	50,774	510	308
Limay	61,723	430	N/d
Chubut	53,801	820	30
Santa Cruz	28,056	383	698
Chico del Sur	1,335	75	N/d
Gallegos-Cüllen-Chico-Gamma	676	N/d	N/d
Grande	7,021	230	N/d
San Martín - Tierra del Fuego	8,406	N/d	N/d

Source: SSRH 2001; GEA 1975

Table 5.1.1. SR38b South Atlantic Ocean Drainage System. Main rivers

These watersheds are located on the so-called "arid diagonal" of South America, characterized by strong water deficit (mean annual rainfall below 400 mm). In this area, the main vegetal covers are the steppe (south and northwest) and "monte" (central area). The Andean ranges, along with the influence of the South Pacific anticyclone system, determine the existence of distinctive humid areas to the West known as the "patagonic-andean forests"[2].

Colorado River basin spreads from West to East, comprising areas of mountains, plateaus and plains. Colorado River rises from the confluence of two mountain rivers (Grande and Barrancas) and on its way to the ocean, constitutes the border of 5 provinces (Buenos Aires, La Pampa, Neuquen, Mendoza and Río Negro).

Relief features determine some reaches where the river flows through narrow stretches and others where meanders are formed. Next to its mouth, the river develops a delta formed by several branches. The main water uses are mainly the supply of riparian urban settlements and irrigation. A dam has been built for irrigation and flow regulating purposes. This river also drains the Desaguadero River basin, which collects water of several rivers (Atuel, Diamante, Tunuyán) that irrigate farming areas in the western part of Mendoza Province.

[1] Urciuolo (2001): *Subregión 38, Plataforma Patagónica. Cuencas Patagónicas y Sur de la provincia de Buenos Aires*. Preliminary Report prepared to Subregional Focal Point (GIWA-UNEP Project).

[2] Daniele and Natenzon (1994): "Las regiones naturales de la Argentina: caracterización y diagnóstico", in Bukart (ed): *El sistema nacional de Areas Naturales Protegidas de la Argentina. Diagnóstico de su patrimonio natural y su desarrollo institucional*. Buenos Aires, APN.

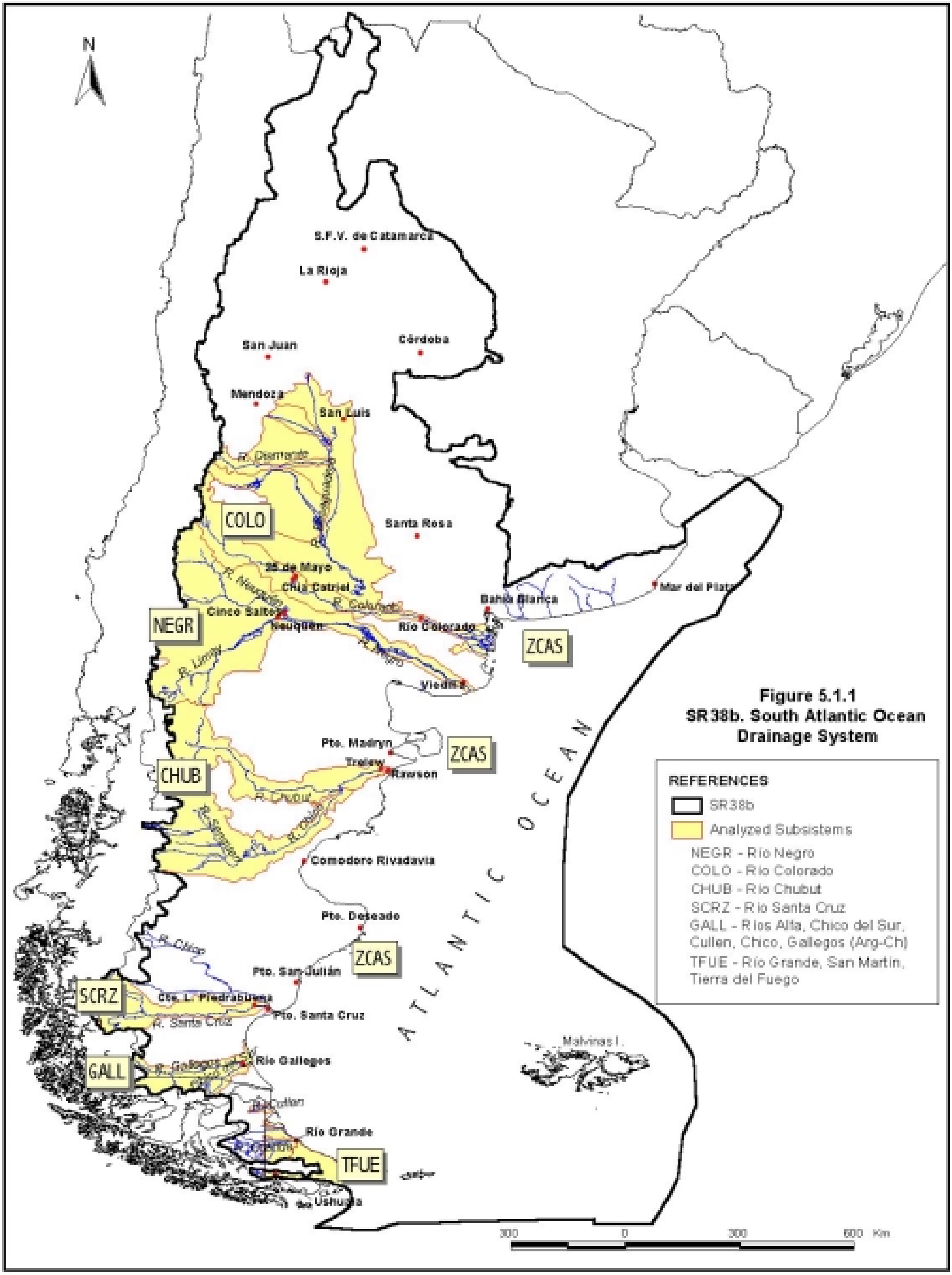


Figure 5.1.1
SR 38b. South Atlantic Ocean Drainage System

Negro River rises from junction of Neuquen and Limay Rivers, which drain mountain range and lake areas in the West. Important systems of hydroelectric power plants and reservoirs have been built on both rivers, providing flood control and regulation of low flows for irrigation. The Neuquen River supplies water to a large irrigation system in the Negro River valley, known as “upper valley oasis”, devoted to high quality fruit plantations. The Negro River itself crosses the Patagonian plateau until it discharges into the Atlantic Ocean. It supplies water to riparian urban settlements and smaller irrigation systems.

Chubut River rises from mountain streams flowing down from the “Nevado Mayor” range, and on its way to the sea crosses three different areas: mountains, central Patagonian plateau and the lower valley. Florentino Ameghino Reservoir regulates river flows supplying water to the irrigation system of Lower Valley (Urciuolo 2001). Besides being the source of water for Rawson and Trelew cities, located in the lower valley, Chubut River supplies water through to Puerto Madryn, an industrial city (fisheries, aluminum). The Chico / Senguerr River and its lakes system is an old tributary of the Chubut River, seldom active nowadays, only when exceptional high flows occurs.

Santa Cruz River is the most important of the Santa Cruz province, due to the extent of its basin and the magnitude of its flows. It possesses a very important un-developed hydroelectric power potential. The river rises in the Eastern end of the Lake Argentino. The upper river flows through narrow reaches, rocky bed and numerous rapids. Downstream, in the lower reaches approaching the estuary which discharges its waters into the sea, the river enlarges and forms meanders. In such sector it is navigable.

Basin formed by **Gallegos** and **Chico del Sur** Rivers is the most southern of continental Argentina. Its upper watersheds lie in territories of Argentina and Chile, becoming international transboundary water resources. Chico del Sur River is almost an independent watercourse, which discharges, in the same estuary together with the Gallegos River in its mouth.

Tierra del Fuego has a dense drainage system, having its regime benefited with a relatively uniform distribution of rainfalls along the year. Streams flow predominantly in the West- East direction, following the geologic formations that defined the fluvial valleys, of glacial origin. In the Northern part of the province, **Alfa, Cullen, San Martín, Gamma** and **Chico** Rivers, are shared with Chile, where their upper watersheds are located. All of these rivers have small flows, being Chico River the most important. Activities linked with oil extraction are significant in the Cullen River basin[3].

To the South, there are the so-called “transition basins”, which spread over the mountainous area of Tierra del Fuego Grande Island. **Grande River** is the major surface drainage system, its main flow contribution coming from the Chilean sector, although there are important tributaries in the Argentinean sector. Its valley is constraint by glacier terraces dissected by water erosion in many sectors[4].

Oceanic component

SR38 comprises one of the world’s largest shelves: the area of the continental shelf up to 200 meters is 769,400 km^2, whereas the Economic Exclusive Zone has 1,164,500 km^2. The joint influence of Brazil warm current, which flows to the South, and the Malvinas cold current, which flows to the North, result in waters with high content of nutrients which sustain a large variety of marine mammals and birds, fishes and invertebrates[5].

The littoral in Uruguay on the Atlantic Ocean is about 220 km long, while Argentinean littoral comprises 4,989 km between La Plata River and Tierra del Fuego (excluding the oceanic islands). From a geological point of view, the littoral of Argentina can be split in two regions, north and south of mouth of the Colorado River: the “bonaerense” littoral to the North and the “patagonian” littoral to the South. From a biological point of view, Patagonian littoral is one of the world’s most productive

[3] Urciuolo (2001).
[4] Urciuolo. (2001)
[5] DRIyA (2001): *La biodiversidad marina en la Plataforma Patagónica*. Preliminary Document.

marine systems and one of the most complex in terms of interactions between fauna, flora and physical marine and terrestrial elements.

In the same way than the California and Benguela Currents, Patagonian shelf exhibits a combination of three general factors associated with favourable reproductive habitat for several valuable fish and mollusk species, including: enrichment of the food web by physical processes (e.g., up welling, mixing); opportunity for concentrated patch structure of food particles (e.g., lack of turbulent mixing and/or convergence in frontal structures); and the availability of mechanisms that promote retention of larvae within or transport larvae to appropriate habitat. The three factors combine favourably only in special configurations as otherwise turbulence and mixing may disperse larvae away from the food source[6].

Hake (*Merluccius hubbsi*) and prawn (*Pleoticus muelleri*) are the most valuable species and sustain Patagonian commercial fishing. Total catchment of fishes and invertebrates has grown up four times from 1970s to the present time[7] (DRIyA 2001).

Global climate change related to the greenhouse effect could intensify coastal winds, disrupting the balance of up welling, sheltered areas, and mixing that is so favorable to anchovy and sardine fisheries in the Subregion[8]

5.1.2. Socioeconomic aspects

Subregion 38b is characterized by very low population density (see **Table 5.1.2**) and by high territorial population dispersion. Populations are concentrated especially in the surroundings of water bodies (rivers and lakes), in littoral areas or in areas with relatively better climatic conditions.

The main urban areas are located inside the Argentinean territory[9]. Those are Córdoba (1,157,554 inhabitants) and Mendoza (121,620 inhabitants). What the metropolitan areas of those two cities concerns, the numbers increase to 1,208,554 and 773,113 inhabitants respectively. Other cities of regional and provincial importance are Mar del Plata (512.880 inhabitants), Bahía Blanca (260,096 inhabitants), Comodoro Rivadavia (124,104 inhabitants), Puerto Madryn (44,916 inhabitants), Trelew (78,194 inhabitants), Neuquen (167,296 inhabitants), Río Gallegos (64,640 inhabitants) and Ushuaia (29,166 inhabitants). During the last years, in areas like Patagonia with really very few inhabitants, it has been observed that the urban population increases to a comparatively major pace that the total population.

The main productive activity in Subregion is farming. To the South of Colorado River (Patagonian steppes), the dominant activity is the extensive sheep cattle. This traditional activity has degraded the soils, unleashing severe desertification processes. To the North of Colorado River (area of “monte”), the aridity limits the cattle activity. In this area, the goats adapt better than others species to such environmental conditions.

[6] LME (2002): *LME Patagonian Shelf.* (http://www.edc.uri.edu/lme/text/patagonian-shelf.htm)
[7] DRIyA (2001).
[8] LME (2002)
[9] This section does not include considerations about socioeconomic aspects of Chile since the participation of the Chilean territory in the SR38b is minimal and it is not possible to specify the quantitative data for such area.

SR38b provinces	Total population	Area (km^2)	Density (pop/km^2)	Population growth (1991-2001, in %)
Catamarca	333,661	102,602	3.3	26.3
Chubut	413,240	224,686	1.8	15.7
Córdoba	3,061,611	165,321	18.5	10.3
La Pampa	298,460	143,440	2.1	14.6
Mendoza	1,576,585	148,827	10.6	11.6
La Rioja	289,820	89,680	3.2	31.3
Neuquen	473,315	94,078	5.0	21.7
Río Negro	552,677	203,013	2.7	9.1
San Juan	622,094	89,651	6.9	17.7
San Luis	366,900	76,748	4.8	28.1
Santa Cruz	197,191	243,943	0.8	23.4
Tierra del Fuego	100,960	21,571	4.7	45.8

Source: INDEC 2001.

Table 5.1.2. SR38b. South Atlantic Drainage System. Total population, area, density and population growth

The farming is limited to the oasis related to the existence of rivers (or other water bodies) and the “mallines”, which are humid lowlands in Patagonia. Oasis of San Juan and Mendoza provinces are the center of wine production, destined to local and international market. The same thing happens in Pampeanas Saws oasis, located in the west center of the country.

The fruit growing is also an important activity in the Negro River high valley (Río Negro and Neuquen provinces), whereas onion for exportation is obtained in the lower basin of Colorado River (Buenos Aires province).

Forests located in the Patagonian Andes hillsides are subject of different uses. On the one hand, there exist several protected areas (especially national parks) implemented to preserve the value of landscape and forest’s species. On the other hand, the forest is exploited to obtain diverse products (even for export) and it is deforested to practice small-scale farming.

Another central activity in the SR38b is the exploitation of underground resources (oil and coal). In this area the main Argentinean petroleum basins are located, such as the Neuquina basin (in the upper basin of Colorado River), the Cuyana basin (Mendoza and San Juan provinces), the San Jorge Gulf basin (South of Chubut province and North of Santa Cruz province) and the Austral basin (Santa Cruz province and North of Tierra del Fuego province). Comodoro Rivadavia and Bahía Blanca harbors are the outlets of the major part of Patagonian oil production.

In SR38b there are also a number of relevant reservoirs like Florentino Ameghino (50 Mw, in Chubut River), Casa de Piedra (60 Mw, in Colorado River) and Chocón- Cerros Colorado System (1,200 Mw, in Limay and Neuquen Rivers).

The Atlantic Ocean littoral is the focus of fishing activity. Mar del Plata and Puerto Madryn are the main fishing ports of the country, according to fish catchments of the year 1999 (307,000 tons in Mar del Plata and 290,000 tons in Puerto Madryn). In the last years, the arrival of foreign ships caused increases in catchments, which put several valuable species in risk of extinction, such as the case of the Argentine hake (*Merluccius Hubbsi*).

5.2 Concern I: Freshwater shortage

This concern was ranked as second priority in Sub Region 38 as a whole, being assigned priority 2 in SR38b, South Atlantic Drainage System.

Freshwater Shortage - Environmental Impacts by Issue: Present Conditions	*
1. Modification of stream flow	1.0
2. Pollution of existing supplies	1.0
3. Changes in the water table	3.0
Overall Impact	1.9

* Weighted score

Water deficit is a common feature in the arid and semiarid zones comprised by this system.

Therefore, freshwater shortage is, together with climate, a most relevant factor which constrains living and production conditions. This concern was assessed as moderate, according to GIWA methodology, and has been ranked as second priority for the region.

As regards the issue 1, a decrease of spring water areas has been observed in some areas of the region. There exists evidence of change of salinity in some coastal lagoons. Building and operation of reservoirs in the Limay, Neuquen and lower Chubut Rivers have resulted in changes in the seasonal flow pattern, affecting the drainage of irrigated lands, rising water tables and favoring salinization, impairing the use underground waters as sources of rural freshwater.

There are indications in some monitoring stations of bacteriological contamination, presence of hydrocarbons from oil spills and pollution of groundwater from oil industry activities. There exist reports of fish kills in some streams.

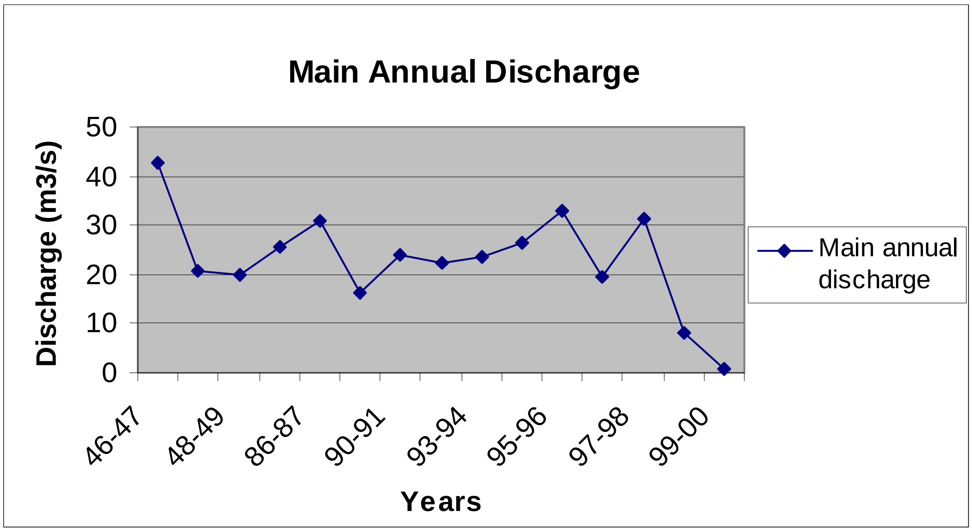
There is evidence of salinization at regional level in the irrigated areas, associated to major rivers (Chubut, Negro, Colorado) due to an increase in the water table as a consequence of low irrigation efficiency and insufficient underground drainage capacity. Also, there are indications of lowering of the water table, associated with springs, in a number of areas as a consequence of soil compaction due to sheep overgrazing and trampling in the local recharge zones. Thus water availability in springs (“mallines”) is affected by interventions of human origin. In some spots, underground water supply is becoming impaired by salinization processes as a result of over exploitation.

5.2.1 Issue 1: Modification of stream flow

A moderate diminishing of wetlands surface has been observed in some areas of the region, such as Colhue Huapi Lake **(Box 12),** within the Senguer River Basin, which is located in the province of Chubut and is undergoing desiccation and desertification process resulting from both human and natural causes.

Nowadays, Colhué Huapi Lake surface is about 1/8 from its original size due to: (a) A decrease in the Senguerr River flow due a decrease of rainfall and ice melting in the last years; and (b) Extractions of larger amounts of water mainly for irrigation, domestic water supply and oil industry. The continuous incorporation of lands for irrigation jointly with aqueducts for domestic water supply and industrial use may have broken the weak balance which occasionally allowed outflows from Colhué Huapi Lake into Chico River.

Irrigation practices in the lower Senguerr basin are carried out mostly by extensive flooding of grasslands, covered by "mallin" type and steppe vegetation. Controlled irrigation on systematized lands is done to a quite lesser extent. Such inefficient generalized irrigation practices in the basin are usually done by means of poor infrastructure (channels, dams, small embankments), favoring the infiltration of large water volumes and causing, like in Colonia Sarmiento, the elevation of the water table and soil salinization. Similar practices, near Alto Río Senguerr town, imply the flooding the lower lands of the steppe plains, which in the summer season may represent up to 78% of the Senguerr river mean flow (Manilow *et al*.). This kind of water resource management results in a much lower flow input into the Colhué Huapi Lake than used to be in the past (**Figure 5.2.1**) (EVARSA 2000).



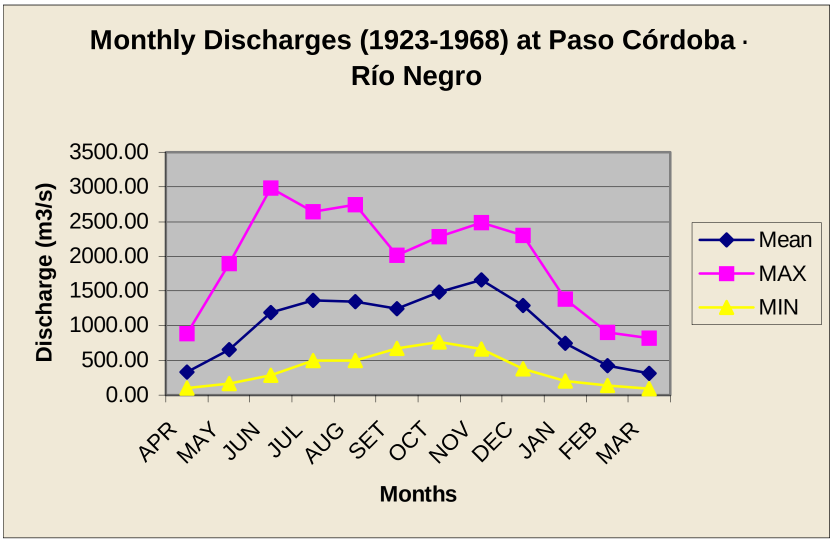
Source: SSRH - EVARSA

Figure 5.2.1 Annual discharge at Puente Camino Buen Pasto gauging site. Senguerr River near Colhué Huapi Lake

Building and operation of dams in the Limay, Neuquen and Chubut Rivers have changed the seasonal pattern of drainage as well as has increased evaporation from reservoirs.

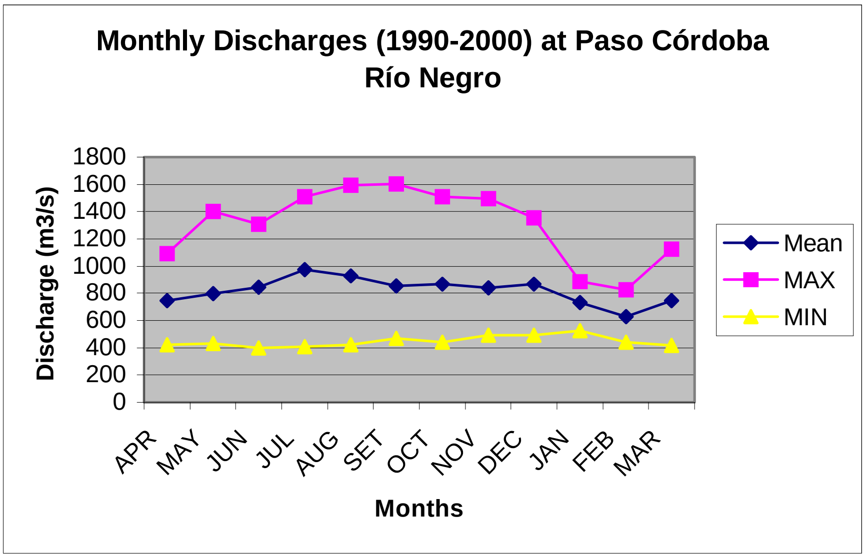
The first dam built in the Limay River was El Chocón in 1973 and four more have been built in the river since 1983. In 1978 started to operate the Planicie Banderita Reservoir in the Neuquen River, the only one devoted to hydropower generation of the Cerros Colorados System.

The changes in the mean discharge, as well as in the maximum discharge and minimum discharge due to reservoir operation are shown in **Figure 5.2.2** and **Figure 5.2.3** which present the modification of the stream flow for two different periods, after and before dams operation, at Paso Córdoba gauge that lies downstream of the confluence of Limay River and Neuquen River (EVARSA 2000).



Source SSRH - EVARSA

Figure 5.2.2 Maximum, Minimum and Mean discharges at Paso Cordoba gauge (province of Río Negro) before operation of Cerros Colorados System (1978)



Source SSRH - EVARSA

Figure 5.2.3 Maximum, Minimum and Mean discharges at Paso Cordoba gauge (province of Río Negro) after operation of Cerros Colorados System (1978)

As it is shown in the figures, the seasonal variability and the monthly discharge during the year have both decreased with the operation of the reservoir. Similar changes were observed in the Colorado River at Pichi Mahuida gauge downstream of Casa de Piedra Reservoir as well as downstream of Florentino Ameghino reservoir in the Chubut River.

On the other hand, building and operation of reservoirs have increased the water availability allowing incorporate new lands for irrigation in the provinces of Neuquen, Río Negro and Chubut, which have led to an important economic development and farmers livelihood improvement as well. However, the increasing of the minimum discharges in the regulated rivers caused an increasing in the water table affecting the lowest areas in the nearly valleys. Such change affected basically the root zone of the irrigated crops (mainly apple and pear trees) due to root asphyxia. Some cases of soil sanilization due to poor drainage and capillary ascent and water evaporation were also caused by increasing in the water table.

Box 12 SR38b Modification of stream flow: Reduction of the Colhué Huapi Lake

A moderate decrease of wetlands have been observed in some areas of SR38b. Colhué Huapi Lake, (Senguerr - Chico River basin and originally tributary of the Chubut River), located in the province of Chubut is a relevant example (Figure 1). It is undergoing a desiccation and desertification process resulting from both human and natural causes. Lake Colhué Huapi (810 km^2) (Figure 2), occupies a large shallow depression of structural and eolic origin, fed by the Senguerr-Musters water system (SSRH 1995). It is separated from the Lake Musters (414 km^2) by an isthmus. In the past, its waters fed the Chico River, which ran in a south-north direction to discharge into the Chubut River. Due to low water conditions, dunes were formed blocking off the outlet.

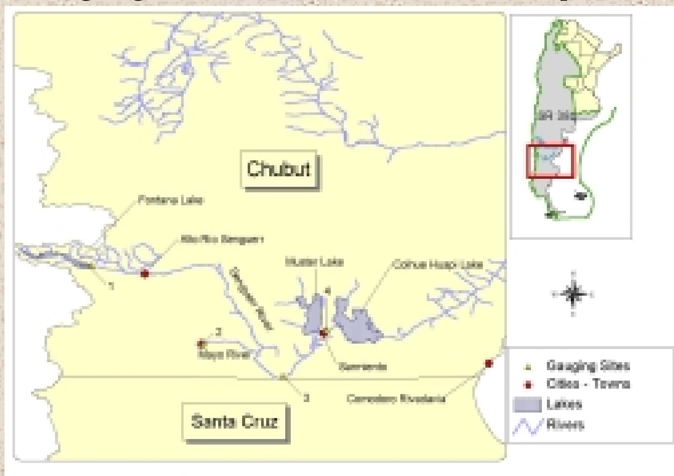


Figure 1 Location of the Colhué Huapi Lake in the Senguer River basin

Strictly speaking, the system has become endorheic, characterized by a negative water balance over the second half of the last century. Due to progressive reduction in size and concentration of salts, the zooplankton diversity has noticeably diminished. Nowadays, Colhué Huapi Lake surface is about 1/8 from its original size due to: (a) A decrease in the Senguerr River flow due a decrease of rainfall and ice melting in the last years; and (b) Extractions of larger amounts of water mainly for irrigation, domestic water supply and oil industry. The continuous incorporation of lands for irrigation jointly with aqueducts for domestic water supply and industrial use may have broken the weak balance which occasionally allowed outflows from Colhué Huapi Lake into Chico River. Irrigation practices in the lower Senguerr basin are carried out mostly by extensive flooding of grasslands, covered by "mallin" type and steppe vegetation. Controlled irrigation on systematized lands is done to a quite lesser extent. Such inefficient generalized irrigation practices in the basin are usually done by means of poor infrastructure (channels, dikes, small embankments), favoring the infiltration of large water volumes and causing, like in Colonia Sarmiento, the elevation of the water table and soil salinization. Similar practices, near Alto Río Senguerr town, imply the flooding the lower lands of the steppe plains, which in the summer season may represent up to 78% of the Senguerr River mean flow. This kind of water resource management results in a much lower flow input into the Colhué Huapi Lake than used to be in the past (Figure 3) (EVARSA 2000). This adds to the local high evapotranspiration rate –over 1,200 mm/yr, resulting in the reduction of its surface water level (Malinow *et al.*). Desiccation of the lake produces an impact on aquatic life by both, a decrease of water availability and salinization. On the other hand, there is an increase of eolic erosion processes due the action of the wind over the bald fine sediment lands around the lake exposed by the reduction of the lake area.

Figure 2 Colhué Huapi Lake.
Source: Lakes and reservoirs catalogue

Furthermore, the soil around the lake is affected by salinization due salt accumulation caused by water evaporation. The long term mean flow of the Senguerr River is 48 m^3/s. Irrigation, which is the main water, uses about 26 m^3/s. Water supply (mainly for Comodoro Rivadavia and Colonia Sarmiento cities with 170,000 inhabitants) and oil industry (secondary extraction of oil wells) are 1.3 m^3/s and 1.1 m^3/s respectively. January is the most critic month by both, high evapotranspiration and the highest crop water requirement.

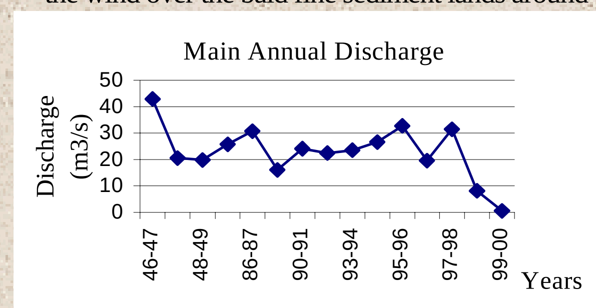


Figure 3 Annual discharge at Puente Camino Buen Pasto gauging site. Senguerr River near Colhúe Huapi Lake.

5.2.2. Issue 2: Pollution of existing supplies

As result of the preliminary analysis of the information available related to freshwater shortage due to pollution of the sources of supply in the Subregion 38, it was possible to assess some water components, assigning a score to them, according to the Criteria of Valuation of the Environmental Impacts agreed in the Workshop I, which in general could be between 1-2 (low and moderate impact).

In the Colorado River between 1997 and 1999 has been carried out a detailed assessment of water quality for different uses regarding the potential sources of pollution related to the main human activities in the basin such as urban discharges, agriculture, oil industry, mining, etc. Such assessment took into account the aquatic environment in the Grande, Barracas, and Colorado Rivers, as well as Casa de Piedra Reservoir. By monitoring of polynuclear and aliphatic hydrocarbons, heavy metals and metalloids, agrochemicals, as well as analysis of river bed sediments and fish it has been determined that water quality is not a barrier for the different water uses. This conclusion has been confirmed by complementary studies carried out in 2000 (COIRCO).

In some localities of the Negro River basin water treatment for domestic water supply has problems due to presence of algal. Similar problems are found in Trelew city downstream of Florentino Ameghino Reservoir in the Chubut River basin. There are also problems of water treatment in Paso Piedras Reservoir, which supplies water for Bahía Blanca city, due to eutrophication. The lake is mesotrophic, and with algae blooms (more than 1,000,000 cel/ml, varying from little diatoms and filamentous green-blue algae). The water treatment by disinfectants is not effective and the algae remain in the water supply annoying THL, odor and taste. There are risks of bacterial re-growing (Marquez 1991).

There have been reported some cases of groundwater affectation in this sub-region. Río Gallegos city is supplied from both groundwater and surface water. The groundwater supply network has 30 wells, 9 of them abandoned (**Box 13**). Some wells located near the estuary would be more affected by sea water and show chlorate / bicarbonate quality instead of bicarbonate/ chlorate, and there is a negative trend for such condition (Baumann and Castillo1999). In Mar del Plata city seawater intrusion affects water supply.

5.2.3 Issue 3: Changes in the water table

Information about quantity, availability and exploitation of groundwater in Argentina is still incomplete and variable. Groundwater is a very important resource in Patagonia since it is the only source of freshwater in too many areas for domestic water supply, irrigation and animal supply (sheep raising). However, such a important resource is affected by human activities. There are evidences of salinization, pollution, and changes in the water table, both increasing and lowering.

In the province of Mendoza 80,000 has are irrigated from groundwater. In the Northern oasis, including Mendoza City, the first layer of the aquifer was affected by salinization due to inefficient irrigation practices and pollution due to agrochemicals and, industrial and domestic discharges. The second layer of the aquifer with a better water quality started to be exploited but by mistakes made during the wells construction allowed infiltration from the upper polluted layer and then theses wells were abandoned. Nowadays, a third deeper layer of the aquifer is being exploited. (DGI 1999).

Inefficient irrigation practices, together with lack of drainage infrastructure and poor drainage soil capacity, originated an increasing in the water table and started a salinization process at regional level. Such salt accumulation in the soil effect the normal growing of crops by changing the soil structure and chemical properties. Lower irrigated valleys of the Colorado, Negro and Chubut Rivers are some areas affected.

On the other hand there also exist evidences of lowering in the water table in many areas due to overgrazing and changes in the physical and chemical soil properties which affect the water dynamic into the soil.

The springs or "mallines" are wetlands of arid regions. The mallines develop in areas where there is a water availability for extended periods during the year which allows vegetation growing. The main feature of the mallines is to have part or the whole soil profile saturated. Although the mallines are about the 4 – 8% of the Patagonian surface, they produce 50% of the vegetation in the region (Horne 1999).

The deterioration of the ¨mallines¨ is basically related to the human activities. The process starts decreasing the vegetation availability in both quantity and quality due to overgrazing and increasing runoff towards the central channel of the ¨mallín¨. The increasing of the flows originates a deepening of the river bed which operates as a drainage of the ¨mallín¨ by lowering the water table in order to reach the new equilibrium level (**Figure 5.2.4**). Besides the deterioration of the ¨mallines¨ related to water availability, it is frequent other deterioration due to salt concentration mainly in the eastern Patagonia and coastal zones (Horne 1999).

Source: Horne 1999

Figure 5.2.4 Main gully downstream the Aguada del Sapo mallín. Filipín Comunity

Although groundwater resource is not widely affected in the SR38b for domestic water supply there are some located affectations due to pollution from oil industry or overexploitation. In Río Gallegos city, located in the Southern part of the province of Santa Cruz, groundwater is a very important source of water supply which have changed its quality since 1982. Overexploitation might have originated seawater intrusion changing the water quality from Bicarbonate type to Chloride type (**Box 13**). The last one is an indicator of worst quality (Baumann and Castillo1999).

Box 13 SR38b Pollution and changes in the water table level: Groundwater supply to Río Gallegos city (Argentine)

Groundwater is an important source in the entire Santa Cruz province, located in the southern part of Patagonian Shelf (**Figure 1**). However, the regional features of the soil determine aquifers with high vulnerability to lowering of water table, overexploitation and salinization.

Río Gallegos is the capital city of Santa Cruz province characterized by 238 mm of annual mean rainfall and a main temperature of 7 C. The city is located on the Río Gallegos estuary. Its population about 75,000 inhabitants is supplied from both groundwater and surface water. The water supply network has 30 wells, 9 of them abandoned.

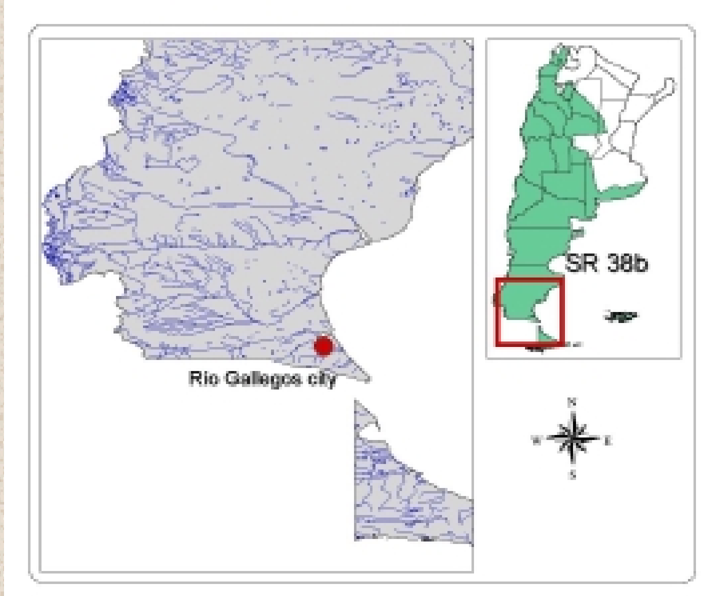


Figure 1 Location of the Río Gallegos city

Recent studies have identified two different types of groundwater quality: chloride / bicarbonate and bicarbonate / chloride. The first one is related to salinization processes since the relationship of chloride and bicarbonate is very sensitive to changes in water quality. Some wells located near the estuary would be more affected by sea water and show chloride / bicarbonate quality (Baumann and Castillo1999).

Since 1982 temporal and spatial analyses have been carried out in the area order to monitor the behavior of the underground system as regards the domestic water supply. Measurements indicate that since 1995 the equilibrium between both types of waters (bicarbonate / chloride waters in the western part of Río Gallegos and chloride / bicarbonate in the eastern part) has been broken, having the last ones, suspected be polluted with sea saline waters, invaded the whole local aquifer (**Figures 2** and **3**) (Baumann and Castillo1999).

Such situation is an indicator of the resource damage that could be originated by seawater intrusion.

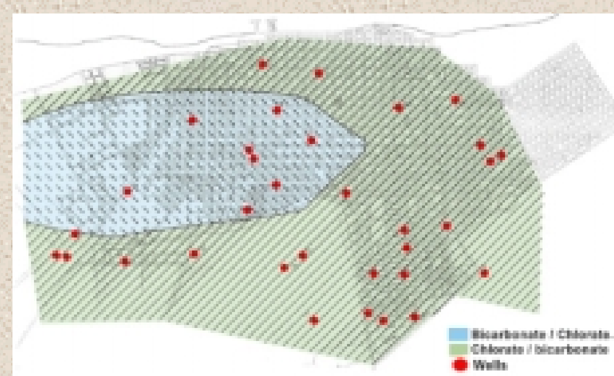


Figure 2 Río Gallegos City. Groundwater in 1982

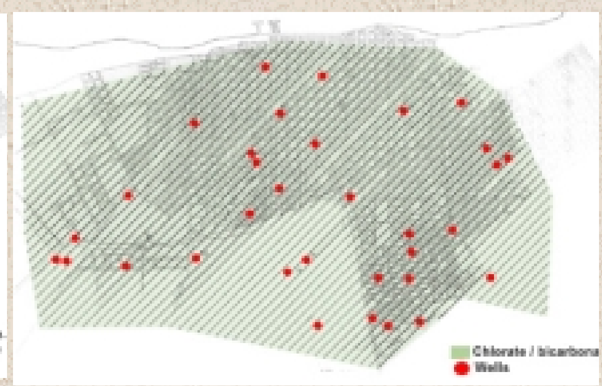


Figure 3 Río Gallegos City. Groundwater in 1998

5.3 Concern II: Pollution

This concern was ranked as second priority in Sub Region 38 as a whole, being assigned priority 4 in SR38b South Atlantic Drainage System:

Pollution - Environmental Impacts by Issue: Present Conditions	*
4. Microbiological	1.0
5. Eutrophication	1.0
6. Chemical	1.0
7. Suspended Solids	2.0
8. Solid Wastes	2.0
9. Thermal	1.0
10. Radionuclides	0
11.Spills	2.0
Overall Impact	1.5

* Weighted score

Some problems related with pollution were detected in water systems of this Sub-region. For instance, there are evidences of eutrophication in Nahuel Huapi and Pellegrini Lakes and there were detected some chemical contaminants, particularly in relation with the intensive use of pesticides in extensive areas in the Sub-region. There is an intensive use of biocides in all agricultural areas under irrigation.

Another problem has to do with increase in turbidity in various streams, reservoirs and receiving marine water bodies due to several causes: use of water for mining purposes, substitution of native forests by exotic species, alteration of the natural vegetation cover of extensive sedimentary areas devoted to sheep raising in Southern Patagonia.

Interference of solid wastes with fishing activities are observed all along the Patagonian Atlantic coast. Also there exist frequent reports of entanglements with litter (about 1/oo in the case of sea wolfs).

Discharge of thermal waters have been observed without significant effects and there is not evidence of radionuclide effects.

There exists evidence of surface waters pollution by oil spills in the Colorado River, of underground waters used for secondary recovery of oil in the province of Santa Cruz and other sectors in the Atlantic coast, where some species suffer from contamination or poisoning due to the frequency of the spills. There is also evidence of toxic spills during hazardous substances transportation.

5.3.1. Issue 4: Microbiological pollution

As result of the preliminary analysis of the information available related to microbiological pollution in the Subregion 38b, it was possible to assess some water components. Score 1 (low impact) to this issue during First Workshop was assigned taking into account its impacts on human health, mainly gastrointestinal disorders related to fish consumption. However, this issue assessment has been carried out taking into account other indicator since there is not available information on such impact.

During the summer 2000-2001, 36 recreational resorts were surveyed to assess their suitability for water direct contact (**Box 14**). According to the results 31 of them turned out to be suitable and 5, in the area of the confluence of the Limay and Neuquen Rivers and in the upper reaches of the Negro, were found not suitable. The monitoring was carried out in the framework of the Program of Bacteriological Control of River Beaches (Secretary of Environmental Management, Interjurisdictional Basin Authority of the Negro River) and according to the criteria recommended by the Canadian Guides of Water Quality. The bacterium Escherichia coli, was considered the main indicator

The main sources of microbiological pollution in South Atlantic Drainage System are industrial and urban discharges. Mar del Plata, the main tourist city in Argentina (**Figure 5.3.1**), and Bahía Blanca city have effluents pre treatment. Puerto Deseado. Puerto Santa Cruz, Comandante Piedrabuena, Puerto San Julián and Puerto Madryn cities apply secondary treatment of effluents before discharging them to the sea. Finally, Río Gallegos and Comodoro Rivadavia cities discharge untreated effluents directly to the sea.

Figure 5.3.1. Aerial view of Mar del Plata city

Fundación Patagonia Natural has detected pathogens in the Atlantic seashore that in some cases have been over the International Legislation recommended levels.

Box 14 SR38b Pollution in Limay, Neuquén and Negro Rivers

The basin of the Negro River has a total surface of 115,800 km² and drains into the Atlantic Ocean. Total population in the basin was close to 700,000 inhabitants (INDEC 1991), and its 48% is located on the sub Basin of Limay River. Numerous indigenous communities live in the area. Main productive activities are hydroelectric generation, gas and oil extraction, fruit-growing, tourism, mining industry and cattle raising. Most of them, result in the discharge of waste waters into these rivers, in various ways and to different extents. As a result there are evidences of microbiological pollution which impairs tourist and recreational activities; eutrophication (i.e.: Nahuel Huapi Lake); chemical pollution with hydrocarbons and heavy metals from oil fields and facilities next to the Neuquen River; organic, heavy metal and chemical pollution from agro-industrial activities; agro-chemical pollution from irrigation systems along the lower Neuquen and upper Negro River reaches (i.e.: pesticide Metil Azinfos was frequently, found, with an average value of 3.2 µg/l in groundwater quality monitoring carried out in Colonia Centenario city (Loewy *et al.* 1999).

Figure 1 Neuquen River at Cinco Saltos area

During the summer 2000-2001, 36 recreational resorts were surveyed to assess their suitability for water direct contact. According to the results 31 of them turned out to be suitable and 5, in the area of the confluence of the Limay and Neuquen Rivers (**Figure 1**) and in the upper reaches of the Negro, were found not suitable. The monitoring was carried out in the framework of the Program of Bacteriological Control of River Beaches (Secretary of Environmental Management and Interjurisdictional Basin Authority of the Negro River) and according to the criteria recommended by the Canadian Guides of Water Quality. The bacterium Escherichia coli, was considered the main indicator. Table 1 shows zones with potential problems in the sub basin of the Limay River (Cifuentes *et al*. 1996).

Table 1 Potential Pollution and its impacts in Limay River Basin

Zone	Cause of pollution	Expected contaminant	Consequences
Nahuel Huapi Lake	Discharge of raw domestic and industrial waste waters	Organic matter, suspended solids, nitrogen, phosphorous, coli forms, heavy metals	Eutrophication, affectation of water for recreational purposes, disease transmission, accumulation in biota and sediments
Alicurá Reservoir	Floating cages aquaculture	Organic matter, nitrogen, phosphorous, pathogens	Eutrophication. Diseases in wild fish populations
Embalse Exequiel Ramos Mexía	Increase in nutrients produce algae blooms.	Algae toxic substances	Degradation of drinking water quality
Downstream Arroyito Dam	Discharge of wastewaters from the “Heavy water” Factory	Increase of temperature, Compounds of ammoniac	unknown
Downstream Plottier city	Discharge of domestic waste waters. Agricultural runoff.	Organic matter, suspended solids, nitrogen, phosphorous, coli forms, agrochemicals	Affectation of water for recreational purposes, bioaccumulation
Downstream Neuquén city	Discharge of raw domestic and industrial waste waters.	Organic matter, suspended solids, nitrogen, phosphorous, coli forms, heavy metals	Eutrophication, impacts on recreational uses, disease transmission accumulation in biota and sediments

5.3.2. Issue 5: Eutrophication

As a result of the analysis of the information available about Eutrophication for the Subregion 38b, could be evaluated some of the water components in relation to what has been observed in the First Workshop.

In the Negro River basin, the Interjurisdictional Basin Authority of the Negro River makes systematic monitoring of waters quality since 1998. The presence of algal due to dam building and operation and clear water condition originates problems in water treatment since there are not removed by conventional treatments., A similar situation is found in the Chubut River, downstream of the Florentino Ameghino Reservoir where there are problems in the purification of the water to Trelew city.

According to the monitoring carried out in the Pellegrini Lake (**Box 15**) during November 1996, the environment could be characterized as mesotrophic-eutrophic (Amalfi andVerniere 1995). Many records during 1995 indicate that cyanophyte algae blooms occurred in summer, with predominance of *Microcystis aeruginosa* and *Anabaena spiroides* (Amalfi and Verniere 1995).

The Nahuel Huapi Lake has been classified like ultra oligotrophic - oligotrophic, according to the low concentrations of nitrogen, phosphorus, chlorophyll *a*, high transparency of the water and little phytoplankton biomass. Some sectors characterized by a restricted water circulation present a different trophic state with greater values of nutrients concentrations due to the discharge of punctual and non-punctual sources. In these cases can take place development of phytoplankton, as it happened in the summer of 2000 - 2001, near of the effluents treatment plant. In 1999, they had already observed high values of biomass (CRUB-DPA-AIC).

Ramos Mexia Reservoir in the El Chocón village area, was characterized as mesotrophic (Labollita and Pedrozo, 1997) with periodic algal bloom.

Serious problems of water treatment exist in Paso Piedras Reservoir that supply to Bahía Blanca city due to its eutrophication. The lake is mesotrophic, and its main characteristic is the algal blooms (more than 1,000,000 cel/ml, varying from diatomeas to little and filamentous green-blue algae) (Marquez 1991).

In the Atlantic seashore impacts from eutrophication have been found in the Nuevo Gulf due to the effluents discharges with biological treatment of Puerto Madryn city.

Box 15 SR38b Eutrophication in Pellegrini Lake, Rio Negro, Argentina

Pellegrini Lake is located in Río Negro province (68º6'W 38º6'S) at 270 m above sea level, in the upper valley of Negro River. This is a region of major economic and demographic importance in the province, because its water resources are utilized for intensive irrigation agriculture. Pellegrini Lake is an artificial water body, created by the flooding of Vidal basin (a natural dip of wind origin), through the "Arroyón", a small stream which connects the Neuquen River with the Pellegrini Lake during high flows to mitigate floods produced during autumn and spring. The lake basin is formed by sand and saline soils. The lake has an area of 112 km², a perimeter of 69 km and a mean depth of 9.4 m. It is a mesohaline environment located in an endorheic watershed. The area has semiarid climate, with an annual mean temperature of 14.7 ºC and annual mean precipitation of 238 mm. The city of Cinco Saltos is located near the lake and it had 18,000 inhabitants, according to 1991 census (**Figure 1**). The lake is utilized for recreation, aquatic sports, commercial fishing and sport fishing

According to monitoring carried out in November 1996, concentrations of nitrates, phosphates and total phosphorus found in Arroyón were 135, 14.7 and 49.9 µg/l, respectively. **Table 1** indicates some relevant values measured in Pellegrini Lake. Lake transparency was 2,185 m (Campanello *et al*. 1996).

As regards chlorophyll "*a*", the highest values measured were 6.53 µg/l at 0.5 m depth and 6.1µg/l at 3 m depth. According to these parameters, the environment could be characterized as mesotrophic-eutrophic (Amalfi and Verniere 1995). Many records of 1995 indicate that cianophyte algae blooms occurred in summer, with predominance of *Microcystis aeruginosa* and *Anabaena spiroides* (Amalfi and Verniere 1995).

Table 1
Pellegrini Lake: November 1996 measurements

Parameter	Depth			
	Surface	0.5 m	1.2 m	3 m
Nitrate (µg/l)	72	82	134	137
P total (µg/l)	39.8	62.5	42.3	80.1

The surrounding vegetation is dominated by *Larrea* (Cabrera 1975) whereas the aquatic vegetation is represented by algae and submerged macrophytes. Community of fish is represented by valuable species that support commercial fishing (Quirós and Baigún 1985). Besides, the lake shelters a great quantity of bird species, batrachians, mollusks and aquatic microorganisms.

Figure 1. Pellegrini Lake

Nowadays a number of problems are affecting the lake. Those of major concern are:

- Flooding in the vicinity of Lake Pellegrini, due to Neuquen River which poses threatens to agricultural production;
- Pollution of "Arroyón" stream, due to effluents coming from of illegal settlements of approximately 400 families in its margins Pollution includes chemical components and phosphates;
- Impacts of water pollution on aquatic biota, such as birds and fishes which inhabit the lake. This fact, which adds to fishing pressure, threatens the communities of the different fish species;
- Lake eutrophication, due to contributions of fertilizers from farming areas and domestic wastes from summer resorts located on the lake shore.

5.3.3. Issue 6: Chemical pollution

The Colorado River is affected by oil and agricultural exploitation. In the past, oil dehydration industries used to discharge effluents into this system. Moreover, farming activities in Neuquen, Río Negro and La Pampa provinces are still potential sources of agrochemical inputs.

Metal concentrations in water used for human drinking water supply were generally below quality guidelines, except for lead at Rincón de los Sauces (12 µg/L),where it exceeded the water quality guideline of 10 µg/L (WHO 1993; COFES 1996). Water quality records indicated high levels of: zinc (317 µg/L) at the exit of Casa de Piedra dam, copper (12 µg/L) at Buta Ranquil and lead (25 µg/L) at the entrance Casa de Piedra dam, exceeding aquatic life guidelines: 30 µg/L, 4 µg/l and 7 µg/L respectively (CCREM, 1987). This levels are supposed to be related to non anthropogenic causes , though no verification has been done.

Copper concentrations in sediments downstream oil dehydration industries and the entrance to Casa de Piedra dam were clearly higher (300 ± 30 µg/g) than those found at other reference stations (27 ± 3 µg/g and 40 ± 4 µg/g), suggesting the influence of anthropogenic activities. Lead and chromium concentrations in the fine fraction ,< 63 µm, also exceeded guidelines for fresh water aquatic life (53 ± 6 µg/g and 56.2 ± 4.8 µg/g, respectively). Acenaphthene was detected in seven out of twelve sampling stations and presented concentrations ranging from 0.0106 µg/g to 0.0183 µg/g. This contaminant was the only aromatic hydrocarbon that exceeded guidelines for fresh water aquatic life.

Mercury and selenium concentrations in fish muscle exceeded Argentine SENASA edible food guidelines for human consumption in all fish species at all sampling stations (0.05 µg/g, wet weight and 0.3 µg/g, wet weight ,respectively). The maximum fish tissue mercury concentration (4.05 µg/g, wet weight) was reported for *Odonthesis argentinensis* (silver side) at Desfiladero Bayo. While the highest selenium fish tissue concentration (1.17 µg/g, wet weight) was recorded in *Perca fluviatilis* at Rio Barrancas.

In spite of its long term exposure to oil and agriculture exploitations, the Colorado River system is suitable for drinking water supply , does not require restrictions for fish human consumption and poses no serious risks for aquatic biota (Alcade *et al.* 1999). Nevertheless, further studies are needed, specially for metal residues in fish since sampling was not sufficient enough to assess human consumption recommendations (Alcade *et al.* 1999).

The **Patagonian coastal** zone presents low to moderate toxic chemicals pollution. Petrogenic hydrocarbons in sediments reported the highest concentrations in oil tankers' loading stations (Caleta Córdoba, Comodoro Rivadavia and Caleta Olivia), where discharges of oil effluents and tanker ballasts washing takes place. This is especially important at Caleta Córdoba where these hydrocarbons concentrations in sediments increase. Winds and marine currents are potential transport agents of those persistent pollutants (situation already reported in Faro Aristazábal) posing environmental risks on vulnerable coasts with a greater ecological sensibility.

High heavy metal concentrations in sediments (lead, zinc and copper) were registered in San Antonio Bay and in San Matías Gulf. These coastal areas were the only ones where cadmium was found affecting local flora and fauna, and threatening migratory species such as *Calidris melanotos* and *Charadrius wilsonia* ,who cross this zone during their seasonal journey. High cadmium concentrations were detected in kidney and liver of *Cephalorhynchus commersonii* and *Lagenorhynchus obscurus*, and in kidneys of *Larus domonicanus.* pp'-DDE in *Spheniscus magellanicus* and *Larus dominicanus* was the only halogenated persistent pollutant detected in biota, though in resent studies significant halogenated residues were found in dead just born cubs of *Otaria flavescens* suggesting parent transmission mechanisms.

5.3.4. Issue 7: Suspended solids

Sharp increase in turbidity has been observed in various streams, reservoirs and receiving marine water bodies due to use of water for mining purposes and alteration of the natural vegetation cover of extensive sedimentary areas devoted to sheep raising in Southern Patagonia.

In the province of Santa Cruz the Río Turbio mining industry discharges a high amount of solids generated by the mineral carbon treatment into the Gallegos River. The carbon wastes in the banks of the San José and Turbio Rivers are carried out by the pluvial and eolic erosion and discharged into the river. The solids concentration upstream the mining complex is of 0.05 gr/l reaching as high as 15.48 gr/l downstream of the mine. Such amount of suspended solids affected the aquatic life as well as the water availability for human use (Brea and Loschacoff 2000).

Wind and water erosion are other sources of sediments. About of 30% of the Patagonian is under a desertification process basically caused by overgrazing due to sheep cattle. Sheep raising started at the beginning of the XX century in a extensive way and characterized by a high animal load which together with hard climate features of the region accelerated the degradation process. Reductions in the vegetation coverage increased the runoff and losses of soil and in many cases affected the water bodies.

On the other hand, decreasing of suspended solids can also affect the water resources and originate economic impacts. In the Negro River there have been a high decreasing of suspended solids after building and operation of Cerros Colorados System in 1978. Before the reservoir operation the sediment load, mainly clays and mud, had precipitated into the irrigation channels making them waterproof. The sedimentation in the channels was as much as 2.3 cm/yr and sediment accumulation for about 50 years in the irrigated field represented almost 3% of the soil. After the dam building sediments were retained in the reservoir and the clear water discharged in the irrigation channels affected the water infiltration and caused algal growing due to decreasing of turbidity. Such higher infiltration, which represent about 68-74% of the channel inflow, caused a increasing in the water table affecting up to 66% of the irrigated lands (Landricini *et al.* 2000).

5.3.5. Issue 8: Solid wastes

The analysis of the information related to the contamination of water resources by solid waste, gives a negligible impact to the surface waters. Nevertheless along the Patagonian Atlantic coast has been observed interferences of solid wastes with fishing activities. The most important aspects that we can mention for each one of the components are:

- In Atlantic South Coastal Area there are some environmental impacts due to solid wastes disposal practices, mainly in urban areas close to the coast; where is very usual the disposal of solid wastes in open dump sites. Some landfills located in harbour areas also receive large quantities of fishing waste. Producing offensive odours, water pollution and negative effects in the coastal landscape, affecting the tourist and recreation activities.
- Regarding the Negro River, the dumping of solid wastes in open sites, riverbanks and lakes generates environmental and human health impact, mainly due to non biodegradable wastes.

5.3.6. Issue 11: Spills

The spills issue is closely related with the chemical pollution issue in the SR 38b, weighting each one in accordance with the nature of the pollution source, the presence of treatment facilities and the frequency of the events.

In the upper Colorado River Basin (Mendoza and Neuquén provinces) significant oil drilling activities are performed (40% of the argentine oil production comes from this basin) and were the sources of historical intermittent oil spills. ¨Accidental¨ spills events since 1995, linked to oil drilling, have affected the quality of the water of this course seriously. One of the most important accidents happened in early 1997. An oil spill of 100,000 – 300,000 liters of petroleum polluted this river. The impacts generated by such oil spill determined the closure of drinking water supply to the near towns (more than 10,000 inhabitants were affected) and the interruption of the irrigation water source to 5,000 ha. The affected coastal length reached about 10 km (La Razón, 3/11/1997). Nevertheless the records of relevant oil spills go back to January 1992, when an oil spill (a 30 hectares oil plumes) from YPF oil pipeline fracture at Rincón de los Sauces, affected the irrigation water intakes and caused the closure of the drinking water supply to Catriel and 25 de Mayo cities.

In February 2002, a new oil spill took place due to overflows of two oil ponds containing chemicals, generating an avalanche of mud contaminated with hydrocarbons that entered into the Colorado River.

The Colorado River Basin Committee (COIRCO), along with the Argentine Energy and Mining Secretary and the Oil Enterprises Group performed a water quality survey (1997-1999) monitoring PAH's in water, sediments and biota, and eco-toxicological bioassays (zooplankton, benthos) and fish PAH's bioaccumulation. These data showed naphthalene concentrations in sediment at Casa de Piedra intakes over international reference standards and compliance conditions in the remaining sampling locations. Chronic toxicity to *Hyalella curvispina* was found at Puesto Hernández, in the oil drilling area. PAH's were detected in fish muscles of various species (*Odontesthes bonaerensis*, *Oncorhynchus mykiss*, *Percichthys colhuapiensis*, *Percichthys altispinnis*, *Cyprinus carpio* and *Diplomystes viedmensis*) at levels in the ng/g order of magnitude at two sampling places (Desfiladero Bayo in the Colorado River and Casa de Piedra Reservoir).

Figure 5.3.2
Penguins covered by oil in Patagonian coast.

In the Patagonian maritime coast, impacts due to accidental spills or to daily activities in ports coast, have been observed. In the first case, the most relevant accident was in September 1995; when approximately 30 tons of gas-oil were spilt and affected an extension of 10 km of beaches in the surroundings of Puerto Deseado (Santa Cruz Province). Another oil spill happened in 1991, when an unidentified hydrocarbon (crude oil or fuel oil) was spilt near Peninsula Valdés (Chubut Province). Due to this oil spill approximately 1,100 penguins were covered with oil and died from hypothermia and poisoning (DRIyA 2001).

5.4. Concern III: Habitat and community modification

The Concern Habitat and Community Modification was assessed as moderate, according to GIWA methodology, and was ranked as first priority in SR38 as a whole, as well as in SR38b South Atlantic Drainage.

Habitat and Community Modification – Environmental Impacts by Issue: Present Conditions	*
12. Loss of Ecosystems or ecotones	2.0
13. Modification of ecosystems or ecotones, including community structure and/or species composition	2.0
Overall Impact	2.2

* Weighted score

Overgrazing by sheep cattle and indiscriminate cutting of shrubs for firewood and other uses, have resulted in the expansion of desertification in Patagonia. Those sites with larger productive potential, like water springs (known as "mallines"), are becoming seriously deteriorated. About 30% of the territory limited between Parallel 41º to the North and Magallanes Strait, is affected by severe and intense wind and water erosion processes.

There are evidences of species introduction like: forestation with exotic species in large areas in the north of Patagonia, introduction of carps in the Colorado River and beavers in Tierra del Fuego, which cause alterations in the aquatic systems as a result of their activity.

Construction of reservoirs for flow regulation and flood control has altered seasonal flow patterns affecting environmental conditions for most species. However there is very scarce information to support the extent of the resulting impacts. They have also transformed fast running water courses into lentic reservoir environments with long residence times, large impounded areas and lengthy lake shores.

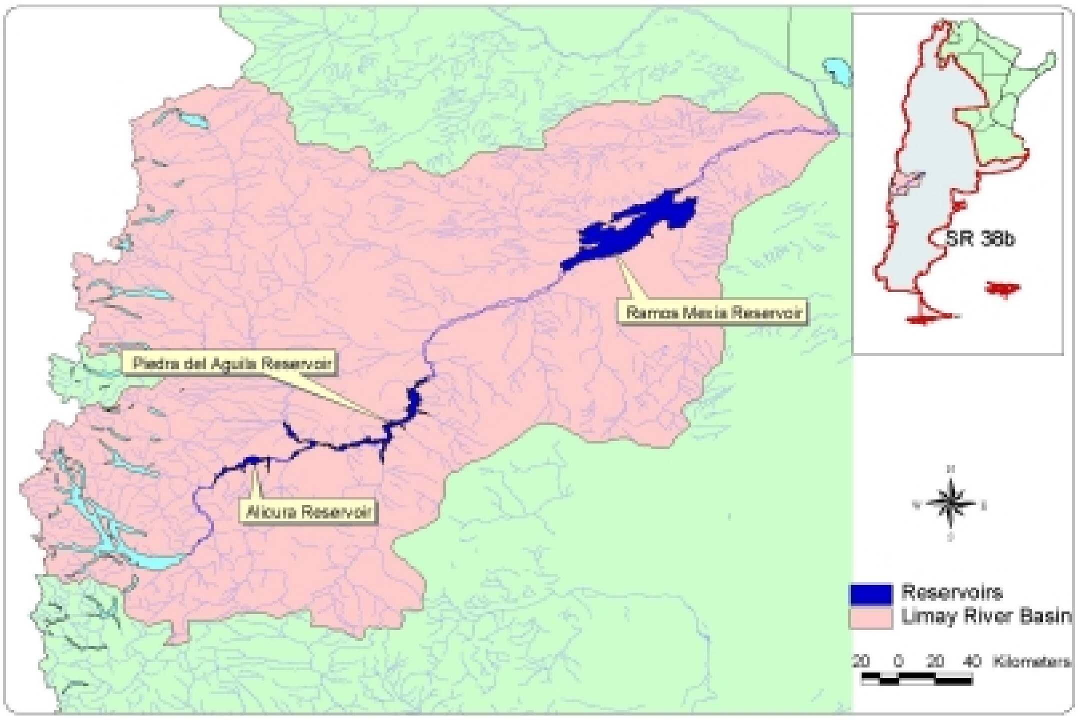
Along the ocean environment, there exist evidences of fragmentation of sandy foreshores, the littoral belt system and coastal fringes as a consequence of discrete urban settlements, infrastructure works, fishing and recreational beach facilities. The mouth of rivers and streams, estuary marshlands and littoral belts are affected by water sports during the summer season and sport motor boating results in an important alteration of the shores which are relevant refuge and nursery grounds for marine and estuarine species.

Operation of harbours and oil shipping facilities in some areas (Puerto Madryn, Comodoro Rivadavia, etc.), along the shore, resulted in pollution hot spots which locally affect coastal habitats and attached aquatic communities.

Intensive fish exploitation, incidental captures and discards and fishing practices have affected aquatic community structure and population dynamic of the various trophic levels.

5.4.1. Issue 12: Losses of Ecosystems and ecotones

A large number of reservoirs have been built in SR38b mainly in the Neuquen and Limay Rivers (**Table 5.4.1**). Reservoir creation transforms fluvial riparian ecosystems into lake type ones, notably increasing their longitudinal development, as well as changes terrestrial ecosystems into aquatic ones and increases the mean annual residence time of water. The transformation rate of lotic environments into lentic and semi-lentic ones for the Limay River is about 44% (**Figure 5.4.1**).



Source: SSRH -INA 2002

Figure 5.4.1 Location of the Limay River basin and its reservoirs

Name	River	Province	Country	Reservoir feature	
				Surface	Residence time
				Km^2	Year
Arroyito	Limay	Neuquen/Río Negro	Argentine	38.6	0.013
Piedra del Aguila	Limay	Neuquen/Río Negro	Argentine	292.00	0.56
Alicurá	Limay	Neuquen/Río Negro	Argentine	67.50	0.38
E. Ramos Mexia	Limay	Neuquen/Río Negro	Argentine	816.00	1.17
Florentino Ameghino	Chubut	Chubut	Argentine	74.00	0.82
El Chañar	Neuquen	Neuquen	Argentine	10.00	0.004
Loma de la Lata	Neuquen	Neuquen	Argentine	409.00	2.83
Portezuelo Grande	Neuquen	Neuquen	Argentine	39.00	0.001
Planicie Banderita	Neuquen	Neuquen	Argentine	174.00	1.41
Casa de Piedra	Colorado	La Pampa/Río Negro	Argentine	360.00	1.04

Table 5.4.1 Main reservoirs built in SR 38b

Other ecosystems at risk due to antropic activities are the springs so called ”mallines”. The “mallines” are wetland of arid and semi-arid regions. Although their represent only the 4% – 8% of the provinces of Río Negro, Neuquen, Chubut and Santa Cruz, this ecosystem is quite important for the economy since it is the main component of the sheep cattle activity.

The structure and dynamic of the mallines are highly related to water availability. Alteration of the mallines features due to sheep overgrazing have broken such a wake equilibrium deteriorating and even losing the vegetation coverage (Horne 1999). **Figure 4.5.2** shows a “mallín” degraded by overgrazing that used to be seeded until 1975.

The main alteration of the physical environment in the Patagonian shore are consequences of mining activities, urban and coastal development (harbors, roads), and degradation due to tourism activities. (DRIyA 2001)

Source: Horne 1999

Figure 4.5.2: Degraded “Mallin”.

5.4.2. Issue 13: Modification of structure or communities

The Patagonian coast is a very important component of the Argentine marine shelf, which has a wide variety of environments and a highly productive sea. Sea resources have been under an accelerated demography and industrial growing during the last 15 years. Although such economical development is a positive impact regarding provincial citizen livelihood, it has been developed in an uncontrolled way and without infrastructure and coordinated management. Thus, biodiversity as well as sustainable exploitation of the renewable resources are seriously endangered (Fundación Patagonia Natural 1999). As a consequence of the Human settlement and activities there is a modification of the marine ecosystems by degradation, fragmentation or losses of habitats (Gray 1997).

There is a growing pressure over the sea resources by human activities due to an extractive use of the resource and the settlement of aquiculture activities. There is an impact on the structure of the seashore communities, mortality of fauna components and conflicts among different uses of the resource (tourism, aquiculture, fishing).

The main threats for biodiversity in Patagonian are: i) Overexploitation of natural resources with productive objectives, mainly fisheries; ii) pollution; iii) introduction of exotic species; iv) losses of habitats; and v) activities linked to tourism (FUCEMA 1999).

Physical alteration or habitat destruction of the marine ecosystems occurs mainly in the lesser deep waters of the shore due to dredging, port building, coast stabilization, embankment construction, building of pools for marine organism raising, and fishing methodologies (DRIyA 2001). Harbor activities have been increased in several areas such as Puerto Deseado, Caleta Olivia, Ushuaia, Comodoro Rivadavia, Bahia Camarones and Puerto Madryn (Fundación Patagonia Natural 1999).

The urban and industrial pollution is a general problem in the Patagonian coast since there is not treatment for liquid wastes or it is too deficient. Such discharges started an eutrophication process in some areas of the shore (Fundación Patagonia Natural 1999). Chemical discharges and other elements such as sediments and solid wastes pollute the sea. Commercial fishing and fish industrial wastes affect bird communities, benthic organism and human population due to the high BDO of its discharges (DRIyA 2001).

Hydrocarbons derivate from petroleum show the highest concentration in the areas of oil-ships charging. An increasing trend has been observed in Caleta Córdoba in the province of Chubut. However, the negative impacts on the ecosystem affect shores beyond the harbors areas since the sea currents and the wind carry the pollutants towards other areas more ecologically sensitive generating a chronic pollution very difficult to mitigate, such as areas of industrial algal harvest (Fundación Patagonia Natural 1999).

There is little information about introduction of exotic species. Some accidental species introduced were brown algae (*Undaria pinnatifida*), Asian clam (*Corbicula fluminea*) and "dog's teeth" (*Balanus glandula*). Other not accidentally introduced species were brown trout, rainbow trout (*O. mykiss*), pacific oyster (*Crassostrea gigas*), Chilean oyster (*Tiostrea chilensis*), chinook salmon (*Onchorhynchus tshawystcha*) and beavers.

The brown algae, originally from Japan coast, were accidentally introduced in Puerto Madryn by the water ballast of foreigner ships and they have been quickly spread in the Nuevo Gulf area (Casas y Piriz 1996). Probably, the maintenance and development of this algae in our shores would be due to sewage discharges, oil spills and wastes discharged from ships and boats (Fundación Patagonia Natural 1999).

The Asian clam has been probably introduced with the water ballast in the Paraná – Uruguay Rivers system in the 60´s and the Southernmost area which has colonized is Colorado River since cold temperature might affect its surviving (Cazzaniga 1997).

The majority of the species introduced officially registered have been for aquiculture activities. Pacific oyster (*Crassostrea gigas*), Chilean oyster (*Tiostrea chilensis*), chinook salmon (*Onchorhynchus tshawystcha*) and rainbow trout (*O. mykiss*) are the main species produced in Patagonia. Although aquaculture does not seem to be a threat for biodiversity, it could become a threat if these species blend each other with the natives ones reducing the genetic diversity. At the same time exotic species might introduce new pathogens for the native species affecting the ecosystem structure and dynamics (DRIyA 2001).

On the other hand, tourism is a negative impact on the ecosystems. Feeding and reproductive areas in the shores such as dunes and beaches are disturbed by 4x4 trucks and motorcycles. Another important tourism impact is due to the excessive amount of boats for whale observation (DRIyA 2001)

5.5 Concern IV: Unsustainable exploitation of living resources

This concern was ranked third priority in SR38b, South Atlantic Drainage system.

SR38b: Environmental Impacts by Issue: Present Conditions	*
14. Overexploitation	3.0
15. Excessive by-catch and discards	2.0
16. Destructive fishing practices	2.0
17. Decreased viability of stocks through pollution and disease	1.0
18. Impact on the biological and genetic diversity	1.0
Overall Impact	2.0

* Weighted score

Overexploitation occurs in the oceanic component, particularly concerning hake fishing, which is seriously affected since it has been being exploited beyond safe biological limits. Only sport fishing is carried out in inland waters.

Incidental by-catch and discards amounts to about 30 to 60% of fish production in hake fishing.

Destructive fishing practices result from trawling methods used in the maritime zones, since net operations are usually repeated above 10 times.

There are no indications of major impacts in the populations as a consequence of diseases.

The introduction of carp and trout (of great economic importance for the region) in rivers and the cultivation of jelly producing algae in the maritime zone of Nuevo Gulf has not resulted in large changes in community structure.

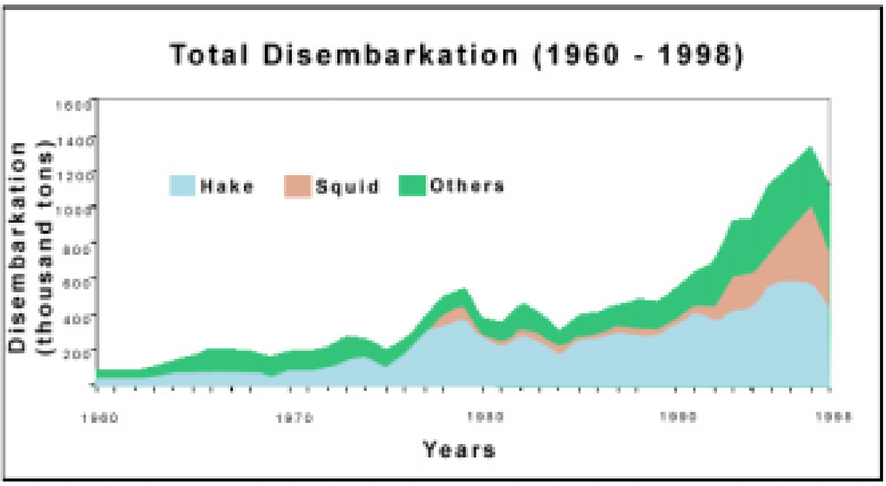
There have been analyzed only issues 14. Overexploitation, 15. Excessive by-catch and discards and 16. Destructive fishing practices since they have obtained greater score and weigh than issues 17. Decreased viability of stocks through pollution and disease and 18. Impact on the biological and genetic diversity.

5.5.1. Issue 14: Over-exploitation

Recent studies have found that overexploitation of fisheries not only has gone out of Argentine Hake stock, almost extinguished, but also has negatively effected marine mammals and birds as well as their habitats. As regards FAO estimations, about to 90% of the hake fishing in the Oceanic component of SR38b has been done by Argentine and foreigner ships. Some indicators of overexploitation are (DRIyA 2001):

- Fishing efforts of the freezer trawling ships have been quintupled between 1989 and 1996.
- Fishing efforts of the fresher fleet have been tripled between 1989 and 1996.
- The major amount of captures were juvenile and spawning fish.
- Missing of adult fish in both stocks and captures
- Increasing in the population mortality that effectively reduce the fishing yield.
- High discards of small fish due to actual fishing practices.

Fisheries in the Argentine seacoast have experimented an accelerated growing in the last decades (**Figure 5.5.1**) starting an overexploitation process that has affected many fish species and originating ecological consequences which have not yet well assessed (**Box 16**) (Fundación Patagonia Natural 1999).



Source: DRIyA, 2001

Figure 5.5.1: Disembarkation evolution (1960 – 1998)

Overexploitation of hake in the Mar del Plata area (province of Buenos Aires) started to be evident in 1997 due to capture expansion (Bertolotti *et al*. 2001). The reproductive hake stock Southern of 41º parallel in the 2000 year has been the lowest since 1986 (Pérez 2001). Status Indicators show a critical situation: north and south stocks were overfished, total biomass was decreasing, reproductive biomass was lower than the biologically acceptable level and the fishery was sustained by a few year classes (Bezzi 2000, Aubone 2000, Grupo de Evaluación Merluza 2000, Pérez 2000).

In the Oceanic component of SR38b there should be improved the efficiency of the fishing prohibition as well as the close seasons for both hake and Patagonian prawn in order to protect juveniles and reproductive adults, and reach the sustainability of the resource in a medium term (Caille y González 1998).

As a consequence of "vieiras" (*Aequipecten*) overexploitation in the Golfo Nuevo and San José there was such a decreasing in the resource availability that nowadays the ¨vieiras¨ capture is prohibited -in 1994 vieiras were the 42% of the captures while in 1985 they were 90% (Ciocco 1996, Elías 2002).

The estimated "polaca" (*Micromesistius australis*) population is about 77% lower than used to be. Its exploitation rate is 0.56 and the mortality by fishing has been estimated in 0.195 (Wöhler et. al. 2001). Decreasing in the average size of the "gatuzo" (*Mustelus schmitti*) population, diminishing in the coastal density in Buenos Aires and Uruguay, and diminishing in the capture by effort unit are some signs of overexploitation (Massa et. al. 2001).

Mackerel (*Scomber japonicus*), as well as blood corvine (*Micropogonias furnieri*) and shore ray species (Family *Rajidae*) biomasses have decreased since 1996 in the the Oceanic component of SR38b. Codfish (*Genypterus blacodes*) stock is more critic than used to be in 1999 and it is near the acceptable exploiting limit (Perrota y Garciarena 2001, Cordo 2001, Carozza *et al.* 2001).

5.5.2. Issue 15: Excessive by-catch and discards

The trawling fishing of prawns has high incidental by-catch rates of juveniles fish species with commercial value as well as mammals such as "marine hair wolf" (*Otaria flavescens*), dark dolphin (*Lagenorhynchus obscurus*) and "tonina overa" (Cephalorhynchus commersonii) (**Box 16**). Capture of "one hair seal" has been estimated around 1 – 2% of the whole population per year in the South of province of Chubut (Crespo et. al. 1997). Incidental by-catch rate of the freezer and factory fleet vary between 9.9% - 24.3%, and 2.3% - 37.2% respectively (Cañete *et al*. 1999). Codfish situation has been getting worse since 1999 because of it is highly captured as accompanying specie in the hake fishing (Cordo 2001).

Commercial fishing by vessels and trawling also affect penguins, albatross, petrels and sea gulls. Albatross are the more vulnerable specie since they hatch only one egg and their maturity age is about 9 – 12 years old (DRIyA 2001)

Incidental capture of macrobenthic organisms were registered in the 89% of the total hauls. The fraction of benthic organisms retained in nets stay with 28% values related to the total species which integrates the benthic community of the shrimp fishing grounds in the Golfo de San Jorge and Chubut seashore (Roux 2000).

Discards produce changes in the community structure, in the food web as well as in the marine bed composition. Assessments carried out during 1993 – 1996 have found that about 100 species had been captured and individuals of 85 of them thrown back to the sea as discards (21 of them with commercial value). High seas fleet discard about 25 %–30 % of their captures while the coastal fleet discards are about 25% (Caille and González 1998).

As regards official estimations, between 1990 and 1996 were discarded between 20,000 and 75,000 tons/year of young hake that represent between 80 and 300 millions of fish. The majority of such discards were hake under 2 years old. In 1997 prawn trawling fleet disembarked 5.500 tons of prawn and 40.000 tons of hake. The annual young hake discard by prawn fishing was estimated in about 20.000 tons. It is also very important the young and adult hake discards from factory fleet and fresh trawling fleet (DRIyA 2001).

The main target of the Argentine high seas trawling fleet is the Hake (*Merluccius hubbsi*). This fleet works by means of non selective nets capturing a wide variety of species which later might be either selected or discarded. In sectors with high average yields of Hake fishing the accompanying species such as Codfish and Tail hake are discarded. However, in sectors with low average yields of Hake fishing (Buenos Aires seashore) the relative importance of accompanying species such as "gatuzo", Codfish and "pescadilla" become higher (Irusta *et al*. 2001).

In the factory fleet, observers verified that catches showed no relation with the factory processing capacity which implies that there is a trend to catch much more than what can be processed. There is no control on what enters in the net to regulate trawl duration. In general, trawl frequency and duration are independent of the presence of raw material in the plant to saturate lowest points. Discard level is very high and related to variable criteria difficult to predict. To a large extent this is conditioned by the previous item, since bad quality fish is rejected or the processing line accelerated too much. This is not exclusively associated to fishing gear selectivity. Failures were detected in the processing lines that can be attributed to calibration and maintenance of the equipment, to handling and selection of specimen by operators and to the quality of raw material (crushed fish that block the machinery). All those factors diminish yield and increase discard (Cañete *et al.* 2000).

5.5.3. Issue 16: Destructive fishing practices

The marine bed trawling practices have a significant impact on the benthic habitats and their use might result in serious consequences not only for the target species but also for other marine organisms (**Box 16**). Despite the fact that there are a wide variety of possible negative effects on the ecosystem, up to day there no have been carried out environmental impact assessment of the trawling practices in the Argentine seashore. In the San Jorge gulf and Chubut seashore the most effected groups by the trawling nets of prawn fishing were sea horses and "poliquetos" (Roux and Bertuche 1998). Net operations during trawling fishing are repeated over 10 times

Another fishing practice that might highly affect the marine bed is the drag. Such practice is using by the vieiras fishing boats which in San Matías gulf between 1969 and 1972 negatively affected the marine beds as well as several species (Ciocco *et al*. 1998, Orenzanz *et al*. 1991).

Box 16 SR38b Unsustainable exploitation of fisheries and other living resources

Overexploitation: Fishing activity in Argentine seas generates a series of threats to the biological marine diversity. The most relevant ones are overexploitation of resources (Table 1), discard of individuals of not commercial heights and of accompanist species, and incidental by-catch (DRIyA 2001). Unfortunately quantitative data to assess the modification of structure by these causes is not available and, therefore, here is presented a qualitative appraisal of the impacts. Fisheries in Argentine sea have undergone an accelerated growth in the last decades, involving mostly hake (Merluccius hubbsi), squid (Illex argentinus), polish (Micromesistius australis), tail hake (Macruronus magallanicus) and prawn (Pleoticus muelleri).

Year	Maximum permissible capture of hake (ton)	Hake landing (ton)	Over fishing (%)
1992	390	369	-5
1993	390	422,2	8
1994	390	435,8	12
1995	398	574,3	44
1996	395	589,8	49
1997	395	585,7	48
1998	289,5	458,6	58
1999	188	313,9	67
2000	130	187	44

Table 1. Hake fishing in SR38b

It has resulted in the overexploitation of hake, which has led to the current collapse of its population, while the ecological consequences still have not been evaluated (Fundación Patagonia Natural 1999). Measures to avoid the overexploitation of hake have been taken as a consequence, which resulted in the decrease of the total landed tons in 1998 and 1999 (**Table 1**). Between 1988 and 1999, the participation of hake in the total landing fell down from 62 % to 31 %. In 1999, hake, squid and polish represented 31, 34 and 5.4 % of the total landing, respectively (DRIyA 2001). The intense exploitation may have caused important changes in the structure and the productivity of the aquatic ecosystems. The promotion of new fisheries tends to conceal the decreases in the trophic levels of the most exploited fisheries. The abundance of the pelagic species increased due to the excessive exploitation of hake and bass; that is why between 1993 and 1996 stocks of "anchoita" tripled in Buenos Aires and doubled in Patagonia. Due to the fact that many marine species of fish and crustaceans suffer the depredation of marine mammals and birds, the increase of the rate of exploitation generates concern for the possible competition between fisheries and these predators. The disappearance of the pillaged stocks causes a negative effect on the survival of the marine mammals and birds. Besides, the selective fishing of big and old individuals changes the volume and the age structure of exploited population, reducing the reproductive activity of the population and the probability of the success in the recruitment (DRIyA 2001).

Habitat loss: Trawling impacts significantly on the benthic habitats and generate serious consequences for the target specie and for other marine organisms. The trawl net was used in the vieyra tehuelche's fishery (Aequipecten tehuelchus) in San Matías Gulf between 1969 and 1972 and had negative effects on the sea beds and the resource (Orenzanz *et al.* 1991). Predominance of vieyra in Nuevo and San Jose Gulfs has decreased and has shown signs of overexploitation in the last years due to the deterioration of the availability of the resource (Ciocco 1996); that is why its capture has been forbidden (Elías 2002).

By-catch discards: The fishery of Argentine prawn registers an important quantity of by-catch of hake (**Table 2**). About 100 species had been captured (between 1993 and 1996) and individuals of 85 of them thrown back to the sea as discards (21 of them with commercial value). The species most affected by by-catch are the marine hair wolf (*Otaria flavescens*), dark dolphin (*Lagenorhynchus obscurus*) and "tonina overa" (*Cephalorhynchus commersonii*). The incidental capture of the marine wolf is estimated between 1 and 2% of the whole population per year in the south of the province of Chubut.

Composition by species of the secondary fishing of prawn

Specie or group of species	Biomass (%)	Frequency (%)
Argentine Hake (*Merluccius hubbsi*	66	91
Argentine Prawn (*Pleaticus mueller*	18	91
Anchoita (*Engraulis anchoita*)	4.8	24
Pollack (*Genyperus blacodes*)	2.2	35
Other invertrebrates	1.7	56
Skates (*Rajidae*)	1.6	32
Brachyura	1.4	53
Munida sp.	0.88	29

Source: Pettovello 1999

Table 2 Composition by species of the secondary fishing of prawn

5.6. Socioeconomic impacts

5.6.1 Concern I

Freshwater Shortage - Socioeconomic Impacts Present Conditions	Score
Economic Impact	2.3
Human Health Impact	0
Social & Community Impact	2.3

Despite its large and evident benefits, stream flow regulation has resulted in the rising of the water table and consequent increase in salinity, due to increase in low water levels controlling regional drainage; higher infiltration in the irrigation network due to absence of sediments; increased algae growth due to lower turbidity and losses in agricultural land use because of salinization. The economic size of the sector affected, is quite significant, in terms of SR38b productive capacity. Recent studies on the effects of clear water in the High Valley of the Negro River irrigation system have estimated in about U$S 225 millions the economic losses due to absence of sediments in the last 21 years (Landricini *et al.* 2000).

There was consensus in that there is no ready available evidence about the significance of the effects of this concern on human health. Given the low density and extensive characteristics of production and land use in the region, impairment of water sources or degradation of its quality has a relevant social impact on rural workers, which, although not relevant in number, are severely and long term affected.

5.6.2 Concern II

Pollution - Socioeconomic Impacts Present Conditions	Score
Economic Impact	2.3
Human Health Impact	2.0
Social & Community Impact	1.0

Economic impacts derived from pollution in the Subregion 38b are principally related to increases in costs of water treatment to diverse uses. Algae blooms in reservoirs of the area and oil spills are the episodes that demand major economic investment in contingency measures and water treatment.

Paso Piedras Reservoir, which supplies water to Bahia Blanca, Paso Alto and other cities in the province of Buenos Aires, is subject to a intense eutrophication process. The main problem in the reservoir is the occurrence of algae blooms (about 1,000,000 cel/ml of *Ceratium Hirundinella* and *Anabaena Spiroides*) during autumn and summer (Marquez 1991). The water treatment is not effective and the algae remain in the water that is used for human consumption and there are risk of bacterial and THL re-growing.

In the upper basin of the Colorado River exists problems in water supply due to recurrent oil spills. These spills especially affected the irrigated agriculture in the area near to Catriel (province of Rio Negro) and 25 de Mayo (province of La Pampa) cities. There is an area of approximately 48,000 ha, cultivated with vegetables, alfalfa and fruits, 30% of which was affected by the suspension of the irrigation, with consequent economic losses. Spills also affected to Rincón de los Sauces, a small town in the province of Neuquen. In this case, local authorities suspended water distribution and the cost of the emergence was assumed by private oil companies, which distributed thousands of litres of mineral water for population supply (Daniele and Natenzon 1998).

Access to drinkable water and sanitation systems gives a first approximation to the sanitary condition of population related to the pollution in Subregion 38b. According to the data of 1990 decade, the total population covered by drinkable water was reaching 61.2%, whereas 31.8% of the population was possessing connection to sewage network (INDEC 1991). As regards to urban population, the percentages show an improvement respect to the previous numbers: 79.9% of the urban population relies on access to drinkable water, whereas 51.6% is connected to sewage network (SPIDES-ENHOSA 1999).

As regards pollution due to eutrophication and oil spills, the same incidents relieved for economic impacts present aspects linked to human health. The episodes of algae blooms are habitual in Paso Piedras Reservoir from the 1977, but in the summer-autumn of 2000, a considerable incident took place as consequence of Anabaena Spiroides's bloom. Between April and May of this year the crisis reached its maximum peak, when the Health Department of the Province of Buenos Aires qualified the water as “not drinkable”, recommending the completely interruption of the water supply (Mancini and Santoro 2000) due to the long term risk to human health by the appearance of trihalomethanes (THM´s), formed by the combination of the algae with chlorine utilized in the water treatment.

The interruption of water supply is also a great impact in the upper basin of the Colorado River, as consequence of oil spills. In the 1990s, several accidents seriously affected small towns located in river coast: Rincón de los Sauces (8,000 inhabitants), 25 de Mayo (6,000 inhabitants) and Catriel (16,000 inhabitants). As an example of the seriousness of the impact and the risk on human health, in March, 1997, 300,000 ton oil spill caused the interruption of drinkable water provision and local authorities declared an epidemiological alert (La Nación 13-3-97), due to the possibility of diseases related to contact with polluted water, as diarrheas. The cause of this interruption mainly was the obstacles that the revenue of hydrocarbons causes in the purifying systems of water, which prevents from guaranteeing sanitary minimal conditions (Daniele and Natenzon 1998).

Algae blooms in Paso Piedras Reservoir caused other impacts associated with disagreeable smells and tastes. The algae of the specie *Anabaena Spiroides* caused a conflict in autumn of 2000, due to a very disagreeable taste and smell, besides of a green-bluish coloration to the water. The algae of the specie *Ceratium Hirundinella*, which caused problems to the water supply system since 1997 to 1999, gave a brown color and high turbidity to the water (Mancini and Santoro 2000).

In the upper Colorado River basin, the settlers and leaders of the towns affected by successive oil spills led protests and lawsuits to the provincial authorities (La Nación 28-5-97). In Rincón de los Sauces, local NGOs and representatives of Chamber of Trade took part of the complaint (La Nación 29-5-97). Farming producers, which invoke loss in soil quality, pollution of groundwater and decreases in culturing yields led protests too (La Nación 11-7-97).

Other impacts associated with oil exploitation have to do with damage to or losses of different animal species. In the case of the upper basin of Colorado River, it is pointed out the presence of remaining sinks of purge waters, where the birds settle and get caught since these sinks have a similar refraction to those of a water body (Daniele and Natenzon 1998).

In the marine coast similar problems are observed due to accidental spills or to the daily activity in ports of the Subregion. In the first case, the most serious accident was in September 1995, when approximately 30 tons of gas oil were spilt and affected an extension of 10 km of beaches in the surroundings of Puerto Deseado (province of Santa Cruz). Another incident of importance happened in 1991, when a not identified hydrocarbon (crude oil or fuel oil) was spilt in the surroundings of Valdés Peninsula (Province of Chubut). As a consequence of this spill approximately 1,100 penguins were cover with oil and died for hypothermia and poisoning (DRIyA 2001). The same report indicates that during 1991 a very high mortality of penguins was observed on the whole Chubut coast, but the incident has not been repeated up to the moment.

In case of pollution by harbor activity, the beaches remain affected by the presence of "balls" of tar and birds cover by oil. These incidents would be related to operative problems in the ports and to the wash of bilges and tanks (DRIyA 2001).

5.6.3 Concern III

Habitat and Community Modification - Socioeconomic Impacts: Present Conditions	Score
Economic Impact	2.3
Human Health Impact	0
Social & Community Impact	3.0

Climate and soil conditions make the Patagonian region extremely dependent on water resources and the goods and services provided by aquatic ecosystems. Most population is concentrated in urban settlements near to the Atlantic Ocean shore, most of them highly dependent on ocean fisheries or in river valleys where irrigation provides opportunities for intense economic activity.

Therefore habitat losses and aquatic community negative modifications have a significant economic and social impact in the dependent populations, particularly those related to irrigated agriculture and fisheries exploitation. Economic losses and increase in costs associated with this major concern affect both the State and private sector, the latter integrated mainly by small enterprises, cooperatives and individuals, which are most vulnerable.

No significant linkages between health impacts and this major concern have been identified.

Decrease in fish yield resulted in serious economic losses to local fishermen, inducing the authorities to establish catch limits and controls to allow recovery of stocks in major commercial species. Social and community impacts are even larger because of the vulnerability of the affected sector (see Concern IV socioeconomic impacts).

The loss of agricultural productivity, which affects labor resources and induces the abandoning of ranches and emigration towards urban settlements, has been particularly considered. The affectation of tourist activities also contributes to this phenomenon.

5.6.4 Concern IV

Unsustainable exploitation of living resources - Socioeconomic Impacts: Present Conditions	Score
Economic Impact	2.2
Human Health Impact	0
Social & Community Impact	2.2

Scoring was based fundamentally on the problem of hake over exploitation, since the high prices of vieira and shrimps act as a positive factor in the protection of these species. Highest scores were given to the degree of impact and frequency and duration since the impact on the community is strong.

No significant linkages between health impacts and this major concern have been identified by the Group.

Stopping of hake fishing due to over exploitation would result in severe social problems due to the loss of employments and the bankrupt of fishing enterprises, affecting also tourism. Larger weights were assigned to frequency and duration, taking in account that the impact on the local community is quite strong.

Capture sector in Patagonian has the following distribution: 71% are from factory fleet, 18% are from trawling fresh fleet and 11% are from coastal fleet. The manufacturing involves both factories and cooperatives. Although the whole sector employment have decreased about 11% between 1987 and 1996, in Patagonia the manufacturing employment has constantly increased (about 37%) due to the settlement of several plants (DRIyA 2001).

By the time the Hake overexploitation started to be evident in 1997 the maximum crew employment was registered. As it shown in the Table 5.6.1 since 1997 the sector employment has decreased about 22% while it has decreased about 8 - 9% in the last year - 13% for Patagonian region and 6% for Buenos Aires region (Bertolotti, Errazti and Pagani 2001).

Recent estimations on coastal fleet show that disembarkations have decreased and sailed days have increased indicating a diminishing of the captures per trip and a decreasing in the mean benefits as well. Since profits are divided into the crew members the incomes per trip or worked day have also decreased (Bertolotti, Errazti and Pagani 2001).

Production, sailed days and employment of the high sea fleet decreased about 13%, 9% and 9% respectively between 1999 and 2000. In the same period and for the freezer and factory fleets the decreasing rates were 14%, 7% and 9% (Bertolotti, Errazti and Pagani 2001).

Years	Crew in the Buenos Aires region	Crew in the Patagonian region	Total crew
1997	1,540	259	1,799
1998	1,416	265	1,681
1999	1,459	265	1,724
1st. Semester of 2000	1,283	233	1,516
2nd. Semester of 2000	1,272	241	1,513
1st. Semester of 2001	1,199	202	1,401

Source: Bertolotti, Pagani and Errazti 2001.

Table 5.6.1: Evolution of the coastal fleet crew employment

From 38 industrial plants established only 26 were operative in 2001. Since 1998 have been a cooperative process which set up poorer work conditions, lower incomes and even losses of work benefit such as health and retirement covers

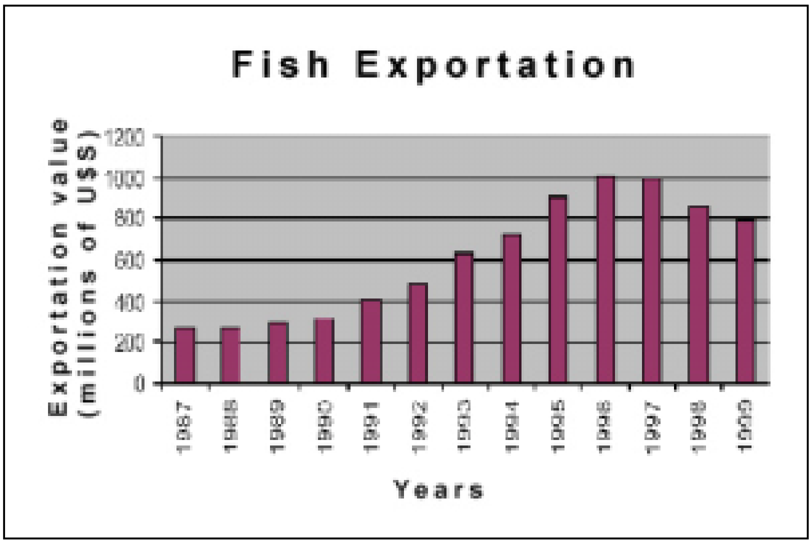
The processing plants of Comodoro Rivadavia, Trelew and Rawson are mainly devoted to Hake manufacturing. Due to the decreasing of the Hake disembarkation there has been a sharply diminishing in the industry inputs. And thus, many plants were closed and too many jobs were lost – Table 5.6.2 (Bertolotti, Errazti and Pagani 2001).

Puerto Madryn, Rawson y Trelew	Summer 1995/6	March 1999	March 2001
Total of Plants	27	28	32
Inactive Plants	8	12	16
Employees	2,705	2,625	1,694
Variation regarding the former period (%)		-3	-35
Permanent employees		1,067	519
Variation regarding the former period (%)			-51
Temporary employees		1,558	1,175
Variation regarding the former period (%)			-25

Source: Province of Chubut 2001

Table 5.6.2 Number of Plants and employment in Puerto Madryn, Rawson and Trelew

In 1999 exportation of fish reach U$S 794 millions showing a decreasing compared to exportations in early years - US$1,014 millions in 1996, US$1,003 millions in 1997 and US$860 millions in 1998 (Figure 5.6.1). Such lowering was mainly due to international and national market conditions, and lesser disembarkations as well.



Source: SAGPyA

Figure 5.6.1: Argentine fish exportation between 1987 and 1999 (U$S millions)

A slight increase in the economic, social and community negative future impacts deriving from unsustainable exploitation of fisheries were agreed by the Group, taking in account that this major concern was expected to evolve negatively in terms of environmental impacts.

6 PREDICTIVE ANALYSIS

Projections of trends in human affairs may be legitimate over the short-term, but they become unreliable as time horizons expand from months and years to decades and generations. Fundamental uncertainty is introduced both by our limited understanding of human and ecological processes, and by the intrinsic indeterminism of complex dynamic systems. Moreover, social futures depend on human choices, which are yet to be made (Gallopín *et al*., 1997).

6.1 Subregion 38a: La Plata River Basin

6.1.1 Demography

The **Table 6.1.1** and the Figure 6.1.1 show the population evolution since 1970 in the five countries that share La Plata River Basin and the projections within the 20 next years. Annual rates of population growth in the countries of the basin are: Argentina 1.3%; Bolivia 2.4%, Brazil 1.4%; Paraguay 2.6% and Uruguay 0.7% (**Table 6.1.2**).

Country	Year							
	1970	1980	1990	2000	2005	2010	2015	2020
Argentina	23,962,314	28,093,507	32,527,094	37,031,802	39,301,753	41,473,702	43,497,671	45,347,004
Bolivia	4,211,625	5,355,157	6,572,770	8,328,699	9,274,964	10,229,399	11,218,577	12,193,210
Brazil	96,020,778	121,671,674	148,029,503	170,693,424	181,604,292	192,239,544	202,447,842	211,882,215
Paraguay	2,350,388	3,113,698	4,218,732	5,496,450	6,215,948	6,980,323	7,773,091	8,570,322
Uruguay	2,808,426	2,913,600	3,105,556	3,337,062	3,455,127	3,565,825	3,681,010	3,793,341

Source: http://www.eclac.org.cl

Table 6.1.1 Estimated population and projections by calendar years in SR-38 Patagonian Shelf

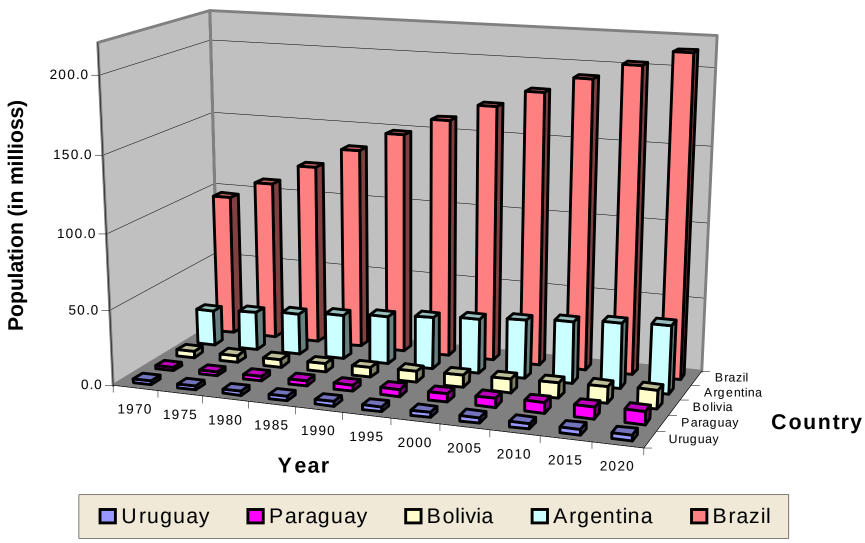


Figure 6.1.1 Population evolution in the counties of La Plata River Basin

Country	Years									
	1970/75	1975/80	1980/85	1985/90	1990/95	1995/00	2000/05	2005/10	2010/15	2015/20
Argentina	16.7	15.1	15.2	14.2	13.3	12.6	11.9	10.8	9.5	8.3
Bolivia	24.4	23.6	19.2	21.8	24.1	23.3	21.5	19.6	18.5	16.7
Brazil	23.8	23.5	21.2	18.0	15.1	13.4	12.4	11.4	10.3	9.1
Paraguay	24.7	31.6	29.5	31.2	27.0	25.9	24.6	23.2	21.5	19.5
Uruguay	1.4	5.9	6.4	6.3	7.1	7.3	7.0	6.3	6.4	6.0

Source: http://www.eclac.org.cl

Table 6.1.2 Total population growth rates by country in La Plata River Basin

Present trends indicate that these rates will tend to decrease until year 2025 at least. Therefore in the First Workshop the Expert Group assumed, with conservative criteria, that an increase of 1.1% annual percent in the population adequately might reflect an average population growth rate for La Plata River Basin. On this base, by 2020 the population in La Plata River Basin is estimated in 160,780,000 inhabitants (**Figure 6.1.2**).

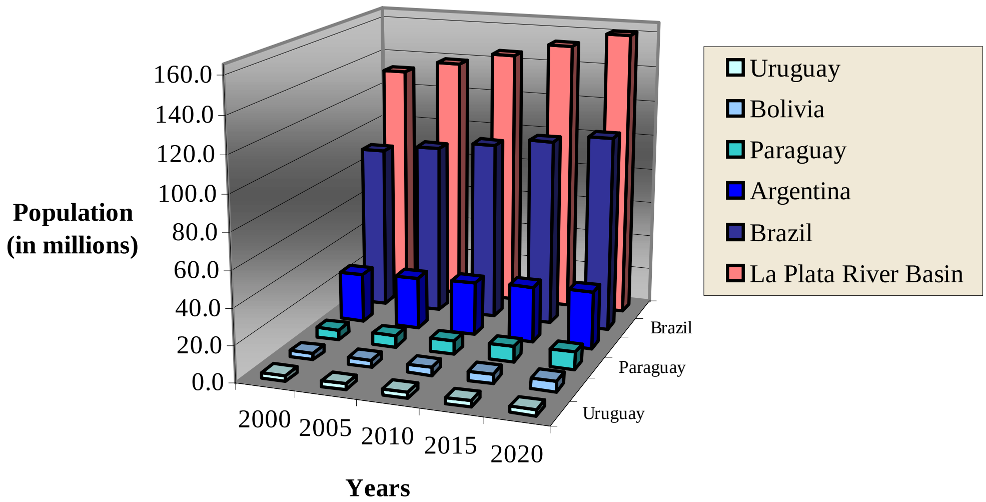


Figure 6.1.2 Estimated population by country within La Plata River Basin

Although it is evident a general trend of increase in urban concentrations, it would adopt different characteristics in each of the countries, as follows (Figure 6.1.3):

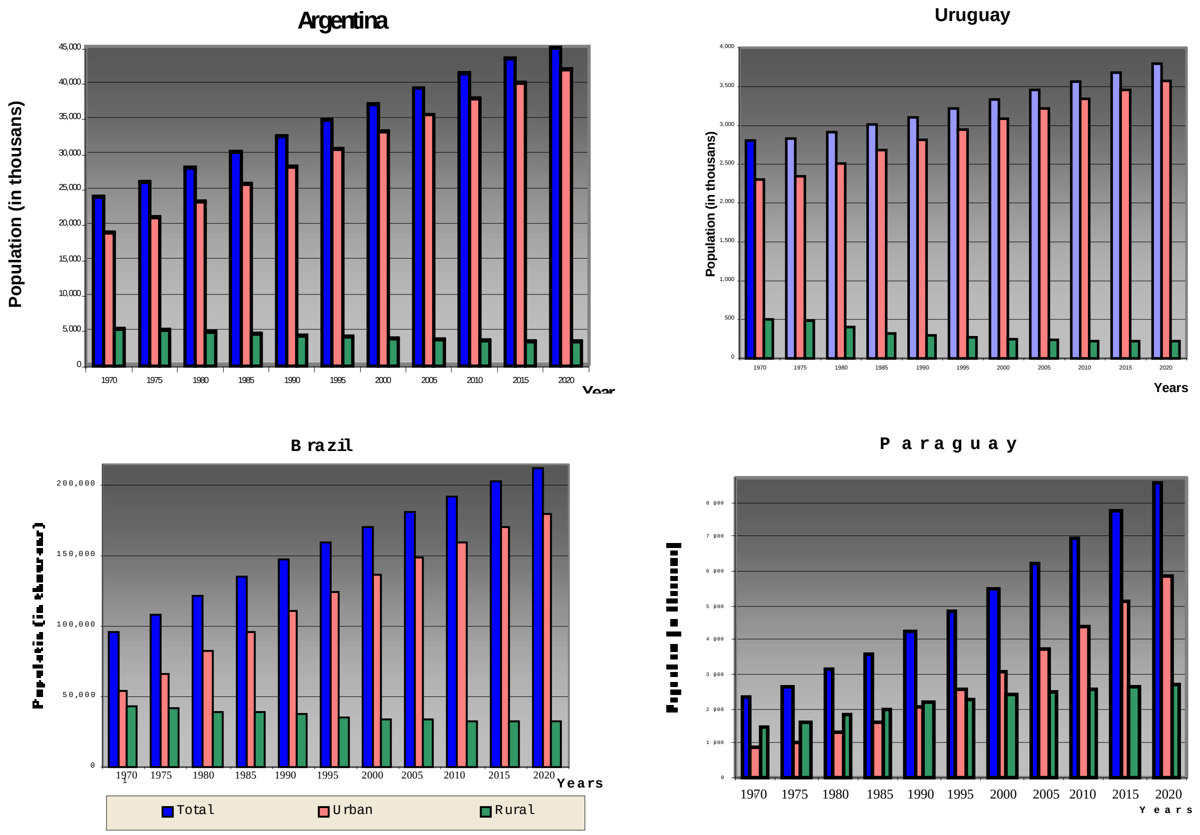
Argentina: The process of urbanization remains constant with a flux of population from major urban settlements to smaller ones where people estimate they would be able to achieve better living conditions even with lower incomes.

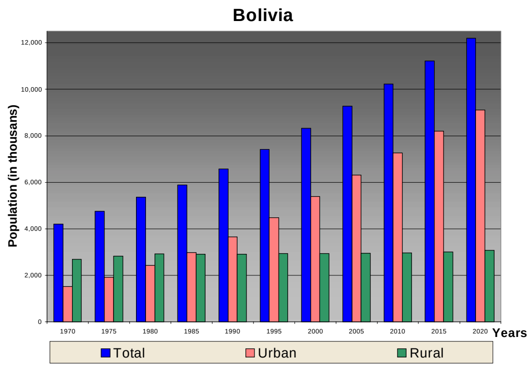
Brazil: Urbanization process continues but redressed to smaller cities, taking place a redistribution of urban population accompanied by the production sector. Redistribution of population will also involve different regions and basins. Industries will become expelled from urban environments to industrial poles.

Uruguay: Current urbanization trends will maintain.

Paraguay: Urbanization process keeps as at present, with migration of people from large to smaller settlements where they presume could achieve better perspectives of economic development. As a consequence new development poles may be created.

Bolivia: same trends that in the rest of the Basin.





Source: http://www.eclac.org.cl

Figure 6.1.3 Total, urban and rural population growth by country

Notwithstanding the former comments, it is expected that a net increase in the concentration of the largest metropolitan urban areas will take place in the future involving: Great Buenos Aires (La Plata river), Great Rosario (Paraná River), Curitiba (Iguazú River), Asunción (Paraguay River).

6.1.2 Economy

The construction and interpretation of a scenario will be influenced by the beliefs and theoretical assumptions of the analyst. During the First Workshop (August, 2001), the Expert Group discussed extensively about the validity of providing an estimate of the annual expected production change for the Subregion. Due to the complexity and variability of the economic scenarios either within and external to the region and the vulnerability of the country economies, no estimation could be reasonably feasible. However, as a rough guess for the long term expected production growth for the region an average rate of 2% was considered acceptable within the next 20 years. The estimated average of 2% was assigned on the based of the GDP gives in **Table 6.1.4.**

Years	Country				
	Argentina	Bolivia	Brazil	Paraguay	Uruguay
1980-1990	-0.7	-0.2	2.7	2.5	0.5
1990- 2000	4.3	4.0	2.9	2.2	3.4

Source: World Bank (www.worldbank.org/data/wdi2002/tables)

Table 6.1.4 Growth Domestic Products by country 1980 – 2000 (average annual in %)

Related to the composition of output and consumption and based on the available information (**Table 6.1.5**) and the restrictions above mentioned to provide a sound assessment of future trends, a rough first hand estimation indicates that:

* Argentina may keep the current productive structure with some increase of the agriculture frontier;
* Uruguay will tend to increase the forestry production;
* Bolivia will maintain the current productive profile;
* Paraguay will expand agriculture production and diversity and
* Brazil will increase it agricultural and industrial production.

Years	Country				
	Argentina	Bolivia	Brazil	Paraguay	Uruguay
Agriculture					
1980-1990	0.7	---	2.8	3.6	1.8
1990- 2000	3.4	3.3	3.2	2.5	2.8
Industry					
1980-1990	-1.3	---	2.0	0.3	1.2
1990- 2000	3.8	4.0	2.6	3.2	1.1
Manufacture					
1980-1990	-0.8	---	1.6	4.0	1.7
1990- 2000	2.8	---	2.1	0.7	-0.1
Services					
1980-1990	0.0	---	3.3	3.1	2.4
1990- 2000	4.5	4.3	3.0	1.6	4.6

Source: World Bank (www.worldbank.org/data/wdi2002/tables)

Table 6.1.5 Structure of the economy by country 1980 – 2000 (annual average in %)

As consumption is concerned (**Table 6.1.6**), it is assumed that in long terms all countries will experiment a low increase with the exception of Bolivia that will keep the current pattern. Available information indicates that food, clothing and domestic appliances consumption increase will follow vegetative population growth while in long terms green or organic products may experiment a slight increase.

Country	Years			
	1978	1988	1997	1998
Argentina	58.1	73.7	70.7	70.7
Bolivia	73.2	79.0	73.2	75.2
Brazil	68.6	59.5	63.2	63.6
Paraguay	69.8	71.8	74.1	72.9
Uruguay	66.8	69.0	73.8	71.0

Source: World Bank. 2000

Table 6.1.6 Private consumption sector of economic (% of GDP)

There may be a significant increase in the tertiary sector in terms of electric energy (**Tables 6.1.7**, **6.1.8** and **6.1.9**) and natural gas transportation and distribution services, water supply and sanitation services (**Table 6.1.10**). Housing construction and tourism are also expected to increase in the region, perhaps with stronger dynamics than agricultural (**Table 6.1.5**), mining (**Table 6.1.11**) and industrial production (**Table 6.1.5**).

Country	Average annual rates				
	1990	1994	1995	1996	1997
Argentina	0.7	4.5	3.5	5.8	6.7
Bolivia	6.3	16.3	5.2	7.4	4.5
Brazil	1.6	3.2	6.6	5.4	6.3
Paraguay	3.0	14.6	15.4	80.0	-37.7
Uruguay	6.7	3.9	5.1	5.9	5.6

Source: http://www.eclac.org.cl

Table 6.1.7 Growth of total consumption of electric energy by country

Countries	Kilowatts hours				
	1990	1994	1995	1996	1997
Argentina	1,591	1,948	2,082	2,080	2,192
Bolivia	326	395	406	426	435
Brazil	1,673	1,855	1,948	2,025	2,124
Paraguay	575	812	913	1,601	972
Uruguay	1,580	1,864	1,946	2,046	2,145

Source: http://www.eclac.org.cl

Table 6.1.8 Electric energy consumption per capita by country

Countries	Percentages				
	1990	1994	1995	1996	1997
Argentina	35.6	24.1	40.2	32.9	38.6
Bolivia	58.7	46.9	45.8	45.0	44.8
Brazil	92.8	93.3	92.1	91.3	90.6
Paraguay	99.9	99.9	99.7	99.7	100.0
Uruguay	94.2	98.0	92.9	86.5	90.7

Source: http://www.eclac.org.cl/

Table 6.1.9 Share of hydroelectric power in generation of electricity by country

Countries	Drinking water		With sanitation	
	Percentages			
	1990	2000	1990	2000
Argentina	64	79	89	84
Bolivia	46	73	34	63
Brazil	96(1)	78	78	85
Paraguay	33	44	58	67
Uruguay	85	98	60	94

(1) The differences observed is probably due to an overestimation of the population supplied.
Source: CEPIS-OPS, 2001

Table 6.1.10 Coverage in water supply and sanitation by country

Countries	Average annual rates					
	1994	1995	1996	1997	1998	1999
Argentina	11.1	7.8	9.0	6.6	5.7	-0.2
Bolivia	5.2	13.3	-4.0	1.7	4.0	-9.7
Brazil	7.3	5.3	6.2	5.5	6.5	8.8
Paraguay	---	---	---	---	---	---
Uruguay	---	---	---	---	---	---

Source: http://www.eclac.org.cl

Table 6.1.11 Growth of Mining Production (including petroleum) by country

6.1.3 Technical and other type of changes

Based on their experience and information during the First Workshop the experts considered that technological changes in the next will probably comprise the following issues, by country:

Argentina: It is expected an improvement of the regulatory framework, incorporation of agro-ecological practices (reduced land labor practices, biotechnology, biologic control of plagues); modernization of irrigation systems and management towards better efficiency. Increased pressure on water resources development for hydroelectric generation.

Brazil: Improvement in environmental control at State level; strengthening of capacities for water resources management at national level; development of basin management. Pressure to employ better technologies and restoration of degraded water bodies.

Paraguay: Institutional strengthening due to the recent creation of the Secretary of Environment, including the regulatory framework; improvement of public awareness.

Uruguay: Improvement in measures for control and management; better technologies.

Available information indicates that it is expected a slight increase in the implementation of clean production technologies in the primary, secondary and tertiary production activities as well as the development and enforcement of environmental control regulations at the MERCOSUR level.

6.1.4 Environment

On one hand it is expected that more sustainable production practices and environmental improvements in the Subregion 38a will result from improvements in technologies for pollution control, at least in the industrial sector and main urban settlements and the introduction of cleaner and safe production technologies in industrial and agricultural activities. The improvement of the regulatory frameworks and their enforcement as well as enhanced community awareness will also contribute towards said objective. However, these positive trends will be counterbalanced by the serious economic conditions currently affecting the five countries, in terms of unemployment, poverty, scarce public investment and pressing social needs which will push governments to facilitate private initiatives and capital investments even at the risk of a major pressure on natural resources and environmental goods and services. Therefore, it is expected, on the average, a slight decrease in the pressure on the environment in La Plata River Basin within the period of analysis (**Table 6.1.12**).

Environmental Issues	Major Concerns	Present Score	Future Score
1. Modification of stream flow 2. Pollution of existing supplies 3. Changes in the water table	**I Freshwater shortage**	1.4	2.0
4. Microbiological 5. Eutrophication 6. Chemical 7. Suspended solids 8. Solid wastes 9. Thermal 10. Radio nuclide 11. Spills	**II Pollution**	1.75	1.5
12. Loss of ecosystems 13. Modification of ecosystems or ecotones, including community structure and/or species composition	**III Habitat and community modification**	2.5	3.0
14. Over-exploitation 15. Excessive by-catch and discards 16. Destructive fishing practices 17. Decreased viability of stock through pollution and disease 18. Impact on biological and genetic diversity.	**IV Unsustainable exploitation of fisheries and other living resources**	2	2.5
19. Changes in hydrological cycle 20. Sea level change 21. Increased UV-b radiation as a result of ozone depletion 22. Changes in ocean CO_2 source/sink function	**V Global change**	1	2.0

Table 6.1.12 Scoping for Environmental Impact under Future Conditions

Concern I: Freshwater shortage

Due to its linkage with pollution of water sources, the future situation of this concern was also analyzed in the context of the concern pollution. Despite it was agreed that future trends in pollution control will improve, it was thought that these improvements would take place mainly at industrial level and major urban settlements. However population growth, urban concentration and economic limitations may hamper the possibility of drastically improving the very low percentage of waste water treatment currently exhibited by the Subregion 38a (CEPIS – OPS, 2001). Thus degradation of water sources may maintain or even increase while water demands will naturally increase, resulting as a consequence, in the future increase of water shortages in the region.

World population growth and the better fed (from 2800 Kcal today to 3050 kcal by 2030) will increase the pressure over the agriculture (FAO, 2002), and some river Sub-basin will not have enough available water, like Quareim river basin. Nevertheless, is not expected a serious problem within La Plata River Basin.

Concern II: Pollution

The situation will be clearly subject to the management each country would be able to carry out (CEPIS – OPS, 2001). There exists a tendency to reduce organic pollutant effluents in Argentina and Brazil (**Table 6.1.13**).

Country	Years		
	1985	1990	1993
Argentina	100	79.95	77.87
Brazil	100	88056	78.24

Source: GWP, 2000

Table 6.1.13 Percentage (related to 100 in 1985) of organic pollutant effluent

It was thought that an improvement and more effective enforcement of the regulatory framework for pollution control would take place in the region. Most efforts would be devoted to cope with large pollution sources, mainly represented by industrial facilities and large urban settlements. Together with governmental action, the influence of environmental NGOs, enhanced community awareness and commitment and increased industry self regulating behaviors (ISO standards) will induce industries to incorporate cleaner processes and environmental technologies reducing wastes and contamination loads. While this is true for large enterprises having access or being funded by foreign private investments, small and medium industries and other activities are thought to remain, in average, stable in terms of pollution control due to economic and financial restrictions.

As a consequence, in the long run and on the average, only a slight improvement in the situation is expected at global level in La Plata River Basin.

Concern III Habitat and community modification

In the coastal region it is expected that the situation in future conditions will keep negative, since present conflicts and degradation demand long times (over 20 years) to reverse and it is yet not even known the effect of the exotic species introduced. However, a social awareness about water resources is starting to develop, helping to stops the degradation. As regards continental habitats and ecosystems, new nature conservation areas are being created, but the general expected trend is towards an increase in the pressure on natural resources and environment while no restoration is taking place in present degraded areas. As a result a moderate deterioration of this major concern will take place towards year 2020.

Concern IV Unsustainable exploitation of fisheries and other living resources

A moderate negative change is foreseen in the evolution of this major concern towards future conditions. It is thought that exploitation conditions of fisheries resources will remain stable where regulations are complied with and will tend to deteriorate in the rest of the areas.

Concern V Global change

IPCC Report on Climate Change (WMO and UNEP, 2000) indicates that warming will accelerate since it is expected that an increase of +0.6ºC in the mean annual world temperature will occur during the present century. Even in the case that the Kyoto Protocol would be signed by all participating countries and be effectively implemented, the situation will still be worse. According to forecasts, climate evolution in La Plata River Basin will be negative. Although major modifications in the total annual precipitation are not expected, precipitation intensities and distribution will change and climatic variability will increase.

Therefore expected future conditions will deteriorate. It was decided to consider a more than moderate negative change for this major concern.

6.1.5 Socioeconomic

Major Concerns	Economic Impacts		Health Impacts		Other Social and Community Impacts	
	Present Score	Future Score	Present Score	Future Score	Present Score	Future Score
I Freshwater Shortage	3	3	1.6	2	1.9	2.5
II Pollution	3	3	1.6	1.5	2.3	2.0
III Habitat and community modification	2	2.5	0	0	2	2.5
IV Unsustainable exploitation of fisheries and living resources	2.2	2.5	0	0	2.2	2.5
V Global change	2. 7	3	2.4	3	2	2.5

Table 6.14 Scoping for Socio-Economic Impacts under Future Conditions

Some details about the socioeconomic impacts in future conditions that support the scores given to each major concern (**Table 6.1.14**) are the following:

Concern I: Freshwater Shortage

Having agreed that the concern freshwater shortage would have a low to moderate increase in the next decades, it become apparent that economic costs, associated to increased water treatment, restoration of supply sources or incorporation of more costly new ones, would become larger, health problems associated to lack of safe water would increase and consequently social and community impacts become more stringent. These issues are expected to be more intense in the next decade and will be reverted in the long run so on the average the resulting deterioration would become small to moderate.

Concern II: Pollution

Improvements in pollution control will require major investments by private and public sector, so the improvement in terms of environmental impacts will reflect in an increase of the economic impact (PAHO and WHO, 2001). The corresponding score for future conditions was kept at the same maximum value given for present conditions. Health problems and social and other community impacts will become less negative as a consequence of better environmental conditions.

Concern III: Habitat and community modification

There is a simultaneous existence of positive and negative effects as a consequence of the exploitation of natural resources and degradation of the environment. Positive ones related to the satisfaction of community basic needs and negative from environmental degradation and generational inequity as long as such development is not carried out in a sustainable way.

Based on the expected slightly negative evolution of habitat and community structure modification, despite efforts and improvements of the various sector of society towards environmental protection and restoration, it was considered that economic and social impacts directly associated to ecosystems degradation would increase in negative terms.

Habitat and community modification is supported by the transformation of fluvial lotic systems into lentic or almost lentic ecosystems in a large number of reservoir in the main reaches and its tributaries.

The major part of the dams in La Plata Basin is devoted to hydropower generation. Recent statistics, indicate that in South America only 19.7% of the 2.7 million Gwh/year technically feasible potential is currently in operation (Hydropower and Dams, 2002 and International Journal on Hydropower and Dams, 2002). The technically and economically feasible potential still unexploited doubles that figure, amounting to about 39.6%. Currently there are over 11,438 Mw of hydro under construction in 8 countries (Brazil, Argentina and Paraguay among them) and hydroelectricity supplies over 50% of the electricity in 9 countries. The **Table 6.1.14** provides some insights on the five countries involved in Subregion 38a.

Country	Generation contributed by Hydropower	Installed Capacity in operation	Total number of large dams [(1)]	
	%	Mw	Existing	Planned[(2)]
Argentina	~45	9,581	104	8
Brazil	94.1	59,583	634	37
Bolivia	49	330	6	n/a
Paraguay	99.9	8,100	4	2
Uruguay	90	1,534	6	None

[(1)]According to ICOLD definition
[(2)]Hydropower and Dams, 2002 and International Journal on Hydropower and Dams, 2002

Table 6.1.14 Brief insights of the hydroelectricity capacity in the countries that share La Plata Basin

A significant number of currently planned reservoirs are located in Subregion 38a. In Brazil, although the greatest potential for development is in the Amazonian region, present development activities are mainly in the central and southern regions of the country. Previsions indicate that hydroelectric generation in Brazil (61 Gw in 2002) will expand to about 93.3 Gw by 2010, amounting to a 50% increase (Noibre Varella 2002 and Hydropower&Dams, 2000).

Decision making in the future will tend to be based on objective informed processes, options assessments and multi-stakeholder participation to comply with some threshold standards of public acceptance and ensure compliance. This will provide grounds for more active participation of affected people and NGO advocacy groups opposing to dam building, thus making those processes longer in time although more sustainable as regards the decisions finally taken. Current fragmentation of fluvial ecosystems in La Plata River Basin will give raise to strong opposition for additional new developments, at least in the main reaches of the river system.

Therefore foreseeable trends indicate that further transformation of ecosystems, loss of habitats and modification of ecosystem structures, due to dam and storage building, will diminish in the next decades in la Plata River Basin, as compared with the last decades, because less number of dams will be built. Dam decision processes will be more lengthy and careful of environmental, social and health issues, based on options assessment and multi-stakeholder participation, thus minimizing impacts as a result of selecting less impacting options and the improvement of mitigation measures.

Concern IV: Unsustainable exploitation of fisheries and other living resources.

A slight increase in the economic, social and community negative impacts derive from unsustainable exploitation of fisheries, taking in account that this major concern was expected to evolve negatively in terms of environmental impacts.

Concern V: Global Change

Given that environmental impacts of global change are expected to increase in the near future, particularly in La Plata River Basin which has proved to be an area quite sensible to global scale climatic phenomena, an increase in costs, health problems and social and community impacts is expected. Therefore scores were increased slightly in relation with those in present conditions which were already high. As regards health impact, it is predicted that, as consequence of climate change, vectors of tropical and subtropical diseases will increase expanding to areas where the population is neither prepared nor resistant to such affections. Therefore maximum score was given to such impacts.

6.2. Subregion 38b: South Atlantic Ocean Drainage System

6.2.1 Demography

The **Table 6.2.1** shows the population evolution since 1970 in the twelve provinces that share South Atlantic Ocean Drainage System[1] and **Table 6.2.2** shows the official projections within the 10 next years. Based on a conservative approach, it is assumed that there will be internal migration to the region from other zones of the country and that the annual growth rate would be positive about 1%, indicating the expectative of a slight population increase. As consequence the total population by 2020 would be about 10,000,000 inhabitants.

Province	Year			
	1970	1980	1991	2001*
Catamarca	172,323	207,717	264,234	333,661
Córdoba	2,060,065	2,407,754	2,766,683	3,061,611
Chubut	189,920	263,116	357,189	413,240
La Pampa	172,029	208,260	259,996	298,460
La Rioja	136,237	164,217	220,729	289,820
Mendoza	973,075	1,196,228	1,412,481	1,576,585
Neuquén	154,570	243,850	388,833	473,315
Río Negro	262,622	383,354	506,772	552,677
San Juan	384,284	465,976	528,715	622,094
San Luis	183,460	214,416	286,458	366,900
Santa Cruz	84,457	114,941	159,839	197,191
Tierra del Fuego	15,658	29,392	69,369	100,960
Total	4,788,700	5,899,221	7,221,298	8,286,514

Source: INDEC, 1970/1980/1991/2001 census

Table 6.2.1. Population by province

[1] Chilean indicators are not considered into the predictive analysis due to the size of the Chilean territories involved in SR 38b are very small.

Province	Estimated population				
	1990	1995	2000	2005	2010
Catamarca	261,627	289,212	318,147	348,166	377,866
Córdoba	2,763,800	2,929,734	3,090,803	3,244,875	3,384,125
Chubut	351,861	399,125	448,028	496,699	540,446
La Pampa	257,903	282,356	306,113	328,419	347,087
La Rioja	217,482	247,575	280,198	315,351	351,911
Mendoza	1,407,742	1,508,959	1,607,618	1,703,726	1,793,260
Neuquén	377,915	463,266	560,726	668,431	780,660
Río Negro	500,202	559,590	618,486	679,562	741,483
San Juan	528,451	555,223	578,504	599,457	614,951
San Luis	282,626	321,890	363,345	405,733	445,919
Santa Cruz	157,149	181,198	206,897	233,983	260,547
Tierra del Fuego	64,861	89,992	115,538	147,714	188,847
Total	7,171,619	7,828,120	8,494,403	9,172,116	9,827,102

Source: INDEC - CELADE, 1996.

Table 6.2.2 Population estimated by province from 1990 to 2010

At the same time, urbanization process will keep inducing rural migration toward cities (**Table 6.2.3**).

Province	1980			1991			2001		
	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
Catamarca	207,717	119,513	88,204	264,234	184,483	79,751	333,661	247,001	86,660
Córdoba	2,407,754	1,943,557	464,197	2,766,683	2,380,024	386,659	3,061,611	2,718,369	343,242
Chubut	263,116	214,049	49,067	357,189	313,692	43,497	413,240	370,011	43,229
La Pampa	208,260	135,110	73,150	259,996	192,871	67,125	298,460	242,483	55,977
La Rioja	164,217	101,247	62,970	220,729	167,142	53,587	289,820	241,289	48,531
Mendoza	1,196,228	824,430	371,798	1,412,481	1,099,526	312,955	1,576,585	1,243,863	332,722
Neuquen	243,850	185,608	58,242	388,833	335,553	53,280	473,315	419,350	53,965
Rio Negro	383,354	275,373	107,981	506,772	405,010	101,762	552,677	466,253	86,424
San Juan	465,976	335,376	130,600	528,715	424,416	104,299	622,094	528,267	93,827
San Luis	214,416	150,170	64,246	286,458	232,400	54,058	366,900	320,006	46,894
Santa Cruz	114,941	99,776	15,165	159,839	146,076	13,763	197,191	189,577	7,614
Tierra del Fuego	27,350	24,240	3,110	69,369	67,303	2,066	100,960	97,991	2,969
Subregion 38b	**5,897,179**	**4,408,449**	**1,488,730**	**7,221,298**	**5,948,496**	**1,272,802**	**8,286,514**	**7,084,460**	**1,202,054**

Source: INDEC, 1980/1991/2001 census.

Table 6.2.3 Total, urban and rural population growth by province

6.2.2 Economy

The **Table 6.2.4** shows the evolution of the Growth Domestic Product by province since 1991 to 1995. On this base and for long terms the increasing of production growth was estimated in about or over 2%.

No substantial increase in fishery production is expected (**Tables 6.2.5** and **6.2.6**). Present captures will be maintained, while tourist and mining activities are likely to increase. It is also expected a slight increase in irrigated agricultural activities and forestry production. The structure of the economy is shown in **Table 6.2.7**. Increase in consumption will be slight to moderate.

Province	Year				
	1991	1992	1993	1994	1995
Catamarca	6.0	-2.1	7.2	7.1	-4.0
Chubut	1.4	8.5	6.0	8.3	-1.5
Córdoba	8.3	8.8	7.0	7.0	-3.9
La Pampa	s/d	s/d	6.0	12.1	-1.3
La Rioja	9.3	6.9	6.3	6.9	-4.6
Mendoza	2.3	6.9	7.1	5.8	-4.1
Neuquen	12.9	16.8	6.2	9.1	-0.7
Rio Negro	1.5	-0.006	0.5	5.0	-2.9
San Juan	7.7	8.2	6.1	7.6	-3.5
San Luis	8.4	6.2	3.0	6.2	-5.1
Santa Cruz	7.2	10.1	8.7	9.4	-1.3
Tierra del Fuego	9.9	-35.6	12.6	-4.6	-2.2

Source: Ministerio del Interior, 1996

Table 6.2.4 Growth Domestic Products by province

Year	Total	Name of the port				
		Mar del Plata	Puerto Deseado	Punta Quilla	Puerto Madryn	Comodoro Rivadavia
1996	1,059,613	340,413	140,023	131,648	124,637	28,798
1997	1,180,291	325,419	148,054	117,392	106,962	35,061
1998	996,961	271,653	128,020	49,189	121,537	88,614
1999	886,956	222, 550	119,818	47,119	106,043	31,135
2000	759,475	194,625	82,981	43,759	109,000	16,493

Year	Name of the port				
	Bahía Blanca	Quequén	San Antonio Este	San Antonio Oeste	Others
1996	26,007	25,019	22,024	1,862	2,784
1997	26,389	40,738	17,618	2,112	29,923
1998	21,226	34,147	4,668	2,216	24,497
1999	11,187	38,216	5,885	3,069	11,608
2000	9,601	28,723	3,329	2,621	23,987

Source: Dirección de Pesca y Acuicultura. Secretaría de Agricultura, Ganadería, Pesca y Alimentación

Table 6.2.5 High seas fishing by port.

Year	Name of the port					
	Total	Mar del Plata	Rawson	San Antonio Oeste	Quequén	Comodoro Rivadavia
1996	178,665	139,318	17,853	5,965	3,090	1,389
1997	160,967	116,590	17,790	5,875	3,021	10,267
1998	119,729	74,633	6,649	4,564	4,698	18,870
1999	125,849	81,275	7,582	6,673	3,152	16,189
2000	93,206	65,599	5,439	6,330	3,461	6,317

Year	Name of the port				
	Puerto Madryn	San Antonio Este	Bahía Blanca	Ushuaia	Others
1996	777	1,571	309	445	7,948
1997	85	2,415	242	463	4,220
1998	469	2,127	191	475	7,054
1999	493	635	260	327	9,264
2000	99	508	203	328	4,966

Source: Dirección de Pesca y Acuicultura. Secretaría de Agricultura, Ganadería, Pesca y Alimentación.

Table 6.2.6 Coastal fishing by port.

Province	Year	Primary sector (%)	Secondary sector (%)	Tertiary sector (%)
Catamarca	1995	9	28	63
Córdoba	1994	11	31	58
Chubut	1994	28	21	51
La Pampa	1994	47	14	39
La Rioja	1993	3	39	58
Mendoza	1993	11	32	57
Neuquen	1995	53	14	33
Río Negro	1995	19	15	66
San Juan	1995	14	2	61
San Luis	1993	7	65	28
Santa Cruz	1996	54	11	35
Tierra del Fuego	1995	26	34	40

Source: CFI, 2002

Table 6.2.7 Structure of the economy by province

6.2.3 Technical and other type of changes

It is expected a productive expansion over fragile ecosystems (peat lands, "mallines", etc.). It is assumed that some progresses will be achieved in relation with the environmental regulatory framework.

6.2.4 Environment

Based on the above-mentioned comments, a moderate increase in total pressure on the aquatic environment (**Table 6.2.8**) is expected.

Environmental Issues		Major Concerns	Present Score	Future Score
1. Modification of stream flow 2. Pollution of existing supplies 3. Changes in the water table		**I Freshwater shortage**	1.8	2
4. Microbiological 6. Chemical 8. Solid wastes 10. Radio nuclide	5. Eutrophication 7. Suspended solids 9. Thermal 11. Spills	**II Pollution**	1.5	1.2
12. Loss of ecosystems 13. Modification of ecosystems or ecotones, including community structure and/or species composition		**III Habitat and community modification**	2	3
14. Over-exploitation 15. Excessive by-catch and discards 16. Destructive fishing practices 17. Decreased viability of stock through pollution and disease 18. Impact on biological and genetic diversity.		**IV Unsustainable exploitation of fisheries and other living resources**	1.95	2.5
19. Changes in hydrological cycle 20. Sea level change 21. Increased uv-b radiation as a result of ozone depletion 22. Changes in ocean CO_2 source/sink function		**V Global change**	+0.2	0

Table 6.2.8 Scoping for Environmental Impact under Future Conditions

Concern I: Freshwater shortage

It is assumed that it will be a slight trend to a worsening of the present situation, due mainly to further pressure on the humid lowland spots ("mallines").

Concern II: Pollution

Demographic pressure in the region will continue to be low and therefore the pressure on water resources will not increase significantly, providing a good perspective.

Action from environmental NGOs and increased community awareness would tend to improve the situation diminishing pollution loads. Also it was thought that major investments in the region are carried out by large enterprises subject to international funding which oblige them to be environmental friendly and comply with self regulating ISO standards. Even though, some degradation from them is expected.

Concern III: Habitat and community modification

This concern has serious negative effects in SR 38 b since recovery is too slow and it is expected that over 20 years will be needed until the humid lowland spots ("mallines") improve their situation, provided measures are readily taken. Even though recently protected areas have been created and it is expected that this trend will continue, degradation of the rest of the areas will continue and even increase.

In the ocean area, improved awareness about marine resources will help in stopping the degradation but in the continental zone, the impact of introduced species on the ecosystem in the long run is not known, but it is presumed serious.

Concern IV: Unsustainable exploitation of fisheries and other living resources

Conditions will become worse. In the ocean area visible results are not expected and in the continental areas, where regulations are not complied with, unsustainable exploitation will increase.

Concern V Global change

Given the lack of results of studies on some aspects involving the Patagonia system, based on the precautionary principle a slight worsening of the situation is expected.

6.2.5 Socioeconomic

Major Concerns	Economic Impacts		Health Impacts		Other Social and Community Impacts	
	Present Score	Future Score	Present Score	Future Score	Present Score	Future Score
I Freshwater Shortage	2.3	2.5	0	1	2.3	2.5
II Pollution	2.3	2.5	2	1.5	1	1
III Habitat and community modification	2.3	3	0	0	2	3
IV Unsustainable exploitation of fisheries and living resources	2.2	2.5	0	0	2.2	2.5
V Global change	+1.4	+1	0	0	+1.67	+1

Table 6.2.9 Scoping for Socio-Economic Impacts under Future Conditions

Some details about the socioeconomic impacts in future conditions that support the scores given to each major concern (**Table 6.2.9**) are the following:

I. Freshwater Shortage

Having agreed that would have a slight increase in the next decades, it becomes apparent that economic costs, associated to increased water treatment, restoration of supply sources or incorporation of more costly new ones, would also experiment a similar degree of increase. However, health problems associated to the lack of safe water are expected to increase more intensively while social and community impacts will become somewhat more stringent.

Since agricultural is responsible for about 70 percent of all fresh water withdrawal for human use, its trend has big relevance. In developing countries is expected an increasing of 14% of the irrigation by 2030 (FAO 2002).

II. Pollution

Improvements in pollution control will require major investments by private and public sector, so the improvement in terms of environmental impacts will reflect in an increase of the economic impact. Health problems and social and other community impacts will become less negative as a consequence of better environmental conditions, thus a slight decrease in the score for future conditions was agreed by the Group. Social impacts will also experiment a positive change but slight enough to maintain the present conditions score.

III. Ecosystem and ecotone modification

Based on the expected slightly negative evolution of habitat and community structure modification, despite efforts and improvements of the various sector of society towards environmental protection and restoration, it was considered that economic and social impacts directly associated to ecosystems degradation would increase in negative terms. A very slight increase in the scoring was adopted for both issues, while health impacts were assumed difficult to assess and still not significant.

Habitat and community modification is partiality supported by the transformation of fluvial lotic systems into lentic or almost lentic ecosystems in reservoirs. In SR 38b is expected the construction of dams for irrigation and water supply, but only one of them would be built in the short term.

IV Unsustainable exploitation of fisheries and other living resources.

It was expected a slight increase in the economic, social and community negative impacts deriving from unsustainable exploitation of fisheries, taking in account that this concern was expected to evolve negatively in terms of environmental impacts.

It estimated that fish consumption would be slightly higher than it was at the end of 1990´s based on the total quantity of product consumed per person and per year would not fluctuate greatly. A breakthrough in aquaculture (eg. an extremely rapid spread of tilapia culture in Latinamerica) would be the only major reason for altering such a prediction (FAO 2000).

V. Global Change

Given that environmental impacts of global change are expected to increase in the near future, an increase in costs, health problems and social and community negative impacts is expected. This negative perspective resulted in the slight reduction of positive scores assigned to the present conditions.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 SR 38 a: La Plata River Basin

7.1.1 Concern I: Freshwater shortage

Freshwater shortage concern was ranked as second priority in Sub Region 38 as a whole, being assigned priority 3 in SR38a La Plata River Basin System.

As regards Issue 1 **Modification of stream flows**, slight impact score was assigned given evidences of significant discharge decrease due to intensive water extraction in the Quarai/ Cuareim basin and changes in low water flows and to some extent in high water flows due to land use and reservoir operation in the Paraná River system. In the Cuareim or Quaraí River basin (15,000 km^2) there is evidence of competence between domestic water supply and rice irrigation. Despite the fact that Cuarein River basin is smaller than 40,000 km^2 as set forth in GIWA methodology, it is an emblematic case.

Issue 2, **Pollution of freshwater sources,** was considered more relevant receiving a score 2. There is an extended bacteriological contamination due generalized discharge of raw sewage into rivers.

The more important problems are found in Sao Pablo and Buenos Aires metropolitan regions. In some urban and industrial areas (Tietê River, Paraguay River, Lower Paraná -La Plata River coastal fringe, Pilcomayo River during peak flows, etc.) have been found very high levels of pollution, including evidence of toxic substances. The presence of algae, which are difficult to remove by conventional water treatments, is another problem in some localized areas of the SR. There is also evidence of contamination of aquifers (Buenos Aires Metropolitan Region, Paraná coastal region, and Guaraní aquifer recharge areas), used as urban and industrial water supplies, due to domestic and industrial pollution and intensive agriculture and cattle raising activities.

Issue 3, **Changes in the water table**, received score 1 given some evidences of water table lowering, well's deepening, overexploitation of aquifers and presence of salinization in some hot spots in Brazil, Uruguay and Argentina. Such score given by the expert group is consistent with aquifers affectation as a direct or indirect consequence of human activities analyzed in the Buenos Aires Metropolitan Region as well as some areas of the Guaraní Aquifer System in Brazil.

It is important to say, however, that there is no homogeneous information for the five countries of the La Plata River basin, and there is scarce information about groundwater exploitation for different uses as well. In consequence is recommended to carry out further regional studies on groundwater availability, exploitation and management.

Information gathered is considered enough in order to support the score given to Environmental Freshwater Shortage Concern by the expert group during the Scoping. Therefore, the valuation of these three issues is considered adequate.

Fresh Water Shortage is mainly due to Pollution of water source and its socioeconomic impacts (scored 3, 2 and 2) basically are the some ones identified for Concern II. On the other hand, it was not possible found enough information of socioeconomic impacts related to Modification of stream flows and Changes in the water table, to support the score given during the First Workshop. As a consequence, score 3 for socioeconomic impacts should be changed.

Degradation of water sources may maintain or even increase while water demands will naturally increase, resulting as a consequence, in the future increase of water shortages in the region. Therefore a moderate increase in the score of this major concern was adopted.

7.1.2 Concern II: Pollution

This concern was ranked as third priority in Subregion 38 as a whole, being assigned priority 2 in SR38a La Plata River Basin System.

As regards Issue 4 **Microbiological** pollution, there are numerous indications of bacteriological contamination. Score 1 (low) was given following the GIWA criteria, based on the fact that registered cases of gastroenteric diseases due to fish consumption are no significant. However, water quality in terms of fecal coliform bacteria presence, which are used in the detailed assessment, indicate that the impact may deserve a higher score.

There is evidence of **Eutrophication** (Issue 5) in localized areas of the large reservoirs on the international rivers, while the phenomena affects has a higher incidence in a number of water bodies in their tributaries. In all cases, eutrophication affects water treatment.

Heavy metals pollution is ubiquitous in La Plata River Basin and is the main **Chemical** pollution (Issue 6) stress within the basin. The most affected watercourses are the Upper Pilcomayo River (Bolivia) and the Upper Paraguay River (Brazil), where non-sustainable mining operations produce significant inputs of heavy metals. Industrial Persistent Organic Pollutants (POP's) pollution is related with large metropolitan centers in this basin. Thus incipient PCB's and dioxins detections in local fish tissue were reported in the southern shore of the Río de La Plata estuary, Argentina.

Chemical pollution, due to its broad spatial and temporal scales, is the main aspect within the pollution concern problem issue that determines the second priority of concern in La Plata River Basin. Due to these consideration the moderate impact (score 2) given to this issue by the First Subregional Workshop is ratified.

Issue 7, **Suspended Solids,** received score 2 given some evidences of increases in turbidity due to erosion processes caused by changes in land use and unsustainable agricultural practices. This occurs in particular in humid areas subject to deforestation for agricultural purposes, in various regions in the Basin (upper Paraná, Paraguay and Uruguay basins in Brazil). Suspended sediments are particularly high in the Bermejo and Pilcomayo Rivers. Although sediment generation by anthropogenic causes is a low percentage of the total sediment river load it is important from a quantitative point of view. Regardless their origin, sediments have a key role in the transport and dynamic of pollutants.

In the same way, although it is well known the effects on sediments generation and erosion of unsustainable agricultural practices, as well as deforestation and mining, there is a lacking in regional studies that quantify the relative impact of each sediment sources. Therefore, it is recommended further regional studies on this issue.

Issue 8, **Solid wastes,** is of negligible impact to the surface waters and has a local impact on groundwater of large metropolitan areas within the subregion. Nevertheless attention should be given to the increasing development of non engineered disposal of municipal and industrial wastes in urban areas, associated to declining socio-economical status of the Mercosur countries. Due to the limited spatial scale effect of this issue the score 2 given by the First Workshop should be changed for 1, low impact.

The moderate impact 2 assigned to Issue 11, **Spills**, is supported by the various ship oil tankers accidents and the COMSUR Mine tailings spill of heavy metals (Porco, Bolivia, 1996). Most of these oil spills took place in La Plata River Basin (Río de la Plata estuary, Uruguay –Atlantic seashore, Iguazú River) along the last 5 years and their environmental impacts were minimized by implementing effective contingency plans. The spills issue is closely related with the chemical issue, weighting each one in accordance with the nature of the pollution source, the presence of treatment facilities and the frequency of the events. The moderate impact score (2 points) given by the First Workshop is ratified.

The considerations made about socioeconomic impacts of pollution tend to confirm, in general way, the conclusions agreed in the First Workshop. In the same way, the valuation is considered as adequate.

As regards economic impacts (scored 3, severe) there exists an absence of quantitative regional data. Anyhow, the collected information and the consult made with experts, permit to confirm the following main economic impacts: problems derived from increases in cost of water treatment, specially in great metropolitan areas; investments in cleaning, contingency and emergency tasks in case of spills; decreases in fishing linked with microbiological and chemical pollution or increases in costs of fishing and losses in properties values.

Related to health impact (scored 2, moderate), main causes of water borne diseases are the lack of adequate water treatment and sanitation systems, and discharges of industrial effluents or mining activities. There are reports of international agencies that point out the existence of water origin diseases (especially cholera and diarrhea) in La Plata Basin (except Uruguay). Other reports link diseases with microbiological and chemical pollution; as well as infantile mortality rate with sanitation and water supply.

Finally, as regards other social and community impacts (scored 2, moderate), there have been found several reports of beaches closure due to oil spills and microbiological pollution, loss of tourism, recreational activities and aesthetic values, damage in protected areas and impacts on biodiversity.

As regards predictive analysis, in the long term only a slight improvement in the situation is expected due to governmental action, the influence of environmental NGOs, enhanced community awareness and commitment and increased industry self regulating behaviors (ISO standards).

7.1.3 Concern III: Habitat and community modification

The Concern Habitat and Community Modification was ranked as first priority in SR38 as a whole, as well as in SR38a La Plata River Basin.

Issue 12**, Losses of Ecosystems and ecotones,** received score 3 given a variety of losses of ecosystems and ecotones, in terms of destruction or transformation into others different types. The construction of a large number of reservoir in the main reaches and its tributaries have caused the transformation of fluvial lotic systems into lentic or almost lentic ecosystems. Riparian river ecotones into lake ecotones extending considerably their total length and destruction of terrestrial habitats as a consequence of the impoundments turning them into aquatic littoral and pelagic ones. It was possible to state that over 35 % of the total length of the Paraná River has been altered by the creation of a number of large reservoirs. However, since there are no comprehensive studies on loss of ecosystem in the La Plata basin it is recommended that such studies should be carried out in the framework of some regional program. Nevertheless, the analysis developed for this Detailed Assessment widely support the score given by the expert group in the First Workshop.

Issue 13**, Modification of structure or communities**, received score 2 since development of large urban settlements along the river shores, like São Paulo, Posadas, Encarnación, the coastal belt of the lower Paraná River and La Plata River, from Rosario to Ensenada city, have resulted in the destruction of riparian habitats. Reservoir cascades in the main international stretches (Paraná River) and their tributaries have also altered the habitats and interrupted system continuity, affecting community structure and the population dynamics of migratory species of biological and commercial value. As a consequence of the accidental introduction of exotic species, like *Limnosperma Fortune, Corvícula fluminea* and Tyllapia, the ecosystems exhibits species exclusion and changes in the food web. The amount of information gathered widely supports the valuation given to this issue in the First Workshop.

Socioeconomic impacts of habitat destruction and modification (scored 2, 0 and 2) become evident mainly in relation to decreases in fishing and to some extent in hunting of commercial interest species in community sectors which feed from or trade them. As a consequence, the impact is higher in regional economies as well as fishing, sporting and tourism activities. Although there is no enough published information on such socioeconomic impacts the valuation as moderate given by the expert group is considered adequate regarding their relationship with environment affectation. Additionally, the cost of controlling invasive species, costs of habitat restoration, loss of educational and scientific values and fundamentally, generational inequity, should be taking into account as important issues to be studied and incorporated into regional plans and programs.

The general expected trend is towards an increase in the pressure on natural resources and environment while no restoration is taking place in present degraded areas. As a result the Group understands that a moderate deterioration of Modification of structure or communities concern will take place towards year 2020.

7.1.4. General conclusion

In La Plata River Basin, as a results of the Detailed Assessment done, it is possible concluded that Concerns III: Habitat and Community Modification and Concern II: Pollution have enough data gathered that justified the score assigned during the First Workshop as well as their inclusion in next stages of GIWA project.

It was not possible to prove the score assigned to socioeconomic impacts of Concern I: Freshwater shortage. Thus, the inclusion of this concern in next stages is not suitable. Nevertheless, as the score given to Concern I was mainly based on the score obtained by the issue 2: Pollution of existing supplies, it will be indirectly included in the Causal Chain analysis.

7.2 SR 38 b: South Atlantic Drainage System

7.2.1 Concern I Freshwater shortage

This concern was ranked as second priority in Subregion 38 as a whole, being assigned priority 2 in SR38b. Water deficit is a common feature in the arid and semiarid zones comprised by this system.

Issue 1, **Modification of stream flows**, received scored 1 since a measurable decrease of spring water areas has been observed in some zones. Although in the Colhue Huapi Lake is undergoing desiccation and desertification process there is scarce information for supporting the valuation given to the issue in the First Workshop, even being low.

Issue 2, **Pollution of existing supplies**, was scored with 1 (low) due to indications in some monitoring stations of bacteriological contamination, presence of hydrocarbons from oil spills and pollution of groundwater from oil industry activities. Eutrophication is low but affects all the reservoir in a greater or lesser extent.

Issue 3, **Changes in the water table**, received score 3 given some evidences of salinization at regional level in the irrigated areas and indications of lowering of the water table, associated with springs in the local recharge zones. In some spots, underground water supply is becoming impaired by salinization processes as a result of overexploitation.

Nevertheless salinization in irrigated areas affects soil and water resources due to an increase in the water table while GIWA methodology is focused on its lowering instead, even more since this issue should support the freshwater shortage concern. As regard lowering in the water table related with springs (“mallines”) although there is evidence of affectation, the information available is relatively recent and it is not clear yet the real impact on the water resources at regional level. Finally, there is no information on groundwater salinization or lowering in the water table due to overexploitation at regional level.

Information gathered on changes in the water table in the SR 38b does not support the valuation given at the First Workshop. Therefore, it is recommended change the valuation from 3 (severe) to 1 (low). However it is also recommended to carry out studies at regional level in order to generate baseline information.

Only was possible to found some evidences of economics impacts related to the clear water problems in the Negro River Basin. However there is a relevant social impact on rural workers in SR 38b due to impairment of water sources or degradation of its quality, although it is not relevant in number.

It is assumed that it will be a slight trend to a worsening of the present situation.

7.2.2 Concern II: Pollution

This concern was ranked as second priority in Subregion 38 as a whole, being assigned priority 4 in SR38b.

Issue 4, **Microbiological** pollution, was scored 1 (low) due to industrial and urban discharges especially in Bahia Blanca and Rio Gallegos cities. Like in SR 38a the indicators taken into account were fecal coliforms and total coliforms since GIWA criteria are not representative.

Issue 5, **Eutrophication,** was scored 1, given evidences of eutrophication in some reservoirs, being Paso Piedras (Bahia Blanca City) the most affected.

Chemical Pollution, issue 6, scored 1 is of local scale and limited magnitude not supporting a relevant concern. Hydrocarbons from oil fields and harbors are the main chemical pollutants in the Patagonia basin, both in continental (Upper Colorado Basin) and ocean (Bahía Blanca, Puerto Madryn, and Ushuaia) waters. Presence of heavy metals in sediments and aquatic biota of the Beagle Channel was related to manufacturing activities in Ushuaia City, Argentina.

The low impact given to Issues 4, 5 and 6 is ratified.

Issue 7 **Suspended solids** received score 2 given some problems with increase in turbidity in various streams, reservoirs and receiving marine water bodies due to several causes: use of water for mining purposes, substitution of native forests by exotic species, alteration of the natural vegetation cover of extensive sedimentary areas devoted to sheep raising.

In the province of Santa Cruz the Río Turbio mining industry discharges a high amount of solids generated by the mineral carbon treatment into the Gallegos River affected the aquatic life as well as the water availability for human use. On the other hand, lack of sediments as a consequence of dam building has affected irrigated areas by rising the water table due to infiltration increasing.

The valuation as moderate is adequate taking into account the analysis of the information available.

Solid wastes pollution, issue 8, was scored moderate due to interference of solid wastes with fishing activities are observed all along the Patagonian Atlantic coast. However, according to the assessment carried out, this issue is of negligible impact to the surface waters. Due to the limited spatial scale of this issue the score should be decided as low impact.

Issue 11 **Spills** was scored as moderate given evidence of: frequent surface waters pollution by oil spills in the Colorado River producing water quality impacts constraining irrigation and drinking water supply in this semiarid region and underground water pollution due to secondary recovery of oil in the province of Santa Cruz and other sectors in the Atlantic coast.

The moderate impact score is ratified.

The considerations related with socioeconomic impacts of pollution tend to confirm, in general, the conclusions agreed at the First Workshop, despite it did not find information related to the impacts of use of biocides, which was pointed out by the Group of Experts.

The pressure on water resources will not increase significantly providing a good perspective.

7.2.3 Concern III: Habitat and community modification

This concern was ranked as first priority in Sub Region 38 as a whole, being assigned priority 1 in SR38b.

Issue 12 **Losses of ecosystems and ecotones** received score 2 given evidences of transformation of fast running watercourses into lentic reservoir environments with long residence times, large impounded areas and lengthy lakeshores. The transformation rate of lotic environments into lentic and semi-lentic ones for the Limay River is about 44%. Construction of reservoirs for flow regulation and flood control has altered seasonal flow patterns affecting environmental conditions for most species. There is also deterioration in structure and dynamic of the mallines, which are highly related to water availability.

However there is very scarce information to support the extent of the resulting impacts at regional level.

As regard issue 13 **Modification of structures and communities** (scored 2), operation of harbors and oil shipping facilities in some areas (Puerto Madryn, Comodoro Rivadavia, etc.), along the shore, resulted in pollution hot spots which locally affect coastal habitats and attached aquatic communities. As a consequence of the human settlement and activities there is a modification of the marine ecosystems by degradation, fragmentation or losses of habitats.

Habitat losses and aquatic community modifications have a significant negative economic and social impact on the dependent populations, particularly those related to irrigated agriculture and fisheries exploitation.

In the ocean area, improved awareness about marine resources will help in stopping the degradation but in the continental zone, the impact of introduced species on the ecosystem in the long run is not known, but it is presumed serious.

According to the data gathered it was possible ratify the score moderate given by the experts.

7.2.4 Concern IV: Unsustainable exploitation of living resources

This concern was ranked third priority in SR38b, South Atlantic Drainage System.

Highly linked to Concern III intensive fish exploitation, incidental captures and discards and fishing practices have affected aquatic community structure and population dynamic of the various trophic levels. Therefore Concerns III and IV will be analyzed together during the Causal Chain Analysis component.

Issue 14, **Overexploitation,** scored 3, occurs in the oceanic component, particularly concerning hake fishing, which is seriously affected since it has been being exploited beyond safe biological limits. Status Indicators show a critical situation: north and south stocks were overfished, total biomass was decreasing, reproductive biomass was lower than the biologically acceptable level and the fishery was sustained by a few year classes.

Issue 15**, Incidental by-catch and discards**, was scored 2 and amounts to about 30 to 60% of fish production in hake fishing. According to official estimations, between 1990 and 1996 were discarded between 20,000 and 75,000 tons/year of young hake that represent between 80 and 300 millions of fish.

Issue 16, **Destructive fishing practices** result from trawling methods used in the maritime zones with a significant impact on the benthic habitats. This issue was scored moderate or 2.

Affectation of hake fishing due to over exploitation results in severe social and economic problems due to the loss of employments and the bankrupt of fishing enterprises, taking in account that the impact on the local community is quite strong.

In the future the exploitation of living resources will become worse since in the ocean area visible results from implemented regulations are not expected, while in continental areas, where regulations are usually not complied with, unsustainable exploitation will increase.

7.2.5 General conclusion

In South Atlantic Drainage System, as a results of the Detailed Assessment carried out, it is possible concluded that Concerns III: Habitat and Community Modification, Concern IV: Unsustainable exploitation of living resources and Concern II: Pollution have enough data gathered that justified the score assigned during the First Workshop. As regards Concern I: Freshwater shortage, it has not been found enough information in order to support the second priority assigned. As a consequent Concern III and IV will be included in the next stages of GIWA project.

7.3 Lesson learned

The First Workshop S&S in Subregion 38 was held 20 days after the effective beginning of the focal point activities. As a consequence, there was not enough time for the complete involvement of the experts. This is a key point since the methodology is based on Expert Judgment.

Due to the heterogeneity between La Plata River Basin and South Atlantic Drainage System, it results convenient to analyze each system independently during the causal chain analysis and the policy option.

7.4 Recommendations

Some of the recommendations given below were outlined during the scoping stage and lately confirmed during the detailed assessment process. Others were identified while the task team was gathering information to support the scores.

Modification of stream flow, GIWA methodology should be changed since the issue description includes increasing of stream flows, as an indicator while the concern is freshwater shortage.

Microbiological pollution is assessed on the base of gastrointestinal disorders related to fish consumption and fishing prohibition. Since fish consumption in the countries within SR38 is low, it is needed to incorporate other indicators such as total coliforms and fecal coliforms.

Since the eutrophication level is not the same in all the water bodies within a Subregion, the percentage of the lakes, reservoirs or coasts affected over the total water bodies should be added to GIWA criteria.

Infrastructure (routes, dams and embankment) and the urban settlements affect the natural drainage pattern especially during the floods. The effects are more serious in plains where the slopes are very small. Such issue should be included in GIWA.