



Pitting the polluted against the flooded: water resource management in Tigre, Buenos Aires

Francisco Suárez and Ruben J Lombardo

Francisco Suárez and Ruben J Lombardo are researchers and professors of urban ecology at the Instituto del Conurbano of the Universidad Nacional de General Sarmiento, Buenos Aires, Argentina.

Address: Instituto del Conurbano, Universidad Nacional de General Sarmiento, J M Gutierrez 1150, Los Polvorines (B1613GSX), Provincia de Buenos Aires, Argentina; e-mail: fsuarez@ungs.edu.ar

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1. This study is part of the project on "Integrated Management of the Water Basins of the Buenos Aires Metropolitan Region; Geo-referencing of the Information about the Condition of the Basins and Analysis of the Ecological Sustainability for the Management of the Water Resource in the Region".

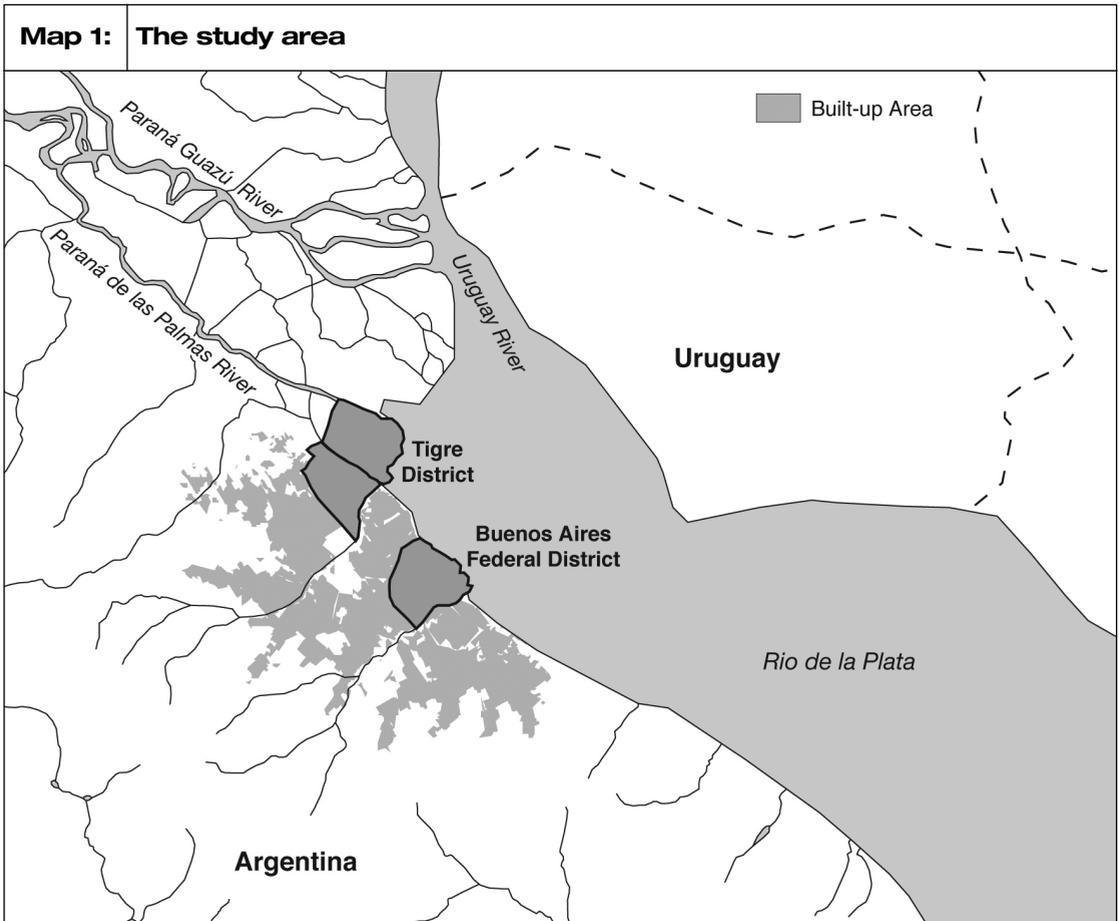
2. Lombardo, R J, M G Alsina, A D Crojethovich, F Suárez, A C Herrero and L Reboratti (2000), "Criterios de evaluación de riesgo y

SUMMARY: People residing on the banks of the lower stretches of the Reconquista and Luján rivers, as well as in the first section of islands in the Tigre delta bordering Greater Buenos Aires, are affected by the water-management operations carried out in the Reconquista. This paper presents the findings of a study to analyze the perception and actual risk of water pollution, drawing on a survey of the population's social vulnerability and an analysis of surface water quality. Exposure to the consumption of polluted water was examined using various parameters, including water quality, pH, turbidity, dissolved oxygen and surface temperature, so as to establish a hazard gradient. A focal area of risk was established, where there was spatial overlapping of social vulnerability with higher hazard levels. Systematic household sampling sought to identify water use and consumption habits, the level of perception of the quality of the resource and the degree of community organization. The level of social conflict relating to the water engineering works was also analyzed. This study demonstrates the need for integrated water resource management at an ecosystem-wide level, with a concern for a fairer distribution of the socio-environmental costs and benefits.

I. INTRODUCTION

THE STUDY AREA⁽¹⁾ is made up of the mainland and the first section of the Paraná delta islands, which are part of the municipality of Tigre in the Buenos Aires Metropolitan Region. This sector is separated from the mainland by the Luján River, and delimited by the Paraná de las Palmas River, the Gobernador Arias channel and the Río de la Plata (Maps 1 and 2). In this area of confluence, water is used in a variety of ways: for the collection and disposal of domestic and industrial waste, for marine activities (commercial and sports) and for recreation. The mouth of the Reconquista River is the main point of articulation between the Buenos Aires Metropolitan Region and the Paraná delta, with numerous environmental, economic, social and cultural relationships. In previous studies, we detected high social vulnerability in this area with regard to the deterioration of the water resource.⁽²⁾

The Luján River is a plains river with an average flow of 5.4 cubic metres per second. Before entering the Río de la Plata, it receives waters from the Reconquista River, the Gobernador Arias channel (from the Paraná River) and the spillway channel of the Reconquista River. The Reconquista is a plains river with an average flow of three cubic metres per second. It runs



for 84 kilometres through the Buenos Aires Metropolitan Region, then divides into two to form the Reconquista Chico and the Tigre. It receives untreated effluent from 12,000 industries, and wastewater from 3 million people,⁽³⁾ with inadequate or no treatment. In the lower stretches, concentrations of heavy metals exceed the authorized values for water quality for aquatic life; high concentrations of organo-chlorine pesticides were detected, and the dissolved oxygen concentrations were near to zero.⁽⁴⁾ The combination of pollutants and reduced flow means that the river's capacity to break down pollution, or dilute non-biodegradable pollutants is exceeded,⁽⁵⁾ rendering the waters unfit for most uses.

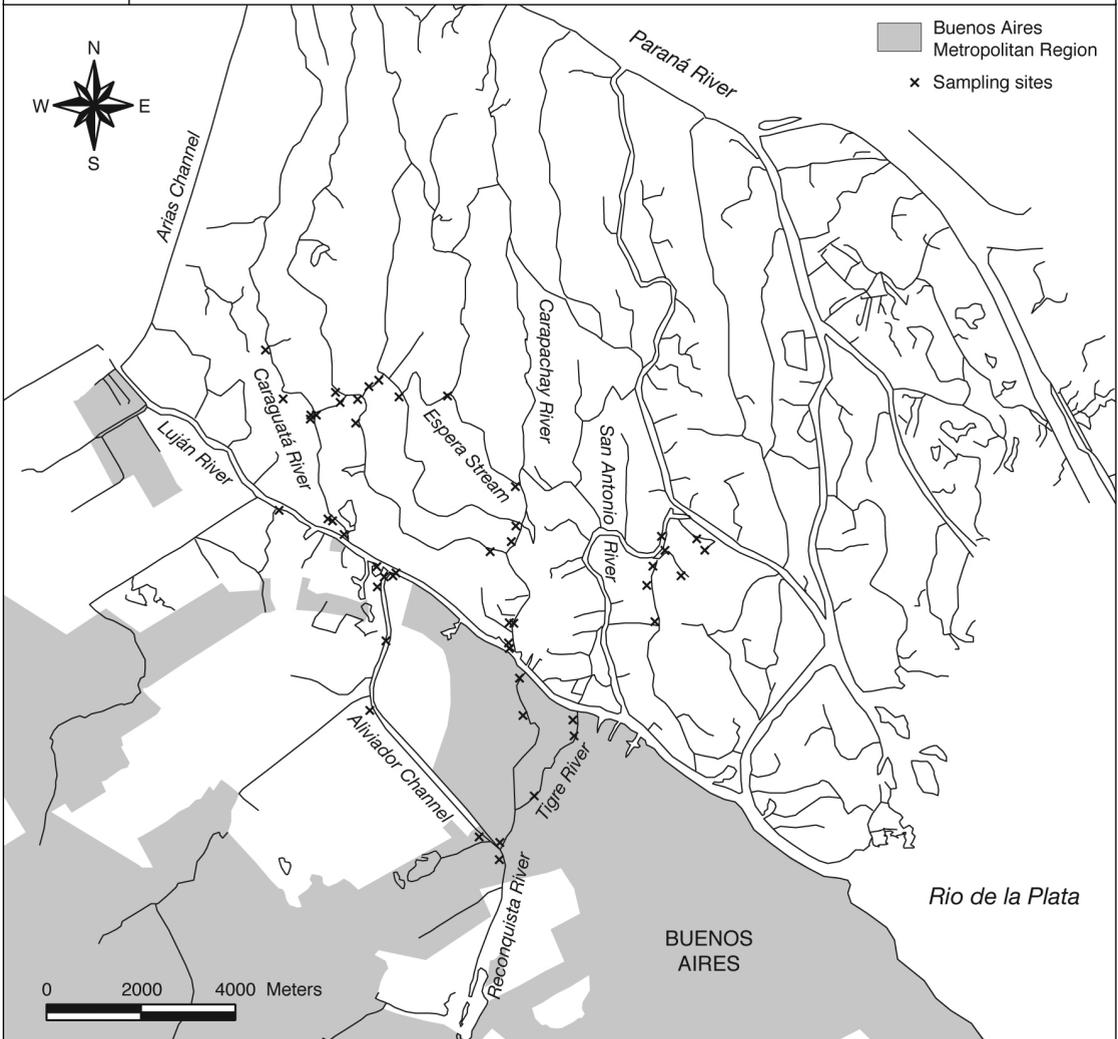
The dynamic of the affected water system is complex because, in the lower stretches of the Luján and Reconquista rivers, the water regime is influenced by the rains in the high and medium basins, by the fluctuations and flood tides of the Paraná River, by the Río de la Plata tides and by the *sudestadas* (strong winds from the southeast). These winds hinder the normal flow of the Río de la Plata towards the sea, pushing it instead towards the coast; the rivers and streams that flow into it are also affected. Likewise, the tidal regime of the Atlantic is reflected in the Río de la Plata and in the lower stretches of the Luján River and its tributaries. Here, there is an inversion in the direction of water flow approximately every six hours, in accordance with the tidal regime in the Reconquista, Carapachay and Caragatá rivers, among others (see Map 2). This flow inversion

vulnerabilidad social en relación al recurso hídrico en la Región Metropolitana de Buenos Aires", paper presented at the Second Annual Research Meeting, Universidad Nacional de General Sarmiento, San Miguel, Argentina.

3. Zalazar, R H (1996), "Cuencas hídricas: contaminación y evaluación de riesgo y saneamiento, Instituto provincial de medio ambiente", Government of the Province of Buenos Aires.

4. Loez, C R and M L Topalián (1999), "Use of algae for monitoring rivers in Argentina, with a special emphasis on the Reconquista River (region of Buenos Aires)", in Prygiel, J, B A Whitton and J Bukowska (editors), *Use of Algae for Monitoring Rivers*

Map 2: Location of sampling sites



III, Agence de l'Eau Artois-Picardie Centre Tertiaire de l'Arsenal, Douai (France), pages 72-83.

5. Castañé, P M, C R Loez, H F Olguín and A Puig (1998), "Caracterización y variación espacial de parámetros fisicoquímicos y del plancton en un río urbano contaminado" (Reconquista River, Argentina), *Revista Internacional de Contaminación Ambiental* Vol 14, No 2, pages 69-77, México.

produces interchanges of water masses between zones that might be unnoticed in a unidirectional water system. Thus, a water mass that flows down the Reconquista River and through the Aliviador channel reaches the Luján River during the ebb tide. When the tide flow inverts, this water mass is situated at the mouth of the Caraguatá River, and may be pushed upstream by the flood tide, entering the delta island sector through the Caraguatá.

a. Hydraulic works in the Reconquista River

Over the last four decades, there have been major floods in the Reconquista basin. To control the flooding, in the 1970s a 7.5-kilometre spillway channel was built to relieve the flow of the Reconquista River from a point five kilometres from its mouth up to the Luján River, 5.5 kilometres upstream of its natural confluence. There was a weir that worked mainly when the water level of the Reconquista rose. In 1985, the weir was destroyed by major floods (11,900 hectares were flooded and 200,000

people affected), and the Reconquista River became linked directly to the spillway channel. In August 2000, within the framework of a project on environmental sanitation and flood control in the Reconquista basin, an embankment was constructed that obstructed outflow from the Reconquista along its natural course, and diverted the whole of its flow to the spillway channel. For several months, the highly polluted waters from the Reconquista, which previously had been divided between the Tigre River (mainly), the spillway channel and the Reconquista Chico arm (to a lesser extent), were diverted to the Luján River upstream, to the island sector between the Caraguatá and Carapachay delta rivers (Map 2). This was partly alleviated by the construction of a sluice gate in the embankment of the main course of the Reconquista, which regulates the rain floodwaters, with 90 per cent of the water flowing through the spillway channel and 10 per cent through the Reconquista Chico and Tigre systems.⁽⁶⁾

b. Social and economic aspects

The confluence of the Reconquista, Luján and Paraná basins is in the territorial district of Tigre, which has 300,000 inhabitants⁽⁷⁾ and where 23 per cent of households have unsatisfied basic needs.⁽⁸⁾ The island sector has 5,000 inhabitants in an area of 24,383 hectares, with more than 350 rivers and streams.

Tigre began to be colonized⁽⁹⁾ for agricultural and port activities at the beginning of the seventeenth century. By the end of the nineteenth century, it was the place for the elites of Buenos Aires to spend their weekends and summer holidays. In the 1930s, Tigre was replaced by other tourist centres, and it moved towards production, receiving products from the delta, such as wood, fruit and wicker. Since the 1990s, the local government has been trying to revive the tourist boom that Tigre had previously enjoyed, but giving priority to the mainland over the delta, encouraging the establishment of entertainment facilities (casinos, funfairs) and private urban developments such as major planned urban developments for middle- and upper-income groups. It is currently one of the districts (municipalities) in Buenos Aires with higher population growth, a pole of tourist development and of urban development in the public and private sectors. This relates to the process of suburbanization for middle- and upper-income groups in the city of Buenos Aires and to improvements in road accessibility, a growth in trade and the provision of services, and to an increase in urban insecurity.⁽¹⁰⁾

As a result, Tigre is an important center of micro-tourism⁽¹¹⁾ in the Buenos Aires Metropolitan Region. Primary activities are only significant in the islands where 10 per cent of the total area is devoted to intensive agriculture and cattle-raising. On the mainland, there are more than 1,000 industries, and light industry prevails over heavy industry. Although industries that damage the environment have been banned, there are still some surviving older industries such as paper mills and slaughterhouses.

With regard to infrastructure for sanitation, almost all the mainland is connected to the public water system, while only the downtown population is connected to the sewer system. Eighty-four per cent of households in the Tigre delta collect water directly from the river.⁽¹²⁾ In this delta, there are three distinct population groups with regard to socioeconomic profiles:

- A low-income population that undertakes primary activities such as wicker production and the growing of fruit and vegetables, and/or the

6. UNIREC (1999), "Proyecto de saneamiento ambiental y control de las inundaciones en la cuenca del río Reconquista", UNIREC, Buenos Aires.

7. Instituto Nacional de Estadísticas y Censos (2001), *National Census of Population and Housing*, INDEC, Buenos Aires.

8. A household is considered to have unsatisfied basic needs when it has at least one of the following indicators: more than two persons per room; children of school age who do not attend school; toilets with a water closet without a cistern; unsuitable dwelling (earth floor, precarious walls and roof); family heads who have not completed primary education and on whom more than two members of the household depend.

9. When the Spanish conquerors arrived, there were three kinds of native groups living in the area that is the present Tigre: the Querandíes in the continental area, and the Chaná-Timbú and Guaraníes in the islands.

10. Suárez, F (1997), "Nuevas tendencias residenciales en la ciudad de Buenos Aires", *Carta Económica Regional* Vol 9, No 52, Universidad de Guadalajara, Mexico.

11. The first section of the islands is the area of the delta that is more visited by tourists. There are around 40 restaurants, also entertainment facilities, hotels and camping areas. Hotel capacity is about 300 beds, a minimum for existing demand.

12. See reference 7.

maintenance of parks and construction services. Some have lived in the delta all their lives, coming from remoter islands and moving closer to the mainland for labour opportunities and services. Others are immigrants from other countries, or come from other provinces of Argentina.

- A young or middle-aged, middle-income population that moved from Buenos Aires in search of a different kind of life, more linked to nature and marine activities. This population either works on the mainland or provides different kinds of services in the islands (water taxis, boats, trade, restaurants, tourism); there are also those who have trades related to construction and primary activities.
- An older, middle-income population; some have lived there for a long time, and others have moved there more recently. They live on their pensions and/or on the rents from houses on the islands; there are also those who continue to work.

This study focuses the socio-environmental impacts of the above-mentioned hydraulic sanitation works at the mouth of the Reconquista River.

II. METHODOLOGY

DEMOGRAPHIC STATISTICS WERE gathered from the municipality's census of population and housing to identify the vulnerable population with regard to the use and consumption of surface water. Social vulnerability occurs when a population is exposed to or threatened by a phenomenon of human or natural origin, which is liable to cause a disaster.⁽¹³⁾ Vulnerability depends on the specific conditions in each community and, depending on the situation, there are groups who are more or less at risk. The concept was applied in order to identify the characteristics of the groups of people exposed to situations that threaten their individual/social development capacity in broad terms.

Risk could be defined here as the interaction between vulnerability and hazard, where hazard is the probability that a phenomenon liable to cause a disaster will occur, and vulnerability the condition whereby a population is exposed. Thus: Risk = Vulnerability x Hazard.

This expression of risk, as the dynamic coexistence of threatening factors with vulnerability factors, indicates that there is an increase in risk when the vulnerability of a population to a possible hazard increases.

Social vulnerability must be specifically assessed with regard to each hazard. This particular work focused on the vulnerability of the population to the health risk from the consumption of non-drinkable water. In order to evaluate this, a social vulnerability index was prepared, which considered how water was accessed,⁽¹⁴⁾ the forms of wastewater discharge, and the population's socioeconomic status. Households were considered as units of social analysis, and the census areas were considered as units of territorial analysis (using the minimum unit of census information).

To establish hazard gradients, water-quality parameters were determined at a variety of sites from the Reconquista, Tigre and Luján rivers, and from several streams in the island sector (Map 2). These were taken at different tide levels in Río de la Plata. The temperature, pH, conductivity, dissolved oxygen and turbidity of sub-surface water were determined *in situ*. Ordination of sampling sites was performed using principal component analysis based on the correlation matrix. The spatial overlap of the distribution of social vulnerability with the hazard gradient allowed an

13. Wilches-Chaux, G (1998), "Auge, caída y levantada de Felipe Pinillo, mecánico y soldador o yo voy a correr el riesgo", Guía de La Red para la gestión local del riesgo, Perú.

14. The questionnaire of the National Census of Population and Housing records only one source, and does not enquire about uses. Thus, it may be impossible to distinguish whether there are several sources of water, and whether such water is intended for drinking, for cooking or for hygiene purposes.

Table 1:	Levels of perception and participation with regard to water resource conditions
<p>Levels of perception of the condition of the water resource</p> <p>A. High perception</p> <ul style="list-style-type: none"> • Knowledge of the tidal regime and of meteorological phenomena (<i>sudestadas</i>) • Perception of water conditions (colour, smell, taste) and/or knowledge of its chemical aspects • Knowledge of the hydraulic works of UNIREC and of the municipality of Tigre, and of the real-estate undertakings <p>B. Medium perception</p> <ul style="list-style-type: none"> • Mastery of two out of the three aspects in (A), or imprecise knowledge of all three <p>C. Low perception</p> <ul style="list-style-type: none"> • Little or imprecise knowledge of the tidal regime and meteorological phenomena • Perception of changes in the condition of the water resource without significant details • Ignorance of the hydraulic works <p>D. Absence of perception of changes in the water conditions</p> <p>Levels of participation in activities and organizations at community level, related to the problem of the water resource and of the delta</p> <p>A. Participation in organizations related to the island problems</p> <p>B. Sporadic participation in activities related to the island problems</p> <p>C. Recognition of activities and organizations related to the island problems, but without any participation</p> <p>D. Little knowledge, or ignorance, of the island organizations, lack of interest in participating</p>	

identification of the area with the higher relative risk. Then three different social approaches were used:

- Surveys were undertaken in 20 households located on the banks of the most affected rivers in the focal area, including the first eight kilometres of the Carapachay and Caraguatá rivers, and a stretch of the Luján River (Map 2). The surveys were based on semi-structured interviews designed to obtain qualitative and quantitative information, including household characteristics, water use and consumption habits, perception of pollution, and degree of community participation and organization with regard to water use.
- Interviews were undertaken with key informants. Twelve representatives from different sectors of the local community were identified and interviewed, including members of community organizations, public servants, area leaders and people working in the real-estate sector. We tried to gather information on how water pollution (and possible solutions) is perceived by these social stakeholders. From this study, the main areas of social conflict caused by the water engineering works were identified.
- A three-week long ethnographic study was undertaken,⁽¹⁵⁾ with the aim of observing how people live in the focal area exposed to pollution, and of participating in the daily lives of the islands' inhabitants, in order to identify how they have been affected by the water engineering works.

The focal area study concentrated on the preparation of a specific vulnerability index, on identifying those factors that increased or reduced risk, on an analysis of the perceptions of the condition of the water resource, and on use and social conflict relating to the water engineering works. To prepare a vulnerability index, the following factors were taken into account: the kind of dwelling, the educational level of the family head, the household's livelihood base, the presence of children and elderly

15. By ethnography, we understand here a prolonged process of participatory observation that allows a certain level of involvement in the daily lives of a certain group or community, where practices are recorded, and the sense that is assigned to them is interpreted.

people, and the forms of water collection, treatment and consumption.

Households' situation of risk was requalified in accordance with two aspects that are considered to increase or decrease it: the level of perception and the level of community participation (see Table 1). We understand that a higher level of perception tends to encourage domestic strategies of prevention – treating the water, drinking bottled water or rainwater – thus reducing the risk. And participation in community demonstrations, public events and judicial claims encouraged community organization and increased demands, which had an impact on public opinion and on the actions and decisions of the local administration.

III. RESULTS AND DISCUSSION

IN THE PROCESS of analyzing the hazard, information on the kind of water supply for the population at each site was cross-referenced with its corresponding physicochemical assessment. This allowed the hazard gradients to be compared to the level of social vulnerability with regard to the condition of the water resource.

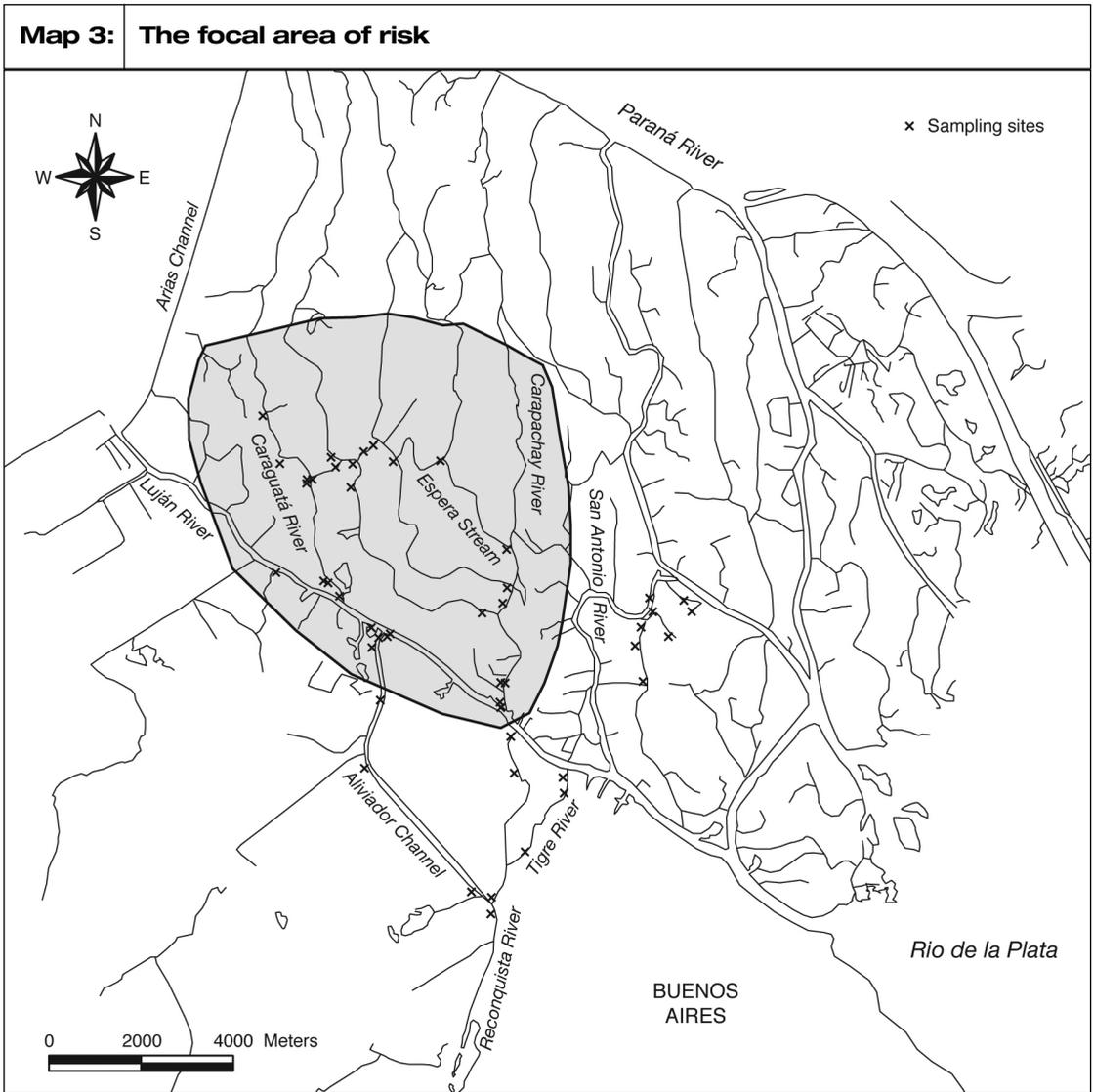
Eighty per cent of the total variability is explained by the two eigen values extracted by a principal component analysis of the water quality data. The first factor is correlated with dissolved oxygen and conductivity, and the second factor with pH. This allowed three well-defined groups of sampling sites to be identified as follows:

- Aliviador channel waters, with low concentrations of dissolved oxygen and high conductivity, and high pH;
- Waters from the middle stretch of the Caraguatá stream and lower stretch of the Carpachay River, with low dissolved oxygen levels and high conductivity, but a lower pH; and
- Luján River and Espera stream waters, with higher concentrations of dissolved oxygen and lower conductivity.

From this, it was possible to identify a water mass in the middle sector of the delta with a water composition similar to that of the Aliviador channel.

From the physicochemical assessment of the waters, three zones with different degrees of hazard were defined:

- The area of high hazard level includes the Reconquista River, the Tigre River and the Aliviador channel. Here, the risk is low because the population is supplied with water through a piped network.
- The area with the lowest hazard level is in the island sector near the Paraná River, in the northern section of the Espera stream. Water samples did not show any effects from the Reconquista River, and the population interviewed in an exploratory survey did not say that they had noticed any changes in water quality.
- The area of intermediate hazard level corresponds to the Carapachay and Caraguatá rivers, up to approximately eight kilometres from their confluence with the Luján River. The water quality analysis showed the presence of water masses, which were the result of waters from the Paraná during periods of ebb tide of the Río de la Plata mixing with waters from the Reconquista–Aliviador system during periods of flood tide of the Plata. As noted in the introduction, the water masses of the Reconquista circulate in this island sector, with a variable level of dilution as a result of contributions from the Luján. The population in this area usually consumes river water, and is therefore exposed to a high



level of water risk.

For mapping purposes, social vulnerability was considered to be low in those populations who consumed water from the public network or from the deep aquifer, and high in those populations who consumed water from the water table or from the river. In order to categorize vulnerability in accordance with the population's socioeconomic level, the educational level of the family head was used as an indicator of socioeconomic level and level of sanitary/environmental education. The categories were: incomplete primary school, primary school only, and above primary school.

Considering the different combinations of situations of social vulnerability and hazard, three areas of risk can be distinguished:

- An area of high hazard but low vulnerability, corresponding to the coastal area of the Reconquista and Tigre rivers and the Aliviador channel (mainland), where the chemical parameters determine a high

degree of pollution of surface water. In this area, risk is low because the population is supplied with water from the network or underground waters.

- An area of high vulnerability and low hazard, located on the banks of the San Antonio River and the mainland banks of the Luján River. Here, risk is low because most of the population is supplied with water from the river and also has the lowest educational level, but the quality of the water is good.
- An area of high vulnerability and intermediate hazard, located on the banks of the Caraguatá and Carapachay rivers and the stretch of the Luján between these two rivers (shaded area in Map 3). In this area, the risk situation ranges from medium to high because most of the population is supplied with water from the river, has an intermediate educational level and is exposed to the presence of very polluted waters from the Reconquista as a result of the local water regime. Here, there is a situation of higher relative risk, and therefore it was selected as a focal area for an in-depth analysis of the risk.

a. Specific analysis of the situation of risk of households in the focal area

Bearing in mind that the hazard level is uniform in all the focal area due to the fact that the local water dynamic, influenced by the tidal regime, causes the circulation of water masses from the Reconquista River in all the area, a uniform value was allocated to it, so that the index of risk was coincident with the index of vulnerability of the focal area.

The results of the application of the index to the households in the focal area showed three levels of risk:

- low risk: those who drank bottled water;
- medium risk: those who did not drink water from the river but did have a high level of interaction with the river as a result of activities they had developed, for example, the provision of services to tourists and the resident population, production in the islands (fruit and vegetable-growing, floriculture, wood, wicker, otter-hunting); and
- high risk: those who drank water from the river.

Finally, the situation of risk of households in the focal area has been recalibrated in accordance with the level of perception of water pollution and the level of community participation in community activities and with organizations linked to the problem of water resources and the delta.

After analyzing the information, it was considered that two-thirds of the households had a high or medium level of risk, and that for 50 per cent of them the risk is increasing due to the low levels of perception and community participation.

b. Qualitative analysis in the focal area

After processing the information from the interviews and field observations made during the survey, a qualitative matrix was developed where the following themes were analyzed:

- perception of the condition of the water resource;
- consumption habits;
- explanations of the changes in the dynamic of the river and the water quality; and
- participation and organization of the community.

Perception of the condition of the water resource. The islanders have several strategies to assess water quality, and these allow them to make decisions about how they will collect the water, and also to anticipate the river flooding. The main criteria are smell, colour and turbidity, and their frequent use makes them popular indicators of the condition of the resource.⁽¹⁶⁾

During the survey, assessments of colour and smell were linked to a serious deterioration in the water resource; for example: "...when the colour is darker, it is very dirty," and "...an indication that the water is poor is that when it rains, small bubbles are formed." Many people mentioned that the changes seemed to occur at specific times of the day; some said in the morning, others at night.

Changes in water turbidity related to an increase in sediments were also mentioned: "...it has been very muddy recently, with much sediment." Other indicators of pollution, as perceived by the islanders, are the presence of dead fish, and a deterioration in the metal in boats and piers. Health problems relating to a deterioration in the river waters include skin problems, diarrhoea and laryngitis. The flora of the islands is also affected.

Consumption habits. In recent years, many households have begun to diversify their water collection and treatment strategies, as they started to notice a deterioration in the river waters, or as a result of health problems. Some collect rainwater, others get it from public taps on the mainland; some drink well water and others have started to buy bottled water. Many of those who buy bottled water to drink use water from the river to cook and for cleaning and hygiene purposes, which they have either treated or boiled.

It is very common for those who still drink water from the river to wait for the ebb tide of the Luján River in order to avoid the polluted tide. At present, some people say that they continue to drink water from the river, although the forms of treatment have increased. They are usually people who belong to the first profile of inhabitants. As a precautionary measure, they filter the water and add chlorine and/or aluminium sulphate. However, they also say that the mud filters don't last as long because of the condition of the water.

Explanations of changes in the dynamic of the river and the water quality. Many of the islanders' explanations for the problems in the delta and for the deterioration in the water resource concern the carelessness of people and their lack of concern about making improvements; in short, it is a "problem of the islander's culture". This can be linked to the fact that the islanders dump waste in the river. There is also agreement on the fact that flooding from the Luján River brings pollution and redistributes the stagnant water in fields and cesspits. It is also believed that the *sudestadas* make the situation worse.

The strategies of mitigation of *sudestadas* are part of the islanders' sub-culture;⁽¹⁷⁾ in fact, for many new inhabitants, their presence in the islands during the great floods is a kind of initiation into this local sub-culture. The population's experience with the *sudestadas* develops their capacity for anticipation, prevention and resistance, which prevents each *sudestada* from becoming a local disaster. The pollution and the modifications in the dynamic of the river as a result of the water engineering works have helped weaken local knowledge and adaptation, in that the people no longer know how the *sudestadas* are going to affect the flow of waters or the flooding patterns.

Many of the people who were interviewed said that the main changes

16. These popular indicators of the condition of the resource are part of a range of practical knowledge that is created in the same context of use. See Baraona, R (1987), "Conocimiento campesino y sujeto social campesino", in Gonzalo Tapia (editor), *La Producción de Conocimiento en el Medio Campesino*, Programa Interdisciplinario de Investigaciones en Educación (PIIE), Santiago de Chile.

17. Quarantelli developed the concept of "disaster sub-culture" to refer to those local communities that were able to develop a capacity for useful mitigation of disaster before, during and after an emergency. Hannigan and Kueneman understood that such a sub-culture only developed through the impact of a specific and repeated geophysical event, allowing a certain predictability and control, as in the *sudestadas* and floods in this particular case. This sub-culture was composed of rules, values, beliefs and technological knowledge, and comprised a significant part of community life. See Quarantelli, E (editor) (1978), *Disasters, Theory and Research*, Sage, California; also Hannigan, J A and R M Kueneman (1978), "Anticipating flood emergencies: a case study of Canadian disaster sub-culture", in Quarantelli, see above.

that had taken place since 2000 were as a result of the water engineering works, which are linked to real-estate developments on the mainland, which have an interest in the clean waters of the Tigre River. The people who live at the mouth of the Caragatá River in the Luján point to the formation of a new lake on the island, which is the result of land-dredging to fill in floodable areas in mainland Tigre, for a new urban development. As one resident pointed out, "...land is more expensive there than here." The impacts were multiple: the island's land and soil were ruined; there was deforestation; the amount of fauna decreased, especially the birds; the water became turbid; and some of the houses in the vicinity of the new lake collapsed as a result of a deterioration in their foundations.

Participation and community organization. As a result of local geography, there is a strong perception that: "...the islander lives in isolation", "...the neighbours have neither the time nor the money to become organized", "...the islanders have no one to represent them; there are different groups of people but they are not joined together." This is made even worse because communication networks are weak or non-existent, as are spaces for social interaction. The most common method of communication is through the store boat, and the most common space for interaction is the schools. Other than in the construction of bridges and piers, local government is practically non-existent in the islands. Many people say that this is because the municipality provides no services, nor does it collect maintenance fees for lighting and cleaning;⁽¹⁸⁾ others point out that the number of voters from the islands is insignificant compared to the mainland. In some cases, the lack of a municipal presence in the islands is evident from the fact that there are people from the first section of islands who do not know in which municipality they reside.

As to the organization of islanders, the march carried out to demonstrate against the obstruction of the Reconquista was mentioned as the main public protest. Although many of those interviewed said that they had not been able to participate, the overall assessment of the demonstration was favourable. However, some people stated that the mobilization was not really worthwhile because they would not be able to face up to the decisions of the local government.

c. Social conflict scenarios

In the last few decades, various environmental organizations that arose in response to different socio-spatial and environmental problems in the municipality of Tigre have consolidated.⁽¹⁹⁾ Starting with the diversion of the Reconquista River, these organizations, together with neighbours concerned about the deterioration of the water resource, have promoted public demonstrations, organized fora, participated in public events organized by government institutions, and filed claims. Each of these has become a complex scenario⁽²⁰⁾ of social confrontation and conflict, where different strategies have been put forward to give legitimacy to people's demands on one side and to justify the water engineering works on the other. Three social confrontation scenarios are presented below: the nautical march, public events, and denunciations before the justice and government bodies.

The "nautical march" and the counter-march: the neutralization of the conflict. Acknowledging that they were victims of pollution, the islanders of the first section of the Tigre delta area carried out a nautical march to demonstrate against the construction of the embankment that

18. Waste in the islands is collected by private individuals, who collect fees directly for the service provided.

19. For example, problems of risk of flooding, river and underground aquifer pollution, the inter-island road, etc.

20. Velásquez et al. understand by "scenario" a social space of encounter between individuals or groups and social and/or political forces that allows the confrontation of opinions, aspirations, initiatives and proposals, representing a different range of specific identities and interests held by such agents. In these scenarios, relationships of power are developed, in which the different stakeholders participate with their different resources and, as a result, unequal possibilities of influencing decisions develop, by virtue of the position they hold in the network of social and/or political relationships that serve as a context for such scenarios. See Velásquez, F, M Muñoz and E Gonzalez (1994), "Gestión local de servicios públicos en Colombia: agua potable, alcantarillado y basura. Los casos de Armenia y Santander de Quilichao", in Rodríguez A and F Velásquez, *Municipio y Servicios Públicos, Gobiernos Locales en Ciudades Intermedias de América Latina*, Ediciones Sur, Santiago de Chile, page 271.

caused the diversion of waters. Around 100 boats, canoes and other craft departed from the mouth of the Reconquista in the Luján and sailed across several kilometres of the affected area. A counter-march was organized with neighbours from different areas of mainland Tigre, by those who defended the works as being beneficial for flood control.

There is evidence that this counter-march was organized by area leaders linked to the local government. Nevertheless, those who participated in the counter-march claimed a legitimate right to be protected from floods. In fact, associations of neighbours participated in the counter-march. Thus, the nautical march and the counter-march became the scene for playing out need against need, of flooded people against polluted people. The counter-march diluted the conflict and nothing changed – so the water engineering works ended up determining that certain areas would not get flooded and other areas would get polluted.

Public events: ignoring the knowledge of affected people. The body responsible for the water engineering works in the Reconquista organized at least three meetings. There was no consultation, and even less opportunity for inhabitants to take part in any decision-making.⁽²¹⁾ In all these events, government staff and professionals minimized the danger, and ignored the inhabitants' knowledge concerning water deterioration and the tidal regime. Therefore, dialogue became impossible and these instances of participation failed.

Denunciations before the judicial and public bodies. The denunciations linked to this conflict are numerous. Between August 2000 and March 2001, more than 20 denunciations were made by different local stakeholders and institutions, most of them before the nation's ombudsman and, less frequently, before the Ministry of Environmental Policy, the Children and Family Council, UNICEF and other institutions. These denunciations focused on the illegality of the diversion of the river, the removal of the toxic mud, the violation of the rights of children, the alteration of the zoning code, the poisoning of the Tigre delta, etc. They also claimed a violation of the national and provincial constitutions, as well as of numerous national and provincial laws and decrees.⁽²²⁾

IV. CONCLUSIONS

IN THIS SYSTEM of a complex water dynamic, which is strongly influenced by the tidal regime of the Río de la Plata, the diversion of most of the flow of the Reconquista River through the Aliviador channel, sending its waters into the Luján River five kilometres upstream from its natural mouth, results in the intrusion of water masses from the Reconquista River into the delta's island sector through the Caraguatá and Carapachay rivers. The result is that water masses from the Reconquista, with high levels of pollutants, circulate in this sector of islands, with variable levels of dilution due to contributions from the Luján River.

The people from the area usually consume water from the river, and therefore have been exposed to a situation of high vulnerability and water risk. Since the diversion of the Reconquista River to the Aliviador channel, people have started to notice a deterioration in water quality and, in some cases, have suffered from health problems. Some households have started to change the way in which they obtain and treat water for consumption, which implies an increase in the cost and/or the time devoted to collection and treatment. Colour, smell and turbidity are important popular indi-

21. Several authors distinguish between three kinds of participation, namely informative, consultative and decisional. Planning where the social stakeholders involved have some capacity and power of decision is seen as a goal of participative planning. Undoubtedly, in the whole process of social agreement, the different social stakeholders have different resources and capacities. However, the dynamic of these processes may reduce partly the inequalities between the stakeholders involved, thus constructing areas of equality in unequal and heterogeneous contexts. See Robirosa, M, G M Cardarelli and A Lapalma (1990), "Turbulencia y planificación", UNICEF, Siglo XXI, Buenos Aires, 141 pages; also Cardarelli, G M and M R Rosenfeld (1991), "La planificación al borde un ataque de nervios", in UNICEF Document 9, Buenos Aires.

22. The breach of the following legal provisions is claimed: National Constitution, articles 16, 41, 43 and 75; Provincial Constitution, article 28; National Law 24051 about hazardous waste; National Law 24375 about biological diversity; National Decree 691 about protection of wild fauna; National Decree 666 about preservation of wild fauna; National Law 21836 concerning the protection of the world cultural and natural heritage; Provincial Law 11723 about environmental protection; Provincial Law 11820, article 4, paragraph (e); Provincial Law 12257 about water management of the province; Provincial Law 5965 about the protection of the sources of supply and of the water courses and bodies receiving water and the atmosphere; Provincial Law 5961 about public hearings; Resolution 238/97 about implementation of the provisions of Law 11459; and Resolution 136/99 about certificate of environmental capability.

cators of the condition of the water resource that warn the population and encourage a diversification of strategies for the collection and treatment of water for domestic consumption, including the purchase of bottled water, water collection from a public tap on the mainland, rainwater collection, and collection from wells and rivers according to the ebb and flood tide regime, as well as filtering and chemical treatment.

The determination of areas of higher risk, based on the integration of social and bio-physicochemical variables, social hazard and vulnerability, was enriched by the qualitative analysis that enabled an assessment of the risk as perceived by the people. Thus, factors that reduced the situation of risk were identified, such as the perception of the condition of the resource and, indirectly, the participation of the community in the social demands. As to this last factor, the participation of the community in the area of study (through marches, public events and denunciations before the judiciary) has a strong impact on public opinion and, to a certain extent, on the actions of the local government.

The water engineering works at the mouth of the Reconquista River are evidence of how environmental costs and benefits are distributed at a social level. There have been attempts to legitimize the situation, by fragmenting civil society and creating antagonism between the "benefited" and the "affected" (flooded versus polluted) people on the one hand, and by discounting the knowledge of islanders concerning the dynamic of the river and water quality. If this water management logic is to continue, the major real-estate and recreational investments will develop Tigre as a modern centre, promoting tourism at the expense of a socio-environmentally deteriorated delta, which is a backdrop to the major recreational and real-estate undertakings.

This study shows that if water resource management is not approached integrally and at an eco-systemic level, socio-environmental costs and benefits will be unevenly distributed. Actions adopted in the municipality of Tigre to control floods, consisting of the diversion of a great part of the flow of the Reconquista River to the Aliviador channel, have caused the intrusion of polluted water masses into the island sector, which results in high social vulnerability. The problem is created because these actions are not accompanied by pollution control works in the medium and high basins of the Reconquista.

An integrated management of water resources should incorporate, along with sanitation and flood control works, institutional agreements for the administration and control of the different uses of the resource. An appropriate strategy, which allows for a rational management of the resource for all social stakeholders, should be developed by an inter-jurisdictional and intersectoral institution (such as, for example, a basin committee) that guarantees socio-environmental equity in the management of the resource.

