

The river basins of Pirapó, Paranapanema 3 and Paranapanema 4: socioeconomic and environmental aspects

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(With 1 figure)

Abstract

Scarcity of water in the world, virtually, has two sources: the quality and the quantity made available for populations. In the area covered by this study, the selected municipalities from the river basins 3 e 4 of the Paranapanema River and from the basin of the Pirapó River, availability is always greater than the demand and the environmental problems are more often linked to the quality than to the quantity of water. To check the socioeconomic aspects and the daily practices involving water resources and environmental problems we selected a representative sample of families from 10 studied municipalities. The main conclusions point to the existence of key municipalities, regarded as foci of pollution, i. e., the municipalities do not contribute in equal measure to the pollution of rivers from their regions and some stand out in economic activities and inherited cultural practices. However, respondents did not always relate the environmental impacts with their routine and productive activities. Thus, although the new legal environment imposes new practices, there are still cultural heritages, which require more incisive and continuous public interventions.

Keywords: river basins, Paranapanema 3, Paranapanema 4, Pirapó, environment.

As bacias hidrográficas do Pirapó, Paranapanema 3 e Paranapanema 4: aspectos socioeconômicos e ambientais

Resumo

A escassez das águas, no mundo inteiro, praticamente, tem duas fontes: a qualidade e a quantidade disponibilizada para as populações. Na área de abrangência do presente estudo, nos municípios selecionados das bacias hidrográficas do Paranapanema 3 e 4 e o Pirapó, a disponibilidade é sempre maior que a demanda e os problemas ambientais estão ligados mais à qualidade do que a quantidade de águas. Para verificação dos aspectos socioeconômicos e das práticas cotidianas que envolvem os recursos hídricos e os problemas ambientais selecionou-se uma amostra significativa de famílias dos 10 municípios estudados. Como algumas conclusões tem-se que existem municípios-chaves focos de poluição, ou seja, os municípios não contribuem de maneira igual para a poluição dos rios de suas regiões e alguns se destacam nas atividades econômicas e incorretas práticas culturais herdadas. Contudo, os impactos ambientais nem sempre são relacionados, pelos entrevistados, com as suas atividades rotineiras e produtivas. Com isso, por um lado, verifica-se que o novo ambiente legal impõe novas práticas, contudo, por outro lado, ainda persistem as heranças culturais herdadas que, o que exige intervenções públicas mais contundentes e contínuas.

Palavras-chave: bacias hidrográficas, Paranapanema 3, Paranapanema 4, Pirapó, meio ambiente.

1. Introduction

For some time in Brazil and in the world, water, virtually, has two sources of scarcity: the pollution that changes the water quality and restrictions on the amount available due to growing demand, changes in the hydrological cycle and inefficient use. In general, it is understood that the scarcity of water due to pollution is a more frequent problem in the South and Southeast regions of Brazil,

which concentrates the major industrial and agricultural uses, higher population contingent and treatments whose efficiency is uneven.

Therefore, this article is based on the fact that existing practices in the study area have an impact on changes in the quality of water supplied to the different municipalities. The environment that contextualizes this article is characterized

by changes and transformations, because on the one hand, there is the cultural heritage of interaction between people and their activities and the physical environment, which is difficult to be modified and, on the other hand, due of inheritance, the differentiated values that the physical environment has for different populations and needs to be modified, because the legal environment imposes new dynamics both in urban as in rural sector.

In this context, this study aims to present socioeconomic aspects of the municipalities from the Basins 3 and 4 of Paranapanema River and the Basin of Pirapó River, which suffered severe process of forest clearing due to the introduction of raw materials and heavy farming implements typical of the green revolution, and the presence of large cattle in highly sensitive environments like Caiuá Sandstone, which are in a legal environment that has a series of rules imposing new relationships with nature.

To verify the practical and assuming that the socioeconomic development of each watershed is different, we conducted a field research with a statistically representative sample, to identify both the socioeconomic features of the population in urban and rural households as the understanding of the respondents about the environmental problems surrounding them.

This study is organized into five sections. The first relates to this presentation and the second is related to the context of analysis. The next section presents the methodology and the fourth section shows some results of the field research. Finally, we present some conclusions.

2. The Background of the Analysis

Until the mid 1980s, the management of water resources was fragmented, sectoral and focused on corrective actions. Agricultural and urban practices were not very concerned about environmental impacts and deterioration of rivers. However, changes in the legal environment, with the National Policy for the Environment (BRASIL, 1981), the Constitution of 1988 (BRASIL, 1988) and the National Water Resources Policy (BRASIL, 1997), have imposed new relationships with the physical environment.

As one of the policies that guide the minimization of impacts on water resources, the Law 9433 of January 8, 1997 (BRASIL, 1997) known as the Water Law either the National Water Resources Policy, which aims to (i) ensure to the current and future generations the availability of water, according to quality standards suitable; (ii) the rational and integrated use of water resources, including waterborne and waterway transportation, with a view to sustainable development; and (iii) the prevention and defense against critical hydrological events occurring naturally or resulting from inappropriate use of natural resources. With this Act, the river basin became the management unit, which became more integrated and centrally focused that water is a limited natural resource (art. 1, II), has multiple uses such as public water supply, industrial, agricultural irrigation, electric power generation, recreation and preservation of aquatic life (Art. 1, IV). Furthermore, private waters were

converted into the public domain (Art. 1, I), i.e., may be used only by granting the right to use.

In the same Act, the river basins become the focus of policies outlined by the River Basin Committees (BRASIL, 2000). In the state of Paraná, the State Law 12,726 of November 26, 1999 (PARANÁ, 1999) follows the same principles of the Federal Law.

In spite of these undeniable normative progresses, in most Brazilian states, the directions of water policies are under the jurisdiction of various state departments which means in practice that the integrated coordination is still incipient or non-existent and / or conflictual. Furthermore, there is a cultural heritage that extends over time on cultivation and cattle-raising techniques and use of raw materials, which are difficult to be broken. As a result, problems and environmental impacts extend and intensify, with degradation and intensive use of land and water, even due to the high degree of dependence of the ways of producing, which changes the access to water resources in quantity and quality as well as the hydrologic cycle in space and time.

One of the aspects to be taken into consideration, as the focus of this article is that environmental degradation is caused by inadequate uses and practices that drive both greater exploitation of water resources as well as their pollution which in turn generate greater social and environmental imbalances.

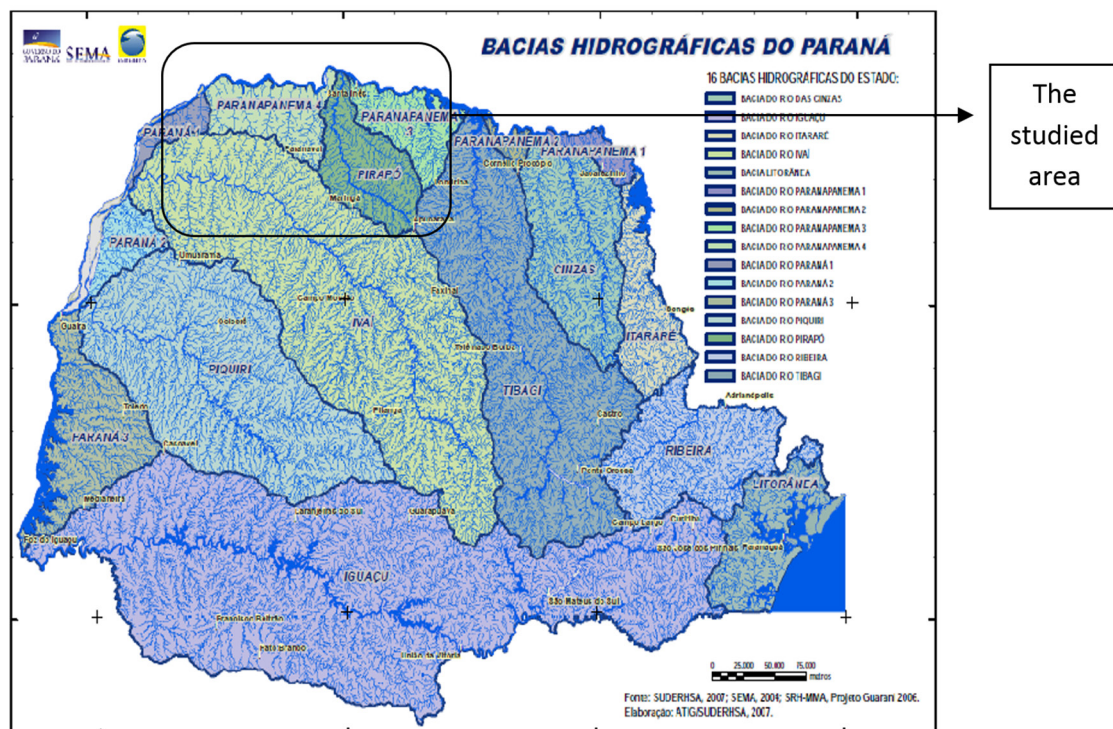
Specifically, in the study area, the agricultural modernization in the 1970s and 1980s, which aimed to intensive and extensive grain production for export and the formation of large agro-industrial complexes, the result was the rapid removal of forests, siltation of rivers and the deterioration of water sources particularly those that supply the urban areas as well as the emergence of gully erosion that destroyed regions and required substantial public investment. In the urban sector, inadequate or non-existent treatment of industrial and domestic effluents contributes to the decrease in the quality of water resources.

In this context, the study focuses on Basins 3 and 4 of Paranapanema River and on the Pirapó River, their urban and rural characterization and the identification of environmental problems perceived by the studied families, presented in the following section.

2.1. Features of the studied river basins

Located in the north of the state of Paraná, the Basin of Pirapó River and the Basins 3 and 4 of Paranapanema River (from a total of 16 basins in the state of Paraná, according to Resolution 024/2006, from SEMA / PR), covers an area of 11,691.27 km² (from a total of 196,490.01 km²) and encompass 56 municipalities (out of a total of 399 municipalities in the state, as shown in Map 1) (PARANÁ, 2006).

The River Basin Paranapanema 3 reaches a total of 15 municipalities in an area of 5,400.16 km², which are equivalent to 27% of the studied area. It is formed by the drainage area of 12 tributaries that flow into the Paranapanema River between the mouth of the Tibagi



Map 1. The River Basins of the state of Paraná and the studied area. Source: Paraná (2007).

River, near the lake of the Hydropower Plant Capivara and the mouth of the Pirapó River (PARANÁ, 2010, p. 92).

The River Basin Paranapanema 4 reaches a total of 15 municipalities in an area of 6,290.77 km² or 31% from the studied area) is located to the west of the river Pirapó, with 15 tributaries of Paranapanema River until the mouth of the Ribeirão do Tigre (PARANÁ, 2010, p. 98).

Most of these basins (3 and 4) are located in Sandstone Caiuá that as Paraná (PARANÁ, 2012a), about 80% is for public supply, from region covered by the Caiuá aquifer, which is done through groundwater (See the Map 1).

The Pirapó River Basin (26 municipalities and area of 8,502.30 km² or 42% of total), has Pirapó river as the major component. The source of the river is in the municipality of Apucarana, about 1,000 meters above sea level, flows northward and covers an extension of 168 km to its mouth at Paranapanema river, approximately 300 meters above sea level in the municipality of Jardim Olinda. Approximately 60 direct tributaries comprise the basin. The Bandeirantes do Norte River is its largest tributary, has its source in the municipality of Araongas and has an extension of 106 km (PARANÁ, 2010, p. 86). This river basin is located in the Serra Geral System (PARANÁ, 2012a).

The water catchment in these river basins is mainly used for human consumption in the case of Pirapó; for industrial use in Paranapanema e and Pirapó and, finally, for irrigation in Paranapanema 3 (PARANÁ, 2012a). Moreover, the coverage of the treatment of sewage is low.

According Godoy and Sousa (2012), the total population of the three basins is 1,362,109 inhabitants. From these,

87,134 (6%) live in the rural sector and 1,274,975 (94%) in the urban sector. The Pirapó river basin concentrates most of the population with 956,806 inhabitants (70.2% of the total population of the three basins), and 909,776 (95% from the Pirapó river basin) are in the urban sector while 47,030 (5% of the basin) are in rural sector.

Urban households are 447,756, of which 320,328 (71.5% of the total) are in the Pirapó, 62,534 (14.0%) are in the Paranapanema 3 and 64,894 (14.5%) are located in Paranapanema 4.

The existing farm units in the three river basins amount to 28,147 in a total area of 1,659,796 hectares. From these, 15,176 farm units (53.9% of the total, with an area of 722,545 ha) are located in the Pirapó basin; 7,256 units (25.8% with an area of 556,915 ha) are in the Paranapanema 4 and in the Paranapanema 3 basin there are 5,715 properties (20.3%, corresponding to 380 336 ha). Regarding the individual size of the farms, 7,745 are micro farms and 14,991 are small, i.e., those categories are 22,736 farm units (80.8% of total). There are 2,800 properties (10.2% of total) classified as large, highly concentrated in the Pirapó river basin.

The River Basin Paranapanema 3 is characterized by having a high rate of deforestation since the 1980s. Currently remains about 5% of remaining coverage, of which 4% is protected by the Conservation Units of Integral Protection. Temporary crops are featured at 2,750 properties, which occupy an area of 229,229 ha and permanent crops are in 792 properties and occupy an area of 61,075 ha (Godoy and Sousa, 2012). The region has a predominant use of

intensive agriculture in 90% of the territory. Based on the occupied area, the main activity is the cultivation of cane sugar (higher production), which stand out municipalities of Porecatu (area of 9,455 ha, which produced 772 823 tons), followed by Santo Inácio (9,750 ha and 729,970 tons produced) and Centenário do Sul (8,533 ha and 707,300 tons). Soybeans is the second largest activity according to the occupied area, especially in the municipalities of Cambé (32,000 ha and 102,400 tons), followed by Primeiro de Maio (21,887 ha and 68,287 tons) and Alvorada do Sul (19,650 ha and 61,308 tons). The Paranapanema 3 river basin has 4,731 farm units and 340,961 ha are managed by the owners. Lessees cultivate an area of 24.312ha and settlers are responsible for 9.380ha of farms.

The River Basin Paranapanema 4 is occupied almost entirely with artificial pastures and grasslands occurring small areas of intensive agriculture and forest coverage. The number of owners is 6.030 whose area corresponds to 479,519 ha. In this basin highlights the area of settled from the Agrarian Reform program of the federal government, amounting to 46.724ha (the largest of the three river basins). Lessees handle with 18,521 ha (the smallest of the three river basins). It has 1,448 properties with temporary crops and area of 140.655 ha. Paranaíba is the municipality that stands in the temporary crops, because it has 443 farms (30.6% of the total basin), with temporary crops in 32,360 ha (23.0% of the basin).

The second city that stands out is Alto Paraná with 164 properties (11.3% of the total basin) with temporary crops and area of 11,071 ha. (7.8% of the basin). Permanent crops are present in 869 properties and 89,915 ha. In this basin stands out again Paranaíba which has 157 properties (18.1% of the basin with 23,868 ha (26.5% of the basin). Also noteworthy Diamante do Norte with 128 properties and 2,823 ha of permanent crops. The most significant products in planted area are firstly the Sugarcane, which highlights Cruzeiro do Sul (8,189 ha and 622,541 tons), followed by Guairaçá (9,057 ha and 618,617 tons) and Inajá (5,419 ha and 411,766 tons). Cassava has the second highest planted area, highlighting Alto Paraná (3,000 ha and 78,518 tons) and Terra Rica (2,820 ha and 73,320 tons produced) and Santo Inácio do Caiuá (1,431 ha and 33,810 tons).

The River Basin Pirapó gathers 15,176 properties, of which 12,693 properties (83.6%) and 645,265 ha (89.3%) are managed by the owners. In this basin is the largest area with lessees with 59,928 ha or 8.3% of the total basin area. There are also 5,574 properties (533,460 ha or 73.8%) with 3,714 properties and temporary crops (177,953 ha or 24.6%) with permanent crops. In this basin, the municipality of Marialva has 718 properties with temporary crops and 28,197 ha and 701 farms with permanent crops and 6,131 ha. Another municipality that stands out is Apucarana with 664 properties with temporary crops (22,726 ha) and 596 properties with permanent crops (12,276 ha). Another important municipality is Rolândia, which has 548 properties and 27,621 ha with temporary crops and Mandaguaiçu with temporary crops in 329 properties totaling 5,327 ha. Among the most

significant products in area and production, soybean is first (higher production) in the municipality of Araçongas, which has an area of 19,200 ha with this culture and produced 53,760 tons, followed by Apucarana (18,500 ha and produced 53,650 tons) and Astorga (17,100 ha and 51,300 tons). The Cane Sugar is the second and has the largest acreage in Colorado (15,056 ha, with 1,175,680 tons produced), followed by Jaguapitã (8,404 ha and 678,623 tons) and Lobato (6,820 ha and 557,262 tons) gathered.

GDP - Gross Domestic Product - which is the sum of the values generated within each municipality - total of the three River Basins is R\$ 18,173,979 thousand, of which 75.6% originate from the Pirapó Basin (R\$ 13,740,772 thousand), Paranapanema 3 participates with 12.9% (R\$ 2,349,075 thousand) and Paranapanema 4 with 11.5% (R\$ 2,084,132 thousand). The tertiary sector (commerce and services) in all basins stands out over 62%. Draws attention that the agricultural GDP of Pirapó basin is 4.7% (IPARDES, 2012).

The basins concentrate industries that generated 6,409 on the average R\$ 321,690 in 2010, which are highly concentrated in the Pirapó basin (5,140 establishments or 80.2% of total). Consequently, the Pirapó River Basin stands out on economic aspects of the basins by having the main city in the region, Maringá, which focuses sharply the population, employment and wealth generated in the region. A summary of the socioeconomic and environmental conditions is presented in Frame 1.

In general, the socioeconomic data released by the competent agencies indicate the characteristics of the basins and the concentration of activities and population. However, due to its lag in time, it is necessary to deepen the analysis of existing practices and their understanding of the environmental problems related to water resources in the cities studied. For this, we carried out a field research, whose methodology is presented below.

3. Methodology

The methodology includes three stages: (a) the classification of municipalities in the respective river basins analyzed; (b) the elaboration of a database for analysis of the general characteristics and the calculating of samples; (c) sampling and application of a questionnaire.

3.1. The classification of municipalities in the appropriate river basin

To perform the classification of municipalities in the River Basins, we use the data provided by the State Department of Environment (SEMA) and the Environmental Institute of Paraná – IAP/PR (PARANÁ, 2010), which allowed us to evaluate the amount and size of the municipalities located in more than one basin, because a municipality may be in two basins (such as the municipality of Colorado that has 88% of its land in Pirapó Basin and 12% in the Paranapanema 3). After discussion in the research group, we adopted the criterion that a municipality would be framed in the basin that contained more than 50% of their land. For the example shown, Colorado was within

Frame 1. Summary of socio-economic and environmental conditions of the river basins Paranapanema 3, Paranapanema 4 and Pirapó.

River Basin	Paranapanema 3	Paranapanema 4	Pirapó
Legal area	378,377.85 ha	426,310.60 ha	511,106.55 ha
vegetation coverage	14,745.27 ha or 3.9%	22,001.65 ha or 5.16%	15,774.84 ha or 3.09%
Population	High degree of urbanization	Degree of urbanization: 80%	Higher degree of urbanization: 91%
environmental condition	High rate of environmental degradation - Intense deforestation	High rate of environmental degradation - Intense deforestation	High rate of environmental degradation - Intense deforestation
Use and occupation of the land	90% of the territory is occupied by intensive agriculture - Low levels of DBO • - Contains one Hydroelectric Power Plant	- 47% of the territory have inappropriate land use • - Formation of soil: Sandstone Caiuá • • High vulnerability - In the 1950s, the field of coffee farming	- 10% of the territory is used inappropriately • - Between the 1930s and 1940s, it was occupied by coffee farming
Water resources	- Negative rate of population growth - population loss • Significant poverty-rate	- The higher use of groundwater - Concentration of remaining DBO is small	The use of surface water is high
social indicators	- Few employment and income opportunities - Proximity to major centers complements many lacks of services and labor.	Negative Population growth rates -0.40% per year - population loss - High rates of poverty	- The two largest municipalities contribute to more stable population growth rates - It has one of the lowest poverty rates between river basins. - Two more dynamic and structured Municipalities (Maringá and Sarandi) complement, in part, the needs of jobs.
economic development	- The use of pesticides stands above the 15.0 kg / ha / year - 50% of the municipalities have no formal structure for environmental management actions	- Limitation in generating jobs and income Low-contribution in the formation of state GDP - Since 1960 the agricultural sector replaces the coffee farming - Recently, sugar cane and cassava stand out Small-production contributes to the diversification of the region	- Activities of livestock, soybeans, sugar cane, corn and wheat have expanded and consolidated the modern agro: Sugar mills, meat and dairy processors Sundry cultures expand strengthening productive chains Urban Centres concentrate processing plants - Sectors of clothing are rapidly expanding - Formal employment have significant weight in the regional industry
environmental management	Low-rate of effluent generation - 80% of wastewater are treated	- Use of pesticides is below 10.0 kg / ha / year - There are no actions to minimize anthropogenic actions only in one municipality, of the ten, there is no municipal secretary focused on the environment	- Amount of pesticides is on the average of the state - from 10.0 to 11.8 kg / ha / year - None of the 22 municipalities of the basin has exclusive secretary to the environment issues.
Infrastructure and services	- 54% of effluents are treated - Even incipient services like garbage collection, waste treatment and drainage, are actions expanding	- 80% of effluents are treated - drainage systems are being expanded as well, garbage collection and waste treatment	- 80% of effluents are treated - drainage systems are being expanded as well, garbage collection and waste treatment

Source: Paraná (2012b, p. 47, 48 and 50).

the Pirapó the Basin. The situation of belonging to more than one basin occurred in the following municipalities: Colorado; Cruzeiro do Sul, Guairaçá, Itaguajé, Jaguapitã, Jardim Olinda, Marialva, Nossa Senhora das Graças, Nova Esperança, Paranacity, Paranaipoema, Rolândia, Santa Ines (located in the three river basins) and Uniflor.

As a final result, the amount and municipalities by Basin are:

- a) River Basin Parapanema 3 (total of 15 municipalities): Alvorada do Sul, Bela Vista do Paraíso, Cafeara, Cambé, Centenário do Sul, Florestópolis, Guaraci, Lupionópolis, Miraselva, Nossa Senhora das Graças, Porecatu, Prado Ferreira, Primeiro de Maio, Santa Inês and Santo Inácio. The total area is 3,776 km²;
- b) River Basin Parapanema 4 (15 municipalities): Alto Paraná, Cruzeiro do Sul, Diamante do Norte, Guairaçá, Inajá, Itaúna do Sul, Jardim Olinda, Loanda, Nova Esperança, Nova Londrina, Paranaipoema, Paranaivaí, Santo Antonio do Caiuá, São João do Caiuá, Terra Rica. The total area in this basin is 4,183 Km²;
- c) River Basin Pirapó (26 municipalities): Ângulo, Apucarana, Arapongass, Astorga, Atalaia, Cambira, Colorado, Florida, Iguaraçu, Itaguajé, Jaguapitã, Jandaia do Sul, Lobato, Mandaguaçu, Mandaguari, Marialva, Maringá, Munhoz de Melo, Paranacity, Pitangueiras, Presidente Castelo Branco, Rolândia, Sabáudia, Santa Fé, Sarandi, Uniflor. The total area in this basin is 5,067 Km².
- d) Elaboration of a database and the calculating of samples

The development of a database of socio-economic and environmental data (urban and rural) was based on data provided by the Brazilian Institute of Geography and Statistics (IBGE, 2012) and the Statistical Notes of the Paraná Institute of Economic and Social Development (IPARDES, 2012).

As it was intended to conduct a field research and attempt to bringing the economic issues to an understandable level to all members of the group, we have done several meetings in order to address the various fields of study (as a multidisciplinary project). The first trial was conducted with the staff from Geography, in which it was decided to choose the cities for field research based on the way of dependence of water resources.

For that, we collected data from the National Water Agency (ANA, 2012), about the catchment points of raw water for the water supply to the urban sector. With this, the municipalities were characterized by the source of supply (underground, surface or mixed), the system (integrated or isolated) and which sub-basin are supplied. These data were compared with the population, the industrial GDP, agricultural GDP, GDP per capita, per capita income. We carried out several tests and not come to any conclusion. Then we tried to differentiate by use of surface water or groundwater resources, which also failed to differentiate. We conclude that there is a set of factors (economic activities, total population, GDP and GDP per capita) that reinforce or were reinforced by soil type and therefore interfere with the demand of water resources. What can be said is that the greater the activity and the largest concentrated population, the greater the demand. Table 1 presents some data by basin.

It was found that in all municipalities of the studied Basins, the supply of water resources exceeds existing demand. The problem encountered is regarded to the access, because in some municipalities investments in infrastructure to expand the supply of services is needed. Whereas both the form of use of water resources as the availability did not differentiate municipalities basins, further meetings occurred at the research group.

3.2. Sampling and application of a questionnaire

In the third phase, a range of factors led to the choice of municipalities. It was decided to select three municipalities in each basin, while in the Pirapó Basin, four municipalities were selected because, necessarily, by the historical studies conducted by the group, Maringa should be included.

Table 1. Availability and demand for water - River Basins of Pirapó, Parapanema 3 and Parapanema 4.

Variables	Parapanema 3	Parapanema 4	Pirapó
Number Municipalities	15	15	26
Área calculada da bacia (Km ²)	3,318.93	3,787.18	4,585.16
Surface water availability (2004)	16,580 l/s	19,859 l/s	30,047 l/s
Underground water availability	4,000 l/s (Guarani aquifer, Serra Geral e Caiuá)	3,000 l/s (Guarani aquifer, e Caiuá)	6,000 l/s (Guarani aquifer, Serra Geral e Caiuá)
Total Demand	1,237.5	550.3	2,627.8
Municipalities in need of expansion	Bela vista do Paraíso e Cambé	Alto Paraná e Loanda,	Arapongass, Colorado, Jandaia do Sul, Mandaguari e Rolândia

Source: Paraná (2012b, p. 47, 48 and 50).

In addition, as a determinant, it was decided in a meeting of the group of researchers that the link the various studies would be the points of hydrological data collection done by the Group of Chemical Engineering and Geography.

According to information exchanged among researchers in Paranapanema 3 there are three collection points. Regarding drainage density, municipalities that interfere with point 1 are Rolândia and Cambé. Point 2 is also influenced by these municipalities, and Prado Ferreira and Bela Vista do Paraíso. The collection point 3 is directly influenced by Miraselva and Guaraci. Then there was the choice of Miraselva, Bela Vista do Paraíso and Cambé.

In the river basin Paranapanema 4, municipalities that interfere with each collection point is at point 1: Nova Esperança, Alto Paraná and Cruzeiro do Sul; at point 2: Uniflor, Paranacity and Santo Antônio do Caiuá, in addition to the previous (P1) and in the point 3 include Paranavaí, Guairaçá and Terra Rica. Thus, Paranavaí and Terra Rica interfere in the same collection point (P3); whereas Paranavaí has higher drainage density. Was chosen, therefore, Alto Paraná, Paranavaí and Terra Rica.

For the Pirapó river basin, depending on the monitored points picked up Paranacity, Arapongas, Maringá (the municipality that most contributed to the decline in water quality of the River Pirapó) and considering that the River Bandeirantes do Norte is the main tributary of Pirapó interfering in some sites, we chose Colorado.

From the choice of the 10 municipalities the sample based on the number of households was calculated using the Formula 1:

$$n = \frac{N.Z^2.p.(1-p)}{Z^2.p.(1-p) + e^2.(N-1)} \quad (1)$$

where:

n - Calculated sample;

N - Households in the municipality (urban and rural);

Z - Confidence level = 95% = 1.96;

p - Probability of the event = 50%;

e - Sample error = 5%.

As a result, we constructed Table 2.

In parallel, we prepared a questionnaire that was applied in December 2012, with 50 families of elementary school students in Elementary School Marechal Floriano Peixoto, in the district named Floriano belonging to the city of Maringá. Considering the results obtained, it suffered a series of adjustments that were made in the research team meetings.

Between July and October 2013, the questionnaire was applied in 10 municipalities. We conducted 639 interviews in the urban area covering 1,735 people and 78 in a rural area that comprised 215 people, amounting to 717 questionnaires and 1,813 respondents.

The data collected were systematized into a database in an Excel spreadsheet. The results are shown below.

4. Results and Discussion

This section was divided into two parts: a) demographic and social aspects of the interviewed families of elected municipalities in each river basin and b) rural and environmental aspects. We point out that it was not always possible to separate these contents, as, for example, in rural areas they were closely related.

Table 2. Number of urban and rural domicile selected by municipality.

Municipality.	N° domicile urban	N° Quest. urban	N° domicile Rural	N° Quest. Rural
Paranapanema 3				
Bela Vista do Paraíso	5,025	66	411	6
Cambé	31,589	67	2,055	5
Miraselva	502	48	185	18
Sub-total	32,029	181	2,651	29
Paranapanema 4				
Alto do Paraná	3,836	59	865	13
Paranavaí	27,304	69	1,607	4
Terra Rica	4,397	57	1,138	15
Sub-total	35,537	185	3,610	32
Pirapó				
Arapongas	35,203	71	941	2
Colorado	7,437	66	683	6
Maringá	127,011	72	2,453	1
Paranacity	3,191	64	380	8
Sub-total	172,842	273	4,457	17
TOTAL	240,408	639	10,718	78

Source: Prepared by the authors based on IBGE (2012).

4.1. Demographic and social aspects

According to IBGE (2012), the area of the municipalities studied in the three basins is 4760.98 Km², of which most are located in Paranapanema 4 (48.6% of total) and the lowest is in Paranapanema 3 (17, 4% of total).

The population is composed of 717,970 inhabitants, mostly living in the Basin Pirapó (493,822 inhabitants or 68.8%). The municipalities are highly urbanized (with an average of 96.5%) and the smallest degree of urbanization observed (91.7%) is in Paranapanema 4 and higher degree in Pirapó basin (97.8%). This situation appears to be stronger than the Paraná average, which is 85.3%. In all basins, the female population is larger than the male, and this situation is sharper in the Pirapó River Basin (51.6%), as shown in Table 3. Spite of this relative homogeneity of the data, the distribution of variables was unequal between municipalities of the Basins, as shown in the same Table 3.

As can be observed, there is a municipality in each basin which has the largest share of total and urban population: the municipality that stands out in the basin Paranapanema 3 is Cambé (85.1% of the total population and 85.6% of the urban population of the river basin); in Paranapanema 4 is Paranaíba (73.9% of the total and 76.7% of urban) and in the Pirapó Basin is Maringá (72.3% of the total and 98.2% of the urban population), pointing to the fact that environmental problems arise or are accentuated from some municipalities, which concentrate not only the population but also the industries and farms, a reflection of increased job and development opportunities in the region.

There are differences not only between basins as well as within each basin. In the Paranapanema 3 Miraselva has

76.8% of the urban population while Cambé has 96.1%. In the basin Paranapanema 4, the degree of urbanization varies from 81.3% (Terra Rica) to 95.3% (Paranaíba). In the Pirapó basin this variation is smaller, ranging between 92.4% (Paranacity) and 98.2% (Maringá).

When comparing the average number of inhabitants per household (IBGE, 2012) with those found in the field research, presented in Table 4, the average is 2.8 people per household in Paraná and in the region of study such average is 2.7 people per household. However, the differences are accentuated.

Regarding the urban data, we have the following information in Table 4.

As can be observed, 639 families were interviewed. Of these, 71.2% (455 families) owned their own house and 28.3% (181 families) rented their houses. The analysis by basins reveals that the percentage of households with own house range: a) in the Paranapanema 3 is 79.0% (143 families); b) in the Paranapanema 4 is 63.8% (118 families) and c) in Pirapó is 71.1%. (194 families). The families numbered 1,725 inhabitants, of whom 525 (30.4%) were in Paranapanema 3; Paranapanema 4 concentrated 433 people (25.1%) and 767 inhabitants (44.5%) were in Pirapó.

In addition, 5.6% of respondents are illiterate and the highest percentage is in Paranapanema 3 (6.3%); further 26.5% had incomplete primary education (458 people) and the highest percentage is in Paranapanema 4 (31.9%) and 17.6% (303 people) had completed elementary school, ranging 22.6% in the Paranapanema 4. The complete and incomplete secondary education corresponds to 33.9%

Table 3. Current, urban and rural, male and female population of the selected municipalities of River Basins Paranapanema 3 and 4 and Pirapó River Basin – 2010.

Municipalities Basins	Pop. current	%	Pop. urban	Distrib. Pop.	Degree urban	Pop. rural	Pop. Fem.	Pop. masc.
Paranapanema 3								
Bela Vista do Paraíso	15,079	13.3	14,196	13.1	94.1	883	7,762	7,317
Cambé	96,733	85.1	92,952	85.6	96.1	3,781	49,434	47,299
Miraselva	1,862	1.6	1,430	1.3	76.8	432	939	923
Subtotal P3	113,674	100.0	108,578	100.0	95.5	5,096	58,135	55,539
Paranapanema 4								
Alto Paraná	13,663	12.4	11,221	11.1	82.1	2,442	6,821	6,842
Paranaíba	81,590	73.9	77,728	76.7	95.3	3,862	42,308	39,282
Terra Rica	15,221	13.7	12,370	12.2	81.3	2,851	7,612	7,609
Subtotal P4	110,474	100.0	101,319	100.0	91.7	9,155	56,741	53,733
Pirapó								
Arapongas	104,150	21.1	101,851	21.1	97.8	2,299	53,111	51,039
Colorado	22,345	4.5	21,005	4.3	94.0	1,340	11,303	11,042
Maringá	357,077	72.3	350,653	72.6	98.2	6,424	185,353	171,724
Paranacity	10,250	2.1	9,469	2.0	92.4	781	5,135	5,115
Subtotal PI	493,822	100.0	482,978	100.0	97.8	10,844	254,902	238,920
TOTAL	717,970		692,875		96.5	25,095	369,778	348,192

Source: IBGE (2012).

Table 4. Characteristics of urban households by family and formal education of people in the selected municipalities – 2013.

Munic.	Family			People								TOTAL
	PP	AL	O	Analf	F Inc.	F com	M Inc.	M Com	S Inc	S com	NR	
Paranapanema 3												
B.V.	54	12		11	63	20	21	50	6	20	5	196
Paraíso												
Cambé	50	16	1	14	41	35	21	50	9	28	5	203
Miraselva	39	9		8	29	15	10	33	9	21	1	126
subtotal	143	37	1	33	133	70	52	133	24	69	11	525
Paranapanema 4												
Alto Paraná	30	29		4	43	40	4	20	7	15		133
Paranavaí	42	26	1	13	47	27	9	40	10	19	1	166
Terra Rica	46	11		2	48	31	11	25	9	8		134
Subtotal	118	66	1	19	138	98	24	85	26	42	1	433
Pirapó												
Arapongas	55	16		14	55	29	28	51	13	10	6	206
Colorado	49	16	1	17	40	35	22	50	10	20	1	195
Maringá	48	24		6	51	37	28	48	9	14	8	201
Paranacity	42	22		7	41	34	32	32	3	14	2	165
Subtotal	194	32	1	44	187	135	110	181	35	58	17	767
TOTAL	455	181	3	96	458	303	186	399	85	169	29	1,725

Obs: PP = own house; AL = rented; O = other; AS = settler; Analf = illiterate; inc = incomplete; Com = complete; F = primary school; M = high school; S = higher education; NR = not answered. Source: field research (2013).

(585 people) and Pirapó is the highest percentage (37.9%). The respondents that had finished the graduation correspond to 14.7% (254 people) and the largest percentage is located in Paranapanema 3 (17.7%).

This latter result is surprising because, in Pirapó lies the city of Maringá, an educational hub, as it concentrates 8 colleges and a state university, which should be reflected in the results. Another aspect that stands out is that the largest number of people with complete or incomplete higher education in the basin is concentrated in Maringá (almost 50%), which shows the concentrating characteristic of the municipality.

The average number of persons per household is presented in Table 5, in a comparison between IBGE Cidades (IBGE, 2012) with the field research.

The field research shows that both the Paranapanema 3 as the Pirapó follow values of the IBGE to the average and urban sector and are quite different for the rural sector, thus, are significantly higher (2,7 in Paranapanema 3 and 2.8 in Pirapó). This situation may indicate a process of population retention or return to their rural areas, which needs to be further explored in future population surveys. In the case of Paranapanema 4 data collected are presented quite different: the average and the urban sector are below and to the rural sector presents similar, which may indicate a process of expulsion / migration, which also deserves further investigation.

It was also verified by the data collected that the average population per household is higher in rural areas than in the urban sector in all of the municipalities surveyed in Pirapó and Paranapanema 4. In Paranapanema 3, the exception is Bela Vista do Paraíso. These data are similar

to the consensus that there is a greater number of children per inhabitant in the rural sector.

Regarding poverty we chose to use the latest data of the number of families who register and receive the Bolsa Família¹, because can only be on the federal government program those who are poor or live in extreme poverty. We alert that these data differ from those found in the 2010 Census. As a result, it is presented the Table 6. This table shows the total number of families and people of the municipalities surveyed, the number of registered families which receive up to R\$ 70.00 (extreme poverty) and those who earned between R\$ 70.00 and R\$ 140.00 (poor) so as the number of beneficiaries, the average payment and the number of people surveyed who receive the Bolsa Família or other government support (milk, electricity, PETI). In the field research, with the exception of Alto Paraná, in all municipalities, we interviewed people who receive Bolsa Família.

According to the data of Table 6, the number of poor families and individuals and extreme poverty is alarming. Furthermore, the beneficiaries of Bolsa Família are concentrated in the urban sector, because only in Cambé (1 family) and Miraselva (3 families) were registered beneficiaries in the rural sector. According to the Ministry of Social Development and Fight against Hunger (BRASIL, 2013a) in all municipalities of the Basins there are percentages approaching 50% of households in the municipality as beneficiaries of the income transfer program of the federal

¹ The Bolsa Família Program is a program of direct income transfer conducted by Brazil's federal government that benefits families in poverty and extreme poverty across the country.

Table 5. Average people per household, the total, urban and rural.

Municipalities	IBGE			Observed		
	Average total	Average urban	Average rural	Average total	Average urban	Average rural
Parapanema 3						
B.Vi.Paraíso	2.8	2.8	2.1	2.9	3.0	2.3
Cambé	2.9	2.9	1.8	3.1	3.0	3.6
Miraselva	2.7	2.8	2.3	2.6	2.6	2.6
Subtotal	2.9	2.9	1.9	2.9	2.9	2.7
Parapanema 4						
Alto Paraná	2.9	2.9	2.8	2.4	2.3	3.0
Paranavaí	2.8	2.8	2.4	2.4	2.4	1.8
Terra Rica	2.7	2.8	2.5	2.3	2.4	2.3
Subtotal	2.8	2.9	2.5	2.4	2.3	2.5
Pirapó						
Arapongas	2.9	2.9	2.4	2.9	2.9	3.0
Colorado	2.8	2.8	2.0	3.0	3.0	3.5
Maringá	2.8	2.8	2.6	2.8	2.8	4.0
Paranacity	2.9	3.0	2.1	2.6	2.6	3.0
Subtotal	2.8	2.8	2.4	2.8	2.8	3.2
TOTAL	2.8	2.8	2.3	2.7	2.7	2.8

Source: IBGE Cidades (IBGE, 2012) and field research (2013).

government, such as: (a) in Parapanema 3: Bela Vista do Paraíso (49.4% of the families and 54.9% of the inhabitants) and Miraselva (47.3% of the families and 55.7% of the people); (b) in Parapanema 4: Alto Paraná (37.9% of the families and 43.4% of the individuals), Terra Rica (48.8% of the families and 55.0% of the inhabitants) and (c) in Pirapó: Arapongas (46.3% of the families and 43.7% of the people) and Paranacity (39.4% of the households and 44.5% of the inhabitants). The lowest percentages are in Pirapó in the municipalities of Colorado (14.7% of the households and 17.7% of the inhabitants) and Maringá (20.2% of the families and 21.6% of the people), which points to different dynamics and conditions in these municipalities.

When analyzing the number of registered persons and beneficiaries, in the Table 6, it is not possible to identify a direct relationship, i.e., not necessarily the larger the number of poor people more benefits. Apparently, the number of registrations has greater weight, but this needs to be researched more thoroughly, because the information to identify if all who are in extreme poverty have been benefited by the program is not available.

Another point that stands out is that some municipalities that have higher percentages of registered families with income up to R\$ 70.00 per capita (such as Cambé -23.1% in Parapanema 3; Alto Paraná-32.4% and Paranavaí-26.6% in Parapanema 4 and Paranacity -22.6% in Pirapó), in which, although there is high rate of extreme poverty among registered families, these municipalities are not always receiving higher amount of beneficiaries or benefits.

There are also coincident cases of major beneficiaries, such as Cambé (82.2%), Alto Paraná (20.9%), Paranavaí

(68.6%), but also Maringá (63.2%), which has lower rate compared with the other. The poverty rate in Parapanema 3 represents 6.2% of total households in the basin and, by all indications, public policies contribute very little to the generation of jobs and income.

With regard to access to welfare, all households in which interviews were conducted have electricity in both the rural and the urban sector. There is piped water supplies in all of the urban and rural households. However, the source of this resource is differentiated. In the urban sector, the majority of families (626 families) uses the public water supply, however the use of wells was verified as follows: (a) Parapanema 3: Cambé- 1 family (1.5%) and Miraselva- 6 families (13.0%); (b) Parapanema 4: Alto Paraná- 1 family (1.7%) and Terra Rica- 1 family (1.8%); (c) Pirapó: Colorado- 2 families (3.0%) and Maringá- 2 families (2.8%).

In the rural sector, all households have piped water drawn from wells, except in Parapanema 3, the municipalities of Cambé (which has 2 families who use public system of water and 1 family that uses the river) and Miraselva (1 family that uses public water supply). In the basin of Pirapó both Arapongas (2 families) and Colorado (2 families) beyond the well also use river water. The situation of the interviewed families that do not have sewer is worrying, as shown in Table 7.

As can be observed, in the rural sector, not all families are served by sewage treatment and, as seen above, all draw water from wells, which present risks to both human health and for the environment, including water resources.

It is noteworthy that all basins and municipalities are above average provided by IPARDES (2013, p. 225),

Table 6. Families and People registered in the Bolsa Família Program and urban and rural respondents with Bolsa Família or another benefit – 2013.

	Total registered			Total registered until RS 70,00 per capita			Total registered of RS70,00 until R\$140,00			Benefit			Mensal por benefit			Receive BF others					
	Families		People	Families		People	Families		People	Q		%	R\$		Q	%	Q	%			
	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%			
Paranapanema 3																					
B-Vista do Paraíso	5,436		15,079		2,684	49.4	8,272	54.9	308	11.5	1,017	12.3	492	18.3	1,921	23.2	596	15.9	118.67	4	1
Cambé	33,644		96,733		11,992	35.6	36,491	37.7	2,767	23.1	8,520	23.3	2,772	23.1	10,312	28.3	3,075	82.2	132.39	3	4
Miraselva	687		1,862		325	47.3	1,037	55.7	57	17.5	185	17.8	70	21.5	291	28.1	69	1.8	139.13	5	3
Subtotal P3	39,767		113,674		15,001	37.7	45,800	40.3	3,132	20.9	9,722	21.2	3,334	22.2	12,524	27.3	3,740	100.0	130.45	12	8
Paranapanema 4																					
Alto Paraná	4,701		13,663		1,780	37.9	5,932	43.4	576	32.4	1,922	32.4	510	28.7	1,954	32.9	921	20.9	136.98	0	0
Paraná	28,911		81,590		7,932	27.4	24,641	30.2	2,111	26.6	6,851	27.8	2,180	27.5	8,020	32.5	3,026	68.6	134.31	20	1
Terra Rica	5,535		15,221		2,699	48.8	8,371	55.0	245	9.1	788	9.4	642	23.8	2,395	28.6	464	10.5	119.81	2	0
Subtotal P4	39,147		110,474		12,411	31.7	38,944	35.3	2,932	23.6	9,561	24.6	3,332	26.8	12,369	31.8	4,411	100.0	130.36	22	1
Pirapó																					
Arapongas	36,144		104,150		16,748	46.3	44,470	42.7	1,732	10.3	4,917	11.1	1,996	11.9	7,205	16.2	2,701	28.6	116.87	2	1
Colorado	8,120		22,345		1,190	14.7	3,963	17.7	224	18.8	704	17.8	179	15.0	717	18.1	352	3.7	136.86	1	1
Maringá	129,464		357,077		26,121	20.2	77,091	21.6	3,880	14.9	12,025	15.6	6,445	24.7	23,608	30.6	5,976	63.2	122.15	21	1
Paranacity	3,571		10,250		1,406	39.4	4,557	44.5	318	22.6	898	19.7	352	25.0	1,373	30.1	422	4.5	135.07	7	0
Subtotal PI	177,299		493,822		45,465	25.6	130,081	26.3	6,154	13.5	18,544	14.3	8,972	19.7	32,903	25.3	9,451	100.0	127.74	31	3
TOTAL	256,213		717,970		72,877	28.4	214,825	29.9	12,218	16.8	37,827	17.6	15,638	21.5	57,796	26.9	17,602	100.0	130.74	61	12

*Data from September 2013. Source: Ministry of Social Development and Fight against Hunger (BRASIL, 2013a) and field research (2013).

which is to Paranapanema 3 with 37.2% of families with treatment; Paranapanema 4 is 35.0% and in the basin of Pirapó is 42.5%. Exceptions, however, are worrisome because there are municipalities with families with more than 40% non-attendance as Terra Rica and Paranacity. The situation is alarming in Miraselva because all families interviewed claimed not to have sewage treatment (do not forget that this municipality has the largest number of families who have wells, i.e., 6 from 18).

4.2. The situation in the rural sector and the environment

The conditions of possession of the house and educational level are presented in Table 8.

The Table shows that from the 78 families interviewed, most of them have their own property (87.2%), 7 were tenants (9.0%) and two were sharecroppers (2.6%) and one was settler (1.2%). In the Pirapó river basin, all families have their own property. We found other conditions in all

Table 7. Presence of sewage treatment, urban and rural sector – 2013.

Municipality	Urban				Rural	
	Yes	% Yes	Not	% Not	Yes	Not
Paranapanema 3						
Bela Vista do Paraíso	44	66.7	22	33.3		6
Cambé	60	89.6	7	10.4		5
Miraselva	0	0	48	100.0		18
Sub-total	104	57.5	77	42.5	0	29
Paranapanema 4						
Alto Paraná	49	83.1	10	16.9		13
Paranavaí	62	89.9	7	10.1		4
Terra Rica	32	56.1	25	43.9		15
Sub-total	143	77.3	42	22.7	0	32
Pirapó						
Arapongas	56	78.9	15	21.1		2
Colorado	58	87.9	8	12.1		6
Maringá	62	86.1	10	13.9		1
Paranacity	38	59.4	26	40.6		8
Sub-total	214	78.4	59	21.6	0	17

Source: Field research (2013).

Table 8. Characteristics of rural households by family and formal education by municipality – 2013.

Municipalities	Domicile rurais				Schooling of people						TOTAL	
	PP	AR	PC	AS	Analf	F. Inc.	F. Com	M. Inc.	M. Com.	S. Inc.		S. Com.
Paranapanema 3												
B.V.Paraíso (6)	5	1			2	3	3	1	5			14
Cambe (5)	4	1			0	8	6	1	2	0	1	18
Miraselva (18)	16	1	1		4	23	8	4	7	0	1	47
Subtotal (29)	25	3	1		6	34	17	6	14	0	2	79
Paranapanema 4												
Alto Paraná (13)	12			1	6	7	12	1	9	3	1	39
Paranavaí (4)	4					1	3	1	2			7
Terra Rica (15)	10	4	1		2	13	8	7	2	2	1	35
subtotal (32)	26	4	1	1	8	21	23	9	13	5	2	81
Pirapó												
Arapongas (2)	2						4		1		1	6
Colorado (6)	6					4	5	4	7		1	21
Maringá (1)	1				1	1	1		1			4
Paranacity (8)	8				1	7	9	3	3	1		24
subtotal (17)	17	0	0		2	12	19	7	12	1	2	55
TOTAL (78)	68	7	2	1	16	67	59	22	39	6	6	215

Obs: PP = own property; AR = leaseholder; PC = sharecroppers; AS = settler; Analf = illiterate; inc = incomplete; Com = complete; F = primary school; M = high school; S = higher education. Source: Field research (2013).

municipalities of Paranapanema 3 (presence of tenants and sharecroppers). In the basin of Paranapanema 4 only Terra Rica has recorded the presence of tenants and sharecroppers. In Alto Paraná only one settler was interviewed.

The respondent families aggregate 215 people, 79 of whom were in Paranapanema 3; 81 in the Paranapanema 4 and in the Pirapó 55 people. Out of this total, 16 (7.4%) are illiterate and the highest percentage is in Paranapanema 3 (6.3%); further 26.5% had incomplete primary education (458 people) and the highest percentage is in Paranapanema 4 (50.0%).

We found 27.4% of the respondents (59 people) with complete primary education while the highest percentage is in Paranapanema 4 (39.0%). The complete and incomplete secondary education corresponds to 28.4% (61 people) and in the Pirapó is the highest percentage (34.5%). The complete and incomplete higher education corresponds to 5.5% (12 people) while the highest percentage is located in Paranapanema 4 (8.6%). Once again, this last result is surprising because in the Pirapó lies the city of Maringá, an educational hub. Another aspect that draws attention is that in Maringá there is no presence of people with complete or incomplete higher education. In the rural case, we find more people with the completed elementary school and lower values for education levels of high school and higher education.

The practices of the rural sector are result and dependent on the history of the region characterized by the green revolution and the introduction of heavy machinery and equipment, high technology and intensive livestock farming introduced in regions with highly vulnerable land. As a result, the practices found by the field research are presented in Table 9.

It is noteworthy that no-till farming is associated to not soil tillage, permanent coverage with organic material (reduces the use of chemical fertilizer) and crop rotation. The integrated management, in its turn, though admitting the use of chemical and biological raw materials is also associated with crop rotation (BRASIL, 2013b, p. 52). Thus, when analyzing the Table 9 we can infer the following: In the Paranapanema 3, most families conducts no-till farming (45%), using transgenic seeds (72%) and chemical fertilizers (48%), makes crop rotation (48%) and does not perform integrated management (72%).

However some aspects draw attention: (a) all the respondents in Cambé reported using chemical fertilizer, which influenced the percentage of the basin; (b) transgenic seed is predominant in all the studied families; (c) the no-till farming predominates in Bela Vista do Paraíso and Cambé; (d) in Bela Vista do Paraíso and Cambé there were slash-and-burn farming practices². There is some coherence in practices, because those families who perform no-till farming usually perform crop rotation too and partly perform integrated management, with the exception of

² We cannot forget that the cultivation techniques inadequate (deforestation, deforestation and slash-and-burn techniques) accelerate the process of soil erosion.

Cambé (where 60% reported performing no-till farming, however only 20% do crop rotation).

Thus, Cambé seems to be the most problematic municipality because all respondents stated that they only perform chemical fertilization, although most do not perform no-till farming or crop rotation, do not use organic fertilizer and don't perform integrated management.

In the Basin Paranapanema 4 predominates organic fertilization (78%), farmers do not use genetically modified seeds (81.3%), the technique of no-till farming (59%) as well as crop rotation (65%) are made in a smaller proportion. However they do not perform the integrated management. Paranavaí stands out for presenting 100% of no-till farming, 100% of organic fertilizers use and 100% of integrated management, although only 50% claimed to perform crop rotation.

In the Pirapó Basin no-till farming predominates (76%) as well as crop rotation (58%), organic fertilization (77%) and integrated management. However, both in Colorado and in Paranacity the percentage of those who perform no-till farming and integrated management is greater than those who declare to make crop rotation. Furthermore, in Arapongas respondents use chemical and organic fertilization.

One of the toughest questions to be answered was regarding the use of transgenic seeds³, whose highest incidence occurred in the Paranapanema 3 (72.4%) and the lowest frequency in the Pirapó (6.3%). Regarding the pig farming, whose wastes are highly contaminating, we present the Table 10.

There is a greater presence of pigsties in the Paranapanema 3 (51.7% of the respondents of the basin) and Pirapó (56.3% of the respondents of the basin). With the exception of Paranavaí, Maringá and Arapongas, whose facilities match or approximate of the number of families who perform pig farming, it is clear that the families who declare to perform any kind of swine production is greater than those who claim to have pigsties (minimal installation), because of these respondents in the three river basins sell and / or create for their own consumption, which can impact the environment. Although the nutrients present in the feces (manure) and urine of these animals have encouraged their use as organic fertilization, this procedure also present hazards of environmental contamination resulting from its storage form, distribution and use. Furthermore, hormones

³ There is still much controversy surrounding the spread of genetically modified food. The defenders argue that transgenic aggregate greater nutritional value and even eliminate some undesirable characteristics (lower cholesterol of the egg, for example) generate crops more resistant to the cold, drought and pest attacks and diseases increasing productivity. The opposites to introduce of transgenic in food argue that there is still much ignorance about the effects of genetic manipulation, which may represent a serious risk to human health and to the environment. Meanwhile, government agencies and consumer protection organizations advocate labeling of all foods that contain a genetically modified ingredient in its composition, to facilitate the identification of such products and guarantee consumers the power to decide whether to consume them or not (BRASIL, 2013b, p. 47).

Table 9. Practices in the rural sector, in percentage, by selected municipalities in the river basins – 2013.

Municipalities of Basins	no-till farming			Crop rotation			Chemical fertilizers			Organic fertilizers			Slash-and-burn			transgenic seeds			Management integrated				
	S	N	NR	S	N	NR	S	N	NR	S	N	NR	S	N	NR	S	N	NR	S	N	NR		
Parapananema 3																							
B.V.Paraíso(6)	67	33		100	0	0	33	33	33	50	50	0	50	50	0	50	50	0	50	50	0	67	33
Cambé(5)	60	20	20	20	60	20	100	0	0	0	100	0	20	80	0	80	20	0	80	20	0	40	60
Miraselva(18)	33	67	0	39	61	0	39	67	0	44	56	0	0	100	0	78	22	0	78	22	0	11	89
Sub-total(29)	45	52	3	48	48	4	48	45	7	38	62	0	14	86	0	72	28	0	72	28	0	28	72
Parapananema 4																							
Alto Paraná(13)	8	54	38	31	31	38	8	54	38	62	15	23	0	100	0	23	77	0	23	77	0	8	92
Paranavai (4)	100	0	0	50	50	0	25	75	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100
Terra Rica (15)	20	80	0	0	100	0	7	93	0	86	7	7	0	87	13	20	80	0	20	80	0	0	100
Sub-total (32)	25	59	16	19	65	16	9	75	16	78	9	13	0	94	6	19	81	0	19	81	0	3	97
Pirapó																							
Arapongas (2)	0	100	0	100	0	0	100	0	0	100	0	0	0	100	0	0	100	0	0	100	0	100	0
Colorado (6)	67	33	0	50	50	0	50	50	0	83	17	0	66	17	17	17	66	17	17	66	17	33	67
Maringá (1)	100	0	0	100	0	0	100	0	0	0	100	0	0	100	0	0	100	0	0	100	0	100	0
Paranacity (8)	100	0	0	50	50	0	25	75	0	75	25	0	0	100	0	0	100	0	0	100	0	50	50
Sub total (17)	76	24	0	59	41	0	35	65	0	77	23	0	24	71	5	6	88	6	6	88	6	53	47

Obs: S = perform; N = No perform; NR = not aswered. Source: Field research (2013).

Table 10. Presence of pigsties and pig farming in the selected municipalities – 2013. Obs: v = sell.

Municipalities	Pigsties		Pig farming			
	Yes	Not	V	Use	V+ Use	Not
Paranapanema 3						
B.V.Paraíso (6)	33.3	66.7	0	3	3	0
Cambé (5)	60.0	40.0	1	2	1	1
Miraselva (18)	55.6	44.4	2	10	1	5
Sub-total (29)	51.7	48.3	3	15	2	9
Paranapanema 4						
Alto Paraná (13)	7.7	92.3	1	1		11
Paranavaí (4)	25.0	75.0	0	1	0	3
Terra Rica (15)	0.0	86.7	0	2	0	13
Subtotal (32)	6.3	87.5	1	4	0	27
Pirapó						
Arapongas (2)	100.0	0.0	0	2	0	0
Colorado (5)	20.0	80.0	3	2	1	0
Maringá (1)	0.0	0.0	0	0	0	0
Paranacity (8)	75.0 (3vd)	25.0	2	1	4	1
Sub-total (16)	56.3 (4 vd)	43.8	5	5	5	2
Total (77)	33.8	66.2				

Source: Field research (2013).

Table 11. Practices for waste separation, recovery of riparian vegetation and septic tank – 2013.

Municipalities	waste separation		recovery of riparian vegetation		septic tank	
	Yes	Not	Yes	Not	Yes	Not
Paranapanema 3						
B.V.Paraíso (6)	3	3	2	4	3	3
Cambé (5)	3	2	1	4	3	2
Miraselva (18)	4	14	2	16	13	5
Subtotal	10	19	5	24	19	10
Paranapanema 4						
Alto Paraná (13)	12	1	1	12	13	
Paranavaí (4)	4			4	4	
Terra Rica (15)	7	8		15	15	
Subtotal	23	9	1	31	32	0
Pirapó						
Arapongas (2)	2			2	2	
Colorado (6)	5	1	3	3	3	3
Maringá (1)	1			1	1	
Paranacity (8)	6	2		8	8	
Subtotal	14	3	3	14	14	3

Obs: NR = not answered. Source: field research (2013).

and antibiotics can be eliminated with the feces and urine of animals, being incorporated into the soil (BRASIL, 2013b, p. 44).

Among other practices analyzed are those relating to the households (septic tanks and waste separation) and the production (recovery of riparian vegetation), as shown in Table 11.

As seen in the table, the river basin Paranapanema 3 concentrates the most troubled municipalities, because the majority does not separate waste (65.5%), does not

perform the recovery of riparian vegetation (82.7%) and has the highest incidence of not having septic tank (34.5%). This frame contrasts with the other municipalities of the basins in which all respondents have septic tanks, with the exception of Colorado, where only 50% have this structure.

The biggest problem in all municipalities is the non-recovery of riparian vegetation in all basins and no separation of waste. On this last issue is the identification of street cleaning by the public sector, as shown in Table 12.

Table 12. Frequency of cleaning of public areas on the interviewees' opinion – 2013.

Municipalities	Frequency of cleaning of public areas				Not
	Weekly	Biweekly	Monthly	Less than once / month	
Paranapanema 3					
B.Vista Paraíso (6)		3	3		
Cambe (5)		2	3		
Miraselva (18)	15		1	1	1
Sub total (29)	15	5	7	1	1
Paranapanema 4					
Alto Paraná (13)		11	2		
Paranavaí (4)		4			
Terra Rica (15)	9	6			
Sub total (32)	9	21	2	0	0
Pirapó					
Arapongas (2)	1				1
Colorado (6)	1				5
Maringá (1)					1
Paranacity (8)					8
Sub total (17)	2	0	0	0	15

Source: Field research (2013).

As seen in the Table 12, the situations are different, but present trends. In the Paranapanema 3, the vast majority claims to have weekly cleaning, however in Bela Vista do Paraíso and Cambé cleaning is biweekly and monthly (which may depend on the location of the property). Crossing the data of Table 11 with Table 12, only 1 respondent claims not to have public collect although most of the households didn't separate the recyclable materials.

In the Paranapanema 4, the majority declares that cleaning is biweekly and most of the respondents in Terra Rica (9) have argued that cleaning occurs weekly.

The situation is most critical in Pirapó because all respondents reported the lack of public cleaning, with the exceptions of Arapongas (1 family) and Colorado (1 family). In all municipalities there is no collect of construction debris and rubble or debris from trees. In these municipalities, when comparing the Tables 11 and 12, we see a curious situation because, while most claims separate waste also claims that there is no garbage collection by the public sector, with the exception of one family in Arapongas and another one in Colorado. This situation deserves further clarification.

These situations which were described point to the problems generated by waste of the establishments, which may be impacting the environment, including rivers.

Another aspect that was investigated was the view of environmental problems and, again, the basins have different characteristics. Among the various problems studied, treated the native vegetation. In the Pirapó river basin, the area of native vegetation coverage increased in percentage (49.1%) in the period 2008-2011. In the same period, the Paranapanema 3 reduced its coverage

area by 3.3% and Paranapanema 4 declined sharply its area of native vegetation coverage (43.0%), according IPARDES (2013).

As a result of field research, the view of the respondents with regard to rainfall, the floods, erosion, pollution of rivers, among others, i.e., the outlined imbalances are presented in Table 13.

There was no record of flooding and water logging in rural households of respondents as well as water rationing, with the exception of one family in Paranacity (Pirapó) and another one in Terra Rica (Paranapanema 4).

We chose to present the data by frequency and percentage clarifying that there are environmental issues that were systematized in an aggregate form such as soil erosion and compaction and clearing of the banks of rivers and siltation of rivers, in the Table 13. Thus, the first observation to be made with respect to the data collected in rural households is the low percentage of responses, including the Maringá's respondent that do not answered these questions, although he had answered the others. There are some explanations for this: (a) they were unable to have the dimension of the problem; (b) they do not want to answer; (c) they do not want to point out the problem by not having the notion of the consequences of their answer; (d) they do not know how to respond. This is an aspect to be better researched, although it is believed to be the alternative a that best explains this situation.

With respect to soil erosion and soil compaction in all municipalities surveyed there was the record of the respondents, with the exception of Arapongas. Deforestation and siltation of rivers is also registered with the exception

Table 13. Frequency and percentage of environmental problems raised by rural families – 2013.

Municipalities	Soil erosion and soil compaction		Deforestation and siltation of rivers		Urban and hospital waste		Polluted rivers	
	Q	%	Q	%	Q	%	Q	%
Paranapanema 3								
B.Vista Paraíso (6)	3	50	1	16.7	1	16.7	1	16.7
Cambé (5)	1	20	-		2	40	1	20
Miraselva (18)	2	11.1	4	22.2	2	22.2		
Sub total (29)	6	20.7	4	13.8	5	17.2	2	6.9
Paranapanema 4								
Alto Paraná (13)	2	15.4	5	38.5	1	7.7	2	15.4
Paranavaí (4)	1	25.0	2	50.0	-		1	25.0
Terra Rica (15)	3	2.0	4	26.7	1	6.7	-	
Subtotal (32)	6	18.8	11	34.4	2	6.3	3	9.4
Pirapó								
Arapongas (2)	-	-	2	100.0	-	-	1	50
Colorado (6)	3	50.0	3	50.0	3	50.0	5	83.3
Maringá (1)	-	-	-	-	-	-	-	-
Paranacity (8)	2	25.0	4	50.0	1	37.5	3	37.5
Sub total (17)	5	29.4	9	52.9	4	23.5	9	52.9

Source: Field research (2013).

Table 14. Use of Rivers by the rural families – 2013.

Municipalities	Don't use	recreation	irrigation	Consumption	Fishery	Others
Paranapanema 3						
B.Vista Paraíso (6)	4	1			1	
Cambé (5)	3		2			
Miraselva (18)	16	1	1			
Sub total (29)	23	2	3	0	1	0
Paranapanema 4						
Alto Paraná (13)	7	2			4	
Paranavaí (4)	4					
Terra Rica (15)	9	4			2	
Sub total (32)	20	6	0	0	6	0
Pirapó						
Arapongas (2)		2	2			
Colorado (6)	3	3				
Maringá (1)	1					
Paranacity (8)	7				3	
Sub total (17)	11	5	2	0	3	0
TOTAL (78)	54	13	5	0	10	0

Source: Field research (2013).

of Cambé. Improper disposal of urban and hospital waste is also noted, with the exception of Paranavaí and Arapongas.

Furthermore, among those who answered the question occurred higher frequency on the polluted rivers. However, while respondents from the three basins pointing the problem, often did not know or did not indicate the source as the pesticides. As always, environmental issues always create resistance in the responses.

Regarding the use of rivers, we present the Table 14.

According to the data presented in the table, with the exception of Maringá and Paranavaí, in which respondents use the rivers for any activity, it is observed that the vast majority of rural households do not use the rivers (69.2%). Those who use, do for recreation and fishing (29.5%) and irrigation (6.4%) located predominantly in Paranapanema 3 (3 families) and Pirapó (2 families). This low frequency in the use of rivers for recreation and / or productive activity is interesting because, in part, may explain some distance from the developed practices and environmental impacts.

5. Conclusions

The region has no problems in terms of water quantity, because the availability is always greater than the demand, although access to this water in some municipalities demands investments in expansion the distribution system (public investment, therefore). Since there are no quantitative problems, the issues listed assume qualitative nature. The rivers and their tributaries receive originating from domestic, industrial and rural discharges pollutant loads, although there is increasing actions for their treatment, particularly in Pirapó. In this basin, there are high percentages of wastewater that in rural areas, which do not receive any treatment. In the urban sector, the percentage of treatment tend to increase.

The socioeconomic conditions of the interviewed families in the selected municipalities are differentiated, and the 'best condition' is in the Pirapó River Basin due to its history marked by a hub city (Maringá), since the colonization and severe process of implementing the green revolution. The conclusion is that there are a number of factors (economic activities, total population, GDP and GDP per capita) that reinforce or were reinforced by soil type and therefore interfere with the demand of water resources.

What can be concluded with data collected is that many environmental problems or are not perceived and / or does not make the relationship between the practices and impacts, particularly on water resources. We can mention the issue of waste, while only 11 households / respondents stated that there are problems in the disposal of waste (Table 13), at the same time 31 families stated that they do not sort rubbish (Table 10). Another example is that although 24 families indicate the problem of deforestation and silting of rivers, only 9 families (Table 10) makes the recovery of riparian forests. Pollution of rivers was noted, particularly in the river basin Paranapanema 3 for two families (Table 13) while 10 families had no septic tank, 20 of the 29 families have pig farming and only 11 have pigsties.

During the interviews, there was much resistance to answer questions relating to the environment and its impacts.

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