04-038

DETERMINATION OF THE WATER QUALITY OF THE SANTA ANA AND PAJONAL RIVERS IN THE COMMUNITY OF ENTRE RÍOS

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For this investigation, the population of Entre Rios in southern Bolivia was used as the study area. In recent years, this region has experienced a population growth that has brought with it negative impacts on its water resources. The Santa Ana and Pajonal rivers run through the urban area of Entre Ríos, being exposed to different sources of pollution generated by it. These waters, which are used for consumption and irrigation, require a constant evaluation of their quality to ensure the well-being of rural communities and the local ecosystem. In this work, five sampling points in the study area were monitored for physical and chemical analysis of the samples. High levels of organic contamination that exceed the national regulations were identified, the source of these being a combination of factors linked to poor wastewater management in the area. Based on the results obtained, strategies are proposed to optimize the current water management, considering the health risks to which the rural communities downstream are exposed due to the lack of an adequate water purification systems.

Keywords: safe water; water management; organic pollution

DETERMINACIÓN DE LA CALIDAD DE AGUA DE LOS RÍOS SANTA ANA Y PAJONAL EN LA POBLACIÓN DE ENTRE RÍOS

Para el presente trabajo se tomó como área de estudio a la población de Entre Ríos ubicada al sur de Bolivia. En los últimos años esta región ha experimentado un crecimiento poblacional que ha traído consigo impactos negativos en sus recursos hídricos. Los ríos Santa Ana y Pajonal recorren la zona urbana de Entre Ríos, siendo expuestos a diferentes fuentes de contaminación generadas por la misma. Estas aguas, que son empleadas en consumo y riego, requieren de una evaluación constante de su calidad para asegurar el bienestar de las comunidades y ecosistema local. En este trabajo se monitorearon cinco puntos representativos del área de estudio, para realizar un análisis físico químico de las muestras. Se identificaron niveles de contaminación orgánica elevados que sobrepasan la normativa nacional, siendo el origen de estas una combinación de factores vinculados a la gestión deficiente de las aguas residuales de la zona. En base a los resultados obtenidos, se proponen estrategias para optimizar la gestión hídrica actual de la población, tomando en consideración los riesgos a los que están expuestas las comunidades rurales que habitan aguas abajo y que no cuentan con sistemas de potabilización adecuados.

Palabras clave: agua segura; gestión hídrica; contaminación orgánica

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1. Introduction

Water pollution has significant adverse effects on the development of communities worldwide, reducing their quality of life. These situations are influenced by social and economic inequalities (Pastorino, 2013), and communities far from cities are often more vulnerable due to the lack of adequate management of their water resources. A community with access to clean water and the capacity to treat its effluents will have more significant opportunities for sustainable development (Castilla, 2013).

Bolivia, a developing country, has conducted several studies on water quality and its effects on crops for consumption in communities (Valdez, 2005), showing that there are high amounts of biological pollutants that exceed the established limits. For example, in the city of Cochabamba, a water quality analysis of the Rocha River determined that contamination easily exceeds national regulations (Toledo & Amurrio, 2006 Water pollution is a known problem affecting many developing countries, and several investigations have been conducted on this topic as a way of studying the relationship between water pollution and environmental degradation (Tenecota, 2015) and the need for management to reduce its impacts.

It is possible to affirm that, as a country, Bolivia still faces significant challenges when trying to achieve SDG 6 related to clean water and sanitation. Only 67% of the rural population has access to drinking water services and only 43% have basic sanitation services (GIZ, 2019). The SDG-6 states as one of its targets to reduce pollution due to untreated wastewaters and to give priority to vulnerable communities. The objective of this research was to determine the sources of pollution that could influence the water quality of the Santa Ana and Pajonal rivers in their path through the community of Entre Ríos, through sampling and literature review, as a tool for local water management. This goal is set to help generate more information for decision-making regarding the management of local water-resources in the study area thanks to updated water quality parameter and a vulnerability analysis related to the risk of water pollution. The region has a rich biodiversity and a rural population that could be exposed to wastewaters that could put them in risk of reduction of quality of life.

1.1 Characterization of the area

Entre Ríos is located in the department of Tarija, in southern Bolivia. The 2012 census estimated an urban population of 4044 inhabitants (INE, 2012). There is a low level of local integration between towns due to the few existing roads exposed to occasional landslides (Casas, 2010). The large distances between communities, the uneven topography, and the low population density affect communication between areas.

The main economic activities in the region are livestock and fish farming and agriculture based on corn, potatoes, green peas, peanuts, soybeans, peaches, and tangerines. In a smaller scale, there is forestry, beekeeping, handicrafts, and local tourism (PDM, 2015). Mining and hydrocarbon extraction are present in some specific areas. Entre Ríos's economic activities tend to be small to medium scale, without big industries.

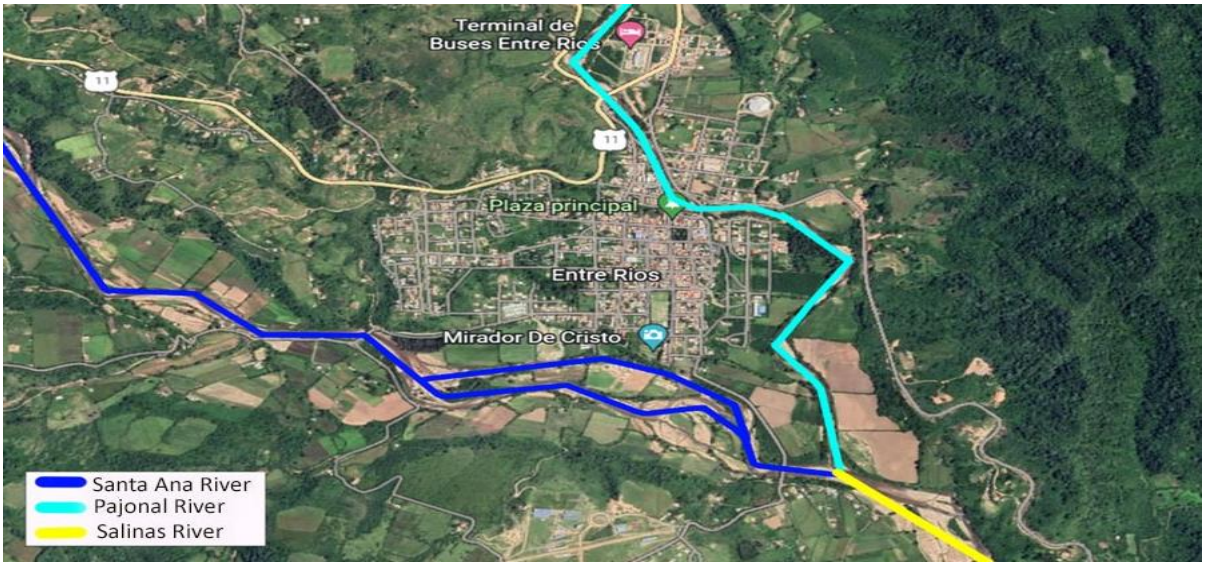
A largely rural community is scattered in the region, including indigenous groups such as the Guaraní, who represent 15% of the province's total population. As these are rural communities, access to essential services is limited, especially water for human consumption and waste treatment. The Tariquía Flora and Fauna National Reserve, located south of Entre Ríos, is one of the most relevant areas in biodiversity and climate regulation for the region. It holds 808 species of flora, more than 1500 species of higher plants and around 406 animal species (SERNAP, 2017). Water quality has a big impact on the stability of these ecosystems.

This region is part of the La Plata River Basin, encompassing Argentina, Bolivia, Brazil, Paraguay, and Uruguay (Tarija, 2015), so water resource management is important. In the case of the area of interest, Entre Ríos is part of the Bermejo River basin in the south of the country (PDM, 2015).

1.2 Water resource management

The community of Entre Ríos is located between two surface water courses, the Santa Ana River in the southern part and the Pajonal River that crosses the eastern part (Figure 1). The first one is mainly used for agriculture and the latter is related to the local population's water supply (Gobierno Autónomo Municipal de Entre Ríos, 2021). The union of both watercourses gives rise to the Salinas River, which flows through several communities downstream until it connects to the Grande de Tarija River. Figure 1 shows the ubication of the Entre Ríos community.

Figure 1: The Pajonal and Santa Ana rivers paths around Entre Ríos



Source: Own elaboration, 2023.

Due to human activities, wastewater is continuously generated daily, so it is necessary to carry out adequate treatment to reduce pollution (Torrez, 2017). Entre Ríos has a wastewater treatment plant, which unfortunately does not receive all the waste from the homes in the area. The sanitary sewer system does not have full coverage for the community. Torrez (2017) performs an analysis of five water quality parameters, revealing that, despite having wastewater treatment, the output values remain high. The data of this study are detailed in Table 1.

Table 1: Entre Rios wastewater treatment efficiency

Parameters	Units	Pre-Treatment	Post-Treatment
Total Coliforms	NMP/100 ml	4,6E+08	9,3E+05
DBO5	Mg/l	137,4	30,7
Total Phosphate	Mg/l	7,7	18,4
Total Nitrogen	Mg/l	7,8	36,4
Total Suspended Solids	Mg/l	65,3	30,7

Source: Torrez , 2017

2. Methodology

The research was divided into five phases and was carried out over a period of five months.

2.1. Phase 1 - Data collection

During this phase, all available and public information was collected to develop the research. Consultations and official requests were made to entities linked to the area, such as the Honorable Municipal Mayor's Office and its Secretariat of Productive Development, the National Technical Office of the Pilcomayo - Bermejo Rivers, and the Departmental Environment Secretariat. Unfortunately, the information that was presented was from more than five years ago and there has been no in deep study of the water quality that is accessible to the public.

The most valuable information was recovered from college thesis from the Autonomic University Juan Misael Saracho about environmental issues of the local region. In the last five years little to no new studies have been conducted related to water management. The last water quality analysis was conducted by Jimena Mamani in 2017, where she stablishes a deficient quality for the Pajonal River.

2.2. Phase 2 - Water sampling

For the sampling, the points Jimena Mamani (2017) used in her research about the contamination of the Pajonal River were used as a reference for three points. Due to being the only research done with sampling, it was implemented for this study. The reason Mamani choose these point is due to one (Point 1) being in the entrance to Entre Rios, the second (Point 2) is a location within the city with a low chance of wastewater discharge, the last point (Point 3) was the closest to the newer urbanizations and the closest point to where Pajonal River leaves the city. Two more samplings were made for the Santa Ana River, one point (Point 5) before entering the town and another at the exit before joining the Pajonal River (Point 4), because no other quality studies were made as a reference for this river. The location of both points was arbitrary due to economic limitations for the sampling. Table 2 indicates the coordinates for each point that was established.

Table 2: Sampling points

Sampling Points	Latitude	Longitude	Description
Point 1: Pajonal River entrance	-21.5199746	-64.173265	Entrance point to Entre Ríos.
Point 2: Midpoint of Pajonal River	-21.5244553	-64.170562	Within the urban area
Point 3: Pajonal River exit	-21.5262142	-64.1669116	Behind the urbanized area. The river begins to leave the populated area.
Point 4: Santa Ana River exit	-21.5355537	-64.1695327	Point of convergence with the waters from the Wastewater Treatment Plant. Exit of the urban area.
Point 5: Before the urban area Santa Ana River	-21.530635	-64.1843339	Point located before the urban area. No urbanization nearby.

Source: Own elaboration, 2023.

Once the samples were collected, they were transferred from Entre Ríos to the Center for Analysis, Research, and Development of the Autonomic University Juan Misael Saracho in

Tarija. The procedure for sampling, storing, and transporting the water samples was carried out according to NB-496 Agua Potable - Sample Collection and the laboratory specifications with which we worked.

2.3. Phase 3 Information analysis

With the results obtained from the laboratory analysis, the next step was their interpretation. Considering the possibility that this water could be used for human consumption downstream. These communities would not have access to pre-treatment services for water meant for human consumption.

Law No. 1333 Ley del Medio Ambiente and its regulations on water contamination (Bolivia, 1992) were reviewed, where water intended for human consumption is classified as it follows:

- CLASS "A" Natural waters of maximum quality, which qualifies them as drinking water for human consumption without any previous treatment or with simple bacteriological disinfection in the necessary cases verified by the laboratory.
- CLASS "B" General utility waters, which for human consumption, require physical treatment and bacteriological disinfection.
- CLASS "C" General utility waters require complete physical and chemical treatment and bacteriological disinfection to be authorized for human consumption.
- CLASS "D" Waters of minimum quality, which, for human consumption, in extreme cases of public need, require an initial process of pre-sedimentation, as they may have high turbidity due to the high content of suspended solids, and then complete physical-chemical treatment and exceptional bacteriological disinfection against eggs and intestinal parasites.

As an international reference, Directive 75/440/EEC (Council of the European Union, 1975) was included, establishing the parameters of water intended to produce drinking water for human consumption in Spain. According to this regulation, water bodies can be classified into three categories:

A1: Simple physical treatment and disinfection, e.g., rapid filtration and disinfection.

A2: Normal physical treatment, chemical treatment, and disinfection, e.g. pre-chlorination, coagulation, flocculation, settling, filtration, and disinfection (final chlorination).

A3: Intensive physical and chemical treatment, refining, and disinfection, e.g. chlorination to break point, coagulation, flocculation, decantation, filtration, refining (activated carbon), and disinfection (ozone, final chlorination).

2.4. Phase 4 - Water Quality Risk Analysis

Based on the results obtained and the context study, this phase analyzed the risks associated with water quality. It was based on the procedure proposed by the Deutsche Gesellschaft für Internationale Zusamme- narbeit (2018), where aspects of threats, vulnerability, and exposure are considered for climatic risks.

2.5. Phase 5 - Identification of Strategic Actions.

The information gathered and the risk analysis allowed the identification of strategic actions that should be prioritized. These actions could help respond to the main problems linked to the management of local water resources. The focus must be to ensure the welfare of the population of Entre Ríos and the rural communities in the study area.

3. Results and Discussion

Based on the laboratory results, a comparison was made with current Bolivian regulations to classify water use in the study area.

3.1 Pajonal River

The laboratory analysis for the Pajonal River yielded values for eleven quality parameters, which are exposed in Table 2. These parameters were determined considering the characteristics of the area and the main local economic activities.

Table 3: Laboratory analysis of the Pajonal River

Parameters	Units	Point 1: Entrance	Point 2: Midpoint	Point 3: Exit
BOD5	mg/l	23.5	4.9	43.8
COD	mg/l	34.0	6.0	57.5
Conductivity	µS/cm	657.5	706	738
Total Phosphorus	mg/l	<0.01	0.04	<0.01
Nitrates	mgNO3/l	3.00	1.40	4.4
Nitrites	mgNO2/l	3.7	4.5	14.2
Dissolved Oxygen	mg/l	5.08	5.42	2.16
pH		8.38	8.4	7.46
Sedimentable solids	mg/l	<0.01	<0.1	0.2
Suspended solids	mg/l	<1	<1	35.00
Heat resistant coliforms	UFC/100ml	2.1×10^5	7.0×10^3	1.5×10^9

Source: Own elaboration, 2023.

The Pajonal River is exposed to biological contamination before entering the Entre Ríos area by merchants who discharge their wastewater directly into the watercourse. As the waters continue to the urban population, there is a decrease in the organic load. Due to a sizeable clandestine discharge, the values rise to worry levels before joining the Santa Ana River.

3.2 Santa Ana River

The eleven parameters analyzed for the two points of the Santa Ana River are shown in Table 4, where a difference can be observed concerning the Pajonal River. The BOD5 value is significantly higher than the previous one.

Table 4: Laboratory analysis of the Santa Ana River

Parameters	Units	Point 5: Before the urban area	Point 4: Exit
BOD5	mg/l	144.0	134.0
COD	mg/l	195.0	205.0
Conductivity	µS/cm	457	437
Total Phosphorus	mg/l	<0.01	<0.01
Nitrates	mgNO3/l	4.40	7.00
Nitrites	mgNO2/l	2.15	52.5
Dissolved Oxygen	mg/l	5.46	4.23
pH		6.83	7.4
Sedimentable solids	mg/l	<0.01	<0.1
Suspended solids	mg/l	<1	<1
Heat resistant coliforms	UFC/100ml	1.4×10^4	15×10^6

Source: Own elaboration, 2023.

According to the information gathered, the current treatment plant does not provide an efficient level of treatment to meet the current demand of the population of Entre Ríos; therefore, it is necessary to redesign and expand the facilities.

3.3 Analysis of parameters that are outside the permissible limits

The parameters that exceed the permissible limits are detailed below.

a) Suspended Solids

In the Pajonal River, in the outflow section of the city, high values exceed the permissible limits of the Bolivian standard; they are shown in Table 5. During observation, the water was observed to have a cloudy color, with organic and inorganic material floating on the surface.

Table 5: Comparison of suspended solids values with environmental standards

Sampling point	Value registered (mg/l)	Directive 75/440/CEE (mg/l)	Comparison
Point 1	<1	25	COMPLIES TO A1
Point 2	<1	25	COMPLIES TO A1
Point 3	35.00	25	DOES NOT COMPLY
Point 4	<1	25	COMPLIES TO A1
Point 5	<1	25	COMPLIES TO A1

Source: Own elaboration, 2023.

According to the Spanish Directive 75/440/EEC, the total suspended matter for water is 25 mg/l. Considering this value, the waters of the Santa Ana River exceed the limit considered. Still, it is at Point 3 where the value detected exceeds the range corresponding to the Pajonal River.

b) BOD_5

The Biological Oxygen Demand expresses the amount of oxygen that living beings need to consume the organic matter in the water. The BOD5 is used to determine the oxygen needed in five days. The units used are mg/l.

In the Pajonal River, an increase in the level of contamination can be observed when it receives clandestine wastewater discharges, exceeding category D of the Bolivian regulation. For the Spanish directive, the values exceed their ranges in points 1 and 3.

In the case of the Santa Ana River, both sampling points show values well above the established limits, so the waters cannot be considered within the maximum permissible values. When comparing the requirements of the Bolivian classification, both of the two points reach the maximum permissible. Table 6 shows the comparison of BOD_5 values.

Table 6: Comparison of BOD_5 values with environmental regulations

Sampling point	Value registered (mg/l)	Bolivian classification	Directive 75/440/CE (mg/l)	Comparison
Point 1	23.5	CLASS D (<30)	7	NOT COMPLIANT
Point 2	4.9	CLASS B (<5)	5	A2
Point 3	43.8	NOT COMPLIANT	7	NOT COMPLIANT
Point 4	134.0	NOT COMPLIANT	7	NOT COMPLIANT
Point 5	144.0	NOT COMPLIANT	7	NOT COMPLIANT

Source: Own elaboration, 2023.

c) Fecal Coliforms

Coliforms exist in warm-blooded living beings and should be analyzed because their presence indicates contamination by organic material, specifically feces. The consequences of consuming water with these bacteria range from mild stomach discomfort to life-threatening infections.

The waters of the Pajonal River before it enters the urban area of Entre Ríos have a value of 2.1x105 CFU/100 ml of water; the origin of this contamination comes in part from the settlements upstream where several businesses along the road connects Entre Ríos with the Chaco region. Determining the destination of the wastewater generated by these businesses is necessary.

In the case of the Santa Ana River, there is a minor increase in coliforms in the water, ranging from 1.4x104 CFU/100 ml (CALSE D) to 1.5x106 CFU/100 ml, a range that exceeds regulatory values. The regional hospital and discharges from the wastewater treatment plant influence this section of the river. The point where the sample was taken is a section where both the city's tributaries and the natural flow of the river have combined. This may be the reason why the quality of the water is better in this case, considering the natural purification that takes place until the water is mixed. of the Bolivian classification, both of the two points reach the maximum permissible. Table 7 shows the comparison of Fecal coliform values.

Table 7: Comparison of Fecal Coliform values with environmental standards

Sampling point	Value registered (UFC/100 ml water)	Bolivian classification	Directive 75/440/CE (mg/l)	Comparison
Point 1	21 000	CLASS D (<50000)	50 000	A3
Point 2	7000	CLASS D (<50000)	50 000	A3
Point 3	1.5x109	NOT COMPLIANT	50 000	NOT COMPLIANT
Point 4	1 500 000	NOT COMPLIANT	50 000	NOT COMPLIANT
Point 5	14 000	CLASS D (<50000)	50 000	A3

Source: Own elaboration, 2023.

To consider these waters for human consumption, it will be necessary to implement complex treatment systems to reduce the amount of organic contamination present. Currently, rural communities in the region still need this type of treatment due to the precarious conditions in which they live. Considering that health centers tend to be concentrated in the more urbanized areas, the more remote communities would be at risk in the event of an increase in cases of gastrointestinal diseases.

3.4. Risk Analysis for the Study Area

Based on the information collected and the results of the laboratory, a risk analysis for the contamination problem was developed based on the methodology used in the book "Climate Risk Assessment for Ecosystem-based Adaptation" published by the Deutsche Gesellschaft für Internationale Zusamme-narbeit (2018) where the potential risk is analyzed based on three factors: the threat to be considered, the existing vulnerability and the exposure to the danger. This methodology was applied in the Entre Ríos region to analyze the risk and the vulnerable population that will depend on a problem linked to the responsible management and management of local water resources. Figure 2 presents the results of the applied methodology.

A) Threat

The threat, in this case, is the contamination generated by human activities in the community of Entre Ríos, specifically contamination from wastewater discharges into the Pajonal and Santa Ana rivers without adequate treatment to comply with national regulations.

B) Exposure

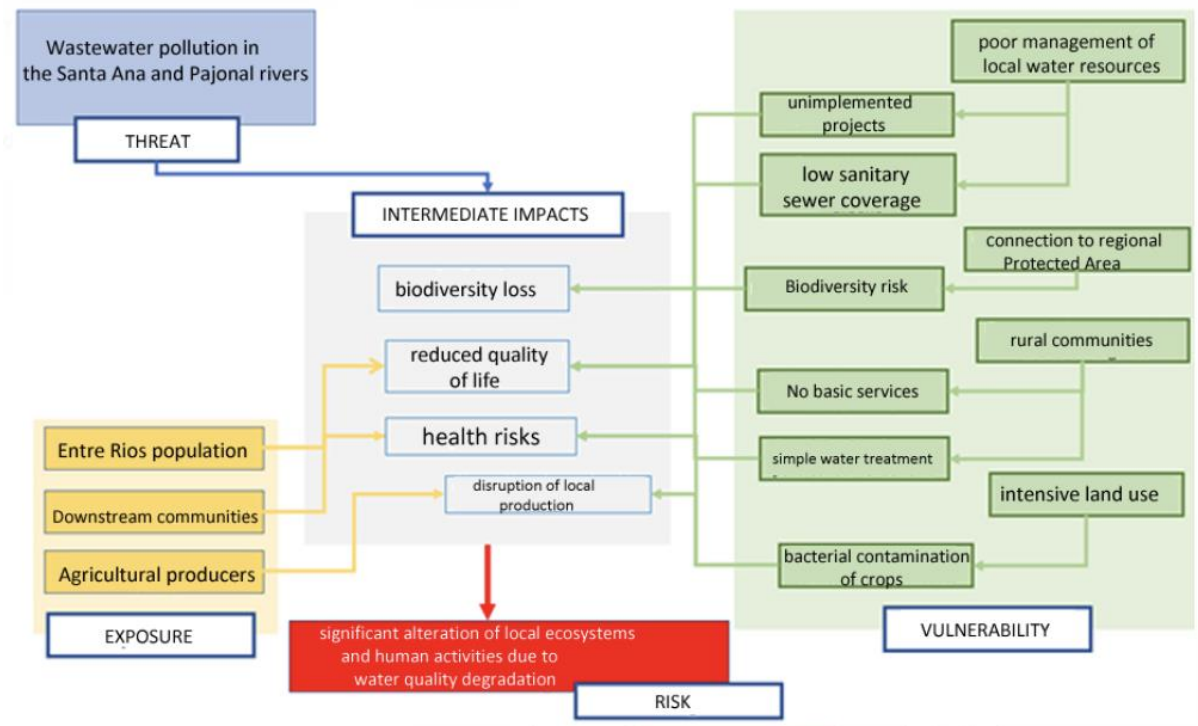
Exposure will be all those groups, individuals, or objects that are exposed to the threat and may be significantly harmed. For the present document, three groups are identified:

Habitants of Entre Ríos: Exposure is due to the proximity of homes to bodies of surface water, so activities near rivers can pose a risk of infection.

Downstream communities: Entre Ríos is mainly a rural area, where the urban area is concentrated in the city of the same name; however, small rural communities and indigenous groups are distributed throughout its territory. These settlements may be exposed to contaminated waters originating in the urban area.

Agricultural producers: Although the amount of organic matter in the water may lead to an increase in local agricultural production due to the high presence of coliforms, these crops may become contaminated, posing a risk to consumers.

Figure 2: Water-related analysis for the population of Entre Ríos, Tarija



Source: Own elaboration, 2023.

C) *Vulnerability*

Vulnerability refers to the response capacity and organization of the actors involved in the face of the threat detected. Therefore, vulnerability within the study area will be, on the one hand, those factors linked to water pollution prevention; and, on the other hand, factors that will be altered due to water quality degradation.

Deficient management of local water resources: Local authorities recognize the current problems of wastewater management in Entre Ríos and propose implementing projects to improve and mitigate water pollution. However, these projects have not been implemented to date due to administrative and economic factors. There is also low participation of departmental authorities and institutions in monitoring water resource management, evidenced by the lack of updated information available to the population.

Intensive land use: Agriculture is one of the main economic activities in the municipality, so a loss of water quality in the rivers could negatively affect the quality of marketed products. Also, pesticides and fertilizers can be sources of diffuse contamination in the areas surrounding the Pajonal and Santa Ana rivers.

Presence of rural and indigenous communities: The level of basic sanitation for households in more rural areas within the municipality is relatively low, so the treatment of river water could be more complex and present in some cases. This puts the health of community members and indigenous groups in the southern part of the municipality at risk.

Connection with local protected area: Within the municipality, in the southern zone, is part of the Tariquía Flora and Fauna Reserve, a protected area of great regional relevance due to

its high biodiversity and the ecosystem services it provides about the local hydrological cycle. Because of its environmental relevance, adequate controls should be in place to ensure the quality of the water that reaches the buffer zone and the reserve itself. However, with the current lack of information, there may be a degradation of the river waters due to contamination from human activities.

Based on the analysis, it can be concluded that the combination of vulnerabilities and exposure to the threat of contamination of the Santa Ana and Pajonal rivers will significantly alter local ecosystems and human activities in the area due to water quality degradation. It will be the responsibility of the competent authorities to design and implement actions to mitigate water pollution from the population of Entre Ríos so that local water resources can be managed efficiently and responsibly to enable sustainable development.

3.5 Strategic Actions Proposal

Taking into consideration the different initiatives and projects that currently exist to protect the health of the inhabitants of the city of Entre Ríos and adequate management of the waters that flow through the city, critical points have been identified that should be addressed as soon as possible to have efficient management of local water resources.

The Salinas River basin, to which the Pajonal and Santa Ana rivers belong, is part of the Bermejo River, a basin of departmental importance; therefore, any activity in the area must be carried out in coordination with the Municipal Government and the National Technical Office of the Pilcomayo and Bermejo Rivers. In this sense, the following priority actions have been identified to reduce water pollution in the local rivers, including recommended periods in which action should be taken considering the limitations that may exist based on the current local management. Table 7 exposes the strategic actions for control and reduction of current water contamination of the community of Entre Ríos, Tarija.

Table 7: Strategic actions for control and reduction of current water contamination of the community of Entre Ríos, Tarija.

Main Activities	Duration	Resource	Monitoring	Responsible	Objective
Increase of local sewerage system coverage	5 years	Annual Operating Plans (AOP)	Semiannual (Technical reports and inspections)	Municipal Mayor's Office	100 % of the homes in the community have a sanitary sewerage system.
Remodeling and expansion of the Entre Ríos Treatment Plant	5 years	Authorities of the Municipality of Entre Ríos	Semiannual (Technical reports and inspections)	Municipal Mayor's Office	All domestic wastewater reaches the local treatment plant for proper management and disposal.

Source: Own elaboration, 2023.

3.5.1. Increase in the coverage of the local sanitary sewerage system.

Currently, a significant percentage of homes in Entre Ríos discharge their wastewater without prior treatment into nearby watercourses. This is because the current sanitary sewer system coverage does not cover the entire populated area, and local urbanizations have created their drains.

Sanitary sewerage projects need to be accelerated to ensure the well-being of the population and downstream communities. This is considered a critical strategic activity due to the high number of fecal coliforms recorded in both rivers.

3.5.2. Remodelación y ampliación de la Planta de Tratamiento de Entre Ríos

The current wastewater treatment plant is a significant source of pollution in the Santa Ana River due to poor management of gray and black water from parts of the city. It is essential to start expanding the facilities to improve the efficiency of physical and biological water treatment.

At the time of data collection, local authorities have stated that there are projects for remodeling and improving the conditions of the local treatment plant; however, the dates proposed are not definite and may be influenced by various social and economic factors, which could be detrimental to the population.

4. Conclusions

According to the results obtained and the information gathered, it can be established that the study area is in a situation of high risk related to managing its wastewater and its discharge into watercourses for agriculture and human consumption. The leading causes of this situation are linked to deficiencies in the implementation of sanitary sewer services and a wastewater treatment plant that cannot process the necessary volume. Although some activities and projects could reduce the negative impacts of water pollution, conflicts have arisen over the management of local economic resources, so there is no short- or medium-term solution to the current situation.

The organic contamination currently affecting the Pajonal and Santa Ana rivers as they flow through the community of Entre Ríos poses a significant threat to the well-being of its inhabitants, downstream communities, and the ecosystem itself. The uncontrolled wastewater discharges should be addressed as soon as possible, considering that the rural communities downstream will use the waters of the Salinas River, which joins the two rivers, as the primary water source for human consumption. In these communities, the level of treatment given to the water before consumption is minimal, which could generate health risks due to water contamination.

Entre Ríos, and Bolivia to an extent, needs to stablish several lines of action to assure the reduction of pollution generated by the wastewaters from the urban regions and its impact on vulnerable areas, especially on rural and poor communities. As of now, the biggest risk identified in the study area is the alteration of local ecosystems and human activities due to water quality degradation, with a high change to cause health issues the rural area and the Tariquía Flora and Fauna National Reserve. The implementation of new water treatment facilities could help to reduce the negative impact of the wastewater in the region as a first step to achieve the SDG-06 in the long run. Unless the local government establishes similar initiatives as the ones proposed in this document, it will not be possible to achieve the SDG-06 until 2030.

Further research could consider the results obtained in the present study to conduct more detailed and extensive research in the study area. It will be possible to analyze the ecotoxic impact on the people living in downstream communities and the local ecosystem.

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