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THE DEGREE OF CONTAMINATION OF THE WATERS OF THE RAMIS RIVER DUE TO INDISCRIMINATE SPILLAGE OF SUBSTANCES DERIVED FROM TAILINGS AND ITS IMPACT ON THE LIVING STANDARDS OF THE POPULATION NEAR THE MOUTH OF THE RIVER

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ABSTRACT

The contamination of water resources is a relevant environmental and social problem in regions where extractive activities are carried out without adequate environmental management. In this context, the objective of this study was to analyze the contamination of the waters of the Ramis River, in its mouth area, and its relationship with the reported impacts on the health and productive activities of the surrounding population. The research was developed under a quantitative, explanatory-correlational approach, with a non-experimental and cross-sectional design. Physicochemical analysis of water samples was carried out to identify the presence of heavy metals, complemented by the application of surveys to a sample of 252 families residing in the study area. The results showed the presence of metals such as iron, zinc, arsenic and lead, with variations between the sampling points analyzed. At the same time, a high frequency of human health conditions was identified, mainly gastrointestinal, dermatological and respiratory diseases, as well as impacts on domestic animals, aquatic fauna and local production systems. The comparison of the physicochemical results with normative reference values allowed contextualizing the quality of the water for different uses, pointing out potential restrictions for human consumption and productive activities in certain sectors of the river. In conclusion, the findings of the study show relevant associations between the contamination of the water of the Ramis River and the impact on the living standards of the riverside population. Although the methodological design does not allow establishing direct causal relationships, the results provide empirical evidence that contributes to the understanding of the environmental problems in the basin and reinforce the need to strengthen the strategies for monitoring, control and integrated management of water resources.

KEYWORDS: Water Pollution, Mine Tailings, Public Health, Andean Ecosystems, Quality of Life.

1. INTRODUCTION

The contamination of water resources is one of the main environmental and public health problems at the global level, particularly in regions where extractive activities are carried out without adequate environmental planning. Rivers play an essential role in ecological balance and in sustaining human activities, as they provide water for consumption, agriculture, livestock and fishing. However, when these bodies of water receive continuous discharges of industrial, mining or urban waste, their capacity for self-regulation is exceeded, generating progressive degradation processes that affect both ecosystems and the populations that depend directly on them (Gleick, 2014; World Health Organization [WHO], 2017).

In the Andean context, water pollution acquires particular relevance due to the fragility of high-altitude ecosystems and the close relationship that rural communities maintain with their natural environment. In these areas, rivers not only fulfill an environmental function, but also a social and economic one, as they constitute the basis of traditional production and subsistence systems. Studies have shown that the presence of heavy metals in water, such as mercury, lead, cadmium and zinc, can have cumulative adverse effects on human health, flora, fauna and the quality of agricultural soils, even when individual concentrations do not immediately exceed the permissible limits established by environmental regulations (Gammons et al., 2003; Müller, 1979).

The Ramis River, one of the main tributaries of Lake Titicaca, represents an emblematic case of this problem. Along its course, from its source in areas of intense gold mining activity to its mouth in the lake, the river crosses multiple communities that use its waters for domestic and productive activities. In the upper part of the basin, informal and artisanal gold mining has historically been developed without adequate infrastructure for tailings management, which has favored the direct dumping of mining waste and contaminated sediments into surface waterways. These materials are transported downstream, increasing the turbidity of the water and facilitating the dispersion of pollutants along extensive stretches of the basin (Guerrero & Zavala, 2005; Salinas et al., 2004).

The impacts of this process are not limited to the physical-chemical deterioration of the water. Previous research has documented the presence of heavy metals in sediments and aquatic organisms of the Ramis-Titicaca system, as well as bioaccumulation processes in fish intended for human consumption, which increases toxicological risks for the riparian population (Gammons et al., 2003; Vaux et al., 1988). At the same time, the poor coverage of sanitation systems in the basin's localities contributes to the organic load of the river, aggravating unsanitary conditions and reinforcing a scenario of chronic exposure to pollutants of chemical and biological origin (World Health Organization [WHO], 2017).

From a social perspective, the degradation of water quality translates into a direct impact on the living standards of the surrounding population. Reduced agricultural productivity, loss of hydrobiological species, deterioration of health, and the need to adopt alternative or migratory livelihood strategies are some of the consequences reported in areas with persistent water pollution. However, in many cases, these impacts have been analyzed in a fragmented manner, without systematically integrating environmental evidence with the social impacts perceived by local communities.

In this context, the present study aims to analyze the contamination of the waters of the Ramis River in its mouth area and its relationship with the reported impacts on the health and productive activities of the surrounding population. Through an explanatory-correlational approach, which combines the physicochemical analysis of water samples with social information obtained through surveys and interviews, it seeks to provide empirical evidence that allows understanding the magnitude of the problem and supports the need to strengthen environmental monitoring, control and management strategies in the Ramis River basin.

2. THEORETICAL FRAMEWORK

2.1. Water Pollution And Dynamics Of River Systems

Water pollution is defined as the incorporation of physical, chemical or biological substances that alter the natural properties of the water resource and limit its suitability for human and ecological uses. In river systems, this process acquires particular relevance due to its dynamic nature, since rivers act as vectors for the transport and redistribution of pollutants over large territorial extensions. The dilution and self-purification capacity of a river depends on hydrological, geomorphological and climatic factors; however, when pollutant loads exceed these limits, there is a progressive degradation of water quality and associated ecosystems (Gleick, 2014).

In regions where extractive activities are carried out without adequate environmental controls, rivers often receive continuous discharges of fine sediments

and toxic substances that remain suspended or deposited in the bed. This phenomenon increases water turbidity, reduces the penetration of solar radiation and alters basic biological processes, such as phytoplankton photosynthesis and zooplankton survival, indirectly affecting higher trophic levels (Vaux et al., 1988).

2.2. Heavy Metals As Environmental Pollutants

Heavy metals are one of the most persistent and problematic groups of pollutants in aquatic ecosystems. Elements such as mercury, lead, cadmium, arsenic, and zinc are not easily degraded and can remain active in the environment for long periods, accumulating in sediments and living organisms. In mining contexts, these metals are often released as by-products of mineral processing, especially when adequate infrastructure for tailings management is not in place (Gammons et al., 2003).

From an environmental point of view, the presence of heavy metals in water depends not only on their dissolved concentration, but also on their association with suspended solid particles. Several studies have shown that a significant fraction of these pollutants are transported adsorbed to fine sediments, which facilitates their dispersion downstream and their subsequent accumulation in areas of lower flow velocity, such as floodplains and mouths (Müller, 1979).

2.3. Bioaccumulation And Ecotoxicological Effects

One of the most critical aspects of heavy metal pollution is its ability to bioaccumulate and biomagnify along food chains. Aquatic organisms can incorporate these elements through water or food, storing them in soft tissues and vital organs. As pollutants are transferred between trophic levels, their concentrations can increase, creating significant risks to top predators, including humans (Gammons et al., 2003).

In lake and river systems associated with Lake Titicaca, the accumulation of mercury in fish species destined for human consumption has been documented, which represents a direct route of chronic exposure for coastal populations. This process not only compromises public health, but also affects the sustainability of traditional fishing activities, by reducing the availability of safe hydrobiological resources (Vaux et al., 1988).

2.4. Water Pollution And Human Health

The relationship between water quality and human health has been widely documented in the scientific literature. The use of contaminated water for consumption, hygiene or agricultural irrigation increases the incidence of gastrointestinal, dermal and respiratory diseases, especially in contexts where there are no adequate drinking water treatment and basic sanitation systems. Long-term exposure to heavy metals, even at low concentrations, can lead to cumulative effects that manifest themselves in the medium and long term (World Health Organization [WHO], 2017).

In rural areas, where direct dependence on water resources is greater, health risks are intensified due to the absence of safe supply alternatives. The coexistence of chemical pollutants from mining activities and organic loads derived from domestic wastewater configures scenarios of environmental and social vulnerability that disproportionately affect communities with limited institutional response capacities.

2.5. Socioeconomic Impacts Of Water Resource Degradation

The degradation of water quality has implications that transcend the environmental and health spheres, directly affecting the living standards of the population. The decrease in the fertility of soils irrigated with contaminated water, the mortality of domestic animals and the loss of aquatic species affect the productive base of local economies, forcing families to modify their subsistence strategies. In many cases, these transformations translate into processes of migration, informalization of employment, and increased economic vulnerability (Salinas et al., 2004).

From this perspective, water pollution should be understood as a multidimensional phenomenon, in which environmental, health and socioeconomic impacts are interrelated and mutually reinforcing. Analysing these processes in an integrated manner is essential to understand the real magnitude of the problem and to inform the formulation of environmental management and sustainable development policies.

2.6. Environmental Management And The Need For Integrated Approaches

The specialized literature agrees that the effective management of water resources in basins affected by extractive activities requires integrated approaches that articulate environmental monitoring, the regulation of productive activities, and the participation of local communities. The absence of systematic controls and coordinated environmental governance favors the persistence of polluting

practices and hinders the implementation of timely corrective measures (Guerrero & Zavala, 2005).

In this sense, explanatory-correlational studies allow the generation of relevant evidence on the existing associations between water pollution and perceived social impacts, constituting a valuable tool for decision-making. Without pretending to establish direct causal relationships, this type of analysis contributes to making visible patterns of impact and to support the need to strengthen environmental control and surveillance systems in strategic watersheds such as the Ramis River.

3. OBJECTIVES

3.1. General Objective

Evaluate the degree of contamination in the waters of the mouth of the Ramis River, applying laboratory sample tests to determine the control and measurement of the levels of danger that affect the standard of living of the surrounding population.

3.2. Specific objectives

a) To determine the degree of contamination of the river waters by toxic chemical substances derived from mine tailings and their impact on the flora and fauna of the place.
b) Determine the level of knowledge of the population about the pollution and environmental conservation of their environment.
c) To establish to what extent the waters of the Ramis River are polluted by pollutants, causing unhealthiness in the surrounding population.

4. METHODOLOGY

4.1. Study Type And Design

The study was developed under a quantitative, explanatory-correlational approach, with the aim of analyzing the relationship between the pollution of the waters of the Ramis River and the reported impacts on the health and productive activities of the population surrounding its mouth. This approach made it possible to integrate environmental information obtained through physicochemical analysis of water with social information collected through surveys applied to the inhabitants of the study area.

The research design was non-experimental and cross-sectional, because the variables were observed in their natural context, without deliberate manipulation, and the data were collected at a single time point. This type of design is appropriate for identifying associations between environmental and social variables in contexts where direct experimentation is not feasible for ethical and operational reasons (Hernández-Sampieri et al., 2014).

4.2. Scope Of Study

The geographical scope included the populated sectors located in the vicinity of the mouth of the Ramis River, in the districts of Taraco and Huancané, department of Puno, Peru. This area is characterized by a high dependence on water resources for the development of agricultural, livestock and domestic activities, as well as by prolonged exposure to pollution processes associated with the mining activity carried out in the upper part of the basin.

4.3. Population And Sample

The population was made up of 730 families residing in the communities surrounding the mouth of the Ramis River. From this population, a representative sample was determined by probability sampling, considering a confidence level of 95% and a margin of error of 5%.

The sample size was calculated using the formula for finite populations:

$$n = \frac{N \cdot Z^2 \cdot p \cdot q}{E^2(N-1) + Z^2 \cdot p \cdot q}$$

(Equation 1)

Where:n = sample sizeN = population sizeZ = value of the normal distribution for a 95% confidence levelE = margin of errorp = probability of occurrenceq = probability of non-occurrence

Table 1: Sample Size Determination.

Parameter	Description	Value
N	Total, population (families)	730
Z	Confidence level (95%)	1,96
E	Margin of error	0,05
p	Probability of occurrence	0,50
q	Probability of non-occurrence	0,50
n	Sample size	252

Source: Authors.

Applying the equation described, a sample size of 252 families was obtained, which were surveyed directly.

4.4. Study Variables

The independent variable corresponded to the contamination of the waters of the Ramis River, operationalized through physicochemical indicators such as the presence of heavy metals, suspended solids and water quality parameters. The dependent variable was associated with the impacts on the living standards of the population, evaluated through indicators related to human health, productive activity, soil fertility, and local socioeconomic dynamics.

4.5. Data Collection Techniques And Instruments

Environmental and social techniques were used to collect information. In the environmental component, water sampling from the Ramis River was carried out at representative points of the study area, in order to determine the concentration of heavy metals and other relevant physicochemical parameters. The samples were analyzed in specialized laboratories, following standardized environmental analysis procedures.

In the social component, a structured survey was applied to the families selected in the sample, composed of closed questions aimed at identifying the perceived effects of water pollution on health, agricultural production, livestock, fishing and living conditions. In addition, semi-structured interviews were conducted with key informants, with the purpose of contextualizing the quantitative results.

4.6. Data Analysis Procedure

The data obtained were processed using descriptive statistics, calculating frequencies and percentages to characterize the impacts reported by the population. Subsequently, statistical association tests were applied in order to assess the relationship between water pollution and the observed effects on living standards.

Pearson's Chi-square test was used to test hypotheses, whose mathematical expression is as follows:

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

(Equation 2)

Where: χ^2 = Chi-square statistic valueO = observed frequencyE = expected frequency

The level of significance considered was $\alpha = 0.05$. The results allowed the identification of statistically significant associations between the variables analyzed, without establishing direct causal relationships, in coherence with the non-experimental design of the study.

4.7. Ethical Considerations

The research was carried out respecting the principles of confidentiality, anonymity and informed consent. Respondents' participation was voluntary, and the information collected was used exclusively for academic and scientific purposes.

5. RESULTS

The results obtained allow us to characterize the effects of the contamination of the Ramis River from an environmental and social perspective, integrating physicochemical information of the water with the impacts reported by the population surrounding the study area.

5.1. Impacts On Human Health

The information collected through surveys showed a high prevalence of health conditions associated with the use of the waters of the Ramis River. As shown in **Table 2**, 55.56% of the respondents reported the presence of gastrointestinal diseases and recurrent febrile states, followed by dermatological and infectious diseases (25.79%) and respiratory conditions (18.65%).

These results reflect a consistent pattern of health impact in the riverside population, particularly in diseases related to consumption and contact with low-quality water. The magnitude of the percentages observed suggests continuous exposure to environmental risk factors, consistent with the levels of contamination recorded in the physicochemical analyses of the water.

Table 2: Effects Of Ramis River Pollution On Human Health.

Type of disease	Frequency	Percentage
Gastrointestinal and febrile	140	55,56
Dermatological and infectious	65	25,79
Respiratory	47	18,65
Total	252	100

Source: Survey Applied To Residents Near The Ramis River.

5.2. Impacts On Domestic Animals

In relation to domestic animals, the results indicate a significant impact on their health status. According to **Table 3**, 63.49% of the respondents indicated that their animals have stomach and

intestinal discomfort, while 28.97% reported infectious signs and 7.54% motor coordination problems.

The predominance of digestive diseases suggests a close relationship with the use of contaminated water for animal consumption and pasture irrigation, which reinforces the hypothesis of a transversal environmental impact on local production systems.

Table 3: Effects Of Ramis River Pollution On Domestic Animals.

Type of involvement	Frequency	Percentage
Stomach and intestinal discomfort	160	63,49
Infectious signs	73	28,97
Torpedo Engine	19	7,54
Total	252	100

Source: Survey Applied To Residents Near The Ramis River.

5.3. Effects On Hydrobiological Resources

Regarding aquatic fauna, the results show a progressive deterioration of fish populations. As shown in **Table 4**, 55.95% of the respondents indicated an increasing extinction of species, while 26.59% reported episodes of sudden death and 17.46% the displacement of fish to other channels.

These findings show a significant alteration of the ecological balance of the river, compatible with conditions of high turbidity and the presence of pollutants that limit the survival of aquatic species.

Table 4: Impacts Of Pollution On Ichthyological Fauna.

Observed impact	Frequency	Percentage
Progressive extinction of species	141	55,95
Sudden fish death	67	26,59
Movement to other channels	44	17,46
Total	252	100

Source: Survey Applied To Residents Near The Ramis River.

5.4. Physicochemical Results Of Water

Laboratory analyses confirmed the presence of heavy metals in water samples collected at different points of the Ramis River. As can be seen in **Table 5**, relevant concentrations of iron, zinc, arsenic and lead were identified, with variations between the sampling points.

These spatial differences show a heterogeneous pattern of pollution, influenced by fluvial dynamics and proximity to mining waste discharge areas.

Table 5: Physicochemical Results Of The Water Of The Ramis River (Mg/L).

Determination	River Water Shows 02 Fork	River water sample 01 Hatun Pampa mouth	River Water Shows 03 Ramis Bridge	Units
Cyanide (CN-)*			< 0.004	mg/L
Arsenic (As)*	0,014	0,012		mg/L
Cadmium (Cd)*	< 0.006	< 0.006		mg/L
Lead (Pb)*	0,016	< 0.01		mg/L
Mercury (Hg)*	< 0.0002	< 0.0002	< 0.0002	mg/L
Nickel (Ni)*	0,007	< 0.001		mg/L
Fierro (Fe)	3,64	1,72		mg/L
Zinc (Zn)	0,52	2,68		mg/L

Source: Ramis River Water Analysis (M-1 Hatun Pampa Lago). Bhios Laboratories Test Report N° 0108- Huancané - Puno - 2008

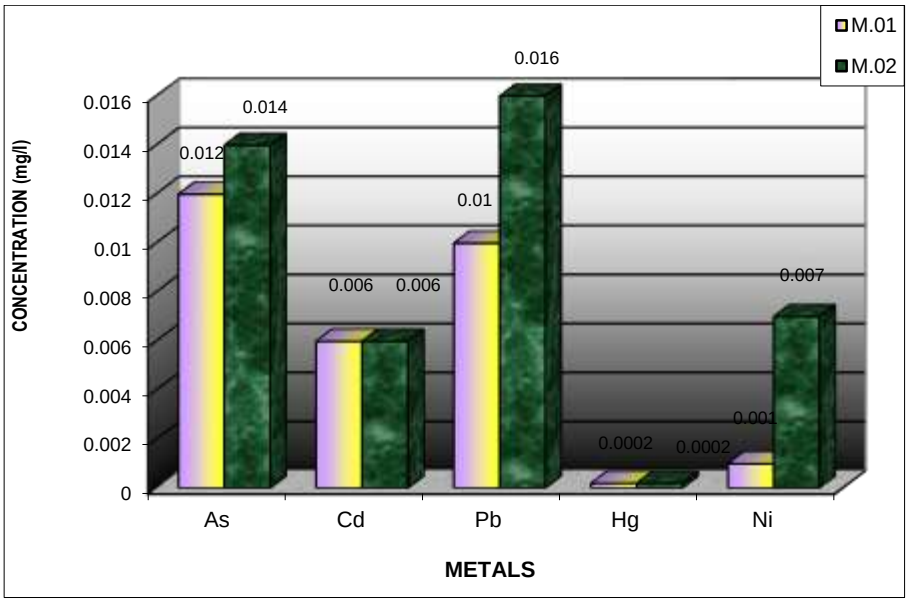

Figure 1: Comparison Of Heavy Metal Concentrations (Fe, Zn, As And Pb) At The Sampling Points Of The Ramis River.

Figure 1 presents the comparison of two types of samples in which chemical tests show that in Sample 02 taken at the fork of the Ramis River the concentration level of the contaminant of the metals: Arsenic, Cadmium, Lead, Mercury and Nickel are higher than in Sample 01 at the mouth of the river.

5.5. Comparison Of Results With Permissible Limits

The values obtained in the physicochemical analyses of the water of the Ramis River were contrasted with the maximum permissible limits established for different uses of the water, in accordance with the regulations of the Ministry of Energy and Mines of Peru, the World Health Organization and the Food and Agriculture Organization of the United Nations. This comparison allowed us to contextualize the magnitude of the pollution levels recorded at the sampling points.

The results show that some parameters, such as iron and zinc, have concentrations that exceed the values recommended for human consumption at certain points of the river, while other heavy metals, such as arsenic and lead, are close to the limits established according to the type of water use considered. These differences suggest potential restrictions for the use of water resources in domestic and productive activities, especially in areas near the mouth and areas influenced by discharges of mining origin.

The normative comparison does not intend to establish definitive regulatory judgments, but to provide a framework of reference that facilitates the interpretation of the physicochemical results obtained and their possible implication in human health and in local production systems.

6. DISCUSSION

The results obtained in this study allow us to analyze the problem of the contamination of the Ramis River from an integrated perspective, articulating physicochemical evidence of the water with the impacts reported by the surrounding population. In coherence with the non-experimental and explanatory-correlational design, the findings do not intend to establish direct causal relationships, but to identify relevant associations that contribute to understanding the magnitude of the phenomenon and its environmental and social implications.

6.1. Relationship Between Water Quality And Human Health

The high prevalence of gastrointestinal, dermatological and respiratory diseases reported by the population coincides with what has been described in the literature on the effects of the use of contaminated water in rural contexts with limited access to treatment and sanitation systems. The World Health Organization has noted that prolonged exposure to low-quality water significantly increases the risk of infectious diseases and chronic conditions, especially in communities that depend directly on surface sources for consumption and domestic activities (World Health Organization [WHO], 2017).

In the case of the Ramis River, the presence of metals such as iron, zinc, arsenic and lead, identified

in physicochemical analyses, constitutes an additional risk factor that can contribute to the impact on human health. While some concentrations do not uniformly exceed the maximum permissible limits for all water uses, their persistent presence reinforces the hypothesis of continuous environmental exposure. These results are consistent with previous studies carried out in the Ramis-Titicaca basin, which have documented chronic contamination scenarios associated with gold mining activity in the upper part of the basin (Gammons et al., 2003).

6.2. Impacts On Production Systems And Fauna

The effects reported on domestic animals and aquatic fauna reflect an environmental impact that transcends the human sphere. The high frequency of digestive discomfort and infections in animals suggests indirect exposure to pollutants through the consumption of water and pastures irrigated with river water. This pattern has been described in other mining contexts, where water pollution alters the quality of forage resources and compromises animal health, reducing livestock productivity (Salinas et al., 2004).

Similarly, the perception of a progressive decline in fish species and the occurrence of sudden mortality events are consistent with the ecotoxicological effects associated with the presence of heavy metals and high levels of turbidity. The literature indicates that the alteration of the water column and the accumulation of pollutants in sediments affect the reproductive processes and survival of aquatic species, generating ecological imbalances in the medium and long term (Vaux et al., 1988; Müller, 1979). In this sense, the results of the study reinforce the existing evidence on the vulnerability of Andean river ecosystems to unregulated extractive pressures.

6.3. Interpretation Of Physicochemical Results In The Regulatory Framework

The comparison of the physicochemical results with the maximum permissible limits established by national and international organizations allowed to contextualize the quality of the water of the Ramis River for different uses. As evidenced in the results, some parameters exceed or approach the recommended values for human consumption and agricultural irrigation at certain sampling points, suggesting potential restrictions for the safe use of water resources.

However, it is important to note that the normative interpretation made in this study fulfills a referential and not a regulatory function. In accordance with the methodological approach adopted, the comparison with international standards seeks to facilitate the understanding of the magnitude of the problem and its possible implications, without replacing the formal environmental assessment processes that correspond to the competent authorities. This approach has been recommended in exploratory and correlational environmental studies, where the main purpose is to generate evidence for decision-making and the design of public policies (Gleick, 2014).

6.4. Socioeconomic And Environmental Implications

The results related to the loss of soil fertility, the decrease in fishing activity and the adoption of alternative labor strategies reflect a direct impact on the living standards of the population surrounding the Ramis River. These findings are consistent with research indicating that sustained environmental degradation can trigger processes of impoverishment, informalization of employment, and migration in rural communities dependent on natural resources (Salinas et al., 2004).

From this perspective, the pollution of the Ramis River should be understood as a multidimensional phenomenon, in which environmental, health and socioeconomic impacts are interrelated. The evidence obtained in this study provides empirical elements that reinforce the need for integrated approaches to watershed management, capable of articulating environmental monitoring actions, control of extractive activities and strengthening of local capacities for the protection of water resources.

6.5. Scope And Limitations Of The Study

Although the results obtained allow us to identify relevant associations between water pollution and the impacts reported by the population, it is necessary to recognize certain limitations. The cross-sectional design of the study does not allow the temporal evolution of the observed effects to be analysed or direct causal relationships to be established. Likewise, social information is based on perceptions reported by respondents, which may be influenced by contextual and subjective factors.

However, these limitations do not invalidate the findings, but rather delimit their scope and reinforce the relevance of future studies that incorporate longitudinal analyses, a greater number of sampling points and multivariate techniques. In this sense, the present study constitutes a relevant empirical basis for further research and for the formulation of

environmental management strategies in the Ramis river basin.

7. CONCLUSIONS

The results of the study allow us to affirm that the Ramis River presents a scenario of environmental contamination that is manifested both in the physicochemical quality of the water and in the impacts reported by the population surrounding its mouth. The integrated analysis of environmental and social data evidenced relevant associations between the presence of contaminants in water and the impact on the living standards of local communities, in coherence with the explanatory-correlational approach adopted.

The physicochemical analyses of the water confirmed the presence of heavy metals such as iron, zinc, arsenic and lead, with variations between the sampling points. The comparison of these results with reference values established by national and international regulations made it possible to contextualize the magnitude of pollution and to point out potential restrictions for the use of water resources in domestic and productive activities, particularly in areas influenced by discharges of mining origin.

From the social perspective, the results showed a high frequency of human health problems, especially gastrointestinal, dermatological and respiratory diseases, as well as effects on domestic animals and aquatic fauna. These findings reflect a consistent pattern of environmental vulnerability in the riparian population, associated with the continuous use of low-quality water and direct dependence on the river for subsistence activities.

Likewise, significant impacts on local production systems were identified, expressed in the progressive loss of soil fertility, the decrease in fishing activity and the adoption of alternative labor strategies. These transformations show a close relationship between the degradation of water resources and the deterioration of the socioeconomic conditions of the communities, reinforcing the need to address the problem from a comprehensive approach to environmental management.

Although the non-experimental and cross-sectional design of the study does not allow establishing direct causal relationships, the results provide sufficient empirical evidence to point out relevant associations that contribute to the understanding of the environmental problems of the Ramis River. In this sense, the study constitutes a valuable input for the formulation of public policies aimed at strengthening environmental monitoring, the control of extractive activities and the protection of water resources in the basin.

Finally, it is recommended that future research incorporate longitudinal analyses, a greater number of sampling points and multivariate statistical techniques that allow for a deeper understanding of the temporal dynamics of pollution and its effects. It is also essential to promote integrated watershed management strategies that articulate the participation of authorities, productive actors and local communities, in order to mitigate environmental impacts and improve the living standards of the population surrounding the Ramis River.

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