College of Architecture, Planning & Landscape Architecture

REHABILITATION OF THE RÍMAC RIVER

An Analysis of Citizen Participation for the Sustainable Rehabilitation of the Rimac River

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Table of contents

Abstract

Although institutional actions in Lima, Peru aim to address river cleaning, wastewater control, and riverbank recovery, these efforts remain fragmented and uneven in their social and environmental outcomes, resulting in limited long term impact. This research analyzes the rehabilitation of the Rímac River as a public, environmental, and social space within the urban structure, starting from its current condition of deterioration, pollution, insecurity, and disconnection from the city. Previous studies reveal that most rehabilitation approaches prioritize technical and infrastructural solutions, while issues of social equity, citizen participation, and long-term governance are often treated as secondary components.

To address this gap, this research adopts a qualitative methodology based on an auto ethnographic approach supported by document analysis, a comparative study of the Remedios and Xochimilco rivers in Mexico, and an interview with a specialist in cultural ecology. This methodological framework allows for the identification of integrated and context sensitive strategies that combine ecological restoration, technological infrastructure, institutional coordination, and community participation, while also acknowledging the need to distribute environmental benefits and risks more equitably over time within the Rímac River basin.

The alignment of technical interventions, governance structures, and active citizen involvement achieved sustained improvements in environmental quality, reduced health risks, and ecosystem recovery in the reference cases. In contrast, the Rímac River continues to face high levels of pollution, informal occupation, insecurity, and weak public appropriation of its riverbanks, limiting its integration into everyday urban life. The research argues that effective rehabilitation requires moving beyond isolated technical actions toward an integrated and phased framework that incorporates environmental education, social activation, urban safety, and community-based governance. By understanding the Rímac as a socio ecological system, this study proposes a realistic and adaptable approach that strengthens intergenerational equity, supports long term sustainability, urban resilience, and inclusive regeneration along the river corridor.

Keywords: Rímac River, urban rehabilitation, citizen participation, environmental recovery, public space, sustainable urban regeneration.

Introduction

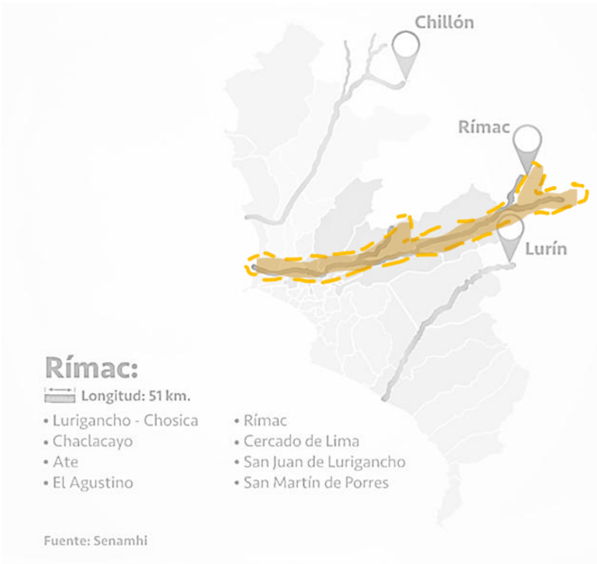
The Rímac River has been a pillar of Lima's development since pre-Hispanic times. Its waters emerge in the Andes Mountain range at more than five thousand meters above sea level. The National Water Authority (ANA) describes this basin as one of the most complex in the country due to the variety of ecological zones it crosses, ranging from glacial and rocky landscapes to agricultural soils, dense urban areas and industrial zones. In its upper section, the Rímac shows cold, turbulent waters with a high rate of descent. It crosses territories where mining activities have historically been established, introducing chemical pressures that gradually alter the water's initial quality. In the middle section, the slopes decrease and the river flows through wider valleys, where agricultural areas coexist with sectors undergoing rapid urbanization. ANA identifies this stretch as one of the most sensitive, because it receives smaller tributaries and simultaneously begins to interact with domestic uses and small discharges that affect its composition.

When entering Metropolitan Lima, the Rímac changes drastically. Its channel narrows, becomes confined between retaining walls, highways and informal constructions, and turns into an element that must coexist with avenues, bridges, diversion canals and treatment plants. The hydraulic authority itself notes that this urban section experiences the greatest pressure due to the intensive use of water for human consumption, the presence of aging collectors, residual discharges and the erosion caused by informal housing growth in marginal floodplain zones. The extent of the Rímac is measured not only as a geographical path, but also as an environmental gradient that reflects the interaction among nature, the city and extractive activities. According to ANA and SENAMHI, as it descends from the mountains toward the coast, it covers nearly one hundred forty-five kilometers before reaching the Pacific Ocean, of which approximately fifty-one kilometers run through Metropolitan Lima.

Figure (01)

Location of the Rimac River

Figure (02)



Tour of the Rimac River basin

Historically, the Rímac River functioned as an ecological corridor; in past decades, researchers recorded the presence of river shrimp and silverside fish in different sections of the valley, signs of a river that offered reproduction and feeding zones for fish and crustaceans. Over time, mining, industrial, and domestic discharges broke that balance, altering the water's composition and the sediment dynamics, which prevented many species from completing their life cycles. Silverside fish and river shrimp did not disappear suddenly at a single point; multiple pressures accumulated to cause their disappearance. In the upper and middle parts of the basin, mining liabilities and specific discharges introduced metals such as lead, arsenic, cadmium, and iron, which filtered into the channel, deteriorating its quality from the first kilometers and altering the water’s ph. In the middle and lower parts, the lack of wastewater treatment and industrial effluents contributed organic matter, detergents and other compounds that reduce dissolved oxygen. These chemical changes, documented by technical monitoring, degrade reproduction habitats and increase larval mortality. According to ANA, the loss is not only biological; it also erased cultural practices and ways of life that depended on river fishing.

Casapalca illustrates this dynamic with stark clarity because it is a section where mining activity and discharges have had concrete impacts on species such as trout. In that area, trout, a species that once constituted a local source of food and income, has shown signs of population stress: frequent mortality, smaller average size and evidence of metal bioaccumulation in tissues reported in studies carried out in the basin. Testimonies from residents and journalistic reports indicate that many breeding efforts and catches have declined or become unviable, forcing families to depend less on local fishing and more on other income sources. This loss also has direct implications for human health: the presence of metals such as arsenic, lead and cadmium in water and sediments raises the possibility that the consumption of local fish represents a risk, because these toxins can affect neurological, renal and cardiovascular systems when they enter the human diet in a sustained manner. This fact is concerning because these are recorded data, and yet the population continues consuming trout or working through fishing activities, knowing that the river is contaminated by chemicals, either due to ignorance or the lack of resources in the locality. However, the state or local municipalities do not take action to intervene in these sectors that are vulnerable to health risks. Where, then, is the right to life? As an architect, it is impossible for me not to question how it is allowed for these conditions to persist; does the life of a living being have a price?

This question is not easy to answer, but we can ask ourselves whether the SDGs are being fulfilled, and I believe they do not meet several Sustainable Development Goals such as SDG 3 (Good Health and Well-Being), which aims to ensure a healthy life; SDG 6 (Clean Water and Sanitation), oriented toward ensuring the availability of quality water; and SDG 11 (Sustainable Cities and Communities), which demands safe and resilient environments. The persistence of these problems reveals a gap between international goals and the actual management of the territory, which is why it is necessary to rethink planning and environmental justice to protect the communities that depend directly on these ecosystems.

However, the flora shows another part of the damage that the Rímac River has been accumulating. In the past, life filled the riverbanks. Reeds and cattails grew in the nearby wetlands, together with low plants and shrubs that helped retain the soil and clean the water naturally. Some trees also grew in the area, providing shade and shelter for birds and insects. This riverside landscape worked as a living system that protected the river and kept its balance.

Over time, water pollution, soil erosion, and human occupation caused many native species to disappear, especially in urban areas and in surrounding zones where land use changed completely. In these spaces, plants that can better resist harsh conditions began to appear. These species grow easily in compacted or even contaminated soils. They are mostly invasive grasses and weeds that establish quickly and occupy the space with few requirements. Although they cover the ground, they do not perform the ecological functions that the original vegetation had before. They do not filter the water in the same way, nor support the same life or stabilize the riverbed as they did in the past. As a result, the river has lost part of the natural protection that kept it in balance.

So how is the recovery and cleaning of the Rímac River expected to happen if we have continually contributed to the degradation of its ecosystem? The river is not going to clean itself.

Figure (03)

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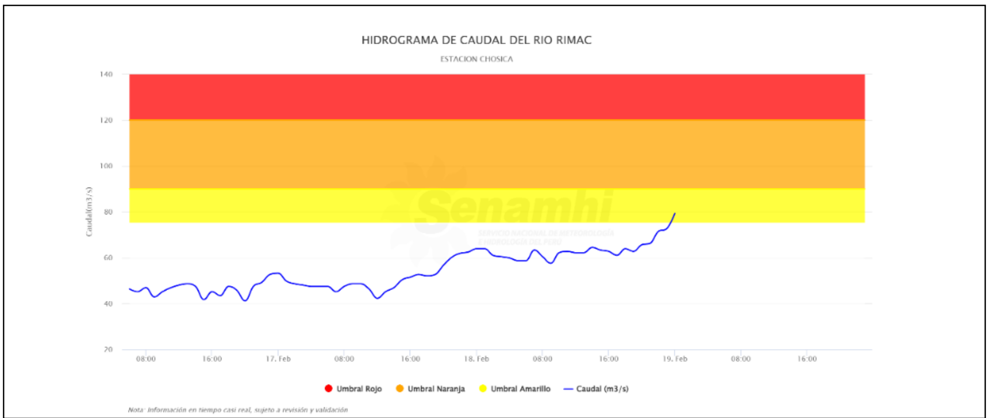
Current state of the Rimac River with weeds.

On the other hand, the climate in the Rímac basin is a key factor for understanding its behavior, especially during the rainy season in the central highlands. When rainfall begins in Huarochirí and in the high Andean zones, the river's flow can suddenly increase and drag sediments, rocks and all kinds of material that detach from the slopes. This behavior is typical of mountain rivers, where the gradient is steep and the soils are often weakened by erosion or by human activity. According to SENAMHI reports, during recent episodes of intense rainfall the Rímac showed abrupt variations in flow within a matter of hours. This would not be a major problem if the riverbed were clear and if the nearby infrastructure were designed to withstand these natural changes. However, when these surges coincide with poorly planned structures or with houses built too close to the riverbanks, the risk increases sharply. This situation becomes more delicate in the lower part of the valley, where informal urbanization has occupied the river margins without technical or safety criteria. That combination of rainfall, increased flow and vulnerable occupation became evident on January third, twenty twenty-five, when the rains in the highlands activated hydrological alerts for the Rímac and the Chillón, putting the population centers of Chosica and Chaclacayo at risk. The event once again showed that the climate and the lack of urban planning form a set of risks that repeat every year and continue affecting the most exposed areas.

Figure (04)



Red	Probable river overflow. Possible flooding in lower populated and agricultural areas, bank erosion, and damage to infrastructure within or near the river's immediate vicinity.
Orange	Probable risk conditions for activities in the river and surrounding areas, with possible bank erosion and damage to infrastructure within or near the river's immediate vicinity.
Yellow	Probable conditions that could affect activities in the river and surrounding areas.

That was precisely the scenario experienced with the Solidaridad Bridge. According to reports broadcast by TV Perú and corroborated by articles from El Comercio, the bridge collapsed because the swelling of the Rímac undermined its foundations, weakening them until the structure gave way. The Comptroller's Office, in a later audit, stated that the project had technical deficiencies and that the base of the bridge was not prepared to withstand intense scouring at a critical point of the riverbed. This event occurred on March seventeenth, twenty seventeen, temporarily leaving the districts of San Juan de Lurigancho and El Agustino disconnected. Although the collapse did not produce direct chemical contamination of the water, it did generate physical contamination, since the debris from the bridge fell into the river channel and temporarily altered the flow; moreover, the incident revealed the prior deterioration of the riverbanks, affected by years of erosion, accumulated waste and lack of protective works. This event demonstrated the vulnerability of the infrastructure built near the river and the need to strengthen environmental management measures and overflow prevention.

Figure (05)

Collapse of the Solidarity Bridge

In the Rímac River basin, more than five million people live, with an average density of approximately one thousand four hundred eighty inhabitants per square kilometer, according to a study on articulated basins from Congress. This population growth is not limited only to Metropolitan Lima; it also includes high Andean and mid-highland districts, which exerts constant pressure on the river. ANA has identified more than one thousand pollution sources throughout the entire basin, especially in areas such as Lurigancho-Chosica, according to the Government of Peru.

This population increase goes hand in hand with contamination: untreated discharges, solid waste and residual effluents have become common in several sections.

This pollution not only affects the ecosystem, but also the people living near the riverbed, since the presence of wastewater, garbage and heavy metals can increase gastrointestinal diseases, respiratory problems, allergies and even risks associated with prolonged exposure to toxic substances. And this pollution is reflected in events such as the one in November twenty twenty-three, when a thick layer of white foam covered several stretches of the Rímac River, especially near the Santa Rosa Bridge. This phenomenon generated concern among residents and authorities, as the foam was persistent and accumulated in large amounts. According to OEFA evaluations, the most probable cause was the discharge of wastewater with a high load of detergents and chemical substances from clandestine connections and industries located along the riverbank. This episode again revealed the lack of control over urban effluents and the need to strengthen oversight in critical areas. Moreover, it exposed that many of these discharges occur constantly and not only in isolated episodes, which worsens the accumulated pollution in the lower basin. For specialists, this case was a clear demonstration of how a single failure in the control system can trigger visible impacts that affect both the ecosystem and public perception of the river’s condition.

Figure (06)

White foam covers the Rimac River

The most recent major contamination event in the Rímac River occurred on February fourth, twenty twenty-five, when a stretch of the river between the Trujillo Bridge and the Alameda Chabuca Granda presented an unusual reddish coloration, which prompted an immediate intervention by the authorities. The National Water Authority (ANA) collected samples to evaluate parameters such as pH and dissolved oxygen, while OEFA carried out inspections in the area and detected a pipe connected to SEDAPAL near La Atarjea as a possible point of origin of the color change. According to information shared by the Ombudsman's Office, the possible causes being considered include industrial discharges, the dragging of mineral sediments and the presence of microorganisms that can generate unusual pigmentation in the water.

Figure (07)

The Rimac River shows a change in color due to pollution.

That is why the authorities have promoted various plans to save the Rímac River. The National Water Authority and the Peruvian State, after identifying hundreds of sources of pollution that include wastewater, industrial discharges and mining liabilities, have designed strategies to reduce effluents and improve water quality.

The Rímac River Master Plan was originally developed between 2012 and 2015 with technical support from South Korea. The plan proposed a long-term vision to organize urban growth, recover the riverbanks, and reduce risks related to erosion and flooding. Although it was a solid and ambitious document, its implementation stayed almost paralyzed for several years due to the lack of stable funding, the constant change of authorities, and the administrative effects of the pandemic. Only in April twenty twenty-five did ANA formally decide to reactivate the process, resuming the updating of the study with the goal of turning it into a binding instrument for the entire basin. Shortly after, in August of the same year, the plan was declared of national interest, which opened a new stage of coordination among institutions and ensured that municipalities would no longer continue developing isolated or contradictory projects. Although it has not yet materialized into physical works, it is once again in technical development, and its updated version is progressing as the guide that will define what can be intervened, where and under what criteria in the coming years.

On the other hand, one of the most representative efforts is the Rímac River Special Landscape Project, an intervention that officially began in twenty twenty-two when the Municipality of Lima and CAF signed an agreement to finance the investment studies with six hundred thousand dollars. Since then, the project has remained in the development phase and focuses on preparing technical studies that will define the transformation of the river's urban section into a landscape corridor with riverwalks, green areas, bike paths, pedestrian routes and safe public spaces. In addition to recovering the deteriorated landscape, it also seeks to implement riverbank defenses to reduce erosion and prevent new informal occupations. Although no formal modifications have been reported that alter its original scope, the technical complexity of the study, the coordination required among multiple institutions and the high budget needed for execution have slowed its progress more than anticipated. Despite this, it remains the only comprehensive project proposing a modern and continuous intervention along the river, and its full implementation is expected to be achieved in the next decade, turning it into an opportunity for the Rímac to regain its environmental and urban value within the city.

That is why, although the Special Landscape Project of the Rímac River represents an important step, it also reveals a deeper problem: the recovery of the river cannot depend solely on partial interventions. Since it does not cover the entire length of the Rímac, its reach is limited and the solution becomes incomplete. Real rehabilitation requires a basin-wide perspective that includes the upper, middle and lower zones, which is still not guaranteed in the current proposals.

Figure (08)

Special Landscape Project of the Rimac River

Finally, the Environmental Recovery Program of the Rímac River, led by ANA together with MINAM, follows a much more immediate path. It began implementation in twenty twenty-three as a response to the recurring episodes of acute contamination in urban and peri-urban areas, and since then it has remained in continuous operation with weekly actions of inspection, closure of clandestine connections and water quality sampling. Its interventions focus on the stretches where historically the highest levels of dumping have been detected, such as Campoy, Puente Nuevo, El Agustino and Huachipa, although over the months new points have also been incorporated thanks to the updated mapping carried out by ANA. Although the plan has not undergone structural changes since its inception, it has expanded its operational scope, including additional brigades and greater coordination with municipalities to accelerate sanctions and corrective measures. Unlike long-term planning projects, this program is perceived directly on the ground: it shows quick results, generates periodic reports and remains under constant execution through twenty twenty-five as one of the most visible interventions to halt the daily deterioration of the river. In this process, its scope covers both the continuous monitoring of the most pressured urban stretches and the detection and attention of new pollution sources, allowing for flexible coverage that adapts to the river's real behavior and strengthens control throughout the intervened corridor.

Figure (09)

Cleaning intervention of a sector of the Rimac River

Despite this scenario, the recovery plans promoted in recent years tend to focus mainly on the central sectors of the river, especially the metropolitan stretches near downtown Lima. Projects such as periodic cleanups, retaining walls, and landscape restoration programs have partially improved the most visible urban area, but they leave out large sections of the upper and middle basin where deterioration continues to advance more quietly. In these stretches, which include small communities and peri-urban areas, the absence of constant supervision worsens the problem because they become points of accumulated waste, clandestine dumping sites, and discharges that do not comply with sanitation regulations.

In addition, the Rímac River has become a high-risk area in terms of security, which shows that the problems are not only ecological but also social. In May 2025, the National Police found an unidentified body floating in the river near Carapongo, in Lurigancho-Chosica; according to local patrols, the man showed head injuries and other signs of violence, and it is suspected that he may have been tortured before being abandoned in the riverbed. More recently, in June of that same year, waste pickers found the body of a man inside a sack on the banks of the Rímac in El Agustino, with a bullet wound in the head; witnesses stated that a vehicle arrived at dawn via Vía Evitamiento to drop off the bundle. In October, the discovery of two more bodies was also reported near the border between Ate and Chosica, right beside the river, suggesting that this is not a controlled or safe space for many.

These events highlight the lack of surveillance in many riverfront zones: dark stretches, difficult access points, and scarce lighting turn them into favorable areas for crime. Although there have been efforts to improve security, such as the “Arturito” robots implemented by the Municipality of Rímac for video surveillance, which have helped reduce certain crime rates according to Radio Nacional, the recovery of the river cannot be limited solely to environmental issues. It must also include a serious security strategy and permanent institutional presence along its margins. If this issue is not addressed, the programs to revitalize the Rímac will remain incomplete, because it is not enough to clean its waters if the lives of those who live nearby continue to be at risk.

Figure (10)

Crime news near the Rimac River

I have observed that crime has increased due to the loss of the relationship between the city and the river. In many stretches of the Rímac there is no protection or institutional presence, and this makes me, just like the residents, feel afraid to remain in those spaces. Although multiple rehabilitation plans have been developed, most of them focus exclusively on Metropolitan Lima. And then I ask myself: what happens to the other sectors of the Rímac River? I perceive that the State prefers to intervene in central areas because they are more attractive for tourism and commerce, while other localities do not have the same privilege. These areas remain on the “dark side” of the river, where vulnerability to crime is much higher. Crime reports also tend to focus more on these districts than on central Lima, which shows a level of neglect that directly affects the quality of life of their residents.

Methodology

Research Design

The research design used in this work follows an auto ethnographic method to answer the research question, in which I am the expert based on my own experience. First, I conduct a documentary analysis in which I examine the urban environment of Lima, considering the ecological problems and the social and economic conditions that exist in the areas near the river. Based on the information I gather, I identify the main challenges and opportunities for rehabilitating the river. After this review, I carry out a comparative analysis of two cases that have similar problems related to the rehabilitation of bodies of water or ecological restoration processes in cities. This analysis helps me see how other cities achieve solutions in similar contexts and serves as a reference to evaluate whether those ideas could work in the case of the Rímac River. This comparison allows me to see which solutions can be applied or adapted to Lima. To better understand whether my proposals are viable, I conduct an interview with an expert in ecological restoration and urban planning.

Research Question

How can citizen participation enhance the design and long-term sustainability of interventions intended to rehabilitate the Rímac River as a functional and inclusive public space?

He gathered data using several qualitative methods to analyze the Rímac River and evaluate the feasibility of interventions aimed at its rehabilitation as a functional and inclusive public space. I have assessed the impact of citizen participation in these interventions, considering the social, cultural, and environmental characteristics of Lima. Through a broad analysis, I have identified the benefits that citizen participation could bring to the river's rehabilitation from an urban development and sustainability perspective. Given the challenges involved in integrating ecological restoration with urban planning, I consider it necessary to evaluate the role of local communities to ensure the long-term success and sustainability of rehabilitation efforts. This research could be applied to other cities facing similar challenges in river rehabilitation and urban regeneration. By analyzing the role of citizen participation in the design of restoration projects and its alignment with local needs, Lima could develop more inclusive, sustainable, and resilient public spaces, improving quality of life and contributing to social and environmental well-being in the city.

<u>Methods</u>

This study analyzes the Rímac River using a current method to determine whether citizen participation can improve the design and long-term sustainability of the interventions aimed at rehabilitating the river as a functional and inclusive public space. I divided my research into different qualitative methods, applied sequentially, to address the factors relevant to my research question. In answering it, I considered the social, cultural, environmental, and urban planning components involved in the relationship between the city and the river.

<u>Method 1: Document Analysis</u>

After analyzing the conditions of the Rímac River and its role within Lima's urban environment, I incorporated a documentary analysis to identify the factors that influence citizen participation within ecological rehabilitation and urban transformation processes. The documentary analysis consisted of reviewing academic sources, institutional reports, and technical documents that address the relationship between citizenship, water management, and the recovery of public spaces in real contexts. This method allowed me to gather data based on existing information and then interpret it critically to support the claims related to the case of the Rímac River. I developed an iterative process between the data collected and my interpretations to understand the meanings, dynamics, and relationships between citizen participation and the city. When I examined the role of citizens in interventions that aim to rehabilitate the river as a functional and inclusive public space, the documentary review helped me deepen my understanding of the concepts, approaches, and limitations present in the urban and social context. This process strengthened the ideas of the study through consolidated theoretical frameworks applicable to the Rímac.

I selected this method because it provides documented evidence to support the research, considering that the development of sustainable and resilient public spaces requires specific conditions to integrate participatory approaches that respond to the real needs of the population. For this reason, I identified the requirements that participatory processes must meet in order to effectively contribute to the integral rehabilitation of the

Rímac River and its integration into the city.

Method 02: Case study comparative Analysis

To determine the key factors that must be considered in rehabilitation interventions for the Rímac River, I collected data through two comparative case studies. According to Robert K. Yin, a case study is an in-depth investigation of a contemporary phenomenon within its real context, which allows complex relationships to be examined in depth.

In my study, I selected two cases of intervention in urban rivers that incorporate citizen participation processes in ecological restoration and in the recovery of public spaces. In this way, I observed and compared various participatory strategies implemented in different contexts, in order to identify patterns, similarities, differences, and the results obtained. Through this analysis, I identified participatory practices that have demonstrated effectiveness in other urban environments.

I chose this method because the comparative approach makes it possible to understand how different social, environmental, and political factors influence the success of citizen participation. It also allowed me to evaluate whether the strategies applied in other contexts can be adapted to the case of the Rímac River, considering the particularities of Lima. Through the review of documents, technical reports, and academic literature, I examined the key elements of each intervention, their impact, and their implications for long-term sustainability.

With this methodology, I sought to identify which participatory practices have worked in other contexts of river restoration and to evaluate their potential application to the Rímac River, ensuring that the proposals are technically viable and inclusive for the community.

Method 03: Interview

To understand the challenges and limitations present in the urban and ecological environment of the Rímac River, I conducted an interview with a specialist in river restoration. I designed this semi-structured interview based on a predetermined set of questions, complemented by an open dialogue that allowed me to delve into emerging topics and adapt the conversation according to the interviewee’s responses.

Through this flexible approach, I was able to obtain an expert perspective on the factors that shape the rehabilitation of the river, including channel management, informal occupation of the riverbanks, vulnerability to landslides, and the environmental deterioration affecting the ecosystem. I also specifically explored the role that the riverside population and local actors can play in intervention processes, considering both their previous experiences and other urban contexts.

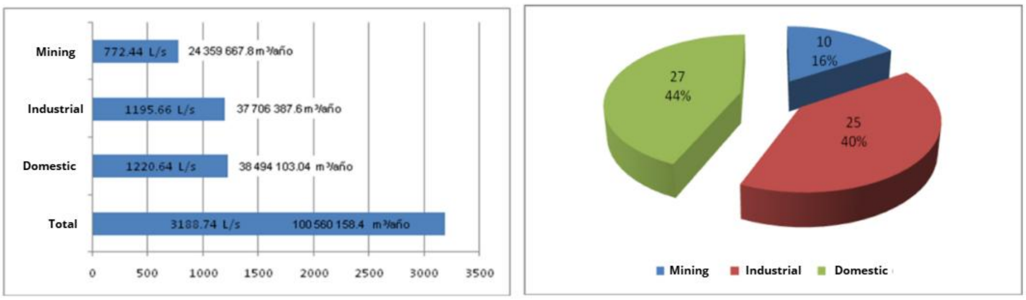
Although various initiatives show potential to improve the river's conditions, the lack of mechanisms for engagement with the city presents significant challenges. In this scenario, consulting an expert allowed me to clarify how citizen participation could be effectively integrated into this study.

Method 01: Document Review and Analysis

It was essential for me to review the Rímac River, because since the earliest settlements it enabled urban growth, water supply, and territorial organization, although with the city's accelerated development that relationship changed and generated visible pressures along almost its entire course. Its channel extends approximately 145 km within a basin of 3,532 km^2 (MINAM, 2013), where more than ten million people live, making it a highly urbanized and vulnerable hydrological system. Added to this is the influence of the climate, since the basin presents temperate conditions with rainfall between December and March and temperatures ranging from 12 °C to 28 °C (MINAM, 2013), so during the rainy season the flow increases and drags sediments from the highlands, modifying the riverbed and putting at risk settlements and infrastructure located near the banks. All of this allows me to understand that the Rímac is not just a body of water but a living system conditioned by human and climatic dynamics that sustains Lima while also reflecting the consequences of its growth. In my review of technical reports I was able to identify that the Rímac River faces severe environmental challenges, especially those related to contamination from domestic, industrial, and mining discharges, in addition to the constant accumulation of solid waste. When analyzing the data reported by MINAM, I found that there are around 62 active discharges that release water into the river, with a total flow exceeding 3,200 L/s. Within this volume, 44% comes from domestic wastewater, 40% from industrial discharges, and 16% from mining waste (MINAM, 2013). This information allowed me to understand that the pressure the river receives does not come from a single source but from multiple human activities acting simultaneously and that, when not controlled, deteriorate water quality progressively.

Technical and institutional studies focused specifically on the Rímac River emphasize the urgent need for integrated rehabilitation strategies to address its environmental deterioration. Reports developed by Peruvian water and environmental authorities identify untreated wastewater discharges, degradation of riparian ecosystems, and insufficient water quality monitoring as the main factors affecting the river. These studies recommend comprehensive interventions that combine wastewater treatment infrastructure, ecological restoration of riverbanks, and continuous monitoring systems, highlighting that isolated or fragmented actions are insufficient to improve the condition of the Rímac River in the long term (Autoridad Nacional del Agua, 2019; Ministerio del Ambiente, 2020; World Bank, 2019).

Figure (11)



Discharge flows in the Rímac basin according to their origin.

Number of discharges according to their origin that flow into the Rímac River basin

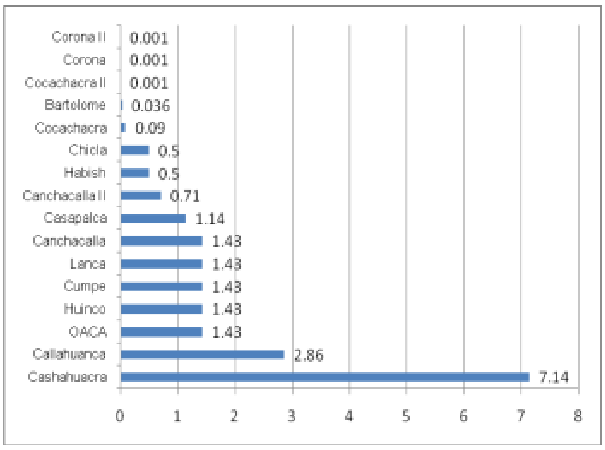
Percentage of domestic, industrial and mining discharges

When reviewing the current regulations, it becomes evident that solid waste management in Peru is structured primarily by Law No. 27314, which defines the responsibilities of the State, local governments, and citizens regarding waste management. When analyzing its operational regulation, DS No. 014-2017-MINAM, it is clear that there is a framework designed to ensure the collection, transport, and final disposal of waste, although the current conditions of the Rímac River show a marked gap between what is established and the territorial reality. Law No. 29090 promotes practices of reduction, reuse, and recycling, which allows me to understand that the sustainability of the hydrological system does not depend solely on infrastructure or public investment but also on constant social participation that enables these policies to remain effective over time.

Regarding mining liabilities, the reviewed bibliography indicates that many of them are linked to informal or illegal activities, which are criminally sanctioned under Legislative Decree No. 1102. The Comprehensive Registry for Mining Formalization, regulated by Legislative Decree No. 1293, shows that only a fraction of operators have managed to regularize their status, leaving a wide margin of environmental risk associated with discharges containing cyanide, mercury, and other heavy metals. This situation reveals that the deterioration of the river is not only an urban problem but a multisectoral phenomenon that requires institutional control, environmental monitoring, and, crucially, an actively engaged citizenry in oversight and reporting.

The recorded figures help illustrate the magnitude of the problem. There are 22 solid waste dumps, 40 mining liabilities, and 14 mine tailings in the Rímac basin. The total volume of waste reaches 20,129 tons per day, with Cashahuacra in Santa Eulalia standing out with approximately 7.14 tons per day. In addition, concentrations of iron of up to 57.88 mg/L are recorded in certain sections, values that exceed safe limits for human consumption. This scenario suggests that any intervention to rehabilitate the river must consider continuous management processes, where the population plays a fundamental role in monitoring, responsible use of space, and oversight of regulatory compliance.

Figure (12)



Tons per day per landfill

In this context, it is also evident that the management of the Rímac River is not sustained solely through institutional actions. Various actors from civil society and local communities have begun to take a more active role in the defense and recovery of the river. Basin committees, neighborhood associations, environmental collectives and universities have promoted clean-up campaigns and citizen-based monitoring actions, as well as environmental education programs aimed at raising awareness about pollution and the responsible use of the riverbanks. This community participation becomes especially important in the urban sections, where pressure on the water resource is greater and the presence of illegal discharges, solid waste and informal occupations tends to increase. According to what I reviewed, it is suggested that without this social component, even the most comprehensive regulatory frameworks or the most ambitious technical interventions tend to lose continuity over time, reinforcing the need to incorporate participation mechanisms as a structural part of the design and management of public space around the river.

When reviewing the districts bordering the Rímac River, it became clear to me that people living near its margins face difficult living conditions. In areas such as Lurigancho Chosica or in vulnerable neighborhoods throughout Metropolitan Lima, it is common to find informal or precariously built housing, often located on land at risk of overflow, flooding or landslides. Observing this context, it seems evident to me that a large part of the riverside population belongs to low or vulnerable socioeconomic levels: access to basic services is limited, job opportunities are often informal and the stability of their homes depends largely on their own efforts.

This social context is directly related to the environmental problems of the river. If people live with uncertainty and limited possibilities, it is natural that their capacity to adopt sanitation, recycling or rehabilitation practices is reduced. Furthermore, precariousness leaves them with less room to reject settlements in risk zones or to demand compliance with environmental standards. That is why I believe that any proposal for the recovery of the Rímac must address not only water cleanliness or ecosystem restoration, but also the improvement of living conditions for those who inhabit its surroundings. Only then could rehabilitation generate a real and sustainable impact, combining social justice, citizen participation and environmental restoration.

When investigating crime in the Rímac River, multiple cases of homicides and findings of bodies were found along it. For example, in January 2025 two bodies showing signs of torture were found in El Agustino, in June of that same year a body inside a sack was found in the same area, and in May another body was discovered floating in Carapongo, Chosica. These incidents show that several sections of the river function as high-risk spaces and as disposal sites after serious crimes because there is no control and these areas remain deserted or abandoned. This condition makes them focal points for transgressions. As a result, fear and distrust grow in the locality, which prevents the development of a sense of connection with the river.

According to these facts, it can be seen that the lack of surveillance and institutional neglect generate vulnerability in the riverside sections. This not only increases the perception of insecurity, but also limits the possibility of rehabilitating the river as a functional public space. The data suggest that any intervention in the Rímac must consider security measures, access control and citizen participation to reduce risks associated with crime and ensure that the river can become an inclusive and safe space.

The Rímac River as a site for analyzing participatory rehabilitation processes

When studying the Rímac River, I realized that it represents a relevant case for analyzing the dynamics of deterioration in urban rivers. Its location within Lima exposes it constantly to pressure from residential, industrial and commercial activities, generating a scenario where degradation is evident in various sections. Observing its channel, I noticed that in consolidated sectors the river is confined by infrastructure and retaining walls, limiting its interaction with the surroundings and its ecological capacity. In other sections, where territorial control is weaker, informal occupations, waste accumulation and alterations in water flow due to unregulated interventions can be identified. This contrast allows me to reflect on how different urban conditions directly influence the state of the river and how citizen participation could help improve its management.

I also perceived a marked contrast between the functions the Rímac should fulfill, such as ecological regulation and the provision of environmental services, and the functions it currently performs within the city. This discrepancy reflects the importance of integrating social perception and community management into any rehabilitation proposal. Observing the presence of institutional and community actors, it became clear to me that the coexistence of municipalities, local organizations and environmental entities generates tensions and management gaps that hinder the continuity of actions. Understanding these dynamics is key to analyzing how citizen participation can influence the design and sustainability of interventions aimed at recovering the river as a functional and inclusive public space.

Focusing on the social impact, I confirmed that the current situation of the Rímac directly affects the lives of riverside communities. The water contains high levels of heavy metals such as lead, arsenic and copper, which pose a health risk, especially in areas with limited access to basic services (Infobae, 2024). Approximately 244,000 people live near its margins (Radio Nacional, 2024), and many face constant exposure to solid waste, unpleasant odors, vectors and risks during floods. This increases pressure on urban infrastructure and creates a sense of insecurity and vulnerability. At the same time, physical and landscape deterioration has weakened the social and cultural bond with the river, which once served as an integrating axis of the city. Today, for many residents, the Rímac functions more as a barrier than as a meeting space.

Considering these elements, it seems evident to me that any rehabilitation strategy cannot be limited to physical recovery of the channel. Citizen participation becomes crucial for interventions to be sustainable and functional. Involving the community in monitoring, cleaning and designing spaces can strengthen the relationship with the river, promote environmental care practices and ensure that policies adapt to the needs of those living along its margins. From my analysis, I understand that without an approach that combines institutional management and social participation, the restoration of the Rímac will hardly achieve its full potential as an inclusive and resilient public space.

Table – Social Sustainability Applied to the Rímac River			
Dimension (equivalent to "Elegant Social Objectives of the City")	**Social objectives for the Rímac River area**	**Social metrics or data to evaluate**	**Solution lines or sustainable actions**
Recovery of Citizen Connection with the River	Rebuild the cultural, historical, and daily relationship between the population and the Rímac	- Public perception of the river - Number of cultural or recreational activities along the riverbank - Neighborhood participation in events and community days	- Implementation of accessible public spaces along the riverbank - Education and awareness programs about the river - Activation of cultural and recreational corridors
Improvement of quality of life in riverside areas	Reduce negative impacts on health, safety, and habitability	- Incidence of diseases associated with contamination - Risk records during flood season - Presence of waste and discharges in different sections	- Control and treatment of discharges - Solid waste management - Ongoing maintenance and cleaning programs
Inclusion and territorial equity	Ensure that river improvements also benefit vulnerable sectors settled along the marginal strip	- Coverage of basic services in riverside areas - Percentage of homes located in risk zones - Levels of access to nearby public facilities	- Land regularization and planning - Public facilities in underserved areas - Improvement of basic urban infrastructure
Community governance and participation	Consolidate regular, not occasional, mechanisms of participation in river management	- Number of active local organizations - Frequency of community meetings - Formal consultation processes or monitoring committees	- Creation of permanent management committees - Citizen participation protocols - Spaces for reporting, monitoring, and neighborhood follow-up
Urban integration	Reduce the role of the river as a physical barrier and turn it into a connecting space	- Accessibility to the riverbank - Pedestrian connectivity between neighborhoods - Percentage of sections with physical barriers	- Opening of pedestrian pathways - Removal of walls in non-critical areas - Integration with transport hubs and public spaces

Table 01: Social Sustainability applied to the Rimac river

Economic Impact

When I analyzed the population living near the Rímac, I identified that most residents belong to socioeconomic level E, with low incomes and a strong dependence on informal jobs such as street vending, recycling, transportation, or small workshops. This situation makes families especially vulnerable to the loss of their belongings due to overflows or floods and to health problems related to river pollution. Environmental precariousness and the lack of infrastructure condition the economic life of these communities, which limits the possibility of private investment and projects that could generate sustainable income (PUCP, 2018).

From an economic perspective, the rehabilitation of the Rímac River also presents the potential to support local economic activity and urban tourism if the riverfront is properly designed and maintained. Studies on urban river regeneration indicate that accessible and ecologically restored river corridors can attract recreational use, cultural activities, and small scale tourism, generating benefits for local businesses and surrounding neighborhoods. In the case of Lima, an improved riverfront environment may enhance the attractiveness of adjacent areas and support economic opportunities linked to leisure, culture, and environmental education, provided that these interventions are integrated within a broader urban and social framework (World Bank, 2019; UN Environment Programme, 2017).

I observed that the deterioration of the riverbank also restricts its economic potential as an urban space. In theory, the Rímac could generate value through recreational activities, local commerce, tourism and cultural events. However, the lack of accessibility, the presence of informal occupations and pollution significantly reduce its appeal. When reviewing international experiences on urban river revitalization, I confirmed that the recovery of these spaces can stimulate the local economy, generate jobs and increase the value of surrounding land (Regional Government of Lima, 2021). This leads me to think that the Rímac represents a missed opportunity, where an adequate intervention could improve the economy of nearby communities and the district as a whole.

In addition, informal settlements located in the marginal strip face recurring economic impacts due to environmental risks. I reviewed reports from the National Institute of Civil Defense (INDECI, 2023) indicating that most of the recorded damages during flood events are concentrated in these areas, causing losses of belongings and limiting the economic stability of families. This shows how environmental degradation and the lack of urban planning have a direct impact on the economy of residents, reinforcing the need to integrate protection measures, planning and citizen participation into any river rehabilitation project.

For this reason, it has been identified that the economic analysis of the Rímac must consider both the costs generated by the current situation and the opportunities that could arise from sustainable and coordinated interventions. The comprehensive recovery of the river could transform not only the urban and environmental landscape but also improve the quality of life and economic stability of nearby residents, promoting more inclusive and functional development.

Environmental Impact

When investigating the environmental state of the Rímac River, I found that its situation is critical and affects both water quality and the ecological balance and sustainability of the territories it crosses. Various studies indicate that the river channel shows high levels of pollution from industrial discharges, untreated domestic wastewater and constant accumulation of solid waste, which deteriorates its natural function as Lima's main water source (ANA, 2023). According to Actualidad Ambiental (2025), approximately 85% of the Rímac's biodiversity has disappeared, revealing the collapse of its aquatic and riverside ecosystems, which reinforces the urgency of implementing ecological restoration and conservation measures.

Additionally, there are specific environmental monitoring studies that include air quality and noise levels in urban areas of the Rímac River. For example, a 2016 study conducted in a section of the Rímac district measured airborne particles and environmental noise, recording average noise levels above 70 dB and PM10 particulate concentrations exceeding recommended limits for residential areas (OEFA, 2016). These findings allowed me to understand that river pollution not only affects water quality and biodiversity but also impacts people's health through exposure to atmospheric pollutants and noise, contributing to negative perceptions of the riverside environment.

During the analysis, I observed that the physical modification of the river channel contributes significantly to the deterioration of its natural conditions. A large part of the river is canalized or confined by retaining walls that limit the natural flow dynamics, reduce infiltration capacity and create a more rigid and vulnerable hydraulic behavior during extreme events. According to SENAMHI (2023), seasonal floods have increased disaster risk, especially in areas where informal settlements have been established on flood zones or former natural floodplains. This demonstrates that urban and environmental management still does not fully respond to the risks generated by the geography of the watershed.

When analyzing the sections of the Rímac, I identified how the loss of riverside vegetation and the fragmentation of the ecological corridor have restricted the presence of fauna associated with the fluvial ecosystem. The urban sections present waste accumulation, organic discharges and flow alterations that hinder natural purification and balance processes. The National Water Authority (2022) indicates that this degradation affects essential ecosystem services such as water regulation, natural sediment control and water quality improvement. Pollution also spreads into the immediate urban environment through odors, vectors and micro-sanitary hotspots, generating environmental and public health problems, particularly in low-income sectors living near the river (Radio Nacional, 2024).

Based on these data, I analyzed that any rehabilitation process for the Rímac requires a deep understanding of the physical, ecological and hydrological factors that explain its deterioration. Although some indicators show specific improvements, such as recent decreases in concentrations of lead, iron and aluminum in certain sections (INEI, 2021), these changes do not represent full recovery. Urban and peri-urban sections continue receiving discharges, solid waste continues to accumulate and biodiversity remains extremely low. This demonstrates that the river's sustainability depends not only on isolated corrective actions but on continuous interventions, permanent monitoring and community participation to restore natural functions, recover flora and fauna, and reintegrate the river into Lima's urban fabric in a functional and safe way.

Rímac Environmental Program – Objectives			
Climate	**Water**	**Clean Communities**	**Ecosystems**
Reduce the vulnerability of urban areas to seasonal floods.	Improve water quality by reducing domestic and industrial discharges.	Reduce the accumulation of solid waste in the riverbed and urban edges.	Restore the ecological continuity of the river corridor.
Promote preventive measures and climate early warning systems.	Strengthen permanent environmental monitoring and enforcement.	Improve sanitary conditions in communities near the river.	Recover riparian vegetation and associated habitats.
Regulate settlements in flood-prone areas.	Increase treatment and collection infrastructure.	Decrease critical points of urban pollution.	Integrate the river as an ecological space within the city.
Rímac Strategies			
Climate	**Water**	**Clean Communities**	**Ecosystems**
Implement mitigation works based on nature-based solutions.	Expand treatment infrastructure and discharge control systems.	Permanent cleaning and collection programs in critical sections.	Revegetation and restoration of degraded areas.
Gradually relocate houses located in the risk zone.	Continuous monitoring coordinated between environmental and municipal authorities.	Local waste management with community participation.	Connect river sections through urban biological corridors.
Create early warning systems for seasonal events.	Update regulations on discharges and penalties.	Strengthen educational campaigns on cleanliness and responsible use of the river space.	Integrate the river into sustainable public space projects.

Table 02: Objectives of the rimac river environmental program

The environmental analysis of the Rímac River allowed me to observe that the main impacts are concentrated along three converging lines. First, the degradation of water quality, evidenced by the presence of heavy metals such as lead, arsenic, and copper, which exceed permitted limits and affect both biodiversity and the health of nearby populations (ANA, 2023; Actualidad Ambiental, 2025). Second, climate-related risks, particularly during seasonal floods, which endanger riverside communities and reflect the vulnerability of infrastructure and informal settlements (SENAMHI, 2023).

Third, the progressive loss of the riverine ecosystem, which has fragmented the ecological corridor, reduced riparian vegetation, and diminished the presence of associated fauna, limiting the environmental and recreational functions of the river.

Based on this analysis, I identify that the sustainability of the Rímac River does not depend solely on infrastructure interventions or occasional clean up efforts, but on continuous processes that include institutional oversight, environmental monitoring, civic education, and ecological recovery strategies operating together. Recognizing these interconnected dimensions at this stage allows me to frame the territorial challenges that rehabilitation projects must address in order to achieve a lasting and systemic impact.

From this documentary review, I observe that the main limitation of current approaches to the Rímac River lies in their fragmented nature. Existing studies and institutional actions tend to address environmental degradation, infrastructure, social vulnerability, or governance as separate issues, rather than as interconnected components of a single urban river system. Through this analysis, I highlight the need to understand the Rímac at the basin scale, where ecological processes, technological infrastructure, institutional coordination, and social dynamics interact over time. Recognizing these interdependencies at this stage is essential for framing the subsequent analyses and for evaluating whether integrated and long term rehabilitation strategies can respond more effectively to the river's complex urban condition.

Method 02: Case study comparative and analysis

When analyzing the Rímac River as a focal point for sustainable projects, I have observed that environmental, social, and territorial factors shape its management. The basin faces strong pressure from urban growth, discharges, and waste accumulation, generating ecological and social risks. Therefore, I consider active community participation to be essential, and to understand its impact, I have studied comparative cases such as the Remedios and Xochimilco rivers, where communities have carried out concrete restoration and governance initiatives in a structured manner.

I selected the Remedios River as a case study because it clearly reflects the combined impacts of pollution, insecurity, and urban vulnerability on riverside communities. In researching its history, I observed that the channel exhibited high levels of domestic and industrial waste, frequent overflows, and health problems associated with water contact. Additionally, the relocation of neighbors after a landslide deepened exposure to risks and increased the sense of insecurity. This context allowed me to understand the need for comprehensive actions, including direct community participation in cleaning and channeling the river, which laid the groundwork for the rehabilitation project. Moreover, I selected the Xochimilco River because it allowed me to analyze how the loss of biodiversity and degradation of a historic system can mobilize the community. I observed that the deterioration of canals and chinampas was due to multiple factors: overexploitation of water, residual discharges, sediment accumulation, and invasive species, which led to eutrophication, decreased oxygen levels, and loss of riparian vegetation. This particularly affected the axolotl, an emblematic species, and reduced the productivity of the chinampas. Studying this case helped me understand how local participation becomes a key factor in restoring ecosystems and maintaining sustainable water management practices. To deepen the analysis, the previous state of each river will be examined, identifying the environmental, social, and urban problems affecting them. This will allow an understanding of the magnitude of pollution, risks to nearby communities, and biodiversity loss. Additionally, the progress of implemented projects will be evaluated, highlighting technical interventions, observable results, and community participation, in order to assess how these actions have improved, or could improve, environmental quality and safety in riverside areas.

Before the implementation of the project on the Remedios River, I was able to confirm that its situation was critical both environmentally and socially. The channel ran through densely populated areas where untreated domestic discharges, industrial effluents, and constant accumulation of solid waste combined, generating high levels of contamination by heavy metals such as arsenic, cadmium, nickel, copper, lead, and mercury, as well as nutrients and organic matter, affecting water quality and riparian soil. Approximately 85 % of aquatic biodiversity had disappeared (Actualidad Ambiental, 2025), evidencing the collapse of the ecosystem.

Figure (13)

Remedios river before

Riverside communities, often low-income and with vulnerable housing, were exposed daily to this situation. Neighbor complaints accumulated over the years indicate that living conditions became unsanitary: recurrent flooding during the rainy season, stagnant sewage water, accumulated garbage, foul odors, environment-related diseases, and a perception of institutional abandonment.

This context of environmental degradation was also intertwined with social vulnerability; the inhabitants of the riverbanks were part of popular urban areas, with limited services, deficient infrastructure, and little capacity for resilience in the face of adverse events. This combination of environmental, social, and territorial precariousness created a high level of risk for the population, including health risks, flood risk, and environmental degradation. The persistence of this situation for years without structural solutions demonstrated a governance problem: multiple spaces of institutional responsibility, administrative fragmentation, inadequate control of discharges, and absence of comprehensive policies. This institutional abandonment contributed to the river remaining a marginal, polluted, unsafe, and largely invisible space in the city. Crime had concentrated along the banks, with frequent robberies and assaults, increasing the sense of insecurity among the population near the river, many of them in low-income areas with limited access to basic services. Social pressure combined with a fragmented institutional context, where the supervision of discharges and waste regulation were insufficient, allowing large volumes of waste to continue accumulating in the channel (Intergovernmental Relations in Mexico, 2004).

This previous profile justifies the urgency of a comprehensive intervention and also explains why its rehabilitation requires not only physical works but also social transformation, community participation, and institutional regulation. Critical sections were channeled to conduct flow, prevent stagnation, and reduce odors and sanitary risks, while dredging operations removed tens of thousands of cubic meters of sediments and hundreds of tons of solid waste, restoring the river's hydraulic capacity.

In parallel with hydraulic management, bioremediation and bioengineering techniques were implemented to stabilize banks, biodegrade organic matter, and reduce microbial load at critical points. These systems include biofilters, constructed wetlands, and in situ biological treatments that address persistent pollution that cannot be solved by infrastructure works alone. Field evaluations in the treated sections show appreciable reductions in coliforms and progressive improvements in parameters such as dissolved oxygen, allowing the return of biological activity in areas where aquatic life had disappeared.

Figure (14)

Remedios River vaulting

Social participation was key: local committees and neighbors oversee the continuity of the work, report subsequent discharges, and collaborate in monitoring progress, ensuring that interventions are sustainable. During cleanup campaigns conducted in 2019, residents, municipal authorities, and armed forces collected more than 50 tons of garbage along 12 km of the channel (Milenio, 2019). Additionally, in 2024, the local drainage authority reported the removal of approximately 900 m^3 of waste in the section known as the “Ferrovalle box” alone, which is equivalent to more than 150 garbage trucks (Milenio, 2024). These citizen and community actions, together with institutional work, show that urban participation has played a decisive role in improving channel flow, reducing pollution hotspots, and preventing floods.

The current assessment indicates that these actions have generated visible short-term improvements: the reduction of organic load, the decrease in foul odors, and the lower presence of vectors have improved sanitary conditions and the perception of safety in riverside neighborhoods. However, consolidating these results requires sustained investment, continuous maintenance, and constant community participation to achieve a healthier, safer, and more functional river in the medium and long term.

On the other hand, before the interventions in Xochimilco, the situation was alarming. Only about 2% of the original freshwater of the lake basin that once fed the canals and chinampas remained, and around 80% of traditional chinampas were abandoned. The canals and water bodies showed severe contamination. Phosphorus concentrations ranged from 2.5 to 7.8 mg/L, and chlorophyll-a values ranged between 66 and 136 µg/L, which indicated eutrophication, organic pollution, and poor water quality. Studies also detected pathogenic bacteria. Authorities documented about 1,374 discharge points of black and gray water directly into the canal system, with an estimated total of up to 3,500 discharges, representing a massive daily load of contaminated water. This water degradation, combined with intensive water extraction from dozens of wells, caused overexploitation of aquifers, subsidence, and water level decline, affecting the traditional hydraulic structure of chinampas and canals.

Furthermore, the system of chinampas and canals, which for centuries had functioned as a productive landscape and biodiversity hub, was seriously deteriorated. This dramatically affected the axolotl, whose population has declined by more than 99 % since 1998, from approximately 6,000 axolotls per km^2 to only 36 km^2 in 2014, highlighting the collapse of the aquatic ecosystem. These data show the degree of deterioration Xochimilco faced: a combination of water depletion, chemical and microbiological pollution, abandonment of traditional agriculture, untreated domestic and industrial discharges, and destruction of the lacustrine ecological system.

Figure (15)

Residents of Xochimilco

To address this situation, a comprehensive biocultural restoration approach called Chinampa Refugio was implemented. This project combined ecological rehabilitation, biofilters, riparian vegetation recovery, reintroduction of native species, and educational programs, including monitoring brigades, workshops for youth and producers, and participatory censuses to assess the state of the water and habitats. These strategies allowed the community to become actively involved in resource management and the maintenance of bioremediation infrastructures.

To date, 21 Chinampa Refugio plots have been rehabilitated, water clarity in the restored sections has improved up to three times compared to previous conditions, and the presence of axolotls has been detected through environmental DNA monitoring in the intervened sections. The coverage of native aquatic plants has increased significantly, the abundance of indicator invertebrates has risen, and water turbidity has noticeably decreased, showing tangible improvements in biodiversity and ecosystem quality.

Social participation has been decisive; residents engage in the maintenance of biofilters, ecological monitoring, riparian reforestation, and the training of new producers. Cooperation among authorities, academics, and the community has allowed actions to be adjusted according to the results of censuses and monitoring, ensuring the effectiveness and sustainability of the measures. Thanks to these interventions, the ecological function of the canals and chinampas has been partially recovered, agroecological production has been strengthened, and the cultural identity of the chinamperos has been preserved, demonstrating that the articulation between infrastructure, ecological restoration, and active population participation is key to the recovery of highly degraded water-agricultural systems.

Sustainable Rivers: Suitability and Analysis among the Rímac, Remedios and Xochimilco Rivers

Upon studying the cases of the Remedios and Xochimilco rivers, I was able to observe how technical intervention alone is not enough to achieve the sustainability of an urban river. In Remedios, the combination of vaulting, sanitation, and bioengineering achieved improvements in water quality and the reduction of health risks, but it was the active participation of the community that allowed the progress to be maintained in the medium and long term, supervising the removal of waste and reporting discharges. In Xochimilco, the restoration of chinampas and canals was only successful because the inhabitants became involved in ecological monitoring, riparian reforestation, and the management of biofilters, achieving measurable improvements in biodiversity and water quality.

Based on these learnings, I was able to identify that, for the Rímac River, citizen participation is key for any intervention to be sustained over time and fulfill its function as a functional and inclusive public space. Involving the inhabitants in planning, monitoring, and maintenance allows the solutions to respond not only to technical criteria but also to the social and cultural needs of the riverside population, ensuring continuity, prevention of contamination, and strengthening of environmental and urban benefits. The evidence shows me that the sustainability of the Rímac will depend both on physical works and on the active co-responsibility of those who live and move alongside the river.

Criteria for the suitability of sustainable rivers					
Sustainability Suitability Criteria	**Río Rímac**	**Río de los Remedios**	**Río Xochimilco**	**Comentarios**	
Urban and social pressure	High population density, socioeconomic level E; thousands of people exposed to risks and pollution	Widespread social mobilization; frequent reporting of crimes along the riverbanks	Organized community; participation in monitoring and environmental education	Urban pressure creates opportunities for sustainable projects and active participation	✔
Pollution and discharges	Heavy metals (As, Pb, Cu, Cd, Hg), solid waste	Removal of tens of thousands of cubic meters of sediment and hundreds of tons of waste	Sediments, nutrients, and invasive species; implementation of biofilters and canal restoration	Actions show tangible improvements in water quality and waste reduction	✔
Environmental and health risks	Seasonal floods, vectors, bacterial contamination	Reduction of vectors and odors; dredging restored hydraulic capacity	Eutrophication and low oxygen levels mitigated; habitat for axolotls and native fauna	Interventions reduce risks and strengthen ecological resilience	✔
Rehabilitation actions	Cleaning, environmental education, community monitoring	Culverting, bioremediation, bioengineering; stabilization of riverbanks	Restoration of 21 chinampas, biofilters, recovery of riparian vegetation, reintroduction of species	All actions contribute to environmental and social well-being	✔
Community participation	Watershed committees, associations, and universities	Monitoring committees, supervision of operations, community reporting	Participatory censuses, maintenance of biofilters, training workshops	Active participation ensures continuity and effectiveness of actions	✔
Results or improvements	Partial pollution reduction and increasing positive perception	Return of biological life in sections, decrease in visible waste, increase in dissolved oxygen	Water clarity increased threefold, expansion of vegetation cover, detection of axolotls	Quantitative and sustainable results in the short and medium term	X

Table 03: Criteria for the suitability of sustainable rivers

From the comparative analysis presented in the table, I identify that environmental equity emerges as a central factor in successful river rehabilitation processes. In the reference cases, technological interventions such as water treatment systems, ecological monitoring, and adaptive infrastructure are not applied uniformly, but are strategically directed toward reducing environmental risks in the most vulnerable areas. This comparison allows me to understand that technology functions not only as a technical solution, but also as a tool to redistribute environmental benefits and mitigate long standing inequalities. These findings are relevant for the Rímac River, where future interventions must consider how technological and ecological strategies can address both environmental degradation and unequal exposure to risk across the river corridor.

Method 03: Interview and analysis

One of the main concerns related to the design of sustainable interventions to rehabilitate the Rímac River as a functional and inclusive public space has been the way in which citizen participation influences long-term sustainability. In many existing proposals for river rehabilitation, it has been seen that the proposals were made mainly from technical or institutional perspectives, and for that reason many times the spaces are not properly maintained or do not fully respond to what residents actually need in order to generate a relationship between population and city. In cities like Lima, where pollution and the informality of chemical waste are common, it has been considered essential to understand how the community participates in the care of the river. Several experiences show that when residents are not included from the beginning, public spaces end up deteriorating more quickly and long-term maintenance strategies become more difficult to sustain.

For this reason, an interview was conducted with an expert who works at the Watershed Management Group, since his experience in community water management and urban ecological restoration was considered relevant to this topic. The interview was carried out through a group conversation in which several questions were asked and an open discussion was also generated about how citizen participation can influence river rehabilitation projects. The purpose of this interview was to obtain information on how other cities have managed contaminated rivers, how the community has been integrated into the restoration process, and how it could be applied to the case of the Rímac River to achieve a more sustainable and inclusive public space.

Interview

P: Can bioremediation completely solve the problem of the river?

R: It can help, but it will not solve it completely. Bioremediation only reaches a certain level; you cannot expect it to solve such big problems on its own. It can reduce or mitigate pollution, but it cannot eliminate it entirely.

P: So, what is needed in addition to bioremediation?

R: Educational programs and also urban programs: better treatment plants, garbage collection systems, tree planting, rain gardens, etc. It is better to have a holistic strategy than to address the problem from a single angle.

P: Why is a solely technological strategy, such as bioremediation or treatment plants, not enough to rehabilitate the Rímac River?

R: Because these plants can only clean up to a certain point. Bioremediation mainly treats organic pollutants, while stronger or chemical substances require more complex treatment plants. However, none of them reduce waste generation or sewage discharge; they only process the waste after it has already reached the river. Without a citizenry involved in reducing waste, separating trash, and demanding adequate infrastructure, any technological system will eventually become saturated. Population participation ensures that, in addition to cleaning, new contamination is prevented.

P: What specific citizen actions can complement municipal efforts for more effective urban design on the Rímac riverbanks?

R: Actions such as reducing excess waste in the rivers, using water more efficiently, implementing domestic greywater treatment systems, and organizing community cleaning campaigns help reduce the pollutant load reaching the river. These practices, together with collaboration with local authorities in environmental education campaigns, improve the effectiveness of urban interventions such as rain gardens, green areas, trails, or boardwalks. Communities can also participate in planning, validation, and maintenance of these spaces, ensuring that the design truly responds to local needs and is sustained over time.

P: What can be done with houses that are already connected to the Rímac River?

R: A treatment system needs to be generated for those houses: divert the drainage to another point, use bioremediation plants, and also conventional treatment plants.

P: What specific citizen actions can complement municipal efforts for more effective urban river design?

R: Actions such as reducing household waste, using water more efficiently, implementing domestic greywater treatment systems, and organizing community cleaning campaigns help reduce the pollutant load reaching the river. These practices, together with collaboration with local authorities in environmental education campaigns, improve the effectiveness of urban interventions such as rain gardens, green areas, trails, or boardwalks. Communities can also participate in planning, validation, and maintenance of these spaces, ensuring that the design truly responds to local needs and is sustained over time.

P: According to your experience in other cities where you have intervened, how do they manage rehabilitation and pollution control of their urban rivers?

R: In several cities, combined systems of treatment and urban design are applied, which could serve as a reference for the Rímac River. For example, cities like Santa Cruz have multiple treatment plants: some large-scale, responsible for processing large volumes of wastewater, and others smaller at the neighborhood level. These smaller plants are even integrated as parks or recreational spaces, which facilitates community maintenance and makes them part of the public space without losing their relationship with the city. The water that reaches the river goes through a pre-treatment process, which significantly reduces the pollutant load.

P: So, what is needed in addition to bioremediation?

R: Educational programs and also urban programs: better treatment plants, garbage collection systems, tree planting, rain gardens, etc. It is better to have a holistic strategy than to address the problem from a single angle.

P: Why is a holistic strategy, based on technology, community, and government, more effective for rehabilitating the Rímac River?

R: Because it allows the problem to be addressed at multiple levels:

1. Residential, reducing waste generation and improving water use.
2. Community, through educational programs and maintenance of public spaces.
3. Government, with infrastructure such as treatment plants, bioremediation, waste collection, and comprehensive urban design.

Citizen participation is the link that connects these levels for a relationship with the city. Without it, solutions become isolated and insufficient; with it, a sustainable model is created where the river’s recovery does not depend on a single system, but on long-term change.

Analysis

When analyzing the interview with the expert from the Watershed Management Group, I was able to confirm that citizen participation is key to guaranteeing the long-term sustainability of interventions in the Rímac River. From the conversation, I understood that bioremediation and treatment plants are useful tools, but insufficient if they are not accompanied by a change in the population’s habits. The expert emphasized that without environmental education, reduction of domestic waste, efficient water use and community collaboration, any technological system will eventually become saturated and the progress will be temporary.

What caught my attention the most was the idea that the community should not only maintain the spaces and participate in their cleaning, but also become involved in the planning, validation and supervision of the interventions. This ensures that urban designs, such as rain gardens, green areas and pathways, respond to local needs and create a real connection between the population and the river. In addition, I was able to understand that active participation works as a bridge between the residential, community and governmental levels, linking education, infrastructure and waste management in an integrated model.

Based on this analysis, I understand that the sustainability of the Rímac River does not depend solely on technological solutions or institutional action, but on sustained community involvement. The interview highlights that the effectiveness and long term maintenance of interventions are closely linked to the active participation of local residents. From this perspective, community engagement emerges as a critical condition for transforming the river into a functional public space capable of supporting inclusive and durable outcomes over time.

From the expert interview, I identify that the feasibility of rehabilitating the Rímac River depends not only on technical capacity, but also on the ability to integrate technological solutions within existing social, institutional, and political frameworks. The expert emphasizes that environmental equity must be considered when prioritizing interventions, as communities with greater exposure to pollution and risk often have fewer resources to respond to environmental impacts. This analysis reinforces my understanding that technology alone cannot resolve the river's degradation, but can support more equitable and sustainable outcomes when combined with long term governance, community involvement, and adaptive management strategies.

Discussion

My objective in this research was to understand how citizen participation influences the recovery of the Rímac River and the permanence of its interventions, since I observed that many previous projects did not manage to sustain themselves over time. That is why, while researching the Rímac River, I observed that its situation was more complex than what the visible environmental conditions reflected, so I analyzed the state of the water, the sources of pollution and the social vulnerability present along the riverbank. I considered it important to understand not only the ecological damage, but also the associated human impact, since I identified that domestic and industrial discharges are directly connected to the lack of control, insecurity, informal occupation and the absence of territorial management. Through documentary analysis, international references and the interview with an expert, I was able to recognize that the degradation of the river does not respond only to technical failures, but also to community habits and social gaps that sustain the problem over time.

The findings of this research suggest that community participation plays a significant role in the rehabilitation of the Rímac River. Based on the comparative case studies, different participatory mechanisms emerge as relevant within similar urban and ecological contexts, including participatory design workshops for riverfront spaces, community based environmental monitoring programs, environmental education initiatives, and local watershed or river committees. These mechanisms indicate potential pathways through which residents may engage more actively with the river, contributing to its social appropriation and supporting broader ecological rehabilitation processes.

That is why, when analyzing the methodologies, it was demonstrated that restoration works when there is a present community that cleans, monitors, and maintains, while in the Rímac, despite previous interventions, pollution persists because there is no appropriation of the riverbed nor habits that reduce the waste that reaches the water. The interview reinforced this, indicating that if people continue to pollute and do not get involved in the daily care of the river, the improvements would not be maintained, so I interpret that the problem of the Rímac is not only ecological but cultural and structural. This allowed me to understand more clearly the research question: sustainability arises when the river becomes part of people's lives, because without active participation any recovery becomes temporary and fragile.

Therefore, I demonstrated that no technical rehabilitation process can be sustainable without citizen participation. The interview with the expert clearly supports this idea, as it states that no method will work if the population does not change its consumption habits, waste practices, or relationship with the river. The references also confirm this argument, since improvements in Remedios and Xochimilco remain stable thanks to organized communities. This relationship shows that sustainability appears only when technical actions and the social fabric work together, consolidating interventions that do not depend on a single actor but on an active and constant collective network.

The social appropriation of the river turns restoration efforts into lasting cultural changes. Xochimilco maintains chinampas, canals, and biodiversity because the community manages and uses the territory productively, generating identity. In Remedios, monitoring committees and neighborhood supervision strengthen transparency and legitimize continuity, something the Rímac can replicate to consolidate results. When citizens recognize themselves as part of the river and not as spectators, restoration becomes more resilient and adaptable.

The central challenge for the Rímac's sustainability is that its recovery does not yet generate social or productive uses that keep the river active. In Remedios, the riverbank was initially unsafe and little-used, but rehabilitation incorporated cultural activities, community presence, and daily use that restored trust. In the Rímac, insecurity and institutional abandonment have weakened the city-water relationship, making it a place remembered only during crimes. Sustaining the Rímac means giving it use, presence, and meaning. The challenge lies in linking restoration to compatible uses that integrate ecological production, recreation, and environmental management, unlike Xochimilco, where the chinampa system balances use and conservation. The Rímac requires new human–ecosystem interactions so restoration transforms territorial bonds, providing function, identity, and real benefits.

Water quality remains low because domestic and industrial discharges continue, which shows that past efforts have not changed the structure of degradation. The expert confirmed that without source control and active biological recovery, any progress remains superficial and reversible. The main challenge is to create ecological resilience that allows the system to sustain itself without constant external corrections, making the river functional, alive, and capable of self-regulation.The main challenge is the high technical and operational cost of sustained interventions. Systems like Xochimilco and Remedios are maintained through permanent investment in invasive species control, water infrastructure, and flow monitoring. In the Rímac, cleaning programs are fragmented and dependent on occasional budgets, interrupting progress and prolonging recovery. Without stable financing, interventions lose continuity and ecological impact.

Sustainability depends not only on citizen participation, but on its type and cultural connection with the river. Xochimilco succeeds because the community lives the territory and recognizes it as part of its identity. In Remedios, participation arises from health alerts rather than tradition, making it functional but less rooted. For the Rímac, promoting community presence is not enough; belonging and social utility are essential to sustain the river through collective will, not just technical intervention.

Recovering a river relies on citizen participation generating belonging and shared responsibility, not just infrastructure. For the Rímac, environmental education, local monitoring, active public spaces, and visible benefits are necessary. Co-management models between authorities and residents should be planned, creating uses that emotionally connect citizens with the river. A river survives not because of installed infrastructure, but because of those who sustain it.

This research has limitations: historical Rímac information is fragmented, continuous ecological records are lacking, and only one expert interview was conducted. Work with communities was indirect, so social perception is interpreted externally. Even so, the patterns found provide a useful framework for future research and intervention strategies.

Altogether, this research shows that restoring the Rímac is not only about decontamination, but also about rebuilding the relationship between the city and the river. The future of the river depends on how inhabitants choose to engage with it, because recovery is not only cleaning the water, but reclaiming memory, territory, and shared life.

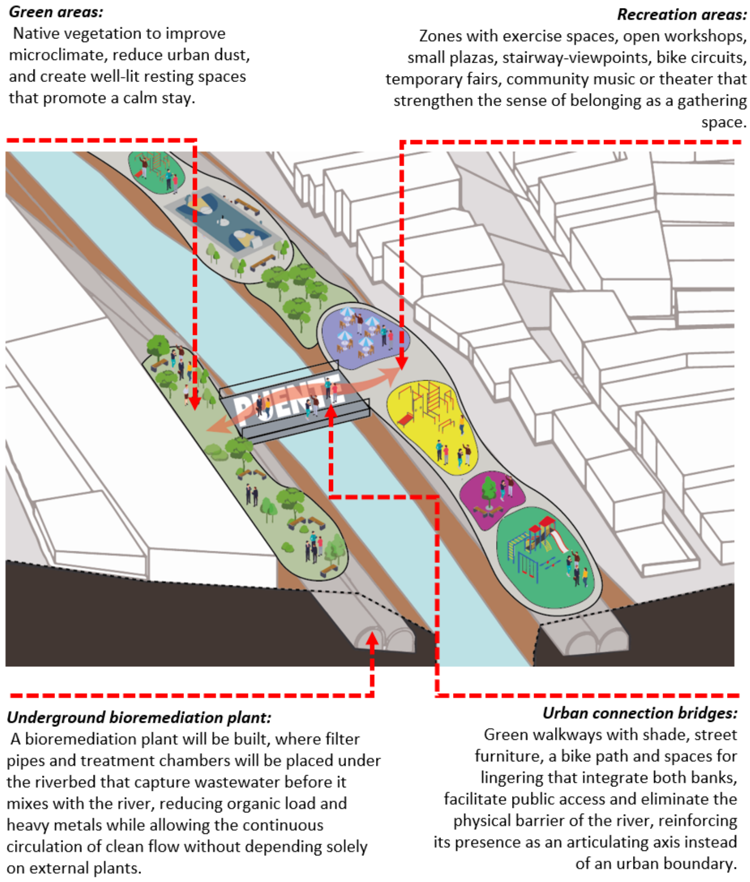
Conclusion

The Rímac River cannot depend on isolated interventions or fragmented investments. Although there are six hundred thousand dollars allocated for technical studies and more than six hundred sixty million projected to rehabilitate a single stretch, these efforts remain insufficient if the riverbed is restored in segments while sewage continues to flow in the lower section and unregulated extractive activities persist in the upper section. Restoring only one stretch ultimately means postponing the problem rather than addressing it at its root.

From an intergenerational equity perspective, this fragmented approach is particularly problematic. The rehabilitation of the Rímac River is not only a response to current environmental and social challenges, but also a responsibility toward future generations. The continued degradation of the river transfers environmental risks, health impacts, and economic limitations to those who will inhabit the city in the coming decades. Conversely, integrated rehabilitation strategies that combine ecological restoration, infrastructure improvement, and community engagement contribute to preserving environmental resources and urban opportunities over time. Addressing the Rímac River today therefore supports a more equitable distribution of environmental benefits and risks between present and future generations.

Within this integrated framework, the activation of the riverbanks as public space becomes a key component of long term rehabilitation. In sections with greater urban access, pedestrian circuits, sports areas, open workshops, agricultural and cultural fairs, reading areas, viewpoints, and small stages can transform the riverbank into a place of encounter. In areas with lower levels of activity, strategies may focus on linear parks, native reforestation, ecological crossings, and well lit green spaces that improve safety and strengthen neighborhood connectivity. Greater everyday interaction with the river can foster collective memory, a sense of belonging, and shared responsibility for its long term care.

Figure (16)



Idea of a living river in a vulnerable sector of the Rimac River

This research demonstrates that the rehabilitation of the Rímac River cannot be addressed through a single disciplinary or sectoral approach. Environmental restoration, technological infrastructure, economic viability, citizen participation, and intergenerational equity are deeply interconnected dimensions that must be addressed simultaneously. The analysis shows that fragmented interventions tend to shift problems spatially or temporally, while integrated strategies at the basin scale offer greater potential for long term ecological recovery, social inclusion, and urban resilience. Understanding the Rímac River as a socio ecological system allows rehabilitation efforts to respond not only to environmental degradation, but also to the social and economic conditions that shape the river’s relationship with the city.

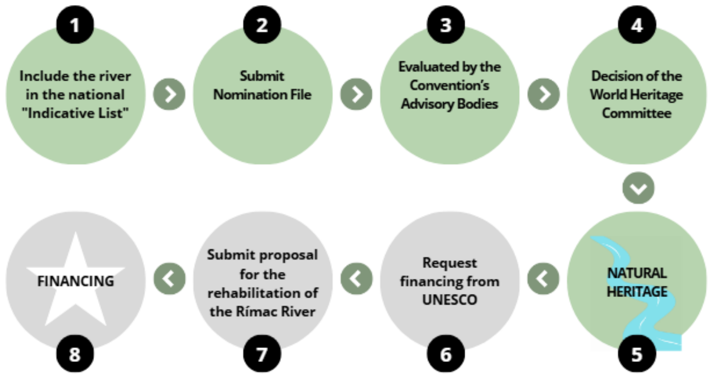
Recommendations:

I propose understanding the Rímac as a living system that must be restored from within and from outside. I propose an underground filtration system as a continuous green drainage network capable of gradually purifying contaminated water through biofilters or linear collectors buried beneath the riverbed or its margins, similar to those used in Xochimilco. This system would function as an underground bioremediation plant that reduces pollutants as the water flows, ensuring constant treatment, biodiversity recovery, and self-regulation capacity. I also incorporate vaulting to improve water flow, reduce overflows, and protect urban areas. With filtration systems like those in the Remedios case, it would be possible to reduce solid waste, improve water quality, and strengthen environmental infrastructure, achieving safer and more sustainable management of the Rímac.

My idea does not seek a partial intervention, but a strategic path that benefits the entire Rímac River and allows the project to request funding from UNESCO, the IDB, and CAF. The goal is to develop an integrated plan with ecological monitoring, environmental education, cultural activation, and community participation in order to restore both the riverbed and Lima's connection to its river. If the State has already shown the will to study and plan, society must push for sustained restoration that generates urban memory. Reviving the Rímac means recovering identity and future. For this reason, the project will initiate a nomination of the Rímac River to UNESCO as a living cultural landscape. The river is not currently part of the World Heritage List, but it can become one if its historical, ecological, and social value is clearly demonstrated. The proposal will present the river as urban memory and as a threatened territory that requires urgent recovery. A cultural, educational, and environmental plan will support the nomination and allow the project to request international assistance, showing that the objective is to rehabilitate the water and reconnect the city with its river. If the process moves forward, the project will direct the funding toward green infrastructure, active public spaces, a symbolic bridge, and a constant underground filtration system.

Since the river does not have Natural Heritage status, the first step is to include it in the national Tentative List. Then a Nomination File is prepared describing its ecological, cultural, and landscape importance, its threats, and the proposed conservation measures. The advisory bodies evaluate its universal value, integrity, and authenticity. Based on that review, the World Heritage Committee decides on its inscription. If it is recognized as Natural Heritage, funding can be requested from UNESCO and a rehabilitation proposal can be submitted to implement the actions in a planned manner.

Figure (17)



Route for UNESCO financing

To apply to the IDB, the project can present the case of the Rímac as an urgent public health and ecological resilience problem, considering that more than seventy percent of its pollution comes from untreated domestic and industrial discharges. The investment would allow the installation of filtering systems, regulated drainage, and modular purification plants, as well as improvements to slopes and stronger environmental monitoring. The project can support its viability with indicators such as reduced BOD levels, greater oxygenation, and the creation of more green areas with community participation, which demonstrate real impact. This approach reinforces the idea that recovery is possible through continuous infrastructure rather than isolated actions, taking the megaproject approved in Juliaca as a reference.

To access IDB financing, the project must be presented as an initiative of sanitation, ecological recovery, or watershed management, demonstrating social, environmental, and urban relevance. A technical, social, and environmental profile is required, including diagnosis, objectives, actions, indicators, and a sustainability plan. The proposal must have institutional support through local or national authorities. It must also include the recovery of riverbanks, public spaces, pollution control, and community participation. With this support and a complete dossier with costs, schedule, and expected results, the application is submitted following the model of similar projects already approved by the IDB.

Figure (18)

Route for IDB financing

To request financing from CAF, the proposal builds on previous investments in river studies, so the next step focuses on progressive and territorial implementation. The project proposes a phased intervention that integrates underground filtration, ecological corridors, public facilities, and monitoring stations. The proposal argues that intervening in only one section reduces efficiency, while a comprehensive restoration prevents setbacks and makes the investment more effective. This approach shows that the project does not start from zero, but continues an existing process that can expand with external financing to restore a river that is on the verge of collapse.

Figure (19)

Route for CAF financing

In conclusion, I understood that the Rímac is not destined to disappear, but to recover if collective will and management bring together technical action and community involvement. The evidence shows that sustainability emerges when the river stops acting as an edge and becomes a lived space again. Recovery will not be immediate or simple, but it is possible. The cases of Xochimilco and Remedios demonstrate this, the analysis of the Rímac demands it, and the interview confirms it. Today the riverbed is weakened, but it can be reborn if belonging and memory are built. My proposal does not remain in diagnosis, but in action: seeking financing, consolidating ecological infrastructure, activating its edges, and reconnecting the city with the water. Restoring the Rímac means giving life back to the river and also to Lima, because if the city walks toward it again, the river will belong once more.

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