

ORIGINAL ARTICLE

Perceptions of cultural ecosystem services provided by urban rivers. The case of the Chili River in Arequipa, Peru

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Abstract

Urban rivers, as components of the blue-green infrastructure, offer diverse Cultural Ecosystem Services (CES). However, their intangible nature often limits public perception and valuation. This research assessed CES perception along the Chili River in Arequipa, Peru, using surveys and participatory mapping with experts and the general population. Results indicated high valuation of scenic beauty (population: 43%; experts: 63%) and potential for research development (population: 47%; experts: 63%). Experts also emphasized cultural heritage and physical/mental health (50%). The public's primary activities were hiking (57%) and photography (30%), but a gap existed between perceived value and active participation in recreation and education. Experts highlighted tourism potential (78% strongly agree) and intangible heritage (67% strongly agree), while noting a lack of integration in environmental education (64% disagree). Mapping revealed distinct perceptions: the public identified the Intraurban section with the highest CES concentration (scenic beauty, education, heritage, knowledge, research), whereas experts emphasized the North for ecotourism (53%) and spirituality (36%), the Center for culture/landscape, and the South for research (39%) and education (28%). Water pollution (62%) and land use regulation (33%) were identified as key challenges. This study underscores the need to integrate CES into urban planning, promote community engagement, and conduct further research for the Chili River's sustainable management.

Keywords: Cultural Ecosystem Services, blue-green infrastructure, climate change, environmental perception, environmental psychology

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1. Introduction

As key components of a city's blue-green infrastructure, urban rivers enhance human-nature connections (Grzyb, 2024), facilitate habitat connectivity, and protect biodiversity (Sikorski et al., 2021). They also reduce landscape fragmentation from urbanization (Liao, 2019; Valladares et al., 2017; European Environment Agency - EEA, 2011). Their diverse Ecosystem Services (ES) position them as vital in combating climate change and bolstering urban resilience (Ollero et al., 2021; Dong et al., 2021; Magdaleno et al., 2018; Verduyck et al., 2020).

The Common International Classification of Ecosystem Services (CICES) V5.1 defines Ecosystem Services (ES) as “the contributions that ecosystems make to human well-being” (Haines-Young and Potschin, 2018). These are categorized into regulating, provisioning, supporting, and cultural services. ES are recognized as vital tools for climate change adaptation and mitigation (Das et al., 2022; Bellezoni et al., 2021; Cavan et al., 2021), making them effective for environmental management and urban planning (Iruri-Ramos et al., 2023; Zhao et al., 2022; Grunewald et al., 2021). Within this framework, Cultural Ecosystem Services (CES) are defined as “the intangible characteristics of ecosystems” (Haines-Young & Potschin, 2018), with their perception shaped by three key factors such as: the landscape's biophysical and spatial attributes (Hale et al., 2019; Nowak-Olejnik et al., 2024), user-related social and personal factors (Valença Pinto et al., 2024; Graves et al., 2017), and the nature of user-nature interactions (Valença Pinto et al., 2024; Grzyb, 2024; Bieling, 2014; Bryce et al., 2016).

Urban rivers are notable for their abundant provision of CES, directly contributing to the health, well-being, and quality of life of urban residents (Iojă et al., 2018; White et al., 2020; Smith et al., 2022; Grzyb, 2024). Research indicates that CES foster identity, belonging, ownership, and refuge (Yli-Pelkonen et al., 2006; Grzyb, 2024), support cognitive development and social-aesthetic experiences (White et al., 2010; Riechers et al., 2016; Dou et al., 2017; Stepniewska & Sobczak, 2017; Grzyb, 2024), and promote physical and mental well-being (Vert et al., 2019; Durán Vian et al., 2021; Grzyb, 2024). Their linear structure and flowing water encourage activity and stimulate the senses (Stepniewska & Sobczak, 2017), while also facilitating reflection and spiritual enrichment (Völker & Kistemann, 2011; Rall et al., 2017; Korpilo et al., 2023) and enabling the transmission of ancestral knowledge (Carrasco-Torrentegui et al., 2021). Grzyb (2024) highlights the high value of urban rivers as climate change adaptation measures due to their diverse cultural benefits, suggesting they can offer more CES than urban green spaces (Dou et al., 2017).

To fully understand CES, it's essential to examine the spatial and temporal patterns of river landscape use for urban river management. Grzyb and Kulczyk (2023) demonstrate that the spatial concentration of CES varies by type. Knowledge development, social connections, and reflective experiences in nature are strongly influenced by landscape and space. Conversely, the sense of belonging, identity, and the transmission of ancestral knowledge are more closely tied to individual or cultural group characteristics (Nowak-Olejnik et al., 2024; Carrasco-Torrentegui et al., 2021).

CES, while vital for well-being, are frequently underestimated due to their non-material benefits and the subjective nature of their perception (Milcu et al., 2013). This leads to quantification challenges, including user preference variations (Harrison et al., 2018; Schutter et al., 2021). Developing countries face additional hurdles like institutional distrust and resource limitations, affecting CES valuation (Chan et al., 2016; Vollmer et al., 2015). Consequently, CES management can be compromised, and they may be overshadowed by other priorities (Le Corre et al., 2021; Bachi et al., 2020). To overcome these challenges, researchers often employ mixed methodologies. Structured surveys with Likert scales are effective for capturing perceptions and attitudes (Joshi et al., 2015; Dillman et al., 2014; Wang & Hayashi, 2023), particularly in urban cultural and landscape assessments (Riechers et al., 2016; Espinoza & Ceciliano, 2021). Participatory methods, such as spatial mapping and collaborative workshops, are crucial for evaluating urban rivers (Vidal-Llamas et al., 2024; Grzyb, 2024; Nowak-Olejnik, 2024; Cheng et al., 2019). While social network analysis and economic valuations are less common, the integration of diverse methods provides a comprehensive approach to developing sustainable conservation and management strategies aligned with community values (Hale et al., 2019; Ghermandi et al., 2020; Langemeyer et al., 2018; Vollmer et al., 2015; Zhang et al., 2021; Lee, 2024).

Current understanding of CES remains inadequate (Jones et al., 2022), with knowledge of their spatial patterns particularly fragmented (Grzyb, 2024), jeopardizing their conservation. Furthermore, CES provided by rivers and other blue-green infrastructures are under-researched (Zhang, 2014), especially when compared to urban parks (Cheng et al., 2021; Veerkamp et al., 2021). These gaps highlight the necessity to integrate CES into ecosystem service assessments and management policies (Wang and Hayashi, 2023), and to develop adaptable research strategies tailored to regional contexts.

To address this knowledge gap, the urban section of the Chili River in Arequipa, Peru, was selected as a case study. This river, a key territorial axis, supplies water for urban and rural uses (Oficina de Asesoría y Consultoría Ambiental, 2002) and holds significant symbolic value for residents. However, its ecological corridor is threatened by environmental changes and human activities (Zeballos, 2020), impacting its ecosystem service provision. While studies have focused on water decontamination and physicochemical, hydrobiological, and biodiversity aspects (Huarachi et al., 2012; Talavera et al., 2011; Salazar et al., 2017; Montesinos-Tubée, et al., 2019), local research on ecosystem services remains limited. Carrasco-Valencia et al. (2024) evaluated water yield using remote sensing, and Iruri-Ramos et al. (2023) identified the Chili River's main ecosystem services and their role in climate change adaptation and mitigation. This research concluded that international experts prioritized environmental education, whereas local experts undervalued CES compared to provisioning and regulating services, despite acknowledging the importance of scenic beauty, environmental education, physical and mental health, and cultural heritage.

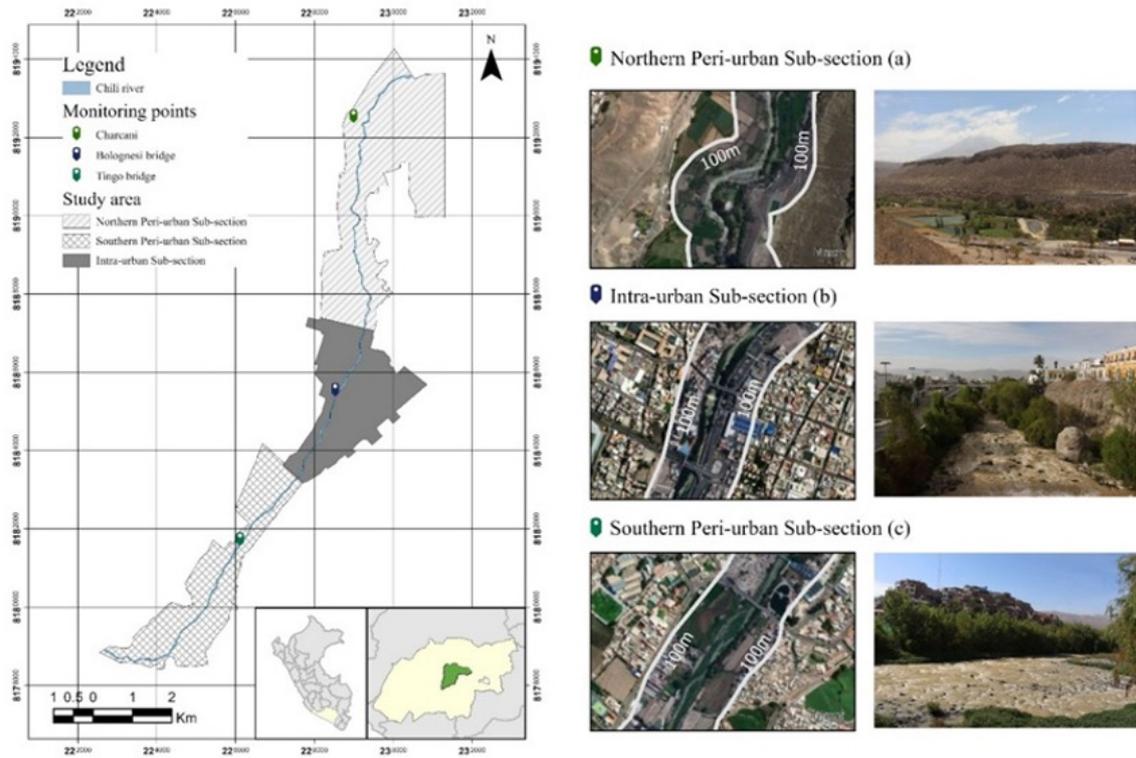
This research aimed to study residents' perceptions of CES provided by the urban Chili River and to analyze the spatial patterns of these perceptions. Differentiated questionnaires for residents and experts, alongside participatory mapping, were employed. This approach yielded critical information for achieving socio-ecological balance in the river landscape and ensuring sustainable CES management, thereby preserving the river as a vital component of community well-being and climate change adaptation.

2. Study area

The study area, the urban section of the Chili River, is located within the Quilca-Chili basin in Arequipa, Peru. This basin, situated on the western slopes of the Andes, drains into the Pacific Ocean. The Quilca-Chili basin comprises 11 hydrographic units, with the study area falling within the Medio Quilca-Vítor-Chili unit, spanning 2334.60 km². The Chili River is 88.2 km long (ANA, 2013), with the urban section covering 39.7 km.

Iruri-Ramos et al. (2023) defined the urban section, dividing it into three sub-sections based on urban and peri-urban land use (Figure 1). The northern peri-urban sub-section extends from the Virgen de Chapi – Charcani Sanctuary to the Chilina bridge. The intra-urban sub-section, characterized by urban development on both banks, stretches from the Chilina bridge to the San Isidro bridge. The southern peri-urban sub-section, marked by intermittent urban use, runs from the San Isidro bridge to the Congata bridge (Figure 1).

Figure 1. Map of the urban basin of the Chili River and the defined Subsections



Source: Iruri-Ramos et al. (2023).

3. Methodology

CES encompass the non-material benefits people derive from ecosystems, such as spiritual inspiration, recreation, and aesthetic appreciation (Santos-Martín et al., 2022; Riechers et al., 2016). To assess CES perceptions, a clear classification is essential for developing effective questionnaires. The classification of these services was based on a comprehensive review of scientific literature and key conceptual frameworks.

A thorough review of scientific literature and recent conceptual frameworks was conducted to establish a suitable classification. First, the Millennium Ecosystem Assessment (Sarukhán & Whyte, 2005) was analyzed, providing a foundation for understanding the ecosystem-human well-being relationship and highlighting the role of cultural services. Recent studies on blue-green infrastructure and its CES provision were also considered. Notably, findings from “Ecosystem services of blue-green infrastructure for climate change adaptation and mitigation: case of the urban section of the Chili River, Arequipa (Peru)” were incorporated, identifying 8 cultural services among 36 ecosystem services (Iruri-Ramos et al., 2023; Grzyb, 2024; Vidal-Llamas et al., 2024; Cheng et al., 2019). This analysis refined and validated the initial categories with empirical data from the Latin American context.

Furthermore, the latest contributions from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), particularly the concept of Nature’s Contributions to People (Díaz et al., 2018; Wang & Hayashi, 2023; Espinoza & Ceciliano, 2021), were reviewed, broadening the understanding of CES within diverse geographical and social settings.

Through this process, cultural ecosystem services were synthesized and organized, guided by theoretical and empirical evidence, yielding a current and comprehensive framework. The primary services identified include:

1. Scenic beauty
2. Ecotourism and recreation
3. Education
4. Physical and mental health
5. Cultural legacy or heritage
6. Traditional knowledge
7. Spiritual and intellectual interactions
8. Research

3.1 Evaluation Instrument

This study employed two distinct questionnaires – one for the general population and another for experts – to analyze (CES) perceptions along the urban Chili River in Arequipa, Peru. This dual approach was essential to capture the nuanced perspectives of both groups, which, as Cano and Haller (2018) suggest, often converge and diverge in ways that enhance our understanding of hydrological ecosystem services.

The expert questionnaire was distributed to professionals from public institutions, NGOs, and private entities managing water resources in the Chili River basin. It utilized technical terminology appropriate for their expertise. The general population questionnaire, aimed at water resource users like farmers and residents, was designed with simpler language (Espinoza Cisneros & Ceciliano Calderón, 2021). Both questionnaires included Likert scales and multiple-choice questions to quantify perceptions of river-related CES. Likert scales allowed for the measurement of agreement or importance, enabling detailed statistical analysis (Joshi et al., 2015), while multiple-choice questions categorized preferences and revealed usage trends (Dillman et al., 2014). To maintain respondent engagement, each questionnaire was limited to 20 questions, aligning with recommendations to minimize fatigue and maximize response rates (Dillman, Smyth, & Christian, 2014).

3.2 Instrument validation

The selection of experts began with an evaluation table using criteria including academic qualifications, specialization, research output, practical experience in environmental management, methodological expertise, and involvement in consulting or public service. Each criterion was rated on a scale of 1 to 5, with 5 indicating high proficiency. From an initial pool of 10 experts, the top five, those scoring above 3.5, were selected. These experts then evaluated each survey question for suitability, required modifications, or necessity for removal, using a 1-to-3 scale. Following this evaluation, the survey was revised and subjected to a pilot test to confirm its validity and practical use.

3.3 Sample determination

Population density was calculated for each district within the study area. Using 2017 national census data and district area (km²) derived from QGIS 3.40.4, Equation 1 was applied. The results are shown in Table 1.

Equation 1. Calculating Population Density

$$DP = Nh/A$$

Dp: population density

Nh: number of inhabitants

A: area in square kilometers

To accurately reflect the study area, district political boundaries were modified, yielding the precise area of each district within the defined limits. This adjusted area, measured in square kilometers, was subsequently multiplied by the corresponding district's population density, enabling an estimation of the total population residing within the study area (Table 1).

Table 1. Population per district

DISTRICT	Total area per district	Total population per district	Population density	Study area by district	Population of the study area
JACOBO HUNTER	20.583	50164	2437	2.247	5475.939
TIABAYA	37.1536	16191	436	1.5014	654.6104
SACHACA	14.2767	24225	1697	2.7052	4590.724
AREQUIPA	11.4137	55437	4857	6.1369	29806.92
YANAHUARA	3.6672	25417	6931	1.2207	8460.672
MIRAFLORES	26.1281	60589	2319	0.3663	849.4497
ALTO SELVA ALEGRE	67.6241	85870	1270	7.276	9240.52
CAYMA	232.8314	91935	395	3.9922	1576.919
TOTAL					60655.76

Source: Instituto Nacional de Estadística e Informática (2017).

Equation 2 (Aguilar-Barojas, 2005; Bravo et al., 2024) was employed to determine the sample size. The total population “n,” representing the sum of inhabitants within the study area, was obtained from Table 1. Given the socio-environmental nature of the study, a 95% confidence level (Z = 1.96) was selected. Values of p = 0.8, q = 0.2, and d = 0.05 were assumed.

Equation 2

$$N = \frac{nZ^2pq}{(n - 1)d^2 + Z^2pq}$$

N = Sample size.

n = Total population size or universe.

Z = Standard Normal Distribution Value at 95%

p = 0.8 Estimated proportion of the phenomenon in the reference population (given that the study area is close to the river, this value is adopted as representative).

q = 0.2 Proportion of the reference population that does not present the phenomenon under study.

d = accuracy level 0.05.

3.4 Application of reliability index

The surveys for both the general population and experts were developed and adjusted based on specialist observations. To ensure reliability, Cronbach's alpha coefficient was employed, a widely recognized technique in social research for evaluating the internal consistency of Likert-scale questions (Joshi et al., 2015). A pilot test involving 30 participants, deemed an adequate sample size for reliable estimations (Roco Videla et al., 2021), was conducted to confirm the survey's representativeness.

Cronbach's alpha was computed using the "psych" package in RStudio. The interpretation of results followed George and Mallery's (2003) guidelines: $\alpha \geq 0.9$ (excellent reliability), 0.8-0.9 (good reliability), 0.7-0.8 (acceptable reliability), 0.6-0.7 (questionable reliability), and values below 0.6 (low reliability), which would require instrument revision. Multiple-choice questions underwent validation through peer review and subsequent adjustments, a standard approach for ensuring the clarity, consistency, and relevance of questionnaire items (Elangovan & Sundaravel, 2021).

4. Results

4.1 Sample and validation of the survey

A minimum of 245 participants were determined for the population survey, and 48 experts for the expert survey, based on the sample calculation. The reliability of the survey instruments was evaluated using Cronbach's alpha coefficient, resulting in values of 0.88 for the population survey and 0.72 for the expert survey in the Likert-scale questions, demonstrating high internal consistency. The validity of multiple-choice question content was established through peer review and evaluation.

4.2 Population Valuation of Cultural Ecosystem Services (CES)

4.2.1 Characteristics of survey participants

A total of 261 responses were collected, surpassing the minimum sample and indicating strong participation. The majority were women (62.5%), suggesting greater survey responsiveness compared to men (36.4%). Most respondents were aged 18-29 (57%), highlighting significant youth representation. Additionally, 66% held university degrees, which may influence their perceptions and responses, providing context to the results.

4.2.2 Activities associated with the urban section of the river

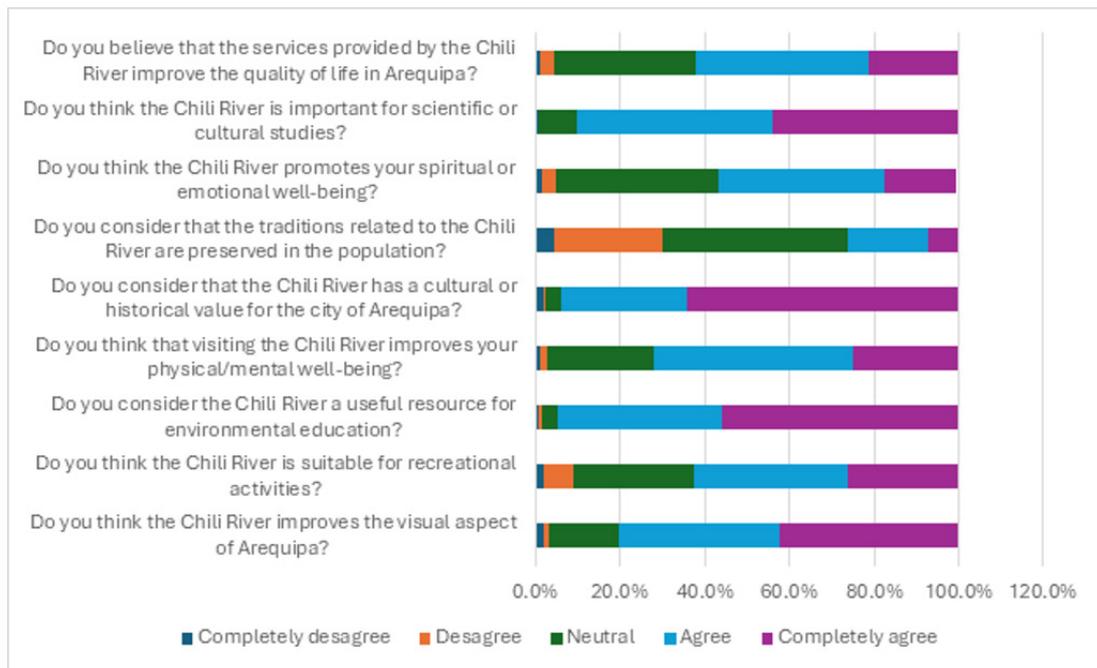
The primary activities participants engage in to appreciate the river's scenery are hiking (57%) and photography (30%). Recreational pursuits commonly include bird watching (46%), along with walking, cycling, canoeing, and relaxation. Despite the predominantly university-aged demographic, 41% of participants have not undertaken river-related educational activities. Nonetheless, a substantial 40% have participated in field trips, suggesting a degree of environmental interaction. Traditional knowledge, specifically agriculture (41%) and traditional irrigation practices (34%), continues to hold importance. Direct engagement with the river's benefits or services is generally low, with more than 50% of respondents reporting rare or no participation. However, 38% of participants do engage in physical activities in proximity to the Chili River.

4.2.3 Identification of CES provided by rivers

To identify the ecosystem services provided by the Chili River, a Likert scale was used to evaluate the perception of the respondents of the river's different benefits and potentialities. The results indicate that there is a high valuation of these benefits. The cultural and historical importance of the river is highlighted (64% totally agree) and its use as a resource for environmental education (55.6% totally agree). On the other hand, the least recognized benefits were those related to traditions (44.1% neutral, 25.3% disagree), the promotion of spiritual or emotional well-being (38.3% neutral), recreational activities (28.7% neutral, 6.9% disagree) and the improvement of quality of life in the city (33.7% neutral, 3.1% disagree) (Figure 2)

Respondents identified the cultural, historical, and educational value of the river. However, the results also suggest the need to strengthen the connection with the traditions related to the river, its spiritual or emotional benefits, as well as its impact on the quality of life in the city.

Figure 2. Identification of CES provided by the urban section of the Chili River

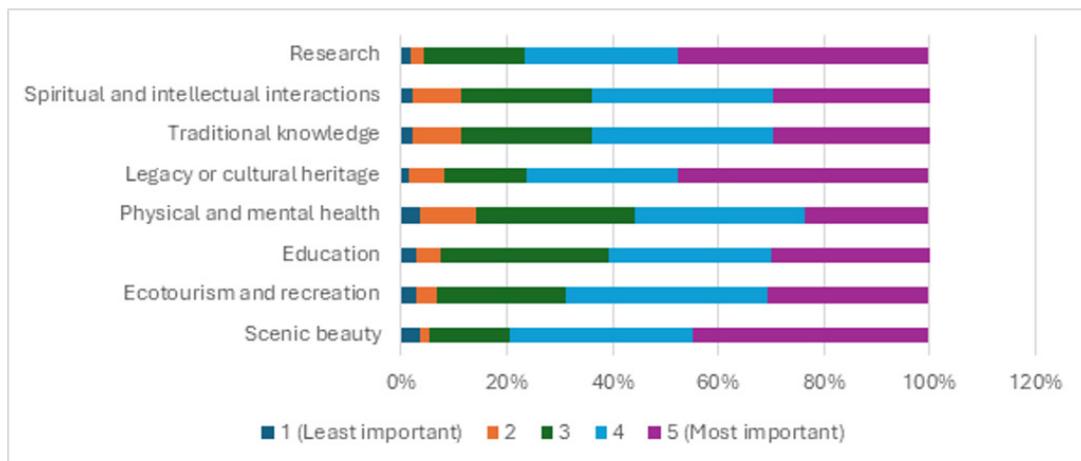


Source: Authors' own elaboration based on CES perception survey.

4.2.4 Importance of CES in the urban stretch of the river

The importance of river CES was evaluated using a Likert scale ranging from 1 to 5. The results revealed a high valuation of these services, with scores of 4 and 5 surpassing 50% across all categories. Research and cultural legacy/heritage were identified as the most significant services, each scoring 47% in the highest importance category, followed by scenic beauty, which reached 43% (Figure 3). This suggests a strong recognition of the river's cultural and landscape significance.

Figure 3. Importance of CES in the urban section of the Chili River



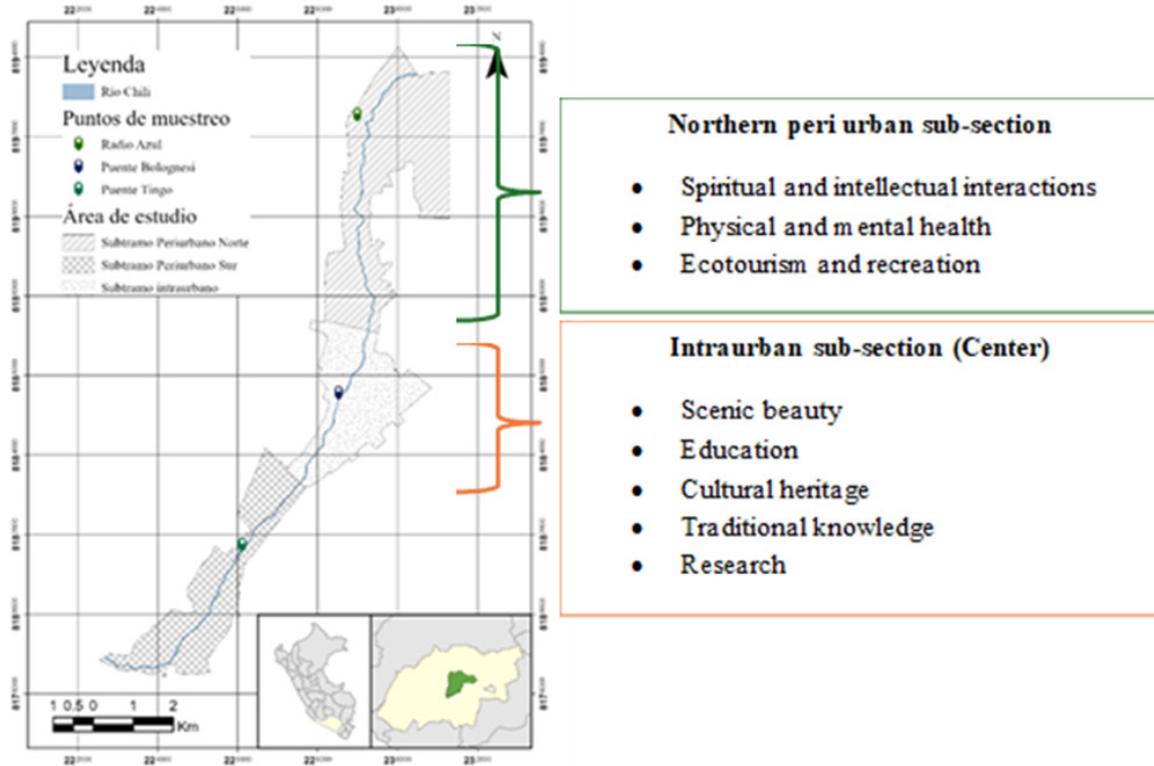
Source: Authors' own elaboration based on Likert-scale survey results.

4.2.5 Mapping of the CES of the urban stretch of the river

Mapping of river CES across the north, center, and south subsections revealed variations in perception, influenced by land use and human intervention. The center (intra-urban) subsection

had the highest concentration of identified CES (5), followed by the north (peri-urban) subsection (3). No single predominant CES was identified in the south. In the center, scenic beauty, education, cultural legacy, traditional knowledge, and research were prominent, while the north emphasized spiritual interactions, health, ecotourism, and recreation. Services in the south received lower ratings (Figure 4). These findings underscore the need for tailored conservation and management strategies, focusing on strengthening less recognized services in each area.

Figure 4. Map of CES identified on each urban sub-section of the Chili River



Source: Authors' own elaboration based on spatial analysis and CES survey results.

4.2.6 Problems and conservation measures associated with the river

The principal challenges facing the river, as perceived by participants, were water pollution (62%), accumulated refuse (18%), and the decline of fauna and flora (8%), encompassing fish, aquatic plants, and amphibians. Essential protection measures were identified as preventing water pollution (84%), preserving fauna and flora (11%), and regulating tourist activities (3%). The overwhelming focus on pollution underscores the river's critical role in providing freshwater, a vital ecosystem service. Although the importance of biodiversity conservation was recognized, addressing pollution remained the foremost priority.

4.3 Expert Assessment of Cultural Ecosystem Services (CES)

4.3.1 Characteristics of survey participants

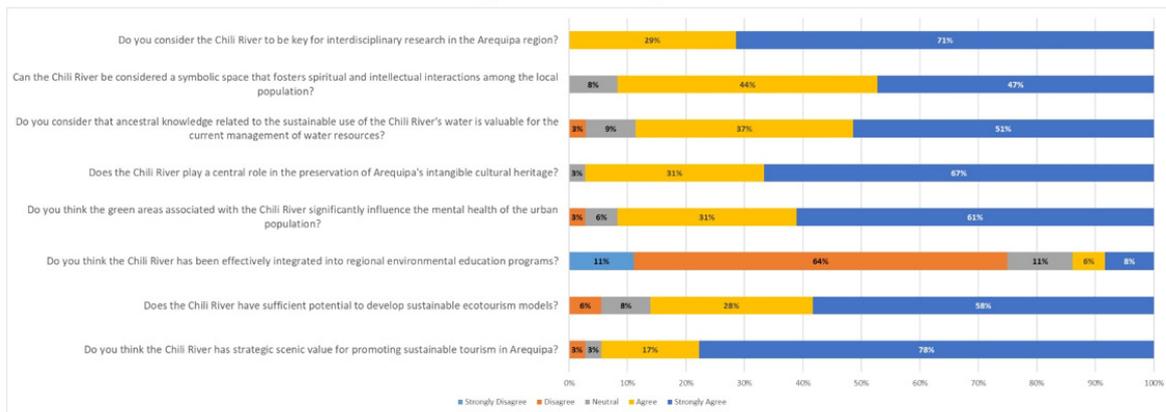
A total of 50 responses were obtained, revealing a balanced gender representation: 53% male and 47% female. The majority of respondents fell within the 30-44 age bracket (56%), suggesting that they are currently in a phase of active employment and professional development. Regarding employment sectors, the private sector was most prevalent (78%), markedly surpassing the public sector (11%), self-employment (6%), and non-governmental organizations (NGOs) (6%). This distribution indicates

that most of the responses came from professionals engaged in academic-related activities, which could have potentially impacted the results of the assessment.

4.3.2 Identification of the CES provided by the river

Experts strongly rated sustainable tourism (78%) and sustainability-based ecotourism (58%). They also recognized the river’s role in preserving intangible cultural heritage (67%) and its importance in interdisciplinary research (71%). However, environmental education integration was negatively perceived (64% disagree), highlighting an opportunity for collaboration between academic institutions and river management. The river was valued for its symbolic, spiritual, and intellectual significance (47% strongly agree, 44% agree) and positive impact on mental health (61% strongly agree, 31% agree). Overall, experts positively assessed the Chili River’s environmental, cultural, and tourism aspects, but emphasized the need to improve educational integration and sustainable management (Figure 5).

Figure 5. Identification of the CES provided by the Urban section of the Chili River

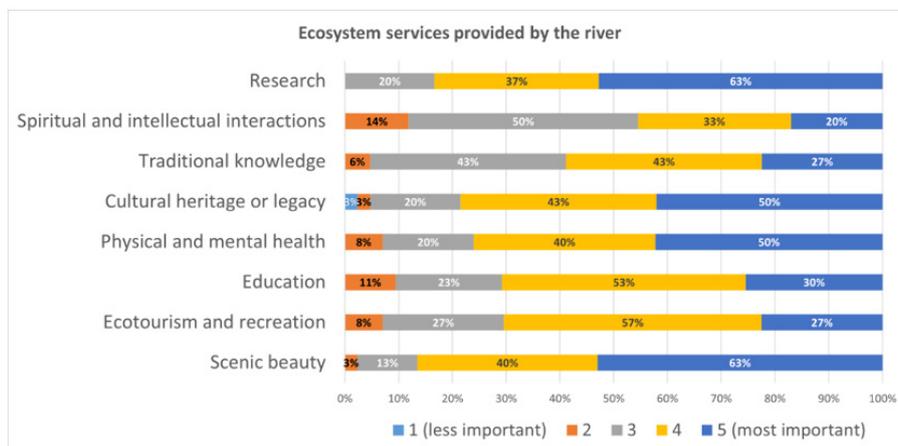


Source: Authors’ own elaboration based on expert perceptions of CES.

4.3.3 Importance of Urban River CES

Scenic beauty and research were the most highly valued services (63% at level 5), followed by cultural heritage and physical/mental health (50% at level 5). Education and ecotourism also received high ratings (53% and 57%, respectively). Spiritual/intellectual interactions and traditional knowledge were moderately valued. The river’s cultural, health, and research aspects were positively perceived, but traditional knowledge and spiritual interactions require greater recognition (Figure 6).

Figure 6. Importance of Urban River CES according to experts

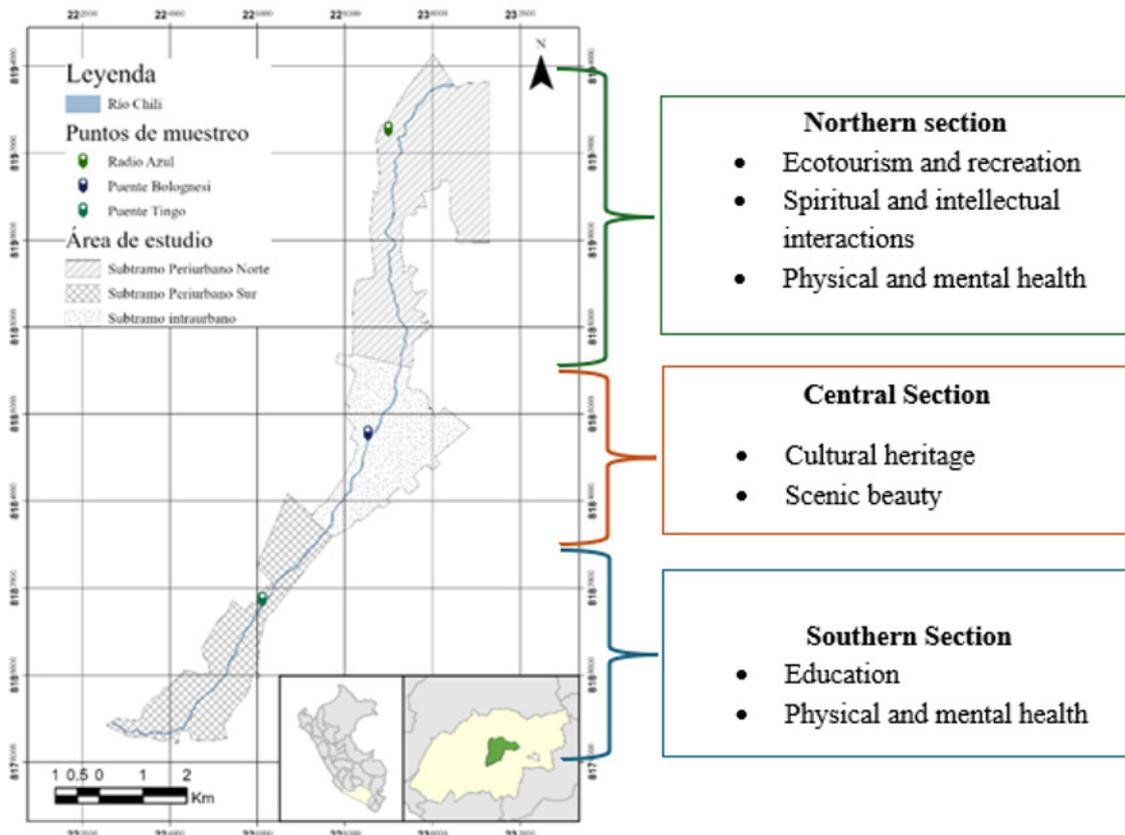


Source: Authors’ own elaboration from expert assessments of CES importance.

4.3.4 Urban River CES Mapping

The northern subsection is distinguished by its contribution to ecotourism and recreational activities (53%), with spiritual and intellectual interactions (36%) and physical and mental health benefits (33%) also being highly valued. The central subsection is characterized by its strong cultural legacy (33%) and scenic beauty (31%), demonstrating a high level of appreciation for its heritage and landscape richness. In the southern subsection, education (19%) and physical and mental health (17%) are the most significant CES, but they register lower values compared to the northern and central subsections (Figure 7).

Figure 7. Map of CES identified on each urban sub-section of the Chili River



Source: Authors' own elaboration based on expert CES survey and spatial analysis.

4.3.5 Priorities and approaches for river conservation and management

Conservation and management priorities for the Chili River focus on riparian vegetation (29%) and landscape composition (25%). Hiking (36%) and wildlife observation (24%) are deemed most compatible with ecological carrying capacity. Field workshops (38%) and school projects (32%) are considered effective for raising river awareness. The river is seen as a contributor to mental health by reducing stress (49%) and improving mood (40%). It's also valued for artistic creation (54%) and meditation (27%), providing urban respite. Cultural priorities include historical riverside architecture (42%), oral stories (36%), ancestral irrigation (26%), and agriculture (24%). Research priorities are biodiversity conservation (29%) and water resource management (25%), with water quality and scenic value (both 26%) identified as potential research topics. Urgent protection measures include land use regulation (33%) and ecological restoration (29%), highlighting the need for comprehensive sustainable management strategies.

5. Discussion

Citizens generally recognize the Chili River's most relevant CES as its cultural and historical value, as well as its role in environmental education and research. This aligns with Arequipa's recognition as a UNESCO Cultural Heritage of Humanity since 2000, due to its monumental architecture, agricultural areas, and the river's presence in the Historic Center. This natural and cultural landscape holds high symbolic value and is deeply rooted in the residents' identity (UNESCO, 2000). Local experts concur with the population regarding these primary CES but also emphasize the river's potential for sustainable ecotourism development. They highlight the importance of understanding spatial patterns and landscape associations for this development (Hale et al., 2019).

The river's urban section is associated with improved physical and mental well-being, enhancing the city's visual appeal. To a lesser extent, it's considered suitable for recreational and spiritual/emotional activities. Among these CES, scenic beauty is most valued, indicating a preference for contemplation over active recreation. This aligns with findings from other urban river studies, where high symbolic value is assigned to CES without necessarily translating into daily engagement (García-Martín et al., 2020).

A significant percentage of the population remains neutral regarding the Chili River's connection to traditional knowledge conservation, despite experts considering this CES crucial for preserving intangible cultural heritage. This indifference is concerning, as ancestral knowledge can be vital for climate change adaptation (Carrasco-Torrontegui et al., 2021).

While the population acknowledges the river's positive impact on their quality of life, most have limited direct engagement through spiritual/meditative activities, education, research, festivals, or physical activities. The relationship is primarily based on symbolic recognition and scenic beauty within the Historic Center. This disconnect between perception and practice is common, with CES valuation not always leading to direct environmental interaction (Langemeyer et al., 2018).

Participatory mapping reveals that cultural/historical legacy and scenic beauty, the most valued CES, are concentrated in the central intra-urban section, due to the Historic Center's presence. Experts and residents agree that research and education can be practiced in all subsections. They also concur that less practiced activities, such as spiritual interactions and recreation, are focused on the northern peri-urban subsection, largely seen as tourist attractions. Factors like accessibility and infrastructure limitations may contribute to this (Nowak-Olejnik et al., 2024). However, experts emphasize ecotourism's potential for economic development. Carrasco-Valencia et al. (2024) warn of urbanization pressures in the northern subsection, jeopardizing CES provision. Similarly, Vilca-Campana et al. (2025) highlight how urban growth and insufficient territorial regulation contribute to the degradation of the river corridor and its loss of multifunctionality. Experts prioritize land use regulation and ecological restoration. These findings highlight the need for community engagement and environmental awareness programs. Ecotourism and sustainable recreation in the northern subsection could foster a more active relationship between residents and the river (Nowak-Olejnik et al., 2024).

Despite high CES valuation, integrating them into conservation and urban planning policies remains a challenge. Iruri-Ramos et al. (2023) corroborate this, noting that local experts prioritize scenic beauty, cultural identity, and research potential. Residents and experts agree that water pollution is the river's primary problem, indicating that freshwater supply takes precedence over other CES.

The integration of CES into climate change mitigation and adaptation strategies is limited. This is partly due to CES being intangible and less quantifiable, often taking a backseat to regulation and provisioning services (Grzyb, 2024; Iruri-Ramos et al., 2023).

6. Conclusions

Comparing surveys from the general population and local experts regarding the Chili River's ecosystem services reveals a shared appreciation for its multifunctionality, albeit with key differences. Both groups highly value scenic beauty and potential for research development, recognizing their contributions to well-being and knowledge. However, the population places greater emphasis on

cultural heritage and education, while experts prioritize tourism potential and intangible heritage.

Mapping by subsection indicates that the northern area is associated with ecotourism and spirituality, the central area with cultural and landscape richness, and the southern area with research and education. This suggests the need for tailored urban management and planning strategies. While the population identifies water pollution as the primary concern, experts advocate for land use regulation and ecological restoration as urgent measures.

Despite the high valuation of CES, a gap exists between public perception and active participation in recreational, educational, and spiritual river activities. This highlights the need for strategies that encourage greater space utilization, including improved infrastructure, cultural events, and environmental education programs to foster community ownership. Furthermore, the limited integration of CES into urban planning and public policy underscores the urgency of their incorporation into territorial development and climate change adaptation strategies to maximize their contribution to public well-being and the river's ecological resilience.

This study emphasizes the importance of recognizing and valuing the Chili River's diverse ecosystem functions, promoting a management approach that balances human needs with ecosystem and landscape integrity. The findings highlight the need for continued research into the spatial and temporal patterns of CES in urban rivers, enabling the development of more effective management strategies for these ecosystems in similar contexts.

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