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Management of Residual Urban Spaces to Mitigate Environmental Pollution in A Peruvian Population Center

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Abstract

This research titled “Management of Residual Urban Spaces to Mitigate Environmental Pollution in the Alto Puno Population Center – 2024” aimed to determine how the management of residual urban spaces contributes to the mitigation of environmental pollution. This was a basic-theoretical study with an explanatory-causal level, using a quantitative approach, non-experimental cross-sectional design, and a hypothetico-deductive method. A probabilistic simple random sampling method was used to select 1,204 residents of the population center. The primary data collection technique was a survey using Likert-scale questionnaires. Key findings revealed a statistically significant influence of the management of residual urban spaces on the reduction of environmental pollution, as confirmed by the chi-square analysis ($\chi^2 = 47.558$, $p = 0.000 < 0.05$). The study concludes that effective management of residual urban spaces significantly contributes to reducing environmental pollution, highlighting the relevance of their strategic planning within sustainable environmental frameworks.

Keywords: Urban Management, Residual Spaces, Environmental Mitigation, Urban Pollution, Alto Puno.

Introduction

Environmental pollution has become one of the most pressing threats to urban sustainability, affecting air, soil, and water quality, as well as public health and overall well-being in both urban and peri-urban populations (Sun et al., 2023). In this context, residual urban spaces—also known as vacant or leftover lands—represent a critical yet often overlooked dimension in environmental planning. These areas, typically lacking defined use or proper maintenance, frequently become informal dumping grounds for solid waste and debris, thereby contributing to socio-environmental degradation (Azhar et al., 2022; Torres Samillán, 2020). According to Münzel et al. (2024), pollution of soil, air, and water is among the leading environmental causes of disease, accounting for over nine million premature deaths annually.

In Latin America and the Caribbean, this issue is exacerbated by challenges in municipal solid waste (MSW) management. An estimated 216 million tons of MSW are generated annually, of

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which only 4.5% is recycled. The rest is primarily directed to sanitary landfills (56%), while approximately 40% is disposed of in uncontrolled open dumpsites (Correal et al., 2021).

In Peru, the volume of waste generation is also substantial. According to CEPLAN (2023), environmental pollution sources increased from 88.3% in 2011 to 92.8% in 2022. Furthermore, the Ministry of the Environment (MINAM, 2024) reports that Peru produces around 8.45 million tons of municipal waste annually. This trend is influenced by population growth, which correlates with higher per capita waste generation (Gutiérrez as cited in Herrera, 2020).

Several studies have emphasized that proper management of residual urban spaces can transform deteriorated areas into environmental and social assets. The incorporation of green infrastructure into such spaces not only enhances urban aesthetics but also contributes to mitigating air and soil pollution through phytoremediation, particle capture, and runoff control mechanisms (Sinthia & Hoque, 2024; Sultana & Hoque, 2024). This approach is particularly relevant in areas like Alto Puno, where unplanned urban growth has led to the proliferation of neglected residual spaces, contributing to the community's perception of a contaminated environment. Desde un enfoque de sociología urbana, la percepción ciudadana de la contaminación está fuertemente vinculada al estado físico y funcional de su entorno inmediato. Estudios como los de Hernández et al. (2023) y Yang & Tang (2025) demuestran que la recuperación participativa de espacios urbanos mejora la percepción ambiental, fomenta el sentido de pertenencia y refuerza las prácticas comunitarias orientadas al cuidado del ambiente. La articulación entre gestión ambiental y cohesión social se vuelve fundamental en ciudades intermedias de América Latina, donde la presión por el uso del suelo coexiste con déficits históricos en servicios básicos, planificación y espacios públicos sostenibles.

Based on the foregoing, the need to implement measures to mitigate environmental pollution becomes evident, especially in rapidly growing peri-urban areas such as the Alto Puno population center, which is currently undergoing a process of district-level reorganization.

In this context, the data presented regarding the identified problem constitute the starting point for the present research. This is due to the fact that the efficient management of residual urban spaces defined by Curzio & Moreno (2021) as fragments of urban territory that have been neglected or left without a specific use as a consequence of uncoordinated urban planning and the lack of effective solutions in municipal development plans may represent a viable intervention strategy to mitigate environmental pollution

Managing these spaces involves actions aimed at reclaiming and assigning them new functionality, including their transformation into recreational areas, rest zones, or green spaces. Within the sustainability framework, the development of green areas in such spaces can contribute to improving environmental conditions by enhancing air quality, reducing the greenhouse effect, and capturing carbon (ONU-Habitat, 2018).

Moreover, the importance of intervening in these spaces is aligned with the targets established by the Sustainable Development Goals (ODS), which advocate for the rational use of present resources without compromising those of future generations. ODS 11 seeks to achieve inclusive, safe, resilient, and sustainable cities, while other goals emphasize environmental preservation as a fundamental component of quality of life (FAO, 2019). At the national level, the regulatory framework also supports the recovery of these spaces. Peruvian Law No. 31199 (2021), Article 2, explicitly recognizes that the sustainable management of public spaces promotes the environmental, social, and economic well-being of cities.

In this context, the main objective of the present study is to determine how the management of residual urban spaces contributes to mitigating environmental pollution in the Alto Puno population center during the year 2024. Furthermore, the findings of this research support the theoretical incorporation of how residual space management serves as a mechanism for environmental mitigation. Likewise, the study facilitates the development of knowledge and practical solutions aligned with the local context, addressing pollution issues in Alto Puno and positioning this case as a reference model for other communities facing similar environmental challenges.

Results

General Objective:

To determine how the management of residual urban spaces mitigates environmental pollution in the Alto Puno population center – 2024.

		Environmental Pollution									
		Not Severe		Slightly Severe		Severe		Very severe		Total	
		N	%	N	%	N	%	N	%	N	%
Management of Residual Urban Spaces	Good	124	10,0%	425	34,3%	242	19,5%	76	6,1%	867	70,0%
	Fair	40	3,2%	245	19,8%	68	5,5%	10	0,8%	363	29,3%
	Poor	2	0,2%	1	0,1%	4	0,3%	2	0,2%	9	0,7%
	Total	166	13,4%	671	54,2%	314	25,3%	88	7,1%	1239	100,0%

Table 1: Management of Residual Urban Spaces According to Environmental Pollution in the Alto Puno Population Center – 2024

Note: Prepared by the authors

The statistical data in Table 1 demonstrate how the management of residual urban spaces contributes to mitigating environmental pollution. According to the results, in sectors where the management of these spaces is rated as good, 34.3% of respondents classified environmental pollution as slightly severe, reflecting a cleaner and healthier environment. In contrast, in areas with poor residual space management—such as abandoned, unmaintained, or informally used dumping grounds—0.2% of respondents described pollution as very severe, associated with visible waste, dust, foul odors, and other contaminants.

The data highlight an inverse relationship: better management of residual spaces correlates with lower levels of perceived pollution, whereas neglected areas are linked to more severe environmental concerns. When left unmanaged, these residual spaces deteriorate into what urban scholars call 'anti-spaces' or 'terrain vague,' which often become informal dumping grounds and sources of contamination.

These findings are consistent with Azhar et al. (2022), who assert that unmaintained residual spaces often attract waste and rubble, fostering soil and visual pollution. Similarly, Torres (2020), in a Peruvian case study, validated the hypothesis that proper management of such spaces reduces environmental contamination, including improvements in noise, visual, and soil quality. Implementing green interventions and control measures significantly improved public perception of environmental conditions.

Zamorano et al. (2021) also found that the lack of adequate intervention in urban spaces heightens the sense of abandonment and ecological decay, adversely affecting both environmental perception and urban quality of life.

From an environmental perspective, the proper management of residual urban spaces generates multiple ecosystem benefits and contributes significantly to the reduction of pollution. The transformation of abandoned lots into green areas—such as parks, community gardens, or reforested zones—helps filter and mitigate air and soil pollutants.

Sultana and Hoque (2024) emphasize that the historical misuse of “gray” or residual urban spaces leads to negative environmental consequences, exacerbating problems such as flooding, urban heat, and biodiversity loss. However, these underutilized areas also represent strategic opportunities to integrate green infrastructure into urban systems. In their study conducted in Dhaka, they propose converting these neglected spaces into green zones to enhance urban ecosystem services—such as stormwater absorption, heat mitigation, and improved air quality—and conclude that such green integration is valued by residents and contributes to urban sustainability..

Environmental studies have shown that the presence of urban vegetation has measurable effects on improving environmental quality. This perspective aligns with the situation observed in the Alto Puno population center, where poor management of residual spaces is associated with waste accumulation and a high perception of pollution among residents.

In contrast, when residual spaces are recovered and efficiently managed, they become urban assets that provide environmental benefits. The recovery of these “urban voids” contributes to cleaner, healthier environments.

Therefore, it can be concluded that when residual spaces are re-vegetated and properly maintained, they not only cease to be sources of pollution—such as from the accumulation of waste—but also serve as regulators of pollutants and barriers against environmental issues. These spaces reduce the dispersion of dust during dry seasons and help mitigate both visual and noise pollution.

Accordingly, the chi-square analysis results indicate a statistically significant influence of residual space management on the mitigation of environmental pollution in the Alto Puno population center ($\chi^2 = 47.558$, $p = 0.000 < 0.05$), allowing for the rejection of the null hypothesis and confirming that proper management of these spaces contributes to pollution reduction. Thus, environmentally conscious management of residual urban spaces plays a key role in mitigating pollution.

Specific Objective 1

To identify how the influence of urban image mitigates environmental pollution in the Alto Puno population center – 2024.

Environmental Pollution									
Not Severe		Slightly Severe		Severe		Very Severe		Total	
N	%	N	%	N	%	N	%	N	%

Urban Image	Good	138	11,1%	512	41,3%	275	22,2%	81	6,5%	1006	81,2%
	Fair	25	2,0%	157	12,7%	37	3,0%	6	0,5%	225	18,2%
	Poor	3	0,2%	2	0,2%	2	0,2%	1	0,1%	8	0,6%
	Total	166	13,4%	671	54,2%	314	25,3%	88	7,1%	1239	100,0%

Table 2: Urban Image According to Environmental Pollution in the Alto Puno Population Center – 2024

Note: Prepared by the authors

The results presented in Table 2 reveal that 41.3% of respondents consider the urban image to be good and perceive environmental pollution as slightly severe. These findings reflect a generally positive perception of the urban environment, highlighting both its aesthetic and functional qualities. This assessment suggests that efforts in urban design, infrastructure development, and planning have been effective in maintaining a visually pleasant and well-structured environment.

Moreover, the fact that environmental pollution is classified as only slightly severe indicates that it is not regarded as a major concern by the residents. This perception may be linked to local policies on waste management, environmental care, and the preservation of public spaces, which have contributed to maintaining a favorable urban image. However, even if pollution is not perceived as alarming, its presence—even at low levels—continues to pose a challenge for cities striving for sustainability and quality of life.

The combination of a favorable urban image and relatively controlled levels of environmental pollution underscores the importance of implementing integrated urban strategies to preserve this balance. Such strategies should aim to maintain the aesthetic appeal of the urban environment while also adopting long-term measures to mitigate potential environmental risks. These findings also suggest the potential to foster civic awareness and encourage sustainable practices that reinforce this positive perception.

These results highlight the critical role of urban planning and management in shaping environmental quality. As noted by Azhar et al. (2022), the interaction between inhabitants and the built environment plays a fundamental role in how urban characteristics are perceived. A strong urban image may include visually appealing features, cleanliness, order, and functional public spaces—all of which reduce the negative perception of pollution.

Specific Objective 2

To establish how the influence of urban furniture mitigates environmental pollution in the Alto Puno population center – 2024.

		Visual Pollution									
		Not Severe		Slightly Severe		Severe		Very Severe		Total	
		N	%	N	%	N	%	N	%	N	%
Urban Furniture	Good	425	34,3%	297	24,0%	184	14,9%	82	6,6%	988	79,7%
	Fair	75	6,1%	125	10,1%	34	2,7%	6	0,5%	240	19,4%
	Poor	2	0,2%	4	0,3%	3	0,2%	2	0,2%	11	0,9%
	Total	502	40,5%	426	34,4%	221	17,8%	90	7,3%	1239	100,0%

Table 3: Urban Furniture According to Visual Pollution in the Alto Puno Population Center – 2024

Note: Prepared by the authors

Table 3 shows that 34.3% of the surveyed population indicated that urban furniture is in good condition and that visual pollution is not severe. This finding suggests that well-maintained urban furniture contributes to mitigating environmental pollution. These results are consistent with Pérez (2022), who argues that the design and upkeep of urban furniture directly influence visual pollution and the aesthetic perception of the city.

Similarly, 24% of respondents stated that urban furniture is of fair quality, and in these areas, visual pollution was considered slightly severe. These results indicate that there are still sectors affected by disorganized advertising, deteriorated infrastructure, or a lack of planning in the distribution of urban elements. Visual pollution plays a significant role in diminishing quality of life and disconnecting individuals from the urban landscape. This highlights the need to promote the care, preservation, and sustainability of the urban panorama shaped by urban furniture. In this regard, Valbuena (2019) notes that visual pollution is a form of environmental pollution that is perceived through sight and is particularly prevalent in urban environments. Urban furniture is therefore essential to minimizing this type of pollution.

While urban furniture elements are not inherently polluting, their misuse—due to arbitrary human decisions regarding placement, order, distribution, quantity, and other factors—can turn them into sources of contamination. It is important to note that although the majority of respondents consider the urban image and furniture to be good, there are still sectors experiencing problems that must be addressed through targeted urban and environmental interventions. Improving the quality and design of urban furniture significantly reduces both severe and very severe levels of visual pollution. Well-designed and properly maintained urban furniture can therefore reduce perceptions of visual pollution and enhance the overall urban experience.

Regarding visual pollution, the presence and condition of urban furniture directly impact quality of life and the enjoyment of public spaces in Alto Puno. However, reducing visual pollution—through the removal of overhead cables, advertising banners, and deteriorated or absent furniture—can help mitigate the negative impacts of environmental pollution. In this respect, Obregón-Biosca (2019) explains that pollution resulting from human activity and urban production systems significantly affects both the quality of life and the environment. Similarly, Azhar et al. (2022) argue that disorganized urban spaces can cause visual stress and negatively affect the experience of those who navigate them.

Specific Objective 3

To describe how the influence of the urban landscape mitigates environmental pollution in the Alto Puno population center – 2024.

		Environmental Pollution									
		Not Severe		Slightly Severe		Severe		Very Severe		Total	
		N	%	N	%	N	%	N	%	N	%
Urban Landscape	Good	121	9,8%	400	32,3%	202	16,3%	64	5,2%	787	63,5%
	Fair	41	3,3%	240	19,4%	95	7,7%	21	1,7%	397	32,0%
	Poor	4	0,3%	31	2,5%	17	1,4%	3	0,2%	55	4,4%

	Total	166	13,4%	671	54,2%	314	25,3%	88	7,1%	1239	100,0%
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Table 4: Urban Landscape According to Environmental Pollution in the Alto Puno Population Center – 2024

Note: Prepared by the authors

Table 4 presents the distribution of responses regarding the severity of overall environmental pollution, based on participants' perceptions of the urban landscape. Among those who described the landscape as "good," 32.3% perceived pollution as slightly severe, 16.3% considered it severe, and only 5.2% classified it as very severe. In the group with a "fair" perception of the urban landscape, 19.4% rated pollution as slightly severe, 7.7% as severe, and 1.7% as very severe. Lastly, in the group who viewed the landscape as "poor," most responses still concentrated on the lower levels of pollution severity.

This distribution suggests that, although there is some awareness of environmental issues, most respondents tend to downplay their severity—especially when they perceive the urban surroundings to be acceptable or favorable. This tendency supports the idea that the urban landscape influences how the population assesses overall environmental impact.

The findings align with the study by De Oliveira et al. (2021), who emphasized that the presence of vegetation and natural elements in urban spaces can mitigate environmental pollution. Vegetation and landscape quality play a key role in reducing pollution levels, but their effectiveness depends on proper planning and the active involvement of local authorities and the community.

Carrasco-Jocope et al. (2023) highlight "the close relationship between urban-environmental pollution and public space." Both air and noise pollution can negatively affect the quality and enjoyment of public spaces in urban areas. However, incorporating vegetation in these environments has also been shown to generate positive impacts. Similarly, Tumi (2024) stresses the importance of promoting environmental attitudes and practices, which can help mitigate the negative effects of pollution, improve air quality, and create healthier environments for urban residents.

Therefore, it can be concluded that integrating public environmental management policies that consider citizen perspectives and the quality of urban space is essential to ensuring sustainability and well-being in Alto Puno.

Methodology

This study was conducted in the Alto Puno population center during the year 2024. It follows a basic-theoretical research type, at an explanatory-causal level, employing a quantitative approach with a non-experimental and cross-sectional design. The research applied the hypothetico-deductive method. The target population consisted of 5,500 inhabitants, from which a representative sample of 1,204 individuals was selected using a probabilistic, simple random sampling method. Eligibility was restricted to individuals aged 18 and older, of both sexes, with a 95% confidence level and a 5% margin of error.

Data collection was carried out using surveys as the main technique, with Likert-scale questionnaires serving as instruments for both primary variables. To assess the reliability of the instruments addressing the variables 'Management of Residual Spaces' and 'Environmental

Pollution', Cronbach's Alpha coefficient was employed, which determines the precision of the instrument.

Data Reliability

The Cronbach's Alpha coefficient was applied to assess the reliability of the instruments designed for 'Management of Residual Urban Spaces' and 'Environmental Pollution'. The reliability scale used is as follows:

Reliability Scale for Cronbach's Alpha

Level of Reliability	Alpha Value Range
Null Reliability	≤ 0.53
Low Reliability	0.54 to 0.59
Acceptable Reliability	0.60 to 0.65
High Reliability	0.66 to 0.71
Excellent Reliability	0.72 to 0.99
Perfect Reliability	1.00

Source: Hernández et al. (2006). Scientific Research Methodology.

To determine the reliability of the Residual Urban Space Management instrument, which comprised 15 items, the following results were obtained:

Cronbach's Alpha	Number of Items
,880	15

Therefore, the table shows that the Cronbach's Alpha for the Residual Urban Space Management instrument is 0.880, which falls within the range of 0.72 to 0.99, indicating excellent reliability.

To determine the reliability of the Environmental Pollution instrument, which consisted of 14 items, the following results were obtained:

Reliability Statistics	
Cronbach's Alpha	Number of Items
,868	14

Therefore, the table shows that the Cronbach's Alpha for the *Environmental Pollution* instrument is 0.868, which falls within the range of 0.72 to 0.99, indicating excellent reliability.

Conclusión

First, there is a statistically significant influence of residual urban space management on the mitigation of environmental pollution in the Alto Puno population center ($\chi^2 = 47.558$, $p = 0.000 < 0.05$), which allows for the rejection of the null hypothesis and supports the conclusion that appropriate management of these spaces contributes to pollution reduction. Alto Puno

exemplifies how the proper care of such areas leads to a lower perception of pollution, whereas their neglect intensifies the feeling of living in a contaminated environment. This finding is consistent with studies from various Latin American cities, where the recovery of vacant land has improved residents' environmental satisfaction. Well-managed residual spaces enhance subjective environmental perception, promote psychological well-being, and foster positive social interactions. In turn, this reinforces environmentally responsible behavior among local residents and strengthens community cohesion and safety.

Second, the findings of this research reveal a predominantly positive assessment of the urban image in the Alto Puno population center. Pearson's chi-square test ($\chi^2 = 34.239$, $p = 0.000$) indicates a statistically significant influence of urban image on reducing environmental pollution, with 32% of respondents rating it as good and 41.3% indicating that environmental pollution is only mildly severe. This suggests that urban planning and management efforts have contributed to fostering an orderly and aesthetically pleasing environment, which can positively influence residents' quality of life. However, despite this favorable assessment in visual and acoustic terms, soil and water pollution remain a major concern for a portion of the population, with 25.8% of respondents identifying it as a serious problem. This finding underscores the need to strengthen environmental management strategies that complement urban improvements and ensure a balance between aesthetics and ecological sustainability. In conclusion, while urban image can help mitigate certain types of environmental pollution, particularly visual and noise pollution, addressing soil and water pollution comprehensively remains essential to achieving sustainable and healthy urban development for the community.

Third, the results of Pearson's chi-square test ($\chi^2 = 21.825$, $p = 0.001$) indicate a statistically significant influence of street furniture on reducing environmental pollution, with 34.3% of respondents rating the furniture as good and 24.0% considering the visual pollution related to street furniture as slightly severe. This reinforces the importance of residents' satisfaction and their sense of protection over objects and structures located in public spaces, which also contribute to aesthetics, local identity, and improved quality of life. Street furniture is thus understood not only as physical infrastructure but also as a category of analysis linked to the visual reality of a territory, which fosters awareness, transformation, and the social construction of space. At the same time, the growing understanding of the role that environmental protection plays in urban development has generated a growing interest in the implementation of government policies aimed at the care and preservation of street furniture, an interest reflected in the results of this study.

Fourth, the perception of the urban landscape is confirmed to have a significant influence. The results of the Pearson chi-square test ($\chi^2 = 15.438$, $p = 0.017$) indicate a statistically significant influence of the urban landscape on the reduction of environmental pollution. This is reflected in the way residents assess the severity of environmental pollution. The data reveal that those with a positive view of the landscape tend to report lower levels of perceived pollution. This suggests that the quality of the urban environment, particularly in terms of vegetation and landscape design, can influence public attitudes toward environmental conditions. In this sense, the case of Alto Puno highlights the need to incorporate environmental management policies that reflect public perceptions and prioritize the improvement of urban landscapes. This is essential to promoting sustainability, environmental awareness, and the overall well-being of urban populations.

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