SOCIOLOGICAL AND ENVIRONMENTAL CONSIDERATIONS FOR THE MANAGEMENT OF AN OPEN DUMPING SITE IN LA LIBERTAD, ECUADOR

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ABSTRACT

Inadequate solid waste management through open dumpsites remains a challenge in Latin America, impacting environmental sustainability and public health. In Ecuador, despite a regulatory framework for integrated solid waste management, this issue persists in urban areas such as La Libertad (Santa Elena Province), where limited infrastructure at waste disposal sites aggravates the city's environmental and social vulnerabilities. This study aimed to assess socio-environmental conflicts in communities near the municipal dumpsite of La Libertad using a non-experimental, survey-based design and to develop a strategic action plan (SAP) to minimize environmental impacts. The methodology followed a mixed-methods approach in three phases: (i) site reconnaissance and data collection, (ii) coding and analysis of responses and impact identification, and (iii) SAP formulation with short- and long-term strategies. Survey results (n = 50) showed that 76% reported environmental impacts, mainly odours (45%), vector proliferation (26%), air pollution (18%) and public waste accumulation (11%). Regarding health, 30% reported that they or a family member experienced a health problem during the last 12 months that they associated with the dumpsite; within this subgroup, the most frequent conditions were infections (36%), respiratory problems (32%), and dermatological conditions (24%). In addition, 78% considered it necessary to improve waste management, prioritizing stronger site control (49%) and environmental education (15%); accordingly, all respondents (100%) preferred implementing a sanitary landfill as the final disposal alternative. Based on these findings, a SAP was developed to support a gradual transition toward controlled final disposal, incorporating leachate and gas control, environmental monitoring, community education and strengthened citizen participation. Overall, proximity to the dumpsite increases perceived socio-environmental risks, while the proposed SAP provides a practical pathway for strengthening environmental management through structured planning, monitoring, and community participation, offering a replicable framework for similar coastal cities facing open dumping challenges.

Keywords: strategic action plan, community participation, environmental pollution, coastal zone, risk perception, waste management.

1 INTRODUCTION

Municipal solid waste (MSW) management poses a pressing challenge to environmental sustainability, social well-being, and public health [1]. In 2024, approximately 2.24 billion tons of solid waste were generated worldwide, and generation is projected to increase by more than 77% by 2050, driven by consumption trends [2]. Currently, about 62% of waste is processed in controlled facilities, while the remainder is disposed of under insufficient technical and environmental safeguards, contributing to air, soil, and water pollution [2]–[4]. In Latin America and the Caribbean (LAC), at least one-third of urban waste is still disposed of in open dumping, reflecting persistent gaps in infrastructure and environmental governance and reinforcing environmental injustice for vulnerable populations, particularly women, children, and informal recycling workers [5]–[7].



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The transition toward Integrated Solid Waste Management (ISWM) has been recognized across Latin American contexts by organizations such as the Economic Commission for Latin America and the Caribbean (CEPAL, Spanish acronym) and the United Nations Environment Programme (UNEP), framing MSW challenges within the Sustainable Development Goals (SDGs), particularly those related to public health, clean water, sustainable cities, and responsible consumption and production (SDGs 3, 6, 11 and 12) [2], [8]. However, many Latin American countries still fall short of technical and social standards for waste collection and final disposal due to limited planning, weak institutional capacity, and insufficient community participation [6], [9]. These challenges are heightened in coastal urban areas; evidence from England shows that coastal dumpsites can be vulnerable to extreme events, increasing the risk of leachate releases and marine pollution, while inadequate MSW management contributes to plastic litter and microplastics in coastal ecosystems [10], [11].

In Ecuador, limited treatment and final-disposal infrastructure, gaps in collection coverage (particularly in rural and peri-urban areas), and continued reliance on informal dumpsites contribute to soil, water, and air pollution and associated risks to public health and biodiversity [12], [13]. Per capita MSW generation averages 0.9 kg/day; however, despite management being the responsibility of the Decentralized Autonomous Governments (GADs, Spanish acronym), 17.2% of municipalities still dispose of waste through open dumping, and at the regional level the Coastal area concentrates the highest proportion of these sites, accounting for 72% of the country's open dumpsites [14], [15]. This reflects implementation gaps in the National Program for Integrated Solid Waste Management (PNGIDS, Spanish acronym), established in 2010 to promote recycling, institutional strengthening, and infrastructure improvement [3], while many municipalities still lack the technical and financial capacity to plan and control final-disposal impacts [3].

In La Libertad (Santa Elena Province), final disposal is carried out in an open dumping site lacking technical infrastructure and planning, contributing to socio-environmental tensions with nearby communities. Although the legal framework, including the Organic Code of Territorial Organization, Autonomy, and Decentralization (COOTAD, Spanish acronym), assigns municipal responsibilities under the PNGIDS [3], local capacity is limited and lacks environmental control, health monitoring, and environmental education [3]. This institutional and operational gap, together with urban growth and local development pressures, has increased conflicts between communities and local authorities, underscoring the need to transition to sustainable waste management models. For this reason, this study evaluates socio-environmental conflicts and perceived health and environmental risks in communities near the La Libertad municipal open dumping using a non-experimental, survey-based design, and proposes a strategic action plan (SAP) to minimize impacts. The research asks: How does proximity to the municipal open dumping of La Libertad influence socio-environmental conflicts and health risks in nearby communities? The proposed approach aims to provide technical and social evidence to support participatory, integrated waste management and strengthen local governance processes.

2 MATERIALS AND METHODS

2.1 Geographical and demographic context

Ecuador's coastal region has been a hotspot for solid waste disposal infrastructure, comprising 34 open dumping, 10 emergency cells and 14 sanitary landfills, distributed across each coastal province (Fig. 1(a)) [16]. This clearly marked distribution of open dumping demonstrates the continued poor management in many coastal cities, with sites lacking

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technical control and adequate treatment. These landfills, exposed to extreme environmental conditions such as high temperatures or prolonged rainfall, pose a potential threat to the health and environment of nearby communities because they lack waterproofing systems, leachate control, or measures to control toxic gas emissions [14]. The case study for this research is located at the La Libertad municipal open dumping site in Santa Elena province (Fig. 1(b)).

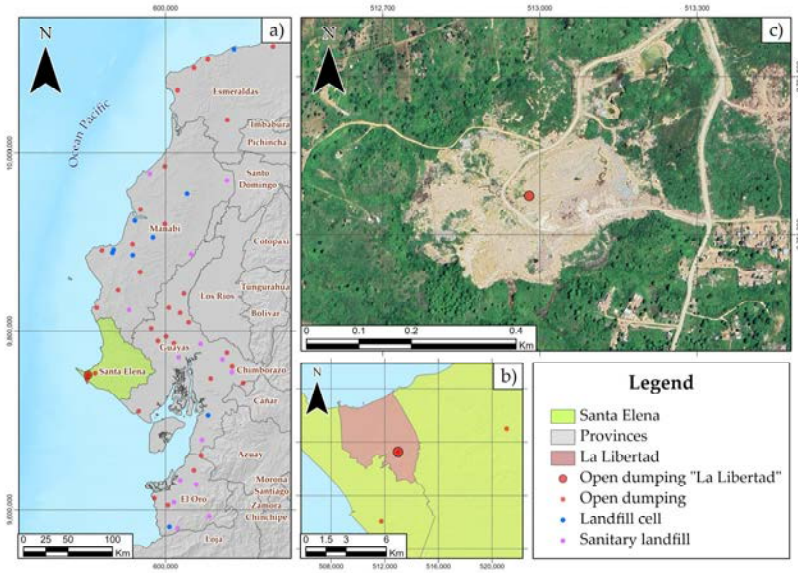


Figure 1: Location map of the La Libertad open dumping. (a) Location of sanitary landfills, emergency cells, and open dumping in the coastal provinces; (b) La Libertad city within the Santa Elena province; and (c) Municipal open dumping (study area). *(Source: Ministerio de Ambiente, Agua y Transición Ecológica (MAATE, Spanish acronym), 2022.)*

The city is characterized by a desert climate and annual rainfall of less than 200 mm, located on a plain with elevations that do not exceed 50 m [17]. With a population of 112,247 inhabitants, its economy is primarily driven by commerce, which is the primary source of tourism and artisanal fishing [16]. The municipal open dumping (Fig. 1(c)) is situated in the vicinity of inhabited areas and is undergoing residential development. Furthermore, it is in one of the highest areas (44 m), which has generated concerns about its socio-environmental impacts.

2.2 Methodological framework

This study followed a non-experimental, observational approach, collecting data without manipulating variables and assessing the phenomenon in its natural context [18]. As shown in Fig. 2, the methodology comprised three phases: (i) field data collection through surveys (supported by interviews and direct observation), (ii) data analysis and interpretation to identify perceived socio-environmental impacts, and (iii) formulation of a SAP derived from the diagnostic findings and oriented to Sustainable Solid Waste Management (SSWM).

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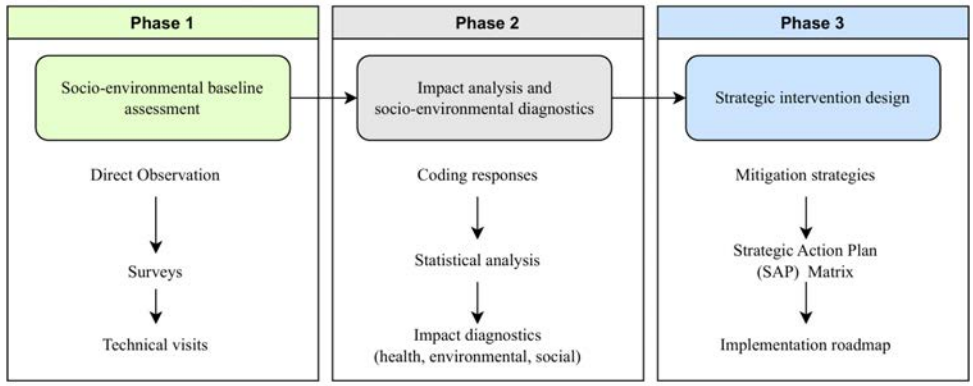


Figure 2: Methodological scheme by research phase as a guide to achieving SSWM.

2.2.1 Phase I: Socio-environmental baseline assessment

Data collection combined structured surveys, semi-structured interviews, and direct observation during field visits [18], [19]. The survey comprised five thematic sections (profile, health and environmental perception, conflicts, and community suggestions). The target population was the Libertad y Progreso Association (N = 100) located near the La Libertad municipal open dumping. The sample size (n = 50) was calculated using the finite-population simple random sampling equation (eqn (1)), ensuring equal selection probability for all residents [20].

$$n = \frac{N}{E^2(N-1)+1} \tag{1}$$

where n = sample size; N = population size; E = maximum admissible error.

2.2.2 Phase II: Impact analysis and socio-environmental diagnostics

The data collected through surveys and interviews were organized and tabulated in spreadsheets to identify frequency and percentages across the main variables and perceived impacts reported by the population. This analysis revealed the general characteristics of the study population and estimated the prevalence of exposures and outcome variables [21]. Systematizing the results facilitated an understanding of the interaction between the open dumping and the daily dynamics of residents within the study area. The research collected sociodemographic descriptors and perception-based information related to health, environmental changes, socio-environmental conflicts, and community suggestions, organized according to the survey's thematic sections.

2.2.3 Phase III: Strategic intervention design

The SAP was formulated in accordance with Ecuador's Environmental Code Regulation (COA, Spanish acronym) and Ministerial Agreement No. 061 (Reform of Book VI of the Unified Secondary Legislation Text), which require corrective proposals in cases of environmental non-compliance [22], [23]. The plan was derived from the diagnostic findings and structured through: (i) scope of intervention, (ii) identification of critical issues, (iii) definition of corrective measures, and (iv) a socio-environmental action matrix specifying objectives, actions, responsible institutions, implementation schedule, estimated budget, and

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performance indicators with their means of verification. This framework was consolidated through an implementation timeline and budget estimation to ensure consistency between the diagnostic results and the proposed strategies. In addition, international references were considered from a 2024 systematic review by Herrera-Franco, which compiled 282 studies on coastal open dumping and 59 studies on Integrated Solid Waste Management (ISWM) [24]. This reference provided the conceptual basis for linking local actions in La Libertad with internationally recognized SDG frameworks.

3 RESULTS

3.1 Socio-environmental survey results

A total of 50 residents living near the La Libertad municipal open dumping were surveyed. Long-term exposure was common, as 42% reported more than ten years of residence in the vicinity of the site. Overall, 76% of respondents perceived environmental changes associated with the open dumping, and environmental perception indicated deterioration associated with the open dumping, with odours and vectors highlighted among the main community concerns (Fig. 3(a)). Health responses showed both perceived and recent impacts. A minority of respondents reported health problems during the last 12 months that they associated with the site, predominantly infections and respiratory conditions (Fig. 3(b)). Social responses suggested localized tension rather than generalized conflict. While 60% did not identify direct conflicts with authorities, 40% reported that conflicts have occurred, mainly due to environmental and health problems in the area. Regarding community coexistence, 40% considered it has not been affected, 34% believed it has improved due to greater unity among some residents, 8% mentioned disagreements or tensions, and 18% preferred not to express an opinion.

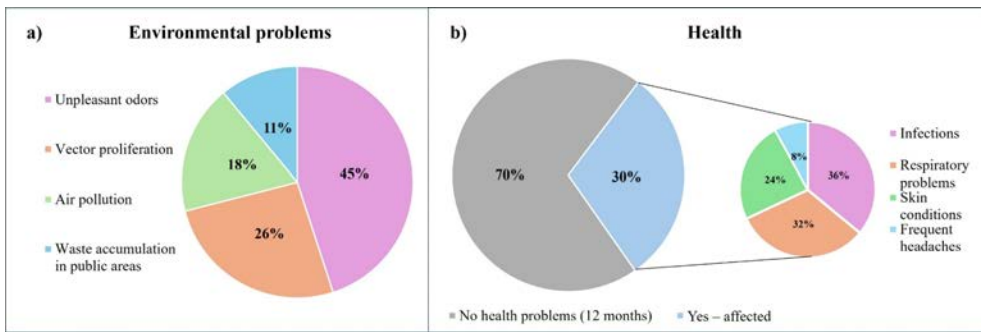


Figure 3: Doughnut charts from section one of the surveys. (a) Environmental problems; and (b) health perception.

Concerning participation, 66% stated that neither they nor their family members have taken part in activities or protests related to the site, whereas 34% indicated that they have participated. Additionally, 78% considered that measures are needed to improve waste management, prioritizing stronger site control (49%) and environmental education (15%), followed by recycling and waste reduction (22%) and relocating or replacing the dumpsite (14%). Finally, preferences regarding waste management alternatives showed a clear consensus. While 90% were unaware of the difference between an open dumping and a

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sanitary landfill, all respondents (100%) expressed their preference for implementing a sanitary landfill as the final disposal option after receiving training on the subject. This agreement provides a clear social basis to support the transition from the diagnostic assessment to the proposed SAP.

3.2 SAP for the city´s open dumping

Based on the diagnosis of the La Libertad municipal open dumping, the SAP consolidates the corrective actions required to mitigate the main environmental, health, and social impacts identified in the study area. The SAP is organized into four strategic axes: (i) solid waste management, (ii) health and environment, (iii) community participation and environmental education, and (iv) reduction of socio-environmental conflicts.

The plan is designed for a 24-month horizon and combines operational and infrastructure improvements with community-focused actions, involving local governments (GADs), environmental authorities, educational institutions, and social organizations to ensure shared implementation responsibilities. The SAP is presented as an operational matrix that specifies activities, responsible actors, timelines, and verification indicators (Fig. 4), supporting the transition from open dumping to controlled final disposal and reducing risks to public health and the physical environment. As priority technical actions, the SAP includes impermeabilization systems and leachate-control measures, supported by periodic environmental monitoring. The estimated implementation budget is approximately USD 637,000, and the proposed actions align with the corrective-action approach established under the COA regulatory framework (Articles 505–506).

Strategic Objective	Proposed Action	Responsible Entity	Timeline	Success Indicator	Budget (USD)	Schedule
Improve the integrated management of solid waste	Design and preparation of the area for the construction of a sanitary landfill	GAD La Libertad, Ministry of Environment, MAATE, and environmental consultants	24 months	Technical report approved by authorities	$ 300.000	
	Installation of impermeabilization systems and gas capture	Specialized environmental consultants and MAATE	18 months	Operational system with quality controls	$ 150.000	
Mitigate negative impacts on health and the environment	Periodic monitoring of air and soil quality	Environmental technicians, MAATE, and universities	Ongoing	Monitoring reports available	$ 80.000	
	Vector control campaigns	GAD and local environmental authorities	Ongoing	Vectors reduction	$ 3.000	
	Implementation of vegetative barriers around the dumpsite	Community and GAD	12 months	Reduction of odors, photographic record	$ 30.000	
Promote environmental education and community participation	Training in waste separation and recycling	Educational institutions and GADs	Semiannual	Number of workshops conducted	$ 20.000	
	Creation of community monitoring committees	Community leaders and GAD	6 months	Active committees	$ 3.000	
Reduce socio-environmental conflicts	Organization of dialogue tables between the community and authorities	Community leaders and GAD	Ongoing	Satisfaction surveys	$ 1.000	
	Development of medical campaigns for community health check-ups	GAD and Ministry of Health	Ongoing	Medical records and visit reportss	$ 40.000	
	Awareness campaigns on the impacts of waste	Schools and GAD	Annual	Increased community participation	$ 10.000	

Schedule: Months 1-2, Months 3-4, Months 5-6, Months 7-8, Months 9-10, Months 11-12, Months 13-14, Months 15-16, Months 17-18, Months 19-20, Months 21-22, Months 23-24

Figure 4: Matrix of proposed strategic socio-environmental actions to be implemented in the La Libertad canton.

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By aligning the SAP actions for La Libertad with international SSWM strategies for coastal areas, it was found that the proposed local interventions are consistent with several globally reported guidelines. Most actions map directly onto the strategies identified in the external framework; however, two community-focused measures (health check-ups and vector control) are not explicitly covered by the eight established strategies. Therefore, an additional strategy referred to as 'Community health interventions', is proposed and linked to SDG 3 and SDG 11. Table 1 synthesizes this alignment, showing how local SAP actions correspond to internationally validated strategies and how they connect with the SDGs, situating the proposal within a broader sustainability context and strengthening its relevance for environmentally responsible and socially inclusive waste management.

Table 1: Alignment of SAP local actions with international SSWM strategies and the Sustainable Development Goals (SDGs).

International strategy	**Local SAP actions (La Libertad)**	**SDGs**
Recycling at the generation and production stage	Training in waste separation and recycling	8, 12
Education for separation at source	Awareness campaigns on waste impacts; training at household level	4, 12
Sustainability culture (reduced consumption, efficient treatment)	Dialogue tables (community, authorities); periodic air and soil monitoring; site planning for controlled disposal	4, 11, 12, 17
Relocation and restoration of landfill sites	Transition actions to move from open dumping toward controlled final disposal; site recovery measures	6, 13, 14, 15
Clay layer plus geosynthetic liner in landfills	Installation of impermeabilization systems; gas capture components	12, 15
Closure of landfill area and conversion to recreational use	Closure-oriented site improvements; vegetative barriers around the dumpsite	4, 11, 12
Community health interventions	Vector control campaigns; medical campaigns for community health check-ups	3, 11

4 DISCUSSION

The results of this study confirm that proximity to the La Libertad municipal open dumping site directly influences population health and the generation of socio-environmental conflicts. Key findings indicate that 30% of respondents reported health problems affecting themselves or a family member during the last 12 months that they associated with dumpsite, with infections being the most common (36%), followed by respiratory illnesses (32%) and skin problems (24%) (Fig. 3(b)). These results are consistent with findings from the FAO in 2022 and the ONU in 2024, which also reported that exposure to emissions and vectors from uncontrolled open dumping is a determining factor in the incidence of respiratory and skin diseases among the most vulnerable populations, such as children and the elderly [1], [2]. The coincidence between local data and regional patterns suggests that the La Libertad case is not an isolated phenomenon, but rather part of a structural problem in waste management in Latin America and the Caribbean [7].

Regarding the environment, 76% of respondents perceived deterioration in their environment, highlighting unpleasant odours (45%), vector proliferation (26%), and air pollution (18%) (Fig. 3(a)). The UN warned that the presence of flies and rodents can spread

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disease in adjacent homes, and that leachate runoff from the soil and river ecosystems can enter the food chain [2]. This parallel demonstrates that, in contexts of technical and institutional deficiencies, communities perceive environmental threats similarly, regardless of geographic location, reinforcing the need for regionally focused solutions.

Social experiences reveal dimensions that often remain invisible in strict technical assessments. A total of 40% of respondents reported conflicts with authorities over the management of open dumping, while 8% indicated that proximity to the site has generated tensions between neighbours. These data, although not always manifested in visible mobilizations, only 34% have participated in a protest or activity related to open dumping, reflecting social erosion and a loss of institutional trust that limits the effectiveness of interventions. This type of qualitative evidence enables assessing the social component of the problem and directly addresses the research question by demonstrating how proximity to open dumping affects community relations and local governance.

In the coastal context of La Libertad, the implications are aggravated by the proximity of the open dumping to surface-water features. This setting increases the likelihood of leachate migration toward surface water and the shallow subsurface, with the consequent risk of contamination. In England, it has been demonstrated that some coastal landfills are beginning to erode and release waste, which is exacerbated by extreme weather events exacerbated by climate change [10]. International experiences, such as the Malé landfill (Maldives) [25], have shown that proximity to bodies of water in island and coastal environments requires waterproofing barriers, permanent monitoring, and contingency plans for climate events, measures that do not exist in the La Libertad. The application of methodologies such as the Key Factors Matrix (KFM) index [26], which weighs critical factors including soil permeability, precipitation, and distance to water sources, can guide the selection and design of a coastal landfill.

The SAP developed in this research, aligned with MAATE guidelines, proposes interventions that combine technical solutions (waterproofing, leachate control, vegetation barriers) with social strategies (environmental education, community management committees, medical brigades) (Fig. 4). This technical–social duality aligns with successful experiences, such as those in Borås (Sweden) [27], where waste-to-energy recovery was strengthened through the integration of advanced infrastructure and a participatory management model. However, unlike European cities, La Libertad faces financial and institutional constraints that limit the immediate adoption of high-investment models. This emphasizes the value of the proposed plan as a progressive, adaptable strategy that works with limited resources, highlighting the importance of using local data to improve waste management policies and developing targeted strategies for each demographic group [28].

The proposal for a new international community health strategy is based on evidence that open dumping generates negative impacts on human health, especially in vulnerable populations [29], [30]. In this regard, Sheriff (2025) warns that many studies lack a comprehensive assessment of exposure pathways and long-term health effects, particularly in children, the elderly, and pregnant women [31]. Therefore, this study proposes implementing medical brigades and vector control as priority measures throughout the open dumping closure process to reduce health and environmental risks.

This study presents a methodological approach for coastal contexts in Latin America and other countries that aim to transition toward sustainability and reduce costs by integrating social perceptions, geospatial characterization, and the design of measures aligned with national regulations into a unified analytical framework. Few studies in the region have documented the interactions among location, environmental impacts, and community experiences, generating evidence base applicable not only to Ecuador but also to other coastal

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areas with high socio-environmental vulnerability. Future research could delve deeper into modelling pollutant dispersion from coastal open dumping using GIS and hydrological simulations, evaluate the economic and social viability of waste recovery technologies adapted to coastal contexts, and conduct interregional comparisons to identify barriers and success factors in transitioning to SSWM models.

5 CONCLUSIONS

This research evaluated socio-environmental conflicts in communities near the La Libertad municipal open dumping through a mixed diagnostic approach integrating community perceptions with regulatory-based planning. The findings supported the development of a SAP focused on sustainability, impact mitigation, and improved environmental management in a coastal urban context.

The analysis demonstrates that proximity to open dumping has a direct influence on the incidence of socio-environmental conflicts and health risks in nearby communities. Nearly three-quarters of the sample reported impacts on family health (mainly infections, respiratory illnesses, and skin problems), while more than three-quarters perceived environmental deterioration due to unpleasant odours, vector proliferation, and air pollution. Likewise, 36% reported conflicts with authorities, and 8% reported tensions between neighbours, indicating social erosion and a decline in institutional trust that impacts local governance. Open dumping location, less than 500 m from river tributaries and 1,000 m from Lake Velasco Ibarra, increases its vulnerability to water pollution, especially in a coastal context exposed to extreme weather events.

Overall, this study provides evidence of the environmental and health impacts of open dumping in coastal areas. Furthermore, they exacerbate social inequalities and community tensions when there is no planned waste management in place. The methodological framework developed is replicable in other sectors with similar characteristics, and the results are amenable to the formulation of public policies, the prioritization of investments in adequate infrastructure, and the strengthening of community participation as a pillar of sustainability. In a global context of increasing waste generation and pressure on coastal ecosystems, this work reinforces the urgency of moving toward integrated management models that integrate technical, social, and environmental criteria, highlighting impermeabilization systems and leachate-control measures supported by periodic environmental monitoring as priority actions for reducing environmental risks, promoting solutions that not only minimize immediate impacts (health, environmental, and social) but also ensure the long-term resilience and well-being of communities.

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