Co-Creating Environmental Solutions through Community-Based Science Education: A Participatory Situation Analysis, Philippines

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Abstract

Rapid urbanization in Metro Manila has intensified environmental challenges, particularly in densely populated communities such as Tondo, Manila. Environmental issues including improper waste disposal, pollution, and the limited availability of green spaces continue to affect both environmental quality and public health conditions in these areas. Addressing these complex problems requires approaches that integrate community knowledge, participation, and locally relevant solutions. This study examines community-identified environmental concerns using Participatory Situation Analysis (PSA) within the framework of Participatory Action Research (PAR). The research aims to generate context-based insights that support sustainable environmental management in urban informal settlements. The study was conducted in selected zones of Tondo, Manila and involved community residents, barangay officials, informal waste collectors, and environmental volunteers. A mixed qualitative and participatory approach was employed to gather data through semi-structured interviews, household surveys, direct observations of waste management practices, document review of barangay environmental programs, and participatory workshops that included community mapping and environmental visioning activities. Qualitative data were analyzed using thematic analysis to identify recurring environmental concerns, while quantitative responses were summarized through descriptive statistics. Data triangulation was applied to enhance the reliability and validity of findings. The results reveal persistent environmental challenges in three key areas: waste management, pollution, and green space availability. Although formal waste collection services exist, informal recycling activities and occasional illegal dumping continue to occur, creating a hybrid waste management system within the community. Residents also reported environmental problems related to polluted waterways, soil contamination, and noise associated with high population density. Furthermore, access to green spaces remains extremely limited due to overcrowding and insufficient urban environmental infrastructure. Despite these constraints, the study found strong community willingness to participate in environmental initiatives, particularly through barangay clean-up activities and small-scale planting efforts. The findings highlight the value of participatory approaches in strengthening environmental governance in marginalized urban communities. Participatory Situation Analysis provides an effective platform for integrating community perspectives into environmental planning and decision-making. The study contributes to the growing body of research on community-based environmental management and offers practical insights for developing inclusive, locally driven strategies that promote environmental sustainability in rapidly urbanizing cities.

Keywords: *participatory situation analysis, environmental governance, waste management, community participation, sustainability*

1. Introduction

Rapid urbanization in Metro Manila has intensified environmental degradation, particularly in densely populated areas such as Tondo. Urban growth has frequently outpaced the development of effective waste management infrastructure, leading to persistent environmental and public health concerns including improper waste disposal, water contamination, air pollution, and limited access to green spaces (Regmi, 2018; World Bank, 2019). Tondo represents one of the most densely populated and socioeconomically marginalized districts in Metro Manila. Residents experience chronic environmental challenges related to waste management, sanitation, and urban infrastructure. Informal waste recycling activities locally known as *pepena*, open dumping practices, and the absence of adequate green infrastructure contribute to environmental and health risks (Ballesteros, 2010; Serrona & Yu, 2009). Participatory approaches such as Participatory Action Research (PAR) and Participatory Situation

Analysis (PSA) have emerged as effective strategies for addressing complex environmental challenges in marginalized communities (Chambers, 2017; Arnstein, 1969; Ostrom, 1990) have emerged as effective strategies for addressing complex environmental challenges in marginalized communities. Strengthening community participation in environmental governance has been recognized as a key component of sustainable urban development (Ostrom, 1990; Arnstein, 1969).These approaches emphasize collaborative knowledge production, where researchers and community members jointly identify environmental problems and co-develop context-appropriate solutions (Paul et al., 2012). Participation transforms residents from passive beneficiaries into active partners in environmental governance. This study applies Participatory Situation Analysis to examine environmental conditions in selected areas of Tondo, Manila. By engaging community members directly in the research process, the study aims to generate locally grounded insights that can inform sustainable environmental management initiatives and strengthen participatory governance in urban informal settlements.

2. Objectives of the Study

2.1 General Objective

To utilize Participatory Situation Analysis to examine community-identified environmental concerns in Tondo, Manila and develop context-appropriate strategies for environmental improvement.

2.2 Specific Objectives

1. Identify existing waste generation and disposal practices in the community.
2. Examine major sources of environmental pollution and their perceived impacts.
3. Assess the availability and utilization of green spaces in a densely populated urban setting.
4. Determine community awareness of environmental initiatives.
5. Propose community-based strategies to improve environmental conditions.

3. Methodology

3.1 Research Design

This study employed Participatory Action Research (PAR), with Participatory Situation Analysis serving as the primary methodological approach. PAR emphasizes collaborative inquiry where community members actively participate in identifying problems, generating knowledge, and proposing solutions. In this study, researchers acted as facilitators guiding participatory discussions and community analysis.

3.2 Study Area and Participants

The research was conducted in selected zones of Tondo, Manila, a highly urbanized district characterized by dense population, limited infrastructure, and significant environmental challenges. Participants included community residents, barangay officials, informal waste collectors, and environmental volunteers. Purposive sampling was used to ensure that participants represented diverse community perspectives, particularly individuals involved in local environmental practices and governance.

3.3 Data Collection Methods

Data were collected through multiple methods to ensure triangulation:

- Semi-structured interviews with community stakeholders
- Household surveys regarding waste management practices
- Direct observation of waste disposal sites and community spaces
- Review of barangay environmental records and program documents
- Participatory workshops involving community mapping and environmental visioning

3.4 Data Analysis

Qualitative data were analyzed using thematic analysis to identify recurring environmental concerns and patterns in community responses. Quantitative data from surveys were summarized using descriptive statistics. Data triangulation was used to validate findings across different sources.

4. Significance of the Study

The study provides several contributions to different stakeholders. Community residents benefit from having their experiences and environmental concerns recognized in local planning processes. Local government units and barangay officials gain access to location-specific information that can inform environmental programs and policy implementation. Environmental organizations and practitioners may use the findings to design community-based interventions for urban informal settlements. Additionally, the research contributes to academic discussions on participatory environmental governance and the application of Participatory Situation Analysis in urban communities.

5. Conceptual Framework

The conceptual framework of the study is based on the relationship between **community** participation and environmental problem-solving**.** The framework follows a process of Inputs – Processes – Outputs**.** Inputs include community knowledge, environmental conditions, and stakeholder participation. The process involves the application of Participatory Situation Analysis through community mapping, workshops, and participatory discussions. The outputs include community-driven environmental solutions, improved awareness, and strengthened local environmental governance.

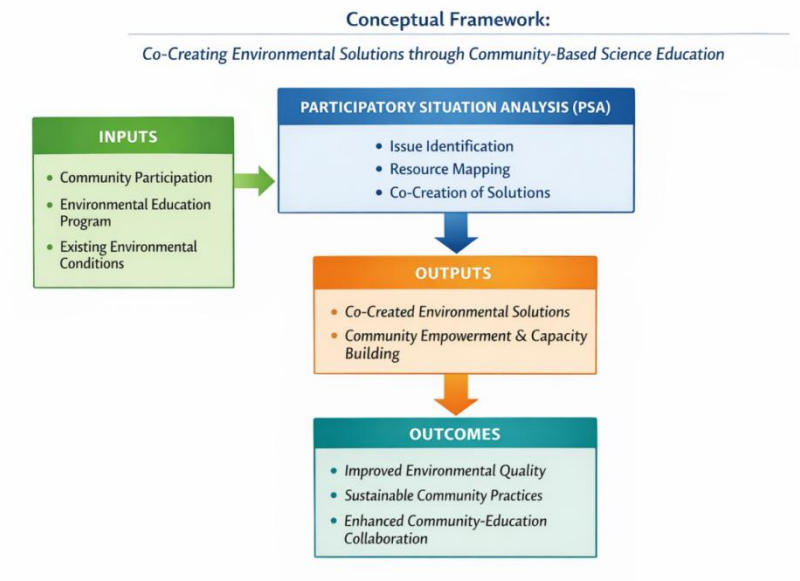

Fig. 1. Co-Creating Environmental Solutions through Community-Based Science Education

6. Results and Discussion

6.1 Waste Management Practices

Table 1. Waste Management in the Community

Waste Management Patterns	1	2	3	4	Other Answers
WM1: Waste generation (types, quantities)	There are assigned street sweepers and garbage trucks collecting garbage everyday (4)	Waste segregation is being practiced (3)	There is a lot of garbage due to overpopulation (2)	WM1: Waste generation (types, quantities)	There are assigned street sweepers and garbage trucks collecting garbage everyday (4)
WM2: Waste collection and disposal methods (segregation, recycling, landfill)	They are observing waste management such as collecting the garbage every morning and afternoon (10)	There are declogging, clean up drive and recycling activities initiated by the barangay (5)	—	—	They are observing waste management such as collecting the garbage every morning and afternoon (10); There are declogging, clean up drive and recycling activities initiated by the barangay (5)
WM3: Informal waste management practices (scavenging, dumping)	There are scavengers looking for recyclable waste (4)	Dumping garbage at the back of the building (1)	—	—	—
WM4: Waste treatment facilities and their effectiveness	There are assigned street sweepers and garbage trucks collecting garbage everyday (6)	There are declogging, clean up drive and recycling activities initiated by the barangay (3)	There is a detection device for copper, bronze, and brass burning (Pagsusunod ng tanso) (2)	—	—
WM5: Environmental impacts of waste management	Too hot weather sometimes causes fire on the mountain. It	Clean surroundings provide good	The quality of soil is contaminated. Plants are difficult	—	—

Waste Management Patterns	1	2	3	4	Other Answers
(pollution, health risks)	also has extracted that stink (4)	health (3)	to grow (1)		
WM6: Public awareness and participation in waste management	There are clean up drives and assigned street sweepers. There are also garbage trucks collecting garbage everyday (6)	There is a MRF project by the barangay (2)	There are designated trash cans every building (1)	—	—

The findings reveal a complex waste management system characterized by the coexistence of formal municipal services and informal waste recovery practices. In several areas, residents reported the presence of regular garbage collection and assigned street sweepers, indicating the existence of formal waste management structures within the barangay. However, informal waste picking remains widespread. Residents reported the presence of scavengers who collect recyclable materials from waste disposal areas. Informal waste workers play a significant role in recycling systems across developing cities and contribute substantially to resource recovery and circular economy processes (Medina, 2007; Wilson et al., 2006).Similar patterns have been documented in other Metro Manila communities where informal waste pickers play a critical role in resource recovery and recycling activities (Gutberlet et al., 2021). Despite the availability of formal waste collection services, instances of illegal dumping were also reported. Some residents indicated that garbage is occasionally disposed of behind buildings or in vacant spaces, suggesting gaps in waste management enforcement and community compliance. These practices contribute to foul odors, pest infestations, and potential fire hazards during dry seasons. The findings align with previous research showing that urban informal settlements often operate within a hybrid waste economy, where formal municipal services coexist with informal recycling systems (Serrona & Yu, 2009). While informal waste picking provides livelihood opportunities, it also highlights the need for improved waste governance and worker protection. Community participation in environmental initiatives was observed primarily through barangay clean-up drives and street sweeping activities. However, awareness of the barangay Materials Recovery Facility (MRF) was limited among some residents, suggesting that existing waste programs may not be fully integrated into community practices. These findings highlight the need for stronger institutional coordination and community education programs to promote sustainable waste management practices.

6.2 Pollution Sources and Environmental Impacts

Table 2. Pollution Patterns in the Community

Pollution Patterns	1	2	3	4	Other Answers
POL1: Air pollution (sources, types, effects)	Burning of wires for copper, bronze, or brass is already prohibited (7)	Too hot weather sometimes causes fire on the mountain. It	—	—	—

Pollution Patterns	1	2	3	4	Other Answers
		also stinks (2)			
POL2: Water pollution (sources, types, effects)	The water from the faucet is cleaner than the water coming from the water tank. The water coming from the water tank is not potable (8)	There is a good water supply (3)	Some are buying mineral water (2)	Sometimes, when it is high tide, the water from the river stinks (1)	The plastic bottles floating on the river (1)
POL3: Soil pollution (sources, types, effects)	Due to over population and crowded building, there is no place for planting (3)	Heavy rains cause landslide and soften the soil (2)	The quality of soil is contaminated. Plants are difficult to grow (1)	—	—
POL4: Noise pollution (sources, effects)	Because of over population, there is a noise pollution especially during weekends or if there is occasion (5)	The place is quiet (2)	The vehicles passing through also contribute to noise pollution (1)	—	—
POL5: Regulations and enforcement related to pollution control	Waste segregation, detection mechanism for copper, bronze, and brass burning, and dumping site (5)	Street sweepers assigned by the barangay (2)	—	—	—

Residents identified multiple forms of pollution affecting their community, including air, water, soil, and noise pollution. Air pollution concerns were linked primarily to the burning of metal wires and other waste materials. Although such activities are officially prohibited, residents reported occasional burning incidents, which generate smoke and toxic emissions. These findings reflect broader challenges in enforcing environmental regulations in densely populated informal settlements. Water pollution was another major concern. Respondents noted that while faucet water is generally considered safe, water stored in communal tanks is often perceived as unsafe for drinking. Additionally, river water during high tide was described as foul-smelling and contaminated with floating plastic waste. These observations are consistent with previous studies documenting water quality challenges in informal settlements located near waterways in Metro Manila (Casiw, 2020). Poor waste disposal practices and limited wastewater management infrastructure contribute to the contamination of urban water systems. Soil pollution was also identified as a concern, particularly in areas where waste accumulates and where soil quality limits the possibility of planting vegetation. Heavy rainfall was reported to worsen soil instability and contamination. Noise pollution emerged as another environmental issue associated with high population density and increased human activity. Residents reported elevated noise levels during community gatherings, weekends, and heavy traffic periods. Overall, the findings suggest that environmental problems in Tondo are interconnected and influenced by a combination of infrastructure limitations, population density, and gaps in environmental governance.

6.3 Green Spaces and Urban Environmental Quality

Table 3. Green Spaces in the Community

Green Spaces Patterns	1	2	3	4	Other Answers
GS1: Types of green spaces (parks, gardens, forests)	There is an ongoing barangay project for planting (3)	Upper part of the mountain used for planting vegetables, Barangay project for vegetation (1)	—	—	—
GS2: Accessibility and availability of green spaces	No area because the area is crowded with buildings (1)	Very few because the soil is contaminated. (1)	—	—	—
GS3: Quality and maintenance of green spaces	The barangay is clean every morning and afternoon because of the street sweepers (1)	—	—	—	—
GS4: Ecological functions of green spaces (biodiversity, climate regulation)	Solar system and generator charge problem (1)	—	—	—	—
GS5: Public use and enjoyment of green spaces	It is in order (1)	—	—	—	—
GS6: Urban planning and green infrastructure development	Barangay project for development of the community such as planting and recycling (3)	There is a mountain where they plant (2)	—	—	—

The study found that green spaces in the community are extremely limited. Some residents reported the existence of small planting initiatives led by the barangay, particularly in elevated areas locally referred to as “mountain areas.” These spaces are occasionally used for vegetable gardening. However, many parts of the community lack accessible green spaces entirely. High population density and the dominance of residential structures leave little room for parks, gardens, or other ecological infrastructure. Where green spaces exist, maintenance appears to rely largely on street sweepers rather than organized environmental stewardship programs. This indicates that ecological functions such as biodiversity conservation, shading, and climate regulation remain underdeveloped. The scarcity of green spaces in

urban informal settlements has been widely documented in urban planning research. Urban green infrastructure plays an important role in improving environmental quality, reducing urban heat, and enhancing community well-being (Newman & Jennings, 2008; UN-Habitat, 2020).Communities with limited access to green infrastructure often experience higher exposure to heat, pollution, and environmental stress (Ahorro et al., 2025). Despite these constraints, the study identified signs of emerging community interest in greening initiatives. Barangay planting projects and small-scale vegetable gardens demonstrate local willingness to engage in environmental improvement efforts. These findings suggest that community-driven green initiatives such as container gardening, rooftop planting, and vertical gardens could represent feasible strategies for improving urban environmental conditions in space-constrained communities.

7. Integrated Analysis

The results reveal several key themes regarding environmental governance in urban informal settlements.

First, waste management in Tondo operates within a hybrid system combining formal municipal services with informal recycling practices. While this system provides livelihood opportunities for some residents, it also reveals gaps in regulation and environmental protection. Second, environmental risks such as polluted water, contaminated soil, and poor waste management disproportionately affect marginalized communities. These conditions illustrate the concept of environmental inequality, where vulnerable populations experience greater exposure to environmental hazards. Third, although community participation exists through clean-up drives and barangay initiatives, engagement remains uneven. Expanding opportunities for community involvement in environmental decision-making could strengthen local governance and environmental stewardship. Finally, despite significant structural constraints, the community demonstrates resilience and willingness to participate in environmental initiatives. With appropriate institutional support, these local efforts could form the foundation for more sustainable and participatory environmental management systems.

8. Conclusion

This study demonstrates the value of Participatory Situation Analysis (PSA) as a tool for understanding environmental conditions in urban informal settlements. By engaging community members directly in the research process, PSA enables the identification of locally relevant environmental concerns and solutions.

The findings highlight persistent challenges related to waste management, pollution, and the scarcity of green spaces in Tondo, Manila. At the same time, the research reveals significant potential for community participation in environmental improvement initiatives. Strengthening environmental governance in urban informal settlements requires a combination of improved infrastructure, stronger policy enforcement, and increased community engagement. Participatory approaches such as PSA can play an important role in ensuring that environmental interventions reflect the needs and experiences of local communities. Future initiatives should focus on integrating informal waste workers into formal waste systems, expanding environmental education programs, and supporting community-driven green infrastructure projects.

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