



Community-based waste segregation as a foundation for coastal resilience: An environmental politics perspective

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Received Date: June 17, 2026

Revised Date: July 26, 2026

Accepted Date: July 30, 2026

ABSTRACT

Background: Indonesia's coastal communities face increasing environmental pressures from climate change and ineffective waste management, threatening ecosystem sustainability and community resilience. Although community-based waste segregation has been widely promoted, existing studies provide limited understanding of its governance dimensions and contribution to coastal resilience. Therefore, this study systematically reviews the literature to identify governance patterns and research gaps related to community-based waste segregation for coastal resilience. **Methods:** This study employed a Systematic Literature Review (SLR) using a qualitative synthesis approach. Data were sourced from peer-reviewed journals indexed in Scopus, Web of Science, Google Scholar via SciSpace, and other additional source. Six eligible studies were selected and comparatively analyzed across the reviewed literature to examine governance patterns supporting community-based waste segregation and coastal resilience. **Findings:** Six eligible studies were reviewed. The findings indicate that community-based waste segregation is more effective when supported by polycentric governance involving communities, governments, and other stakeholders. Adaptive governance was reflected in collaborative decision-making, institutional flexibility, and cross-scale coordination, whereas limited institutional support reduced the long-term sustainability of waste management initiatives. **Conclusion:** Community-based waste segregation contributes to the socio-ecological resilience of coastal areas by strengthening sustainable collaborative governance. Its effectiveness depends on institutional support, cross-scale coordination, and inclusive environmental policies. Strengthening polycentric governance is therefore essential for the sustainability of community-based waste segregation. **Novelty/Originality of this article:** This study synthesizes existing evidence to explain how polycentric governance and institutional arrangements shape the contribution of community-based waste segregation to coastal resilience, providing an integrated governance perspective that has received limited attention in previous studies.

KEYWORDS: coastal resilience; environmental politics; governance; polycentric; socio-ecological.

1. Introduction

Indonesia, as an archipelagic country with a coastline approximately 108,000 km long stretching from Sabang to Merauke, serves as a coastal ecosystem (Ministry of Marine Affairs and Fisheries, 2021). This system faces increasingly complex environmental pressures due to human activities, known as anthropogenic pressures. One of these pressures is the accumulation of solid waste, the sources of which come not only from coastal communities but also include waste leakage from human activities in upstream areas through rivers and/or drainage networks. From the perspective of human life systems and the environment, the coast is a system that depends on the balance between ecological capacity, human behaviour, and governance (Ostrom, 2009). Therefore, pollution

Cite This Article:

Hastuti, Y. (2026). Community-based waste segregation as a foundation for coastal resilience: An environmental politics perspective. *Journal of Character and Environment*, 4(1), 16–32. <https://doi.org/10.61511/jocae.v4i1.2026.3866>

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disturbances from waste can damage coastal ecosystems and disrupt the food chain. This can reduce fishery productivity and increase environmental health risks, which can weaken the overall resilience of coastal systems. In addition, coastal communities also face other impacts from the ongoing climate change. These cumulative impacts must be prevented to maintain the ability of coastal systems to survive, adapt, and recover (Voronkova et al., 2025). This study positions the issue of waste as part of systemic and political socio-ecological problems, not merely a matter of technical transportation and final disposal. From this perspective, practices of waste segregation and management from its source that are community-based, such as waste banks, TPS3R, 3R initiative communities, eco-enzyme communities, Eco bricks, community-based composting, zero waste movements, and others are often promoted as solutions that enhance public participation, social ownership, and sustainability of environmental management (Amir et al., 2025; Akhadi et al., 2024). Several studies have shown that these practices can contribute to the reduction of inorganic waste, strengthen cross-actor collaboration in policy, local circular economy, and waste management governance. Their effectiveness is highly determined by institutional support, policy design, and the coordination capacity of government both upstream and downstream.

In addition, research related to waste management or waste segregation and marine pollution in coastal areas, as well as cross-scale governance, has still focused on the sources of pollution, their distribution, and their impact on coastal ecosystems (Voronkova et al., 2025; Yang, 2023). In these studies, few integrate urban political ecology, cross-scale governance, and waste segregation practices into a single comprehensive analytical framework, and this has not been widely explored. Various studies, both in Indonesia and internationally, that examine the relationship between the dynamics of the distribution of waste segregation responsibilities and power relations (environmental politics), the role of institutions and multi-actor coordination (polycentric governance), as well as the collective capacity of communities to manage material flows, are still relatively limited and rarely used together. This gap requires an analytical approach capable of integrating ecological, social, and institutional dimensions in understanding the role of communities for waste segregation and interacting with the environmental political dynamics as well as polycentric governance in coastal social-ecological systems. This study will analyse how community-based waste segregation can be positioned within the framework of environmental politics and polycentric governance to support coastal resilience. Most research related to community-based waste segregation still focuses on technical and behavioural aspects, the effectiveness of recycling programs, increasing community participation, and changes in household waste management practices (Suyeno et al., 2025). Studies in Indonesia mostly emphasize the implementation factors of waste bank programs and their impact on reducing waste volume (Fatmawati et al., 2022; Ismiraj et al., 2023). At the international level, literature related to polycentric and environmental governance has developed in explaining how environmental management involves various actors and levels of government (Morrison et al., 2019; Ostrom, 2009).

The novelty of this research lies in the effort to integrate three main conceptual frameworks (panarchy, urban metabolism, and Elinor Ostrom's design principles) to analyse the distribution of waste flows and the inequalities in its management burden, as well as a polycentric governance framework in assessing its effectiveness. In a system framework where the coast is considered a social-ecological system, management failures downstream can only be mitigated through material flow control (input control) upstream as a control mechanism at the starting point of material flows. The role of the community in sorting waste at its source as a key factor in this environmental governance. At times, there is inequality regarding who produces the waste and who bears the burden. For example, in the establishment of waste banks in Indonesia, not all villages or urban neighbourhoods receive weighing equipment facilities from their local government. The purpose of this study is to analyse how community-based waste segregation through the perspective of environmental politics can be used as a governance mechanism that contributes to coastal resilience. In addition, it aims to assess whether this approach can strengthen collaborative

environmental governance or instead shift the responsibility of waste segregation from the state to the community without adequate structural support. Thus, it can answer how policies, institutions, distribution of responsibilities, and power relations in the scientific literature explain the role and effectiveness of community-based waste segregation practices within the framework of environmental politics and polycentric governance to support coastal resilience.

The concept of environmental politics in Indonesia is still inadequate compared to developed countries. There is still a shift of state responsibility to citizens through a governing at a distance mechanism, which is a mechanism where the state directs public behaviour through the devolution of environmental management responsibilities to local communities and other participatory initiatives. The state still controls policy direction, incentives, and environmental governance mechanisms (Alene, 2018; Rose & Miller, 1992). However, the implementation in Indonesia involves a national recycling system that is still weak and uneven, with limited infrastructure in certain areas and producer responsibility not yet optimal (Heffernan, 2023). From a panarchy perspective, which is a theory that explains the dynamics of change in social-ecological systems through an adaptive cycle consisting of growth, conservation, release, and cross-scale reorganization phases (Holling, 2001). Community-based waste segregation is part of the reorganization phase in social-ecological systems, where communities begin to develop social innovations and alternative governance as a response to the waste situation and its management system (Gunderson & Holling, 2002; Moore et al., 2014; Walker et al., 2004). The benchmark of its success is effectively present if there is healthy connectivity between governance levels; otherwise, community initiatives risk becoming fragmented and not integrated into the broader policy system. From this arises the question of whether the state strengthens this reorganization phase through regulatory support, financing, and coordination, or actually lets society bear the adaptation process on its own without structural support. Furthermore, within the framework of urban political ecology, where the concept of urban metabolism is used to view waste as part of the city's material flows and the politics of producing the 'urban nature' through relations of power, policy, and economy. In this regard, the city functions as a system that absorbs energy and materials from other regions and then produces waste that is often redistributed unfairly (Kennedy et al., 2011; Parris, 2016). The urban metabolism approach can clarify the dimension of inequality regarding who generates large amounts of waste (large-scale producers and consumers) and who is responsible for managing it downstream (Newell & Cousins, 2015). Therefore, community-based segregation needs to be analysed as an intervention in the metabolic flows that tend to produce uneven socio-ecological impacts.

To assess whether the community-based approach can truly strengthen governance, this study also adopts a polycentric governance framework by referring to Elinor Ostrom's eight design principles for managing common-pool resources. These principles include clearly defined boundaries; rules adapted to local conditions; participation in rule-making; monitoring; graduated sanctions; conflict resolution mechanisms; recognition of the right to self-govern; and nested enterprises/multi-level institutional networks (Ostrom, 1990). These principles become concrete in community-based waste segregation to assess whether community governance is functioning effectively or not. Furthermore, it clarifies that the success of waste segregation is not merely the result of moral awareness but depends on institutional design that enables coordination and accountability. In Indonesia, the results of the evaluation study on national waste management performance based on GIS (Geographic Information System) have shown spatial disparities between regions. This was found with waste deposits concentrated in Java, Sumatra, and Kalimantan; the estimated national waste deposits reaching 56-60 million tons per year; the average individual waste deposit ± 0.58 kg/person/day, exceeding the SNI standard of 0.5 kg/person/day; not all regencies/cities reported in *Sistem Informasi Pengelolaan Sampah Nasional* (SIPSN) (coverage only ± 46 -53%); there is a disparity in waste management and reduction facilities between regions.

This indicates that issues of information governance also affect policy planning (Gutama & Iresha, 2023; Ministry of Environment and Forestry, 2023). Other study results related to community-based waste segregation in the Jakarta area show that the communication model between local government parties and local communities influences the effectiveness of waste reduction, including the role of communities in source separation, waste volume reduction, and citizen participation (Puspawati & Besral, 2008). By combining panarchy (Holling, 2001; Walker et al., 2004), urban metabolism within the framework of urban political ecology (Heynen et al., 2006; Newell, 2021), and Elinor Ostrom's design principles, it is emphasized that community-based waste segregation can strengthen coastal resilience only if it becomes part of coordinated cross-scale polycentric governance. Without this integration, community initiatives risk becoming partial solutions that do not address the root of the distribution of burdens and power relations within the waste management system.

2. Methods

The research approach uses a qualitative method through a Systematic Literature Review (SLR) as the main method, supported by desk study of policy documents, institutional reports, and, if available, secondary data related to waste segregation. SLR is used to combine various theoretical perspectives into an integrative analytical framework (Pambudi et al., 2025; Snyder, 2019). This allows researchers to systematically identify patterns in previous research findings. The linking of empirical findings based on various studies is intended for the framework of urban political ecology, urban metabolism, and polycentric governance, where this study seeks to explain how community-based waste separation practices are expected to serve as environmental governance mechanisms that influence the distribution of responsibilities, power relations, and the adaptive capacity of coastal social-ecological systems. Data were collected by analyzing scientific journals that have gone through the peer-reviewed process that indexed in Scopus, Web of Science, ScienceDirect, additional literature, as well as various journals from other institutions. Literature review using scispace.com as a supporting platform in the process of exploring and identifying scientific literature before rechecking and final selection using Scopus, Web of Science, ScienceDirect, additional literature, and others. The time frame limitation for the scientific journals to be analyzed is within the last ten years (2015-2025). Meanwhile, desk study (literature study) will be used if necessary to enrich the empirical context, especially regarding waste segregation conditions in Indonesia, regional policies, and supporting information on the relationship between upstream and coastal areas. From the literature search process, then analyzed using the PRISMA 20 flow diagram, which is the reporting standard recommended for Systematic Review and Meta-Analysis. The stages consist of four steps, namely identification based on keywords, screening literature based on title and abstract, full-text review, and selecting literature that meets the criteria. The criteria for the selected journals were those relevant to urban political ecology, polycentric governance, environmental politics, coastal resilience, community-based waste segregation, political ecology of waste, and urban metabolism. Literature that only discusses waste treatment technology without addressing social or governance aspects and that is not relevant to the research title or identified keywords will be excluded from the literature list. Furthermore, duplicate literature is immediately removed and then ranked through scispace.com for the relevance.

The selected literature will undergo data analysis using thematic analysis to identify patterns of findings with the following groupings: production and flow of waste materials in urban systems/urban metabolism, the role of the community in waste segregation from the source (waste segregation based community), distribution of responsibilities and power relations in waste segregation, coordination among actors in a polycentric governance system, the contribution of waste segregation to the resilience of coastal social-ecological systems. Based on this grouping, it is possible to identify relationships between concepts to see whether it can address the environmental political perspective on community-based

waste segregation as part of social interventions in social-ecological systems, which aims to control the flow of waste materials for coastal resilience (Kennedy et al., 2011; Morrison et al., 2019; Ostrom, 2009). The SLR approach is very appropriate for research fields where empirical data are spread across various disciplines and geographic regions, and where insights relevant to policy require the integration of environmental, social, and technical dimensions (Snyder, 2019; Tranfield et al., 2003). From the primary data sources, the journals retrieved using the literature search keywords were “waste segregation” OR “waste bank” OR “environmental policy” OR “coastal resilience” OR “urban metabolism” OR “polycentric” OR “ecological politics.” Then, with the search strategy, the relevance level was analyzed in depth and presented in a comparison table from each data source. Based on that table, it facilitates researchers in rechecking with the DOI listed in the table from scispace.com to the primary data source.

The search results were filtered using the PRISMA flowchart process (Figure 1). The screening process consists of three stages, namely review of titles and abstracts, review of full texts, and relevance assessment. This three-stage data screening process includes bibliographic information, theoretical characteristics (main framework, application, key concepts), focus on waste segregation (types of waste, community approaches and mechanisms), coastal resilience dimensions, governance and power, main findings, and alignment with the study objectives. The data that has been extracted is then organized in a structured table. The table with the title of each column is number; author/year, study location/context, study focus, method, main findings, Ostrom elements that appear, political ecology dimensions, implications for coastal resilience, and lastly “gap/notes” (if any). This synthesis table of study results is used to compare findings between studies, identify patterns of similarities and differences, and to extract the main factors that influence the effectiveness of community-based waste segregation. This is of course in line with environmental study practices and resource governance to produce cross-context syntheses and recommendations based on previous research evidence (Pambudi et al., 2025). Furthermore, the use of theory-driven thematic analysis allows this research to be not only descriptive but also analytical in examining how the concepts of urban metabolism, political ecology, panarchy, and polycentric governance interact in shaping waste segregation systems. This approach has been widely used in environmental governance studies to understand the complexity of social-ecological systems and to produce a more comprehensive understanding of system adaptation and transformation dynamics (Folke et al., 2010; Morrison et al., 2019). Thus, the combination of these methods enables the research to produce a synthesis that not only describes community-based waste segregation practices but also explains how these practices function as governance mechanisms within coastal social-ecological systems, as well as their implications for coastal resilience from a political ecology perspective. Its application in this research will focus on the environmental political perspective that is relevant in building better community-based waste segregation governance.

3. Results and Discussion

A systematic search resulted in a comprehensive collection of literature data from various databases and sources, calculation 1,401 from searches through the scispace.com and additional literature platforms, where sixty-seven (67) journals were obtained with the search terms “waste segregation” and “waste management.” Then, the identified data calculation 1,468 (n= 1,468) were data that had not yet been screened for duplicates. After removing 184 duplicate entries, 1,284 (n= 1,284) remained, which then had to be screened for the journal time period, considering only the last ten years (2015 – 2025), reducing the total by 740, leaving n= 544. There were 2 (n= 2) entries that were letters / notes / conference papers, leaving n= 542. At this screening stage, based on systematic criteria, namely related to waste segregation, region, having an explicit polycentric governance framework, or principles of collective action. It turns out that there are only about one hundred and sixty-nine (169) data items to be assessed for eligibility, because as many as

373 data items did not mention anything related to waste segregation or waste banks, were outside Southeast Asia or South Asia, and/or did not relate to polycentric governance. From the data $n=169$, only six data items were “included” to be evaluated for abstract and content suitability. As many as 163 data points were eliminated at this stage because they did not specifically address top-down governance, did not include multi-level stakeholder analysis, and did not evaluate impacts on social-ecological resilience. Those journals generally focused more on technical aspects of waste segregation, individual behavior, or program operational effectiveness without linking them to environmental governance dynamics, coordination among actors, or their contribution to the resilience of social-ecological systems more broadly.

Data from six journals that ultimately met all inclusion criteria and were retained for synthesis. The six journal data, representing geographical contexts in Southeast Asia and using various methodological approaches to examine community-based waste segregation governance, meet the conceptual framework of this study. The data overview is according to the PRISMA 20 flow diagram as shown below:

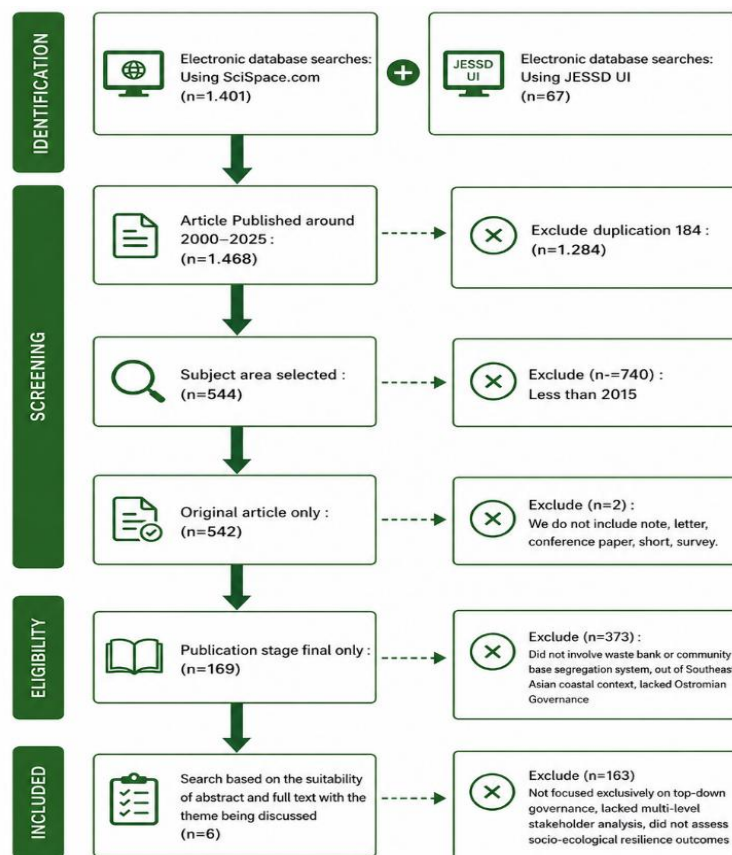


Fig. 1. Systematic review of flow diagram using PRISMA model

Istiyani & Handayani (2022) conducted a case study in Salatiga, East Java using document analysis, in-depth interviews, and observations to explore how waste banks function within a polycentric governance system, showing how community-based circular economy initiatives balance authority across sector levels. Research on the Gemilang waste bank program in Bima City uses an adaptive governance approach, emphasizing synergy among all stakeholders and a polycentric institutional structure that positions waste banks as a community empowerment ecosystem rather than merely a technical solution (Ibrahim, 2025). Other research can use a community service approach to participate with pre-test and post-test evaluations in Biringkasi Village, a coastal village that utilizes social exchange theory to understand how informal community-electoral relationships drive circularity in the waste management system (Andini et al., 2025).

Ramadan & Darumurti (2025) conducted qualitative case study research in the city of Bandar Lampung through literature review and in-depth interviews with environmental agencies, planning bodies, Non-Governmental Organizations (NGOs), and academic actors. They then examined the challenges of collaborative governance and proposed an institutional collective action framework to strengthen integration and collective decision-making in waste management for sustainable development purposes. These studies collectively demonstrate the application of Ostrom's design principles for general governance in community-based waste segregation for coastal resilience. The core of the research reveals how clearly defined community boundaries are, the arrangement of collective choices, monitoring mechanisms, graduated sanctions, and enterprises operating within polycentric governance where multiple centers of authority coordinate waste separation, circular economy practices, and ecosystem restoration. The summary of the 6 journals, which were checked for content and context, examines community-based waste segregation with polycentric governance in Indonesia, as shown in Table 1 below:

Table 1. Initial summary of SLR

Author	Location	Study design	Population/sample	Research focus
Istiyani & Handayani (2022)	Salatiga, Central Java	Case study with documentary analysis, in-depth interviews, and observations	Waste Bank in Salatiga	Embedding Waste Banks in a Polycentric Governance System
Ibrahim (2025)	Dara Subdistrict, Bima City	Unspecified (program evaluation)	Participation in the Gemilang Waste Bank program	Adaptive Governance and Grassroots Governance Strategies
Ananda et al. (2025)	Biringkassi Village (Coastal Area)	Community service activity with a participatory pretest-posttest approach	Community members & informal collectors	Building a Circular Economy Through Collector-Community Relationships
Ramadan & Darumurti (2025)	Bandar Lampung City	Qualitative case study with a literature review and in-depth interviews	Environmental agencies, Bappeda, NGOs, and academic communities	Collaborative Governance and Institutional Collective Action Frameworks
Harnita & Nining (2025)	Depok, Indonesia	Mixed methods	Households (community respondents)	The Influence of Community Participation on Waste Selection and Reduction
Ito (2019)	Kathmandu Valley, Nepal	Ethnographic study (field observation and social analysis)	Local communities and informal waste management actors	Dynamics of Community-Based Waste Management Systems in an Informal Polycentric Framework

Based on the principles of polycentric governance explicitly applied in the journals above, it has shown the relevance of Ostrom's design concepts to community-based waste segregation. The interaction of waste banks with various sectors and levels of government uses a polycentric governance approach, while emphasizing the importance of balancing authority within the waste management governance system (Istiyani & Handayani, 2022). Meanwhile, in the implementation of participation in the "Gemilang" waste bank program, it has illustrated how to build an adaptive and polycentric institutional structure (Ibrahim, 2025). Research results from Ramadan & Darumurti (2025) have investigated the potential of the Institutional Collective Action (ICA) approach. The ICA perspective provides an analytical framework to understand and address institutional risks by strengthening integration and collective decision-making. This research contributes to advancing the

understanding of how the ICA framework enhances the effectiveness of collaborative governance in the implementation of local environmental policies.

Governance and stakeholder levels, based on the study, indicate that community-based circular economy initiatives (waste banks) interact with various sectors and levels and generate initiatives derived from both top-down approaches (city government) and bottom-up approaches (civil society organizations and communities). These civil society organizations play a crucial role in waste segregation within a polycentric governance system, where authority is balanced and cross-sector and cross-level linkages are strengthened. The coordination mechanisms in several research findings vary but consistently emphasize a participatory approach. Ibrahim (2025) emphasizes continuous social learning, multi-level approaches, and comprehensive multi-stakeholder engagement strategies. Ramadan & Darumurti (2025) also identify significant coordination challenges including weak trust among actors, unequal access to resources, and the lack of structured monitoring systems, as well as trust in collaboration with local and higher-level governments. The polycentricity from several of these studies provides evidence of polycentric governance in action. Community-based approaches align with adaptive governance, allowing cross-level actors to network and learn collectively in response to uncertain environmental changes or ongoing environmental degradation. Community-based responses effectively shift the habit of waiting for government action to immediate action from the bottom/community. Formal recognition of community-based initiatives for the above actions is highly needed to ensure the sustainability of communities in supporting better environmental conservation (Ostrom, 2010). Based on Ostrom's theory, which has been examined in several of these studies, it shows that this theory has proven to function effectively when applied to community-based waste segregation in our country.

Comparison with previous research shows that this study has developed rapidly over the past two decades. However, most of it focuses solely on technical or participatory frameworks and has not explicitly linked them to coastal resilience and power dynamics from an environmental politics perspective. Research by Istiyani & Handayani (2022) shows that waste bank initiatives as a form of community-based circular economy practices have been able to strengthen polycentric governance systems through interactions between the government, communities, and civil organizations. However, the main focus is only on the effectiveness of governance and actor collaboration, and it has not examined how these practices contribute to the broader social-ecological system, especially in relation to coastal areas. In the Southeast Asian or South Asian regions, research shows that the main problems in waste segregation lie in weak policy implementation, limited institutional capacity, inadequate reporting systems, and low integration among stakeholders. These studies emphasize the importance of a multi-actor approach and increasing public awareness, but they still tend to view the community as a policy object, rather than as a political actor with the capacity to reshape power relations in environmental management.

Other research highlighting community participation at the household level shows that community involvement has a significant influence on the success of waste segregation and volume reduction. Internal factors such as awareness, as well as external factors such as the availability of facilities and the role of driving actors, contribute to the level of community participation in waste segregation activities. However, this approach is still behavioral and quantitative in nature, emphasizing the cause-and-effect relationship between social variables and environmental output, without delving deeper into structural dimensions such as access inequality, power relations, or benefit distribution within the waste management system (Harnita & Nining, 2025). In addition, anthropological and contextual research in developing countries shows that waste segregation practices in the field often develop informally and complexly, going beyond formal policy frameworks. Research in the Kathmandu Valley has revealed that effective waste management systems emerge from multi-actor interactions that are not fully regulated by the state, thereby creating adaptive yet vulnerable polycentric governance. These findings confirm that communities are not merely implementers of policy, but active actors who shape management systems based on the needs in their area (Ito, 2019). Nevertheless, this research has not yet linked these

dynamics to broader ecological implications, such as their impact on coastal areas. Table below presents a synthesis of reviewed studies, highlighting their contributions to political ecology, polycentric governance and coastal resilience.

Table 2. Synthesis of reviewed studies

Author	Contribution to this study	Governance	Community role	Political ecology dimension	Relevance to coastal resilience
Istiyani & Handayani (2022)	Support the role of community initiatives within polycentric governance systems	Polycentric	Active	Moderate	Indirect
Ibrahim (2023)	Demonstrates community capacity in environmental governance	Adaptive	Active	Moderate	Indirect
Andini et al. (2025)	Show integration of community waste segregation with circular economy	Collaborative	Active	Moderate	Indirect
Ramadan & Darumurti (2025)	Explains coordination mechanisms among actors	ICA	Active	Moderate	Indirect
Harnita & Nining (2025)	Support behavioural dimension of waste segregation	Participatory	Active	Moderate	Indirect
Ito (2019)	Demonstrates community agency beyond formal government systems	Informal Polycentric	Active	Moderate	Indirect

In a broader context regarding waste management, it has begun to move towards the integration of technical, social, and environmental justice aspects. Approaches based on the circular economy and environmental justice emphasize the importance of inclusivity, recognition of the role of the informal sector, as well as a fairer distribution of benefits within waste management systems. Nevertheless, most of these studies still focus on urban contexts and have not explicitly linked waste management to coastal systems as a unified ecological entity interconnected through material flow. Furthermore, studies related to blue economy policies indicate that weak collaboration among actors and the lack of integration between land and marine policies are major factors in the failure of coastal resource management. This indicates that problems in coastal areas cannot be separated from management practices in inland areas, including in terms of waste management. However, the study has not specifically examined how upstream interventions for community-based waste segregation can contribute to coastal resilience. Based on this comparison, it can be concluded that previous research is still fragmented between studies on community-based waste management or segregation, environmental governance, and coastal resilience. Most studies place the community as objects of participation or agents of behaviour change, without seeing them as actors in the wider political-ecological structure. Furthermore, the relationship between local-level waste segregation practices and ecological impacts in coastal areas has not been extensively explored/studied. Using an environmental politics perspective, this research not only analyzes practices and participation, but also highlights power relations, distribution of responsibilities, and connectivity between land and coastal areas. This approach is expected to provide a more comprehensive understanding of the community's role in building coastal resilience through sustainable waste segregation.

The findings from this SLR have shown that community-based waste segregation has significant potential as an early mechanism in controlling material flows within coastal social-ecological systems. Nevertheless, its effectiveness heavily depends on how such

practices are integrated into broader governance structures, namely community coordination with the government, the presence of reporting and monitoring, provision of adequate facilities, well-managed recycling incentive values, and others. From the perspective of environmental politics for urban political ecology, waste flows are not only understood as mere environmental issues but as part of urban social-ecological systems formed through interactions between human activities, economic structures, and ecological processes. Therefore, within this framework, it can also be understood as a reflection of power relations, stakeholders, and economic structures that determine who produces waste and who bears the burden of its management, hence waste management in urban areas must be strict (Newell, 2021; Parris, 2016). Thus, waste segregation is based as a form of social intervention in the urban metabolism system, which is full of inequalities. From the perspective of urban metabolism, cities function as open systems that absorb materials and energy, then produce waste that is often unevenly distributed to other areas, including coastal regions (Kennedy et al., 2011). The findings of this study indicate that upstream interventions through community-based waste segregation can function as an “input control” mechanism to reduce pressure on coastal ecosystems, such as the accumulation of plastic and microplastic waste, disrupted river flows, accumulated waste in mangrove areas, and others. Without structural changes in the production and consumption system, this intervention risks being only a partial solution that is unable to significantly reduce the volume of waste reaching the coast.

Furthermore, within the framework of political ecology, there is a potential shift of responsibility from the state and private sector to the community. Based on the results of a study in Ketapang Village, Tangerang Regency, it was shown that out of 1,988 households, only 448 households have participated in the waste bank. However, among the community members who are not yet members of the waste bank, as many as 94.4% stated that they are willing to become customers of the waste bank if there are improvements in the system and better support (Rachman et al., 2021). The concept of governing at a distance has explained how the state can encourage community participation without providing adequate structural support, thereby shifting the burden of environmental management onto the community. Therefore, the existence of waste banks and other community-based initiatives needs to be critically examined in more depth, whether they truly strengthen the adaptive capacity of the community or instead become a mechanism to divert state responsibility. In Indonesia, there have indeed been government regulations regarding the establishment of waste banks, but in practice, not all regions in Indonesia have facilities for the establishment of waste banks, and not every region has an off taker or private party that will manage the sorted waste from the community that has been submitted. The analysis results have also shown that the principles of polycentric governance as proposed by (Ostrom, 1990) have strong relevance in explaining both the successes and limitations of community initiatives. The studies analyzed indicate that the success of community-based waste segregation is highly determined by the presence of clear boundaries, participation in rule-making, monitoring mechanisms, as well as cross-scale institutional support. However, in many cases in Indonesia, connectivity between governance levels is still weak, so community initiatives often operate in a fragmented manner and are not integrated into national or regional policy systems. There is also no government provision for the price of each type of sorted waste, so it is only determined by private parties/off takers.

From the panarchy perspective, community-based waste segregation can be understood as part of the reorganization phase, which is the phase where the system could innovate and transform after experiencing stress or crisis. Study findings have shown that community initiatives have the potential to drive transformation towards a more sustainable waste segregation system. However, without support from higher levels of governance, this reorganization phase risks not developing into a growth phase, meaning that emerging innovations may not be able to be institutionalized more broadly. The main implication of this finding is the need for a more integrative and cross-scale governance approach in waste segregation. Community-based waste segregation must be positioned as part of a larger system, involving active interaction between the government, private sector,

and society in a sustainable manner. This aligns with the concept of social-ecological systems, which emphasizes the importance of interactions between social and ecological components in building system resilience (Folke, 2006). In addition, it must be supported by an integrated and consistent data management system to be incorporated as part of reporting and monitoring. This study also highlights the importance of environmental justice in waste segregation. Inequities in the distribution of waste segregation burdens indicate that certain community groups, especially in coastal areas, often bear the impacts of activities occurring upstream. Therefore, waste segregation policies need to be designed by considering aspects of distributional justice, recognition, and active community participation (Agyeman et al., 2016).

From the results of this SLR, it is expected to provide an important contribution in expanding the understanding of community-based waste segregation as part of a complex political-ecological system. By integrating the perspectives of urban metabolism, political ecology, panarchy, and polycentric governance, this study shows that strengthening coastal resilience cannot be achieved through sectoral or partial approaches but requires systemic transformation in environmental governance from upstream to downstream. Therefore, the success of community-based waste segregation highly depends on the system's ability to integrate local actions with robust policy support and strong institutions at a broader level. The synthesis of research results shows that community-based waste segregation can serve as part of the process of restructuring environmental governance within coastal social-ecological systems. A polycentric governance structure (multiple centers of authority) should be able to improve waste segregation in cities (upstream) that leak into coastal areas, with clearly defined tasks and authority carried out consistently, as well as the availability of adequate monitoring platforms. Waste segregation at the source must be strictly implemented and sanctions imposed if the community does not comply. Thus, it is expected to be able to build a collective action mechanism in controlling material flow from its source. This practice of waste segregation becomes important not only because it can reduce residues but also because it creates a form of collective oversight over material flows that were previously fully dependent on transportation and final disposal systems. This is in accordance with the study Istiyani & Handayani (2022) which shows that waste segregation communities can become important nodes in building polycentric governance through the connection between the community, government, and civil organizations.

This study also shows that the effectiveness of community-based waste segregation is greatly influenced by the capacity for coordination among actors. A frequently occurring obstacle is the lack of alignment in instructions and policy directions between the government, program managers, and implementing communities at the local level. The polycentric governance approach demonstrates that environmental management success is more adaptive when there is a distribution of roles and coordination mechanisms across levels of government and civil society actors (Ostrom, 2009). However, some studies also indicate that such coordination in Indonesia still faces obstacles in the form of institutional capacity disparities, weak monitoring systems, and limited support facilities at the local level (Ramadan & Darumurti, 2025). This condition causes the sustainability of community initiatives to often depend on certain actors or short-term project support, making them vulnerable to weakening when external support decreases. From the perspective of urban metabolism, the synthesis results show that the waste problem in coastal areas cannot be separated from the concept of material flow from production and consumption patterns in urban areas. Cities function as open systems that generate material flows and waste on a large and continuous scale, which then allows for the possibility of waste leakage from these areas into rivers, coasts, and seas, making downstream and coastal areas often the final accumulation spaces for these materials (Kennedy et al., 2011). Thus, coastal resilience is directly related to the ability of upstream areas to control waste leakage. In Indonesia, weak source segregation systems cause most waste to be mixed from the beginning, increasing the risk of leakage into rivers and the sea. Other studies indicate that spatial disparities in waste management facilities between regions further worsen the national waste control capacity (Gutama & Iresha, 2023).

In addition to governance aspects, the synthesis of this research also shows the presence of an environmental injustice dimension in waste segregation. The ecological burden tends to be borne by communities with lower economic and political capacities, including coastal communities and informal waste management actors. From an environmental justice perspective, this condition indicates an imbalance in the distribution of environmental risks and limited access to adequate management support (Agyeman et al., 2016). In practice, communities are encouraged to actively sort waste, but they do not always have access to infrastructure, material market certainty for recycling, or adequate economic protection within the circular economy chain. This situation indicates that community participation has the potential to create an unequal redistribution of environmental responsibility if it is not accompanied by proper institutional support. Research results also show that most previous studies still focused on technical success indicators, such as waste volume reduction, community participation rates, or the effectiveness of waste bank programs. This approach tends to view the community as program implementers, rather than as part of a broader political-ecological structure. In fact, waste management is inseparable from power relations that influence resource distribution, service access, and the determination of actors who gain economic benefits from the recycling system. In this context, the political ecology approach provides an important contribution because it can explain the relationship between environmental degradation, economic structures, and social inequality in waste governance (Heynen et al., 2006; Newell, 2021). The reviewed studies were further synthesized to examine their relevance to political ecology, polycentric governance, and coastal resilience, the conceptual frameworks of community-based waste segregation for coastal resilience from an environmental politics perspective in Figure 2 below:

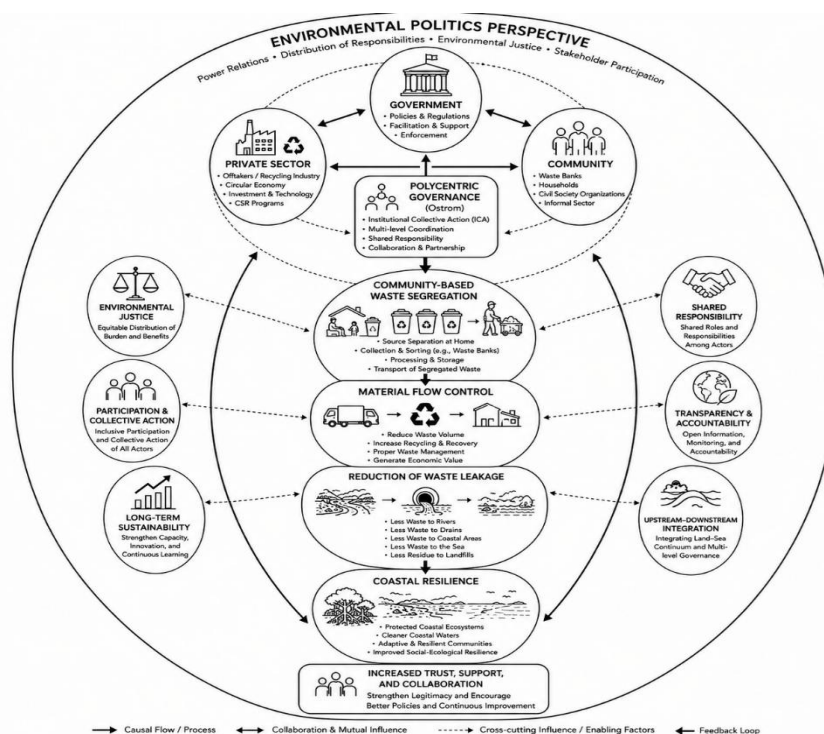


Fig. 2. Conceptual framework of community-based waste segregation for coastal resilience from coastal resilience from an environmental politics perspective

Nevertheless, this study has several limitations. First, the number of literatures explicitly integrating urban political ecology, polycentric governance, and coastal resilience is still relatively limited, especially in Indonesia. Most studies discuss these themes separately, so the synthesis process requires quite broad cross-concept interpretation. Second, the SLR approach does not allow direct observation of social dynamics at the community level, so some aspects such as conflicts of interest, economic dependence on

collectors, and informal relationships among actors are not depicted in depth. Third, the limitation of empirical data regarding the relationship between waste segregation in upstream areas and its impact on coastal ecosystems causes the causal relationship between variables to remain conceptual. To date, there are still few studies that directly measure the contribution of community-based waste segregation to reducing waste leakage into the sea or enhancing coastal social-ecological resilience. In addition, the use of secondary data from various geographical contexts also results in differences in social, institutional, and governmental capacity characteristics that cannot always be compared on an equal basis. Based on these limitations, further research needs to be directed towards a cross-regional empirical approach that combines spatial analysis, material flow measurement, and participatory community governance studies. This approach is important to strengthen the understanding of the relationship between community-based waste segregation, the distribution of ecological burdens, and coastal resilience in the context of developing countries like Indonesia.

4. Conclusions

This study has inferential limitations because it employs an SLR approach without primary field data. The literature synthesis results indicate that from an environmental politics perspective, community-based waste segregation as a foundation for coastal resilience should not only be understood as a technical activity for waste reduction or a standalone partial program, but also as part of the dynamics of power relations, responsibility distribution, and environmental governance within the coastal social-ecological system. Waste segregation issues reflect the inequalities between large-scale waste producers—upstream, downstream, and along the coast—and the communities that bear the consequences. Communities in downstream and coastal areas experience the impacts of these waste issues very acutely. Therefore, community-based waste segregation practices are very important and must be consistently carried out as a form of social intervention in controlling the flow of waste materials from the source before they end up in rivers, mangroves, and the sea.

This study emphasizes that communities such as waste banks have the capacity to build collective action, increase environmental awareness, strengthen collaborative governance, and social connectivity in waste segregation. Its effectiveness is greatly influenced by the support of broader governance. In various cases, the state and private sector still tend to encourage community participation without being accompanied by adequate structural support such as facilities, clear and stable data systems, broad market access, or economic protection for the community. These conditions indicate a tendency for the shift of environmental management responsibility to the community through indirect regulatory mechanisms by the state. The state issues laws and their derivatives related to waste segregation, but structural support is not entirely evenly distributed, and there is no adequate justice in the distribution of benefits. The effectiveness regulations issued by the country heavily depends on the government's ability to establish an integrated cross-scale governance between the community, central government, local government, private sector, academics, communities, informal waste segregation actors, and coastal management systems from upstream to downstream. Based on these findings, this study recommends the need to strengthen policies that position communities as strategic partners in sustainable environmental governance and provide adequate support in the form of facilities, an integrated monitoring system, certainty of access to off-takers/recycling industry parties, as well as fairer incentive mechanisms for sorted, dry, and clean waste. In addition, waste segregation policies should be designed across scales by connecting urban areas, river basins, and coastal zones as a single ecological unit, thus serving as an important foundation for building more adaptive, collaborative, and environmentally equitable coastal resilience.

Acknowledgement

The author would like to thank all parties who contributed to the completion of this research, particularly those who provided valuable support, feedback, and assistance during the research and manuscript preparation process.

Author Contribution

The author was solely responsible for the conceptualization, methodology, data collection, data analysis, interpretation of results, drafting of the manuscript, critical revision of the content, and approval of the final version of the manuscript.

Funding

This research received no external funding.

Ethical Review Board Statement

Not available.

Informed Consent Statement

Not available.

Data Availability Statement

Not available.

Conflicts of Interest

The author declares no conflict of interest.

Declaration of Generative AI Use

During the preparation of this work, the author used grammarly to assist in improving the grammar, clarity, and academic tone of the manuscript. AI-assisted tools were also used to assist in the creation and visual presentation of some figures. These tools were used solely as supporting tools and were not used to generate, alter, or fabricate the underlying research data or results. After using these tools, the author reviewed and edited the content and figures as needed and takes full responsibility for the accuracy, integrity, and final content of the publication.

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