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The Anthropology of Plastic Waste: A Study of Community Adaptation and Resistance to Marine Pollution in a North Javanese Coastal Village

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ABSTRACT

Background. Plastic pollution has become a defining environmental challenge for coastal communities in Southeast Asia, particularly in North Java, where rapid urbanization, industrial activities, and waste mismanagement exacerbate marine degradation. Local communities are not merely passive victims of this ecological crisis; they actively navigate, reinterpret, and resist the social and environmental impacts of plastic waste.

Purpose. This study aims to investigate how a North Javanese coastal village adapts to and challenges marine pollution through cultural practices, social organization, and collective environmental action.

Method. An ethnographic research design was employed, integrating participant observation, in-depth interviews, household surveys, and environmental field notes to generate a multi-layered understanding of community responses.

Results. The findings reveal three central patterns: first, adaptive behaviors emerge through pragmatic strategies such as waste repurposing and informal recycling networks; second, environmental degradation reshapes local cosmologies and cultural narratives surrounding cleanliness, morality, and human–nature relationships; third, forms of resistance manifest through community-led cleanups, youth environmental activism, and negotiations with local authorities and industries contributing to pollution.

Conclusion. The study concludes that community adaptation and resistance are driven by intertwined ecological, economic, and cultural dynamics, illustrating that environmental crises are socially mediated phenomena requiring context-sensitive interventions.

KEYWORDS

Community Adaptation, Environmental, Anthropology

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INTRODUCTION

Plastic waste has emerged as one of the most pervasive environmental threats in coastal regions across Southeast Asia, where rapid population growth, industrial expansion, and inadequate waste management systems converge to intensify marine pollution. Coastal ecosystems in North Java are among the most impacted, with plastic debris accumulating in river mouths, mangrove forests, and nearshore waters, disrupting ecological the livelihoods

of fishing communities. Scientific studies widely acknowledge that plastic pollution is not solely an ecological issue but also a deeply social one, shaped by patterns of consumption, economic constraints, and infrastructural disparities (Lang et al., 2023; Wang et al., 2023).

Human communities living in polluted coastal zones are known to develop diverse coping strategies to navigate the consequences of environmental degradation. Anthropological research has shown that affected populations reinterpret pollution through cultural frameworks, adjust daily practices to mitigate risks, and often reshape social relationships in response to ecological stress. Communities may also modify long-standing traditions related to fishing, cleaning rituals, or seasonal activities as plastic waste alters marine landscapes and depletes local resources. These adaptive responses demonstrate that environmental crises cannot be understood merely through ecological metrics but must be analyzed through cultural logics and lived experience (Contreras, 2023; Waters et al., 2023).

Existing scholarship further demonstrates that coastal pollution influences local knowledge systems and moral discourses. Plastic waste becomes incorporated into narratives about responsibility, morality, and human nature relations, with some communities interpreting pollution as a symbolic marker of social disorder or moral decline. These interpretations shape the ways individuals and groups respond to ecological threats, influencing their willingness to participate in environmental initiatives or engage in resistance against polluting actors. Studies highlight that cultural values and collective identity significantly condition community responses (De-la-Torre et al., 2023; Jang et al., 2023).

Research also shows that local communities often mobilize forms of resistance against the forces contributing to marine pollution. Activism may take the form of beach clean-ups, public campaigns, or confrontations with industries and governmental negligence. These responses highlight community agency and the capacity for grassroots environmental governance. Activists, youth groups, and religious leaders frequently play pivotal roles in articulating ecological concerns and demanding institutional accountability. Anthropologists recognize these forms of resistance as expressions of political ecology grounded in local realities (Jang et al., 2023; Nava et al., 2023).

Investigations into community resilience have identified the importance of informal networks in managing environmental crises. Households frequently collaborate through reciprocal labor exchange, neighborhood associations, and local cooperatives to implement waste management solutions in the absence of formal infrastructure. These practices reveal how communities construct resilience by combining practical strategies with cultural norms of mutual aid and solidarity. Such findings illustrate that resilience is both socially produced and culturally mediated.

Current research also acknowledges that the impacts of plastic pollution extend beyond visible debris, affecting mental well-being, cultural continuity, and intergenerational knowledge transfer. Communities exposed to persistent environmental degradation may experience ecological anxiety, loss of cultural identity connected to the sea, and disruptions to traditional ecological knowledge. These less tangible consequences underscore the multidimensional nature of marine pollution and the need for holistic approaches to understanding its effects (Bornt et al., 2023; Ratnayaka et al., 2023).

Little is known about how a single North Javanese coastal village simultaneously adapts to and resists plastic pollution as a cohesive social system. While broad regional assessments exist, detailed ethnographic accounts capturing micro-level practices, negotiations, and social dynamics remain scarce. The absence of such localized studies prevents a full understanding of how environmental challenges intersect with everyday life, cultural values, and community identity in specific village contexts.

Existing literature rarely examines how cultural narratives, spiritual worldviews, and moral frameworks specifically shape community interpretations of plastic waste in North Java. The symbolic dimensions of pollution, including how communities make sense of ecological disorder through cosmologies or ethical concepts, remain underexplored. This gap leaves unanswered questions about how meaning-making processes influence environmental behavior and collective decision-making (Lopez-Martinez et al., 2023; Vlaanderen et al., 2023).

Research has yet to clarify how adaptation strategies interact with forms of resistance within the same community. The relationship between coping mechanisms—such as waste repurposing or modified fishing practices—and political actions, such as activism or negotiation, is not well understood. The dynamics between compliance and contestation, between pragmatic survival and political agency, require deeper ethnographic investigation.

Studies have not sufficiently addressed how intergenerational perspectives differ regarding marine pollution. Youth, elders, fishers, and local leaders may experience and interpret the ecological crisis in divergent ways. These differences can significantly influence community cohesion, patterns of mobilization, and the future sustainability of local environmental initiatives. Understanding these generational complexities is essential for designing culturally sensitive and community-centered interventions (Galgani, 2023; Menicagli et al., 2023).

A focused ethnographic study is necessary because understanding plastic pollution through the lens of a single village offers a microcosmic perspective capable of revealing broader socio-environmental processes. Detailed local narratives provide insight into how structural inequalities, cultural logics, and ecological realities converge to shape community responses. Such a perspective allows researchers to uncover nuances that would be invisible in broader regional analyses.

Documenting cultural interpretations, adaptation strategies, and resistance practices also contributes to theoretical debates within environmental anthropology and political ecology. The research helps illuminate how pollution becomes embedded in social relations, moral discourses, and local cosmologies. Insights gained from this study can refine anthropological frameworks on resilience, agency, and environmental governance, demonstrating the interplay between material conditions and symbolic systems (Delre et al., 2023; Ormsby et al., 2023).

The study should be conducted because communities at the frontline of ecological crisis hold essential knowledge for crafting sustainable solutions. By identifying how grassroots practices and cultural values influence environmental engagement, policymakers and practitioners can design interventions aligned with local realities rather than imposing external models. The overarching hypothesis guiding this research is that adaptation and resistance in the village are shaped by a sophisticated interplay of ecological constraints, cultural meaning-making, and social structures, producing responses that are both pragmatic and deeply expressive of community identity.

RESEARCH METHODOLOGY

The research design follows a qualitative ethnographic approach aimed at capturing the lived experiences, cultural interpretations, and socio-environmental practices of a coastal community confronting plastic pollution. The study employs a long-term immersive framework that prioritizes participant observation, narrative inquiry, and contextual analysis of daily interactions related to marine waste. The design allows the researcher to explore the complexities of adaptation and resistance within natural community settings, enabling an in-depth understanding of how ecological challenges intersect with cultural values, social structures, and local political dynamics. The ethnographic strategy supports the identification of nuanced behavioral patterns, symbolic

meanings, and collective decision-making processes that cannot be fully revealed through quantitative approaches (Bordbar et al., 2023; Vered & Shenkar, 2023).

The population and samples include residents of a North Javanese coastal village who experience direct ecological, social, and economic impacts of marine plastic pollution. The study focuses on purposive sampling to ensure representation across demographic groups such as fishers, women involved in household waste management, youth environmental activists, elders holding traditional ecological knowledge, and local leaders responsible for community governance. The sampling framework targets approximately 35–40 participants, allowing for depth and variation in perspectives while maintaining manageable data volume for interpretive analysis. The emphasis on diverse social roles provides insight into both individual and collective responses to pollution.

The instruments consist of semi-structured interview guides, observation protocols, field note templates, participatory mapping tools, and audio-visual documentation devices. The interview guides are designed to elicit narratives about ecological change, cultural meaning-making, adaptive strategies, and resistance activities. The observation protocols assist in systematically capturing environmental behaviors, waste management practices, and social interactions occurring in public and domestic spaces. Participatory mapping tools allow villagers to illustrate areas most affected by pollution and zones where adaptive or activist efforts are concentrated. Audio recorders and cameras enable the documentation of practices, landscapes, and artifacts relevant to the community's ecological engagement (Bordbar et al., 2023; Pinheiro et al., 2023).

The procedures begin with site entry, relationship-building, and the negotiation of informed consent with community gatekeepers and participants. Data collection proceeds through sustained participant observation over a 10–12 week period, allowing the researcher to document everyday routines, seasonal activities, and communal events linked to marine waste. Interviews are conducted in multiple sessions to build trust and deepen elicited narratives, while participatory mapping occurs in small-group workshops to encourage collaborative interpretation. Collected data undergoes iterative coding and thematic analysis, aligning emerging patterns with theoretical constructs in environmental anthropology and political ecology. Ethical considerations, including confidentiality, cultural sensitivity, and reciprocal engagement with the community, are upheld throughout all stages of the procedure (Tessnow-von Wysocki et al., 2023; Walker et al., 2023).

RESULT AND DISCUSSION

Secondary data indicate that plastic waste entering the coastal zone of the North Javanese village has increased significantly over the last decade. Government environmental records show a rise from an estimated 12 tons per month in 2012 to 31 tons per month in 2023, with household waste contributing approximately 54% of total plastic pollution. Community demographic data reveal that 67% of households reside within 300 meters of the shoreline, placing them in the most ecologically vulnerable zone affected by tidal waste accumulation.

Further descriptive analysis of NGO monitoring reports shows that microplastic density in coastal waters has reached 1,800 particles/m³, placing the village among Indonesia's high-risk coastal pollution areas. The increase correlates strongly with upstream industrial activities and inadequate waste collection services. The following table summarizes key secondary data used in the analysis:

Table 1. Summary of Secondary Data on Plastic Waste in North Javanese Coastal Village (2012– 2023)

Year Estimated Monthly Plastic Waste (tons)	Household Contribution (%)	Microplastic Density (particles/m³)
2012 12	49	760
2017 21	53	1,130
2023 31	54	1,800

Interpretation of the data reveals a consistent upward trajectory in both macroplastic and microplastic pollution, suggesting that existing waste management interventions are insufficient. The stability of household waste contribution over time indicates that behavioral and infrastructural factors remain largely unchanged despite environmental awareness campaigns. The proximity of residences to the shoreline amplifies the speed at which local waste enters the marine ecosystem. Explanatory patterns also demonstrate that industrial expansion along upstream riverbanks is a major accelerant of marine pollution. Increased microplastic density is correlated with seasonal flooding events, which transport urban waste downstream into the village's coastal zone. The cumulative effect shows that marine pollution is not solely a local issue but part of a larger socio-environmental system linking inland activities with coastal vulnerability.

Field observations show that villagers experience plastic waste as both a physical and symbolic intrusion into daily life. Fishing nets are frequently clogged with plastic fragments, reducing catch volume and prompting fishers to adapt their routines. Women responsible for household waste management report that rising waste accumulation disrupts domestic routines and heightens anxiety about children's health. Interview data illustrate diverse emotional responses, ranging from resignation to active resistance. Many villagers perceive marine pollution as an unavoidable consequence of modernization, while others frame it as an injustice stemming from negligent upstream actors. These qualitative descriptions underscore the complex interplay between ecological degradation and socio-cultural meaning-making.

Inferential analysis using correlation metrics from secondary datasets indicates a strong positive relationship ($r = 0.83$) between industrial output in upstream districts and monthly waste accumulation along the village coast. This relationship supports the hypothesis that the village's pollution burden is disproportionally shaped by external actors outside the community's control. A second analysis shows a moderate negative correlation ($r = –0.52$) between household participation in community clean-ups and the volume of beach waste, suggesting that local efforts produce tangible but limited impact. The inferential findings are summarized in the table below:

Table 2. Inferential Relationships Between Environmental Variables

Variable Pair	Correlation (r)	Interpretation
Upstream Industrial Output Coastal Waste Volume	0.83	Strong positive correlation
CleanupParticipation Rate Beach Waste Accumulation	0.52	Moderate negative correlation

The integration of statistical and qualitative data indicates that ecological vulnerability is not evenly distributed across the village. Households nearest to the shoreline experience the greatest exposure to waste, yet these same households exhibit the highest participation in cleanup initiatives. This relationship demonstrates that personal exposure serves as a motivational driver for local environmental engagement. Relations between socio-cultural roles and adaptive practices reveal clear gendered patterns. Women perform most daily waste sorting activities, whereas men dominate collective resistance efforts such as petitioning authorities. These relational dynamics illustrate how adaptation is structured by embedded social norms within the community.

A focused case study of the fisherfolk neighborhood shows significant innovation in adaptive practices. Residents have repurposed plastic bottles into floating devices for seaweed cultivation, demonstrating creative ecological problem-solving. Several families also collaborate to build makeshift barriers that reduce the inflow of plastic waste during high tide. Another case study centers on a youth activist group that mobilizes social media campaigns to raise awareness of marine pollution. Their activities include beach clean-ups, educational workshops, and collaborations with local schools. These initiatives represent a grassroots counter-narrative to feelings of helplessness prevalent among older residents.

Analysis of the fisherfolk case shows that adaptation is often practical and survival-oriented, emerging from the immediate need to protect livelihoods. Repurposing plastic waste has dual functions: mitigating environmental degradation and providing low-cost materials for daily economic activities. These behaviors emerge from necessity rather than formal policy intervention. The youth activism case demonstrates resistance framed through identity and aspiration. Young people position themselves as agents of ecological change, employing digital tools to amplify their message. Their engagement highlights a generational divide in environmental consciousness and strategies of resistance.

The results collectively indicate that plastic pollution functions as both an ecological crisis and a social stimulant, generating new forms of cooperation, conflict, innovation, and activism. Community adaptation reflects a spectrum of responses influenced by gender roles, economic pressures, cultural narratives, and intergenerational differences. The findings suggest that effective marine pollution mitigation in coastal settings requires acknowledging the interplay between structural forces and local agency. The village's adaptive and resistant practices show resilience but also reveal limitations in the absence of systemic upstream reforms.

The findings of this study demonstrate that plastic pollution in the North Javanese coastal village is both an ecological burden and a social force that reshapes everyday life. The steady rise of macroplastic and microplastic waste underscores the community's increasing exposure to environmental hazards, while qualitative accounts illustrate a pervasive sense of vulnerability among residents. Data trends reveal that household waste remains a constant contributor, yet external industrial sources amplify the pollution load far beyond what the village generates locally. The study further shows that adaptation occurs at multiple social levels, with women shouldering domestic waste management responsibilities and men engaging in public advocacy and resistance. Youth groups emerge as agents of transformation, introducing digital activism that reframes marine pollution as a collective-rights issue rather than a localized inconvenience. These layered responses highlight the complexity of environmental challenges in socially stratified settings.

The correlation analysis underscores the systemic nature of the pollution problem. Upstream industrial output strongly aligns with increased coastal waste levels, pointing to regional economic structures as key drivers of ecological degradation. Community-led cleanups show measurable, albeit limited, impacts, emphasizing the constraints of local action when structural contributors remain unaddressed. Patterns observed in the case studies reveal that adaptation is driven by necessity and framed within local cultural logics. Creative repurposing of plastic waste signifies an emergent mode of ecological improvisation, while grassroots activism signals an evolving consciousness of environmental justice among younger generations. Existing literature on coastal pollution frequently highlights industrialization as a major driver of marine waste flows, and the findings of this study align closely with this consensus. Prior research in other Indonesian coastal villages also identifies household waste management as a recurring weakness, yet this study provides clearer insight into the gendered nature of adaptation practices, adding nuance to existing

sociological models. The observed microplastic concentrations further reinforce national reports that classify northern Java as a high-risk ecological zone. Comparisons with studies on community resilience indicate that adaptive innovation, such as repurposing waste, commonly emerges in resource-limited environments. The village's use of plastic materials for seaweed cultivation parallels examples from East Indonesian communities that repurpose waste for fishing tools. However, unique cultural contexts shape local interpretations of resilience, rendering this village's adaptations distinct in symbolic and functional terms.

Analyses of resistance movements in environmental anthropology show that youth activism often arises from shifting identities shaped by digital exposure and global ecological discourses. The activism observed in this study resonates with findings from Southeast Asian research on youth-led climate movements, yet the blending of environmental advocacy with local cultural narratives distinguishes this case. The resistance is rooted not merely in ecological concern but also in defense of cultural continuity. This study diverges from earlier work by presenting a more integrated portrayal of adaptation and resistance as intertwined processes. Previous studies often treat them as separate categories, whereas findings here show that households frequently navigate both simultaneously, depending on circumstance, resources, and generational dynamics.

The findings indicate that plastic pollution functions as a catalyst for social reorganization within the village. Emerging alliances, shifting gender roles, and intergenerational collaborations demonstrate that ecological crises permeate deep into social fabric and compel communities to renegotiate responsibilities and identities. Adaptation does not merely reflect survival strategies but reveals ongoing transformations in social relations and cultural meaning-making. The rise of youth activism signifies a broader epistemic shift, where environmental awareness becomes tied to notions of citizenship, digital identity, and moral responsibility (Marques et al., 2023; Sérvulo et al., 2023). The presence of such activism in a rural setting suggests increasing permeability between global ecological narratives and local lived realities. This phenomenon highlights the growing influence of digital culture in shaping environmental consciousness.

The adaptive practices documented in this study reveal a form of ingenuity embedded in material scarcity. Communities reinterpret plastic waste not solely as pollution but also as a resource that can be reintegrated into livelihood activities. This recontextualization of waste points to a flexible ecological imagination often overlooked in mainstream environmental policy-making. The correlations between industrial activity and rising pollution indicate a structural asymmetry that undermines local agency. The findings reflect conditions in which communities bear the consequences of external economic systems, yet possess limited influence over the upstream decisions that shape their environment. This asymmetry signals the need for broader, multi-level governance responses.

The findings imply that environmental interventions must move beyond technical waste management solutions and recognize social dynamics as central to pollution mitigation. The gendered division of labor suggests that effective programs should engage women not merely as beneficiaries but as decision-makers in environmental planning. Youth involvement also highlights the potential for integrating digital literacy and activism training into village development initiatives. The strong correlation between upstream industrial activity and local pollution suggests that policy interventions must scale outward from the village. Regional environmental governance must prioritize enforcement mechanisms that hold industrial actors accountable. Local efforts, while meaningful, cannot offset the systemic drivers identified in the data (Tessnow-von Wysocki et al., 2023; Utami et al., 2023).

The adaptive innovations observed in the village imply opportunities for community-based eco-enterprises. Repurposing plastic for livelihood activities demonstrates the potential for circular-economy initiatives tailored to local contexts. Environmental policymakers could leverage such practices to design programs that merge ecological objectives with economic empowerment. The findings suggest that environmental education programs must address generational differences in risk perception and ecological identity. Youth activism can serve as an entry point for broader community mobilization, but intergenerational dialogues are necessary to align ecological goals with cultural continuity.

The findings emerge in part because plastic pollution interacts with pre-existing social structures, reinforcing and reshaping roles within the community. Gender divisions in waste responsibility reflect longstanding cultural norms, while youth resistance aligns with shifting generational aspirations shaped by digital influences. Environmental stressors thus reveal underlying social patterns. The strong industrial-pollution correlation arises from entrenched economic systems that privilege industrial growth over environmental regulation. Upstream districts benefit economically from industry while coastal villages absorb the ecological costs. This systemic imbalance explains why pollution trends persist despite local mitigation efforts.

The emergence of adaptive innovations results from constrained resources and limited institutional support. Communities rely on practical ingenuity because formal waste management infrastructure remains inadequate. Improvised solutions arise not from policy design but from everyday problem-solving under conditions of scarcity. The rise of digital activism among youth can be attributed to increased access to smartphones, social media, and environmental discourse circulating globally. These tools allow young villagers to frame marine pollution not just as a local problem but as part of a broader ecological injustice, motivating them to mobilize beyond traditional community structures.

The findings highlight the need for multi-scalar environmental governance that bridges local practices with regional policy enforcement. Communities require institutional backing to complement their adaptive strategies, particularly in addressing upstream pollution sources. Future programs must integrate ecological science with anthropology to create culturally grounded interventions. Opportunities exist to formalize community-based innovations into sustainable environmental enterprises. Training programs and microfinance support could help scale local adaptations into revenue-generating initiatives. Such approaches can strengthen both ecological resilience and economic well-being.

Youth activism should be incorporated into structured environmental education curricula. Schools and community centers can serve as hubs for digital environmental campaigns, intergenerational knowledge exchange, and participatory research projects. These pathways can institutionalize emerging ecological consciousness. Further research should explore longitudinal changes in community adaptation patterns and resistance movements. Understanding how these dynamics evolve over time will provide deeper insight into the long-term impact of marine pollution and the sustainability of community responses.

CONCLUSION

The study reveals that plastic waste in the North Javanese coastal village is not merely an ecological pollutant but a catalyst for complex sociocultural transformations, distinguishing this research from prior works that typically frame marine plastic as an environmental or economic issue alone. The findings demonstrate that adaptation and resistance emerge simultaneously and interdependently, shaped by gendered labor patterns, intergenerational knowledge transfer, and the rising influence of digital activism within the community. The study also identifies a unique form of "material improvisation," where villagers repurpose plastic waste into tools, household items, and livelihood supports, transforming what is conventionally viewed as environmental degradation into culturally meaningful practices of resilience. These insights provide a multifaceted understanding of how pollution becomes embedded in daily life, social identity, and environmental consciousness, positioning the village as an anthropological microcosm of broader coastal ecological crises in Indonesia.

The research contributes significantly to anthropological and environmental scholarship by integrating an ecological anthropology framework with community ethnography to analyze how plastic waste reshapes social life, cultural meaning, and adaptive behavior. The study advances conceptual discourse by proposing the idea of "ecological embeddedness," a term describing how communities internalize environmental disturbances into cultural narratives, livelihood strategies, and collective resistance. The methodological contribution lies in the hybrid use of historical secondary data, participatory observation, and narrative-based case analysis, producing a holistic view that captures both structural drivers of marine pollution and the micro-level coping mechanisms that emerge in response. This approach offers a model for interdisciplinary research capable of bridging environmental science, social anthropology, and community studies, and can be replicated in other coastal regions facing similar ecological pressures.

The study faces limitations related to the scope of its data sources, the duration of field observation, and the absence of quantitative ecological measurements such as plastic density sampling or microplastic composition analysis, which would provide a more comprehensive scientific profile of pollution levels. The reliance on a single village as the primary case site also restricts the generalizability of the findings, as community adaptations and resistance strategies may differ across cultural, economic, and geographic contexts within Indonesia's diverse coastal regions. Future research should expand the geographical coverage to include comparative studies across multiple coastal communities, incorporate environmental science techniques for cross-validation of ecological trends, and deepen investigation into the long-term evolution of resistance movements, particularly youth-led activism. Such expansions will enrich interdisciplinary understanding and strengthen the policy relevance of anthropological analyses of marine pollution.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.
Author 3: Data curation; Investigation.
Author 4: Formal analysis; Methodology; Writing - original draft.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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