Indonesian Journal of Community Engagement
Jurnal Pengabdian kepada Masyarakat
Vol. 11, No. 3, September 2025, Page. 188-194
DOI: http://doi.org/10.22146/jpkm.96740

Classification of Plastic Waste in Community-Based River Cleanup Initiatives for Water Quality Restoration

Riyanto Haribowo*, Prasetyo Rubiantoro, Sharon Kezya Java Irawan, Pradinska Nahda Wafiya, Muthi'ah Raudhatul Jannah, Hizkia Kharah Anggi Sihombing

Department of Water Resources Engineering, Faculty of Engineering, Universitas Brawijaya, Malang, Indonesia

Submitted: June 03rd 2024; Revised: July 25th 2025; Accepted: July 29th 2025

Keywords:
Citizen science
Community-based waste management
LDPE
Plastic waste
River pollution

Abstract This study investigated the classification of plastic waste collected through community-based river cleanup initiatives and evaluates its implications for restoring water quality. River pollution in Indonesia poses an escalating environmental challenge, primarily driven by increased human activity and the mismanagement of solid waste. This research integrates citizen science via the BrantaSae platform and the collaborative efforts of the RIVER research group to actively involve local communities in cleanup programs. Employing a participatory approach, the initiative included cleanup campaigns, educational outreach, and waste-sorting activities. Digital tools were used to report and monitor waste, while local coordinators played a central role in maintaining community engagement throughout the process. Plastic waste collected from three strategic sites was categorized by type, polymer composition, and functional use. The findings indicate that plastic was the most prevalent waste material, with low-density polyethylene (LDPE) as the dominant polymer and plastic bags as the most frequently encountered item. These results underscore the significant impact of everyday consumer behavior on river pollution and emphasize the need for targeted waste reduction, enhanced recycling infrastructure, and broader public awareness. This study illustrates how structured, community-driven actions, when supported by digital mapping technologies, can contribute meaningfully to sustainable river ecosystem management and the restoration of water quality.

1. INTRODUCTION

The condition of rivers in Indonesia – particularly in Malang City – raises significant environmental concerns due to persistent challenges in water resource management and river ecosystem conservation. A critical issue compromising river health is the uncontrolled disposal of waste into waterways (Buwono et al., 2022). This practice, carried out by both community groups and industrial actors, severely degrades river ecosystems by contributing to extensive pollution. The accumulation of waste in rivers deteriorates water quality, intensifies sedimentation, and can obstruct water flow. Among various pollutants, plastic waste is especially problematic due to its persistence in aquatic environments, where it poses threats to aquatic life and diminishes the visual and ecological integrity of riverine landscapes. Inadequate waste management efforts further endanger river ecosystems and may result in serious consequences for communities that depend on river water for their daily needs.

Raising public awareness about the dangers of littering and enforcing regulations against such practices are essential steps toward mitigating river pollution. Strategic measures include effective educational campaigns, active community participation in river cleanup efforts, and the development of sustainable waste management infrastructure (Angriani et al., 2018). One promising approach is citizen science, which refers to a research methodology that involves public participation in scientific research and environmental monitoring. Over the past three decades, citizen science has grown exponentially in both scope and impact (Follett & Strezov, 2015; Kullenberg & Kasperowski, 2016; Shirk et al., 2012; Zhang et al., 2023). In citizen science initiatives, individuals typically engage

ISSN 2460-9447 (print), ISSN 2541-5883 (online)
*Corresponding author: Riyanto Haribowo
Department of Water Resources Engineering, Faculty of Engineering, Universitas Brawijaya, Jl. MT. Haryono No.167, Malang, 65145, Indonesia
Email: riyanto_haribowo@ub.ac.id

in data collection, analysis, or interpretation, supporting researchers in gathering information across broader geographic and temporal scales. This participatory model has proven effective in advancing environmental protection by generating scientific knowledge, informing policy, and encouraging civic action (Bonney et al., 2016; Burgess et al., 2017). Citizen engagement in such efforts may involve diverse activities, including environmental monitoring, biodiversity mapping, and water quality assessment (Capdevila et al., 2020; D'Alessio et al., 2021; Ramírez et al., 2023). Thanks to modern digital technologies—such as smartphone applications and online platforms—participants can contribute meaningfully to scientific projects without requiring formal scientific training (Scardino et al., 2022).

BrantaSae is an innovative web-based mapping application developed by the Department of Water Resources Engineering, Faculty of Engineering, Universitas Brawijaya (Departemen Teknik Pengairan, 2021). The name BrantaSae stands for Brantas Basin System of Assessment and Environmental Research. This platform is designed to facilitate the exchange of knowledge and coordinate activities aimed at improving water quality within the Brantas Watershed. Given the unique geographical characteristics and complex social dynamics of the Brantas watershed (Fadhilah & Haribowo, 2023; Haribowo et al., 2023), local communities have actively engaged in various environmental improvement efforts. However, many of these initiatives remain undocumented. BrantaSae specifically aims to identify and examine actions undertaken by individuals and communities related to both water quantity and quality in the Brantas region. The concept behind BrantaSae was inspired by the success of its sister platform, ClimateScan, which has cataloged more than 5,000 international climate adaptation efforts. ClimateScan has demonstrated its effectiveness in numerous international workshops and has addressed the needs of a wide range of stakeholders (Boogaard et al., 2017; Restemeyer & Boogaard, 2020). Building on these proven concepts, BrantaSae adapts and localizes this approach, offering a valuable tool for documenting grassroots initiatives and developing sustainable strategies to address water quality challenges in the Brantas watershed.

In addition to addressing the challenges of water pollution, sedimentation, and water quality degradation, prioritizing litter management is essential for achieving sustainable river conservation and management in Malang City and its surrounding areas. A collaborative approach involving government, communities, and the private sector is expected to foster holistic solutions that ensure the long-term sustainability of river ecosystems.

The Water Resources Engineering Department, Faculty of Engineering, Universitas Brawijaya, seeks to make tangible contributions to the advancement of water resource science and technology, particularly through community service initiatives. One such effort is led by the Water Quality and Environment Research (RIVER) group, an integral part of the department. The RIVER team focuses on the understanding, monitoring, and preservation of river ecosystems and actively engages in river cleanup efforts. The term "RIVERlution", a combination of "RIVER" and "Revolution," reflects the group's commitment to transforming river stewardship beyond academic research through meaningful, sustained contributions to environmental preservation and restoration.

Based on this commitment, the group's community service initiative aims to facilitate public participation in river cleanup movements, enhance water quality conservation, and promote the sustainability of river ecosystems within the Brantas watershed. It also seeks to generate insights and recommendations for the development of sustainable waste management strategies in Malang City and nearby regions.

Beyond its practical impact, this study contributes to scientific advancement by introducing a structured method for classifying plastic waste based on community-collected data—an approach that remains underexplored within the Indonesian citizen science literature. Moreover, it strengthens community engagement practices by illustrating how digital platforms like BrantaSae can be effectively integrated with grassroots environmental actions to support education and data-driven waste management. This paper presents a detailed classification of plastic waste by type, polymer, and function within a community-based cleanup initiative, offering a rarely documented citizen science model in the Indonesian context. The integration of the BrantaSae platform with the RIVER group's initiatives provides a practical framework for combining community participation with scientific methodologies to advance environmental education and water quality restoration.

2. METHOD

The implementation of this community service initiative followed a series of structured steps. To encourage community participation, the BrantaSae platform was employed as a forum for collecting information on river conditions. An initial review of the data available on BrantaSae was conducted to gain a comprehensive understanding of the problems and challenges affecting the Brantas River. Based on this assessment, the team identified strategic locations for river cleanup activities, with site selection guided by critical factors such as pollution levels and site accessibility. The implementation team consisted of lecturers and researchers from the RIVER research group, student volunteers, and local residents. This collaborative structure ensured both the effective execution of technical tasks and the active involvement of the community throughout the cleanup and reporting process.

Preparations for the river cleanup involved two main components. First, equipment for the physical cleanup was assembled, including cleaning tools, waste containers, and personal protective gear. Second, instruments for water quality analysis were prepared to support environmental assessment activities (Fadhilah

& Haribowo, 2023; Haribowo et al., 2023). These two components complemented each other, ensuring the efficient implementation of the cleanup efforts and the accurate collection of water quality data.

The river cleanup activities were implemented comprehensively, with active community participation in both the waste collection and sorting processes. Upon completion of waste collection, sorting was conducted as a critical step toward sustainable waste management.

The initial sorting phase involved categorizing waste into three broad groups: plastic, organic, and other. The plastic category included all types of plastic materials, the organic category comprised biodegradable substances, and the "other" category encompassed materials not classified in the previous two groups.

In the second phase, the plastic waste was subjected to more detailed sorting based on polymer type. The plastics were classified into seven categories: low-density polyethylene (LDPE), high-density polyethylene (HDPE), polyethylene terephthalate (PET), polypropylene (PP), polystyrene (PS), polyvinyl chloride (PVC), and other plastics (Sartain et al., 2021).

In the classification of plastic types, examples of LDPE included plastic bags and wrappers; HDPE encompassed detergent or soap bottles, non-beverage bottles, and plastic toys. PET included beverage bottles and cooking oil containers. PP was represented by snack packaging, straws, sauce bottles, bottle caps, and diapers. PS covered items such as Styrofoam, plastic utensils, and cups for hot beverages. PVC was primarily found in plastic pipes. The "other" category included eyeglasses and miscellaneous non-plastic items. This categorization enabled each plastic type to be processed through the most appropriate and effective recycling methods.

The third stage of sorting focused on the function of each plastic item. Plastics previously categorized by polymer were further classified based on their specific uses, such as food containers, beverage packaging, soap or detergent products, and miscellaneous items. This multilevel sorting process promoted a more refined and recycling-oriented waste management system, thereby contributing positively to environmental sustainability.

The final step in the implementation process involved reporting. The results and key findings from the cleanup activities were transparently communicated to relevant stakeholders and the broader public to foster increased awareness and encourage continued community participation in maintaining river cleanliness (Figure 1).

3. RESULT AND DISCUSSION

3.1 BrantaSae Project Scan

A scan of the BrantaSae website conducted on December 12, 2023, identified a total of 655 citizen science projects across various thematic categories (Figure 2). These projects include seven initiatives focused on water quality improvement, 126 related to domestic wastewater treatment, and ten addressing pollution from agriculture (seven projects) and livestock (three projects). Additionally, 16 projects focus on industrial wastewater management, and 150 are dedicated to solid waste management.

Other notable categories include 28 river care group projects and four projects linked to formal education. Furthermore, nine projects are centered on creative and circular economy development, while 13 support eco-riparian and ecotourism initiatives.

Among the total, 291 projects specifically target water quality issues, indicating a significant concentration of efforts in this area. One particularly notable project, Oppama JHS, represents a collaboration that promotes the exchange of scientific and cultural knowledge between Indonesia and Japan. The diversity and scale of these projects reflect the broad commitment and active participation of local communities involved in the BrantaSae movement to enhance and maintain the environmental quality of the Brantas River.

3.2 Implementation of river cleanup activities

River cleanup activities under the BrantaSae initiative constitute a central effort to preserve water quality in the Brantas River. Among the 291 projects conducted, many were explicitly aimed at supporting this objective. However, the selection of appropriate sites was a critical step, requiring consideration of key factors such as the severity of pollution and accessibility. Based on a comprehensive review, three locations were prioritized due to their high

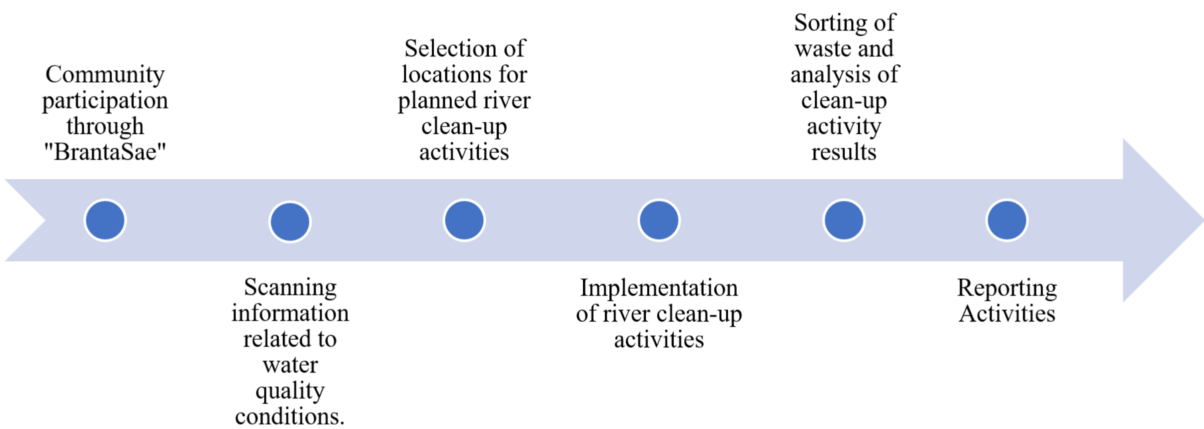

Figure 1 . Structured implementation flow of community-based river cleanup activities

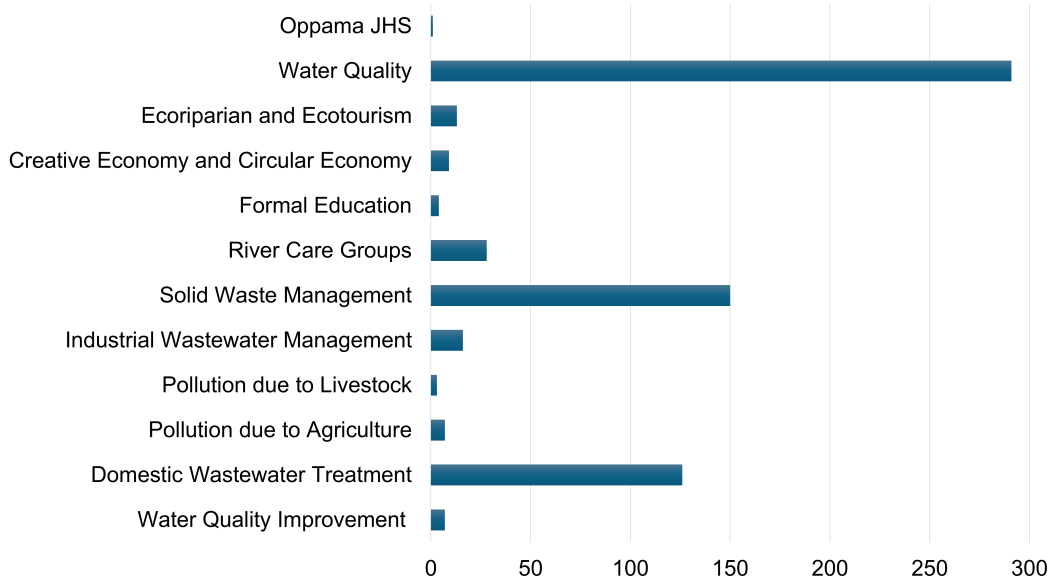

Figure 2 . Results of initial waste classification by general type in the Brantas River

levels of contamination and logistical feasibility for carrying out cleanup operations. These locations included the drainage area behind STIH on Jalan Joyo Raharjo, the site along Jalan Ikan Piranha, and the FTUB Drainage area.

Figure 3 . Field implementation of river waste collection and sorting activities

The cleanup process was executed in two stages. The first stage was conducted on November 10, 2023, at the drainage site behind STIH. The second stage was implemented at the remaining two locations—Jalan Ikan Piranha and the FTUB Drainage. Through these efforts, the initiative aimed to improve the environmental conditions surrounding the river and enhance public awareness of the importance of maintaining environmental cleanliness (Figure 3).

3.3 Results of waste stockpile analysis

As shown in Figure 4, plastic waste was the dominant category across all three locations studied. In Location 1 (Jl. Joyo Raharjo), the total waste collected weighed 67.3 kg, of which 37.9 kg (56.32%) was plastic waste, 23.4 kg (34.74%) was organic waste, and 6.0 kg (8.94%) fell into the "other" category. In Location 2 (Jl. Ikan Piranha), the total waste amounted to 7.0 kg, consisting of 4.0 kg (57.14%) plastic waste, 1.0 kg (14.29%) organic waste, and 2.0 kg (28.57%) other waste. In Location 3 (FTUB Drainage), the total waste weight reached 18.4 kg, with 14.5 kg (78.80%) comprising plastic waste, followed by 2.0 kg (10.87%) organic waste and 1.9 kg (10.33%) other waste.

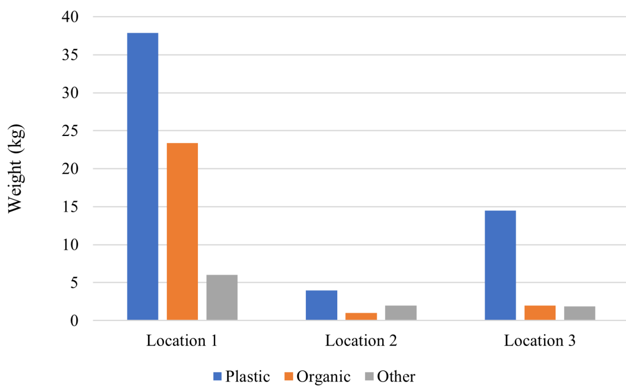

Figure 4 . Waste composition from river cleanup activities based on general type

These findings clearly indicate that plastic waste is the most pressing issue in all three locations (Buwono et al., 2022). Among them, Location 1 (Jl. Joyo Raharjo) exhibited a relatively more balanced distribution of waste types compared to the other sites. Nevertheless, all locations require focused efforts in plastic waste management.

The results align with previous research emphasizing the predominance of plastic waste—particularly low-density polyethylene (LDPE)—in urban river systems in developing countries (Buwono et al., 2022; Haribowo et al., 2023). LDPE is known for its persistence in aquatic environments, where it poses a serious threat to water quality due to its resistance to degradation and its potential to release microplastics over time. Consequently, the analysis underscores the need for targeted interventions that go beyond waste collection, including upstream community education and the promotion of environmentally friendly product alternatives.

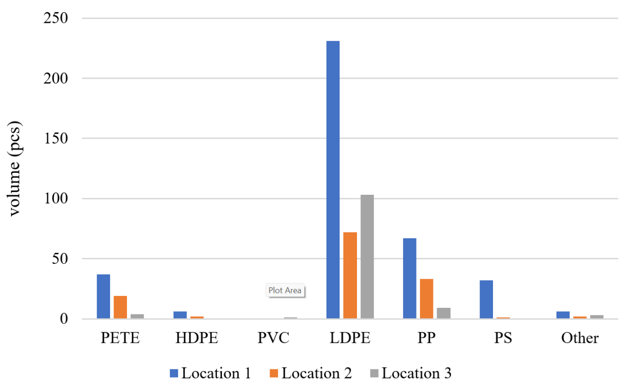

Figure 5 . Plastic waste composition by polymer type

Figure 5 illustrates that plastic waste across the three studied locations is predominantly composed of low-density polyethylene (LDPE). In Location 1 (Jl. Joyo Raharjo), LDPE accounted for 60.95% of the 379 plastic waste items, followed by polypropylene (PP) at 17.68%, polystyrene (PS) at 8.44%, polyethylene terephthalate (PETE) at 9.76%, and both high-density polyethylene (HDPE) and other plastic types at 1.58% each. In Location 2 (Jl. Ikan Piranha), of the 129 plastic items collected, LDPE again dominated with 55.81%, followed by PP at 25.58%, PETE at 14.73%, and HDPE, PS, and other types each comprising 1.55%. In Location 3 (FTUB Drainage), out of 120 plastic items, LDPE made up 85.83%, followed by PP at 7.50%, PETE at 3.33%, and polyvinyl chloride (PVC) at 0.83%. No HDPE or PS was identified at this location.

These results confirm that LDPE is the most prevalent polymer across all three locations, with the highest proportion recorded at Location 3 (FTUB Drainage). PP and PETE also contributed significantly in specific areas. Therefore, plastic waste management strategies should prioritize the reduction and recycling of LDPE, while also addressing other polymers based on their localized distribution (Ramírez et al., 2023).

These findings are consistent with previous studies highlighting the frequent occurrence of LDPE and PP in urban river systems in Indonesia (Haribowo et al., 2023). LDPE's dominance is largely attributed to its widespread use in inexpensive, single-use packaging materials. Its chemical structure makes it highly resistant to degradation, which increases the likelihood of microplastic formation. This underscores the urgent need to enhance the traceability and recyclability of LDPE, particularly within community-based waste management systems.

From Figure 6 presents the distribution of plastic waste by functional category across the three study locations, revealing notable differences in composition. In Location 1 (Jl. Joyo Raharjo), out of 575 plastic waste items, the "Other" category was the most prevalent, accounting for 245 items (42.61%), followed by plastic bags with 196 items (34.09%), food packaging with 63 items (10.96%), beverage packaging with 61 items (10.61%), and soap and detergent containers with 10 items (1.74%).

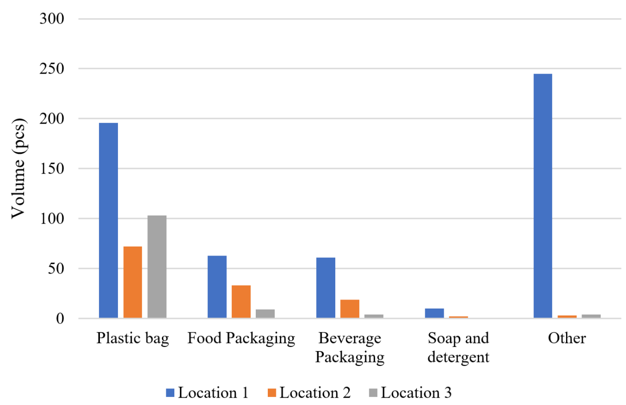

Figure 6 . Functional categorization of plastic waste collected from river cleanup

In Location 2 (Jl. Ikan Piranha), of the 129 plastic items collected, plastic bags dominated with 72 items (55.81%), followed by food packaging at 33 items (25.58%), beverage packaging at 19 items (14.73%), and only a minor presence of other categories. In Location 3 (FTUB Drainage), out of 120 plastic waste items, plastic bags overwhelmingly dominated with 103 items (85.83%), followed by food packaging with 9 items (7.50%) and beverage packaging and "Other" categories with 4 items (3.33%) each. No waste items from the soap and detergent category were recorded at this location.

Overall, plastic bags emerged as the most commonly found type of plastic waste across all locations, with particularly high prevalence in residential areas. Location 1 (Jl. Joyo Raharjo) displayed a greater diversity of plastic waste types, with a significant proportion falling into the "Other" category. Despite this variation, the widespread dominance of plastic bags across all sites suggests that waste management efforts should prioritize reducing their use. In addition, improving the handling and recycling of food and beverage packaging is essential to support more effective and sustainable waste management systems.

These waste categories – especially plastic bags and food packaging – are closely linked to daily household consumption patterns. The findings reinforce the relevance of citizen-generated data in informing behavioral change and shaping waste management policies, consistent with similar community-based studies in Southeast Asia (Capdevila et al., 2020). Categorizing plastic waste by type, polymer, and function not only enhances targeted waste management strategies but also serves as an indirect indicator of pollution pressure within river systems.

For instance, the dominance of LDPE and plastic bags signals a heightened risk of persistent pollutants that may fragment into microplastics and compromise water quality. By identifying specific sources and types of waste, stakeholders can adopt more targeted interventions—such as limiting plastic bag use, improving LDPE recycling processes, and promoting community behavioral change. These actions are expected to lead to measurable improvements in river water quality over time.

Several solutions can be proposed to address the predominance of plastic waste at the three study locations. First, programs aimed at reducing the use of single-use plastics—particularly plastic bags—should be implemented through policy measures, such as bans or additional charges for plastic bag usage in shops and markets. Second, recycling facilities for LDPE and other plastic types need to be enhanced, with priority given to locations where LDPE dominates. Investment in efficient recycling technologies and supporting infrastructure is essential to ensure that collected plastics are processed effectively. Third, public education campaigns are critical to raise awareness about the negative impacts of plastic waste and to promote responsible waste management. These campaigns can be delivered through outreach activities in schools, community centers, and mass media platforms.

In addition to these strategic solutions, several specific activities can be undertaken to further mitigate plastic waste. Investing in research and development to identify environmentally friendly alternatives to plastic and to improve recycling technologies should be prioritized. The establishment of waste banks in each location could facilitate the collection, sorting, and recycling of plastic waste. Furthermore, regular waste cleanup activities in neighborhoods surrounding the three study sites would help reduce environmental contamination and reinforce long-term waste management habits.

By implementing these solutions and proposed actions, the plastic waste problem at the study sites can be significantly reduced, contributing to a cleaner and healthier environment. Moreover, by linking detailed plastic waste categorization with recognized indicators of pollution, this study offers a valuable proxy for understanding pollutant sources and assessing risks to river water quality. Although direct water chemistry measurements were not conducted, the observed dominance of persistent polymers such as LDPE strongly suggests a sustained pollution load that may progressively impair water quality over time.

4. CONCLUSION

This study underscores the importance of classifying riverine plastic waste by type, polymer, and function through a community-based cleanup initiative conducted under the RIVERlution campaign. The findings consistently revealed that plastic was the dominant waste material across all three sites, with low-density polyethylene (LDPE) emerging as the most prevalent polymer and plastic bags as the most common functional category. Location 1 (Jl. Joyo Raharjo) exhibited a wide range of plastic waste, including food wrappers and single-use bags. Location 2 (Jl. Ikan Piranha) showed a mix of packaging-related plastic waste, while Location 3 (FTUB Drainage) was dominated by plastic bags and larger containers, indicating potential commercial sources.

The study demonstrates that structured waste classification, when integrated with citizen science and digital mapping tools such as BrantaSae, can generate valuable data to inform targeted plastic reduction strategies and community education. The combination of scientific analysis and local participation offers a practical model for enhancing environmental awareness and supporting water quality restoration efforts.

To address the challenges identified in this research, we recommend reducing single-use plastic consumption, upgrading recycling infrastructure—particularly for LDPE—establishing local waste banks, and promoting regular community cleanup activities. These interventions are essential for achieving sustainable river ecosystem management in Malang and other urban environments facing similar waste-related pressures.

ACKNOWLEDGMENT

The authors wish to extend their heartfelt appreciation to Rizky Almarendra W. P., M. Ja'far Shiddik, and Tsabita Putri Anggani for their invaluable assistance in the execution of this study and the essential data collection.

CONFLICT OF INTERESTS

The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this manuscript.

REFERENCES

Angriani, P., Sumarmi, Ruja, I. N., & Bachri, S. (2018). River management: The importance of the roles of the public sector and community in river preservation in Banjarmasin (A case study of the Kuin River, Banjarmasin, South Kalimantan – Indonesia). *Sustainable Cities and Society, 43*, 11–20. https://doi.org/10.1016/j.scs.2018.08.004

Bonney, R., Phillips, T. B., Ballard, H. L., & Enck, J. W. (2016). Can citizen science enhance public understanding of science? *Public Understanding of Science, 25*(1), 2–16. https://doi.org/10.1177/0963662515607406

Boogaard, F. C., Tipping, J., Muthanna, T. M., Duffy, A., Bendall, B., & Kluck, J. (2017). *Web-based international knowledge exchange tool on urban resilience and climate proofing cities: www.climatescan.nl* [Paper Presentation].

14th IWA/IAHR international conference on urban drainage (ICUD).

Burgess, H. K., DeBey, L. B., Froehlich, H. E., Schmidt, N., Theobald, E. J., Ettinger, A. K., HilleRisLambers, J., Tewksbury, J., & Parrish, J. K. (2017). The science of citizen science: Exploring barriers to use as a primary research tool. *Biological Conservation, 208*, 113–120. https://doi.org/10.1016/j.biocon.2016.05.014

Buwono, N. R., Risjani, Y., & Soegianto, A. (2022). Spatio-temporal patterns of occurrence of microplastics in the freshwater fish Gambusia affinis from the Brantas River, Indonesia. *Environmental Pollution, 311*, 119958. https://doi.org/10.1016/j.envpol.2022.119958

Capdevila, A. S. L., Kokimova, A., Ray, S. S., Avellán, T., Kim, J., & Kirschke, S. (2020). Success factors for citizen science projects in water quality monitoring. *Science of The Total Environment, 728*, 137843. https://doi.org/10.1016/j.scitotenv.2020.137843

D'Alessio, M., Rushing, G., & Gray, T. L. (2021). Monitoring water quality through citizen science while teaching STEM undergraduate courses during a global pandemic. *Science of The Total Environment, 779*, 146547. https://doi.org/10.1016/j.scitotenv.2021.146547

Departemen Teknik Pengairan. (2021). Tentang BrantaSae. *Brantasae.ub.ac.id*. https://brantasae.ub.ac.id/about-us

Fadhilah, A. & Haribowo, R. (2023). Analisis kualitas air berdasarkan tata guna lahan di Sungai Bango. *Jurnal Teknologi Dan Rekayasa Sumber Daya Air, 3*(2), 104-112. https://doi.org/10.21776/ub.jtresda.2023.003.02.09

Follett, R. & Strezov, V. (2015). An analysis of citizen science based research: Usage and publication patterns. *PLOS ONE, 10*(11), e0143687. https://doi.org/10.1371/journal.pone.0143687

Haribowo, R., Rubiantoro, P., Fadhilah, A., Alovy Petra Denindya, Z., Ayu Kristanti, Y., Rismiati, W., & Aulia Arsal, M. (2023). Assessment of small-scale microplastics abundance and characterization in urban river: A case study in Metro River, Indonesia. *Journal of Engineering and Technological Sciences, 55*(2), 167–176. https://doi.org/10.5614/j.eng.technol.sci.2023.55.2.6

Kullenberg, C. & Kasperowski, D. (2016). What is citizen science? – A scientometric meta-analysis. *PLOS ONE, 11*(1), e0147152. https://doi.org/10.1371/journal.pone.0147152

Ramírez, S. B., van Meerveld, I., & Seibert, J. (2023). Citizen science approaches for water quality measurements. S*cience of The Total Environment, 897*, 165436. https://doi.org/10.1016/j.scitotenv.2023.165436

Restemeyer, B. & Boogaard, F. C. (2020). Potentials and pitfalls of mapping nature-based solutions with the online citizen science platform climateScan. *Land, 10*(1), 1-17. https://doi.org/10.3390/land10010005

Sartain, M., Wessel, C., & Sparks, E. (2021). *Microplastics sampling and processing guidebook*. Mississippi State University. https://extension.msstate.edu/publications/microplastics-sampling-and-processing-guidebook

Scardino, G., Martella, R., Mastronuzzi, G., Rizzo, A., Borracesi, Q., Musolino, F., Romanelli, N., Zarcone, S., Cipriano, G., & Retucci, A. (2022). The nauticAttiva project: A mobile phone-based tool for the citizen science plastic monitoring in the marine and coastal environment. *Marine Pollution Bulletin, 185*, 114282. https://doi.org/10.1016/j.marpolbul.2022.114282

Shirk, J. L., Ballard, H. L., Wilderman, C. C., Phillips, T., Wiggins, A., Jordan, R., McCallie, E., Minarchek, M., Lewenstein, B. V., Krasny, M. E., & Bonney, R. (2012). Public participation in scientific research: A framework for deliberate design. *Ecology and Society, 17*(2). https://doi.org/10.5751/ES-04705-170229

Zhang, J., Chen, S., Cheng, C., Liu, Y., & Jennerjahn, T. C. (2023). Citizen science to support coastal research and management: Insights from a seagrass monitoring case study in Hainan, China. *Ocean & Coastal Management, 231*, 106403. https://doi.org/10.1016/j.ocecoaman.2022.106403