Envirotek : Jurnal Ilmiah Teknik Lingkungan
Vol.18, No.2, October, 2026, pp. 10-15
Journal Home Page: http://envirotek.upnjatim.ac.id/
e-ISSN 26231336 p-ISSN 2085501X

Fish Waste Management Model in Fishermen Settlements to Support Coastal Environmental Resilience

Vissia Poppy Puspita Lestari[1], Susilowati[1], Luluk Edahwati[2*]

[1] Master Study Program of Environmental Sciences, Faculty of Engineering and Science, Universitas Pembangunan Nasional Veteran Jawa Timur, Surabaya, Indonesia
[2] Chemical Engineering, Faculty of Engineering and Science, Universitas Pembangunan Nasional Veteran Jawa Timur, Surabaya, Indonesia

Correspondance Email (Author): lulukedahwati@gmail.com

Received: *22-04-2026*
Accepted: *07-06-2026*
Published: *31-10-2026*

Keywords:
fish waste, waste management, fishermen settlements, environmental resilience, SDG 11.

ABSTRACT
Fish processing activities in fishermen settlements generate solid and liquid waste that may cause environmental pollution if not properly managed. Therefore, an appropriate waste management system is required to minimize environmental impacts while supporting coastal environmental resilience. This study aims to analyze the fish waste management system in fishermen settlements and develop a community-based waste management model to improve environmental quality in coastal residential areas.
This study employed a descriptive qualitative approach through field observations and literature analysis to identify waste types and their potential utilization. The results show that fish processing activities produce solid waste, such as fish heads, bones, and skin, as well as liquid waste from fish washing processes. Solid waste can be utilized as fish meal, animal feed, and organic fertilizer, while liquid waste can be treated through simple systems such as sedimentation ponds and biofilters before discharge into the environment.
The proposed model integrates waste segregation, waste treatment, and resource utilization. The model is expected to improve environmental quality, strengthen coastal environmental resilience, provide economic benefits for coastal communities, and support the achievement of Sustainable Development Goal 11 related to sustainable cities and communities.

1. INTRODUCTION

Fish processing activities are one of the main economic activities carried out by communities living in fishermen settlements. These activities generally include cleaning, cutting, and washing fish before they are marketed or further processed. However, these activities also produce various types of waste, including solid waste such as fish heads, bones, skin, and scales, as well as liquid waste originating from fish washing processes. If not properly managed, fish processing waste can cause environmental problems such as unpleasant odors, water pollution, and decreased environmental quality in coastal residential areas (Ghaly et al., 2013).

Fish processing waste actually has considerable potential to be utilized as value-added products. Previous studies have shown that fish processing by-products can be processed into fish meal, organic fertilizer, and animal feed (Arvanitoyannis & Kassaveti, 2008; Rustad et al., 2011). The utilization of these wastes not only reduces the amount of waste disposed into the environment but also provides additional economic value for coastal communities. Previous studies have also highlighted the importance of sustainable fish waste utilization and resource recovery in supporting environmental management and circular economy practices (Shahidi, 2007; Venugopal, 2011; Nurdiani & Dissanayake, 2015). Therefore, proper waste management systems are necessary not only to minimize environmental impacts but also to support sustainable resource utilization and community-based economic development in coastal settlements.

Recent studies have highlighted the importance of circular waste management and resource recovery strategies in coastal communities as effective approaches to reducing environmental pollution while generating economic benefits. The utilization of fish processing waste through recycling, reuse, and value-added product development has been recognized as an important component of sustainable coastal management and environmental resilience. Furthermore, integrated waste management systems are increasingly considered essential for supporting sustainable coastal settlements and achieving the objectives of Sustainable Development Goal 11 (SDG 11) (Rahman et al., 2021; UN-Habitat, 2020).

In coastal settlements, waste management plays an important role in maintaining environmental sustainability. Poor waste management can reduce environmental quality and increase vulnerability to environmental pressures. The concept of

environmental resilience emphasizes the ability of a system to adapt and recover from environmental disturbances while maintaining its essential functions (Holling, 1973; Meerow & Newell, 2016). In the context of fishermen settlements, environmentally based fish waste management may contribute not only to pollution reduction but also to strengthening environmental resilience through cleaner settlement conditions, improved sanitation, and more sustainable community livelihoods.

Several studies have discussed the utilization of fish processing waste and the potential economic benefits of marine by-products (Kim & Mendis, 2006; Jayathilakan et al., 2012). However, most previous studies mainly focus on technological aspects of waste processing and industrial applications. Limited research has examined fish waste management within the context of fishermen settlements and its relationship with environmental resilience in coastal residential areas. In addition, previous studies rarely integrate environmental quality improvement, community-based waste management, and coastal settlement resilience into a single conceptual model.

Based on these considerations, this study aims to analyze the fish waste management system in fishermen settlements and to develop a community-based fish waste management model that supports environmental resilience in coastal settlements. The proposed model emphasizes waste segregation, waste treatment, and the utilization of fish processing waste as value-added products while integrating environmental management with sustainable coastal settlement development. Through this approach, fish waste management is expected not only to reduce environmental pollution but also to improve environmental quality, strengthen coastal environmental resilience, and provide potential economic benefits for coastal communities. This approach also supports the achievement of Sustainable Development Goal 11, which emphasizes the importance of sustainable cities and communities.

Figure 1. Conceptual Framework of the Fish Waste Management Model for Coastal Environmental Resilience

2. METHOD

This study employed a descriptive qualitative approach to analyze the fish waste management system resulting from fish processing activities in fishermen settlements. The study was conducted in Kejawan Lor Fishermen Settlement, Surabaya, Indonesia, which is characterized by intensive fish processing activities carried out by local coastal communities. The study focused on identifying the types of waste generated from fish processing activities and examining existing waste management practices implemented within the settlement.

Data were collected through direct field observations of fish processing activities and documentation of waste characteristics. Observations focused on fish processing practices, types of waste generated, waste disposal methods, and the potential utilization of fish waste as value-added products. Field observations were conducted directly in fish processing areas within the settlement to identify waste generation patterns, waste handling practices, and potential opportunities for waste utilization. The observed waste consisted of solid waste, including fish heads, bones, skin, and scales, as well as liquid waste originating from fish washing processes.

Secondary data were obtained from scientific publications, government reports, and previous studies related to fish waste management, environmental quality, and coastal environmental resilience. These references were used to support the identification of environmental issues and the development of the proposed waste management model.

Data analysis was conducted using descriptive qualitative analysis. The collected data were categorized according to waste type, waste management practices, environmental impacts, and utilization potential. The analysis further involved identifying existing environmental problems and synthesizing relevant concepts from previous studies to formulate a conceptual fish waste management model. The proposed model integrates waste segregation, waste treatment, and waste utilization strategies to improve environmental quality and strengthen coastal environmental resilience.

The development of the proposed fish waste management model was carried out by integrating the findings from field observations with relevant concepts derived from previous studies on waste management, environmental quality, and coastal environmental resilience. The model was designed to provide a conceptual framework for managing fish processing waste in fishermen settlements while supporting environmental sustainability and community-based economic benefits.

The resulting model emphasizes the relationship between waste generation, waste management practices, environmental quality improvement, and coastal environmental resilience as an integrated system within fishermen settlements.

Figure 2. Method

3. RESULTS AND DISCUSSION

3.1 Fish Processing Activities in Fishermen Settlements

Fishermen settlements not only function as residential areas for coastal communities but also serve as spaces for economic activities related to fish processing. Fish processing activities carried out by local communities generally include cleaning, cutting, washing, and processing fish into various processed products. These activities are commonly conducted within the residential environment, which consequently generates waste that directly interacts with the surrounding environment.

The fish processing process produces various types of organic waste originating from fish parts that are not utilized, such as fish heads, bones, scales, and leftover fish meat. In addition to solid waste, these activities also generate liquid waste resulting from washing fish and cleaning the equipment used during the processing process. If this waste is not properly managed, it may cause environmental problems such as unpleasant odors, deterioration of water quality, and potential pollution in residential environments.

Based on field observations conducted in the study area, fish processing activities in fishermen settlements are generally carried out using simple methods and are not supported by a structured waste management system. Direct disposal of fish processing waste into the surrounding environment was commonly observed, particularly for liquid waste generated from fish washing and processing activities. These observations indicate that waste management practices remain inadequate and may contribute to environmental quality degradation in coastal residential areas. Therefore, improving waste segregation, treatment, and utilization practices is necessary to support environmental sustainability in fishermen settlements.

3.2 Types and Characteristics of Fish Processing Waste

Waste generated from fish processing activities can generally be classified into two main types, namely solid waste and liquid waste. Solid waste consists of fish parts that are not utilized, such as heads, bones, skin, and fish scales. This type of waste contains relatively high levels of protein and minerals, which provides potential for further utilization as raw materials for other products.

Meanwhile, liquid waste originates from the fish washing process as well as wastewater generated during processing activities. If discharged directly into the environment without proper treatment, this liquid waste may increase the organic content in water bodies and create unpleasant odors in the surrounding residential environment.

The biodegradable nature of fish waste actually provides opportunities for further processing. Through simple waste management systems that are appropriate for coastal community conditions, this waste can be reused and processed, thereby not only reducing environmental pollution but also generating economic benefits for local communities.

Previous studies have also reported that fish processing waste contains high levels of organic material and has potential for reuse. Research conducted by Rustad et al. showed that by-products from the fisheries industry contain significant levels of protein and nutrients, making them suitable for further utilization as value-added products such as fish meal and animal feed (Rustad et al., 2011). This indicates that fish waste generated in fishermen settlements is not only a potential source of environmental pollution but also a resource that can be utilized to generate economic value.

Table 1. Types of Fish Processing Waste

Type of Waste	Source	Characteristics	Potential Utilization
Solid waste	Fish heads, bones, skin, scales	High protein and mineral content	Fish meal, animal feed, organic fertilizer
Liquid waste	Washing water and processing wastewater	Contains organic materials	Sedimentation ponds and biofilter treatment

Table 1 shows that both solid and liquid fish processing waste have the potential to be managed and utilized through appropriate treatment and recovery approaches, thereby reducing environmental impacts while generating economic benefits.

3.3 Fish Waste Management System in Fishermen Settlements

Fish waste management in fishermen settlements can generally be carried out through several main stages, namely waste segregation, waste processing, and utilization of processed products. The first stage that needs to be implemented is waste segregation based on its type, namely solid waste and liquid waste. Waste segregation is an important step to facilitate the processing stage and to reduce the potential environmental pollution caused by direct disposal of waste into the surrounding environment.

Solid waste such as fish heads, bones, skin, and leftover fish meat contains relatively high organic material and therefore has the potential to be reused. This type of waste can be processed into value-added products such as fish meal, animal feed, or organic fertilizer. The utilization of solid waste not only helps reduce the amount of waste disposed into the environment but also provides potential economic benefits for fishermen communities.

Meanwhile, liquid waste originating from fish washing processes and residual water from processing activities needs to undergo treatment before being discharged into the environment. Liquid waste treatment can be carried out through simple treatment systems such as sedimentation ponds or biofilters to reduce the organic content in the wastewater. Through this treatment process, the potential environmental pollution can be minimized so that the environmental quality of fishermen settlements can be maintained.

Based on the existing waste management conditions, it is necessary to develop an environmentally based fish waste management model that can be applied in fishermen settlements to improve environmental quality and support environmental resilience.

Figure 3. Existing Fish Waste Management System in Fishermen Settlements

3.4 Environment-Based Fish Waste Management Model

Based on the analysis of fish processing activities, waste characteristics, and existing waste management practices in fishermen settlements, this study proposes an environment-based fish waste management model. The model integrates waste segregation, waste treatment, and waste utilization strategies to reduce environmental pollution while creating economic benefits for local communities. The model emphasizes the separation of solid and liquid waste as the initial step to facilitate appropriate treatment and resource recovery processes. This approach is consistent with recent studies emphasizing circular economy principles and resource recovery strategies in coastal waste management systems (Rahman et al., 2021; Xia et al., 2024; Borthakur & Singh, 2023).

In the proposed model, solid waste such as fish heads, bones, skin, and scales can be processed into value-added products including fish meal, animal feed, and organic fertilizer. Meanwhile, liquid waste generated from fish washing activities can be treated through simple treatment systems such as sedimentation ponds or biofilters before being discharged into the environment. Through these approaches, environmental pollution can be reduced while supporting local economic development and improving environmental quality in fishermen settlements. These findings indicate that fish waste can be transformed into economically valuable resources while simultaneously reducing environmental impacts and supporting local community development (Rahman et al., 2021; Nurhayati et al., 2025).

The implementation of the proposed model may face several challenges, including limited waste treatment infrastructure, financial constraints, and community participation in waste segregation activities. Although the model has not yet been validated through field implementation, it provides a conceptual framework that can support future fish waste management programs in fishermen settlements. Further studies are recommended to evaluate the effectiveness of the model through pilot implementation and environmental performance assessment.

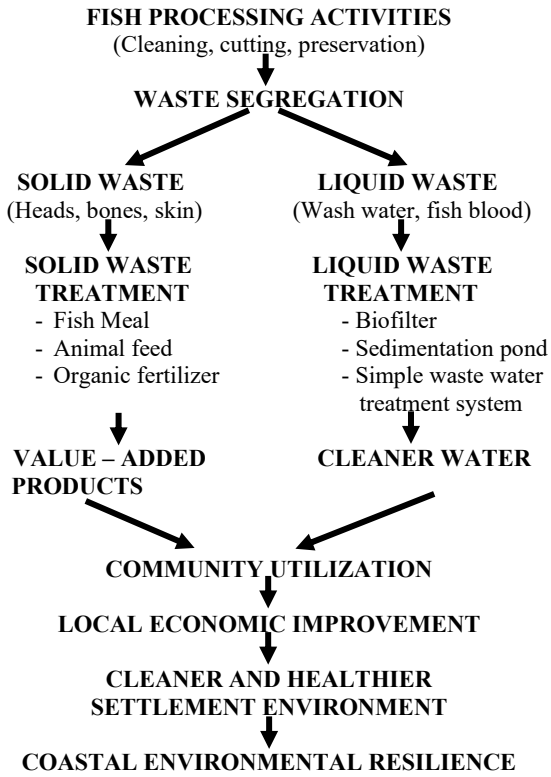

Figure 4. Environment-Based Fish Waste Management Model

3.5 Comparison With Previous Studies

Several previous studies have discussed the management of fish processing waste as an effort to reduce environmental pollution. A study by Arvanitoyannis and Kassaveti (2008) shows that fish processing waste has the potential to be reused as raw materials for value-added products such as fish meal, organic fertilizer, and animal feed. The utilization of such waste not only reduces the amount of waste discharged into the environment but also provides added value to local economic activities.

Another study conducted by Rustad et al. (2011) explains that fishery industry waste management can be carried out through the reuse of organic waste into more useful products. However, most of these studies tend to focus primarily on the technological aspects of waste processing and do not specifically examine the relationship between waste management and the environmental conditions of coastal settlements.

In contrast to previous studies, this research emphasizes the relationship between fish waste management, environmental quality improvement, and coastal environmental resilience in fishermen settlements. Unlike previous studies that primarily focus on waste processing technologies or industrial applications, this study integrates waste segregation, waste treatment, resource utilization, environmental quality improvement, and coastal environmental resilience into a single conceptual framework specifically developed for fishermen settlements. The proposed model positions fish waste as a recoverable resource that simultaneously supports environmental improvement and local economic development. This approach is aligned with the achievement of Sustainable Development Goal (SDG) 11 and highlights the practical role of community-based waste management in supporting sustainable coastal settlements.

The practical relevance of the proposed model lies in its applicability to small-scale fishermen settlements where waste management infrastructure is often limited. The model provides a simple framework that can be adapted by local communities to reduce environmental pollution while creating economic opportunities through fish waste utilization. Therefore, the proposed approach offers both environmental and socio-economic benefits that are directly relevant to the conditions commonly found in coastal residential areas.

Table 2. Comparison with Previous Studies

Researcher	Research Focus	Method / Approach	Findings	Differences from This Study
Arvanitoyannis & Kassaveti (2008)	Utilization of fish processing industry waste	Organic waste processing analysis	Fish waste can be utilized into products such as fish meal and animal feed	Examines waste management and environmental quality in settlements.
Rustad et al. (2011)	Fishery industry waste processing	Waste processing technology approach	Fish waste has economic potential if properly processed	This study adds the aspect of waste utilization within the context of fishermen settlements
Kim & Mendis (2006)	Utilization of fishery by-products	Fish by-product processing study	Fish waste can be utilized into value-added products	This study links waste management with environmental conditions in coastal settlements
This Study	Fish waste management in fishermen settlements	Descriptive analysis and waste management modeling	Produces a fish waste management model based on waste utilization and environmental quality improvement	Demonstrates the relationship between fish waste management, coastal environmental resilience, and its contribution to SDG 11

3.6 Contribution of Fish Waste Management to Environmental Resilience

Proper fish waste management can contribute significantly to improving environmental quality in coastal fishing settlements. Similar findings have been reported in recent studies examining environmental resilience and sustainable waste management in coastal settlements (Rahman et al., 2021; Nurhayati et al., 2025; Khalid et al., 2022). By reducing the amount of waste directly discharged into the environment, sanitation conditions within the settlement can be enhanced and the risk of environmental pollution can be minimized.

In addition, the utilization of fish waste as value-added products can strengthen the economic resilience of coastal communities. This economic benefit indirectly supports both environmental and social resilience, enabling communities to better cope with environmental and economic pressures.

Furthermore, fish waste management efforts are aligned with sustainable development principles that emphasize the importance of developing resilient and sustainable settlements. In this context, effective waste management practices can support the creation of cleaner, healthier, and more sustainable living environments, in line with the objectives of Sustainable Development Goal 11 (SDG 11).

Despite its potential benefits, the implementation of the proposed fish waste management model in fishermen settlements may face several practical challenges. Limited infrastructure for waste collection and treatment, insufficient financial resources, low community awareness regarding waste segregation, and limited institutional support can affect the effectiveness of the proposed management model. In addition, coastal settlements often experience environmental pressures such as flooding, tidal inundation, and inadequate sanitation facilities, which may further complicate waste management efforts. Therefore, collaboration among local governments, community organizations, and fishermen groups is essential to ensure the successful implementation of sustainable fish waste management practices.

4. CONCLUSION

This study demonstrates that fish processing activities in coastal fishing settlements generate both solid and liquid waste, which have the potential to cause environmental pollution if not properly managed. Solid waste such as fish heads, bones, and skin can be reutilized as value-added products, including fish meal, animal feed, and organic fertilizer. Meanwhile, liquid waste originating from fish washing processes can be treated using simple systems such as sedimentation ponds or biofilters prior to discharge into the environment.

This study proposes a fish waste management model based on waste segregation, treatment of solid and liquid waste, and the utilization of processed waste by the community. The implementation of this model has the potential to reduce environmental pollution while simultaneously providing economic benefits for coastal communities. In addition, improved fish waste management can enhance environmental quality in coastal settlements and strengthen environmental resilience in coastal areas.

The findings also indicate that integrating fish waste management into the spatial and environmental system of fishing settlements can contribute to the development of cleaner, healthier, and more sustainable residential areas, in line with the objectives of Sustainable Development Goal 11 (SDG 11).

Despite these findings, this study is limited by the absence of direct quantitative measurements of waste volume and waste characteristics. Therefore, the analysis remains descriptive and conceptual. Future studies are encouraged to incorporate quantitative approaches, including waste generation

measurements, environmental quality indicators, and economic feasibility assessments, to enhance the robustness and validation of the proposed model.

REFERENCES

Adger, W. N. (2000). Social and ecological resilience. *Progress in Human Geography*, 24(3), 347–364.

Arvanitoyannis, I. S., & Kassaveti, A. (2008). Fish industry waste: Treatments, environmental impacts and potential uses. *International Journal of Food Science &Technology*,43(4),726–745. https://doi.org/10.1111/j.1365-2621.2006.01513.x

Borthakur, A., & Singh, P. (2023). Circular economy and sustainable waste management in coastal communities: A review. Journal of Cleaner Production, 402, 136822. https://doi.org/10.1016/j.jclepro.2023.136822

Ghaly, A. E., Ramakrishnan, V. V., Brooks, M. S., Budge, S. M., & Dave, D. (2013). Fish processing wastes as a potential source of proteins. *American Journal of Environmental Sciences*, 9(4), 298–308.

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, 4, 1–23.

Jayathilakan, K., Sultana, K., Radhakrishna, K., & Bawa, A. (2012). Utilization of by-products and waste materials from meat, poultry and fish processing industries. *Journal of Food Science and Technology*, 49(3), 278–293. https://doi.org/10.1007/s13197-011-0290-7

Khalid, M., Ahmad, S., & Rahman, M. (2022). Environmental resilience and community-based waste management in coastal settlements. Sustainability, 14(18), 11672. https://doi.org/10.3390/su141811672

Kim, S. K., & Mendis, E. (2006). Bioactive compounds from marine processing by-products. *Food Research International*,39(4),383–393. https://doi.org/10.1016/j.foodres.2005.10.010

Meerow, S., & Newell, J. P. (2016). Defining urban resilience: A review. *Landscape and Urban Planning*, 147, 38–49. https://doi.org/10.1016/j.landurbplan.2015.11.011

Nurdiani, R., & Dissanayake, M. (2015). Sustainable use of marine resources: Turning waste into food ingredients. *International Journal of Food Science & Technology*, 50(11), 2329–2339. https://doi.org/10.1111/ijfs.12903

Nurhayati, A. P. D., Novitasari, E. D., Ruswandi, E., & Amin, M. (2025). Utilization of fish-processing waste as replacement of fish meal in aquafeed. *BIO Web of Conferences*.

Rahman, M., Hasan, M., & Islam, M. (2021). Fish waste recycling for sustainable coastal management. *Marine Pollution Bulletin*.

Rustad, T., Storrø, I., & Slizyte, R. (2011). Possibilities for the utilisation of marine by-products. *International Journal of Food Science and Technology*, 46(10), 2001–2014.

Shahidi, F. (2007). *Maximising the value of marine by-products*. Woodhead Publishing.

UN-Habitat. (2020). *Resilient cities and sustainable settlements*. United Nations Human Settlements Programme.

Venugopal, V. (2011). Marine products for healthcare applications. *Food Research International*, 44(1), 42–55. https://doi.org/10.1016/j.foodres.2010.09.033

Xia, A., Murphy, J. D., & Chen, Y. (2024). Resource recovery and circular economy approaches for organic waste management: Recent advances and future perspectives. Science of the Total Environment, 912, 169312. https://doi.org/10.1016/j.scitotenv.2023.169312

Yusuf, M., Maina, N. W., & Darodjat, T. A. (2024). Utilization of fishery waste product: The case of MSMEs in Central Java. *LAW & PASS Journal of Public Administration*.