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ANALYSIS OF THE EFFECTIVENESS OF VANNAMEI SHRIMP POND WASTEWATER TREATMENT SYSTEM ON SOCIO-ECONOMIC ASPECTS AT BBPBAP JEPARA: A CASE STUDY OF THE #SAVEKARIMUNJAWA MOVEMENT

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Abstract

The rapid expansion of *Litopenaeus vannamei* shrimp farming activities in the coastal region of Jepara Regency has significantly contributed to the growth of the aquaculture sector and local economic development. However, this growth has also generated serious environmental concerns due to inadequately managed shrimp pond wastewater discharged directly into coastal waters. This study aims to analyze the effectiveness of the shrimp pond wastewater treatment system implemented at the Brackish Water Aquaculture Development Center (BBPBAP) Jepara and to examine its socio-economic impacts on coastal communities, using the #SaveKarimunjawa movement as a case study. A qualitative descriptive research method with a case study approach was employed, supported by field observations, in-depth interviews. The analysis was conducted by interviewing local communities to determine the socio-economic impact of shrimp farm waste on their lives. The results indicate that the wastewater treatment system remains conventional and is limited to sedimentation and equalization stages. Although several water quality parameters such as temperature, salinity, and pH were within optimal ranges, low DO levels and elevated phosphate concentrations suggest that the effluent does not fully comply with environmental quality standards. These conditions contribute to coastal ecosystem degradation and declining community livelihoods, emphasizing the need for a more integrated and sustainable wastewater treatment system.

Keyword: *Shrimp Pond Waste, Social Economics, Quality, Vaname Shrimp, #savekarimunjawa, BBPBAP JEPARA*

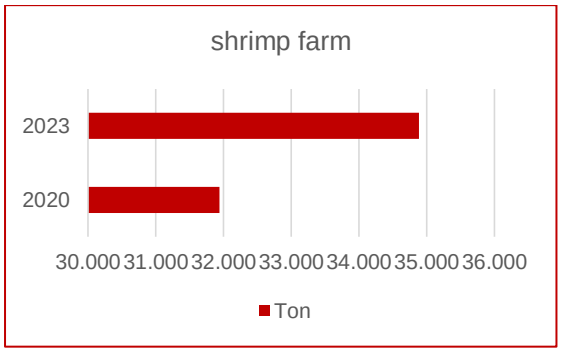
Introduction

Jepara is one of Indonesia's coastal regions with significant potential for fisheries development as a driver of local economic growth. One major utilization of this coastal potential is

aquaculture activities, particularly shrimp farming, which has become a leading sector in several coastal areas of Central Java (Sumantri et al., 2023).

According to data from Statistics Indonesia (BPS, 2023), shrimp aquaculture production in Central Java increased from 31,940 tons to 34,884 tons during the period from 2020 to 2023.

Table 1 Shrimp Farming Fishery Production



Source: BPS (2023)

The expansion of vannamei shrimp (*Litopenaeus vannamei*) farming activities in Jepara's coastal areas has made a tangible contribution to the growth of the aquaculture sector. Nevertheless, behind these economic benefits lies a serious environmental issue related to shrimp pond wastewater, which is often discharged directly into the sea (Utami, 2024). This wastewater primarily originates from uneaten feed, shrimp feces, and residual chemicals used in intensive farming practices. High concentrations of nitrogen, phosphorus, and dissolved organic matter can trigger eutrophication and degrade marine ecosystems if not properly managed.

Public concern regarding shrimp pond pollution in Jepara has intensified alongside the emergence of the #SaveKarimunjawa social movement. This movement highlights the negative impacts of shrimp farming on coral reefs, marine biota, and coastal tourism. The phenomenon reflects increasing public awareness of the interconnection between economic activities and environmental sustainability (Greenpeace, 2023).

As a government institution, the Brackish Water Aquaculture Development Center (BBPBAP) Jepara plays a strategic role in promoting sustainable shrimp pond wastewater management. Therefore, this study is essential to evaluate the effectiveness of the wastewater treatment system implemented at BBPBAP Jepara and to assess its socio-economic impacts on surrounding coastal communities. The objectives of this research are to evaluate the effectiveness of shrimp pond waste utilization, assess the applied wastewater treatment system, and analyze its socio-economic impacts on local communities.

Literature Review

This study is based on several theoretical frameworks relevant to shrimp pond waste management. Effectiveness theory is used to assess the extent to which a system achieves its desired objectives. According to Steers (2013), the effectiveness of a system can be measured based on the extent to which the expected output is achieved using the available resources. (Cameron, 2010). In her 2022 book, Purwanti states that effectiveness is how well a job is done, the extent to which someone produces the expected output. Effectiveness means success in achieving predetermined goals. If the results of an activity are closer to the goal, it means that the effectiveness is higher, and vice versa. (Purwanti, 2022). In the context of shrimp pond waste management, the effectiveness of a waste treatment system can be assessed based on its ability to reduce

nutrient and organic matter loads, improve effluent water quality, and minimise the impact of pollution on the aquatic environment and surrounding communities in accordance with the objectives of sustainable waste management.

The 4R principle (Reduce, Reuse, Recycle, and Replant) is a sustainable waste management theory that is relevant to shrimp farm waste treatment systems. Reduce is applied to minimise waste accumulation at source. Reuse involves reusing items that are still usable for the same or different functions. Recycle processes waste into new products with economic value. Meanwhile, Replant replaces single-use items with environmentally friendly alternatives. (Lestari et al., 2020)

Waste treatment system theory emphasises the importance of an integrated approach to shrimp pond waste management, including sedimentation, biofiltration, and closed-loop recycling systems. Such an integrated approach has been proven effective in reducing the nutrient load and organic matter released into the aquatic environment.

From a social perspective, socio-economic theory explains that an economic activity can have positive or negative impacts on parties other than the main actors involved in the activity. (Sudariyanto, 2019). The theory of socio-economic impact is used to understand how economic activities affect community welfare. Poorly managed shrimp pond waste can reduce fishermen's income and disrupt coastal tourism activities.

Research Method

This study employed a qualitative descriptive method with a case study approach focusing on the #SaveKarimunjawa trend. This approach was chosen to obtain an in-depth understanding of shrimp pond wastewater management systems and their impacts on coastal communities. The case study method allows for contextual and comprehensive exploration of the phenomenon.

The research stages included direct observation and in-depth interviews at BBPBAP Jepara with Fishermen and Local Residents. Observations were conducted to identify wastewater treatment flows, while interviews were conducted with pond managers and surrounding communities. Socio-economic data were collected to assess the impact of pollution on community income and livelihoods. Data analysis was conducted using triangulation techniques to enhance the validity of the research findings.

Data collection involved parameter testing, including proximate testing and physicochemical water quality analysis. Proximate testing was conducted to determine the main components contained in shrimp pond wastewater, including temperature, DO, BOD, pH, alkalinity, transparency, total suspended solids, salinity, ammonia, nitrate, nitrite, phosphate, *Vibrio*, Hg, and Pb. The results of proximate testing aimed to ensure that shrimp pond wastewater in Jepara poses serious environmental impacts (Janna et al., 2022).

Physicochemical water quality testing is a quantitative measurement method for environmental parameters that affect the life of aquatic organisms, including vannamei shrimp. The main parameters include temperature, dissolved oxygen (DO), pH, transparency, and salinity. The results of physicochemical analysis were used to evaluate whether water conditions remained within optimal ranges for shrimp growth. Fahrurrozi showed that temperature stability between 28–32°C, DO above 4 ppm,

and salinity of 25–35 ppt positively influence the survival of vannamei shrimp in intensive ponds. The ideal pH value ranges from 7.5–8.5, with transparency of 30–40 cm indicating a balance between light penetration and plankton growth (Fahrurrozi et al., 2023).

Farkan, Mulyono, and Novriadi (2023) explained that water quality is also determined by plankton abundance and water turbidity. Low DO values or extreme pH can reduce biological activity and cause stress in shrimp. Plankton management and water circulation are key indicators of pond productivity (Farkan et al., 2024). Kurniaji (2023) added that variations in water quality are strongly influenced by water exchange patterns and aeration systems. Stable DO, temperature, and pH values show a direct correlation with the specific daily growth of vannamei shrimp (Kurniaji et al., 2024).

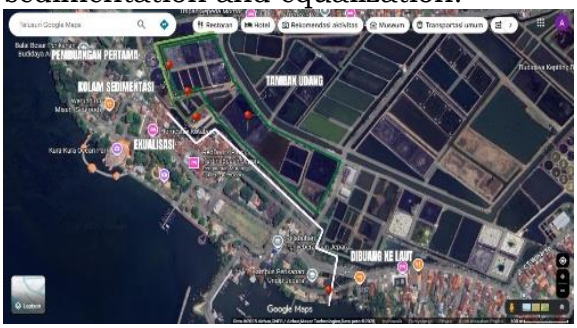
However, the equalized water still causes fish mortality and marine ecosystem damage, indicating that the wastewater still contains harmful substances if discharged directly into the sea.

BBPBAP Jepara still uses conventional fish feed based on fishmeal, which relies on limited resources and has the potential to damage marine ecosystems (Sinaga et al., 2025). Internal survey results and interviews show that shrimp pond wastewater causes coral reef damage, seaweed pollution, and fish mortality (Greenpeace, 2023).

Site selection for shrimp farming is crucial to meet technical requirements from both environmental and land

Research Results

Based on the results of research and development analysis through observation and interviews at BBPBAP Jepara, it was found that shrimp pond wastewater management at the site has not yet operated optimally. Currently, the treatment process consists of only two stages sedimentation and equalization.



Source: Google Earth

Figure 1. waste treatment stage

At the sedimentation stage, shrimp pond wastewater is channeled into sedimentation ponds to undergo a settling process. Subsequently, the sedimented water is transferred to an equalization pond before being discharged directly into the sea. perspectives. The desired site selection criteria for shrimp farming activities are presented in Table 2.

Table 2. Soil Characteristics

NO	Component	Optimal Range
1	Soil Type	Sandy loam (70:30)
2	Soil pH	6,5 – 8,0
3	Organic Matter	3 – 5 %
4	NH_3	0,05 – 0,25 ppm

Source: BBPBAP JEPARA

Based on interviews with coastal communities in Jepara, it was found that shrimp pond wastewater greatly affects community life in socio-

economic aspects. Fish mortality, coral reef destruction, and marine ecosystem pollution due to direct discharge of shrimp pond wastewater into the sea have disrupted the livelihoods of coastal communities who predominantly depend on marine resources (Mustofa, 2017).

Discussion

Based on research findings and observational data at the Brackish Water Aquaculture Development Center (BBPBAP) Jepara, the shrimp pond wastewater management system at the site remains suboptimal and predominantly conventional. The current process involves only two main stages, namely sedimentation and equalization, in which wastewater from shrimp ponds is first channeled into sedimentation ponds to separate solid particles, then directed to an equalization pond to stabilize organic content before being discharged directly into the sea. However, observations indicate that water from the equalization pond, when reused for fish maintenance, still causes fish mortality, indicating that harmful substances such as ammonia, nitrite, and organic matter remain above safe thresholds. This condition is reinforced by water quality testing results showing dissolved oxygen (DO) levels ranging from 3–3.5 ppm, far below optimal standards (≥5 ppm), reflecting low oxygen saturation for marine biota. These findings demonstrate that the existing system has not been able to effectively reduce pollutant loads and does not comply with marine water quality standards stipulated in the Decree of the Minister of Environment No. 51 of 2004.

Kusumaningsih (2006), in a study conducted at Airlangga University on tiger shrimp grow-out management using a closed recirculation system at BBPBAP Jepara, explained that recirculation systems had been tested but not fully implemented due to limitations in resources and infrastructure. This system involves biofilters and ozonation technology to reduce waste loads but has not been widely adopted. Similar findings were reported by Vrananta, Soedarsono, and Afiati (2020) in the *Journal of Aquatic Resource Management*, showing that high organic matter content in pond sediments increases heterotrophic bacterial populations that consume dissolved oxygen, thereby deteriorating water quality around BBPBAP Jepara (Budi Dermawan, 2023). These facts confirm that wastewater treatment relying solely on sedimentation and equalization is insufficient to reduce excess nutrients such as nitrogen and phosphate, which can lead to eutrophication in Jepara's coastal waters.

From the perspective of system effectiveness theory as described by Steers (2013) and Martz (2013), effectiveness is measured by the extent to which a system achieves its objectives using available resources. In this context, the objective of wastewater management at BBPBAP Jepara is to maintain environmental sustainability and minimize marine pollution. However, based on field evidence and water quality parameters, the system has not been effective, as it continues to produce effluent with high organic content, lacks advanced biofiltration stages, and is associated with ongoing fish mortality and coral reef degradation. According to Nur (2023) in *Aquaculture Engineering*, the effectiveness of shrimp pond wastewater treatment systems depends heavily on integrating physical-chemical technologies (sedimentation, ozonation) with

biological processes (phytoremediation, biofiltration), which have not yet been fully implemented at BBPBAP Jepara (Burhani Marda et al., 2023). Therefore, both technically and ecologically, the wastewater treatment system remains at a basic level and requires innovation to achieve higher effectiveness.

From a socio-economic perspective, this study demonstrates significant impacts on coastal communities in Jepara. Interviews revealed that untreated shrimp pond wastewater discharge causes marine pollution, leading to fish mortality, coral reef damage, and seaweed contamination, which ultimately reduce fishers' catches and incomes. These impacts also extend to the marine tourism sector, as polluted coastal waters diminish the attractiveness of beach destinations. These findings are consistent with global research by Primavera (2006) in *Ocean & Coastal Management*, which reported that poorly managed shrimp pond waste can cause environmental degradation, social conflict, and declining coastal community welfare. Paul and Vogl (2011) similarly found that shrimp farming pollution in Bangladesh resulted in decreased local fishers' income and damaged coastal ecosystems. Erlina (2006) further reported declining primary productivity in waters surrounding BBPBAP Jepara due to increased nutrient loads, directly affecting fishery yields.

Overall, these findings indicate that shrimp pond wastewater management at BBPBAP Jepara remains partial and insufficiently integrated from both ecological and social perspectives. The treatment process is limited to physical settling without adequate biological treatment, resulting in low effectiveness in reducing pollution. The impacts are not only ecological but also directly affect the socio-economic well-being of coastal communities, particularly fishers and coastal tourism actors. Therefore, the implementation of an integrated wastewater treatment system combining sedimentation, biofiltration, phytoremediation, and water recirculation is essential to achieve environmental sustainability and improve the socio-economic welfare of surrounding communities (Enika Kusumaningsih, 2016). Thus, the processing of shrimp pond waste at BBPBAP JEPARA is not yet optimal and requires an advanced processing system before it is finally discharged into the sea.

Conclusion

Based on the results of the study, it can be concluded that the shrimp pond wastewater treatment system implemented at the Jepara Brackish Water Aquaculture Development Centre (BBPBAP) has not been effective in supporting environmental sustainability and the socio-economic welfare of coastal communities. The treatment system, which is currently limited to sedimentation and equalisation, has not been able to reduce pollutants, such as organic matter, ammonia and phosphate, to meet the established marine water quality standards. Low dissolved oxygen (DO) levels and the continued death of marine life indicate that wastewater discharged into coastal waters still has the potential to cause negative impacts on the marine ecosystem.

In addition to its ecological impact, the suboptimal management of shrimp farm waste also has a significant socio-economic impact on coastal communities in Jepara. Marine pollution, coral reef damage,

and declining fish catches have led to a decrease in income and disruption to the livelihoods of fishermen and marine tourism operators. This situation is in line with the aspirations voiced through the #SaveKarimunjawa movement, which demands more environmentally friendly shrimp farm management. Therefore, this study emphasises the need to implement a more integrated and sustainable waste treatment system, through the addition of biofiltration, phytoremediation, and water recirculation systems, in order to protect the coastal ecosystem while improving the socio-economic welfare of the surrounding community.

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