

INSTITUTIONAL PERSPECTIVE IN SHRIMP POND WASTE MANAGEMENT IN CV CHANDRA PERDANA ABADI, PESAWARAN REGENCY

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ABSTRACT

Waste management in vannamei shrimp cultivation is an important aspect to maintain a balance between the sustainability of fishery production and the preservation of the coastal environment. This study aims to analyze the management of vannamei shrimp pond waste in Pesawaran Regency from an institutional perspective. Data collection through in-depth interviews, documentation studies, and wastewater quality tests. The data were analyzed using institutional analysis and wastewater quality testing in the laboratory. The results of the study show that the company's waste management system has a strong institutional basis and complies with national regulations, especially the Ministry of Marine Affairs and Fisheries Regulation No. 15 of 2022 concerning national guidelines for the development of region-based vannamei shrimp cultivation, Minister of Environment Regulation No. 4 of 2021 concerning the list of businesses or activities that are required to have an EIA and environmental monitoring efforts, and Minister of Environment Regulation No. 1 of 2025 concerning shrimp farming wastewater treatment. The application of Wastewater Treatment Plants (WWTP) is able to reduce most pollutant parameters to meet environmental quality standards, such as pH, DO, TDS, ammonia, nitrites, nitrates, and sulfides. However, the increase in BOD and phosphate values indicates the need to optimize organic waste and nutrient treatment systems. In addition, it is necessary to add a WWTP pond to the Block B unit to support the overall waste treatment capacity. Coordination between government policies and supervision, as well as the participation of business actors are important factors to realize sustainable and environmentally friendly vannamei shrimp cultivation.

Keywords: Institutional, Policy, Vannamei Shrimp Cultivation, Waste Management, WWTP.

INTRODUCTION

The cultivation of vannamei shrimp (*Litopenaeus vannamei*) is an important sub-sector in the global fisheries industry, including in Indonesia, due to its contribution to increasing the production and export of fishery products (Wang *et al.* 2020). In Indonesia, vannamei shrimp is the leading export commodity and seafood product with the fastest demand growth in the global market (KKP, 2022). This market growth encourages the rapid development of cultivation, both traditionally and through intensive systems that apply sustainable technological innovations (Prawitasari & Rafiqie, 2022).

Intensive vannamei shrimp cultivation activities produce various types of waste, both organic and inorganic, which come from feed residues, shrimp feces, as well as residues of chemicals and medicines used in the maintenance process (Nguyen *et al.* 2024). These wastes have the potential to reduce water and soil quality around ponds, as well as affect coastal ecosystems if not managed properly (Wafi *et al.* 2024). The accumulation of organic matter at the bottom of the pond can also trigger eutrophication and reduce the carrying capacity of the aquatic environment (Liu *et al.* 2024). Therefore, waste management is an important aspect in efforts to maintain the sustainability of vannamei shrimp cultivation, especially in coastal areas

that are sensitive to changes in environmental quality (Mustafa *et al.* 2016).

In the context of aquaculture, waste management is an important aspect to maintain a balance between the sustainability of fishery production and the preservation of the coastal environment. This not only covers the technical aspects of waste treatment, but also involves the institutional role in regulating, supervising, and facilitating the implementation of sustainable aquaculture practices (Rosyidah *et al.* 2020).

Institutions are formal and informal rules that regulate social and economic interactions (North, 1990). In the context of pond management, institutions function as key elements that affect the effectiveness of resource management and the preservation of the coastal environment (Partelow *et al.* 2018, Airawati *et al.* 2023). Based on this, this study aims to analyze the management of vannamei shrimp pond waste from an institutional perspective.

RESEARCH METHODS

This research will be carried out in June-October 2025 at CV Chandra Perdana Abadi (CPA) located in Hanura Village, Teluk Pandan District, Pesawaran Regency. Data collection was carried out by means of in-depth interviews, documentation studies and testing of pond wastewater samples. In-depth interviews were conducted with the pond management to obtain information related to waste management in cultivation activities. The data obtained was then studied using institutional analysis, namely situation, structure, behavior and performance (Schmid, 2008, Nugroho, 2016). Structure is a formal and informal rule that regulates wastewater quality standards. Performance can be studied from water quality analysis conducted at the UPTD Laboratory of the Lampung Provincial Environmental Agency. The parameters tested include pH, DO (Dissolved Oxygen), TDS (Total Dissolved Solid), BOD (Biochemical Oxygen Demand), Ammonia, Nitrite, Nitrate, Sulfide, and Phosphate.

RESULTS AND DISCUSSION

Situation

Pesawaran is one of the districts located in Lampung Province. The region has a coastline of 96 km (BPS, 2023). This district holds great potential in the fisheries and marine sector (Panalaran & Pamungkas, 2024). The waters of Pesawaran have four bays, namely Hurun Bay, Ratai Bay, Punduh Bay and Pidada Bay (Widiarti *et al.* 2024)

Teluk Hurun is located in Teluk Pandan District, Pesawaran Regency with an area of 5 km² (Widiarti *et al.* 2024). The bottom of the bay waters in the southwestern and southern parts is generally sloping with a depth of less than 5 m, and the northern part is covered by mangrove forests. Hurun Bay has one river that empties into the waters of the gulf, namely the Hurun River. Many activities of the population are carried out around the river which can affect the quality of the bay's waters (Putri *et al.* 2021).

In Hurun Bay, various fishery activities have also developed, such as pearl shellfish cultivation, shrimp cultivation, fish farming in floating net cages and marine tourism activities. CV CPA is one of the cultivation actors operating in the region (Figure 1). The company has been established since 1992 and is engaged in the field of vannamei shrimp breeding.

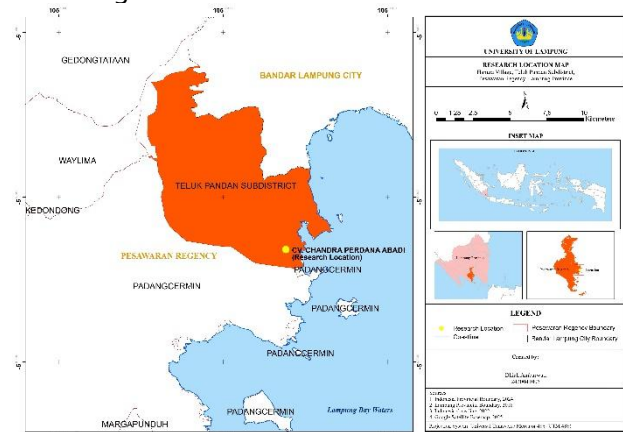


Figure 1. Research location

Structure

The Ministry of Marine Affairs and Fisheries (KKP) through the Decree of the Minister of Marine Affairs and Fisheries Number 15 of 2022 establishes national guidelines for the development of region-based vannamei shrimp cultivation. This regulation is a strategic foundation in the development of the national shrimp farming sector that balances between increasing productivity and preserving coastal ecosystems. The area-based approach is an integrated pond management system from upstream to downstream in one coastal area that has ecological, technical, and socio-economic suitability (KKP, 2022). This Ministry decree requires business actors to provide environmental management infrastructure, such as wastewater treatment plants (WWTP) and water recirculation systems, to prevent pollution of the waters around cultivation areas.

In addition to the Decree of the Minister of Marine Affairs and Fisheries Number 15 of 2022, the Minister of Environment Regulation Number 4 of 2021 concerning the List of Businesses or Activities That Must Have an Environmental Impact Analysis (EIA) and Environmental Monitoring Efforts (UPL) are the main legal basis in all activities that have the potential to have an impact on the environment, including fisheries aquaculture activities. This regulation comprehensively regulates various aspects of licensing, supervision, and law enforcement to ensure that every economic activity runs in harmony with the principles of environmental sustainability.

In addition, the Minister of Environment Regulation Number 4 of 2021 requires the preparation of environmental management documents such as AMDAL, UKL-UPL, or SKKL (environmental feasibility decree) in accordance with the business scale, which must contain a WWTP system and effluent quality monitoring to be in accordance with quality standards (Minister of Environment Regulation No. 5 of 2014 concerning Wastewater Quality Standards, and Minister of Environment Regulation No. 1 of 2025 concerning Shrimp Farming Wastewater Treatment).

The synergy between these two regulations emphasizes that each cultivation area must be equipped with a WWTP that meets environmental quality standards and has a valid liquid waste disposal permit. Collaboration between fisheries technical policies and environmental regulations is expected to form an institutional system of vannamei shrimp cultivation that is transparent, accountable, and oriented towards the sustainability of coastal ecosystems.

Behaviour

At the beginning of its operations, CV CPA only had one production unit, namely Block A, which consisted of 13 cultivation ponds and 1 reservoir pond with soil construction. In 2005, the company converted the construction of the pond to concrete to improve the efficiency and durability of the cultivation facility. Along with the increase in production capacity, in 2016 the company added its operational area through the construction of Block B with land construction, which includes 13 cultivation ponds and 5 reservoir ponds. As an effort to improve the sustainability of the cultivation system, Block A was then renovated so that it has 13

cultivation ponds, 6 reservoir ponds, and 3 WWTP ponds, while Block B now consists of 10 cultivation ponds and 4 reservoir ponds (Figure 2).

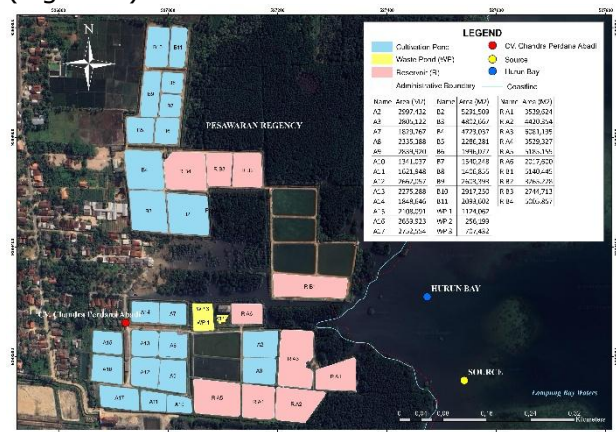


Figure 2. Pond layout

In the implementation of cultivation, CV CPA implements efforts to process waste from pond cultivation using a settling system in WWTP ponds. This is one of the management's efforts to maintain water quality in aquaculture ponds and in the aquatic environment around the location.

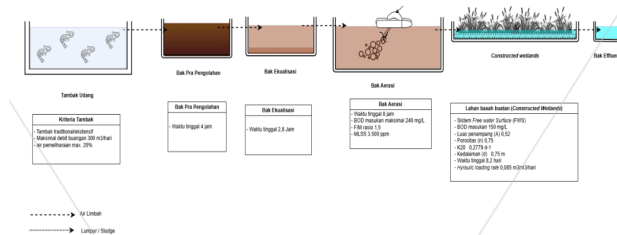
The WWTP system in the research pond consists of three ponds with different functions. The first pond acts as a sedimentation unit that functions to lower suspended solids through gravity deposition. At this stage, bioremediation is applied by planting mangroves around the pond to increase the absorption of nutrients and heavy metals naturally. In accordance with research (Ahmad *et al.* 2017) mangroves function as natural filters that filter solid particles and pollutants through roots and sedimentary substrates. The second pond functions as a biological processing unit, where the process of oxidation of organic matter by aerobic microorganisms and nitrification of ammonia compounds takes place. The third pond acts as a storage unit (equalization) to stabilize the quality of effluent before it is released into sea waters to meet applicable environmental quality standards.

The WWTP component in this study has not functioned optimally in accordance with the technical guidelines for shrimp farming WWTP (KKP, 2019), Regulation of the Minister of Environment Number 1 of 2025, as well as the implementation of good WWTP Standard Operating Procedures (SOP) (Purnomo *et al.* 2022). In general, WWTP in the intensive shrimp pond system consists of four main components (Figure 3):

1. The first pond functions as a sedimentation unit to reduce the total level of suspended

solids (TSS) and reduce odors due to H₂S gases, while the sediments formed are used as fertilizer.

2. The second pond acts as an oxygenation unit, where wastewater experiences an increase in dissolved oxygen levels to reduce the BOD value.
3. The third pond functions to convert nutrients into forms that support biological productivity (eutrophication) for aquatic organisms.
4. The fourth pond acts as the final reservoir unit before the treated water is discharged into the sea waters.



Source: Minister of Environment Regulation No. 1 of 2025

Figure 3. Wastewater treatment plant (WWTP)

Performance

Testing of the physical, chemical, and biological parameters of vannamei shrimp pond wastewater was carried out to assess the effectiveness of WWTP performance. The analysis was carried out on WWTP effluent in 2024 and 2025, then compared with the quality standards of liquid waste from aquaculture based on the Regulation of the Minister of Environment No. 5 of 2014 and No. 1 of 2025. The test results presented in Table 1 are the basis for evaluating the performance of WWTP in reducing the pollutant load from cultivation activities.

Table 1. WWTP water sample test results

Water quality parameters	Test results 2024	Test results 2025	Quality standards
pH	6,8	7,2	6,0-9,0**
DO (mg/l)	5	4	>4*
TDS (mg/l)	304	115	<1000*
BOD (mg/l)	7	10	<50**
Amonia (NH ₃) (mg/l)	0,5	0,4	<5**
Nitrite (NO ₂) (mg/l)	0,01	0,02	<2,5*
Nitrate (NO ₃) (mg/l)	0,4	0,1	<75*
Sulphide (H ₂ S) (mg/l)	0,011	0,002	<0,03*

Phospat (PO ₄ -P) (mg/l)	0,1	1	<0,5**
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Description: - Testing of water quality parameters at the UPTD Laboratory of the Lampung Provincial Environmental Agency

- * Minister of Environment Regulation No. 5 of 2014

- ** Minister of Environment Regulation No. 1 of 2025

The results of the effluent water quality test for vannamei shrimp ponds in 2024 and 2025 show variations in several parameters. The pH value ranges from 6.8–7.2, still within the standard limit of wastewater quality 6.0–9.0, so that the acidity condition of the water is relatively stable and safe for the aquatic environment (Minister of Environment Regulation No. 1 of 2025). pH parameters play an important role in chemical processes, physiological functions of biota, and toxicity levels of ammonia compounds. During the cultivation process, the pH can be affected by the use of lime and chemicals (Ziad, 2012).

The DO concentration in 2024 is recorded at 5 mg/L and decreases to 4 mg/L in 2025. This decline is thought to be due to an increase in suspended solids or the activity of organisms such as phytoplankton, zooplankton, and other aquatic biota (Legasari *et al.* 2023). Despite the decrease, the DO value is still above the minimum threshold (>4 mg/L), so that WWTP effluent is still able to support the sustainability of aquatic biota.

TDS values have decreased from 304 mg/L in 2024 to 115 mg/L in 2025, and both are still well below the maximum threshold of 1000 mg/L, so they do not have the potential to degrade the quality of the waters. High concentrations of TDS are known to cause mortality in aquatic organisms, especially marine fish (Faridah *et al.* 2021), and inhibit the activity of microorganisms in the nitrogen conversion process (Dinh, 2017).

The BOD parameter has increased from 7 mg/l in 2024 to 10 mg/l in 2025, this value is still below the maximum quality standard limit of 50 mg/l. This increase indicates an increased load of organic waste that requires oxygen for decomposition, potentially threatening the quality of aquatic ecosystems and leading to the mass death of oxygen-sensitive organisms (Akinawo, 2023).

Ammonia concentration (NH₃) and nitrites (NO₂⁻) in both test periods were recorded to be below the threshold, <0.1 mg/L and <2.5 mg/L, respectively, indicating the absence of accumulation of toxic nitrogen

compounds in the system. Meanwhile, nitrate (NO_3^-) levels decreased from 0.4 mg/L in 2024 to 0.1 mg/L in 2025, still far below the maximum quality standard of 75 mg/L. This condition shows that the nitrification process in the WWTP unit is effective, characterized by optimal nitrification microorganism activity in oxidizing ammonia into nitrites, then becoming nitrates under aerobic conditions (Zhang et al. 2023)

Phosphate concentrations (PO_4^{3-}) increased significantly, from 0.1 mg/L in 2024 to 1 mg/L in 2025. Although it is still within the quality standard limit (0.1–5 mg/L), this upward trend must be watched out for because the accumulation of phosphate can trigger eutrophication in water bodies. This increase generally comes from feed residues and feces of aquaculture organisms, so feed management and WWTP efficiency are important to prevent increased nutrient load in the waters. (Prasetyono et al. 2022).

Hydrogen Sulfide Content (H_2S) showing a decrease from 0,011 mg/L in 2024 to 0,002 mg/L in 2025, this shows that the water conditions in the WWTP system are relatively not subjected to excessive reductive processes. This value indicates an aerobic dominant environment with a low potential for the formation of toxic gases that can interfere with biota and biological processes of waste treatment. Hydrogen sulfide is toxic when non-ionized and harmful in low pH and anaerobic conditions (Sumaryati et al. 2024).

Overall, the tests showed that the vannamei shrimp pond WWTP was able to treat physical and chemical waste well for the parameters of pH, DO, TDS, nitrogen, and Hydrogen sulfide. However, controlling BOD levels and increasing phosphate that is close to or exceeding the quality standard limit is still a challenge, so continuous improvement and supervision are needed to maintain effluent quality according to environmental standards and support the sustainability of shrimp farming.

CONCLUSION

The management of vannamei shrimp pond waste at CV Chandra Perdana Abadi (Block A) has referred to national regulations, especially the Ministry of Environment Regulation No. 15 of 2022, the Minister of Environment Regulation Number 4 of 2021 and the Minister of Environment Regulation No. 1 of 2025. The application of WWTP is able to reduce most pollutant parameters to meet environmental quality standards. However, the increase in BOD and phosphate values

indicates the need to optimize organic waste and nutrient treatment systems. CV Chandra Perdana Abadi is expected to need to add a WWTP pond in the Block B unit to support the overall waste treatment capacity. In addition, synergy between government policies and supervision, as well as the participation of business actors is an important factor to realize sustainable and environmentally friendly vannamei shrimp cultivation.

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