Strengthening the Spatial Quality of Fishpond towards Disaster Mitigation on the Urban Riparians of Meureudu River, Indonesia

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ABSTRACT

Meureudu City center, which is located on the riverfronts of Meureudu River, Pidie Jaya Regency continues experienced rapid urban development caused dramatic changes in the land use. Developments that occur in this area must be controlled strictly, given often conflicting management and use of land, especially between cultivation activities for the economic improvement of local community and interests of the environmental protection. Conflicting interests in land use in urban area, especially for fishpond cultivation as productive land for the local community, which partly utilizes river borders, riparian corridors, and green open spaces which in the RDTR (Detailed Spatial Planning) of Meureudu District are buffer areas that need to remanage. The knowledge about the potential fishpond is important to ensure the ecological stability of the area in terms of restoration of riparian corridors. Implementing sustainable management of the fishpond land layout is a must, because this area is vulnerable to flash floods, tsunamis, and strong winds. This study aims to examine the development of sustainable fishpond land management and be able to play a role in local disaster mitigation. This research uses a descriptive qualitative approach method. Management strategy analysis was carried out using the SWOT (Strengths, Weaknesses, Opportunities, and Threats) method. The results of the research are; strategies to improve the spatial quality of fishponds that are multifunctional, in addition to having sustainable productive functions and are also capable of disaster mitigation.

Keywords: Disaster mitigation, fishpond, spatial quality, sustainability, urban riparian.

INTRODUCTION

The geographical location Pidie Jaya Regency is at 4°54' 15,702"N to 5° 18' 2.244" N and 96°1' 13.656"E to 96°22'1.007"E. Topographically, Pidie Jaya Regency is located at an altitude of 0 m to 2,300 m above sea level with a land slope of 0 to 40%. The utilization of fishpond land in the Meureudu sub-District, Pidie Jaya Regency, Aceh Province, Indonesia almost stretches across the north side of the river and coast with an area of approximately 116.9 Ha (Pidie Jaya in Figures, 2014). Meanwhile, the existence of mangrove forests as fringe vegetation that can maintain the survival of marine ecosystems is difficult to find, because of the tendency to shift functions to aquaculture. The main cause of the loss of mangrove forests according to (Duke et al., 2007), is conversion to fish and shrimp aquaculture lands, as well as artisanal fisher folks caused of the extinction of mangrove forests.

According to the local fishery office, fishpond yields have increased. For this reason, the change to aquaculture land for the local community is felt like a very profitable decision, considering the results obtained from the aquaculture land are larger even though they have to sacrifice the local environment.

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Whereas the function of mangroves is very important to support human life and to realize the welfare of the community, even mangroves also provide food for a number of important organisms such as crustaceans and mollusks, protect the coasts, nutrient processing, and processing organic matter or sediment deposition (Polidoro et al., 2010). Even the existence of mangrove ecosystems plays an important role for local and national economies in tropical coastal areas (Warren-Rhodes et al., 2011). Moreover, the shift in the economy and work orientation from agricultural and river-based economies to land-based activities is slowly moving people away from dependence on rivers (Setiadi & Kusliansjah 2021). Today, fishpond activities are becoming very popular in the area of Meureudu City.

Natural disasters continue to strike urban areas worldwide. Indonesia waterfront cities face a range of natural disasters, particularly floods, flash-flood, earthquakes, and storms, as well as tsunamis. Rapid urbanization brings greater risk of flooding impacts in urban waterfront areas, the increase in population will also increase the demand for housing facilities in the area and this will cause many new areas to be explored (Othman et al., 2021). The area of Meureudu City often experiences flash-floods and overflows of river water which have a negative impact, especially on the yield of ponds (Figure 1). Moreover, it is also known fact that local wisdom inherited from past generations who survived disasters would serve as precious knowledge with the potential to increase the capability of having a better and safer built environment (Rauzi & Aulia, 2022). Mangroves planting which plays a role in maintaining the stability of beaches and riverbanks from erosion as well as balancing environmental quality needs to be encouraged again because there are many benefits that can be felt by the community and the local environment. In addition, the beauty of the beach and riverside views in the City of Meureudu is also an attraction for local people to visit. This condition is an opportunity to improve facilities in the area around the mangrove ecosystems. Sustainable management of pond land needs to be considered for implementation. According to Sambu [5], indirectly there are two values of using mangrove ecosystems, namely: (1) indirect use of values in physical forms such as barrier abrasion, seawater intrusion, protection from tornadoes and (2) breeding grounds, growing places, food and shelter as well as a provider of organic matter for shrimp, fish and other biota living in the mangrove ecosystems and its surroundings.

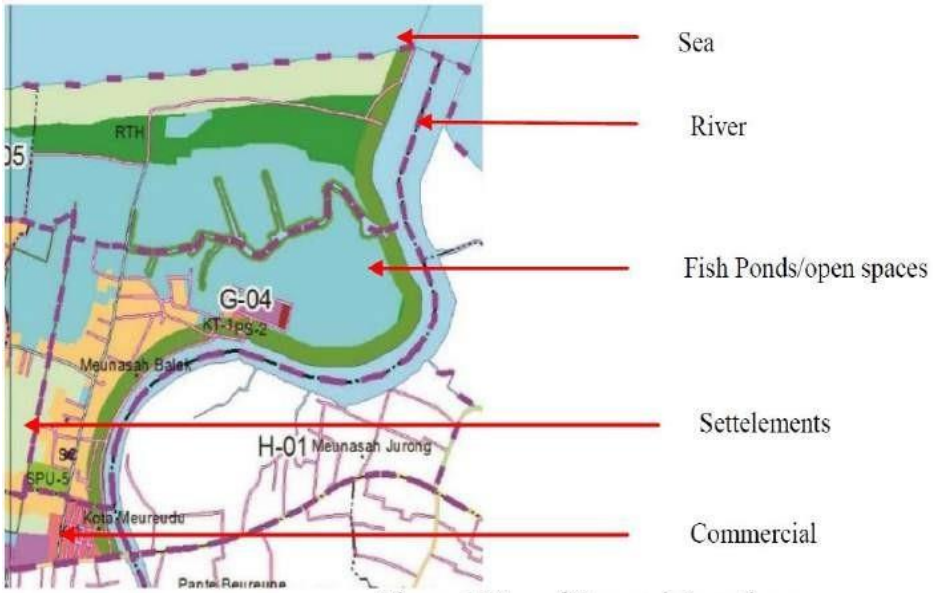

Figure 1 Map of Research Locations

Source: Detailed Spatial Planning (RDTR) Capital of Meureudu Sub-district, Pidie Jaya District

This study aims to examine the development of sustainable fishpond land management, and also play a role as disaster mitigation. This study uses a qualitative descriptive approach, the method used in gathering information about the current state of affairs. The qualitative research technique was chosen because it is expected to explore the possibility of improving pond management. By using this method, it is expected to

be able to identify conditions around the Meureudu River riparians area. Management strategy analysis was carried out using the SWOT (Strengths, Weaknesses, Opportunities, and Threats) method. Provide an overview of the existing problems, analyze the relationship between problems. The explanation of each potential is carried out using a qualitative descriptive analysis thru Strengths, Weaknesses, Opportunities, and Threats. By maximizing strengths, minimizing weaknesses, utilizing opportunities that are there, and avoiding threats, the SWOT analysis seeks to enable decision-makers to create a qualitative structure of a process or system (Khairi et al., 2022, as cited in Fertel et al., 2013).

LITERATURE REVIEW

Pond Land

Pond land is land used for pond farming activities. Ponds are shaped like artificial ponds which are usually found in coastal areas and contain brackish water or seawater which is used as a container for aquaculture. According to (Widigdo, 2000), types of ponds in Indonesia include; intensive, semi-intensive, traditional ponds, and organic ponds. The type of pond in Meureudu is a semi-intensive pond. The difference is in the management techniques ranging from stocking density, feeding, and water and environmental management systems. The cultivated biota is fish, shrimp, and shellfish. Pond modern management is not just to get fish products, but environmental sustainability is also maintained.

The development of ponds in Indonesia has intensively increased since 1990 whose development was carried out through efforts to convert mangrove forests (Gunarto, 2004). The reduction in the area of mangrove forests due to conversion to aquaculture lands will trigger environmental damage and degradation.

Sustainability

Sustainable management of ponds, not only to meet current needs but also to meet the needs of future generations, both sustainable production and environmental balance. Management of pond land is very dependent on and affects the quality of aquatic natural resources. The use of production raw materials that do not damage the environment and harm will also affect the safety of product consumers. For this reason, sustainable pond management through the use of mangrove forests functions is very important to implement. According to (Bengen, 2001), that management is through the protection and rehabilitation of mangrove ecosystems.

Some simple implementations of existing pond management to ensure environmental harmony (Ministerial Decree, 2004), are:

- Replanting mangrove forests in areas around ponds that are no longer • Optimizing pond productivity with environmentally friendly
- Conducting intercropping (silvofishery) or polyculture (shrimp, bandang fish, and/or seaweed) cultivation.

Meanwhile, the benefits derived from sustainable pond management: production costs and risks are much lower and can be operated on a small scale; can produce by-products; environmental restoration and increasing the carrying capacity of ponds from mangrove planting; the resulting product fish and shrimp has premium quality, and pond areas are more resistant to disease.

Mangrove Forest

Mangrove forest is a general term used to describe a tropical coastal community that is dominated by several distinctive tree species or shrubs that can grow in salty waters (Nybakken, 1988). According to (Arief,

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2003), mangroves are forest formations typical of the tropics and slightly subtropical, found on low and calm beaches, muddy, slightly sandy, and under the influence of tides. Mangroves are also an important link in maintaining the balance of the biological cycle in a water.

According to (Salam and Rachman, 1994), mangroves function as strong physical supports to protect and reduce wind, waves and prevent coastal abrasion. Besides that, mangrove forests can also prevent the spread of sediment to the sea, to maintain the integrity of the coral reef ecosystems and other ecosystems. The root system of mangrove plants is varied, such as hanging roots, knee roots, flat roots, pencil roots, and lateral roots that have enough space, gaps, and holes that can serve as shelters for certain types of animals from predators.

For this reason, mangrove planting in coastal and estuary areas needs to be increased, because of its great function for the community and the surrounding environment. To preserve the existence of mangrove forests, it is necessary to implement efforts to protect mangrove forests and rehabilitate mangrove forests (Bengen, 2001). Meanwhile (Putra, 2009), suggested that only 20% of mangrove land should be converted into aquaculture.

Silvofishery

One model of Mangrove ecosystems management to restore its function as a buffer for terrestrial and marine ecosystems is silvofishery, a management model that synergizes ecological and economic aspects. Silvofishery is an integrated technical approach system between fish and shrimp farming activities and planting, maintaining, managing, and preserving mangrove forests.

Silvofishery is an integrated technical approach between fish or shrimp farming activities and mangrove planting, maintenance, management, and conservation efforts. Silvofishery is protection for mangrove areas by making ponds, which both get economic and ecological benefits. The function of mangroves as nursery ground is often used for the benefit of fisheries development. This system is very simple, can be carried out without destroying existing mangroves, and is an activity that can reforest green belts on critical shores and rivers.

Some of the advantages that can be obtained from the application of silvofishery, namely:

- The embankment construction of the pond will be strong because it will be held by the roots of the mangrove trees.
- Mangroves planted along the embankment of the pond will provide comfort for pedestrians because it is covered by mangrove canopy.
- Farmers can use mangrove leaves, especially *Rhizophora sp*, as goat
- This increase in the production of natural catches will increase the income of the aquaculture farming community.
- Prevent coastal erosion and seawater intrusion into a land so that settlements and freshwater sources can be maintained.
- The creation of coastal green belt as well as supporting the mitigation program and adaptation to global climate change because mangroves will bind carbon dioxide (CO2) from the atmosphere and protect residential areas from the tendency of rising sea levels.
- Reducing the impact of natural disasters such as; storms, erosion, and tidal waves, so that the activities of the surrounding community can be saved.

In its development, the silvofishery system has been modified a lot but in general, there are 3 (three) patterns of silvofishery ponds, namely: trench pond pattern, *komplangan*, and lane pattern. The use of the silvofishery system in the mangrove forest ecosystem area can continue to be carried out widely and is

expected to prevent acts of destruction by the community. This system is also able to develop the area as a natural tourism area that functions to maintain and maintain the mangrove ecosystem as well as a job opportunity for the surrounding community. Besides, according to (Saraswati, 2004), the silvofishery system is also one way out to bridge between the designation of protected forest and the designation of aquaculture.

OVERVIEW OF THE POND AREA ON THE EDGE OF MEUREUDU RIVER

Area Land Use

The location of the pond area that is the object of the study is on the banks of the Meureudu river, Meunasah Balek village, Meureudu District, Pidie Jaya Regency (Figure 2). The increasingly widespread use of pond land needs to be re-controlled for harmony with the environment.

Based on the location, the east and west sides are the Meureudu river and pond land, the north side is a coastal tourism area, and the south side is a fish auction place (TPI) facility and residential areas. Most of the residents in Meunasah Balek village work as capture fishermen and pond farmers, because this condition is strongly supported by the area located in the coastal area.

The natural tourist area of the Meureudu beach which is on the north side of the pond area has beautiful views and is a destination for visits from the surrounding community. The beauty of the beach and estuary at Meureudu river as well as local culinary tourism are the potential and priorities of the government for the development of coastal tourism areas. This condition is an opportunity to increase the pond area as part of a sustainable coastal tourism unit.

The existence of Meureudu river on the east side of the pond is only limited by a stone embankment, without considering the existence of a buffer area. This river is used by the surrounding community to irrigate rice fields and ponds, as well as a route for fishing boats to enter and exit. The land use around the area can be seen on the following map

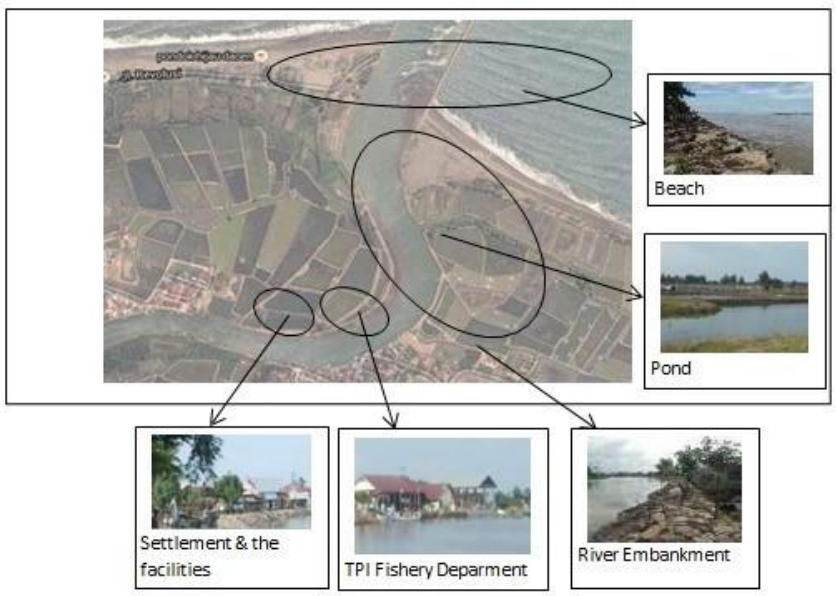

Figure 2: Area location map (existing) Source: Google satellite and survey

The condition of the river, which often experiences flash floods, is a threat to pond farmers. For this reason, it is necessary to consider the protection of the regional environment. Mangrove forests, which are

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characteristic of protective plants for coastal areas, are hard to find again, for that it is necessary to re-cultivate them so that the safety and sustainability of the surrounding environment are maintained.

Pond Land Management Condition Edge of Meureudu River

Pond cultivation activities in Pidie Jaya Regency are dominated by brackish water pond cultivation. From the statistical data of the Department of Marine Affairs and Fisheries Regency of Pidie Jaya in 2013, in Meureudu District for brackish water cultivation activities, reached an area of 117.9 Ha with productive land reaching 104 Ha and a non-productive or abandoned area of 13.9 Ha. The main commodity types are bandang fish and tiger prawns, vanamei shrimp. Pond management is carried out by the local community using a semi-intensive and full-intensive pattern.

The full intensive pattern is the application of technology only to increase production. However, in its development, this pattern harms environmental damage and the aquaculture biota itself as a result of feed waste. Meanwhile, the semi-intensive pattern has a relatively smaller impact on the environment than the full-intensive pattern. The two patterns used by the local community have not met the sustainable management of both environmental quality and production, because they still harm the environment (Figure 3).

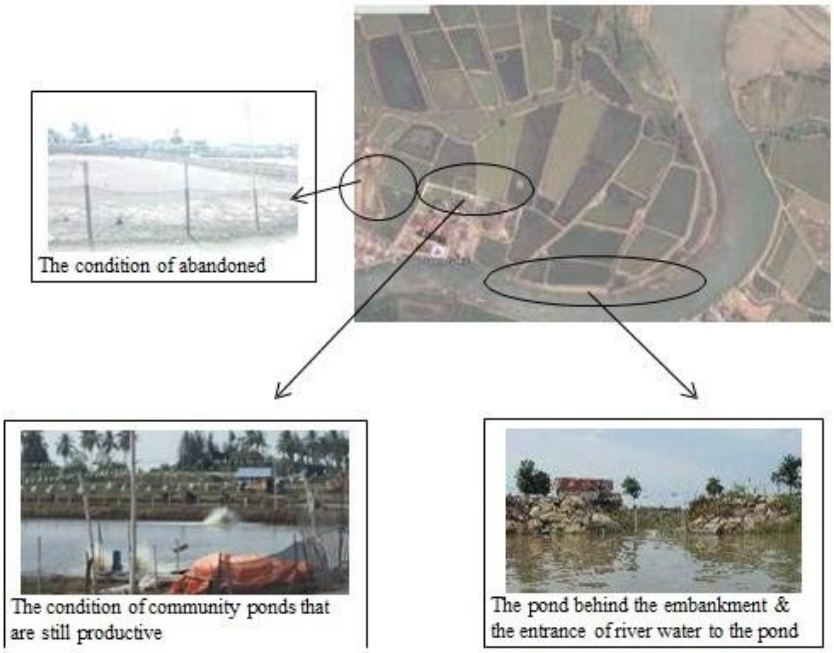

Figure 3: Pond condition (Existing) Source: Research Team Documentation

Damage to some of the ponds that have not been repaired due to the tsunami disaster is still neglected. Efforts to increase the carrying capacity of the area must be a priority for handling, considering the condition of the area which is also vulnerable to disasters. Sustainable management and management of ponds can be carried out by reforesting pond areas through mangrove planting. This combination will further improve the quality of the environment.

Sustainable Pond Land Management Strategy

According to (Law 26, 2007 Spatial Planning), explains that management includes planning, utilization, monitoring, and controlling activities on human interaction in utilizing natural resources and natural processes sustainably. This condition is also supported by the policy of the Government of Aceh regarding

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the strategy of restoring the carrying capacity of the coastal and marine environment by; 1) rehabilitate coral reefs; 2) rehabilitate and build a green belt and buffer zones. Some of the problems found in the research area include:

- An area that functions as a river border zone and buffer
- It is an area that is prone to river overflows and flash In this area, land management can be carried out while still considering the concept of sustainability. Regional development must be accompanied by efforts to reduce the impact of disasters.
- The mangrove ecosystem on the edge of the waters of the Meureudu District is almost difficult to find, due to the widespread conversion of land to aquaculture.
- Loss of buffer zones to protect riverbanks and
- Main management on land used by the community as a pond
- Management of pond land must consider the sustainability of the safety of the surrounding

Sustainable management of pond land on the banks of Meureudu River can be done through:

- Reutilization of the river border area following the RDTR (Detailed Spatial Planning) of the capital city of Meureudu by providing inspection roads and green lanes along the Meureudu river, for ease of maintenance and protection of riverbank areas.
- Rehabilitating mangrove forests in the coastal zone and aquaculture (according to spatial planning) separately or integrated, especially with the silvofishery system.
- Presenting derivative benefits in pond areas and mangrove forests as natural tourism
- Trade zone as a central market that has the potential to be an orientation and view of the mainland with a market arrangement that is also oriented to the waters.
- Boat mooring zone, edge, or riverbank that has easy access from the river to the housing zone and Fish Auction Place (*Tempat Pelelangan Ikan*).

Internal Factor Analysis

Internal factor analysis aims to determine the strengths and weaknesses of the area to manage sustainable ponds.

The strength factor possessed by the region

The strength factor possessed by the area, the potential, among others: ease of achievement from the direction of the city, the resources of the surrounding community, and the potential for fish pond fisheries.

Weakness factors possessed by the region

Weakness factors that exist in the area are the loss of mangrove forests, the absence of achievements from the riverbanks, the number of non-productive ponds, starting to reduce land resources to support production quality (virus in tiger prawns).

External Factor Analysis

External factor analysis aims to determine the opportunities and threats of sustainable pond land management to preserve the environment and manage disasters.

Area utilization

Opportunities for developing pond land management with the concept of sustainability are influenced by external factors supporting the area, namely having the potential for developing coastal areas, the potential

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for areas located around coastal tourism (on the coast), the potential for developing the quality of fishpond products supported by the law on management coastal areas and Aceh Government policies.

Threats of area use

Threat factors that hinder the development of sustainable aquaculture land management include; is an area that often experiences flash floods and river overflow, is a river border area and buffer zone, promotion of increasing pond yields without considering the impact on the environment, there are no rules for pond land management.

Table 1. Regional Spatial Development Strategy

	Strengths	**Weaknesses**
Opportunities	– Ease of reaching from the city direction – Development of aquaculture management with a silvofishery system – The government needs to pay attention to the development of sustainable pond land management.	-Cultivation and re- management of mangroves. -Provision of roads for easy access from river banks. -Increasing the active role of the community in maintaining the quality of the carrying capacity of the land.
Threats	– Control and rehabilitation of waterfront environment through reforestation & mangrove planting. – Conducting cooperation and partnership between government, private sector, and community in area management.	-Installing a monitoring and early warning system in the area. -Reuse of ponds on the banks of the river as border areas and buffer areas.

Based on the results of the SWOT analysis above, a sustainable pond land management strategy is obtained to improve environmental and disaster quality through management with a silvofishery system that utilizes ponds and mangrove forests in an integrated manner on one land. This system is expected to be able to maintain and improve the sustainability of the area's land carrying capacity and production quality.

CONCLUSIONS

The pond area on the Meureudu Riverbank area which is in the river border area and buffer area will have an impact on the decline in the function of the river bank as a barrier and water absorption. Flash floods and river runoff in the area are threats that almost often occur, so it is necessary to reforest the area with mangrove plants which are local coastal plants. Pond land management, which tends to develop by converting mangrove land and applying semi- intensive and full-intensive patterns, is slowly starting to show a decline in the quality and yield of pond production, especially in tiger shrimp ponds. The decrease in environmental quality due to the management of pond land that does not consider the carrying capacity of the land requires prompt and appropriate handling by all parties with a management system that considers the quality of the environment more sustainable.

The introduction of the silvofishery system by combining mangrove forests and integrated aquaculture is believed to be able to provide protection and sustainability of environmental quality and with low inputs. However, with the availability and capability of proper land resources, pond products that have very good quality will be produced.

In addition, the existence of locations around Meureudu beach tourism can also have the potential to be developed as a natural tourism area such as mangrove tourism, fishing, and culinary which are added value to the area.

For this reason, it is necessary to have the support and participation of the government and all parties in providing strict rules for the regulation and management of the area so that the quality and carrying capacity of the land is maintained.

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