Alternatives for Settlement Area Management of Meureudu River watersheds towards Flood Mitigation (Case Study of Meureudu City Center, Pidie Jaya–Aceh)

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Abstract

Meureudu City is a regency capital of Pidie Jaya and located along the Watershed (DAS) Meureudu River up to its estuary, has repeatedly experienced a flood that affected material and non–material damages. Efforts to reduce the effects of flooding caused by overflow of water Meureudu River have been done structurally, such as construction of dams and levees (polders, dikes, flood the canal). But these have not made the Meureudu City free from flooding and still occur repeatedly. Relocating of people is not easy, because the local people already living in the area since long and bound with historical value as an area of development of Islam. Therefore it is necessary and urgent to think about effective pre–disaster planning for the region. The purpose of this study is to find alternative strategies to protect residential areas from flooding through a strategy of adapting to floods and capture the benefits for economic development. Using qualitative description and analysis of management strategies to carried out a method. Results of the study found the handling settlements with waterfront concept can be expected to be one of the solutions that will minimize the risk of flooding. This strategy is effective, easy to apply and compatible with the environment. More importantly, can be incorporated into the long–term development program for the Meureudu City. Therefore, this effort requires consistency of all stakeholders. The participatory approach of stakeholders is a key to the success of the efforts of non–structural.

Keywords: Management strategy, spatial planning, settlement, Meureudu River, flood mitigation

Introduction

City of Meureudu roles as a Capital of Pidie Jaya Regency, as a result of expansion region in early 2007. As a new Capital, Meureudu continue to develop various infrastructures, especially in the areas of housings, human settlements and trade. However, conditions in settlement areas caused by flooding which overflow of the Meureudu River have not been resolved, even though solutions and handling already developed. Various causes of flooding, which is due to damage to the environment in the upstream areas, indiscriminate building of settlements, poor drainage system, reduction in water catchment areas, and various people's behavior toward the river and river border which can cause constriction, sedimentation and water quality degradation. Development that is not sustainable has resulted in a negative drastic change to the environmental conditions of natural resources Meureudu River. Inability to coordinate the urban water system in flood control, one of them is due to lack of coordination in the management of water resources, especially in the watersheds less addressed holistically and professionally, resulting in flooding in urban areas. This was triggered by user behavior that does not care about the existence of river functions.

To improve the environmental quality of the riverbanks Meureudu River, it must be examined and realignment of the region. Aceh Medium Development Planning Year 2012–2017 (RPJM) stated that the quality of the environment and disaster is one of the priorities of development which affects handling regional economic development. Waterfront city development concept is an alternative choice of settlements on the riverbanks in an effort of spatial planning and improvement of environmental quality. Region has been corrected so as to support small to medium sized businesses, the public can be independent and have economic value, as well as have entertainment attractions of the city. The main function of a waterfront city that is the pool that will serve as a retarding basin, which will dampen the flow of local flooding making it useful as a temporary flood shelters.
The term waterfront city contains many typical meanings that reveal the cause and goal, which can be interpreted as a city that used the river or canal as a means of transportation, recreation, and other livelihood sources. Waterfront city development will have a positive impact on communities around the river, because the surrounding community can benefit from the rising groundwater level, which could be used as a means of leisure/water tourism, sports and transportation alternatives. It can be used as water tourism so that it will increase the role of public concern. The results of this study are expected to be a cornerstone in the implementation of policies, rules and guidelines, especially with regard to the arrangement of humanist region of Meureudu City residential area, which eventually can be a proposed regulation followed by a related party.

Natural potential development with waterfront development is a space which when processed will produce a space to be able to do activities as well as the existing space on land. In this case refers to a concept which is a solution waterfront development concept that ties into the water’s edge of the mainland, where the notion waterfront is a meeting area between land and water (Hornby, 1972; Pranoto et al, 1993). The establishment of settlements in the area waterfront at Meureudu River a state of perceived human visual capable of scenery natural and artificial. Meureudu River is part of the city's history as old as Meureudu City itself. Part of Meureudu River which included in the study located at BWP-4, which prioritized to handle a flood, is planned as residential areas, services and trade, education, offices and water catchment areas, nature and sports. Development and construction of waterfront is as a development model that is very concerned about the environment, so the riverfront or waterfront development is built building design and planning of the area identified patterns as building synergy with the local ecological conditions. Activities developed in the waterfront area cannot be separated from the potential that the region possessed. This potential will also affect motivation waterfront development concepts that bring ideas developed complete functional space with its supporting functions. It is needed to do a study on housing conditions to be proposed concept of handling the settlement bank of Meureudu River that minimizes the eviction but may reduce the impact of flooding in the region.

Methodology

The study area is located at Meureudu City Center, exactly in the residential areas of the old town. Meureudu River region which is the object of this study, extends through the town Meureudu and Meunasah Balek village (Gampong) ended towards the estuary. The width of the watershed area of study is ±100 meter on the riverbank.

![Figure 1: Map of Krueng Meureudu watersheds (Source: Authors’ document)](image)

The method used is descriptive qualitative, the methods that is used to collect information and describe on the ongoing situation at the time. Aiming to describe a situation that existed at the time the research is done and examine causation through the identification of conditions that exist on the problem. The selection and arrangement of functional components (as a region segmental) on a segment or piece of the Meureudu River that supports behavioral habits (behavioral settings as a forum for the socio–cultural) surrounding community that supports the potential of the activities and the surrounding environment
(recreation, trade, transport water and cultural tours). Processing site footprint right to exploit the potential, optimizing the open spaces and freedom of circulation as well as attention to the factors that come from within and the environment that supports the objectives of the planning and building functions.

Activities exploration phase conducted data collection: 1). by observation and survey the field (observation and existing survey sites, survey on the development of eco–tourism in the city Meureudu), 2). Interview (on the development of container recreation and creativity for the city Meureudu, flood mitigation), and literature (literature supporting a review of the concept design, literature that support the discussion of architectural, the result of disaster flooding to the region and regional regulations are summarized in Pidie Jaya Spatial Planning (RTRW) and Meureudu City Detailed Spatial Planning (RDTR). The data that have been grouped are presented through a review of the flood mitigation, and leisure/entertainment criteria for the city, review the concept of waterfront and review the condition and potential Meureudu City. Phase conception performed data processing and analyzing the data with the qualitative method. Furthermore, formulated the basic concepts of planning and response strategies residential areas for improvement the space and the anticipated flood with waterfront concept.

Results and Discussion

Conditions of Krueng Meureudu Watersheds

Meureudu Urban Area in Pidie Jaya classified as medium city growing, with functions that will be developed as a Regency Center, tourism, trade centers and crossing town. Topographic study sites in the form of sloping plains with a height of 2–5 m above sea level, has a slope classification < 8%. Measured from the height of the river which is about – 0.5 –1 meters, meaning there are some settlements are under the water level of the river and is limited only by the embankment. This is due to the last few years an increase in the surface elevation of the river are the consequences if the intensity is high enough rain water and flood water beyond the embankment then immediately there was a flood in the area of the settlement. The condition of the river is quite good with a width of 20–30 meters with water depth ranging from levels 5–8 meters. Along the river side of the levee was constructed with a height of 1 meter, rebates concrete materials and giant stones (boulders).

Figure 2. Conditions of Meureudu River with fishermen activity (Source: Authors’ document).

Riparian setback lines did not meet the minimal standard from Ministry of Public Works which is 0–2 meters, where most of the water bodies directly adjacent to the walls of residential buildings. Most border areas become breeding places for cattles, terrace houses, motor parks, latrines, a trash and others. This causes the border area as a safety protective river and residential areas no longer exists. Based on Detailed Sub–District Spatial Planning Meureudu City 2014–2034 (RDTRK), Meureudu River classified as river with embankment in the urban area and must have a border of at least 5 meters along the foot of the other side embankment.
Building Alignment Conditions

Housing facilities in urban Meureudu is spreading clustered in front close to the road (Ribbon Style). Density residential buildings in the study area were medium, but the position and orientation of buildings is not clear as it develops sporadically. The distance between residential buildings close enough, with the distance between the buildings of about 0–1 meters. Building density leads to loss of water catchment areas and green open spaces in the area and the absence of evacuation flood routes.

Infrastructure Conditions

As a safeguard river levee was constructed along the watershed to the estuary with concrete material rebate (non–gabion) and boulders, a height of about 1 meter. Conditions dike built in good condition, but the way the inspections are supposed to follow the embankment is not constant because undercut by the presence of buildings on embankment position. Inspection road has a width of 1–3 meters so it can only be accessed by a 2–wheel vehicles and one car, and even then only halfway. Due to this condition as a safety benefit embankment river border becomes less. Replotting be proposed land for the building is very worth getting up in the river border area in order to build a green open space along the river side with the concept Riverfront–Waterfront Settlement.
Drainage channel is also available on a number of point locations with varying channel dimensions: height 30–40 cm, width up and down 20–30 cm, the concrete material and the condition of most do not work because it was covered with sediment soil, grass, garbage, transformed into a function parking, terraces, and others. The circulation system is inadequate. The main roads in the study area have a width of 3–6 meters that can be accessed by two cars on a number of certain roads. For a neighborhood street/alley, a width of about 1–2 meters. This makes it difficult for residents to evacuate when the flood occurred. Material on major highways settlement with a width of 6 meters is bitumen, while for local road/tunnel is paving and some are still in the form of compacted soil.

Signage for disaster mitigation has not been found in the study area. Compliance with standards for residential areas prone to disasters should be design signage for environmental orientation and evacuation in order to minimize loss of life and materials. The signs of disaster mitigation, among others in the form of an information board evacuation routes, signs of danger ban, river water level monitoring post and others. Percentage of green open space in developed and undeveloped land is 90:10. This means that the availability of public open space or green open space was minimal. 10% undeveloped includes roads, river banks and parks, gardens on the backyard.

The Potential Region

Gampong meunasah Balek community located in the vicinity of Krueng Meureudu, mostly working as fishermen catch and fish farmers. This condition is strongly supported by the potential of the village which is located near the coast. Meanwhile, the women also helps meet the daily needs by producing a mat woven with raw materials obtained from potential around. The existence of Krueng Meureudu used by people around the extent to irrigate the fields, shrimp farms, and as an in–out fishing boats as well as utilize the river bank as a place to moor their ships.
Figures 7. Conditions and Potation at settlements area (Source: Authors’ document).

Settlements area is land that used by fishing communities for housing and other support activities. Residential area on the outskirts of the watershed is an area of river border. Around the residential area there is a boat mooring area on the edge of the river and close to housing. Settlement zone tend to be above the soil moist and watery. Housing surrounding communities tend turned the river and watershed areas not utilized as an area that has the potential view and tours that can improve the quality of the environment and the local economy. Based on Meureudu Capital District Detailed Spatial Planning (RDTR), the area is recommended as a riparian area with a minimum distance of 100 meters. Houses mostly located beyond the river embankment, so that the inspection road cannot go thru towards the estuary. However, to relocate the community in this area is difficult, because in this region was began Meureudu growing urban settlements. Development of Islam also through this river, and around the area there are several historical sites of the greatness and sacred of Islam.

Likely to be developed as a residential neighborhood with a stilt-up building concept. Area under can be used as security against a puddle of water runoff and flooding when the river as a public park area when dry. The potential of the river is the orientation of the buildings around. While the zones are located along the jetty river have easy attainment of housing to the fish auction and so the market potential as a fishing boat mooring area. Improved watershed areas Meureudu River as waterfront area development environment and disaster mitigation is expected to improve the quality of the environment and disaster management. With regard to the protection and maintenance of rivers and improving the recreation area, regional development banks of the Meureudu River to do with the provision of such: road infrastructure inspection continuous, open space, garden sitting, playground, docks, restaurants, fishing areas, sports facilities, and local craft facilities, as well as improving other facilities that characterizes the region.
**Flood Mitigation**

Krueng Meureudu barriers to erosion in the form of a stone embankment that extends from the town Meureudu towards the estuary aims to restrain and avoid flood water flooding inland. From the top of the embankment of the river that created extends till towards the city, visitors can enjoy a view of nature that is winding river flow, pacing boat fishing, expanse of rice fields, plantations and traditional embankment. Based on the Detailed Spatial Planning (RDTR) Capital District Meureudu this area was part of a border river which is a protection zone with a function as protection and control of the environment of the river. Flood canal which is the flow of Meureudu River into the waterway has an attractive tourist potential. The area is often used by local people for fishing and enjoys the view of Malacca Strait, passing fishing boats, and the city center. Flood canal was in the river mouth Meureudu River made to control the flow of water from upstream rivers and adjust the volume of incoming water. This channel is also intended to be crossed by boat or fishing boat. This zone is an area of habitat of various species of fish, and became a favorite area for fishing communities. Canal existence serves as one disaster mitigation being done to reduce the risk and impact of a disaster on the settlement communities prone to flooding.

**Potential of Region and Problems**

The potential of the area around the Meureudu River can attract visitors to enjoy its beauty, thus providing development opportunities in services sectors and entertainment around the area. This potential can improve the quality of space in the watershed areas with considered as protected area, in accordance with the Capital District Meureudu Detailed Spatial Planning (RDTR). The existence of the Meureudu River no longer an area behind the building and dumping areas that have an impact on pollution and silting of the river, but it will be interesting view environment.

Utilization of the area around Meureudu River by the user, each day has increased, especially people who use the existing natural potential as an attractive view for refreshment, fisheries and ponds as well as the potential for local crafts. The local community and the surrounding communities with activities that do not yet supported by environmental infrastructure, public and social facilities were adequate and also not well ordered. Facilities available in the surrounding area are like a fish sales area, fishing area, and parking. While environmental infrastructure such as roads inspections is only available to the market environment, rain water channels are also not well ordered.

- Facilities Inspection roads only in that market area from the bridge down to the neighborhood mosque and yet connected up to the coast. The width of the road inspection + 5 M of the embankment, the condition are not perfect (yet ready paved). These conditions do not provide comfort and convenience for users who want to reach the residential area and the beach, and who want to enjoy the river flow Krueng Meureudu. The existence of this road is expected to function for river maintenance to keep them clean and does not become a dumping ground for debris.
- Drainage of rain water, especially in residential areas has not been functioning well, so it looks wet and humid environments. These conditions provide non convenient for users and gives the impression of a seedy.
- Facility fish sales that were above the embankment must be disciplined and set its placement in the market area.

A planning of public space oriented to the river and recreation into a place for children, youth and adult age to socialize built with processing area of micro includes determining the concept of orientation, system mass, the appearance of the building and landscape, so as to pour expression of joy and interact socially as well as provide design is contextual to their environment. The room is equipped with a pedestrian green open space (RTH) must meet criteria of comfort, climatic conditions and physical characters. RTH pedestrian paths can be used as: 1). Facility to allow for social interactions both passive and active as well as provide an opportunity to sit down and look at other pedestrians; and 2). To balance the temperature, humidity, texture underfoot, vegetation, vehicle emissions, vegetation emit an odor, the smell of garbage and abandoned, audial factor (sound) and visual factors.

**Recommendation**

Based on a number of the above analysis, the proposed concept of handling the settlement to address/minimize the risk of flooding in the study area, which is as follows:

a. Setting land use by increasing the percentage of green open space up to 20% along the outer dike. This can be done through the control/arrangement of river border area. In accordance Ministry of Public Works Decree No. 63/PRT/1993 regarding Line Border Rivers, the area benefits of a river, stream mastery determined based on the condition and location. The sweets were followed through 2014–2034 Meureudu City Detailed Spatial Planning (RDTR), that the Meureudu River is categorized a levee river.
including rivers in the urban area must have a border of at least 5 meters along the foot of the embankment outside.

b. On the banks of the area that does not have the inspection, the inspection must be made paths and green space on the outside of the dike, with land acquisition.

c. Occupancy potentially is developed as a residential neighborhood with a building concept stage. Area under can be used as security against a puddle of water runoff and flooding when the river as a public park area and when dry.

d. In addition to setting the border, can also be done as well as the application of the concept of normalization river riverfront / waterfront settlement. This is so that the river can be kept clean. But this should be monitored (river border control system utilization should be firm) to avoid going over the river border.

e. Returns Greenbelt role in Meureudu River to improve the quality of the watershed area that has a function for flood mitigation. Settling the riverside area in order to create a waterfront city, raised the river as a transportation alternative, maintaining a protected area, covering greenbelt (retarding pond), bog, technical irrigation, and protected areas and strengthening urban functions improved by providing the necessary facilities and infrastructure.

f. Make a commitment to linear greenways and public access to the waterfront, the area along the Meureudu River. Riverfront Development Principles Emphasis on interconnectedness, waterfront development linearly with widespread public access to: 1. Promote the use of green lanes riverfront as a way commute daily and recreational facilities. 2. Indicate the relationship between access, development of green belt and demanders market. 3. Creating an arrangement coherent and pleasing to the eyes towards the waterfront. Create synergy between residential and recreational waterfront by selecting the concept of development and the most imaginative architectural design.

Conclusion

Besides influenced by regional topography sloping river banks that do not meet the standards, the floods in Kota Meureudu exacerbated by housing and infrastructure conditions that do not respond to flooding. Construction of houses and the distance between buildings is not possible to provide a water catchment area neighborhoods, there are only a few houses were constructed stage. Treatment room rivers such as the inspection and its green open space are inadequate, evacuation and flood warning system is not yet available.

The concept of handling the above proposed based on the study of the condition of the settlement, and tailored to the needs and desires of citizens (the interview). Because the concept has been minimized in the eviction of the houses and the most important is the construction of the security system of the river and the protection of settlements are better than the existing condition. Hopefully, through this treatment concept could be one solution to prevent and minimize the impact of the risks posed by floods in Gampong Meureudu and Meunasah Balek. This study needs to be followed up with studies on aspects/other areas, such as socio – cultural studies or economics or government policy. It is intended that the handling of the flood-prone settlements in the study area can take place in an integrated and comprehensive.

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