Rearrangement of green open space along Krueng Aceh based on sustainable urban riverfront

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Abstract. One of the city government’s programs to upgrade the representation of Banda Aceh as a green city was to revitalize the open space of krueng Aceh riverbanks. However, such a work has been progressing slowly. Although some wide banks area have been processed into parks, but, some other areas especially those with narrow areas in sizes of the banks have not been upgraded. Currently, these areas, with less green, have been becoming slum where some illegal settlements occurred. In general, the area along Aceh riverbanks has not been design comprehensively, since there has insecure public accessibility, irregular park zoning, unfunctioned water tourism facilities, unproper waste management system, and unbalanced socio-economic conditions in relation to local environmental conditions. The purpose of this study is to identify the characteristics of green open space at the Krueng Aceh riverbanks, Banda Aceh City and formulate criteria for structuring Green Open Spaces based on Sustainable Urban Riverfront. This research uses descriptive qualitative research method. The research instrument used was interviews, field observations, literature studies. Data analysis was carried out in a qualitative descriptive manner with data reduction analysis techniques, data presentation and conclusion. The results of this study are the design recommendations for Green Open Space (GOS) that apply the principles of sustainable urban riverfront. The development of the potential of the Krueng Aceh riverbank as a green open space is expected to be a sustainable landscape and able to support the function of the area from the ecological, social, and economic aspects.

1. Introduction

The Krueng Aceh river is the longest river found in Banda Aceh City. The river runs through the city center which has a high activity density. In additions, due to the strategic geographical location of the Krueng Aceh riverbank area, its location can be used as the main target for the formation and development of elements of green open space (GOS) for the people of Banda Aceh City. This green open space along the Krueng Aceh river, has been existed since 1985 as a green belt. Meanwhile, several other parks such as APK Keudah Park (Front of Keudah Terminal) and Bustanussalatin Nursery Park (Tepi Kali) are classified as city parks [1].

Green open space is an elongated or clustered area, whose use is more open. It is also the area where plants grow both naturally and intentionally planted [2]. Along with rapid urban development, especially in the city center which is a densely populated area of activity and buildings, the existence of riverbanks as green open spaces and public spaces is very important to balance city life and provide...
breathing space for the community as well as a buffer for the environment. The existence of green open space can provide comfort for various levels of social strata.

The Krueng Aceh River has been designated as a waterfront city area [3]. A waterfront city is an area bounded by river, sea or lake water which in its development is oriented towards having great access for the public. It has functions as a public space to interact between individuals, individual with the environment and as a community gathering space. However, the arrangement of river banks in this area is not evenly distributed and runs slowly. This can be seen from the varied conditions on the banks of the Krueng Aceh River, some of the banks are wide and have been processed into parks but some other areas have very narrow sizes and minim of greenery. In additions, the garden facilities are inadequate and not maintained, pedestrian paths are not available. unsafe for public use along river banks, irregular park zoning, water tourism facilities not functioning and waste management has not been implemented properly. The problems found will have a bad influence on the Krueng Aceh riverside area, so that it can create an area as a negative space that causes the area to become a slum and overall causes a decline in the city's image, social, economic, and environmental quality of urban space [4].

Some researches that use a Sustainable Urban Riverfront-based approach have been carried out in several other studies. Rahma Sakinah's Thesis [5] study on the Arrangement of the Kalimas Riverside in the Kali Tile Area uses the Concept of Sustainable Urban Riverfront. Arie Ranuari's Thesis [6] concentrates on the Arrangement of Green Open Space in the Mahakam Riverside Area of Samarinda City Based on Sustainable Urban Riverfront. The research discusses and examines the arrangement of green open spaces, the use of green open spaces and public spaces with the object of research in the riverbank area. From this research, it can be concluded that the arrangement of green open spaces on the banks of the Krueng Aceh River which pay attention to sustainability aspects are considered important since this consider as an effort to develop the image of Banda Aceh City. It aims to identify the existing conditions and rearrange the Green Open Spaces on Krueng Aceh Riverbanks through a different approach based on Sustainable Urban Riverfront. The benefit of doing this study is the possibility to improve the quality of the environment as an area of green open space and can become a sustainable landscape that is able to support the function of the area in terms of ecology, social, and economic aspects.

2. Materials and methods
The method used in this research is descriptive qualitative, which is to reveal the phenomenon as a whole through the collection of data obtained naturally directly during observations with actual conditions. The qualitative descriptive research used in this study is intended to obtain in-depth and comprehensive information about the study of Green Open Space Arrangement on the banks of the Krueng Aceh Riverfront in Banda Aceh based on Sustainable Urban Riverfront. In addition, this qualitative approach is expected to be able to uncover the situations and problems encountered to find problems and solutions in the form of conclusions. This study is located on the banks of the Krueng River in Aceh. The object to be studied is the arrangement of Green Open Space (GOS) on the banks of the Krueng Aceh River from Peunayong Bridge to Pante Pirak Bridge as shown in Figure 1.

![Research Site Map](Source : Google Earth, 2021)
Research variables are the points of concern that will be observed from the research object. Based on the theory of Sustainable Urban Riverfront by John Benson and Maggie [7] there have been several variables that will be used in this study aimed at achieving the objectives in the research. In this research, the research variables will be emphasized related to landscape design, namely ecology, economy, and social in realizing the design in the green open space area of the Krueng Aceh river bank.

| No. | Research Variable | Indicator | Operational Definition | Criteria |
|-----|-------------------|-----------|------------------------|----------|
| 1.  | Ecology           | Environmental Quality Improvement | Landscape design that can influence life on human interaction | • Green Open Space (GOS) should maximize the use of softscape compared to hardscape.  
• The need for environmental arrangements such as landscape settings,  
• Waste management. |
| 2.  | Economic          | Landscape Efficiency | Landscape design with attention to the selection materials used and and land use for economic value. | • Design must consider landscape materials in terms of durability and aesthetics efficiently,  
• Utilizing open space to improve the community's economy. |
| 3.  | Social            | Public Area    | Public open space that serves as a forum for activities public | • Has open space facilities for the public,  
• Provide security and comfort for the public. |

(Source: John Benson and Maggie, 2000)

The data collection method in this study used a non-probability sampling technique with a convenience sampling method (accidental sampling). Accidental sampling is taking respondents as samples based on the chance that is, anyone who coincidentally meets a researcher can be used as a sample if the person they meet is suitable as a data source [8] with the main criteria being that the person is a resident or visitor of the Green Open Space (GOS) on the banks of the Krueng Aceh River, Banda Aceh City which will be studied. Data collection techniques are based on primary data and secondary data [9]. Primary data is data collected directly from the object of research, namely observation, in-depth interviews, and documentation. While secondary data is data obtained from several sources such as RTRW 2009-2029 city of Banda Aceh, laws and regulations, books, and others that are relevant to research conducted related to riverside green open spaces.

3. Results and discussion

3.1. Area analysis based on sustainable urban riverfront aspect
3.1.1 The existing condition of the left bank of the Krueng Aceh river
Based on the results of observations made on the left bank of the Krueng Aceh river, problems were obtained from the three aspects studied, namely the ecological, economic, and social aspects as shown in Figure 3. After paying attention to the existing conditions, an analysis was carried out based on the focus of observations and the results of interviews conducted with visitors and the government.
Table 2. Analysis of the Sustainability Aspects of the Left Bank of the Krueng Aceh River.

| Aspect (Environmental Quality Improvement) | Parameter | Literature Review | Observation Results | Interview Result |
|---------------------------------------------|-----------|-------------------|---------------------|------------------|
| Ecology                                     | Vegetation| Riverbanks should consist of various types of grass, shrubs and trees native to the area. | There are only shade trees on the pedestrian path above the river embankment as shown in Figure 3 point 3. | Visitors  
• The available green open space (GOS) is currently dry due to a lack of maintenance and no flower plants to beautify the garden.  
Government  
• There is good landscape planning.  
• Inviting the community to maintain cleanliness. |
|                                             | Waste management | There is no visible organic and inorganic waste in the river. | The condition of the river tends to be clean and there is no visible floating garbage due to routine cleaning carried out by the Dinas Lingkungan Hidup Kebersihan Dan Keindahan Kota Banda Aceh every day. |

| Economic (Landscape Efficiency) | Landscape materials | Design should consider the selection of landscape materials in terms of durability and aesthetics efficiently. | The use of materials that are youthful and impressed not durable so that it causes rapid damage as shown in Figure 3 point 2. | Visitor  
• No parking is available.  
• The condition of the riverside chair facilities is not strong and tilted, the garden chair umbrella is damaged, and the boat dock is not functioning.  
Government  
• Encouraging community economic activities to support the economy.  
• Facilitate the garden with garden chairs and durable gazebos. |
| Land use for economic value | Increase the potential of the area in the form of urban green tourism facilities, to attract the public or tourists to visit the area, to increase economic activities. | There are no activities and spaces that can increase the economic value on the left bank of the Krueng Aceh river. |  |  |
Social (Public Area) Facilities for the public There are facilities and infrastructure that serve as a forum for community activities. The activities are not varied along the left bank of the Krueng Aceh river and the lack of complementary garden facilities such as garden chairs, shade umbrellas or garden chairs, trash cans, and garden lights as shown in Figure 3 point 1.

Visitors
- Riverside green open space is unsafe for children to use because there is no barrier between the riverbank and the park.

Government
- Organizing a safe and comfortable Green Open Space for all ages as a place for public activities.

Safety for the public Must pay attention to safety and comfort and be able to accommodate every human activity in it. The guardrail is damaged which endangers the safety of pedestrians as shown in Figure 3 point 4.

Conclusion of Analysis Results
1. The garden softscape is already available, but the arrangement is still lacking, it needs to be cared for and provided boards to not step on the garden grass and the prohibition of littering.
2. The available shade tree vegetation is quite good, only you need to add flowers of various colors to make it attractive to look at.
3. The availability of garden facilities is quite minimal such as garden chairs, trash cans, and lighting for the night. It is also necessary to add park support facilities to facilitate social interaction between individuals such as children's playground facilities, parking areas, buying and selling areas, and others.
4. The unavailability of marine tourism vehicles increases the economic value of the community.
5. Damage to the material of the pedestrian and river bank guardrails can be repaired by using durable and firmly installed materials.

(Source: Personal analysis, 2021)

3.1.2. The existing condition of the right bank of the Krueng Aceh river
After making observations on the right bank of the Krueng Aceh river, problems were found based on the aspects of the study, namely the ecological, economic, and social aspects as shown in Figure 5. Then analyzed these three aspects by explaining the results of interviews to visitors and the government. Here below is the description.

Figure 4. Region Map
(Source: Google Earth, 2021)

Figure 5. Right Bank Existing Condition
(Source: Personal Documentation, 2021)
### Table 3. Analysis of the Sustainability Aspects of the Right Bank of the Krueng Aceh River.

| Aspect                                           | Parameter                  | Literature Review                                                                 | Observation Results                                                                                                                                                                                                 | Interview Result                                                                                                                                 |
|--------------------------------------------------|----------------------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Ecology (Environmental Quality Improvement)       | Vegetation                 | Riverbanks should consist of various types of grass, shrubs and trees native to the area. | The right side of the Krueng Aceh River is only used for 50% of the area of the right side of the river because the other remaining is used as corn plantations for the local community and land belonging to the Iskandar Muda Kodam which is private for the army office in Peunayong as shown in Figure 5 point 3 and 4. | Visitor • There is no vegetation and shade in the cafe area, so it is hot during the day.                                                                                                                     |
|                                                  | Waste management           | There is no visible organic and inorganic waste in the river.                    | Trash dumped under the riverside café.                                                                                                                                                                                  |                                                                                                                                                                                                                                       |
| Economic (Landscape Efficiency)                  | Landscape materials        | Design should consider the selection of landscape materials in terms of durability and aesthetics efficiently. | Not the entire area of the cafe on the banks of the Krueng Aceh River is used as a roof covering, of course this will trigger damage to the floor material, lighting, chairs and cafe tables when exposed to rain as shown in Figure 5 point 2. | Visitor • This riverside cafe is quite comfortable to use in the afternoon and evening.                                                                                                                                                 |
|                                                  | Land use for economic value| Increase the potential of the area in the form of urban green tourism facilities, to attract the public or tourists to visit the area, to increase economic activities. | The economic aspect that can add to the selling value of the banks of the Krueng Aceh River is due to the availability of cafes as shown in Figure 5 point 1.                                                                 | Government • There has been a riverside development in the form of a cafe that can support the local economy.                                                                                                                     |
| Social (Public Area)                             | Facilities for the public  | There are facilities and infrastructure that serve as a forum for community activities | To support the social aspect on the right side, only cafes are available based on the results of observations and observations in this field as shown in Figure 5 point 1 and 2.                                                                 | Visitor • The available facilities can only be used in the afternoon • Not safe to sit, relax and enjoy the river in the morning and afternoon.                                                                                              |
|                                                  | Visitor                    |                                                                                                                                               |                                                                                                                                                                                                                        | Government                                                                                                                                                                                                                           |
Safety for the public

Must pay attention to safety and comfort and be able to accommodate every human activity in it.

In certain areas on the right bank of the river, it is now occupied by homeless people to live, sleep, and bathe. This will be one of the causes for visitors to be afraid, worried, and worried if they walk here because it is not safe to visit.

• There are facilities for the public, such as riverside cafes and Café Live Music

Conclusion of Analysis Results

1. Provide parking space for visitors and shop owners whose money can be used for the prosperity of the local community.
2. Vacant land can be used as other green open space (GOS) areas in the form of amphitheaters, boat docks for water tourism, and others that can support local economic aspects.
3. Facilities and infrastructure are needed that can support social activities at various times in the morning, afternoon, evening, and at night. So that the right bank can be active for the public at any time and can guarantee security for visitors because it is not quiet.
4. It takes vegetation in the form of shade trees and ornamental plants in the form of flowers of various colors to make it attractive to look at and can function as a garden aesthetic as well as a green line barrier with pavement in the form of a cafe.

(Source: Personal Analysis, 2021)

3.2. Design recommendations

After analyzing the area based on 3 aspects of sustainable urban riverfront, namely the ecological aspect, the economic aspect, and the social aspect. Where in each aspect, conclusions are generated based on the results of the analysis based on literature, existing conditions, and interviews with visitors to the Krueng Aceh River.

Table 4. Design Recommendations based on Aspects of Study.

| Aspect                          | Design Recommendations                                                                 |
|---------------------------------|----------------------------------------------------------------------------------------|
| Ecology (Environmental Quality Improvement) | 1. It is necessary to arrange park zoning so that every area on the banks of the Krueng Aceh River can be used as green open space (RTH) to be used entirely as a public space, |
|                                 | 2. Maintenance and addition of Softscape on the river bank.                            |
|                                 | 3. The use of pavement must be minimized so as to maintain its function as a Green Open Space. |
|                                 | 4. Provision of trash bins to dispose of garbage in its place.                         |
| Economic (Landscape Efficiency) | 1. We recommend using materials that are durable and efficient,                        |
|                                 | 2. Adding facilities and infrastructure that can increase the economic value of the area, such as water tourism, cafes, food courts, and others. |
| Social (Public Area)            | 1. Additional park support facilities are needed to facilitate social interaction between individuals, such as children's playground facilities, parking areas, selling areas, and others. |
|                                 | 2. Must be equipped with complimentary garden facilities or elements, such as garden chairs, trash cans, and lighting for the night. |
|                                 | 3. Public space can be separated for passive and active activities (can be seen in Table 5). |

(Source: Personal Analysis, 2021)
4. Conclusions
The discussion that has been carried out, it is concluded that the research is the result of answering research questions in the study of Green Open Space in the Krueng Aceh Riverbank area of Banda Aceh City with the Sustainable Urban Riverfront approach which is studied based on 3 aspects of ecological, economic and social aspects. The conclusions can be as follows:

1. The existing conditions of the Green Open Space found in the Krueng Aceh riverbank area. Social Aspects, the availability of activities that is possible to be processed into more varied along the banks, adequate facilities, and infrastructure that can support social activities as a place to relax, play children and there are no areas that are given a touch of local culture. Economic Aspect, there are only economic activities available on one side of the riverbank, namely riverside cafes, but the other side of the river is facing the office area and trade and services such as coffee shops, clothes shops, sewing shops, and others. Ecological aspects, hardscape elements are still dominant in this green open space on the banks of the Krueng Aceh River, vegetation is well available and this aspect pays attention to the surrounding environment, both through conservation and protection of natural resources.

2. Criteria for the arrangement of green open space based on Sustainable Urban Riverfront that is safe and comfortable for visitors on the banks of the Krueng Aceh River based on the sustainability aspect are as follows. Social Aspect, providing more varied activities along the riverbanks, such as gazebos, park chairs, trash cans, garden lights, and water tourism for visitors along the Krueng Aceh River. Economic aspect, creating the development of facilities and infrastructure from both sides of the Krueng Aceh river, such as the provision of food courts, cafes, water tourism, children's playgrounds, and others that can add to the regional economic value. Ecological aspects, the use of hardscape elements is minimized so that it can maintain its function as a green open space.

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