Green infrastructure pattern of Manggar riverbank as Minapolitan (fishing town) settlement

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Abstract. Manggar Riverbank is one of the high-density settlements with characteristics of wood as the main material. Most residents were worked as fishermen and farmers to support minapolitan (fishing town) activities. The area was located on the edge and surface of the river, linear housing patterns, parallel, and surface the river. The area has been indicated as slum river settlements. The strategy to urban development based on green infrastructure (ecological infrastructure) must be integrated with Balikpapan Spatial Plan (RTRW). Manggar village was established as a traditional protected settlement. Green infrastructure planning should be integrated with the residential space to improve the quality of city and community life. The concept of sustainable city development needs to balance economic, socio-cultural and environmental development by increasing green infrastructure. The purpose of this study is to analyze the priorities of green infrastructures based on its pattern. The distribution patterns by Geographic Information Systems approach was used as a methodology. The results of the analysis concluded that there were three patterns identified from the distribution of green infrastructure in the village over the Manggar riverbank settlement. Clustered patterns, random patterns, and dispersed patterns are found in all variables with different amounts. Clustered patterns are found in the distribution of vegetation. This result shows that the priority of the Manggar village community readiness in preparing the green infrastructure of settlements is available on vegetation. The clustered vegetation does not show a relationship with fishing activities, but rather tourism activities. Green infrastructure that is dispersed according to the use of fisheries space is lighting and public buildings with random patterns.

1. Introduction

The green area in spatial planning as an ecological function consists of hydrology, climatology, and biodiversity for the balance of ecosystems in urban areas. Green areas must be equipped with the provision of green infrastructure that is provided for all residential areas in the form of areas and pathways. The aim is to restore the function of the settlement and balance of the settlement ecosystem to reduce the risk of settlement disasters. [1]. The Spatial Planning Regulation explains that Balikpapan City has a hierarchy as a National Activity Centre (PKN) with main services as trade and services, industry, housing, tourism, and education [2]. One residential area in East Balikpapan, in particular, has different characteristics from other traditional settlements. Manggar Baru Village in East Balikpapan is an industrial area on a city scale. The settlement is located in the village of Manggar Baru, clustering downstream of the Manggar river. Infrastructure-based urban development strategies must be integrated with Regional Spatial Plans (RTRW) and detailed in the spatial structure and patterns that settlements on Manggar riverbank have arranged as protected traditional settlement [2]. On the other hand, all cities
have the same rights as appropriate infrastructure to get security and safety in settlements. Areas that have the potential for disasters in residential areas above water are floods, tidal waves, and abrasion [3].

Manggar Baru Village is one of the slum areas in Balikpapan [4]. Among these areas, there are several Rukun Tetangga (RT) located downstream of the Manggar river with settlements on the water. This condition requires the community and the government to maintain the river ecosystem, which consists of air protection, recreation protection, and cultural protection. The whole basic infrastructure must be identified for feasibility and resilience to settlement disasters.

The patterns of urban settlements on the water have homogeneous characteristics in the function of buildings and spatial form. There are no specific traditional values related to the house. The architectural building is made with traditional and modern rules-based on practicality and convenience. Distribution patterns tend to dispersed, linear or clustered based on economic considerations such as proximity to ports, markets etc. [5].

Urban green infrastructure includes all green elements such as parks, green open spaces, corridors, roadside trees, green roofs, and parks [1] as a concept to facilitate natural elements in the urban planning process [6]. In addition to private spaces such as gardens and green roofs, the city's green infrastructure must be an inclusive element that can be accessed by everyone [7]. Areas that are sensitive on transformation must be preserved as green infrastructure till the paradigm that green infrastructure is not the remaining space between the built environment, but the main elements in urban spatial planning [2].

The purpose of this study is to analyze the pattern of green infrastructure to support fishing activities in the Manggar riverbank settlement.

2. Methods
The research units are three neighborhood units (RT 04, 13, and 26), which are the administrative boundaries of the village for water. The unit of analysis is divided into several regional blocks with physical boundaries. This analysis aims to illustrate and interpret the meaning of data collected systematically, factually and accurately to the characteristics studied which can then be presented through tables and figures. This analysis will describe quantitatively based on the results of primary observations. The Research variable are listed in Table 1.

The nearest neighbor analysis is used to analyze the pattern of green infrastructure with the geographic information system equipment. The nearest neighbor analysis is an analysis tool to explain the distribution pattern of infrastructure based on the location point and area of the study area. The nearest neighbor analysis requires the distribution point of the location of green infrastructure in 2019 and the total area of the Manggar riverbank settlement. The research framework was shown at Figure 1.

| Indicator          | Research Variable       | Definition                        |
|--------------------|-------------------------|-----------------------------------|
| Air protection     | vegetation              | Number and kind of vegetation    |
| Water protection   | Clean water resources   | Domestic clean water resources    |
| Recreational protection | Lighting       | Number of lighting and generator resources |
|                    | Green open space        | Kind and capacity                 |
|                    | Open space              | Kind and capacity                 |
| Cultural protection| Public building         | Identity and characteristic       |

The output of this analysis is the nearest neighbor distribution index/ ratio (T) through the formula:
\[ T = \frac{J_u}{J_h} \quad (1) \]
\[ J_h = \frac{1}{\sqrt{2P}} \quad (2) \]
\[ P = \frac{A}{N} \quad (3) \]

**T**: nearest neighbor’s ratio  
**Ju**: average observed distance  
**Jh**: comparison of the area divided by the number of points  
**P**: Density of each point (kilometer square)  
**A**: Area (kilometer square)  
**N**: Number of points

**Criteria:**
- If the \( T \) value is less than 0.7 (\( T < 0.7 \)), the pattern is clustered;  
- If the \( T \) value is between 0.7 and 1.4 (\( 0.7 \leq T \leq 1.4 \)), the pattern is random;  
- If the \( T \) value is more than 1.4 (\( T > 1.4 \)), the pattern is dispersed.

**Figure 1.** Research framework.

### 3. Result and discussion

Based on the Strategic Plan of the Manggar Baru in 2011-2016 (RPLP Manggar Baru), Manggar Baru Village is determined to be a *Minapolita* (Fishing Town) area, which is a cluster of fisheries that grows and develops along with the system and effort to serve, encourage, attract and hold fisheries development activities in Manggar Baru. Also, as a tourism area, it implies that everything is related to tourism, including tourism attraction and tourism object exploitation, as well as business-related.

#### 3.1. Vegetation

Types of plants consist of wood, fruit trees, and ornamental trees. Most of the tree plants do not have the main function as a protector tree, but food providers, such as banana trees, cherry trees, and breadfruit. There is also a distribution of coconut trees as a characteristic of coastal settlements. Coconut trees cover 24% of the public area of vegetation (Figure 2). The vegetation location is partially located on the side of the environmental road and pedestrian corridor. While the woods in pedestrian riverbank are dominated by ornamental plants.
3.2. Clean water resource
Clean water resources used by the community in the Manggar riverbank settlement consists of regional water companies (PDAM), deep well, and rainwater reservoirs. All RT are served by PDAM, but still need to add deep well and rainwater reservoirs in certain locations (Figure 3). There are 11 houses as deep good users located on the outer boundary of Manggar riverbank settlement. The community is served with clean water facilities to supply drinking, bathing and washing needs (properly protected piping or non-piped). About 95% of the communities have been fulfilling drink, bathing, and washing water needs. There are still some houses have not accessed adequate water facilities.

3.3. Lighting
This type of lighting consists of street lights, Fish Auction lights, and garden lights. The type of lighting is dominated by garden lights (58%). The energy source used comes from the State Electricity Company (PLN), while 6% of the lighting comes from solar panels. The location of the streetlights is partially located on the side of the neighborhood road and pedestrian corridor.

Figure 2. Map of water resource (left) and lighting distribution (right).

3.4. Green open space
The green open space in Manggar riverbank settlement consists of a sports fields and a fish drying field. Based on the green infrastructure approach, green open spaces have functioned as recreation protection. Whereas in the existing condition, green open spaces are still used as protection for primary economic activities of fishermen. About 69 percent is dominated by sports fields, while the other is a fish drying field.

Open spaces in Manggar riverbank settlement consist of sports fields and parking areas. Based on the green infrastructure approach, open spaces have functioned as recreation protection. In existing conditions, open spaces have supported the function of recreation by providing parking areas for market visitors and tourists/visitors of Kampung Warna-warni Manggar.

3.5. Public building
Public buildings as a function of cultural protection for green infrastructure consist of Manggar Market, fishing boat refueling sites, fish auction places, and mosques. In supporting cultural preservation, people interact with each other in this public space and still pay attention to local wisdom aspects.
3.6. Green infrastructure pattern

Analysis of the distribution pattern of green infrastructure in Manggar riverbank settlement used nearest neighbor analysis. Refer to Table 2, the result obtained the value of the Nearest Neighbor Ratio or proximity ratio \( T \) as the following formula:

\[
T = \frac{\text{Observed Mean Distance}}{\text{Expected Mean Distance}} = \frac{0.87}{21.97} = 0.40
\]  

The Nearest Neighbor \( T \) Value Ratio is 0.4 - 2.87 and can be interpreted into three patterns: clustered, random, and dispersed. The distribution patterns of the location of infrastructure in the Manggar riverbank settlement are supported by the level of significance or the level of confidence of calculation results. The result of \( z \)-score and \( p \)-values are indicated as valid values.

| Average Nearest Neighbor Summary | Vegetation | Clean Water Resource | Lighting | Green Open Space | Open Space | Public Building |
|----------------------------------|------------|----------------------|----------|------------------|------------|-----------------|
| Observed Mean Distance           | 8.87       | 41.32                | 25.03    | 52.27            | 90.64      | 9.90            |
| Expected Mean Distance           | 21.978     | 30.39                | 33.59    | 43.84            | 31.57      | 12.27           |
| Nearest Neighbor Ratio           | 0.40       | 1.35                 | 0.74     | 1.19             | 2.87       | 0.80            |
| \( z \)-score                    | -0.99      | 2.28                 | -2.71    | 1.04             | 8.00       | -2.74           |
| \( p \)-value                    | 0.00       | 0.022                | 0.006    | 0.298            | 0.00       | 0.00            |

Based on the analysis results, there are three distribution patterns of green infrastructure in Manggar riverbank settlement:
a. Clustered

Clustered patterns are presented in vegetation. As air protection, decoration trees in Manggar have been clustered according to corridors with a high level of activity around Kampung Warna Warni and around the market. Shading trees are clustered around the neighborhood road. Whereas fruit trees are clustered in the location that is accessed by boat.

b. Random patterns

Random patterns are seen in lighting, public buildings, open space, and clean water resources. All variables cannot be reviewed as green infrastructure provision plans because they are provided according to needs and location. For example, a public building is located on a boat berthar location far from the public market building. Green open spaces are also located in different locations because the recreational needs of sports are enjoyed by local people, while fish drying is needed by businesses. Physical factors of the area cause the distribution can not always be clustered. The Pattern of green infrastructure was shown at Figure 4.

c. Dispersed patterns

Dispersed patterns are found in open space variable. Open spaces are located in dispersed areas because the recreational needs (sports field) are enjoyed by local people, while parking spaces are needed by businesses and tourists. The spread of open space is caused by the tendency of the use of space.

![Figure 4](image)

**Figure 4.** The pattern of green infrastructure in the Manggar riverbank.

4. Conclusion

The results of the analysis concluded that there were three patterns identified from the distribution of green infrastructure in the village over the Manggar riverbank settlement. Clustered patterns, random patterns, and dispersed patterns are found in all variables with different amounts. Clustered patterns are found in the distribution of vegetation. This result shows that the priority of the Manggar village community readiness in preparing the green infrastructure of settlements is available on vegetation. The clustered vegetation does not show a relationship with fishing activities, but rather tourism activities. Green infrastructure that is dispersed according to the use of fisheries space is lighting and public buildings with random patterns.
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