The Impact of Spatial Patterns of Bunaken Subdistrict Settlements on Mangrove Ecosystems in Manado Coastal City

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Abstract. Based on the results of the studies by Sasauw et al (2016), the ecological conditions in the area of mangroves in Manado city is unstable, evidenced by the low diversity of species R. apiculata, although density and frequency of species have high value. Bunaken is one sub-district in the coastal city of Manado, consisting of five sub-rurals, where the 3 villages (Molas, Meras and Tongkaina Neighborhood) are located in the coastal area and 2 sub-districts, such as Pandu and Bailang neighborhood are in mountainous regions. Residential area bordering the Bahowo mangrove area (84 ha) is green open space as Manado city protected area. To obtain and analyse data on settlement patterns, the ArcGIS software with satellite map is utilized and observations of the infrastructure condition are conducted in the three areas of urban villages located on the shore (adjacent to the area of mangrove forests). The results indicated that the housing pattern of three villages is the combination form (linear and cluster), but linear form is more dominant. In general, the pattern of residential infrastructure networks, especially roads and drainage channels (grey water) is dominant in the direction of the road network and ends in the mangrove forest area.

1. Introduction
The growth and development of the city become very significant centre of consumption of resources, where in the last decade, more people live in cities than outside them [1, 2] and this trend will continuously increase to 90% by 2100 (Fragkias, Lobo, Strumsky, & Seto, 2013) [2]. The rapid development of the city increases the demand for urban housing and Manado as one of the developing cities in Indonesia. In the past, several rural areas become now urban areas, including the Bunaken sub-district. Based on the City Regulation of Manado Number 1 in 2014, the city of Manado is divided into 6 sub-city service centres, where the Bunaken Subdistrict is located in the sub-service centre city V with three service functions, including: 1) settlement, 2) trade & services, and 3) tourism. Convergence of economic activities in coastal areas of the city of Manado can lead to land use conflicts that are very difficult to resolve, reducing the quality of coastal resources without management and protection (Sjafi’i 2001). The mangrove forest area covers the Bunaken and Bunaken sub-districts, as one of the wetland resources in the coastal area and as a buffer for life and natural wealth that is important to environmental services for the city of Manado. According to the Presidential Regulation of the Republic of Indonesia Number 73 of 2012 concerning the National Strategy for Mangrove Ecosystem Management, it is necessary to protect, preserve and sustainably use for the welfare of the community.
Sasauw et al. (2016) found that mangrove forest diversity was in an unstable condition, evidenced by the low diversity of species of *R. apiculata*, although the density and frequency of species had high values. Whereas, mangrove forests function as a link between marine and terrestrial ecosystems important for the stability and maintenance of various adjoining ecosystems such as seagrass, coral reef, and other marine ecosystems, providing habitats for juvenile crustaceans and fish [3]. Mangroves also contribute significant quantities of organic matter (OM) through litter fall that can be transported offshore (Odum and Heald, 1972; Alongi, 1990) [3]. Prasad et al discovered that amount of litter produced in a mangrove forest directly affects the particulate organic matter (POM) between mangrove forests and adjacent marine habitats [3]. Nowadays, many of the most productive mangrove forests in the world lose a significant fraction of their net primary production to coastal waters (Robertson et al., 1992; Jennerjahn and Ittekkot, 2002) [3].

As a result, population growth has resulted in increased demand for residential land, while the community settlement pattern in the coastal area of Bunaken Subdistrict is on a sloping topography with the main drainage network in the gravitational area leading to the protected area of the Bahowo mangrove forest. Alberti et al and Marzluff (2001) expressed that the urbanization has an impact on change natural habitats and species composition (Blair, 1996), disrupting hydrological systems (Arnold and Gibbons, 1996; Booth and Jackson, 1997), and modifying energy flow and nutrient cycles (McDonnell and Pickett, 1990; Vitousek et al., 1997; Grimm et al., 2000) [4]. Due to the settlement pattern in the Bunaken sub-district, there was a change in the quality of mangrove natural forests.

Tongkagie (2003) noted that Bunaken National Park (BNP) encompasses about 89,056 hectares of land and sea area, divided into a southern mainland section (the Arakan Wowontulap coast, protected primarily for its old-growth mangrove forests and dugong population) and a northern island section (including five islands with its fringing coral reefs and a mainland section). The area of mangrove forest in Bunaken sub-district included mainland section of BNP located in the urban area of Manado, as a green open space for the urban neighborhoods area of Molas, Tongkaina and Meras.

Today, the city of Manado has currently been planning the development of its territory, including at the sub-district Bunaken. The development plans refer to the guidelines of coastal area and small islands zoning plan (RZWP3K), whereas the designation of coastal areas is the area with general use, conservation areas, strategic areas and grooves. However, according to Law Number 1 of 2014, the classification of areas in coastal areas and small islands, includes: conservation areas, public use areas, sea lanes, certain national strategic areas. The coastline length of the three villages covers: Molas 3.77 km, Tongkaina 3.77 km and Molas 4.13 km used as a public utilization area and conservation area

| Zone                              | Utilization                                      |
|-----------------------------------|-------------------------------------------------|
| Public utilization area           | Tourism                                        |
|                                   | Settlements                                     |
|                                   | Port                                            |
|                                   | Agriculture                                     |
|                                   | Mining                                          |
|                                   | Fishery                                         |
|                                   | Aquaculture                                     |
|                                   | Industry                                        |
|                                   | Public Facilities, and/or                       |
|                                   | Other uses are in accordance with bio geophysical characteristics of the environment. |
| Conservation area                 | Coastal and island conservation areas small     |
|                                   | Maritime Conservation Area                      |
|                                   | Marine Protected Areas                          |
|                                   | Shoreline                                       |

Table 1. Distribution of Allocation of Coastal Areas
| Zone                          | Utilization                                                                 |
|------------------------------|------------------------------------------------------------------------------|
| Particular national strategic areas | Management of maritime boundaries of sovereignty country                      |
|                               | State Defence And Security                                                    |
|                               | Management Of World Heritage Sites                                           |
|                               | Community Welfare; And / Or                                                  |
|                               | Environmental Conservation                                                   |
| Sea lanes                     | Cruise flow                                                                  |
|                               | Underwater Pipes / Cables; And                                               |
|                               | Migration Of Marine Biota                                                    |

Source: the guidelines of coastal area and small islands zoning plan (RZWP3K), 2013

Urban patterns influence the feasibility of using alternative systems to supply resources and services to the urban population; thus, indirectly affecting their environmental impact [4]. Kostof (1983 and Kardi et al (2014) expressed settlement patterns are based on the nature of the community consisting of two types, such as: Community Groups, face to face and combination types. Sub Community Groups are clustered settlement patterns, consisting of several units or groups of residential units, focusing on important spaces, such as drying, public open spaces, mosques and so on (Figure 1). Whereas, face to face type is the settlement pattern of linear shape, between units of residential housing and linearly along the bearing hub of activity that contained a boat mooring or dock, drying room, markets and so on (Figure 1).

![Figure 1](image-url)  
Figure 1. Distribution patterns of settlements based on the community [6]

2. Methods
The study was conducted in three urban villages on the coast of Bunaken Sub-district, Manado City, including Kelurahan Tongkaina, Molas, and Meras (Figure 2). The map of Bunaken was obtained from Google Earth based on the Google Earth imagery projecting a map of the settlement. Primary data was obtained from field surveys for actual data validation of object settlements.
Visual analysis was conducted by the Google Earth imagery interpretation, to identify and interpret the image based on the appearance as seen in the image. Appearance seen in the image will be similar to the appearance of an existing field. The images obtained from Google Earth are digitized to obtain the settlement pattern of the Tongkaina village, Molas village and Meras village. Analysis of the distribution pattern by visual interpretation method is conducted by observing the settlement pattern, either cluster-type or linear type.

3. Results and Discussions
From the results of the field survey, it was found that the settlement pattern of the Molas Village was generally a linear pattern following the road pattern. Settlement land is at an altitude of 8-18 meters above sea level (Figure 4). Building orientation in this research area faces from north-south with its orientation facing the road (face to face) (Figure 5)
From the survey, it was found that the general settlement patterns in the Meras Village area were cluster patterns following the path and clustering. The residential land area is at an altitude of 22-54 meters above sea level (Figure 6).
Based on the results of the field survey, it was found that the settlement pattern in Tongkaina Village was a longitudinal linear pattern following the main road. The residential area is at an altitude of 12-28 meters above sea level (Figure 8) and the orientation of the building faces from north-south and west-east with its orientation facing the road (face to face) (Figure 9).

4. Conclusion
Settlement patterns in the villages of Molas, Tongkaina and Meras are linear patterns with orientation facing the main road and at an altitude of 8-54 meters above sea level. Waste water flows from every house flowed into urban drainage and ends in sea waters or mangrove habitat.
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References

[1] Swilling, M., & Annecke, E. (2012). Just Transitions: Explorations of Sustainability in an Unfair World. Claremont, South Africa: Tokyo, Japan: United Nations University Press

[2] Paola Pulido B. 2015. The Behaviour of Cities: Theoretical Framework for Urban Metabolism from an Ecological Perspective. Thesis. Univeriteit. Utrecht

[3] Prasad B.K, Dittmar T and AL Ramanathan. 2010. Organic Matter and Mangrove Productivity in Management and Sustainable Development of Coastal Zone Environments. Springer. UNESCO. New Delhi India.

[4] Alberti. M et al. 2007. The impact of urban patterns on aquatic ecosystems: An empirical analysis in Puget lowland sub-basins. Landscape and Urban Planning 80 (2007) 345–361

[5] Toengkagie, M.A. 2003 . Bunaken National Park, North Sulawesi (Indonesia) Charting a new course for the co-management of the Bunaken National Park North Sulawesi, Indonesia. http://agris.fao.org/agris-search/search.do?recordID=PH2004000965 diakses 20 Januari 2019

[6] Wardi et al. 2014. Characteristics And Changes In Patterns Of Settlement Fishermen Karang Panas Environment, South Ampenan Mataram City. Jurnal Penelitian UNRAM, Agustus 2014. Vol 18 No. 2