Pattern of land use change base on environmental carrying capacity in small island: a case of Weh Island

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Abstract. As a small island in the western of Indonesia, Sabang has a natural seaport with an ideal depth to dock between intercontinental ships that cross the Malacca Strait every day. But why does the city of Sabang not rise its economy, while the interest of foreign tourists seems to be endless to visit Sabang to date. Realizing this, the author will present the research process that is being carried out in relation to land use change in Weh Island. The research methodology is based on the design development, by assessing the environmental carrying capacity and analysis related to the input and output of materials for the daily needs of the residents of Sabang which are still very much related to supply from the mainland of Aceh and other regions in Indonesia. The supply of goods from abroad has not significantly affected of the environment. Through the Environmental Carrying Capacity analysis, it will greatly assist the control and spatial planning of Sabang City in terms of providing land for the built environment in Weh Island.

1. Introduction
As a developing city in line with the growth of economic activities of the community, the city of Sabang is currently experiencing economic activity development, especially in the downtown area and the port area. This phenomenon of change must be controlled through urban area planning tools through the Sabang City Spatial Plan (RTRW) products and the design of urban space areas in more detail through the Guidelines for Detailed Spatial Planning Areas (RDTRK) of Sukajaya District and Sukakarya District, as well as Building and Environmental Planning (RTBL) the central area of Sabang city. The city must always have the identity and character. Image of the city of Sabang which is very well known as a natural port in the heart of the Weh Island. If the spatial planning of the city of Sabang as a tourist city is done well, it will be accepted by the community because it provides a real contribution to the development of the quality of people's lives. However, how is the response of the community if the arrangement of the central area of Sabang city which has been visited by many foreign tourists so far is not as beautiful as in photos and design drawings, even eliminating elements of urban spatial structure and space patterns that have been formed for a long time and have been included in the Qanun of City Spatial Planning Sabang in 2007-2027 (RTRW Sabang, 2007-2027). Spatial Planning has explained the spatial function to get a safe, comfortable, productive and sustainable atmosphere and environment that must be achieved in every region of the Republic of Indonesia in accordance with the mandate of the 1945 Constitution, namely to prosper the lives of Indonesian people.
2. Materials and Methods
Weh Island is geographically located between 95° 13' 02" and 95° 22' 36" East Longitude, and between 05° 46' 28" and 05° 54' 28" North Latitude. Geographically, this region is the most Western administrative region of Indonesia, and is directly adjacent to three neighboring countries, namely Malaysia, Thailand and India. The city of Sabang consists of five islands, namely Weh Island (121 km2), Rubiah Island (0.357 km2), Seulako Island (0.055 km2), Klah Island (0.186 km2), and Rondo Island (0.650 km2). This study only focused on Weh Island from five islands in the Sabang City region considering the most rapid trading activity on the island. In addition, on Pulau Weh there is a freshwater lake named Lake Aneuk Laot which is the main source of fresh water for people's lives, the tourism industry and the need for passing ships.

Weh Island is a volcanic island, a coral island where the process of experiencing elevation from the surface of the sea. The process of occurring in three stages is evident from the presence of three terraces located at different heights. Weh Island consists of two types of rocks, namely tuff marina and core rock. The marina tuff is found almost along the coast up to an altitude of 40 to 50 meters. The widest tuff layer is around the city of Sabang (RTRW of Sabang City, 2012-2032).

Small islands are defined from the Decree of the Minister of Maritime Affairs and Fisheries No. 41/2000 Jo Minister of Maritime Affairs and Fisheries No. 67/2002 is an island with the size or equal to 10,000 km2, the population is less or equal to 200,000 inhabitants. The characteristics of small islands are ecologically separate from their main islands, have clear and remote physical boundaries from the main island habitat, so they are insular; and high value; unable to influence the hydroclimate; have a relatively small water catchment area so that most of the surface flow and sediment enter the sea. [4, 8, 9].

3. Results and Discussion
Existence of human activity in subsistence would generate waste or waste. Along with the rate of population growth and increased demand for life, the production of waste produced by humans is expected to tend to increase from year to year. Waste will cause many problems if not handled properly.
As a town on a small island in the Province of Aceh, Weh island located on the western Indonesia cannot be separated from the problem of waste, especially solid waste.

Since it was founded by the Dutch in 1881, Sabang serves as a port city that is used for international shipping. Sabang never became as the Free Port and the Free Trade Area in 1970, but was closed in 1985. Sabang is located in the economic development in the South Asian region with the establishment of the Regional Economic Cooperation Indonesia-Malaysia-Thailand Growth Triangle (IMT-GT) on 1993. After the establishment of Sabang as Integrated Industrial Development Zone (KAPET) in 1998 and in 2000 passed Law No. 37 of 2000 on the Free Trade Zone and Free Port of Sabang, an increase in the activity of the free port, but in 2004 the activity stopped because Aceh is set as the Regional Military Emergency. Then Sabang also experienced Earthquake and Tsunami disaster on December 26, 2004.

Sabang is also known as a tourist area under the sea and the unique nature and the "Ground Zero" of the Indonesian archipelago. The rate of population increase and the intensity of the current number of tourists who visit Sabang, causing the need clothing, housing and food increased. The number of tourists per year who visit Sabang reach 4 times the population of Sabang, where the population of Sabang 30 653 people and the number of Travelers to Sabang travelers as much as 121 646 people locally and 3,932 people of foreign tourists in 2010. While the amount of additional tourist arrivals in 2017 has experienced a surge in the number of residential and tourist facilities are built sporadically by the public and investors. For it is necessary to study the built environment as aspects of Sabang city environmental capacity.

As an island, geographically the island of Weh Sabang limited land and natural resources, so it is very dependent and requires a supply of raw materials and foodstuffs from outside the island, especially the city of Banda Aceh. As in the know that the agenda of the UN 21 signaled the many challenges faced in the planning and implementation of sustainable development on an island, limited natural resources, is also geographically isolated and highly dependent on other regions [1]. Sustainable development of an island can be reached by the management of the resources consumed and the protection of ecosystems resulting in minimization of pollution. Waste generated, both liquid and solid waste, including aspects that significantly affect the ecological degradation of the island, let alone alternative treatment and waste management in an island very limited. Based on early studies that focus on this study is the quantity of solid waste, particularly solid waste public consumption results Weh island, Sabang. Solid waste is calculated mainly enter the final disposal (landfill), assuming that the main contributor comes from domestic waste. Solid waste is related to the goods consumed, so to determine what material is consumed Sabang community has made observations and research in the port of Ulee Lheu -Banda Aceh and port Balohan-Sabang as a gateway out of the goods from and to the island of Weh.

Changes in land use within a certain period can be analyzed by land use change and land cover (LULC) methods. Analysis of land changes in Weh - Sabang Island is carried out using satellite images obtained from Google Earth, which is an independent software program that provides satellite and imagery of the Earth. The method also follows from what has been done by several previous researchers [2, 5, 6, 7].

| No | Land Use                  | Area (Ha) | %    |
|----|---------------------------|-----------|------|
| 1  | Forest                    | 8,229.92  | 53.82|
| 2  | Plantations / fields / paddy fields | 4,943.35  | 32.32|
| 3  | Lakes / ponds             | 189.69    | 1.246|
| 4  | Grasslands / open land    | 944.28    | 6.18 |
| 5  | Built Area                | 798.32    | 5.22 |
| 6  | Special area (Harbour / Airport) | 185.13    | 1.21 |
|    | Total                     | 15,290.68 | 100  |

**Table 1. Land Use in Sabang City in 2002-2008**
| No. | Land Use                      | Area (Ha) | %  |
|-----|-------------------------------|-----------|----|
| 1   | Forest                        | 6,814.78  | 41.7 |
| 2   | Plantations / fields / paddy fields | 5,780.28  | 37.8 |
| 3   | Lakes / ponds                 | 67.54     | 0.44 |
| 4   | Grasslands / open land        | 1,300.34  | 8.5  |
| 5   | Built Area                    | 1,554.23  | 10.16|
| 6   | Special area (Harbour / Airport) | 211.92    | 1.38 |
|     | **Total**                     | **15,290.68** | **100** |

Source: BPS Data Processing of Sabang City in 2008-2018, RTRW of Sabang City 2004-2014

Table 3. Land Use in Sabang City in 2015-2018

| No. | Land Use                      | Area (Ha) | %  |
|-----|-------------------------------|-----------|----|
| 1   | Forest                        | 6,072.89  | 39.7 |
| 2   | Plantations / fields / paddy fields | 4,582.04  | 29.96|
| 3   | Lakes / ponds                 | 45.25     | 0.29 |
| 4   | Grasslands / open land        | 1,752.1   | 11.45|
| 5   | Built Area                    | 2,642.2   | 17.27|
| 6   | Special area (Harbour / Airport) | 196.2     | 1.28 |
|     | **Total**                     | **15,290.68** | **100** |

Source: Google Earth 2018 analysis result [6].
The most dominant changes in land use and land cover from 2008 to 2018 were the area of built area which increased by about 70% in the last five years, water bodies in Lake Aneuk Laot reduced 33% shrinkage, agricultural land reduced by 20% and forest area reduced by 12%. Land cover around the lake aneuk laot decreases, it will affect the condition of the availability of raw water on the lake. Based on the results of the LUC 2008-2018 analysis, the body area of water was reduced rapidly.

4. Conclusion

The research to be conducted are expected to gain an overview of development management in Weh island contributing to protect the environment the ecosystem of the island itself and preserving the environment were passed on to the generations to come. As mandated in the Environmental Act No. 32 of 2009 in which one of the instruments to protect the environment are products such as spatial. What has been stated in RTRW (Spatial Planning) is the result of a study to be the concept of land use and environmental carrying capacity.

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