Mangrove Distribution Mapping for Sustainable Utilization and Management (Case Study Langsa City, Aceh)

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Abstract. Mangroves are vegetation that has the most crucial role both for coastal ecosystems and human life. However, as the vegetation with the highest productivity globally, mangroves also experience distribution problems caused by anthropogenic activities. The problem of mangrove distribution occurs not only in the world but also in Langsa City, Aceh. Therefore, the distribution of mangroves must be regularly recorded for sustainable management and utilization. One of the uses of technology currently developing for monitoring the distribution of mangroves is remote sensing (mapping). This study aims to map the distribution of mangroves in Langsa City in 2021 so that further studies can be carried out on the management and utilization carried out by stakeholders in Langsa City. The method used in this research is mapping and descriptive analysis. This study uses Landsat 8 OLI image data recorded in 2021. This study provides results (1) the distribution of mangroves in Langsa City based on the administrative boundaries of the city, sub-district, and kelurahan, (2) sustainable and sustainable management and utilization policies of mangroves by stakeholders both for tourist attractions and other activities, to maintain the mangrove ecosystem. The results of this study are the distribution of mangroves in Langsa City of 4,538.44 Ha. The distribution of mangroves is divided into two sub-districts and eight villages. Management and utilization must be carried out by making policies and having clear objectives, so that the sustainability of mangrove distribution will be maintained.

Keywords: Mangrove, Langsa City, Landsat, Distribution, Management

1. Introduction
Mangroves are one of the plants that have tolerance to salt levels and grow well in tidal areas and are spread in tropical and subtropical climates [1]. According to [2] mangroves dominate in low tropical areas and are located on subtropical coastlines ranging between 32 North Latitude and 38 South Latitude. [3] suggested that mangroves have a very important role in maintaining coastal ecosystems, stabilizing, maintaining coastlines, and maintaining biodiversity. [4] stated that mangroves serve as feeders, breeding grounds for various marine and land species, controlling coastal erosion, and as a tourist attraction.

Currently, mangroves around the world are facing various threats to growth and degradation. [5] stated that research and knowledge that discusses and highlights the threat and degradation of mangroves does little to change or solve the problem of global mangrove loss. [3] stated several threats to mangrove growth that occur globally, namely air pollution, deforestation, fragmentation, and rising sea levels. [6] [7] [8] [9] suggested several factors causing damage and threats to mangrove growth such as anthropogenic activities such as urban development, infrastructure, tourism development, conservation for cultivation, agriculture, excessive use of mangrove resources, climate change, and human activities. Threats to mangrove growth are based on increasing population, excessive development in coastal areas, and climate change [10].

Threats to mangrove growth must be managed because of the many benefits provided by mangroves. Mangroves are one of the ecosystems whose management system must integrate joint ownership, due to the condition of mangroves that are threatened, especially in Southeast Asia [11] [12]. Mangrove management must be carried out by all parties, including the government, stakeholders, and the
community. [7] [13] [14] stated that in managing mangroves, community involvement is the basic key in sustainable mangrove management.

Mangrove management is currently taking place globally and is included in the United Nation's Sustainable Development Goals (SDGs). [15] suggested that the [16] set several targets for mangrove management, namely (1) protecting and restoring water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes, (2) manage and protect the seas and coasts in a sustainable manner to reduce significant adverse impacts, (3) conserve at least 10 percent of the coastal and marine areas of the area, and (4) promote the implementation of sustainable management of all types of forests, stop deforestation, restore the degraded.

One way of managing mangroves is by mapping the distribution of mangroves using remote sensing data. Remote sensing has great ability and potential to monitor the distribution and change of mangrove cover [17]. According to [18] remote sensing can obtain various information on mangrove habitat inventory, land cover changes, ecosystem evaluation and productivity assessment, water quality assessment, and disaster management. In addition to the spatial temporal monitoring of mangroves, remote sensing is widely applied to understanding water and soil quality and the level of environmental pollution around mangrove forests. Remote sensing has the advantage of providing various accurate and efficient mapping methods [1].

Mapping the distribution of mangroves by remote sensing must take into account the research area, this is because the resolution capabilities of remote sensing are different. Mangrove distribution mapping is very important because it provides accurate mangrove information for effective mangrove management, climate change mitigation, and the implementation of ecosystem services strategies [19]. Remote sensing data has been widely used for mapping and monitoring mangroves at local, regional, and global levels [20]. According to [21] mangrove mapping using remote sensing with different spatial and spectral resolutions is needed to address various mangrove management needs. One of the most widely used remote sensing data for mapping the distribution of mangroves is Landsat 8. Landsat 8 was launched on February 11, 2013, with 11 channels, and has a panchromatic spatial resolution of 15 meters [1]. The use of Landsat 8 for mapping mangrove information has been carried out by many previous researchers such as mangrove distribution, mangrove species, mangrove zoning, canopy cover, and carbon estimation. Mapping the distribution or area of mangroves is an important mapping done regularly because it is needed for the protection and sustainable management of mangroves berkelanjutan [1] [18] [22].

Langsa City is one of the areas in the eastern part of Aceh Province, Indonesia which has a mangrove ecosystem. Based on research [23] in 2018 the Langsa City mangrove has an area of 1,338.0 Ha. This study aims to map the spatial distribution of mangroves in Langsa City using Landsat 8 imagery. further studies for sustainable management and use by stakeholders, government, and communities in Langsa City.

2. Research Methods

2.1 Research Location

This research was conducted in Langsa City, Aceh Province, Indonesia (Figure 1). Langsa City has an area of 262.42 km2. Astronomically, Langsa City is located at 04°02'35.68'' - 04°03'47.03'' North Latitude and 97°05'14.59'' - 98°00'42.16'' East Longitude. Langsa City is divided into five sub-districts, namely Langsa Lama, Langsa Baro, Langsa Timur, Langsa Barat, dan Langsa Kota.
Langsa City Mangroves have various types, including Avicenia marina, Avicenia alba, Avicenia officinalis, Sonneratia alba, Rhizophora apiculata, Rhizophora mucronata and Bruguiera gymnorrhiza [24]. The various types of mangroves that exist make the distribution of mangroves in Langsa City a good representation for mapping the distribution of mangroves for sustainable management and use.

2.2 Data Processing

The mapping of the distribution of mangroves in this study uses Landsat 8 image data recorded in 2021. The choice of using Landsat 8 (30 Meters) imagery is because Landsat images provide a large-scale overview of mangroves and can be accessed for free on EarthExplorer (usgs.gov) [25]. Landsat 8 imagery in the study area is inseparable from errors during the recording process so corrections are needed so that image data can be extracted properly to get map results that have a high accuracy value (Figure 2).

Data processing in this study consisted of several stages (Figure 3). The Landsat image is processed using geometric correction and radiometric correction. Geometric correction used is image to map, while radiometric correction is radian correction, reflectance, and atmospheric correction (FLAASH). Furthermore, the image is cut according to the study area and multispectral classification. The image resulting from the classification is then carried out a field survey by taking a sample of 30 points (BIG Head Regulation No. 3 of 2014).
Figure 2. Landsat 8 Image Composite Research Area 754 (Source: Data Processing)

Figure 3. Landsat Image Data Processing 8 (Source: Data Processing)
3. Result and Discussion

3.1 Langsa City Mangrove Distribution

Mapping the distribution of mangroves in Langsa City using Landsat 8 images recorded in 2021 RGB composite (432) results from the multispectral classification of the maximum likelihood algorithm, which is divided into four classes consisting of water bodies, built up land, ponds and mangroves (Table 1). Based on the results of the classification of the distribution of mangroves in Langsa City, which is 4572, 51 Ha (53.56%) of the total land use in the mangrove growth area (Figure 4).

| Land Cover Class | Area (Ha) | Percentage (%) |
|------------------|-----------|----------------|
| Water body       | 994.48    | 11.74          |
| Built-up Land    | 118.19    | 1.40           |
| Mangroves        | 4538.44   | 53.56          |
| Pond             | 2822.29   | 33.30          |
| Amount           | 8473.4    | 100            |

Source: Data Processing, 2021.

The total area of image classification based on land use in the study area (mangrove area) is 8473.4 Ha with the largest land use being 4538.44 Ha (53.56%) mangrove and the smallest land use, 118.19 Ha (1.40%). The distribution of mangroves in Langsa City is located in two sub-districts and eight gampongs (kelurahan) (Table 2).
Table 2. Distribution of Mangroves in Langsa City

| Sub-District | Gampong (Urban village)          | Area (Ha) | Percentage (%) |
|--------------|----------------------------------|-----------|----------------|
| Langsa Timur | Gampong Cinta Raja               | 56.07     | 1.24           |
|              | Gampong Sungai Lueng             | 2966.63   | 65.37          |
|              | Gampong Sungai Pauh Tanjung      | 7.52      | 0.17           |
|              | Gampong Sungai Pauh              | 122.25    | 2.69           |
| Langsa Barat | Gampong Simpang Lhee             | 205.38    | 4.53           |
|              | Gampong Seuriget                 | 179.36    | 3.95           |
|              | Gampong Telaga Tujuh             | 135.84    | 2.99           |
|              | Gampong Kuala Langsa             | 865.39    | 19.07          |

| Amount       | 4538.44                          | 100       |

Source: Data Processing, 2021.

Based on Table 2, the administrative areas that have mangrove distribution are East Langsa District of 3,022.7 Ha (66.6%) and West Langsa District of 1549.81 Ha (33.4%). The distribution of mangroves by sub-district is divided into eight gampongs (kelurahan) with the gampong (kelurahan) having the widest distribution, namely Sungai Lueng Village at 2,966.63 Ha (65.37%) and the least distribution being Sungai Pauh Tanjung Village at 7.52 Ha (0.17%).

Figure 5. Mangrove Density Level in Langsa City (Source: Data Processing)
The distribution of mangroves in Langsa City continues to grow from year to year, this increase is not only in the distribution of mangroves but also in the density of mangroves. Mangrove density in Langsa City is divided into three classes, namely sparse class (non-vegetation), medium class, and high class (Figure 5). [23] conducted temporal mangrove mapping in 1996, 2006, 2016, and 2018. Langsa City mangroves in 1996-2006 decreased by 419.04 Ha, in 2006-2016 experienced an increase of 455.75 Ha, and in 2016-2018 experienced a reduction of 330.57 Ha, the reduction in mangrove area occurred due to the high temperature (surface temperature).

3.2 Langsa City Mangrove Management

Until now, research and observations on the distribution of mangroves using remote sensing data are still very limited and have not been widely carried out by related parties or other researchers so that there is a lack of data that can be used as information reference. Mangroves of Langsa City are inseparable from various threats that can cause damage and death of mangroves such as human activities to build buildings, lack of public understanding of the importance of mangroves, environmental pollution, development of coastal areas for mangrove ecotourism, and high surface temperatures. Mangrove management and utilization must be carried out by all parties and have clear and planned goals and are sustainable. Sustainable management and utilization of mangroves depends on how humans (communities) utilize and manage mangroves [26]. Mangrove management in Indonesia is regulated in the Regulation of the coordinating minister for Economic Affairs of the Republic of Indonesia Number 4 of 2017. In this regulation there are several important values in mangrove management, namely ecological values, socio-economic values, institutional values, and statutory values.

[27] stated that the main objective of mangrove management and utilization is to maintain the health of the mangrove ecosystem and reduce the rate of mangrove loss. Mangrove management will be successfully implemented if it is supported by good data, extensive knowledge, good understanding of mangroves, and awareness of the importance of mangrove management. In management, it must be integrated within the spatial framework of stakeholders and between sectors. Mangrove management and utilization has many benefits for the life of living things in symbiosis with mangroves and humans, among others [28] stating that mangroves are one of the most effective trees compared to other trees in absorbing carbon dioxide. [29] suggests that mangroves as a renewable resource must be managed sustainably where the ecological, economic, and social benefits of mangroves provide optimal distribution in meeting the needs of the present generation and without damaging future generations. Therefore, mangrove management must pay attention to and use a comprehensive, integrated, and integrated approach so that it runs in a balanced manner and does not overlap. Mangrove management and utilization in Langsa City can be carried out with several policies, namely (1) maintaining the condition of mangrove forests by preserving, protecting, and improving mangrove forest ecosystems for the benefit of the wider community, (2) developing spatial plans and coastal area management to maintain and improve the sustainability of mangrove forests, as well as ensure the preservation of the function of mangrove forests and community economic growth areas, (3) make a permanent law for the management and utilization of mangrove forests by local governments, communities, stakeholders, and researchers, (4) improve the welfare of regional communities coastal areas through the development of economic activities, (5) making mangrove forest areas only for activities that do not damage or generate waste, and limit development carried out by coastal communities, (6) increase cooperation, coordination, and partnerships between government local governments, stakeholders, and communities so that there is harmonization in the management and utilization of mangrove forests, (7) planting mangroves at predetermined times and observing natural conditions, so that mangroves can live and develop properly, and (8) mapping the mangrove forest area on a regular basis, so as to know the condition of the mangrove forest well.
4. Conclusion

Mangrove mapping in Langsa City based on Landsat 8 imagery is 4,538.44 Ha which is divided into two sub-districts, namely East Langsa District of 3,022.7 Ha (66.6%) and West Langsa District of 1549.81 Ha (33.4%). Mangroves of Langsa City are inseparable from various threats that can cause damage and death of mangroves such as human activities to build buildings, lack of public understanding of the importance of mangroves, environmental pollution, development of coastal areas for mangrove ecotourism, and high surface temperatures. Mapping of mangroves for management and utilization must be carried out on an ongoing basis because of the many benefits provided by mangroves. Mangroves also provide important values for human life, namely ecological values, socio-economic values, institutional values, and statutory values. Mangrove management and utilization of Langsa City must pay attention to and use a comprehensive, integrated, and integrated approach so that it runs in a balanced manner and does not overlap.

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