ANALYSIS OF MANGROVE FOREST ECOSYSTEM DAMAGE IN POLEWALI MANDAR REGENCY THROUGH ENVIRONMENTAL SCIENCE APPROACH

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Abstract. The reduction in the quantity of mangrove forest ecosystems will certainly have a negative impact on the balance of coastal ecosystems, people who live in coastal areas, and of course sustainable development proclaimed by the local government. The research objective is to analyze the damage of mangrove forest ecosystems through Environmental Science approach. One approach to the study in question is the remote sensing approach. The study was conducted throughout August 2018 precisely at Mampie Beach, Wonomulyo Subdistrict, Polewali Mandar District.

The collection of mangrove forest vegetation data was conducted using purposive sampling (systematic plot) technique. The data used in the analysis of damage to mangrove forest ecosystems is the RBI Sheet Polewali Map Scale 1: 50000 BAKOSURTANAL in 1999, SPOT 4 Image in 2014, SPOT 4 Image in 2015, and Digital Globe Image Acquisition 6/9/2016. Data analysis and processing using the Arc-GIS program to analyze SPOT images, overlay and map making using Geographic Information System (GIS) applications, and descriptive analysis for the bio-physical data of mangrove vegetation. Data analysis of mangrove vegetation area in Mampie showed that overall from 1999 to 2016 the area of mangrove coverage experienced a shrinkage of 10.31 ha, namely 35.23 ha (1999) to 24.92 ha (2014). There is one thing that is quite encouraging that in the following year (2015) mangroves in the Mampie area expanded back to 0.58 ha ie to 25.50 ha but shrank back to 0.29 ha the following year (2016). Mampie Beach's total mangrove area became 25.21 ha. The mangrove forest area in Mampie leaves only a few species of mangrove, the most dominating is Avicennia marina (Forsk.) Vierh.

Keywords: Damage, Mangrove, Remote Sensing, GIS, Environmental Science

1. Introduction

Indonesia is the largest archipelagic country in the world which consists of 13,466 islands with a coastline of 99,023 km\(^2\). Indonesia's coastal area is famous for its wealth and diversity of natural resources. Coastal ecosystems such as coral reefs, seagrass beds and mangrove forests are very wide and varied in this country. Indonesia's mangrove forest ecosystem is the largest in the world. Based on data from Kelompok Kerja Mangrove Tingkat Nasional in 2013 shows that the area of Indonesian mangrove forests is around 3.2 million ha. This amount has been very far down (in 1982 the number of Indonesian mangrove forests was around 4.25 million ha) because in general many mangrove forests in Indonesia were converted into residential, tourism, oil palm, and fishpond areas. Polewali Mandar Regency is one of the regencies in West Sulawesi Province which has a total coastline length of 89.07 km. The coastal border area of this area extends from the coast of Binuang.
Polewali Mandar Regency which borders with Pinrang Regency, South Sulawesi Province to the coast of Tinambung Subdistrict which borders with Majene Regency, West Sulawesi Province. Coastal is a region that connects land and sea, so that the coastal area of Polewali Mandar is strongly influenced by processes that are on land and at sea. Throughout the coast this area is found in various types of mangrove vegetation.

Polewali Mandar Regency Spatial Plan Data in 2008 shows the area of mangrove forest in this area is ± 635 ha while the 2013 RTRW data is reduced to ± 237 ha. This shows that in the last 5 years in Polewali Mandar District there has been a decrease in more area from 50% which is 398 ha. The quantity of mangrove forest ecosystem is not separated from the transformation of the mangrove forest ecosystem area into a pond area.

The extent of mangrove forests that experienced degradation both quantitatively and qualitatively was caused by various factors. One of the factors in question is the conversion of the mangrove forest ecosystem area into a pond area (Carong et al. 2015; Arbit et al. 2016). Of course activities that are not based on ecological concepts will result in damage to coastal ecosystems to ecological disasters such as abrasion, seawater intrusion, or tidal flooding. This condition will certainly have a negative impact on the balance of the coastal ecosystem, the people who live in coastal areas, and of course sustainable development proclaimed by the local government.

All stakeholders such as the local government, private sector, coastal communities, NGOs, and academics (researchers) need to take concrete steps to prevent and deal with the Polewali Mandar mangrove ecosystem today. Related research "Analysis of Mangrove Forest Ecosystem Damage Polewali Mandar District Through Environmental Science Approach" became one of the contributions of the mind in maintaining the mangrove forest ecosystem to remain sustainable. The aim of this research is to analyze the level of damage to mangrove forest ecosystems in the area of Polewali Mandar Regency, West Sulawesi Province.

2. Materials and Methodology
2.1 Study Area
The location of this research is the coastline of Polewali Mandar Regency, West Sulawesi Province precisely in Mampie Beach, Wonomulyo Subdistrict, Polewali Mandar District. The selection of the location of the study was carried out deliberately with the consideration that the Mampie Mandar coastline is one of the coastal areas that has a diversity of mangrove forests with very depressed ecological conditions. This research has been carried out in August - October 2018.

![Figure 1. Map of Research Location](image)
2.2. Data Collection
The data used in this study is SPOT 4 Image in 2014, SPOT 4 Image in 2015, and Digital Globe Image Acquisition 6/9/2016. Secondary data used is the RBI Sheet Polewali Map Scale 1: 50,000 BAKOSURTANAL in 1999.

2.3. Data Processing
2.3.1. Data collection
Data collection techniques were carried out by primary and secondary surveys. Primary surveys were carried out by field observation and measurement. While the secondary survey is carried out by reviewing documents obtained from relevant agencies. As for data collection techniques through primary surveys, namely:
- Field observations: Observations are carried out by documenting the conditions in the field. Direct observations related to ecosystem damage that occurred in the study area.
- Field Measurement: This activity aims to determine the level of damage to mangrove forest ecosystems in the study area. For biotic parameters, the existing condition of mangrove forest vegetation.

The sampling technique used was stratified proportionate random sampling. Each unit will be placed in several plots proportionally (depending on the size of the unit). The plot and sub-plot sizes used for each classification of plants are 2x2 m for seedlings and understory; 5x5 m for sapling; and 20x20 m for trees. The number of plots used was 25 in the study area with consideration of the plot size of 20x20 (400 m²) x 25 units = 10000 m² (1 ha).

2.3.2. Data Analysis and Processing Techniques
The research stage uses the following analysis, namely:
- Analysis in the Laboratory using ArcGis software. SPOT 4 Image Analysis was used by the ArcGIS program, and map making, used the Geographic Information System computer using the ArcGis version 10.3 program at the SIG Laboratory, Faculty of Fisheries and Marine Sciences (FIKP) Hasanuddin University.
- Bio-Physical Data Analysis. Data analysis was carried out using the method of compilation into the summary descriptively, by looking at the results of primary data from field observations, information from the community and secondary data on mangrove vegetation (Umar, 2010). To support understanding of vegetation, measured variables such as density, frequency, and dominance are needed in describing the structure and composition of plants (Rotaquio, et al. 2007; Saru, A., 2013; Carong et al. 2015).

2.3.3. Stages of Research Implementation
The first stage is the inventory of mangrove forest ecosystem areas and analyzing the level of damage. The stages are illustrated in the picture below:
3. Results and Discussion
Sampling is divided into 2 measuring units. The first measuring unit is more terrestrial and the second measuring unit is more towards the water. The first unit of measurement consists of 14 observation plots and the second measuring unit consists of 11 observation plots. A total of 25 observation plots.

Figure 2. Framework for Research Procedures

Figure 3. Map of Research Points
3.1. Mangrove Vegetation Observation Results
The results of observations conducted in Mampie Beach in Wonomulyo Subdistrict with 25 retrieval points showed that there were 4 types of mangrove vegetation. The types of vegetation found at observation points for the tree category were *Avicennia marina*, *Lumnitzera racemosa*, *Rhizophora stylosa*, and *Scyphiphora hydrophyllacea*. *Avicennia marina* mangrove vegetation is very dominant in the study area.

Mangrove associates found at research sites such as *Acrostichum aureum* Linn., *A. speciousum* Willd., and *Excoecaria agallocha* L. (true mangrove groups) were also found around the observation point (but in very small amounts). *Calotropis gigantea* L. Dryander, *Ipomoea pes-caprae*, *Melastoma candidum* D. Don, *Morinda citrifolia*, *Hibiscus tiliaceus*, and *Aturvium portulacastrum* (L.)

3.2. Land Change Analysis Through Remote Sensing Approach
Analysis of land changes is done using the overlay method using ArcGIS software. The data used as an analysis of forest change is the RBI Sheet Polewali Scale Scale 1: 50000 BAKOSURTANAL in 1999, SPOT 4 Image in 2014, SPOT 4 Image in 2015, and Digital Globe Image Acquisition 6/9/2016. The land change data is presented in the following table:

| No | Year | Area (Ha) | Data Source | Loss (Ha) | Time Range (Year) |
|----|------|-----------|-------------|-----------|-------------------|
| 1  | 1999 | 35.23     | RBI 1999    | 0         | 0                 |
| 2  | 2014 | 24.92     | SPOT4       | 10.31     | 15                |
| 3  | 2015 | 25.50     | SPOT4       | -0.58     | 1                 |
| 4  | 2016 | 20.44     | Digital Globe | 5.06   | 1                 |

Data analysis of mangrove vegetation area in Mampie showed that overall from 1999 to 2016 the area of mangrove coverage experienced a shrinkage of 10.31 ha, namely 35.23 ha (1999) to 24.92 ha (2014). There is one thing that is quite encouraging that in the following year (2015) mangroves in the Mampie area expanded back to 0.58 ha ie to 25.50 ha but shrank back to 5.26 ha the following year (2016). Mampie Beach's total mangrove area was 20.44 ha.

The change in Mampie mangrove area is generally caused by the conversion of mangrove land into pond areas. In addition, the surrounding natural conditions are also one of the main contributors to the shrinking of Mampie's mangrove area. Mangrove forest in Monoma of Wonomulyo Subdistrict has been damaged for a long time and suffered great damage since Wonomulyo was established as an area for the development of pond aquaculture in the 1970s to date. To overcome the rate of damage, the government set Mampie area as a green area. In 2015 due to the conflict between the government and the community related to the management of the mangrove forest ecosystem area which was very long and tough, the government whitened the Mampie mangrove area.
4. Conclusions and Recommendations

4.1. Conclusion

The conclusions that can be drawn from this study are changes in mangrove vegetation area other than caused by land conversion (conversion of mangrove forests to ponds) also occur due to the surrounding natural conditions (coastal abrasion). The total loss of Mampie mangrove area from 1999 to 2014 was 10.31 ha.

4.2. Recommendation

There needs to be special attention from the Polewali Mandar District government towards the rate of land change, especially the conversion of mangrove land into ponds, given the importance of mangroves in maintaining the stability of coastal ecosystems.

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REFERENCES

[1] Arab, N. I. S., F. R. Arifin, S. R. Carong, 2016, Valuasi Ekonomi Sumber Daya Hutan Mangrove Di Kabupaten Polewali Mandar, Jurnal Phinisi Vol. 11 No 2 Hal: 63-146, 2016
[2] Badan Perencanaan dan Pembangunan Daerah, 2008, Rencana Tata Ruang Wilayah (RTRW) Kabupaten Polewali Mandar 2008, Polewali Mandar : BAPPEDA.
[3] Badan Perencanaan dan Pembangunan Daerah, 2012, Rencana Tata Ruang Wilayah (RTRW) Kabupaten Polewali Mandar 2012 -2032, Polewali Mandar : BAPPEDA.
[4] Brewer, R., 1994, The Science of Ecology, United States of America : Saunders College Publishing.
[5] Carong, S. R. T. Gunawan, S. Hadisusanto, 2015, Kajian Kerusakan Ekosistem Hutan Mangrove Akibat Aktivitas Manusia Studi Kasus Pesisir Pantai Mampie Kabupaten Polewali Mandar. Tesis. Universitas Gadjah Mada.
[6] Kelompok Kerja Mangrove Tingkat Nasional, 2013, Strategi Nasional Pengelolaan Ekosistem Mangrove Indonesia, Jakarta : KKMTN.
[7] Kusmana, C., Dewanti, R., Onrizal, dan Budhiman S., 2003, *Pemanfaatan Penginderaan Jauh Untuk Memantau Kerusakan Hutan Bakau*, Jakarta: LAPAN.

[8] Lewis, R.R., and Streever, B. (2000). *Restoration of mangrove habitat*, WRP Technical Notes Collection (ERDC TN-WRP-VN-RS-3.2), U.S. Army Engineer Research and Development Center, Vicksburg, MS.

[9] Lewis, R. R., Brown B., 2014, *Ecological Mangrove Rehabilitation : A Field Manual For Practitioners*, Restoring Coastal Livelihoods Program.

[10] Rotaquio, E. L., N. Nakagosji, dan R. L. Rotaquio, 2007, Species Composition of Mangrove Forests in Aurora, Philippines – A Special Reference to the Presence of *Kandeli candel* (L.) Druce, *International Development and Cooperation* 13 : 61 – 78.

[11] Saru, A., 2013. *Mengungkap Potensi Emas Hijau di wilayah Pesisir*. Makassar: Masagena Press

[12] Satyanarayana, B., I. F. Idris, K. A. Mohamad, M. L. Husain, A. M. Shazili, dan F. D. Guebas, 2010, Mangrove species distribution and abundance in relation to local environmental settings: a case-study at Tumpat, Kelantan Delta, east coast of peninsular Malaysia, *Botanica Marina* 53 : 79-88.

[13] Upadhyay, V.P., P.K. Mishra, dan J.R. Sahu. 2008. Distribution of mangroves species within Bhitarkanika National Park in Orissa, India. *Trees for Life*