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THE APPLICATION OF REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM FOR MONITORING CHANGES IN MANGROVE FOREST AREA IN TOROSIAJE VILLAGE

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ABSTRACT

This study aimed to analyze the changes in the area of mangrove forests over the last 5 years (starting from 2019-2023) and formulate management strategy directions for those damaged in Torosiaje Village, Popayato District, Pohuwato Regency. The method used was image interpretation and interviews. Landsat 8 image interpretation method for changes in mangrove cover area over the last 5 years. Methods of interviewing and filling out questionnaires to related agencies and the local community in Torosiaje Village. Data analysis used SWOT analysis to determine the strategic direction for mangrove management. The result of the image interpretation showed that the area of mangrove forest in Torosiaje Village in 2020 saw a reduction in the area of 1.04 Ha from 2019. In 2021, there was an increase in the area of 1.68 Ha since 2020, and in 2022, there was another increase of 1.68 Ha. 3.13 Ha since 2021, and in 2023, there was another increase of 6.86 Ha since 2022. Meanwhile, the results of the priority analysis of mangrove ecosystem management strategies in Torosiaje Village are based on the results of the analysis carried out; 3 things become tactical decisions for recommendations in management efforts regarding the mangrove ecosystem, such as increasing public knowledge and awareness about the function of the mangrove ecosystem as well as the skill of the community around the mangrove area, strengthening the institutional management of the mangrove ecosystem area and Torosiaje tourism, creating a waste and waste processing system

Keywords: Landsat 8, Mangroves, Mapping, SWOT, Torosiaje.

INTRODUCTION

Indonesia is an archipelagic country that is rich in potential coastal natural resources with a diversity of ecosystems. The mangrove ecosystem is one of the main ecosystems in Indonesia's coastal areas that has an important role in human life. Mangrove ecosystems are one of the balancers of coastal areas that have an important role in physical, ecological, and economic aspects. The physical function of mangroves is to resist abrasion, protect the coastline, and filter trash. Meanwhile, the ecological function of mangroves is as a spawning ground for fish, crabs, and land animals (Firdaus et al., 2019). The economic function of mangroves is as a mangrove ecotourism site, fishery source, oxygen source, food source, firewood producer, batik dye and others (Isman et al., 2019). Apart from its economic function, several factors cause a

decrease around mangroves, including illegal logging, natural factors, and changes in land function to fishponds (Ulqodry et al., 2021). Meanwhile, according to (Asri, 2022), the factors that can cause an increase around mangroves are the transfer of land functions, which were initially empty land and then converted into mangrove land, as well as changes in seawater, which affect the nutrients they carry.

Besides being rich in resources, coastal areas are also densely populated areas. Around 60% of Indonesia's population lives within a radius of 50 km from the coastline (Yonvitner et al., 2019). Therefore, coastal areas are very vulnerable to various threats, such as what happened in several areas in Indonesia, one of which is the Torosiaje coast. The mangrove area in Torosiaje Village is currently under threat. This is due to the pressure of economic interests, such as pond aquaculture activities and the development of residential areas, causing the loss of the function of mangrove areas as a buffer for coastal ecosystems and a decrease in fishery resources.

Based on these problems, the researchers are interested in conducting a study entitled "The Applications of Remote Sensing and Geographic Information Systems for Monitoring Changes in Mangrove Forest Area in Torosiaje Village". Remote sensing and GIS, especially with Landsat 8, are important for mangrove forest monitoring because it allow efficient, extensive, regular monitoring and in-depth spatial analysis. This supports a better understanding of environmental change, conservation planning and mangrove management.

The application of remote sensing technology to monitor mangrove ecosystems in Torosiaje Village has never been done before. For this reason, it is necessary to conduct a study that can estimate the potential size of mangrove ecosystem resources by utilizing remote sensing and geographic information systems and formulating management strategies as material for consideration in carrying out better management. The purpose of this study was to analyze changes around mangrove forests over the last 5 years (starting from 2019-2023) and formulate strategic directions for managing mangrove ecosystems in Torosiaje Village.

MATERIAL AND METHOD

Time and Place

This research was carried out for 4 months, from June to September 2023, in Torosiaje Village.

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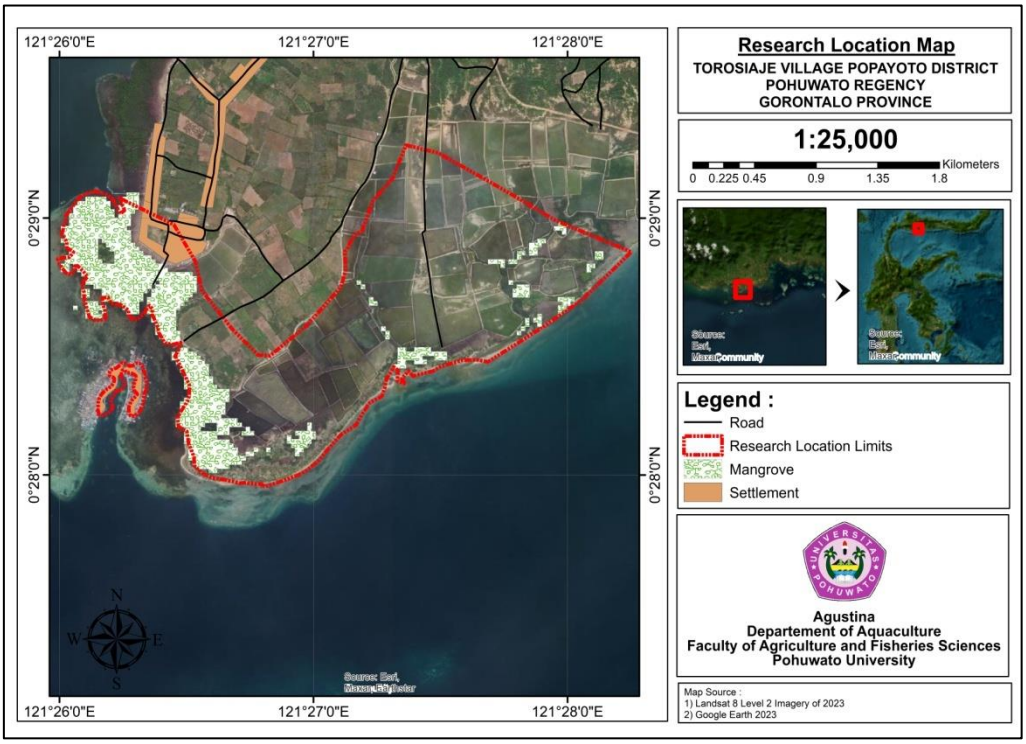

Figure 1. Research Location Map

Tools and materials

The tools and materials used in this study are cameras for documentation, GPS to determine the position of observations, personal computers to input image data, ArcGIS 10.8, and ER-Mapper 7.0 software to process image data, earth maps, Landsat 8 imagery for 2019 – 2023, and stationery and questionnaires.

Data Types and Sources

The data used in this research consisted of primary and secondary data. Primary data were obtained based on direct observation at the research location based on observations and interviews with multi-stakeholders related to the research topic. There were 45 questionnaires collected in this research. The interview method used in this research was the Semi-Structured method with stakeholders, including community leaders, agency representatives, and 1 person each from the Marine and Fisheries Service and the Pohuwato Regency environmental service. Meanwhile, secondary data were data that has been processed and obtained indirectly through data documents from literature reviews from various other sources of information related to research. The secondary data from this research is the administrative map of Torosiaje Village obtained from the National aviation and Space Agency Parepare.

Method of Collecting Data

Regarding the research objectives, this research was a descriptive study. Descriptive data collection techniques were done by

surveying and mapping. The mapping method, in this case, information system technology and geographic and remote sensing based on satellite imagery, a method that was widely used for monitoring the condition of an area and can provide spatially based data effectively and efficiently, as was done by several previous researchers (Heumann, 2011; Giri et al., 2011). The survey and mapping method is research conducted in a large area within a short period.

In the accuracy test, the researcher used a purposive sample technique. The number of samples taken was 20 points. A purposive sampling technique was chosen to ensure a good representation of variations in mangrove conditions in the region. With 20 sample points, this research has a strong basis for testing the extent to which satellite imagery reflects actual conditions on the ground and to validate the results of mangrove mapping with higher accuracy. The formula for determining the accuracy value:

$$\frac{\text{Number of correct sample points in the field}}{\text{Total number of sample points}} \times 100\%$$

Data Analysis

Determination of changes around mangrove cover in Torosiaje Village was done using image data at different times. The image data used was Landsat 8 satellite imagery from 2019 to 2023 in digital format, with less than 20% cloud cover and a map of the Earth's likeness. Landsat 8 satellite imagery was downloaded for free on the website https://earthexplorer.usgs.gov. with OLI/TIRS Collection 2 Level-2 image type with a spatial resolution of 30 meters. The image was processed using Er Mapper 7.1 and ArcGIS 10.8 software. Visual analysis was performed based on the results of object identification. Several stages were carried out in image processing, including image pre-processing, image cropping, composite band, image sharpening, and image classification. Image cropping aims to focus on the area to be studied. Classifying objects will also lighten the workload of personal computers. Image data is cut to separate areas used as objects in each required band (Saputra et al., 2021). After that, it continued with the digitization process of image interpretation, overlay, and map layout. Furthermore, the calculation of the level of accuracy was carried out after analysis and interpretation to determine the accuracy of the analysis process and the results of the interpretation carried out. According to Short (1982) and Estes, accuracy values with an accuracy level of ≥ 80% are considered accurate. Calculations are carried out by determining samples as objects in the latest image. The coordinates of this sample were recorded and

compared with the conditions in the field to see whether they correspond to the actual conditions in the field.

SWOT analysis (Strength, Weakness, Opportunity, and Art) is used to formulate a mangrove ecosystem management strategy, which is qualitative by systematically identifying the various factors surrounding it. The analysis is based on logic that maximizes strengths and opportunities but can simultaneously minimize weaknesses and threats. The steps taken in the SWOT analysis are (1) Identification of strengths, weaknesses, opportunities, and threats; (2) SWOT analysis; (3) Management strategy directions for the results of the SWOT analysis (Rangkuti, 2018).

RESULTS AND DISCUSSION

Overview of Research Locations

Torosiaje Village is a village located on the coast of Tomini Bay, Popayato District, Pohuwato District, Gorontalo Province. In 2005 Torosiaje Village underwent division into three villages namely Torosiaje Village (village above the sea of Tomini Bay), Torosiaje Jaya, and Bumi Bahari which are on land. The area of Torosiaje is around 230 hectares with a population of 1,478 recorded up to 2022 with most of the population embracing Islam (100%) and working as fishermen as well as fish cultivators (around 95%), the rest being boat taxi service providers, traders, carpenters. boats, buildings, workshops, and others.

Torosiaje Village, also known as Kampung Bajo, is located above the seawater of Tomini Bay, which is predominantly inhabited by the Bajo tribe. One of the tourist objects is the mangrove forest, snorkelling, diving, and the lifestyle of the Bajo people, who are the strongest magnet or attraction for Torosiaje. Almost all families have boats instead of motorbikes or cars, just like people who live on the mainland.

The condition of the ecosystem in the Torosiaje coastal area such as mangroves, seagrass beds, and coral reefs is still relatively good. Based on the results of an interview with one of the community leaders in Torosiaje, there are around 125 hectares of mangrove forest spread across three villages, namely: Torosiaje, Torosiaje Jaya, and Bumi Bahari Village. This condition is supported by the local wisdom of the Bajo community which contains the values of preserving coastal ecosystems. In addition, the Torosiaje Village community has also formed an environmentally conscious fishing group with the name "Paddakauang Environmental Awareness Group (KSL)" which consists of three villages in the Bajo Tribe village, namely: Torosiaje, Torosiaje Jaya, and Bumi Bahari Village. KSL Paddakauang is chaired

by Umar Pasandre, who is a native of the Bajo tribe. One of the tasks of the KSL Paddakauang fishermen group is to protect the marine ecosystem by planting mangroves.

Changes in Mangrove Cover Area

Changes around mangrove cover in Torosiaje Village were observed using remote sensing technology and geographic information systems. The image data used is Landsat 8 image data with recordings for 2019, 2020, 2021, 2022, and 2023 where there is no cloud disturbance at the research location making it easier for analysis. The results of the interpretation of mangrove forests from 2019 to 2023 are overlaid to obtain a map of the distribution of mangroves from 2019 to 2023. The data obtained from image processing is presented in map form. Based on the interpretation of Landsat 8 satellite images for 2019, 2020, 2021, 2022 and 2023, the area of mangrove cover in Torosiaje Village is presented in Figure 2. In 2020 the area of mangrove forests in Torosiaje Village amounted to 74.78 Ha. If compared to 2019, in 2020 there was a reduction around mangrove forests by 1.04 Ha. The reduction in mangrove forests is because some of the mangroves planted in the previous year did not grow due to inaccurate rehabilitation technical factors such as weather, planting methods, location selection, and selection of mangrove species. In addition, due to natural factors and human activities, such as illegal logging of mangrove trees by irresponsible people. In addition, in 2020 there will be no mangrove planting activities due to conditions at that time at the peak of the COVID-19 pandemic. In 2021 the area of mangrove forests in Torosiaje Village were 76.46 Ha. It appeared that the area of mangrove forest vegetation has increased from the previous year by 1.68 Ha. This was because the mangrove forest rehabilitation activities carried out from the previous year have started to grow. While the area of mangrove covers in Torosiaje Village in 2022 is 79.59 Ha, it appeared that the area of mangrove forest vegetation has increased from the previous year by 3.13 Ha. In 2023, the area of mangrove cover in Torosiaje Village was 86.45 Ha, it appeared that the area of mangrove forest vegetation has increased from the previous year, as much as 6.86 Ha. This was due to the mangrove forest rehabilitation activities carried out from the previous year which had started to grow. According to residents over the last few years, the community has begun to become aware of the importance of the mangrove ecosystem for life and they no longer carry out illegal logging of mangrove trees. Even some residents are now cultivating mangroves behind their houses.

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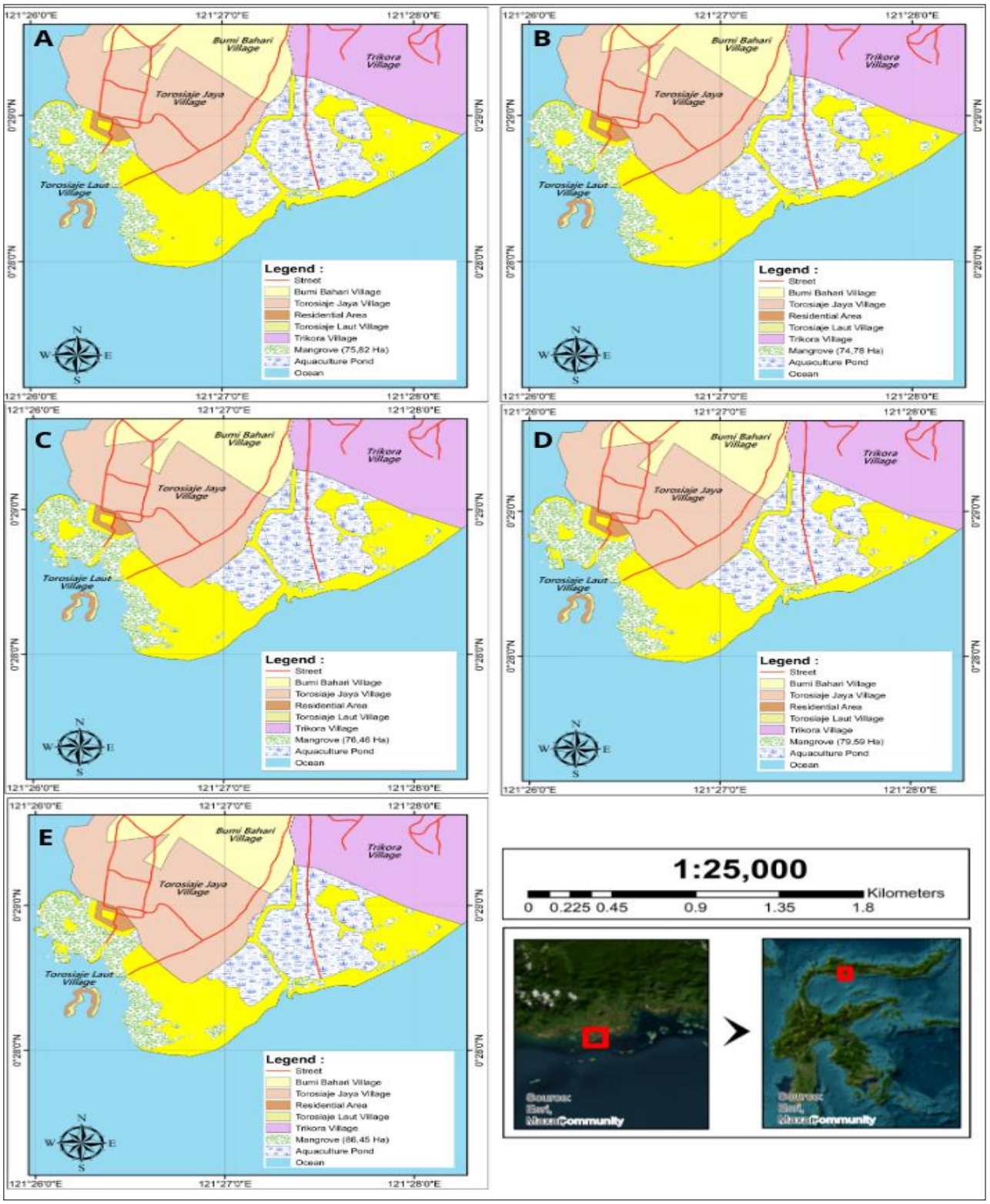

Figure 2. Map of Mangrove Forest Distribution in Torosiaje Village for (A) 2019, (B) 2020, (C) 2021, (D) 2022, and (E) 2023

Following are the changes around mangrove forests in Torosiaje Village, Popayato District, Pohuwato Regency from 2019 to 2023, which are presented in the following table

Table 1. Changes in the Mangrove Forest Area of Torosiaje Village in 2019 – 2023

No	Year	Area (Ha)
1	2019	75,82
2	2020	74,78
3	2021	76,46
4	2022	79,59
5	2023	86,45

Source: Landsat 8 Satellite Image Interpretation Processing 2019 – 2023

Based on Table 1 above, it can be explained that changes around mangrove forests in Torosiaje Village have continued to change in the last 5 years from 2019 to 2023. The results of interviews with the managers of the mangrove area in Torosiaje Village, this is the result of the rehabilitation of mangrove forests by the people of Torosiaje Village starting in 2000 with the assistance of stakeholders such as JAPESDA with the Phinisi Bakti Nusa Expedition team and ISKINDO, Maritime Affairs and Fisheries Service Gorontalo Province together with KSL Torosiaje, OASE Working Cabinet with the Ministry of Environment and Forestry, and involving some government organizations or institutions, non-governmental organizations, students or students and the local community. The current condition of the mangroves in Torosiaje Village is good because the residents continue to care for and look after them with all their hearts. There are even residents who have built a mangrove nursery behind their houses. The Bajo tribe, especially those on the Torosiaje Coast, continue to care for and preserve the mangrove forests in the Torosiaje Region. as a resident of Torosiaje Village who is native to the Bajo tribe and is currently fighting as the head of the KSL fishermen group, for more than 20 years, he has built awareness and invited the local community to jointly protect mangroves and continue to provide education to related to the benefits and functions of mangroves. Now, the residents are slowly starting to realize the importance of the mangrove ecosystem, and most of them no longer cut down mangrove trees.

Image Interpretation Accuracy Level

To see whether the digitized map of changes in the mangrove cover area by the results in the field or not, an accuracy test is needed. This accuracy test is carried out by taking samples on a digitized map and then matching them with data in the field. Because the time of the research was not the same as when the image was recorded, the researchers took several points that had the closest time to the

observation 2023. The points were taken randomly, with a total of 20 sample points.

The results of checking sample points carried out in the field, 18 sample points matched the interpretation results, while 2 sample points were unclear, therefore, an accuracy value of 90% was obtained. According to Short (1982) and Estes, accuracy values that have an accuracy level of ≥ 80% are considered accurate. Accuracy tests were also carried out by (Agustina et, al., 2018) to see whether the digitized coastline change map matched the results in the field and the results obtained an accuracy value of 90.9%.

Directions for the Management of the Torosiaje Village Mangrove Ecosystem Strategy

The results of the research survey and interviews with local community show that there are five forms of utilization of the mangrove ecosystem in Torosiaje Village, Popayato District, Pohuwato Regency, Gorontalo, namely, tourism (recreation), collecting sea cucumbers and octopus, looking for shellfish and shrimp and crabs, fishing, and fruit processing. mangroves are described as follows:

Tourism (recreation)

In 2007, the village of the Bajo Tribe, Torosiaje Village, was inaugurated as a Marine Tourism Village. The local government took this decision because Torosiaje has the natural beauty and local wisdom of the Bajo tribe and the Bajo tribe villages which are located above the waters and are an alluring attraction for tourists. The Torosiaje coastal mangrove area has the potential for ecotourism development as indicated by the presence of mangrove plant species consisting of bruguieragymnorrhiza, rhizophora mucronata, rhizophora apiculata, rhizophora stylosa, ceriops tagal, avicennia marina, and xylocarpus granatum, as well as types of the fauna of the crustacean class, insects, gastropods, pelecypods, fish, amphibians, reptiles, aves, and mammals (Baderan et al., 2015; Hamidun, 2016).

Collection of sea cucumbers and octopuses

Sea cucumbers and octopuses are marine biota that are classified as aquatic invertebrates. Sea cucumbers are invertebrates from the echinoderm phylum of the class Holothuroidea, while octopuses are from the phylum mollusks, class cephalopods. The tools used by fishermen to find sea cucumbers are boats, flashlights, protective boots in the form of boots, and spears. The sea cucumber fishery in Torosiaje is still traditional, meaning that people collect it bit by bit and then sell it to collectors.

Fishermen looking for shellfish and crabs.

Torosiaje fishermen pick up shellfish at low tide and when the moon is dark. This activity is an ancient tradition of capture fisheries that only uses hand-caught which is still practiced today.

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Fishermen looking for shellfish are carried out by fishing families or those who live close to the coast. Fishermen looking for shellfish, lobsters and crabs only do it to meet their daily needs.

Fishing

Fishermen of Torosiaje Village mostly still use simple fishing methods. Ships or boats that are usually used in the fishing process are cage boats and soppe-type boats that are driven by oars, while the fishing gear used is trawls, spears or arrows, and fishing rods. The fish caught are gelodok fish, small pelagic fish such as mackerel, flying fish, snapper, trestle, tuna, and others. The fishermen's catches are generally consumed and sold to meet their daily needs.

Processing of mangrove fruit

Currently, women in Torosiaje are starting to use mangrove fruit as a livelihood that supports family income. The mangrove fruit is processed into a variety of food products such as pia, dodol, sticks, cake, pudding, donuts, crackers, chips, and jam. According to residents, the mangrove fruit processed into food ingredients are Bruguieragymnorhiza, Avicennia marina and Aviceniaovicinalis.

Faktor Internal dan Eksternal Pengelolaan Mangrove

Tabel 2. Penentuan Bobot dan Skor Faktor-Faktor Strategi Internal

Faktor-Faktor Strategi Internal	Bobot	Rangking	Skor
Kekuatan (Strength)			
1. Keadaan hutan mangrove yang terjaga kelestariannya	0,15	4	0,60
2. Terdapat KSL Paddakauang yang didampingi oleh LSM Jaring Advokasi Pengelolaan Sumber Daya Alam (Japesda) dan Program Teluk Tomini Sustainable Coastal Livelihoods and Management (Susclam)	0,15	4	0,60
3. Potensi mangrove, lamun dan terumbu karang yang dapat dikembangkan menjadi kawasan ekowisata	0,15	3	0,45
4. Sikap masyarakat yang mendukung pengelolaan ekosistem mangrove	0,10	2	0,20
5. Pengolahan hasil hutan non kayu mangrove	0,05	2	0,10
Jumlah	0,60		1,95
Kelemahan (Weakness)			
1. Kesadaran sebagian besar masyarakat akan lingkungan yang masih rendah	0,10	3	0,30
2. Kekurangan air bersih	0,10	2	0,20
3. SDM dalam bidang pendidikan masih sedikit yang melanjutkan ke jenjang pendidikan menengah dan tinggi	0,10	2	0,20
4. Pemahaman dan pengetahuan masyarakat tentang pengelolaan ekosistem mangrove masih kurang	0,05	3	0,15
5. Kurangnya pelatihan/penyuluhan tentang pengelolaan hutan mangrove	0,05	3	0,15
Jumlah	0,40		1,00
Total	**1,00**		**2,95**

Source: *Processed Data Year (2023)*

Tabel 3. Penentuan Bobot dan Skor Faktor-Faktor Strategi Eksternal

Faktor-Faktor Strategi Eksternal	Bobot	Rangking	Skor
Peluang/Opportunity			
1. Pelestarian mangrove tidak bertantangan dengan kearifan lokal	0,15	3	0,45
2. Menyerap tenaga kerja untuk objek wisata yang dapat mengurangi pengangguran	0,05	3	0,15
3. Kegiatan penelitian dan pengabdian kepada masyarakat pada kawasan ekosistem mangrove	0,10	2	0,20
4. Potensi pengembangan wisata konservasi mangrove (tracking) besar	0,10	3	0,30
5. Adanya program dan dukungan masyarakat, pemerintah, dan lembaga terhadap pengelolaan ekosistem mangrove	0,10	2	0,20
Jumlah	0,50		1,30
Ancaman/Treath			
1. Konflik kepentingan, adanya pihak yang ingin membuat tambak	0,10	3	0,30
2. Pencemaran lingkungan (sampah)	0,15	3	0,45
3. Krisis air bersih	0,10	2	0,20
4. Penebangan Liar pohon mangrove	0,10	1	0,10
5. Kurangnya perhatian langsung pemerintah terhadap pengelolaan objek wisata	0,05	1	0,05
Jumlah	0,50		1,10
Total	**1,00**		**2,40**

Source: *Processed Data Year (2023)*

Based on the internal factors and external factors explained above, a SWOT diagram can be prepared. The influence values are based on known scores, the difference for each will be calculated, namely by calculating the total difference between the influence values of strengths and weaknesses and the difference between the influence values of opportunities and the threat values. The results of the analysis show that the total value of the influence of internal strategy variables has a value difference of 0.95. Likewise for external variables, the difference is 0.20. The strategy and direction for managing the mangrove ecosystem in Torosiaje Village is in quadrant I with a management point of (0.95/Y; 0.20/X). This first quadrant describes strong internal conditions with a supportive environment so that the appropriate organizational direction, targets and strategies are aggressive in nature (Figure 3).

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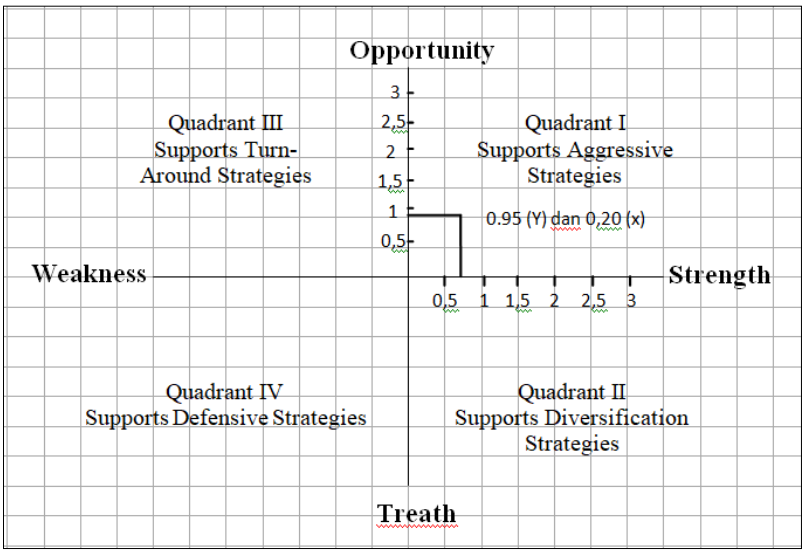

Figure 3. SWOT diagram

Priority strategies for managing mangrove forest ecosystems based on the results of the analysis carried out, determined the 6 best strategies for managing mangrove forest ecosystems in Torosiaje Village, Popayato District, Pohuwato Regency, Gorontalo, as follows:

1. Establish cooperation with the local government to jointly manage the mangrove ecosystem and develop the Torosiaje tourist attraction. This strategy is important because so far it has not been optimal. The importance of cooperation between sectors to minimize conflicts of interest that may occur in the management of mangrove ecosystems and the development of tourist areas.
2. Creating a Garbage and Waste Treatment System. The waste problem is unresolved because there are still many people who do not have awareness and throw garbage directly into the environment, without thinking about the impact that will occur as a result of this act. The importance of community awareness, especially for those who live on the coast. Waste management needs to be done so that the surrounding environment is maintained. Realizing the 3R concept (Reuse, Reduce, Recycle) can reduce environmental pollution.
3. Improvement of MCS (Monitoring, Controlling, and Surveillance). Efforts to develop the Torosiaje mangrove area are inseparable from collaboration with related parties. Monitoring and evaluation are important to monitor, observe, and analyze every developmental status of the utilization activities of the Torosiaje mangrove ecosystem. In essence, monitoring and evaluation activities aim to minimize the negative impacts that have occurred and will occur as well as increase the perceived

positive value for the community. Community involvement will increase awareness and knowledge about the importance of mangroves.

4. Strengthening the institutional management of the mangrove ecosystem area and Torosiaje tourism. Talking about institutions is not only related to rules and sanctions but also the ability of human resources to function as enforcers and supervisors of rules. Community institutions that manage the mangrove ecosystem of Torosiaje Village such as KSL need assistance or guidance from both related agencies and academics. Susilo et al., (2014) explained that mangrove mapping activities are very beneficial for the sustainability of mangrove management because they can determine the spatial and temporal changes in mangrove areas.
5. Utilizing the Potential of Natural Resources of Mangrove Ecosystems for Ecotourism Activities and Supporting Science and Technology. The results of Hamidun's research (2016) state that the Torosiaje coastal mangrove area has the potential for ecotourism development. This potential can be developed as an ecotourism attraction. Therefore, there is a need for collaboration with related parties, especially researchers to explore and study biodiversity and its benefits for the community and the region. The role and participation of the local government and the community are needed to maintain the preservation of the potential of the mangrove ecosystem resources of Torosiaje Village.
6. Increasing Public Knowledge and Awareness About the Functions of Mangrove Ecosystems and the Skills of Communities Around Mangrove Areas. Increasing public knowledge and awareness can be done through counseling about the importance of the existence of mangrove ecosystems, as well as direct action in the field.Field actions that can be carried out include seeding and planting mangroves, cleaning up trash in the area around mangroves, making prohibition boards, and others. Even though in the last few years some people have been cultivating mangrove nurseries and processing mangrove fruit into various foods. It is very important to disseminate information to coastal communities about the importance of conservation and the implementation of environmental care movements carried out by local governments to sensitize people who are not yet aware of the ecological function of mangrove ecosystems (Agustina et al., 2022).

The strategies mentioned above are decisions designed to achieve goals. Based on the strategic priorities of internal and external

factor analysis generated through SWOT analysis, here arethree thingsthat become tactical decisions for recommendations in efforts to manage mangrove ecosystems; increasing public knowledge and awareness about the functions of mangrove ecosystems and the skills of people living around mangrove areas, strengthening institutional management of mangrove ecosystem areas and torosiaje tourism, creating waste management systems.

CONCLUSIONS

Based on the results of research that has been carried out, it can be concluded that the area of mangrove forest in Torosiaje Village in 2020, there was a reduction in area of 1.04 Ha since 2019, in 2021 there was an increase in area of 1.68 Ha since 2020, In 2022 there was another addition of 3.13 Ha from 2021 and in 2023 there was an addition of 6.86 Ha since 2022.

The strategic directions needed for managing the mangrove ecosystem in Torosiaje Village are increasing public knowledge and awareness about the function of the mangrove ecosystem and community skill, strengthening institutional management of the mangrove area and Torosiaje tourism, and creating a waste and waste processing system. The suggestions from this study are to increase control and supervision in the mangrove ecosystem area so that the preservation of mangroves is maintained and to determine the area of mangroves which is then suggested to use images with a higher resolution so that the image interpretation process becomes easier.

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