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REMOTE SENSING LANDSCAPE INDICES ON LAND COVER CHANGE DETECTION BAKUN HYDROPOWER BAKUN, SARAWAK.

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Abstract

Sarawak's location in the equatorial region makes it an area rich in rainfall. Therefore, hydroelectric power generation facilities have been established in several hydrological basins in Sarawak, especially in the Kapit area. In particular, this must be used to improve the economic and social living standards of the people of Sarawak. This article analyzes the stratum changes of the Bakun Dam in Sarawak over the past 30 years (1985 to 2018) and proposes land use and land protection. This study uses Landsat 5 and Landsat 8 satellite data. Both of these data need to be pre-processed, such as radiometric measurement and atmospheric correction. In this study, the selected landscape index was used to classify the water body area, vegetation, and man-made buildings, namely the Modified Normalized Water Difference Index (MNDWI), the Normalized Water Difference Index (NDWI), and the Normalized Difference Vegetation Index (NDVI). Apply overlay analysis to identify areas in the study area that have changed in the past 30 years. The results showed that MNDWI showed better results compared with other selected indicators. The study also found the biggest change from vegetation to water bodies in 30 years. The results showed that the most severely affected land cover was the formation of forests, which was reduced by 740km^2, and was mainly transferred to the water body of 669.9km^2, while the area of human habitation was 68.7 km^2. Land cover mapping is very important when providing information to those responsible for planning for sustainable development. In addition, land cover maps are also important for avoiding land-use conflicts for land use planning and land use regulations.

Keywords: Remote Sensing, Landscape Index, Change Detection, hydroelectric Energy

A. Introduction

Krishna et al. (2019) pointed out that land cover changes in Southeast Asian countries such as Indonesia, Malaysia, Singapore, Thailand, Vietnam, and Cambodia are occurring rapidly. This rapid change is caused by population growth, urban expansion, and large development such as dams. The demand for energy and the rich in rainfall make hydropower plants the best

choice to provide electricity to the people of Sarawak to improve the economy and society. Monitoring, recording, and recording of land cover changes are very important in Malaysia because the product can advise policymakers and improve land management (Ricky and Oliver, 2021). Generally speaking, traditional methods are still used when drawing land cover maps in developing countries. Compared with remote sensing technology, the previous method is time-consuming and expensive. Technology can provide data in multiple time, summary, and repetitive ways. Therefore, remote sensing provides a practical and best tool for mapping and calculating surface changes in different proportions, times, and locations. [Lorbede et al., 2017; Shimabukuro et al., 2014; Cowie et al., 2018). Besides, it is a very useful tool detection and mapping of analytical changes in forest land cover. It also has an important contribution to records Regional land use/land cover changes And the global scale since the mid-1970s (Hoa et al. 2016). A survey of the writing has focused on the recognition of land cover changes utilizing different models, techniques, and satellite pictures, in particular (Ricky and Oliver, 2019), NDVI, Principal Component Analysis (PCA). Nutini et al., (2018) performed the multi-temporal investigation and Landsat imaging. Kim et al. (2015) utilizing Landsat data; Mayes et al. (2016) continued from Landsat 5–8 information and linear mixture examination and Choudhary and Pathak (2017) researched the identification of land-use changes utilizing Landsat TM, ETM, and OLI imaging. Leite et al. (2018) utilized Landsat 5/TM photos and geological items. Sidhu et al. (2019) utilized Google Earth for planning ground cover changes and Zoungrana et al. (2018) utilized MODIS satellites to study the ground cover change recognition applications. NDWI to plan glacial mass lakes dependent on a nearby versatile thresholding technique (Li and Sheng, 2012). This strategy was additionally utilized by Allen and Pavelsky (2015) to create a land/water cover for North America utilizing the Modified Normalized Difference Water Index (MNDWI). Rokni et al. (2014) demonstrated the spatial-fleeting varieties of Urmia Lake over the period 2000–2013. They researched diverse satellite-determined unearthly records (NDWI, MNDWI, NDMI (Normalized Difference Moisture Index), AWEI (Automated Water Extraction Index), NDVI, and WRI (Water Ratio Index)) for water extraction. NDWI showed the best outcomes thought about with the other files (Rokni et al. 2014) The Weighted Normalized Difference Water Index (WNDWI) is proposed by Guo et al. (2017) to diminish mistakes due to misclassified turbid water, little water bodies, and some land highlights in a shadow region. This study to determine the effectiveness of the selected landscape index in extract freshwater bodies. There is no past work in the writing investigating land cover in Bakun, Sarawak. To address this difficulty, the specialists utilized distant detecting information with a spatial goal of 30 meters for a time of 30 years (1990-2020) to identity land chance between the year where there start of construction of the hydroelectric power plant and the current period.

B. Methodology

1. Location of Study

The Bakun hydropower dam is positioned at the Batang Balui, the higher direction of the Rajang River, Kapit division. The Bakun hydropower dam around 37 km upstream of Belaga town (Tipol, 2019). Bakun hydroelectric electricity plant generation ability of 2,400 MW (Tipol, 2019).

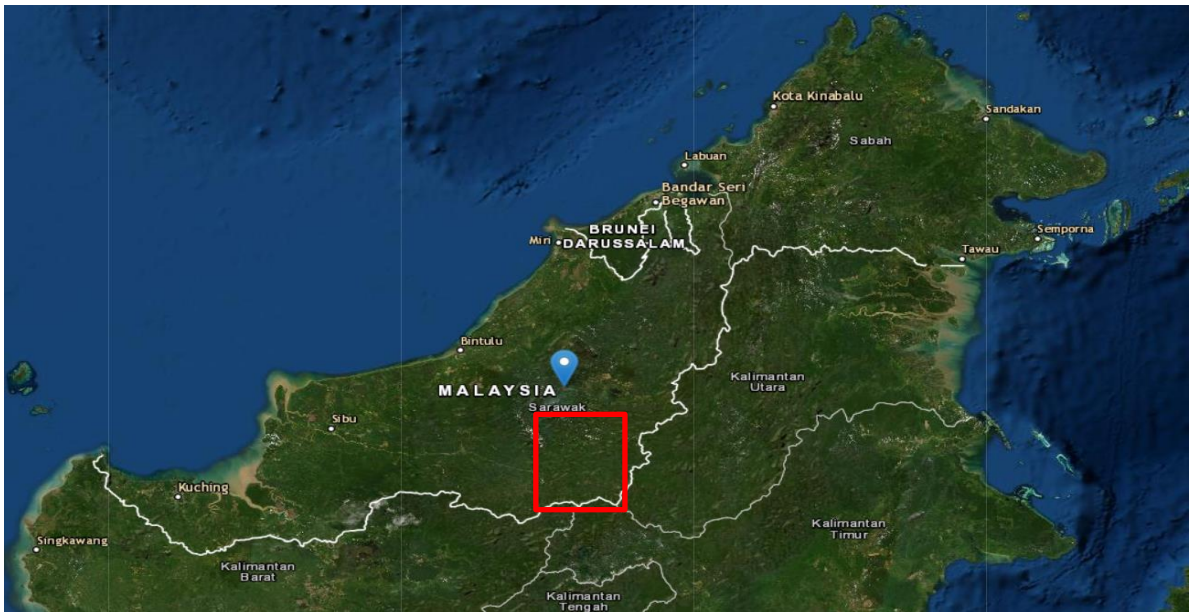


Figure 1: *Location of Study (Bakun Dam)*

Table 1: Information of dataset

Sensor	Data Level	Data Acquisition	Cloud Cover
Landsat 5 Thematic Mapper (TM)	Level 1	25 May 1990	Less from 10%
Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)	Level 1	21 August 2020	Less from 10%

This study uses data from Landsat 5 TM and 8 OLI TIRS satellites as shown in table 1. The provider has been done the geometric correction for both data. The detailed flow of the method will discuss the next sentence.

Table 2: Information of Landsat 5 TM

Landsat 4-5 TM	Wavelength detailed	Wavelength (Micrometers)	Resolution (meters)
Band 1	Visible – Blue	0.43 – 0.45	30
Band 2	Visible – Green	0.45 -0.61	30
Band 3	Visible – Red	0.53 – 0.59	30
Band 4	Near Infrared	0.64 – 0.67	30
Band 5	Short wave Infrared 1	0.85 – 0.88	30
Band 6	Thermal Band	1.57 – 1.65	60
Band 7	Short Wave Infrared 2	2.11 – 2.29	30
Band 8	Panchromatic	-0.68	15

Table 2 shows the bands available in Landsat 5 TM which was applied in this study.

Table 3: Information for Landsat 8 OLI and TIRS.

Landsat 8 OLI and TIRS	Wavelength detailed	Wavelength (micrometers)	Resolution (meters)
Band 1	Coastal Aerosol	0.45 – 0.52	30
Band 2	Blue	0.52 -0.60	30
Band 3	Green	0.63 – 0.69	30
Band 4	Red	0.76 – 0.90	30
Band 5	Near Infrared	1.55 – 1.75	30

Band 6	Shortwave infrared	10.40 – 12.50	60
Band 7	Shortwave infrared	2.08 – 2.35	30
Band 8	Panchromatic	0.50 -0.68	15
Band 9	Cirrus	1.36 – 1.38	30
Band 10	Thermal Infrared 1	10.6 – 11.19	100
Band 11 Thermal	Thermal Infrared 2	11.50 – 12.51	100

Table 3 shows the detailed information for Landsat 8 which applied to this study. NDWI, MNDWI, and NDVI at Landsat 5 TM and Landsat 8 OLI and TIRS can be generated using the following formula:

NDWI = ((Near Infrared – Short Wave Infrared) / (Near Infrared + Shortwave Infrared)).

MNDWI makes use of green and shortwave infrared bands for the enhancement of open water features. It additionally diminishes built-up region features which are frequently correlated with open water in different indices (Xu, 2006).

MNDWI = ((Green – Short Wave Infrared) / (Green – Short Wave Infrared).

NDVI is a standardized index allowing you to generate an image displaying greenness, additionally known as relative biomass. This index takes gain of the contrast of traits among two bands from a multispectral raster dataset—the chlorophyll pigment absorption in the red band and the excessive reflectivity of plant cloth within the near-infrared (NIR) band (Ricky and Oliver, 2019).

NDVI = ((Near Infrared – Red)/ (Near Infrared + Red)).

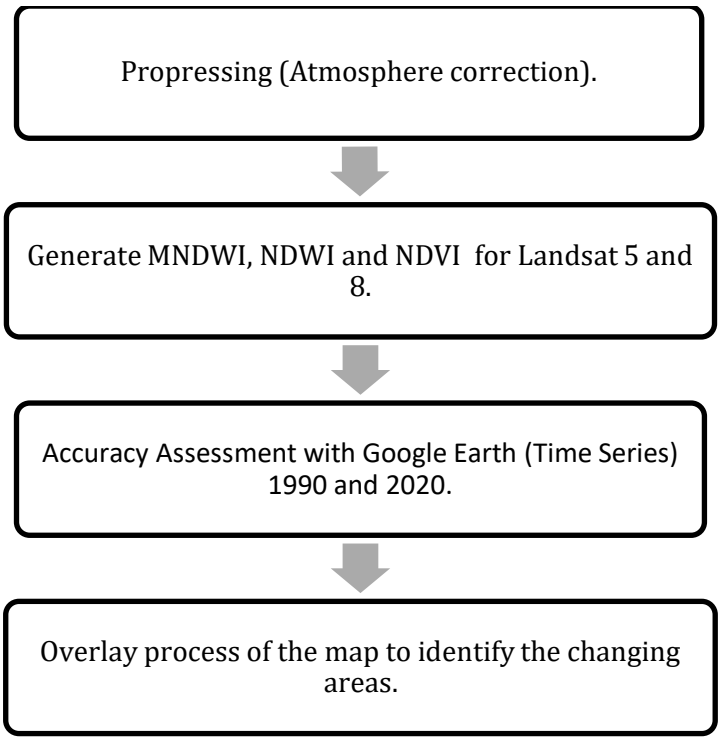


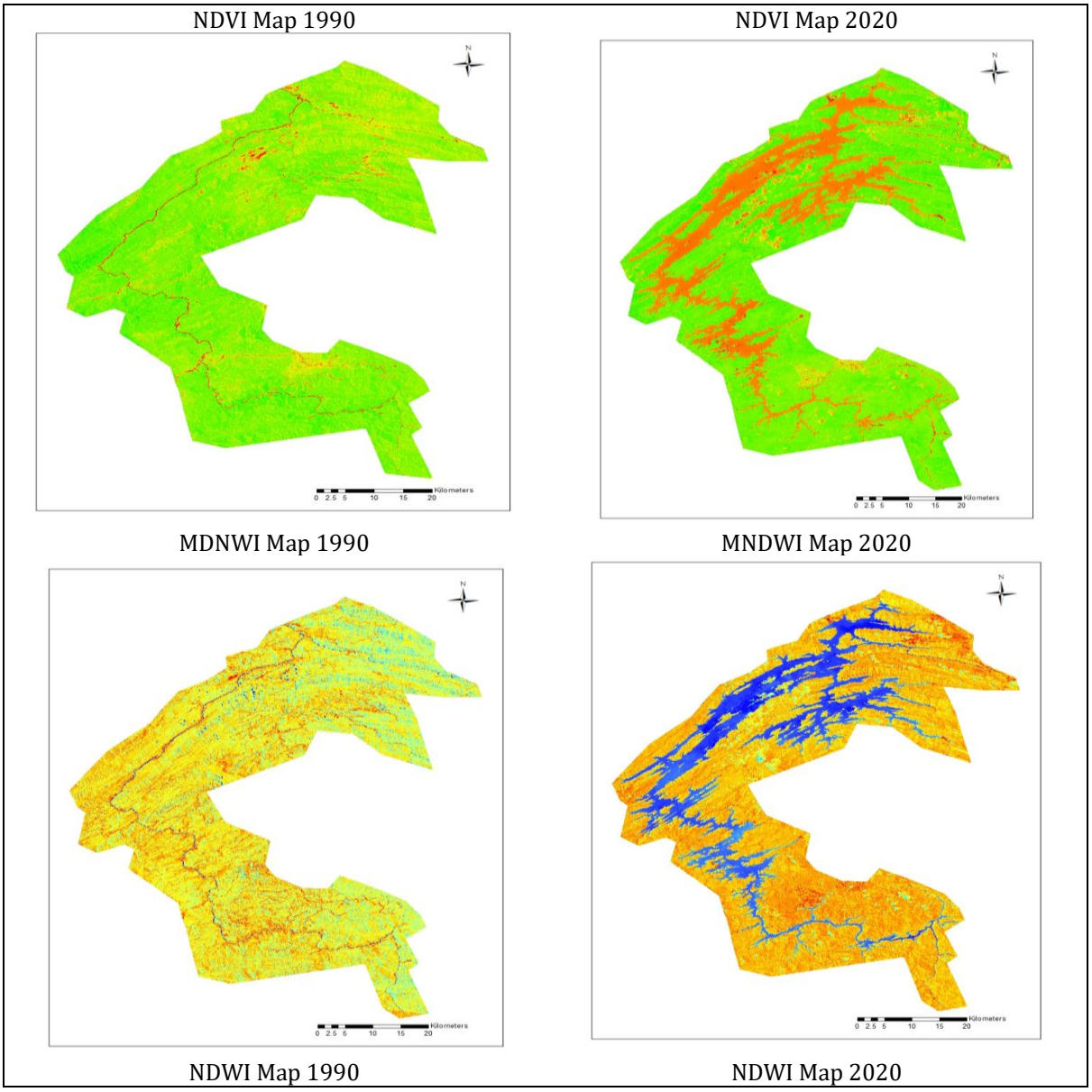
Figure 2: *Flow Methodology.*

Figure 2 indicates the steps that were taken in reaching the goals of the study. Step one is to carry out pre-approaches which includes atmospheric, and radiometric. The second step is

producing a land cover map using landscape indices namely MNDWI, NDWI, and NDVI using a formula that is extensively used. The next step is needed for the calculated areas of every land cover in ArcGIS. Change detection in ArcGIS will be applied to examine the areas of land cover change between the years 1990 and 2020 at study areas. The remaining step is to assess the accuracy of the 1990 and 2020 land cover maps finished with time series analysis on Google Earth as practiced by way of Ricky and Oliver (2021).

C. Findings and Discussion

Referring to figure 3, it is found that all the selected indices successfully classify the area of vegetation, water bodies, and human-built up. For example on the left side of figure 3 is the landscape index map during 1990 and on the right during 2020. For example, for the NDVI map, the green-colored area represents plants and the orange-colored one is a body of water and built-up human. For the MNDWI and NDWI maps, the blue area represents the water body area and the yellow and orange areas are non -water body areas ie built up humans and vegetation. In this context, researchers need to perform classification in ArcGIS for each NDVI, NDWI, and MNDWI image. The discussion of each area based on each landscape index will be discussed in the next paragraph. This study found that there is a difference in the value of the area of each land cover for each selected landscape index. An in-depth discussion of the differences will be discussed in the next paragraph.



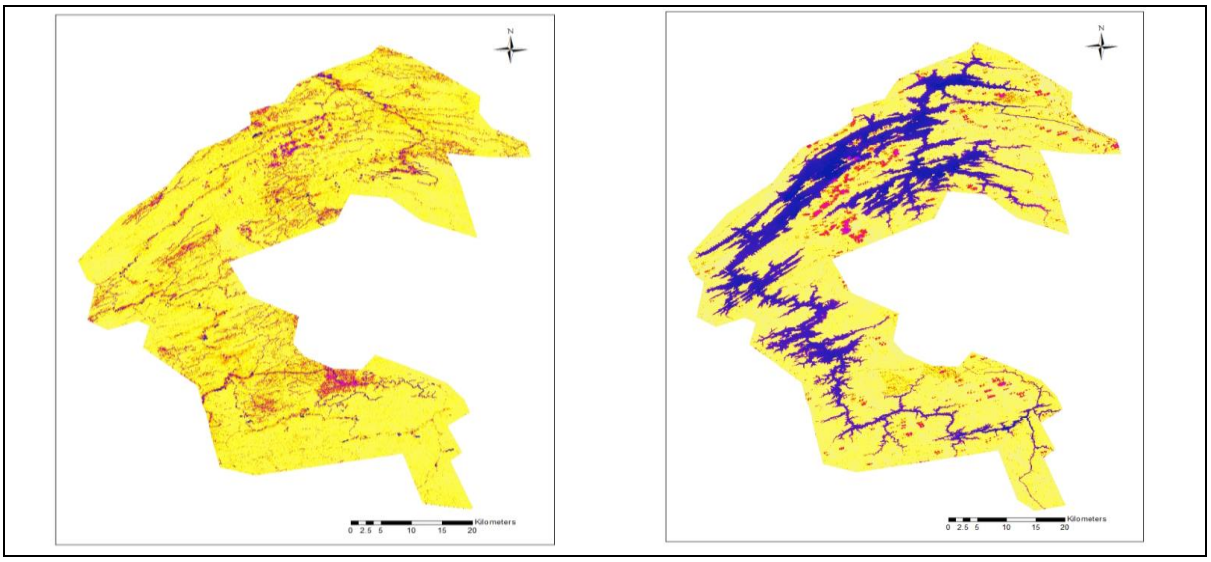
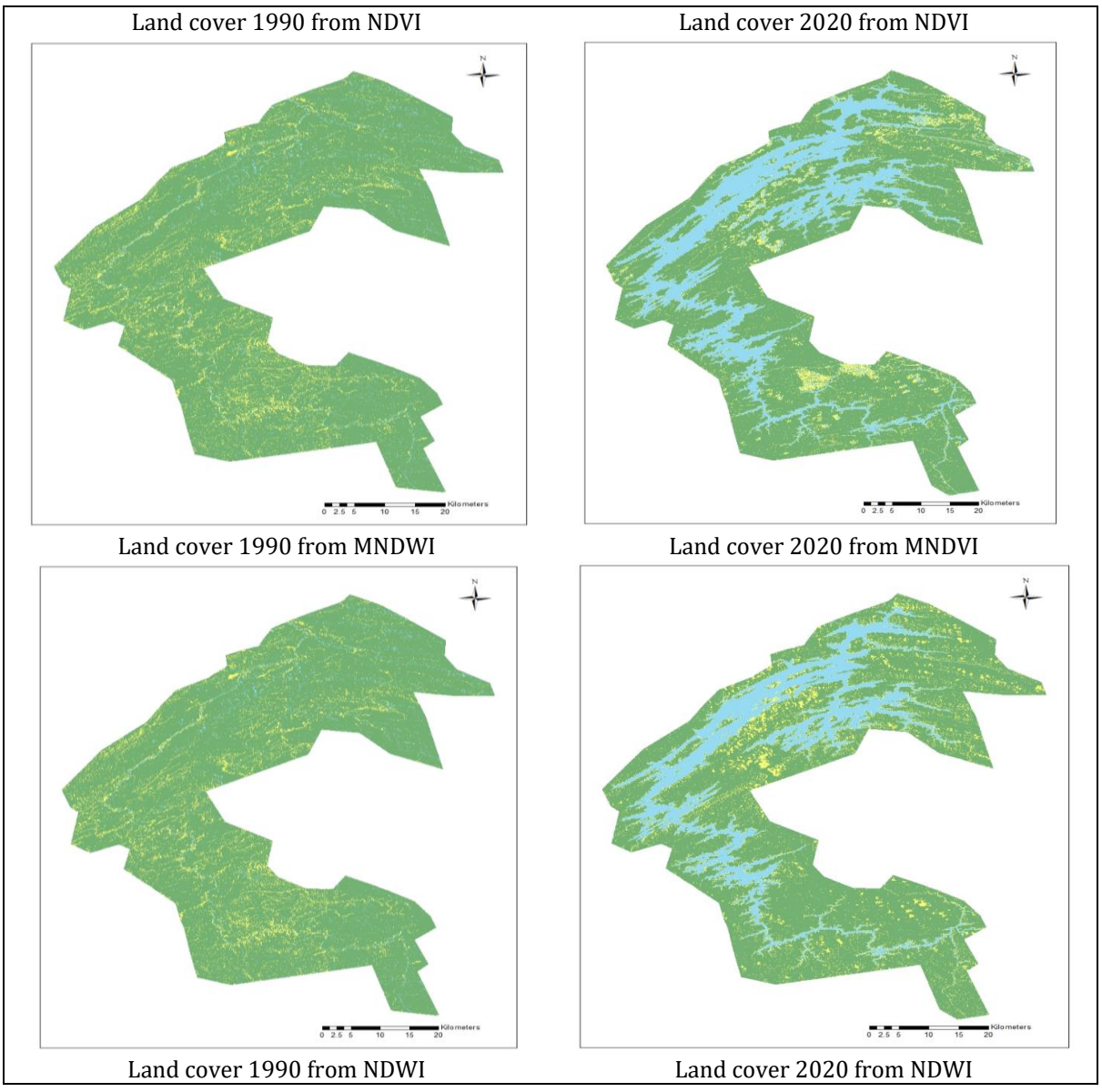


Figure 3: *Map of NDWI, MNDWI, and NDWI for the years 1990 and 2020.*

Refer figure 4 shows the observed big change of vegetation between the years 1990 and 2020. In the year 1990, the figure shows the vegetation area was the largest area at area study compare to the water body and built up.



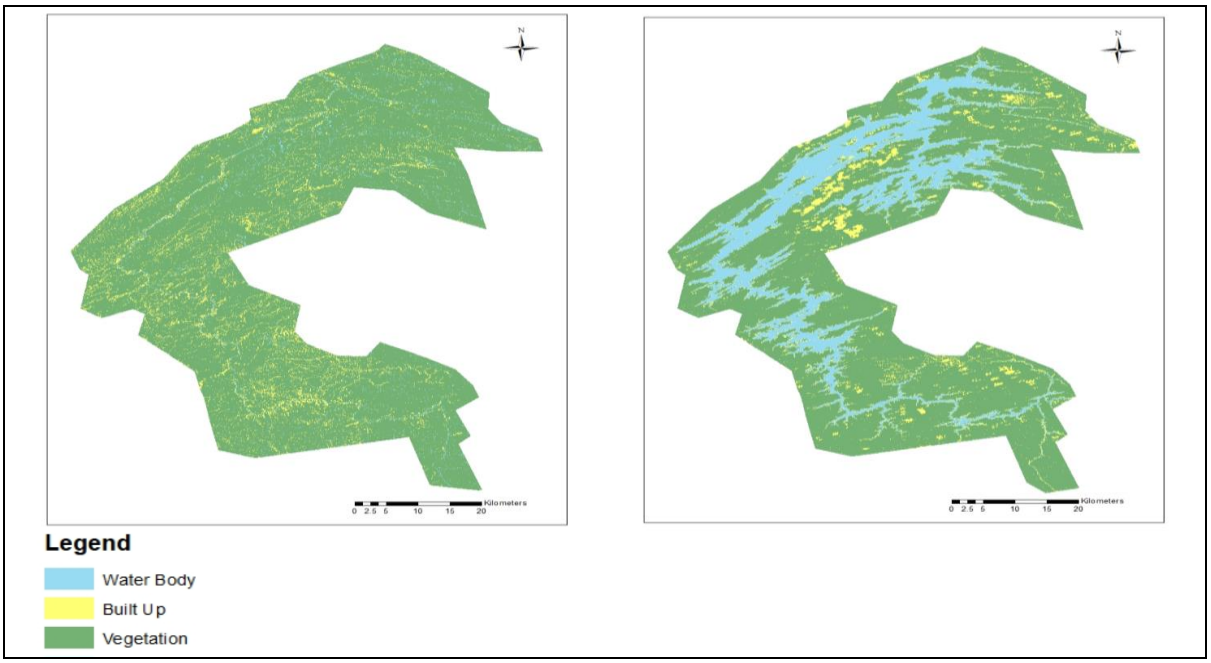
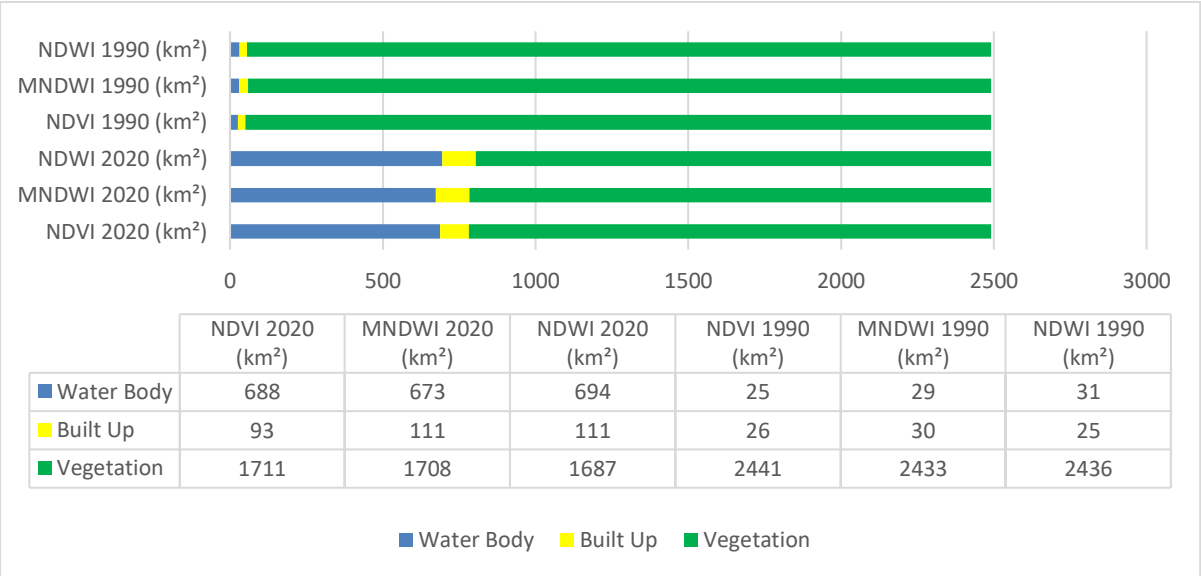


Figure 4: *The land cover map in the Bakun area in 1990 and 2020 from NDVI, MNDWI, and NDWI.*

The year 2020 also shows the vegetation areas still the largest areas compare to build-up areas and water bodies. This major change is due to the construction of the Bakun dam which was fully completed and fully operational in 2011 (Sarawak Energy, 2019; Tipol, 2019). This causes changes in the conversion of land cover from plant areas and water bodies (Tipol, 2019). The detailed explanations of land cover change require to refer to figure 5 for every 3 landscape index.



	NDVI 2020 (km²)	MNDWI 2020 (km²)	NDWI 2020 (km²)	NDVI 1990 (km²)	MNDWI 1990 (km²)	NDWI 1990 (km²)
Water Body	688	673	694	25	29	31
Built Up	93	111	111	26	30	25
Vegetation	1711	1708	1687	2441	2433	2436

Figure 5: *The land cover area for 1990 and 2020.*

Figure 5 shows the area for each land cover area, namely vegetation area, water body, and built-up human. Based on the figure above, it is found that the plant area is the largest in the study area for 2020, namely 1711 km^2 for NDVI and 1708 km^2 for MNDWI, and 1687 km^2 for NDWI. While for 1990 it was found that the total vegetation area was 2441 km^2 for NDVI, 2433 km^{2}for MNDWI, and 2436 km^2. The three selected indexes found that the vegetation area was the largest. The change from vegetation area to water body due to the Bakun reservoir dam which is an area of 688 km^2 for NDVI, 673 km for MNDWI, and NDVI is 694 km^2. The study also found an increase in a human built-up area of 93 km^2 for NDVI and 111 km^2 for both NDWI and MNDWI indices. To confirm the accuracy of the total area of water bodies, this study compares the area of water bodies produced by Sarawak Energy (2019) which is the owner of the dam which is 695 km^2 (Tipol, 2019). The table below shows the differences in water body area from the three indices with the official report.

Table 4: *Difference area water body from Official Report (km^2)*

Landscape Index	NDVI	MNDWI	NDWI
Difference area water body from Official Report (km^2)	7 km^2	22 km^2	1 km^2

Determine table 4 various classifications using NDWI index having a difference of 1 km^2 compared to MNDWI and NDVI. This author is clear the accuracy of NDWI in explaining body areas is best with NDVI da MNDWI. These results differ similar to the findings of Ozlken (2016). The next student is to make changes to the area between 1990 and 2020 by using the NDWI classification.

Table 5: *Changes in different land-use classes in Bakun area from 1990 to 2020*

Land cover type	1990 – 2020 (km^2)	Trend %
Water body	663	Increase 26.6%
Vegetation	749	Decrease 30.05%
Built-up	335	Increase 3.45%

Table 5 shows the change in land area between 1990 and 2020. This study shows that the air body area increased by 26.6 % equivalent to 663 km^2. Area, while developed area, is an increase of 86 km^2 each increase increased by 3.45%. However, the output of the vegetation area decreases by 749 km^2 equivalents to 30.05%. Decreased area output as a result of the conversion of the land cover of the area around the body to the air body due to the construction of the Bakun dam. The construction of dams is very important in providing electricity to the people of Sarawak to improve their social and economic status. Researchers predict activities such as those developed through logging and settlement activities will result in a decrease in the area of growing area in the future.

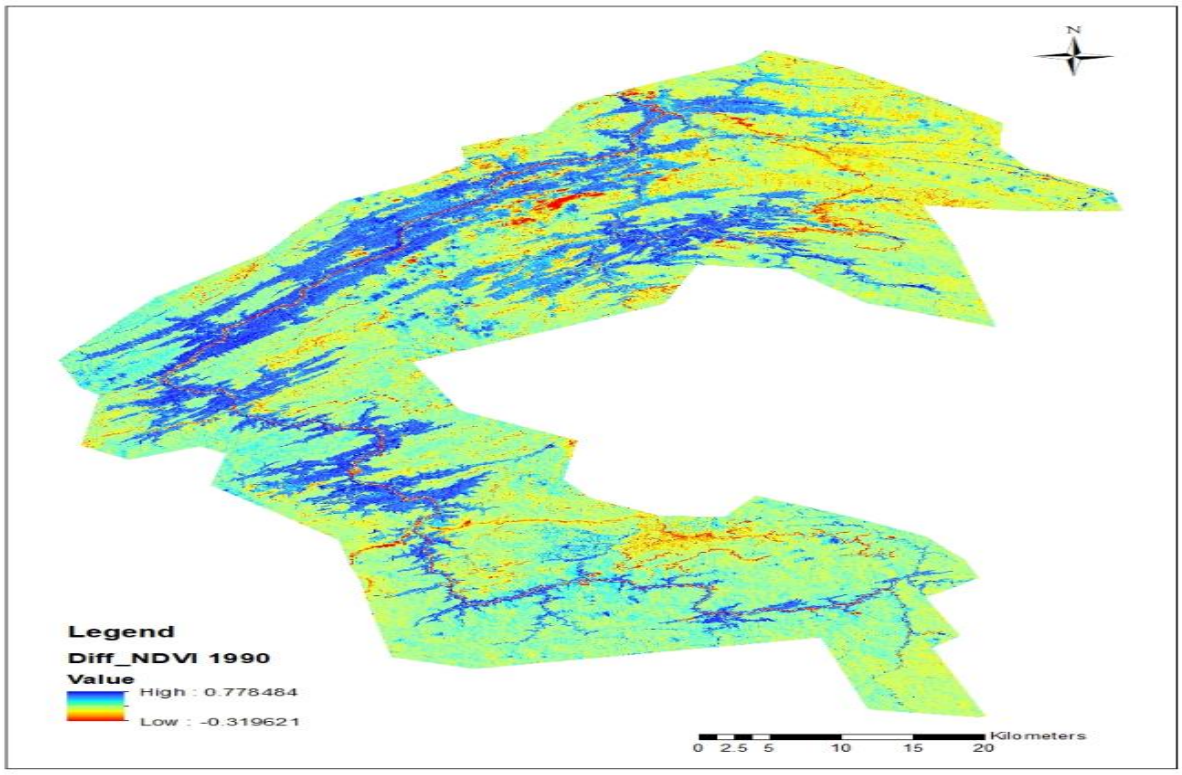


Figure 6: The Bakun area that changed for the years 1990 and 2020 through the GIS Overlay analysis process.

Figure 6 shows the color-changed areas represented in blue and green, yellow and red areas that changed slightly between 1990 and 2020. This study is about the color-changed areas

in the Rajang river bank area in the south and Long Murum River in the north of the study area. In 1990 the study area was a dense forest not occupied by logging activities. In 2020 the study area changes to part 27% of the study area are the water body, 67% is vegetation area, and 4.45% is developed / human-built up. In contrast year, in 1990 for 97% of the study area is vegetation area and 1.003% is developed / human-built up and 1.24% is area air body.

D. Conclusion.

This study successfully achieved the objective of mapping land cover changes in 1990 and 2020 by using the selection of landscape indices on NDWI, MNDWI, and NDVI. This study finds that the NDWI index can map the air body area well and has only 2 km^2 different from the official report from Sarawak Energy. The second-best index is NDVI and MNDWI next. The study is located vegetation areas is the largest area for 1990 and 2020. However, experienced a decrease in area in 2020 of 30% which is different for water bodies 26%. The study expects the area of vegetation will change in the future due to logging activities and placement. The mapping of the study area at all times is very important because the activities related to Bakun will affect the hydrological process of the users of logging activities. Sarawak, a state in Malaysia is less populated and the anthropogenic impact is lower, but deforestation is witnessed in the upper river valleys. This activity may regulate the hydrological behavior of the catchment in destiny and there is a need to examine future changes in catchment characteristics/changes in land use and its impact on river water yields. For this, we use the reservoir garage to not move in the future; which is unlikely to occur under destiny reservoir operations unless the catchment area is designated as a forest reserve and well protected to reduce sedimentation problems in the river. There is also a need to conduct in-depth sedimentation studies to assess the severity of the problem and to address it. Land cover mapped in 1990 and 2020 were compared with google Earth through time series analysis. Information on the ground covering the results is acknowledged and corrected. Monitoring, supervision, and documentation of land cover are critical for policymakers and regional planners to understand the impact of land opportunities on the environment and society. In addition, land cover maps are important as baseline maps for future land management and area planning.

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COMMUNITY BASED DISASTER MITIGATION SYSTEM IN MUNCAR BEACH, BANYUWANGI DISTRICT

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Abstract

Muncar Beach, Banyuwangi Regency is an area with high disaster risk. Community-based disaster management will be much more effective than formal state agencies. But it also does not mean that formal institutions are not important. Education, counseling, and public awareness are one of the non-structural/non-physical disaster mitigation activities. This study aims to analyze the level of knowledge and preparedness of coastal communities in Muncar, Banyuwangi Regency in dealing with disasters, and to find out how is the Community-Based Disaster Mitigation System in Muncar Beach, Banyuwangi Regency. This research uses qualitative methods with qualitative descriptive research. Data obtained through observation, in-depth interviews and documents. The subjects of this research are community leaders, fishermen and the people of Kedungrejo Muncar village. The analysis technique in this research is inductive. In this study, the inductive analysis used is an interactive analysis technique. The results of the research show that the paradigm of disaster management at the population level has not changed much and is still associated with myths. Knowledge and awareness of coastal communities about disaster mitigation is still very low.

Keywords: Mitigation, Disaster, Muncar, Banyuwangi.

A. Introduction

Indonesia is one of the countries known as the island nation. Indonesia has thousands of islands (+ 17,504) ranging from large and small islands. In addition, Indonesia is the second country with the longest coastline which is +95,181 kilometers (Minister of Marine and Fisheries n.d.). In general, urban growth and settlements are located near rivers or on the coast, such as Surabaya, Jakarta, and Semarang are cities on the seafront of Java. Banda aceh is on the edge of the Indonesian Ocean, and so on. Thus, it is undeniable that Indonesia is a maritime country.

As a maritime country Indonesia has a very large and competitive wealth and potential of coastal resources. This potential is rarely owned by other countries because the utilization cost is relatively cheap, thereby strengthening supply capacity. However, Indonesia's

geographical and geological location is surrounded by three continental plates, including the European-Asian continent, the Pacific continent, and the Indo-Australian continent. Which is why Indonesia has the potential to experience natural disasters, either in the form of hurricanes or typhoons, tsunamis, earthquakes, floods, and other natural disasters.

Natural disasters are natural phenomena that are unpredictable and unavoidable and can incur losses for the community, both material and non-material losses. Almost all islands in Indonesia have experienced natural disasters and the intensity is quite high, such as the tsunami in Flores in 1992, the tsunami in Aceh in 2004, the earthquake in Nias in 2005, the earthquake in Yogyakarta in 2006, the earthquake in West Sumatra and Bengkulu in 2007, the earthquake in Lombok in 2018, the earthquake and tsunami in Palu and Donggala in 2018, and more.

Banyuwangi regency itself had an earthquake and tsunami disaster in 1994 in the southern coastal areas, such as in Plengkung Beach, Pancer Beach and Rajegwesi. At that time Banyuwangi regency was hit by a tsunami with an altitude of 13.9 m due to the 7.2 SR earthquake at a depth of 33 km. Banyuwangi has a beach length of up to 175kilometer and almost all of them are potentially tsunamis. According to disaster risk index data (2014) released by BNPB in East Java, Banyuwangi ranked 4th as a city/district at risk of disaster with a high risk class after Lumajang, Malang and Jember. While in Indonesia, Banyuwangi regency ranks 11th as a city/district that is at risk of disaster with multi-threats. Considering these crucial facts, the only option to make anticipatory measures is to conduct awareness activities about the risks of living in coastal areas, especially the coast of Banyuwangi.

According to the law of constitution No. 24 of 2007 that the scope of disasters is quite extensive. Therefore, good cooperation between disaster institutions is needed both in the center and in the region. These institutions must be able to cooperate and work together with the community in each (four) stages. The four stages are:

1) Preparedness: standby planning, early warning
2) Emergency response: emergency review, operational plan, emergency assistance
3) Post-emergency: recovery, rehabilitation, completion, rebuilding
4) Prevention and mitigation or taming can be simultaneously implemented with the active role of the community.

Of the four stages, the most likely to involve the community are the stages of preventive and mitigation measures. This community-based disaster management, will be more effective compared to the formal institutions of the state. But that doesn't mean the formal institution doesn't matter. The institution always has a role as a manifestation of the presence of the state when the community is in a critical situation and condition. That there is no denying that every disaster brings casualties both human and property is a fact. But whatever kind of disaster, before it comes there is always a sign. (Priyowidodo, G., & Luik 2013).

This is where it is important to know and understand correctly and accurately every sign that comes. So of course, what is needed is the knowledge, skills and abilities of how the community, especially in disaster-prone areas, prepare anticipatory measures for the arrival of such disasters. From this description, the relevant map formulation of this study is How is the level of knowledge and preparedness of coastal communities Muncar Banyuwangi in the face of disasters? How is the Community-Based Disaster Mitigation System in Muncar Beach Banyuwangi Regency?

This research aims to analyze the level of knowledge and preparedness of coastal communities Muncar Banyuwangi in the face of disasters, and to know the Community-Based Disaster Mitigation System in Muncar Beach Banyuwangi Regency.

B. Methodology

This type of research is a qualitative descriptive research that focuses on the coastal area of Muncar, Kedungrejo Village. The data collection techniques used in this study are 1) Direct observation. In this research, what is observed is the community environment in Kedungrejo Village Muncar Beach, the ability and preparedness of the community in dealing with disasters, especially the tsunami wave disaster, considering that Muncar beach is one of the areas that have the potential for tsunamis, so the people in Muncar Beach need to have a sense of responsiveness and resilience to disasters. 2) In-depth interviews with the subjects of this study were community leaders in Kedungrejo Muncar Village, fishermen and the people of Kedungrejo Muncar village. 3) Documents. In this study, researchers also used document studies to collect data from archives and documents related to this research, such as magazines,

newspapers, research results, articles and books related to the problems studied in this study. While the technique used in determining the informants is snowball sampling.

The analysis technique in this study is inductive research. What is meant is the analysis technique that is not intended to prove a prediction or research hypothesis, but the conclusions and theories generated are in the form of the data collected. In this study, the inductive analysis used is an interactive analysis technique.

C. Findings and Discussion

1. *History of Kedungrejo Village as a Coastal Village in Muncar District*

Kedungrejo Village is one of 10 Villages in Muncar sub-district, Banyuwangi District, East Java, Banyuwangi with an area of + 668,472 Ha with regional boundaries, the north is Tembokrejo Village, the west is Blambangan Village and Tapan Rejo village, the south is Kedungringin Village and the east directly adjacent to the Bali Strait. Kedungrejo village itself is a coastal village that produces the largest marine fish in East Java, but since 2010 the fish catch of fishermen has decreased.

In the past, Kedungrejo Village was synonymous with the name Muncar, before becoming Kedungrejo Village, Muncar itself was one of the villages that was under the Cluring District area, over time the Cluring District was split so that a new sub-district resulting from fractions emerged with the name Muncar District, the history of the name Muncar itself exists several versions. One of them is a story from HR. Suparjo Denowo, a native of Muncar Sub district, the word 'Muncar' comes from two words, "Monco" (Javanese languange) and "Mancah" (Madurese language) which means various things. This is based on the fact that most of the populations in Kedungrejo village, Muncar are migrants from various ethnic groups or races. Some of them came from South Sulawesi (Bugis tribe), Madura and several areas in Java.

There is no standard history regarding the name of the village named "Kedungrejo" but from several sources the name Kedungrejo Village cannot be separated from the location of the village which is directly adjacent to the Bali Strait or the Ocean, the name Kedungrejo Village itself is two syllables originating from the Javanese language, namely "Kedung" which means a wide water source, and "Rejo" which means crowded , which means that in this village there is a large water source, the sea with all the resources in it and Kedung or the source is getting more and more rejo or crowded with all forms of life activities in it so that the name Muncar which had been used for the name of the District was changed to "KEDUNGREJO" and became the name of a village to this day.

2. *Public perception of disasters*

This type of research is descriptive research. The survey was conducted on 10 coastal communities in kedungrejo village, Muncar subdistrict, Banyuwangi. Data is collected by observing and interviewing correspondents. The collected data is analyzed univariately to describe each item of questions about perception of disaster preparedness.

From the results of the study that 80% of respondents answered surrender to God if at any time there was a tsunami. They reasoned that natural disasters such as tsunamis and earthquakes cannot be predicted when they come and can happen to anyone. This is similar to Agustin's finding research (2014) regarding perceptions of earthquake preparedness for Kenagarian Sumani people, district Koto X Koto Singkarak, Solok Regency, West Sumatra Province.

According to the National Disaster Management Agency (2007) that at the population level has not changed much about the paradigm of handling natural disasters. In general, they think that natural disasters are a reward from God for the sins that have been committed by man and is a tactic of God. In addition, they do not have the initiative to carry out their prevention and re-enactment.

Natural disasters can occur through the process and take place slowly so that it can be predicted and can also happen suddenly. Like an earthquake, until now it can hardly be predicted accurately where, when, and absorbed the strength of the earthquake. However, the impact of earthquakes can be minimized by equipping the community with the ability or skills how to respond to disasters such as skills on how to save themselves and survive from the earthquake, and minimizing the vulnerability of the impact of natural disasters themselves, such as the construction of earthquake-resistant houses with a certain force.

According to Agustin (2014) Natural disasters occur because the threat factors are met with vulnerability factors and inability or low ability to respond to the threat, both of which cause disruption to people's lives such as houses damage, loss of property and fatalities. Generally disaster hazards can occur anywhere with a little or no warning, so it is very important to be prepared for disaster hazards to reduce the risk of impact (Yayasan Jambo Minda 2010).

The knowledge and understanding of the community about the local environment is the most important thing to minimize vulnerability in the community. Community-based disaster mitigation can be done by empowering community members to work together in making strategic and useful plans for the community. The community must be active in re-building its own environment, because the one who understands about the best needs is the community itself. People who face disaster risk will benefit by understanding what to do when disaster strikes (Yayasan IDEP 2007).

There are several benefits of community-based disaster mitigation, including providing and developing knowledge about mitigation to the community so that their level of awareness against the risks faced can increase, stimulate the community to be better prepared and responsive in facing disasters in the environment and help them to understand where and how disasters may occur, strengthen and improve the ability of the community in disaster management, for example, making plans for evacuation routes and establishing sitergitas with institutions that can help in the event of a disaster, forming community groups for disaster management, as well as improving public understanding and awareness about the natural environment and its role in reducing disaster risk (Yayasan IDEP 2007).

D. Conclusion

The paradigm for disaster management at the population level has not changed enough. There are still many people who consider that disaster is a destiny. This is a picture that the conventional paradigm is still strong and rooted in society. In general, people believe that disaster is a retaliation for their sin so that they must accept it as a destiny as a result of their actions and they don't want to try to take any preventive or countermeasures steps.

Mapping disaster prone areas, the construction of early detection systems, and the utilization of national spatial arrangements are structural measures in disaster mitigation. However, the three activities are obliged to provide space for the community to contribute the delivery information related to disaster areas and also as recipients of disaster-related information and ways to avoid the impact of disasters. The third point of the four policies above shows that the importance of the role of the community in disaster risk reduction efforts.

E. Suggestion

In this study, we finally found some conditions that cause disaster mitigation systems in coastal communities kedungrejo Muncar village has not gone well, therefore there are some inputs that we provide in this study, among others:

1. BPBD Banyuwangi regency needs to improve communication and coordination with the

coastal community Muncar, this is because so far coordination is not well established between the implementers of disaster management with the community and with other disaster management implementers.

2. BPBD Banyuwangi regency should increase its intensity in providing socialization and information about disaster prevention and handling in Kedungrejo Village Muncar Subdistrict, because there are still many people in Kedungrejo Village who still do not understand things related to disasters and disaster mitigation systems.
3. There needs to be maximum protection from the local government of Banyuwangi regency and other community elements in improving disaster management capabilities and facilities.

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The Need of Monitoring Forest Fires through Burned Area Mapping in Indonesia

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Abstract

Forest fires have become a regular phenomenon in Indonesia, especially in the dry season. They can be caused by natural and anthropogenic factor. Since Indonesia's soil, especially Sumatra and Kalimantan, is a peatland type, this type of soil is highly inflammable, thus a small fire can easily spread and become massive. This phenomenon provenly disturbs the balance of the ecosystem and socio-economy of the affected country. Previous forest fires resulted in a higher risk of respiratory problems and increased mortality or the death of infants and children. The loss of biodiversity and the increasing amount of Green House Gas (GHG) Emissions that affected the change of climate is also the effect caused by those. For those reasons, the need of monitoring forest fires is essential, especially in climate change mitigation as fire disturbance is one of the key variables in it. This paper will further discuss the method of monitoring through burned area mapping using remote sensing technique.

Keywords: Remote Sensing, Burned Area Mapping, Forest Fires, Landsat

A. Introduction

Fires are -significant factors that contributed to increasing amounts of aerosols and recognized as a major source of greenhouse gases emission which is a vital key to climate change (Andreae, 1991; Knorr et al., 2016; Chuvieco et al., 2019). They have profound impacts on the physical environment including: landcover, land use, biodiversity, climate change and forest ecosystem, and affected the socio-economy system of the area. In densely populated areas, air quality decrease as well as the health, especially the respiratory system. Fires also affect the vegetation and become a significant cause of land use transformation. Massive fires also affect soil erosion and the hydrological cycles (Chuvieco et al., 2019). It damages the ecological value considering the time for regeneration on all the ecosystem services such as soil, vegetation and habitat.

Analysis of fire history data on Global Forest Watch Fires confirms that fires tend to be concentrated on agricultural and peatlands in Indonesia (WRI, 2017). Gellert (1998) stated the fires are the outcome of three decades of opening Indonesia's forests to exploitation and the export of timber products. This pattern of forest exploitation has culminated most recently in the over rapid conversion of large area of Sumatra and Kalimantan into plantations. Gellert

summarized in his book that as long as the expansion of plantation grown in Indonesia, the fires will be likely increased, especially during El-Nino years, such as the large fires that happened in 1982-1983, 1997-1998, and 2015.

National Institute of Aeronautics and Space of Indonesia (LAPAN) stated that in September 2019, there are 9,310 hotspots that was identified in Indonesia with the confidence level greater than 80 %. Most of the hotspots for Indonesia occurred in August and September 2019. Until September 2019, Indonesia's National Department of Disaster Management stated that 857.756 hectares burned area was identified. It also gave severe impact on the health of the people in the affected area. There were 885,026 cases reported of severe respiratory infections due to the haze and smog.

The causes of fires are various but are mainly due to human activity while the rest are caused by natural phenomenon, such as lightning and extreme weather. Human related fires are mainly grouped as intentional and unintentional fires. The area of burning is usually marked in dry season with higher surface temperature. For Indonesia, is highly happened during period of July to October, the peak of the dry season. Therefore, the assessment is needed for identifying the best technique to detect fires in the future.

B. Methodology

The research method used in this research is descriptive qualitative method using library research analysis. The analysis used to answer:

1. Why burned area assessment and analysis is important?
2. What best technique to detect fire damaged forested areas using remote sensing techniques?

The chosen papers and articles mostly associated with Landsat Satellite Imageries in fire investigation. Some of them associated with Sentinel and MODIS. A small portion of the research papers is using Advanced Very High Resolution Radiometer (AVHRR) Imageries, such as SPOT and SAR (Synthetic Aperture Radar). The collective paper was chosen from 2000 to 2019 as the paper is written in 2020 from different sources.

C. Findings and Discussion

The Need of Monitoring Fires and Burned Area Mapping

After a catastrophic event of fires in 1997-1998, the severe fires happened again in 2015. From 21 June to 20 October, fires burned more than 2,4 million hectares of land, of which between 0,43 million and 0,67 million hectares was forested (World Bank, 2016). By one independent estimate, on many days the carbon emissions exceeded those of the entire US economy. The fires polluted the air, closed schools and airports, and damaged crops and timber stands. The 2015 fires in Indonesia made the headlines and dominated international news coverage for months. After 2015 fires, 2019 fire is the largest one that happened in Indonesia (figure 1).

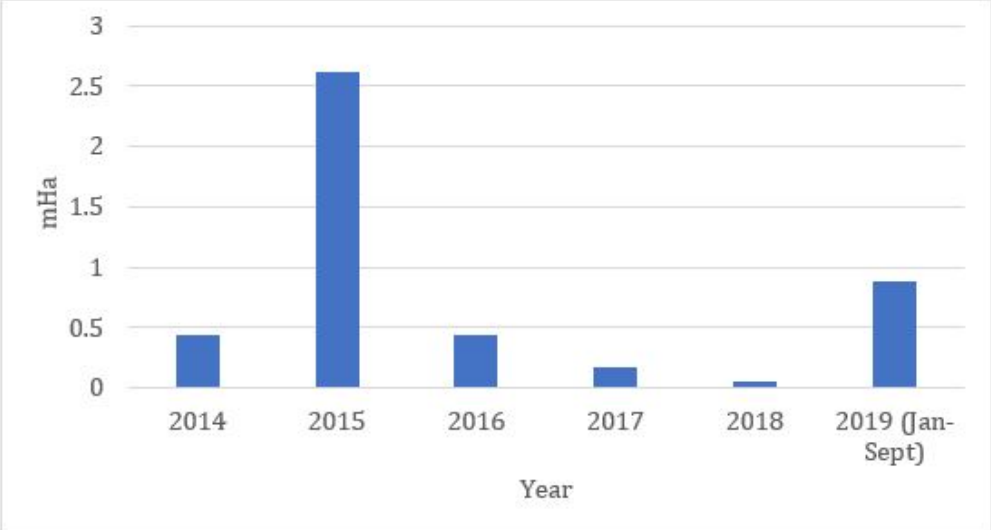

Figure 1. *Total burned area in entire Indonesia by years in million hectares (MOEF 2019)*

A forest fire or wildfire is considered an important disturbance agent, with a long history of shaping landscape patterns and ecosystem processes, relating to both vegetation distributions and physical structures. Large-area of fires can affect climate cycles at a global scale, like what happened in Australia, while, at landscape scales, it influences vegetation structure and pattern (Tran et al., 2018). Assessment of this fire effects is needed to select post-fire treatments, to obtain the information for vegetation recovery monitoring, as well as to provide appropriate variables for future landscape planning (Brewer et al., 2005). Jolly et al. (2015) predicted that the impact of fires is expected to increase in the future due to climate changes. Therefore, it is become relevant to improve the knowledge to foreseen and minimize the impact of the burning fires.

The monitoring of fires and information that extracted from it are necessary to address the climate change issue which are now become the attention of the world, since fire disturbance is considered one of essential climate variables (GCOS, 2016). Policy related to induce fire emission, such as Kyoto Protocol and the agreements at the UN Conference on Climate Change in Paris need the information of fires as a key variable. Therefore, the need of burned area information become important for climate modelling and vegetation recovery monitoring.

Remote Sensing Application for Assessing Forest Fire

There are several different ways to detect fire damaged forested areas using digital image processing, such as classification, Principal Component Analysis (PCA), Spectral Mixture Analysis (SMA), and vegetation indices. In the early year for burned mapping, past research used visual interpretation analysis only from Landsat to validate supervised maximum likelihood classification (Bourgeau-Chavez et al., 2002). Not only by visual, temporal differences also become a good parameter to extract information between pre-fire and post-fire satellite imageries. The maximum likelihood classification was practiced in some research to obtain the burned area information or evaluate other classification methods as a validation tools (Henry, 2008).

Principal Component Analysis (PCA) also has been used since early 1980s for burned area and change detection analysis. Richards (1984), used PCA method for classifying burned area by using an 8-dimensional multi-temporal image dataset. Siegert and Hoffmann (2000) used PCA method for multi-temporal ERS-2 SAR images acquired before and after the fire, while Hudak and Brockett (2004) using a standardized PCA on a Landsat time series dataset consisting of 22 annual images of Landsat from 1972 to 2002 with a simple non-parametric supervised classification and a forward/inverse principal component analysis to enhance the spectral reflectance of burned area.

Another approach that called Spectral Mixture Analysis (SMA) were first applied in burned area mapping in the early 1990s. Sunar et al. (2001) stated that all surface features, such as water, vegetation, soil, have spectral response patterns. If these patterns are unique then the features can clearly be identified from spectral information using remote sensing approach. The spectral vegetation indices analysis method can also be used to detect the change to its reference state (before fires happened) that derived from remotely sensed data and produce a map of the affected area (Mitchell et al., 2017).

Several indices were developed to assess forest fires, such as NBR, NBR2, NBRT, NDMI, and FRI. NBR was developed by Key and Benson (2006) through a joint program between USGS and NPS (US Geological Survey and National Park Services) and the difference between pre-fire and post-fire NBR is become the common method for mapping large fires remotely.

Both of the satellite imageries (Landsat and Sentinel 2) have been used in conjunction for burn severity identification (Mallinis et al., 2018). Landsat imageries widely use to indicate burn severity for years because of its periodical record, accessibility, large coverage, and the variety

of spectral wavelengths. Some research also used Sentinel-2 images for validating the accuracy of burned area product result on Landsat (Roy et al., 2019) since Sentinel 2 band has higher spatial resolution than Landsat 8 OLI/TIRS. Another recent development is Proba-V satellites that also can be downloaded from ESA Copernicus, the same source for Sentinel's download. Proba-V was developed by VITO Belgium and can be used for assessing burn scar through vegetation recovery and mapping land cover. The satellite's spatial resolution is 100 meter and it covered the entire earth surface every two days.

While for detecting active fires, some research stated that Landsat and Sentinel 2 have no detection capabilities and rarely overpass when a fire is burning (Schroeder et al., 2016; Roy et al., 2017). 375-m VIIRS (Visible/Infrared Imager Radiometer Suite) from Suomi NPP and 1-km MODIS active fire detections may be used, but they cannot capture or detect the smallest sign of fire due to the small spatial resolution, as they cannot be observed at Landsat-8 or Sentinel-2 spatial resolution (Roy et al., 2017).

Burn Indices Overview

Several indices were developed specially for identifying burn area and its severity, for example Burn Area Index (BAI). The index is computed from the spectral distance from each pixel to a reference spectral point, where recently burned areas converge. BAI is computed as following formula:

$$BAI = \frac{1}{(0.1-Red)^2+(0.06-NIR^2)} \quad \text{(Martin, 1998)}$$

Garcia and Chuvieco (2004) used BAI for mapping burned areas in Spain, as it showed the greatest sensitivity to discriminate burned areas from other land cover types, combined with NDII (Normalized Different Infrared Index) to avoid confusion with water and cloud shadows. The BAI clarified most confusion between burned areas with vegetation and bare soil covers, while the NDII reduced problems with water and cloud shadows.

Another developed index is Normalized Burn Ratio (NBR) which was formulated in 2005. The formula is similar to a Normalized Difference Vegetation Index (NDVI), except that it uses near-infrared (NIR) and shortwave-infrared (SWIR) wavelengths.

$$NBR = \frac{(NIR) - (SWIR2)}{(NIR) + (SWIR2)} \quad \text{(Key and Benson, 2006)}$$

NBR Index was designed to highlight burned areas, the formula is similar to NDVI, however they used near-infrared (NIR) and shortwave-infrared (SWIR) wavelengths instead of red band and near-infrared (NIR) band. Vegetation before fires has very high near-infrared reflectance and low reflectance in the shortwave infrared portion of the spectrum (Cocke et al., 2005). On the contrary, burned areas have relatively low reflectance in the near-infrared and high reflectance in the shortwave infrared band.

The difference between the pre-fire and post-fire NBR is used to calculate dNBR, and determine the burn severity level. A higher value of dNBR indicates more severe damage, while areas with negative dNBR values may indicate regrowth following after a fire. The value of NBRI Pre-fire is usually higher than postfire, thus resulting positive dNBR for area that got affected by fire.

$$\text{dNBR} = \text{NBR (Pre} - \text{fire)} - \text{NBR (postfire)} \quad \text{(Key and Benson, 2006)}$$

Value of dNBR can vary from case to case, so interpretation should be validated using visual interpretation or field assessment for the best result. The United States Geological Survey (USGS) with National Park Services (NPS) proposed a classification table to interpret the burn severity in 2006 (figure 2).

Correlations between CBI (Composite Burn Index) that based on field measurement on sampling points and dNBR have been used to demonstrate the sensitivity of dNBR to post-fire effects and to establish numerical thresholds in dNBR data that discriminate severity categories (Cocke et al., 2005). NBR data have been shown to correlate to field-based estimations of fire severity based on some researches. Negative values of dNBR indicate a positive vegetation response (growth) and positive values indicate a negative vegetation response (Eidenshink et al., 2007).

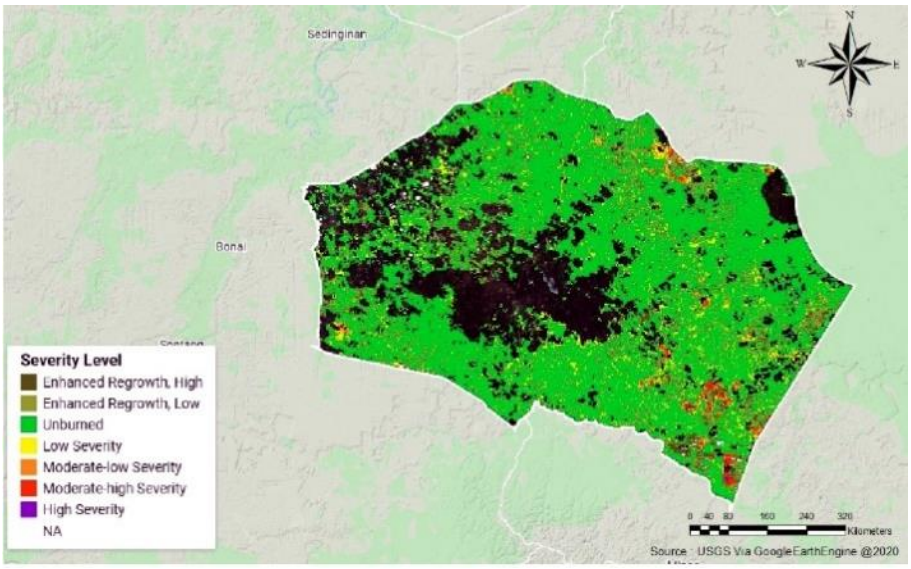

Figure 2. Burn Severity Level Mapping in Bengkalis, Riau in 2019 based on USGS Standard Classification generated from GoogleEarthEngine

Fire parameter and burn severity assessment also can be evaluated using the Relative difference Normalized Burn Ratio (RdNBR) using dNBR and dNBR offset as investigated in study conducted by Morresi et al. (2019). This threshold (RdNBR) was defined by Miller and Thode (2007) as a classification of burn severity class. The dNBR offset was computed by averaging dNBR values within unburned area which were delineated for each study area to minimize changes in reflectance not caused by fire, thus they reduce the disturbance. In this case, they assumed they only calculated and analyse the area that got affected by the fire.

$$dNBR = \frac{(dNBR)*1000) - dNBRoffset}{\sqrt{|NBR^{Prefire}|}} \quad \text{(Miller and Thode, 2007)}$$

Soverel (2010) compared the accuracy of dNBR versus RdNBR for burn severity classification that indicated a higher overall classification accuracy for dNBR than RdNBR in Western Canada National Parks result also validated previous finding by Wulder et al. (2009) who said that RdNBR did not improve post-fire estimation. Further research by Park et al. (2014) introduced the novel index called as Relativized Burn Ratio (RBR) which very similar in concept to the RdNBR for identifying burn severity (Zheng et al., 2018). It is created to avoid some of the mathematical difficulties associated with the RdNBR equation. Park et al (2014) found that RdNBR alongside with RBR performed better than dNBR in Southwestern US.

$$RBR = \frac{dNBR}{(NBR\ prefire + 1.001)} \quad \text{(Park et al., 2014)}$$

RBR adds 1.001 to the denominator ensures that the denominator will never be zero, thereby preventing the equation from falling to calculate. All the indices for determining burn severity is still debated, some researches (Miller and Thode, 2007; Park et al.,2014; Moressi et al., 2019) stated that RdNBR is the best for quantifying, while other researches (Wulder et al., 2009; Soverel, 2010) found that RdNBR did not significantly improve the result compared to dNBR.

Discussion

The findings lead that burned area mapping is important for planning and recovery besides to predict the area which have higher tendency to burn. Burn severity maps can be helpful to predict areas of potential fire hazards (fire-risk mapping), to map fire affected-area, to plan ecosystem rehabilitation and to study vegetation recovery. Severity mapping is likewise of importance for immediate post-fire rehabilitation.

The research paper combined has different result on the best indices based on geography. RdNBR and RBR are performed better than dNBR in United States, however in other regions, dNBR was provenly have higher accuracy that RdNBR and RBR. Therefore, there is a hypothesis that the performance of indices is vary, depends on the region and the satellite imageries which are employed to the index.

One of the researchs also found a novel index which are proclaimed better than dNBR in assessing burned area and forest recovery, it is called IFI (Integrated Forest Index). IFI are provenly performed higher accuracy rather than dNBR in Australia. However, there is no research on IFI in Indonesia to this present day.

In Indonesia, the employment of RdNBR and RBR is not as popular as dNBR and IFI is not yet implemented. Therefore, dNBR still become the best spectral indices to assess fire in Indonesia. With the popularity of Landsat time-series in burned area assessment, it is critical to understand the advantages and limitations of dNBR index. dNBR can become a great index when assessing large forests without residential area or other land cover, however, the accuracy will be likely reduced when assessing small area with less than 500 hectare or the area with the mix of residential area or other land covers. As a result, the identification will be difficult for small forests. RBR is believed to be better in assessing small area of forest. Another limitation of dNBR is water land cover. Water masking becomes essential in dNBR assessment to have greater accuracy in burned area assessment since dNBR is sensitive to water spectral.

D. Conclusion

The urgency of burned area mapping become important as forests will be a vital variable for climate change. The burned area mapping can be used for planning, recovery and predict the future risk of those highly burned area or potential hazard which might be occur. Remote sensing application can be a best tool for assessing the large area of fires. The burned area identification is commonly created by combination of spectral indices such as shortwave infrared and near infrared. The findings found from numerous collective research is dNBR has higher performance compared to other indices such as RdNBR or RBR. Nevertheless, it should be taken consideration that differences in geography, landscape, and type of soils can influence the capabilities of satelites to assess fire. Therefore, the employment of RdNBR, RBR or dNBR might be better in some regions, but not in the other regions. Further researches need to be carried out to gain the information regarding the capability of these indices and compared them between region with different topography to find out their correlation.

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PHYSICAL TYPOLOGY OF COASTAL AREA IN THE TELUK AMBON DALAM

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Abstract

The physical typology of the coastal area in this study is built from a combination of landforms, slopes, and materials. The research method used is a field survey to validate land units on secondary maps and GIS analysis to process typology maps of coastal areas based on a process-response system matrix. The results of this study indicate that the TAD coastal area has only one coastal typology, namely the type of land deposition with a gentle slope characteristic, the constituent material in the form of loose material and the terrain which is dominated by alluvial plains. As a result, in general, the coastal area of Teluk Ambon Dalam is easy to develop and manage.

Keywords: Typology, Coastal, Teluk Ambon Dalam

A. Introduction

The coastal area is one of the unique areas because there is a combination of two different processes, namely land and sea, each of which forms a certain ecosystem. In Indonesia, especially the area of the coast is very large with a long coastline that reaches 99,093 km (Puryono, 2016).

According to Post and Lundin (1996) in Anonimous (2010), coastal areas become important precisely because of their special characteristics. These characters include changes in dynamic coastal properties which are a response to the physical, chemical, biological, and geological characteristics of the surrounding environment (Marfai, 2013).

According to Rahardjo (2003), the study of coastal typology is very important both on a macro and micro scale. Its purpose is to help provide recommendations to related parties in decision-making. Currently, the coastal area is experiencing rapid development so that many overlapping policies have resulted in conflicts in several regions. Of course, the role of typological studies is also contained in this issue. However, studies of coastal typology in Indonesia are still rarely conducted (Hartono, et al., 1999).

The morphology of Ambon City, which is in the form of a bay and directly adjacent to the sea, emphasizes many developments in the coastal area. This massive development has an impact on reducing the quality of the coastal and marine environment (Tiene, 2001). The processes that occur on land and sea continuously will have an impact on the characteristics of the coastal area such as the material and genetics of a landscape to give certain forms and characteristics in the coastal area. These shapes and characteristics can then be grouped into a coastal type category (Khakhim, 2009).

A. Methodology

1. Research Design

This research is included in qualitative research using the integrated rapid survey method (Gunawan, et al., 2007). Broadly speaking, this research is divided into three stages of research, namely the pre, work, and post-field stages. In the pre-field stage, the activities carried out are literature studies, preparation of research materials and tools, collection of secondary data, geomorphological interpretation to obtain landform units in the research area, compilation and drawing of tentative land unit maps, and determination of research locations. Determining the sampling location is done by looking at the distribution of the overlapping map of the same land unit and then proportionally selected the sample points to be surveyed.

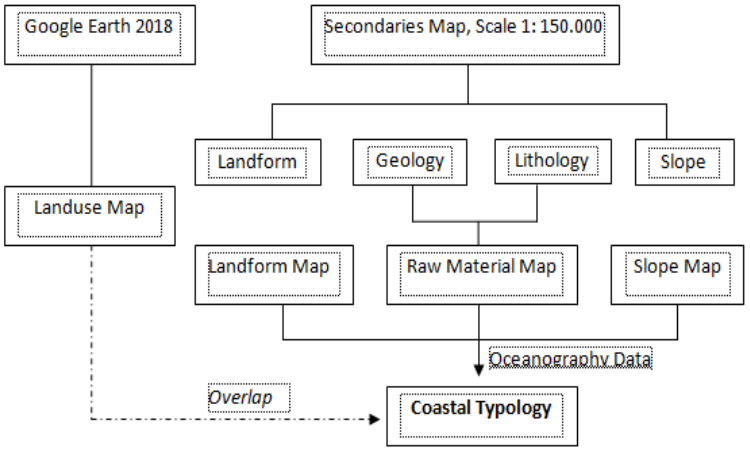


Fig. 1, Flowchart for This Study

The flow of the map depiction of the results of the GIS analysis in this study is shown in Fig. 1. Furthermore, at the fieldwork stage, the activities carried out included terrain orientation, observation, and measurement of geomorphological, oceanographic, and soil parameters through

field checklists. and the final stage which is the formulation and synthesis of research results. For convenience, the research location is presented in the form of a map as shown in Figure 2.

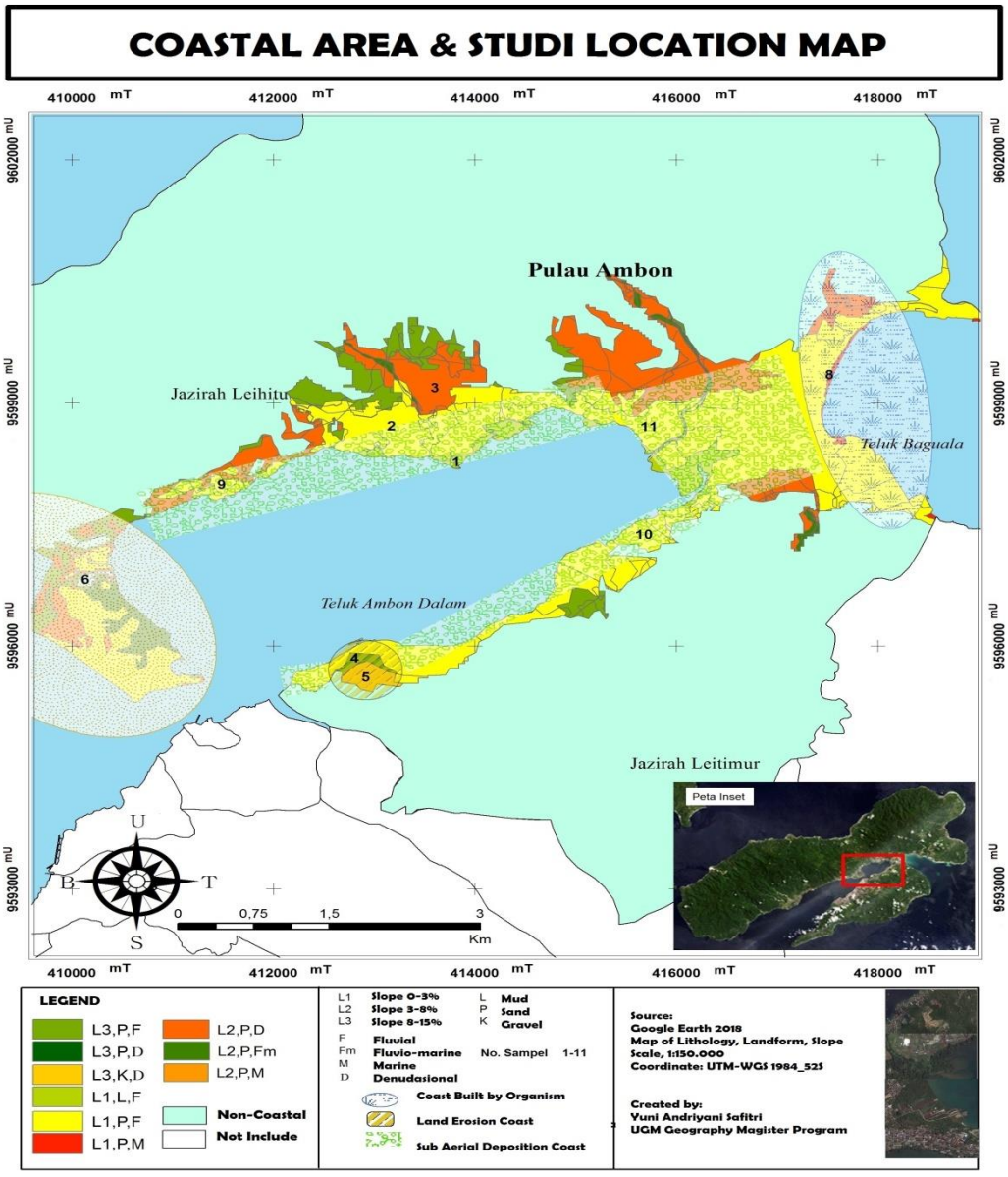


Fig. 2, Location of Study in Ambon City, Indonesia

2. Instruments

The instrument for this research are GPS, used to determine the location of the research sample as well as a tool for coordinate correction in the field. ArcGIS 10.2, for processing spatial data sourced from Google Earth imagery (output; land use maps) and secondary maps in SHP format (output: Map of Slope, Landform, and Fraction of Materials). Field checklists are used to collect oceanographic data.

3. Technique of Data Analysis

The determination of coastal typology in this study is based on a combination of the process-response system (morphology) and the substance/energy flow system in the coastal area (Cascade). The Cascade method focuses more on oceanographic data analysis while the morphological method is used to trace coastal groupings based on slope, genesis, constituent materials as shown in the following matrix table 1:

Table 1. Matrix of Typology Determination of Coastal Areas

Coastal Type / Indocators Typology	Land Erosion Coast	Sub Aerial Deposition Coast	Volcanic Coast	Structurally shaped Coast	Marine Deposition Coast	Wave Erosion Coast	Coast built by organism
Relief							
1. Flat		✓					✓
2. Sloping					✓		
3. Rather Steep	✓		✓	✓			
4. Steep	✓		✓	✓		✓	
5. Very Steep	✓		✓	✓		✓	
Raw Material							
1. Stone	✓		✓	✓		✓	
2. Mud		✓			✓		
3. Sand		✓			✓		
4. Organism							✓
Genesys Process							
1. Structurally				✓			
2. Volcanic			✓				
3. Solusional	✓						
4. Marine Tide					✓		
Wave						✓	
5. Fluvio-marine		✓					
6. Aeoliomarine					✓		
7. Biomarine							✓

Source: Khakhim (2009)

C. Findings and Discussion

1. Findings

After cross-tabulating the variables of landforms, slopes, and compilers of material, it was found that the coastal area of Ambon Dalam Bay was dominated by fluvial activity. Marine activity is not dominant due to the morphology of the deep Ambon bay which is a narrow niche so that air circulation is slow. The process is a result of high sedimentation in this area. The data from the analysis of each variable are presented in table 2.

The area of the variable landforms found in the largest coastal area is the alluvial plain. This terrain generally has a flat to gentle slope. This alluvial plain is the result of accumulated sediment deposition on the coast and river boundaries due to erosion on the upper lands. This land cover is generally residential and agricultural with a few mixed gardens which are randomly distributed and form small groups. Figure (3a) is an example of an alluvial plain form of a coastal area used by local communities as agricultural land.

In the study area, the fluvio-marine plains were built by the origin of the river process and the process of wave currents in Ambon Dalam Bay which is counterclockwise, so that the beach is located in the western part of TAD will occur accumulation of sediment material. The land use in this coastal area is generally for residential areas, educational facilities, and other economic activities.

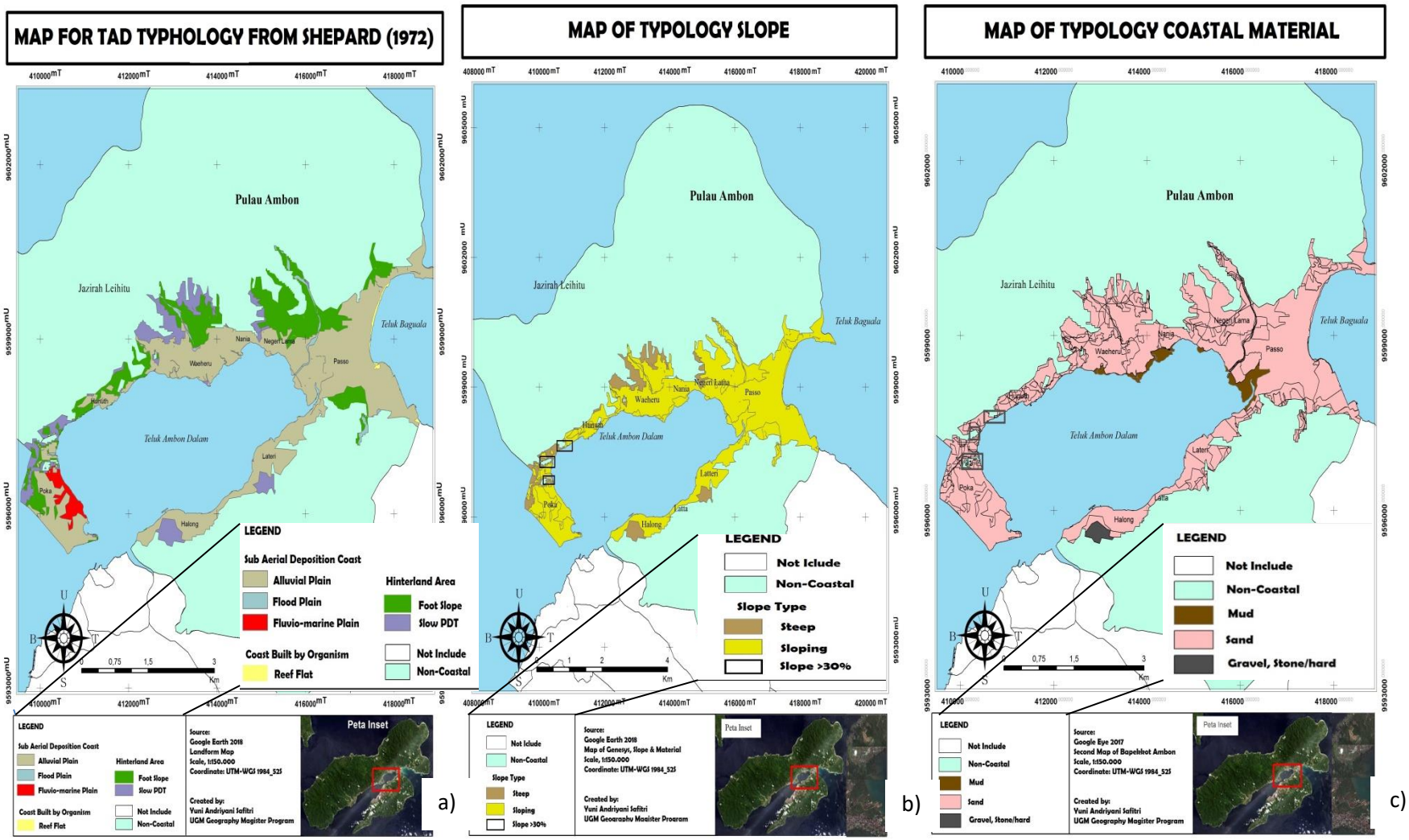
Table 2. Physical Typology of Coastal in Inner Ambon Bay

Genesys	Landform	Slope	Raw Material	Type
Fluvial	Mud Flat	0-3%	Alluvium (Clay)	*Sub Aerial Depositon Coast*
	Alluvial Plain	0-3, 3-8%	Aluvium (mix and and gravels)	
	Flood Plain	0-3%	Alluvium (Sand)	
	BackSwamp	0-3%	Alluvium (mix sand and clay)	
	Point Bars	0-3%	Alluvium (Sand)	
	River Base	0-3%	Alluvium (Sand Mix Gravel)	
	Fluvio-Marin Plain	3-8%	Alluvium (Sand)	
	Lake	3-8%	Alluvium (Clay)	
Denudasional	Foot Slope	8-15%	Sand Stone	*Land Erosion* (*Hinterland*)
	Rest Hill	15-30%	Loose materials	

Source: Analysis Result (2018)

Floodplain landforms (fig. 3b), are found along the Waeheru and Waetonahitu rivers. Areas with flat topography often experience inundation during the rainy season and river water overflows. Existing conditions in the field, this form of land is partially covered by vegetation and partly converted into settlements. The river bed (figure 3c), especially in Waeheru Village, is used by the local community as a sand and stone mining area. This sedimentary material is continuously transported by the river during high-intensity flow conditions in the rainy season.

Fig. 3, Eksisting Landform of Fluvial in Waeheru Village.
Source : Field Photos by Y.A.S (2018)



Fig, 5. Variable of Physical Typology for Map Overlaying
Source: GIS Analysis

Figure 4 (a) has been discussed in advance regarding what landforms are found in the coastal area of the study. Figure 4 (b), the slope map above categorizes coastal areas into two categories, namely flat (0-3% slopes), gentle (3-8% slopes), and slightly steep (8-15% slopes). The basis for determining this typology refers to Sunarto (2000) in Khakhim (2009), that the boundary of the coastal area towards the land is marked by the first topographic change with a slope angle <25%. In the processed data, there are slope angle classes of 15-30%, but if viewed from the aspect of landform, it is not classified as a coastal region forming genesis. As a result, the slope class is generalized into the hinterland area.

Generally, the coast with flat slopes is directly adjacent to the sea and dominates the Ambon Dalam Bay area. However, referring to the map of the largest area of the coastal area with a slope class of 0-3%, it is located in Passo State. It can be explained from a geological point of view that this location is squeezed in the north and south by denuded or further weathered hilly areas. The results of this rock weathering are eroded and carried away by river flow and surface runoff and then deposited in river estuaries or plain areas at the legs of the slopes.

The distribution of coastal areas as a whole is very narrow if the administrative area is used as a comparison. The cause was explained by Ongkosongo (in LIPI, 1991), as a result of the removal of the island which formed nine terraces or steps. These steps in the field are generally included in the 3-8% slope class which is located on the foot slope. The results of the GIS analysis found that the proportion of gently sloping coastal types (<20%) occupied 93% of the study area of 502,136m2. the remaining slightly steep slopes are known to be found at several locations such as Halong, Batu Koneng, and Hunuth. Generally, this slope in terms of lithology is included in reef limestone units.

Figure 4 (c) The constituent materials in the coastal area are made based on the interpretation of the lithology map and the soil type map at a scale of 1: 150,000. The classification of constituent materials is based on a grouping by Sunarto (2003). The constituent material in the coastal area is very diverse so that all groups of constituent materials exist in the area.

The material along the coast of TAD is mud/clay with an area of about 391,831 m2 (3.22%). The constituent lithology is the alluvium group. In the research area, alluvial soil types are visible and generally associated with kambisol, rensina, and gleisol soil types (Lasaiba, 2012). The formation of mud material on the shore is a form of draining sediment that is transported from the upstream of the river and the result of erosion in the hillside / upper lands. Another thing that helps the accumulation of mud material on the beach is the weak flow velocity in the deep bay waters <5 cm/sec.

Apart from the mud/clay material on the beach, the predominance of the constituent material in the coastal area is loose material (sand). This material dominates as seen from the extent of the alluvial plains in the study area. The formation process that occurs is the same as the formation of mud material which is powered by rivers. However, because there is no direct contact with the water, the material does not experience more drainage and accumulation of moisture.

For solid/hard coastal materials, generally found in hilly areas. Appearances in the field such as large rocks and white to brownish-yellow. The distribution of this material is found in Halong Village and parts of Poka Village. Selanno (2009), has researched sediment variation specifically in the Ambon Dalam Bay coastal zone based on grain size (mm). From the results of field

observations and also GIS analysis on secondary maps and literature review, it can be concluded that the constituent material at the research location is gradual. This means that the more towards the sea area, the sediment grains are getting smaller/soft (not coherent), while towards the hinterland the sediment grains are getting bigger/harder (solid).

2. Discussion

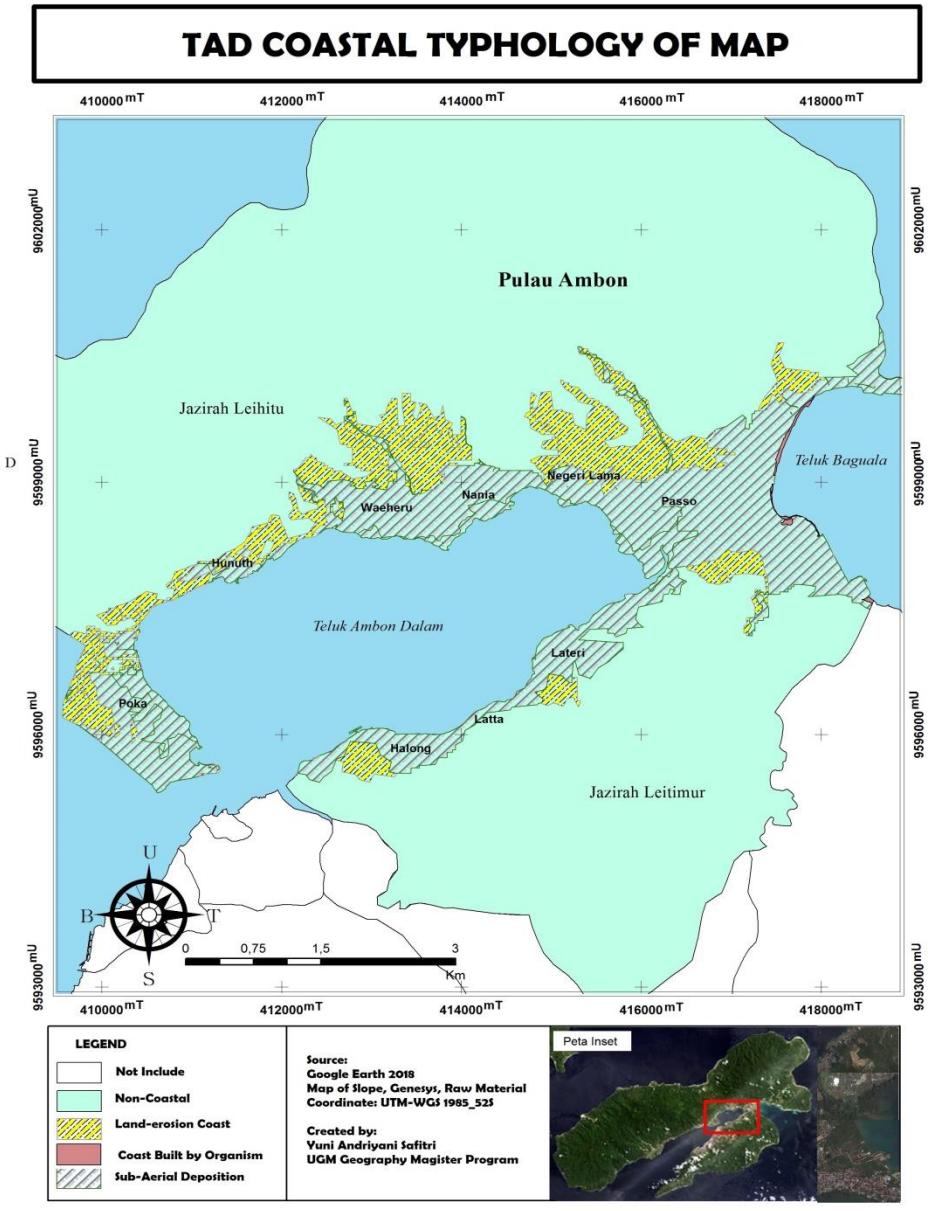


Fig.5, Typologi Map of Teluk Ambon Dalam
Source: GIS Analysis, (2018)

The final result of this research is a physical typology map of the Teluk Ambon Dalam coastal area which is an overlay of genesis type maps, slope maps, and constituent material maps. It was

found that in the study location, the coastal type is homogeneous with the characteristic land-based coastal type (Fig. 5). The characteristics according to Santosa (2015), include (1) the process of deposition of mud material is very intensive, (2) calm waves, (3) high risk of sedimentation, floods, robs and tsunamis, (4) high risk of sea pollution and social conflict, (5) very potential for mangrove ecosystems, wetlands, and aquaculture ponds, and (6) accessibility and infrastructure are difficult to develop due to drainage constraints and high ground/ wrinkled flower movements.

Silt in the study area is an accumulation of material carried by the river during the rainy season. This material is sourced from erosion in hilly areas which have undergone further weathering. The type of soil found on this upper land is generally a red and yellow podzolic soil type that has high wrinkled flowers. during the dry season, this type of soil appears to have cracks on its surface and during the rainy season, it is very easily carried away by surface runoff so that it is prone to soil movement and landslides.

According to Pattipeilohy, (2014), another impact of the formation of mud deposits in the coastal area as a result of erosion of the upper land is the silting of the seabed in Ambon Dalam Bay. This silting has the effect of reducing the quality of marine waters. According to Saiya (2015), the rate of silting the bottom of the waters of Ambon Dalam Bay is 13.9 mm / year. Besides, the influence of the sea cannot be separated from this silt activity. Teluk Ambon Dalam, which is closed water, has a slow water circulation, resulting in high mud material in the mangrove area and a decrease in seagrass conditions. Silting is also exacerbated by reclamation activities that are intensively carried out by the government in the context of providing infrastructure for urban areas.

As for the use of existing land at the research location in the form of agriculture, mixed gardens, settlements, fisheries, industrial areas, and service areas, ports and others. Access in this area is classified as very easy because it is supported by 90% paved road conditions and interconnected roads (BPS Kota Ambon, 2017). Apart from what has been mentioned above, the riverbed landforms as identified in table 2, generally there are mining activities for Quarry C (industrial) materials in the form of sand and stone for building purposes. This activity often creates conflicts of interest between communities who are miners and between communities and the government as regulators. Latupono (2016), researched in Ambon Bay in particular related to the mining of C excavated materials. According to him, sand mining in hilly areas directly changes the landscape and creates channel erosion due to the sharpening of the hillside which has an impact on increasing the intensity of erosion.

Typological analysis is very important to do, besides being able to quickly identify the characteristics of the physical area in general, another thing that can be identified is the type of disaster threat that appears. Based on the results of a review of some historical literature on disasters that occurred in the research location, two types of disasters have been recorded, namely earthquakes and tsunamis, and floods. Summarized from Latief, et.al (2016), there were 13 Tsunamis in the Ambon Dalam Bay area with a height ranging between 2-5 meters. The first incident was recorded in 1648 and the last tsunami occurred in 1983. The 1950 incident was constructed and modeling was carried out to determine the cause of the tsunami. It was found that the tsunami that occurred in the Teluk Ambon Dalam area was (1) a tsunami propagated from Banda Island and (2) a local tsunami as a result of underwater sediment landslides deposited on the coastal slopes.

Apart from earthquakes and tsunamis, the biggest threat to this coastal area of land sedimentation type is flooding. Flooding in the research location was identified as a result of poor drainage, conversion of forests to settlements, upper land which has undergone further weathering to easily erode, decreases in river systems and functions, and short-term flood management. When the rainy season arrives, areas that are flat and close to the coast will generally be inundated although the length of inundation in each area is not the same. Therefore, in

developing or managing coastal areas, it is necessary to identify the physical characteristics of the area as well as the threat of disasters that are always lurking. Ecosystem restoration efforts in the research area are needed to minimize the socio-economic impacts that arise so that the principle of sustainability of an ecosystem management system and coastal areas can be realized.

D. Conclusion

Based on the results of the overlaying map between the physical characteristics indicators of the coastal areas composing the typology, it was found that the coastal areas of Teluk Ambon Dalam were included in the category of land-based sedimentation coasts. This type of coast is generally more difficult to develop, although, in its application, it still pays attention to the regional development directions contained in the regional RTRW and RPJM Documents. This research is limited, so that the typological variables discussed are only from the physical aspect, even though the scope can be expanded towards the built-in coastal type (anthropogenic).

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THE ROLE OF PROBLEM-BASED LEARNING MODELS IN GEOGRAPHY LEARNING INBUILDING STUDENT ECOLITERACY

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Abstract

Ecoliteracy can be said to be ecological literacy or environmental literacy where humans have a high level of awareness of the importance of the environment for life. Problem Based Learning model is a learning model by presenting real problems that are happening, so that the model can be used in geography learning. Geography itself is a science that studies the interaction between humans and their environment, the existence of geography learning can make it easier for teachers to grow ecoliteracy in students. Cognitive knowledge of students increases where they can remember to the ability to solve problems, affective, namely the attitude of students has led to protecting the environment and for their own psychomotor students already have the desire to act such as throwing garbage in its place and doing things related to cleanliness at school . So with these things ecoliteracy in students has begun to grow.

Keywords: Role, Problem Based Learning Model, Ecoliteracy

A. Introduction

Ten major environmental problems in Indonesia include waste (40%), flooding (20%), polluted rivers (11%), global warming (10%), air pollution (6%), damage to marine ecosystems (4%), the difficulty of clean water (3%), forest destruction (2%), abrasion (2%) and soil pollution (2%). Indonesia is included in the top 10 countries with the largest population in the world. This has led to a number of further problems, including waste production and disposal (Suryadi, 2009). The larger the population, the more waste or waste generated.

The school environment that is often seen is that students still often litter, they tend to ignore the trash cans that have been provided by the school, there are even students who throw trash in the trash by throwing it in the trash but the trash doesn't enter so that garbage is scattered around the trash can. . In addition, sometimes students leave their food and drink waste under the table, even the picket schedule provided by the homeroom teacher is not carried out. The difficulty in maintaining the environment makes them still have a low levelof ecoliteracy.

The problems that occur, make ecoliteracy very important for students to have. Environmental awareness and sensitivity to environmental problems can be instilled early on by developing students' ecoliteracy. Revealed that people who understand ecoliteracy are (Goleman, 2012): (1) Ecoliterate people recognize that they are members of a web of diverse relationship within their communities and beyond, (2) Ecoliterate people tend to be more aware that systems exist on various levels of scale, and (3) Ecoliterate people collectively practice a way of life that fulfills the needs of the present generation while simultaneously supporting nature's inherent ability to sustain life into the future. From this opinion, people who are ecoliterated are people whose way of life can meet the needs of the current generation to sustain life into the future.

Education plays a very important role in the dynamics of the life of a nation, education is an agent of development and an agent of change (Suryadi, 2009). With education, students will gain more knowledge which they will later use in both school and community environments because students are a young generation that has the potential to create an improvement in the future.

Geography emphasizes the distribution and spread of a phenomenon by taking into account the dimension of time so that it involves spatial diffusion, which means that geography is a field of scientific study that examines all phenomena in space which include natural phenomena and social phenomena where both are interrelated in space on earth (Kamil, 2002).

The environment and humans cannot be separated, where both are interconnected. The number of activities and human needs causes various disasters such as landslides, floods, fires and so on. The environment is an important component to be always maintained, as in human activities it must lead to sustainable life and development activities to save the environment from various damages. From a systematic point of view, the only solution that should be implemented is a sustainable solution (Capra, 2002).

The process of learning geography can foster student ecoliteracy. Because according to the explanation above, geography consists of both natural and social environments that are interconnected so that teachers have an important role so that students understand the importance of the environment. Ecoliteracy itself is the human ability to (1) understand key concepts and ecological connectivity, (2) think naturally about ecological problems and (3)appreciate the relationship between human actions and the environment (Reynolds & Lowman, 2013).

Problem learning models can be used to assist in instilling ecoliteracy in students, various real problems that exist in the environment can be used as material for them to think what, why, and how to solve these environmental problems. Problem-based learning is one of the learning approaches used to stimulate students' high-level thinking in real-world problem- oriented situations, including learning how to learn (Ibrahim & Nur, 2002). To create a pleasant learning atmosphere, the teacher provides comics media so that students are provoked to think with illustrated pictures and conversations that exist in the media, because comics are made more alive and processed by using the main colors freely (Sudjana & Rivai, 2010). Thus the research aims to identify a model of problem based learning in geography lessons in building students' ecoliteracy

B. Methodology

The study method uses a literature review, both primary literature, derived from research results and books related to the study. Problem based learning model as the dependent variable and ecoliteracy as the independent variable. The researcher is positionedas an instrument with a qualitative approach.

C. Findings and Discussion

1. Problem Based Learning Model

Problem-based learning is a model derived from constructivism theory. Constructivism was first proposed by Giambatistia Vio, an Italian epistemologist in 1710 in his work "De Antiquissima Italorum Saplentia" then popularized by Mark Balwin and deepened and expanded by Jean Piaget (Hermanto, 2009). Constructivism learning theory states that students must construct knowledge in their own minds (Fitriana, 2013). Problem-based learning is based on Bruner's concept of "scaffolding". Scaffolding is a process where students

are helped to master certain problems beyond their development capacity through mentoring teachers or people who have more intelligence (Arendes, 2012).

The objectives of learning-based are (Hmelo-Silver, 2004): a) Construct or build a broad and flexible knowledge base, b) Build effective problem solving skills, c) Build self-directed learning, lifelong learning skills, d) Build effective collaboration, and e) Build intrinsic motivation in learning. With these problem-based learning objectives, the expected outcomes of students have the ability (Duch, *et al*., 2011): a) Critical thinking, able to analyze and solve complex and real problems, b) Able to find, evaluate and use appropriate learning resources, c) Able to work together in teams and small groups, d) Realizing a variety of communication skills both verbal and written, and e) Able to use the knowledge and intellectual skills acquired in school to becomea continuous learner.

The five phases of the problem-based learning model are (Arendes, 2012): a) orienting students to problems, b) organizing students to research, c) assisting independent and group investigations, d) developing and presenting work, and e) analyzing and evaluating In the problem-solving process, the problems used in PBL are problems faced in the real world.

The advantages of the problem-based learning model (Pawson, *et al*., 2006): 1) Student-centred approach, 2) Learning becomes more fun and satisfying for students, 3) Encourages deeperunderstanding, 4) High conceptual ability from participants students, and 5) Focus on developing the skills needed for lifelong learning. As for the shortcomings of the problem- based learning model, namely a) Previous learning experiences have not prepared students adequately to use this model, b) Requires quite a long time. This will have a negative impact on other learning, c) Students are less comfortable and feel confused because they are accustomed to traditional lecture learning, and 6) Failure can occur during group dynamics.

2. Ecoliteracy in Geography

Ecoliteracy comes from eco and literacy where eco comes from the word ecological which means it is a science that discusses the reciprocal relationship between humans and the environment while literacy means literacy, namely being skilled and understanding about something. Ecological literacy or ecoliteracy is a term used by Capra to describe humans who have reached a high level of awareness about the importance of the environment. Ecoliteracy stands for ecological literacy. Explained that ecoliteracy as a condition where people have understood the principles of ecology and live in accordance with these ecological principles in organizing and building life together with human beings on this earth in and to realize a sustainable society (Keraf, 2014).

Ecoliteracy or environmental awareness is defined namely environmental awareness is an effort to foster awareness so that they not only know about waste, pollution, reforestation and protection of endangered animals but more than that, raise environmental awareness of Indonesian people, especially today's youth, to love land and water to build a just, prosperous and sustainable Indonesian homeland (Neolaka, 2008). Furthermore, it is said that this awareness of the environment encourages the human person to live in harmony with nature and thereby fosters a sense of religion and infatuation with the love of Allah swt which is actually written throughthe contents of this earth. Ecoliteracy as a knowledge, must be able to provide severalsolutions to any environmental challenges and problems both local, national and global by providing information and knowledge about the use of locally available natural resources (Pilgrim, *et al*., 2007)

Education is a forum used by teachers in teaching students, by learning they will have broad knowledge. With this knowledge, students can know what is good and what is not good for them to do. Similar to the opinion which states that learning is a process marked by a change in a person, change as a result of the learning process can be shown in various forms such as changing knowledge, understanding, attitudes, behavior, skills, abilities, abilities, reaction power, power recipient, and others (Sudjana, 1990). In this case, ecoliteracy is very important for students to have, because they are the nation's next generation who will later create a good lifefor the environment.

To grow the ecology of students, teachers use learning geography. Because geography itself is a science that studies the earth and everything in it. The material in the geography subject syllabus for the 2013 Curriculum Revised Edition in class XI that can be used in growing students' ecoliteracy is at KD 3.8 Evaluating appropriate actions in environmental conservation in relation to sustainable development and the subject matter of environmental conservation and sustainable development which discusses pollution, damage and environmental risks.

Learning geography is teaching about the spatial aspects of the earth's surface which are the overall phenomena of nature and human life with regional variations (Sumaatmadja, 2001). In addition, geography teaching is oriented to (1) the actual problems that develop around students, (2) the interests and psychology of the development of students, (3) improving living standards through the introduction and utilization of resources, (4) must be future oriented and (5) provides global insight both in the form of opportunities and challenges (Maryani, 2006).

Based on these things, learning geography can be used as a reference to build ecoliteracy of students, where ecoliteracy itself has developed a standard or structure of core competencies in learning, which is related to cognitive (*learning to know*), affective (*learning to be*) and psychomotor (*learning to do*).

Table 1. *A Set of Core Competence Ecoliteracy from Center for Ecoliteracy*

Competence	Sub Competency
Head (Cognitive)	a) Approach issues and situations from a systes perspective Understand fundamental ecological principles b) Think critically, solve problems creatively and apply knowledge to new c) situations d) Assess the impacts and ethical effects of human technologies and actions e) Envision the log-term consequences of decisions
Heart (Emotional)	a) Fell concern, empathy and respect for other people and living things b) See from and appreciate multiple parspectives work with andvalue others with different backgrounds, motivations and intentions c) Commit to equity, justice, inclusivity and respect for all people
Hands (Active)	a) Create and use tools, objects and procedures required by sustainable communities b) Turn convictions into practical and effective action and apply ecological c) knowledge to the practice of ecological desain Assess and adjust uses of energy and resources

With the formation of understanding and knowledge of the environment, students can apply it in the surrounding environment such as participating in anything related to the environment. Ecoliteracy literate individuals are individuals who can understand and behave wisely in using the environment so that ecological sustainability occurs, in which ecological sustainability is an important component and has an important core in the era of globalization (Capra, 2002). A sustainable society is a society that is able to meet the needs of its present life without compromising the opportunities of future generations (Capra, 2007). This is similar to the opinion which states that sustainable development is defined by the World Commission on Environment and Development, namely that humans have the ability to achieve sustainable development for their own sake. Meet the needs of the present without compromising the ability of future generations to meet their own needs (Capra, 2002).

It can be concluded that ecoliteracy can prepare students who will have knowledge of the importance of the environment for life so that they will create good habits in utilizing the environment and awareness that the earth is the most important thing in this world that they must always take care of.

3. The Role of Problem-Based Learning Models in Geography Learning in Building Student Ecoliteracy

Ecology is indispensable in education to provide an understanding of the interdependence of natural processes and the human way of life (Orr, 1992). So here there needs to be a bridge to convey so that students can understand the meaning of ecoliteracy. Learning geography is the right bridge so that students can understand the meaning of ecoliteracy. Learning geography is essentially learning about the spatial aspects of the earth's

surface which are the overall phenomena of nature and human life with regional variances (Sumaatmadja, 2001).

The number of real problems that occur in the environment can be used to foster student ecoliteracy. Problem-based learning is a learning model that can build around real and complex problems that naturally require examination, information guidance and reflection, proving tentative hypotheses and being formulated for truth and solutions (Rianto, 2010).

The new knowledge that students know from various environmental problems in problem-based learning makes them have a caring attitude towards the surrounding environment. Teachers at schools familiarize students with environmental care such as throwing garbage in its place and doing class pickets, so that with this habit, students will get used to it and will always do it. The sense that is embedded in students will make them not feel burdened to always keep the environment clean.

D. Conclusion

Ecoliteracy must be owned by everyone, in the world of education ecoliteracy is grown through learning geography in which there are several subject matter that has a role in increasing student ecoliteracy and with the help of learning models in conveying it. Problem-based learning models can show real environmental problems to students so that they are able to analyze the causes and solutions of these problems. So it can be concluded that the problem-based learning model in geography learning has a role in growing students' ecoliteracy.

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SPATIAL MODELING FOR DETERMINING THE SEATING OF MALEO BIRDS IN THE HUNGAYONO CONSERVATION AREA, EAST SUWAWA DISTRICT

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Abstract

This research is a research conducted in the Hungayono Conservation Area, East Suwawa District. The purpose of this study was to determine the distribution of Maleo bird eggs. The methods used in this research are the model builder, Land Surface Temperature (LST), and Normalized Difference Vegetation Index (NDVI). Data collection techniques through observation and documentation. The results of the research that have been conducted show that the distribution of Maleo Bird eggs in the Hungayono Conservation Area is divided into three criteria, namely, potential one has a land area of 549.947 ha, potential two with an area of 19774.3 ha, and potential three has a land area of 6220.51. ha, so that there are differences in the potential land area of Maleo birds which are categorized based on predetermined criteria. Referring to this fact, the part of the area which is the habitat for the Maleo Bird's nesting ground should always be preserved to protect the Maleo Bird from the threat of extinction.

Keywords: Model Builder, Maleo Bird, Hungayono

A. Introduction

Maleo bird is one of the typical fauna of Sulawesi Island. Sulawesi Island is determined by the World Conservation Society (WCS) as the island with the highest level of endemicity in the world, where 84 endemic birds in Sulawesi cover more than one-third of the 256 species of birds endemic to Indonesia. Based on observations, according to Usman as a conservation officer 15 years ago the number of Maleo birds reached 25,000 and now there are only 10,000 birds despite efforts made by the government. It is estimated that threats to the sustainability of Maleo will continue. Based on the list of reports on the Maleo Citex Bird which has a scientific name (Macrocephalon Maleo) is a typical animal of Sulawesi. Through the Wildlife Conservation Society (WCS) through its mission to save Maleo's habitat, namely protection in several areas of Maleo's nest. Maleo bird is included in the list of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix I which is protected by Law Number 5 of 1990 concerning the conservation of Biological Natural Resources and their ecosystems and Government Regulation Number 7 of 1999. Also, the International Union for Conservation of Nature Resources (IUCN), which is a world conservation agency, has listed Maleo as an endangered species of wild animal under the category of "Vulnerable" since 1966. Also, the Indonesian Government has designated the Maleo Bird. as a protected animal based on the Decree of the Minister of Agriculture Number: 421 / KPTS / UM / 8/1970 dated August 26, 1970. And also the Government of North Sulawesi through Decree No. 522 / XI / 2787 dated 21 July 1987 has prohibited the capture of Maleo birds and the collection of Maleo eggs (R. Megumi, 2017). Another threat is the loss of the corridor of Maleo's movement from forest to nesting sites due to land-use change and land cover. For example, the construction of the Sulawesi (trans) highway, land clearing for monoculture and seasonal agricultural areas, as well as the expansion of settlements and other land use activities by humans.

In overcoming this problem, it is necessary to prevent the extinction of Maleo birds, which until now the number has been decreasing, therefore innovation is to detect the presence of Maleo bird egg-laying locations using this modeling which has several parameters to determine the location of the Maleo bird eggs using the Land Surface method. Temperature (LST) for processing temperature data and model builder for modeling in image processing from grouping several parameters, where the soil temperature is the main parameter, then other parameters are soil type, vegetation, slopes, and hot spring rivers. This design focuses on areas that have been determined to contain Maleo birds such as the Nani Wartabone Bogani Park, the Nantu Wildlife Reserve, and the Panua Nature Reserve in Gorontalo. And for this research, Hungayono Forest is a research site because before it became a conservation forest, hunting of animals in this place was very high (Banthayo, 2019). The Maleo bird is an animal that has long lived in the Hungayono forest. This planning is very effective because the focus is on finding the presence of eggs and making it easier for officers to evacuate Maleo bird eggs in the hatchery of the hatchery.

B. Methodology

1. Research Design

This research was conducted in TNBNW Hungayono Area, East Suwawa District, Bone Bolango Regency, Gorontalo Province. Astronomically, this area is located at 0˚21'00 "- 0˚40'30" North Latitude to 123˚14'30 "- 123˚22'30" East Longitude with an area of 26611.593 Ha. Research variables are anything in the form that is determined by the researcher to be studied to obtain information about it, then conclude. The research variables used in this study consisted of five variables, namely, surface temperature, the slope of the slope, distance to the river, soil type and NDVI.

Surface temperature was used in this study because the maleo bird is one of the animals that is very sensitive to temperature conditions. this is related to the level of dependence of maleo birds on natural heat sources for the egg incubation process. proof of the importance of temperature for the maleo bird is the maleo bird's equipped with a natural temperature measuring device in the form of a bulge on the head called kapseti. The proximity to the river is used in this study because basically every animal needs water, so the closer it is to the river, the higher the chance of maleo birds. The dependence of animals on water is also related to the need for food for maleo birds. Gunawan (2000) also stated that maleo birds often look for food on the banks of rivers. NDVI is used as a variable in this study because vegetation density can

develop a fairly high level of dependence of Maleo birds on vegetation with a good canopy. This dependence is thought to be closely related to the protection and feed needs of Maleo Birds. Baley (1984) states that one of the functions of habitat for animals is as a place to find food and as a shelter from predators. Unlike other types of birds, Maleo birds do not lay their eggs in the nest but in the ground. Therefore, soil type is used as one of the variables in this study. The slope of the slope is used as a variable in this study because the slope of the slope is one of the indicators that plays an important role in the selection of the laying location of the Maleo Bird, that the higher the location of a habitat, the more limited the type and structure of the forest.

There are two secondary data used in this study, namely:

a. Digital data of Landsat 8 OLI and TIRS path 112 rows 60 imagery corrected geometric level 1T, source from the USGS official website of the United States (www.usgs.gov).
b. Digital data shapefile (.shp) base map Gorontalo, source from Topographical Map of Indonesia 2013 scale 1: 50,000 by Geospatial Information Agency (BIG).

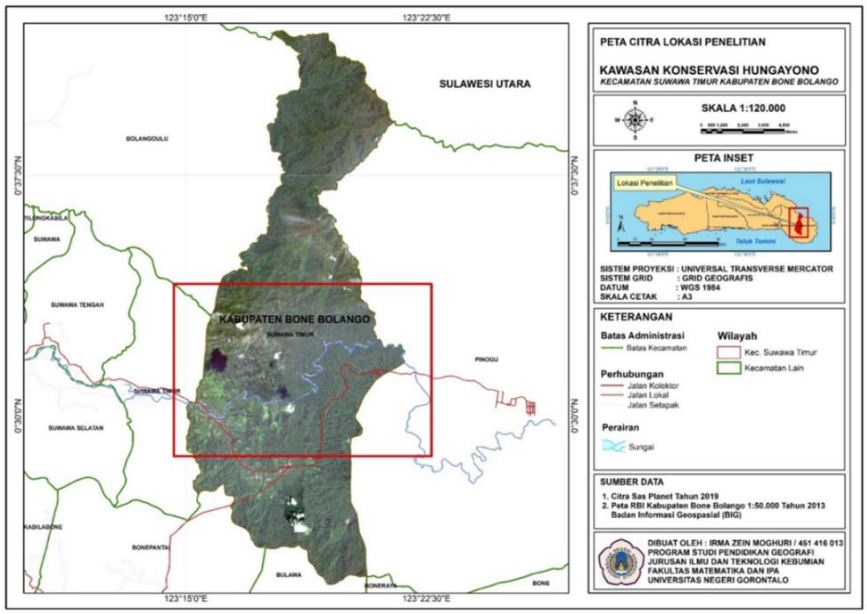

Figure 1. Map of Research Location

2. Technique of Data Analysis

The digital image processing stage

The digital image processing stage includes cutting (masking) the Landsat 8 image according to the study area, namely bone bolango district, the process of estimating LST in the bone bolango district from Landsat 8 images with the SWA algorithm using ArcGIS 10.3 software on a laptop. Following are the digital image processing steps:

a. Image cropping

Landsat 8 image cropping according to the study area is carried out in ArcGIS 10.3. Landsat 8 imagery (path 112 and row 60) was recorded during 2019.

b. Analysis of Surface Temperature (Land Surface Temperature)

Radiometric Correction: TOA Spectral Radiance Calculation

$$L\lambda = MLQcal + AL \ldots\ldots\ldots .. (1)$$

Information:

Lλ: TOA spectral radiance (Watts / (m2 * srad * μm))
ML: Band-specific multiplicative rescaling factor from the metadata (RADIANCE_MULT_BAND_x, where x is the band number)
AL: Band-specific additive rescaling factor from the metadata (RADIANCE_ADD_BAND_x, where x is the band number)
Qcal: Quantized and calibrated standard product pixel values (DN)

c. Calculation of Brightness Temperature

$$TB = (K2 - 273.15) / \ln (K1 / L\lambda + 1) \ldots\ldots (2)$$

Information:

TB: At-satellite brightness temperature (°C)
Lλ: TOA spectral radiance (Watts / (m2 * srad * μm))
K1: Band-specific thermal conversion constant from the metadata (K1_CONSTANT_BAND_x, where x is the band number)
K2: Band-specific thermal conversion constant from the metadata (K2_CONSTANT_BAND_x, where x is the band number)
Table 3.4 Radian values and band thermal constants in Landsat 8

Keterangan	*Band 10*	*Band 11*
Radiance Multiplier	0,0003342	0,0003342
Radiance Add	0,1	0,1
K1	774,89	480,89
K2	1321,08	1201,14

d. Calculation of Normalized Difference Vegetation Index (NDVI)

$$NDVI = \frac{NIR - VIR}{NIR + VIR} \ldots\ldots\ldots (3)$$

Information :
NIR = Near Infrared (channel 5 for Landsat 8)
VIR = Visible Red (channel 4 for Landsat 8)

e. Calculation of *Fractional Vegetation Cover (*FVC)

$$\text{FVC} = ((NDVI - NDVI_{soil}) / (NDVI_{veg} - NDVI_{soil} \ldots (4)$$

Information:
FVC: Fractional Vegetation Cover
NDVI: Previously obtained NDVI values
NDVIsoil: NDVI value for soil = 0.2 (Latif, 2014)
NDVIveg: NDVI value for vegetation = the largest value for NDVI

f. Calculation of *Land Surface Emissivity* (LSE)

LSE = εs * (1-FVC) + εv * FVC…. (5)

Information:
LSE: Land Surface Emissivity
FVC: The value of the FVC that has been previously obtained
ε s: Soil emissivity of bands 10 and 11
ε v: Emissivity of vegetation bands 10 and 11
Table 3.5 TIRS Band Emisity Value in Landsat 8

Emisivitas	Band 10	Band 11
E_s	0,971	0,977
E_v	0,987	0,989

g. Calculation of the combination of LSE band 10 and LSE band 11

m = LSE band 10 + LSE band 11/2…. (6)
Δm = LSE band 10 - LSE band 11 …… .. (7)

Information:
m: mean of LSE
Δm: the difference of LSE
LSE band 10: Previously obtained LSE band 10 value
LSE band 11: Previously obtained LSE band 11 value

h. Calculation of Land Surface Temperature (LST)

LST = TB / [1+ (λ * TB / c2) * ln (e)]… .. (8)

Information :
TB = Temperature Brigthness (C)
λ = Central Wavelength Of Emitted Radiance
c2 = h * c / s = 1.4388 10-2 mK = 143μmK

C. Findings and Discussion

1. Findings

Slope Map

Slope data obtained using DEM (GDEM ASTER/SRTM) data in ArcGIS. The first thing to do is cut the data. After that, enter the data and the administrative boundaries of the sub-district of East Suwawa. The SRTM data that has been cut earlier is then processed by clicking Spatial Analyst -> Surface Analyst then selecting Slope, then the Slope window appears, entering the cut SRTM as Surface input. after that, just classify it according to the existing slope class. To change the slope class, go to the spatial analyzes toolbar -> reclassification, there are various classification options such as natural breaks, standard deviation, minimum, maximum, manual. The final step so that the results of the classification can be used as material for analysis with other data, then the results are converted to vectors using the Raster to Polygon tool.

The sloping slopes are considered suitable habitats for Maleo birds. In the research location, there are all slope classes with the largest area in the very steep slope class (15902.55 hectares) and the smallest area on the flat slope class (1351.94 hectares). The area of each slope class at the study location is presented in table 1

Table 1. Slope Classification and Scoring

No	Slope	Keterangan	Area (ha)	Score
1	0-8 %	Datar	1351,94	5
2	8-15 %	Landai	2843,86	4
3	15-25 %	Agak curam	1012,23	3
4	25-45 %	Curam	5406,88	2
5	>45 %	Sangat curam	15902,55	1

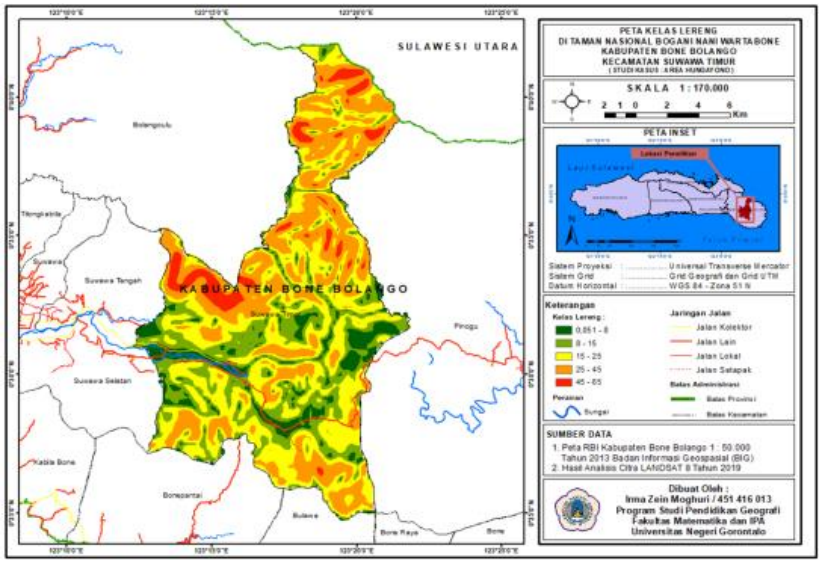

Figure 1. slope map image

Surface Temperature Map

The surface temperature of the research location was obtained at 23,424 - 34,761 oC. which were then grouped into 5 classes. Surface temperature class with a value of 31.800 - 34.761 oC has the largest area, namely 15280.00 ha. and surface temperature class with a value of 26.313 - 29.736 oC has the smallest area, namely 1157.37 ha. The area of each surface temperature class is presented in Table 2.

Table 2. Classification of Surface Temperature

No	Surface Temperature (°C)	Area (ha)	Score
1	23,424	4585,06	1
2	23,423 – 26,312	3015,10	2
3	26,313 – 29,736	1157,37	3
4	29,737 – 31,799	2396,01	4
5	31,800 – 34,761	15280,00	5

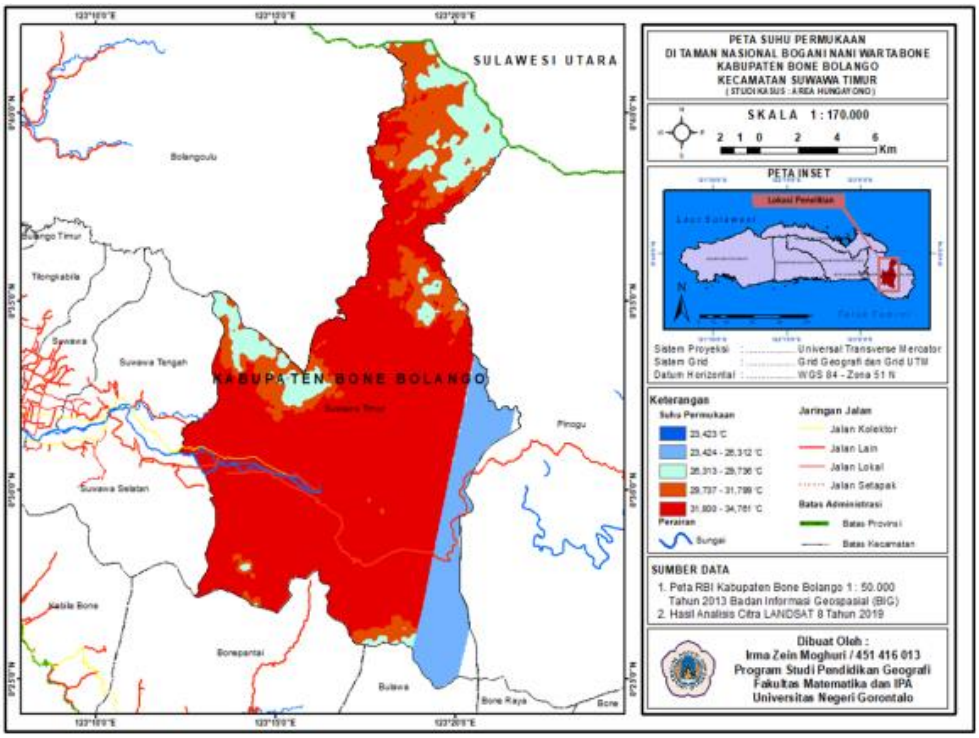

Figure 2. Surface Temperature Map

NDVI Map

NDVI is one of the commonly used vegetation index calculation methods because it has a strong correlation with vegetation characteristics. NDVI is analyzed using pixel values in the near-infrared band (Near Infra-Red) and the red band (red), which in Landsat 8 imagery is obtained from band 5 (near-infrared band) and band 4 (red band). The area of each NDVI is presented in table 3

Table 3. Classification of NDVI Values

No	Keterangan	Nilai NDVI	Luas (ha)	Skor
1	Awan Es, Awan Air, Salju	-0,112	22,5104	1
2	Batuan Dan Lahan Kosong	0.149 – 0.279	210,1673	2
3	Padang Rumput	0.279 - 0.393	24345,0687	3
4	Semak Belukar	0.393 – 0.467	280,7477	4
5	Hutan Daerah Hangat Dan Hutan Hujan Tropis	>0.467	1753,099	5

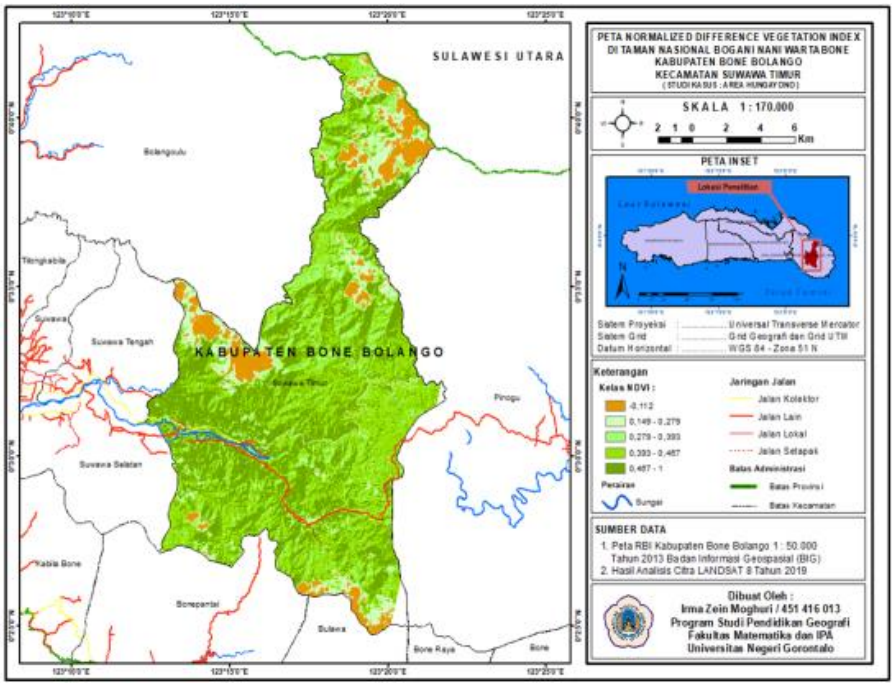

Figure 3. NDVI Map

River Proximity Map

The relationship between the distance to the river and the chance of Maleo Bird presence is a positive relationship, which is shown that the closer to the river, the higher the chance of Maleo Bird presence. This variable is not like the other variables in its classification because the presence of rivers at the research location is not spread out as a whole but only in one area of the total research location.

Table 4. Classification Of River Proximity

Class	Score
50 m	5
100 m	4
200 m	3
250 m	2
>250 m	1

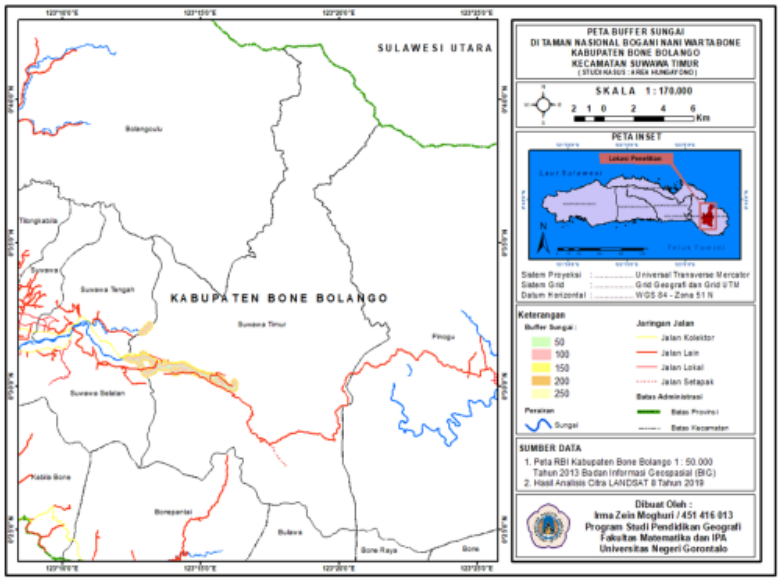

Figure 4. River Distance Map

Soil Type Map

Based on the results of the analysis of soil types in the sub-district of East Suwawa, it shows that there are 3 types of soil. The three types of soil are Latosol, Mediterranean, and Podsolic. The classification and scoring can be seen in table 5.

Table 5. Classification of Soil Types

No	Soil Types	Area (ha)	Score
1	Latosol	22,5104	1
2	Mesiteran	210,1673	2
3	Pedsolik	24345,0687	3

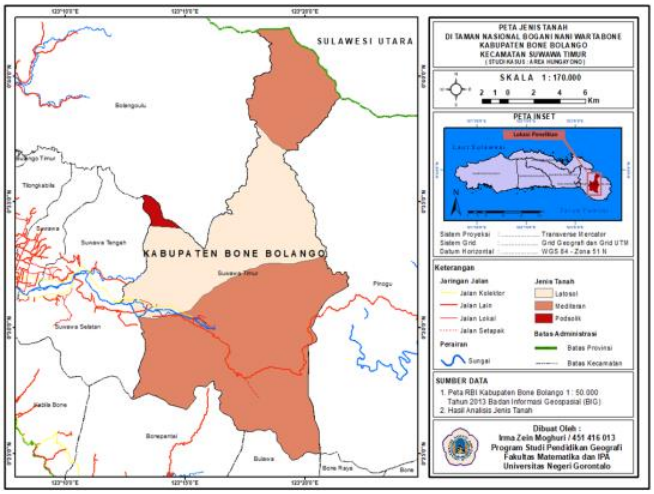

Figure 5. Soil Types Map

Model extrapolation

The modeling process created in the model builder can be seen in the following figure:

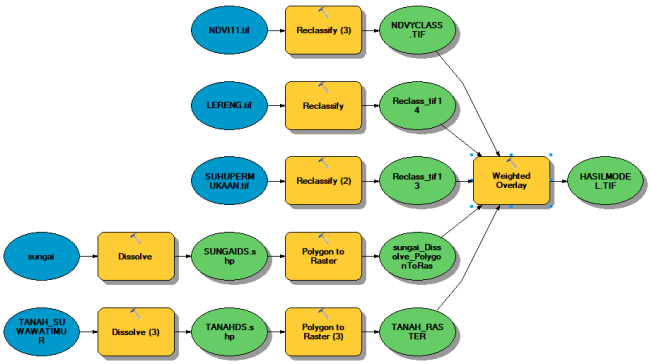

Figure 4.6 Map Making Process

Based on the results of the analysis, the parameters used are slope, river distance, soil type, surface temperature (LST), and also NDVI or vegetation density index. An area that has the potential to become a nesting site for Maleo birds. The areas found are divided into three criteria, namely potential one, potential two, and potential three.

Table 6 Classification Of Potential Map For Maleo Bird Eggs

No	Class	Area (ha)
1	Potential 1	22,5104
2	Potential 2	210,1673
3	Potential 3	24345,0687

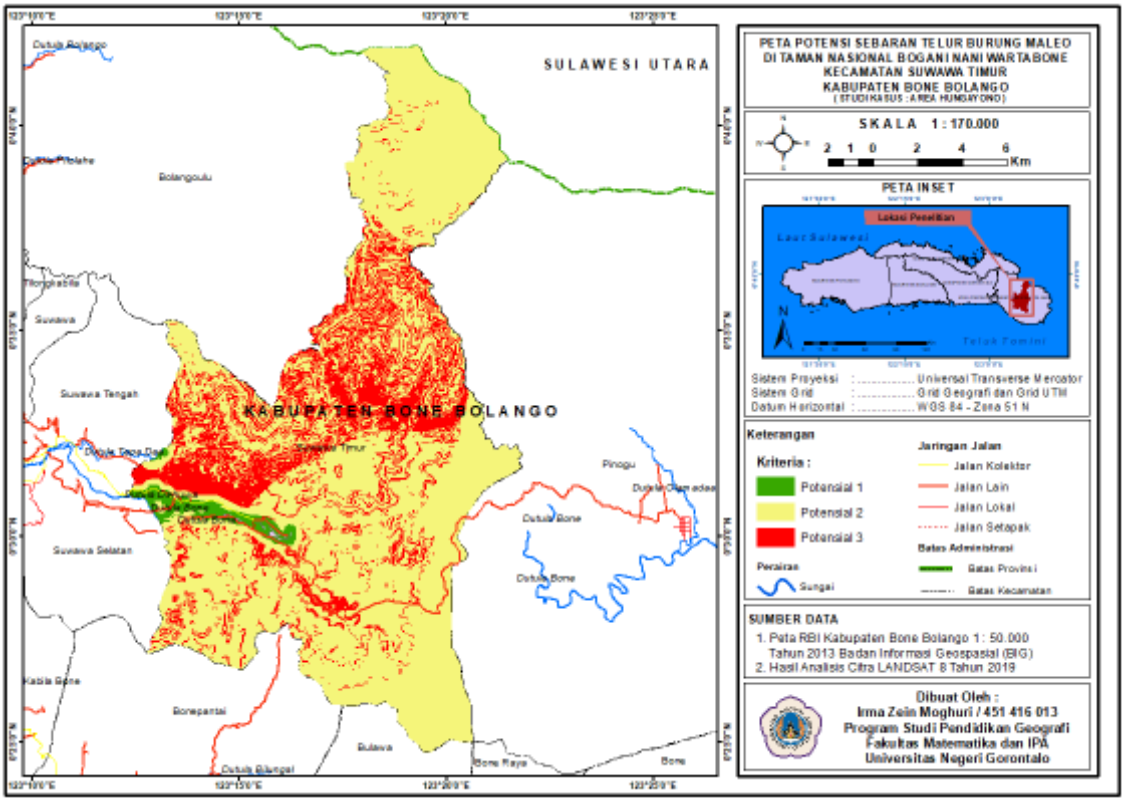

Figure 4.7 Potential map for Maleo Bird eggs

2. Discussion

Surface Temperature

According to alikodra (1990), birds often use sunlight as a guide to react to get the right direction in daily movement. Maleo birds, as animals that are active during the day, are likely to have a lot of influence from solar radiation in their daily activities. Thus, solar radiation is one of the factors for Maleo birds in determining their habitat.

Various animal activities such as reproduction, growth, and even death are greatly influenced by temperature. Maleo bird is one of the animals that are very sensitive to temperature conditions. This is related to the level of dependence of the Maleo Bird on natural heat sources for the incubation process. Evidence of the importance of temperature for Maleo Birds is the completion of Maleo Birds with a natural temperature measuring device in the form of a bulge on the head called a Kapseti (MacKinnon, 1981). Kapseti serves to measure soil temperature when digging the nesting holes.

Slope

The map results show that the slope of a place is, the less likely Maleo Bird will be. This is in line with various previous research results which state that the Maleo bird is a type of animal that likes lowlands (Wallace 1860 in Birdlife International, 2001). According to Wiriosoepartho (1979), Dekker (19990), Del Hoyo et al (1994), and Jones et al (1995) the maximum height of the Maleo bird encounter location is 1200 meters above sea level. The dependence of Maleo Birds on hot water, especially for reproduction, is another limiting factor for Maleo Birds in occupying a habitat. Maleo birds that want to lay eggs will come to the area around hot water in the afternoon and spend the night with the bartender in the trees near the hot water until morning comes (Wiriosoeparthi, 1979). The relationship between dependence on hot water and altitude is related to the consideration of the efficiency of energy use in looking for food (optimal foraging behavior). The choice of habitat for an animal is largely determined by the availability of food and the length of time it takes to get that food (Orians, 1975).

The observations show that the slope of the location where the Maleo bird is nesting ranges from 0% - 8%, which indicates that the location is tinsel in the lowlands. Several other facts related to the slope of the site which is thought to play an important role in the selection of the Maleo bird's nesting location, among others, are that the higher the location

of habitat, the more limited its forest species and structure are. The increase in altitude has an impact on decreasing the amount of available food, also the higher the location of a habitat the lower the air pressure, making it more difficult for animals to be able to live in higher areas. This is related to the process of respiration which will be increasingly difficult with a significant decrease in air pressure (Alikodra, 1990).

Normalized Difference Vegetation Index (NDVI)

Based on the results of the existing NDVI analysis, it shows that the higher the degree of the greenness of a (forested) vegetation, the higher the chance of Maleo Bird presence. NDVI is related to the degree of greenness and the relative biomass content of vegetation. In this regard, the NDVI in grassland vegetation is likely to have a higher tendency than NDVI in forested vegetation or vegetation with annual trees with relatively stable biomass movement.

NDVI values range from -1 to 1. The NDVI value of the map interpretation results in this study ranges from - 0.1 - 1. The results of the study by Syartinilia and Tsuyuki (2008). This shows that the NDVI value of forested vegetation ranges from 0.1 - 0.7. The results of the application of the model in the study area show that the areas suitable for Maleo birds are habitats that have NDVI> 0 or areas that have a positive index value, while areas that have NDVI values <0 or are negative then these areas are not suitable for Maleo birds. This indicates that the level of dependence of the Maleo Birds is quite high on vegetation with a good canopy. This dependence is thought to be closely related to the protection and feed needs of Maleo birds. Baley (1984) stated that one of the habitat functions for animals is as a place to find food and as a place of refuge from predators.

The results of the vegetation analysis showed that the vegetation density in the study location was quite high. According to (Brown, 2008) the NDVI value will be high when the vegetation cover approaches the maximum, so the denser the vegetation, the higher the vegetation NDVI in question. Maleo birds as terrestrial animals range from predators such as wild dogs, jungle cats, and monitor lizards. Maleo birds need high-density vegetation as a shelter from predators.

Distance to River

The relationship between the distance to the river and the chance of Maleo Bird presence is a positive relationship, which shows that the closer to the river, the higher the chance of Maleo Bird presence. Every animal needs water, so the closer to the river, the higher the chance of Maleo Bird's presence. The position of large rivers is generally quite close to the location of the encounter with Maleo Bird. Most likely the Maleo Bird depends on the existence of large rivers. According to Wirioosoepartho (1979), the peak season for Maleo egg-laying in the TNBNW area is in November, December and January. The location of the encounter with Maleo birds was mostly around the spawning habitat. This is following the modeling that has been made, where the distribution of Maleo bird eggs which are mostly around the river. This fact states that the existence of rivers is one of the important factors for Maleo birds in choosing the location for laying eggs. The model made has the same pattern between the relationship between water availability and animals in general, which shows that one of the factors that influence the presence of Maleo birds is the existence of rivers. This is in line with Alikondra (1990), which states that in general, wildlife needs water for various processes including food digestion and metabolism, transporting waste materials, cooling, and evaporation processes. The dependence of animals on the water is also related to the food needs of the Maleo Bird.

Type of soil

The distribution of latosol land is in a hilly and mountainous topography. Soil texture that is formed contains clay/clay such as clay, sandy clay, sandy loam, silty clay loam, and clay loam. This land has an area of 100.68 km^2. Latosol soil is a type of old soil, which is formed from flint which undergoes a further weathering process. This soil is characterized by an acidic character, low to moderate organic matter content, red to yellow, and has a loamy texture.

Model extrapolation

The modeling results also show that the suitable location for the spawning of Maleo birds is generally part of an area that has a lowland habitat, dense vegetation, and a fairly

high surface temperature, and is close to a water source that automatically has a loamy soil type. If it is related to the slope of the slope in the Hungayono area, it indicates that one of the limiting factors for Maleo birds is the slope of the slope. Because the results of the existing modeling at potential one indicates that the area is a lowland area. This is also following the opinion of Wallacee (1986) in international birdlife (2001) which states that Maleo birds are animals that like lowland forests. Changing part of the Hungayono area into encroachment will narrow the habitat of Maleo birds. This condition can lead to fragmentation of the Maleo Bird's habitat, thus forming small groups suitable for Maleo Birds. Isolation of Maleo birds into narrow habitats can increase the occurrence of inbreeding. Inbreeding has the potential to cause a decrease in genetic wealth. This condition will cause Maleo Birds to be very sensitive to environmental changes and threaten the sustainability of Maleo Birds (Indrawan et al 2007).

Also, the edge of the Hungayono area is an area that is directly adjacent to the residential agricultural area and residential areas. This condition certainly puts serious pressure on the Maleo bird. The level of community dependence on conservation areas can hurt Maleo Birds. Some community activities that have the potential to threaten the sustainability of Maleo birds include browsing, hunting for Maleo birds, taking eggs of Maleo birds, and stealing wood. The overlay results from the modeling that have been made show that the area included in the potential criteria 1 for the Maleo bird nesting site is 549,947 ha (2.07%), potential 2 with a land area of 19774.3 ha (74.50%), and potential 3 has a land area of 6220.51 ha (23.43%). The results of modeling for the entire research area show that the best location for the distribution of Maleo eggs is in areas that are included in potential criteria 1. Locations that are considered as habitat or nesting places for Maleo Birds are areas that are still active and serve as a place for the development of pandrunes. The modeling results also show that the suitable location for laying Maleo Birds is generally a part of the area that has a lowland habitat, dense vegetation and a fairly high surface temperature, and is close to air sources which automatically have clay soil types.

the presence of Maleo Birds when dealing with slopes in the Hungayono area, it is possible that one of the limiting factors for Maleo Birds is the slope. The modeling results in potential one show that the area is a lowland area. This is also in accordance with the opinion of Wallacee (1986) in Birdlife International (2001) which states that the Maleo Bird is an animal that has lowland forests. Maleo bird is an endangered species and its existence is threatened with extinction. Maleo bird is also the only animal image used in the TNBNW symbol. Referring to these facts, the part of the area which is the habitat for the Maleo Bird's nesting ground should always be preserved to protect the Maleo Bird from the threat of extinction.

D. Conclusion

Based on the results of the analysis of the data obtained during the study, the following conclusions were obtained: For the Maleo bird nesting site, was dominated by two potential criteria or had sufficiently suitable potential covering an area of 19774.3 ha (74.50%), followed by three unsuitable potentials. with an area of 6220.51 ha (23.43%) and the area corresponding to the potential one is 549.947 ha (2.07%). Further research is needed on the presence of Maleo Bird eggs in the Hungayono Conservation Area to determine the level of confidence or accuracy of the model built, as well as guidance on habitats that maintain to maintain the existence of parts of the area that are suitable for Maleo Birds.

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