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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).

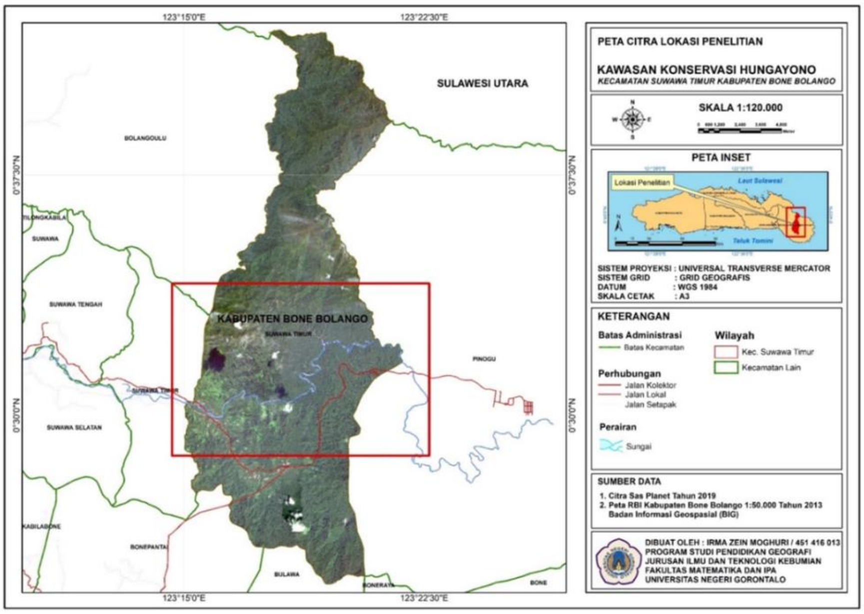

Figure 1. Map of Research Location

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

$$L\lambda = MLQcal + AL \quad \text{......... .. (1)}$$

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

$$TB = (K2 - 273.15) / \ln (K1 / L\lambda + 1) \quad \text{...... (2)}$$

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)

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

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
Es	0,971	0,977
Ev	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

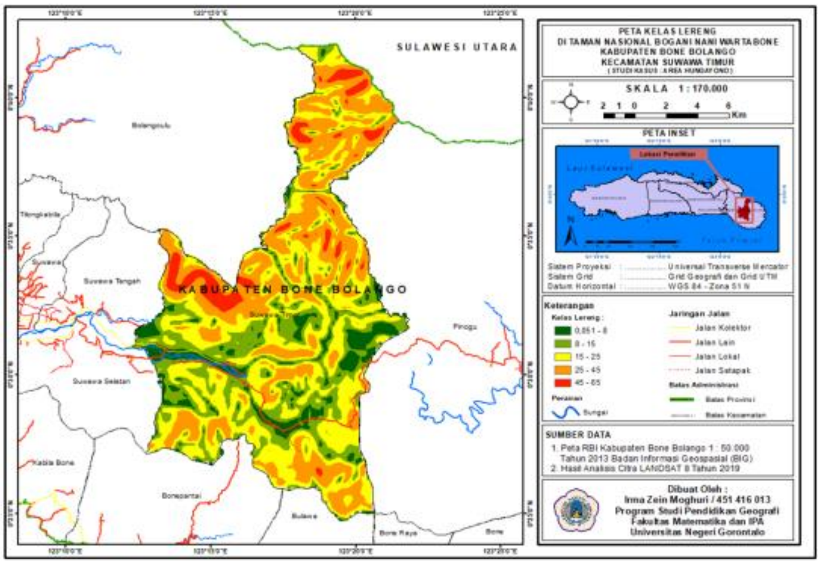

Figure 1. slope map image

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

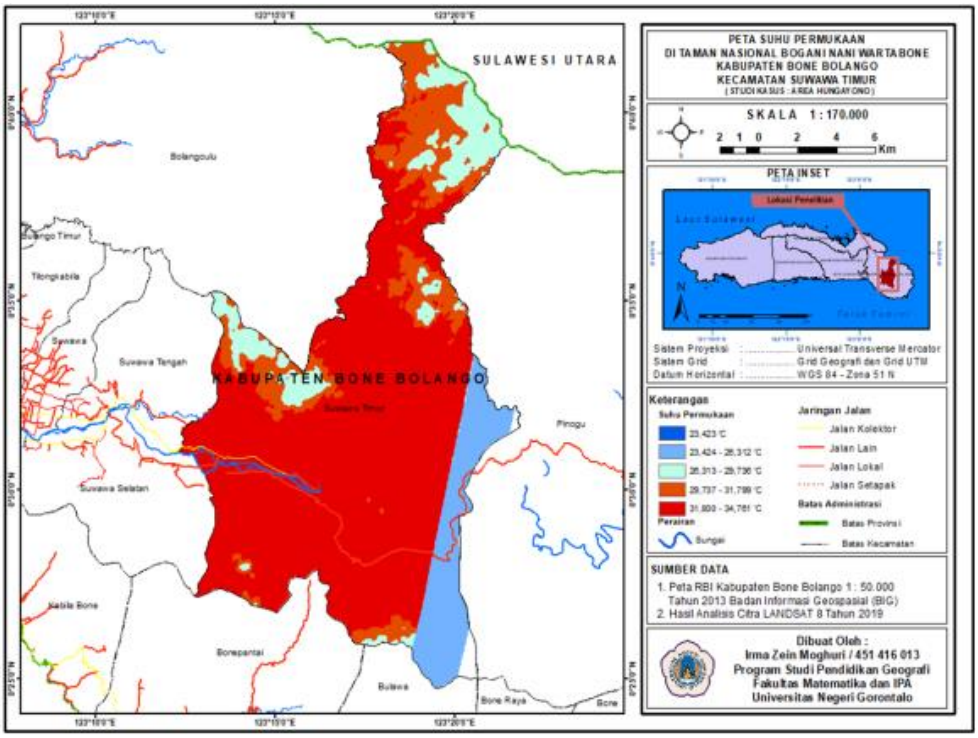

Figure 2. Surface Temperature Map

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

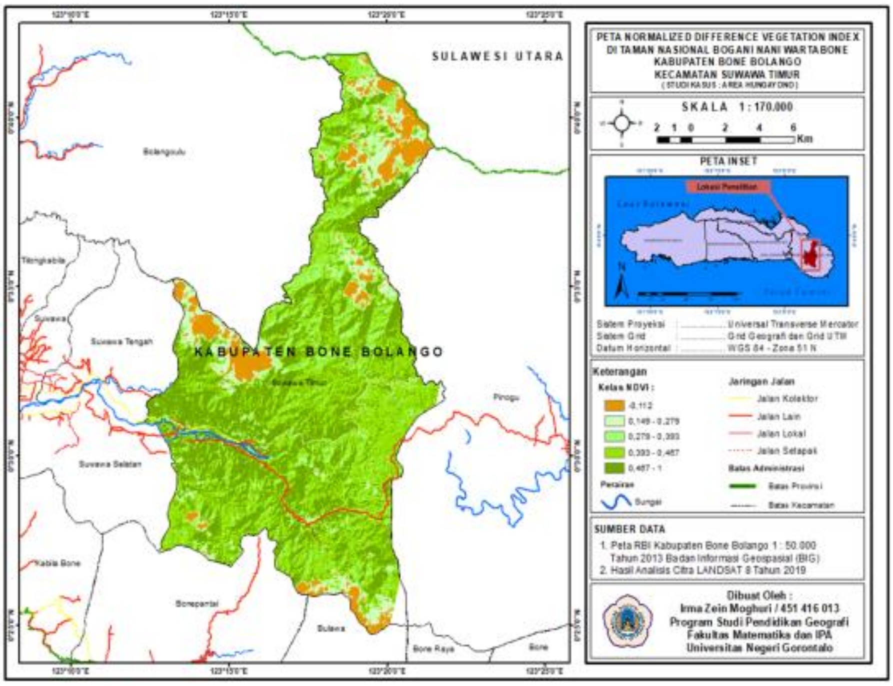

Figure 3. NDVI Map

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

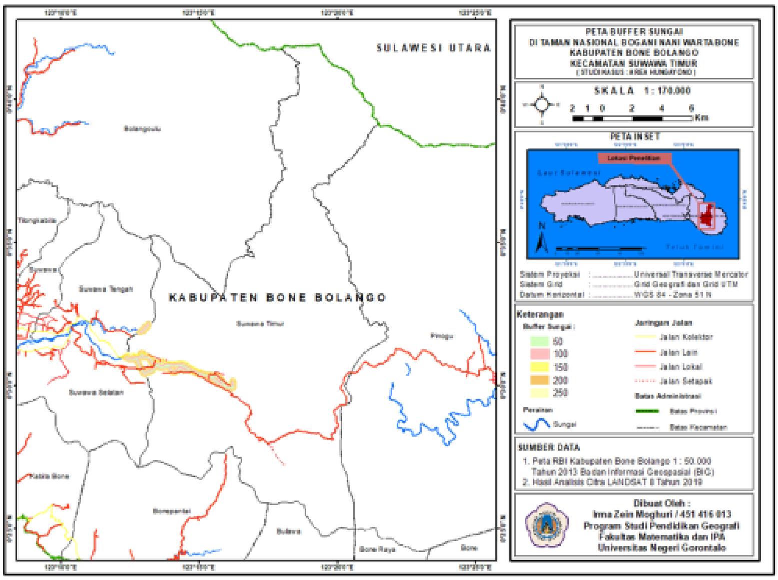

Figure 4. River Distance Map

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

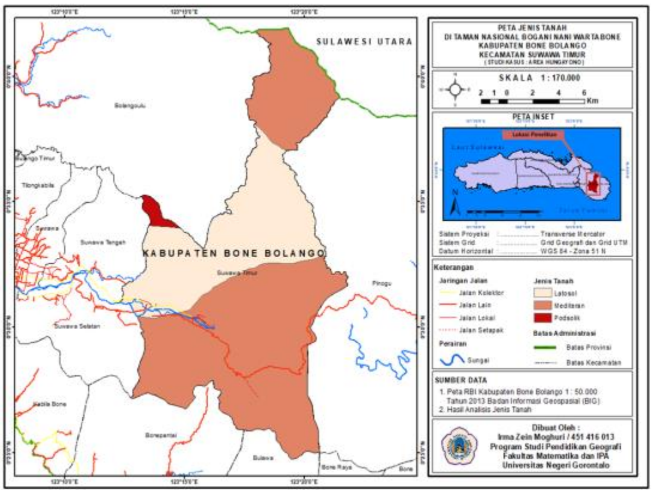

Figure 5. Soil Types Map

Model extrapolation

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

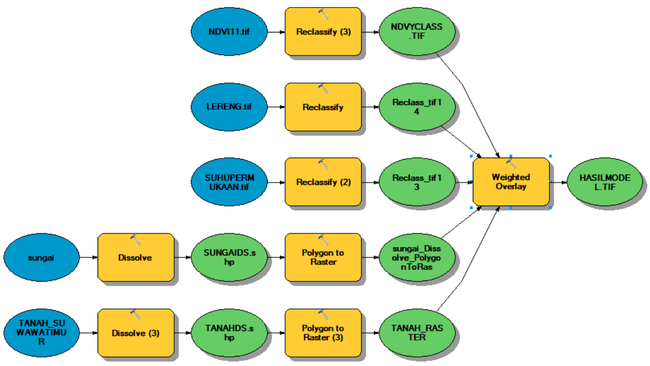

Figure 4.6 Map Making Process

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

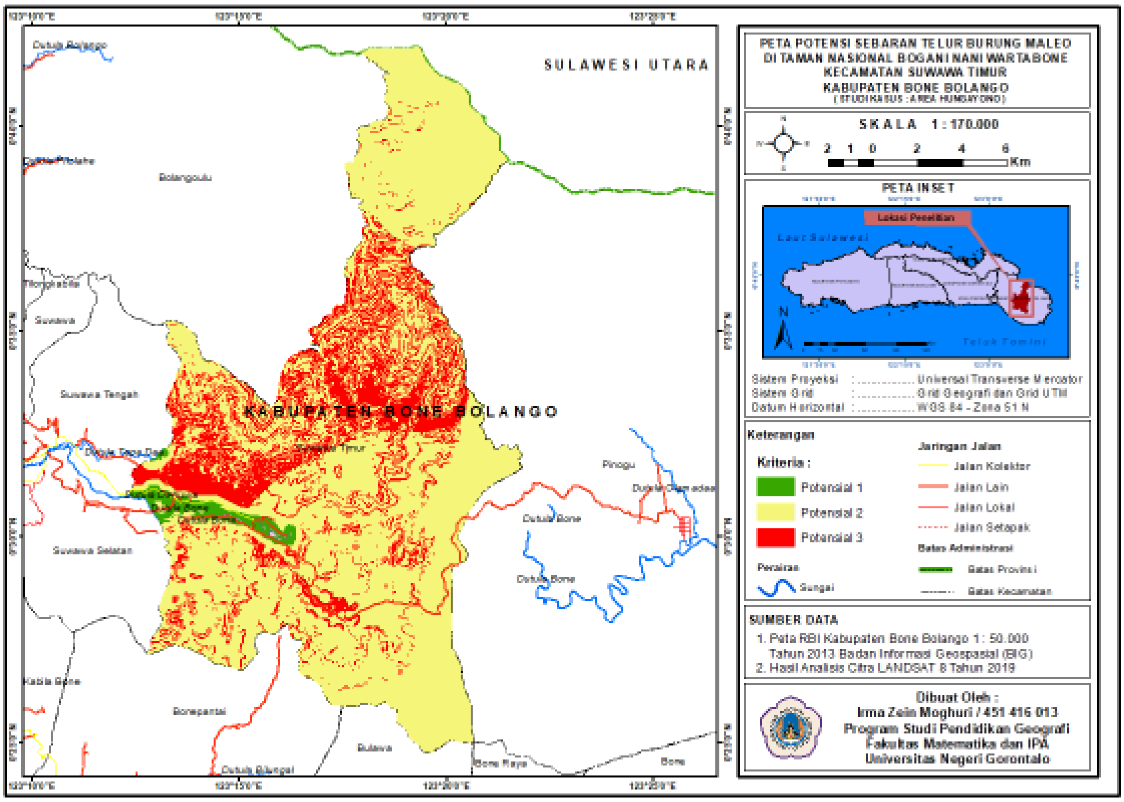

Figure 4.7 Potential map for Maleo Bird eggs

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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