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Landsat-8 Multispectral Satellite Imagery for Rhinoceros Sondaicus Habitat Spatial Distribution Modelling through Biophysical Parameters in Ujung Kulon National Park, Indonesia

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Abstract. The Javan Rhinoceros (*Rhinoceros sondaicus*) was categorized as a red list according to IUCN. Javan Rhinoceros was increasingly threatened due to the lack of available environmental characteristic informations (habitat) that was suitable for Javan rhinoceros to survive in in-situ conservation. The capability of various remote sensing wavelengths sensors can be used to get the environmental characteristics data and obtain information related to Javan Rhinoceros's habitat characteristics through spatial modelling. This research were aimed to (1) knowing the ability of LANDSAT-8 multispectral satellite imagery to identify biophysical parameter of Javan Rhinoceros's habitat in Ujung Kulon National Park and (2) developing a javan rhinoceros's suitable habitat distribution model in order to survive in Ujung Kulon National Park. The data were collected by LANDSAT-8 multispectral satellite imagery interpretation assisted by GIS analysis. The result showed that LANDSAT-8 multispectral satellite imagery can be used to identify several biophysical parameters, such: slope, altitude, vegetation cover index, temperature, and the distance of puddle, river, beach, and glade. Moreover, the result of the distribution model can be visualized as digital maps and software-based maps about Javan rhinoceros habitat information's, and it can be used as guidance for conservation society in order to conserve Javan rhinoceros in Indonesia.

1. Introduction

Declining biological diversity is a main environmental problem issue at this decade [1]. Various species of flora and fauna get threats which causing those species decrease every year. It's caused by land conversion [2], invasion of foreign species [3], illegal hunting [4] and physical changes in the earth such as climate change [5]. This issue also occurred in one of Indonesia's endemic species, Javan Rhino.

Javan Rhino (Rhinoceros sondaicus Desmarest 1822) is one of the rarest large mammals in the world which is on the verge of extinction. Javan Rhino is categorized as critically endangered in the Red List Data Book issued by IUCN (International Union for Conservation of Nature and Natural Resources) since 1978 until now. Javan rhinos are also included in the Appendix I of the CITIES (Convention on

International Trade in Endangered Species of Wild Fauna and Flora) in 1975. Species that are included in the list of Appendix I are species that are very few in nature and feared to be extinct. The population of Javan rhinos in 1960 was estimated at around 20 to 30 rhinos. The population doubled in 1967 to 1978. At present, the Javan rhinoceros population is about 62 individuals. The population of Javan rhinos continues to be stable with a maximum growth rate of 1% per year. The population of Javan rhinos has increased caused by conservation efforts [6] [7].

The stable growth of Javan rhino does not necessarily save this species from endangered status. there are several factors that cause species to face a high risk of extinction, including a small population size, consisting of one or a few populations, providing economic value to humans, and having a narrow geographical distribution [8]. Javan rhino habitat is currently only found in Ujung Kulon National Park. Other populations of different sub-species in Vietnam have been declared extinct since October 2011 [7]. In addition, Javan rhino is much hunted because its horn has high economic value Coupled with Javan rhino can only live in a certain geographical distribution. This condition has resulted in Javan rhinos being threatened with extinction, so an effort is needed to protect certain species from extinction.

Efforts to conserve fauna species that have a high risk of extinction require an in-depth understanding of the causes and consequences of the population of these species which are classified as small and vulnerable [9] [6]. Habitat studies in previous studies illustrate that natural disasters, disease outbreaks, hunting, encroachment, competition and climate change are threats to the preservation of fauna species, especially Javan rhinos [10]. Based on several causes and considerations, habitat management activities are needed including through the application of integrated science in research and development activities so that it can identify specific characteristics of Javan rhino habitat. The integration of science in habitat management is inseparable from geographic knowledge. Geography since the beginning of its development is known as the study of the identification and depiction of the earth in specific places with a spatial approach both vertically and horizontally, is expected to always be able to contribute to solving various problems that occur on earth by examining the interactions and interrelationships between biotic aspects and abiotic holistically [11].

Research studies as mentioned in habitat management actions are carried out by identifying and monitoring environmental conditions in biogeography studies, so as to describe the pattern of distribution of a population from an ecosystem. This identification can be done with remote sensing satellite technology applications. Technological developments make it possible to tackle environmental characteristics data that can cover a wide, continuous, and accurate area [12]. The application of remote sensing technology with the latest sensor capabilities with varying wavelengths of radiation can be used to tap data about the factors of the biosphere's environmental characteristics that influence the distribution of flora and fauna including climatic characteristics, land surface temperature, and biological conditions [13]. Quantitatively the application of remote sensing satellite technology is very important for wildlife population management and conservation strategy planning at a landscape scale, furthermore in quality, satellite technology has been developed very much among them is the Landsat satellite, which has reached the 8th generation since it was first launched in 1972 (even at the time this scientific paper was written, being developed for the 9th generation which is scheduled to launch in 2020).

The combination of studies of habitat characteristics of Javan rhino through Landsat-8 multispectral recent satellite imagery as biophysical parameters will be input data in the geographic information system analysis process. Furthermore, supported by spatial studies that examine spatial interrelations and applying mathematical relations between actual conditions in the field on a map can be used to identify biogeographic characteristics that are visually related to rhinoceros habitat, and enable monitoring of natural phenomena on the earth's surface through spatial modeling. Therefore, through satellite technology interpretation can be obtained a model of habitat suitability of Javan rhino that is able to predict the level of habitat suitability for Javan rhinos based on specific geographical conditions in a region, so that it can support the description of the 15th 2020 Indonesia sustainable development vision that is to increase the capacity of the community generate benefits for the real action of long-term development to reduce environmental damage and provide benefits to humans and all biodiversity that live in it.

2. Materials and Methods

2.1. Materials Used
The materials used in primary data collection include the Indonesian Topography Map (RBI) issued by the Geospatial Information Agency of the Republic of Indonesia with each scale used is 1: 25,000. Satellite imagery used for interpretation is Landsat-8 imagery with a variety of different spectrum lengths and for the purposes of advanced analysis supported by ASTER Global Digital Elevation Model (DEM) imagery. The materials used in secondary data collection include a border map of the national park at the end of the Kulon 1: 250,000 scale issued by the Nature Conservation Information Center, and literature studies from previous research by Rahmat (2012), Ridwan et al (2017), and Endang (2002). Meanwhile, the tool used for this research is GIS Software..

2.2. Methodology Used
This research uses descriptive method with remote sensing satellite image interpretation and visualization assisted by geographic information system technology (GIS). To obtain the required variable data, physiography in the form of slope and altitude, vegetation index in the form of vegetation density, ambient temperature, distance to puddles, rivers, beaches, and ramps. The extraction results are then analyzed by spatial aura analysis (buffering) and overlay using GIS software and reclassify process. Giving scores on each variable comes from the development of previous research. After obtaining a habitat suitability map, the preference of Javan rhino is then overlaid on the location of the appearance of the rhinoceros.

3. Study Area
The Ujung Kulon National Park area has been recognized as an important and credit in national and international. In 1992, the ujung kulon national park was declared the first UNESCO world heritage site in Indonesia. The Ujung Kulon National Park area which has an area of 122,956 Ha is administratively located in the Sumur and Cimanggu Districts, Pandeglang Regency, Banten Province. Geographically, Ujung Kulon National Park is located between 102º02'32 "- 105º37'37" BT and 06º30’43 "- 06º52’17" LS.

4. Results and Discussion
Integration of various biological, physiography and geomorphological parameters based on the various thematic maps such as NDVI and vegetation cover, altitude, slope, and temperature have been mapped. The Javan Rhino Encountered point based on the distribution utilization is around 21 points. It based on the findings of camera traps at the research location based on Setiawan et al work in 2017 **[6]**. Map of indications of distribution of utilization by Javan rhinos at research sites in the Ujung Kulon Peninsula is presented on all interpretation maps. In relation to the proportion of distribution of utilization by Javan rhinos in various types of land cover, it is suspected that the Javan rhino made a selection first in occupying its habitat. Selection of suitable habitat is an action taken by wildlife in order to obtain a series of conditions that are beneficial for reproductive success and survival. Wild animals do not use all existing forest areas as their habitat but only selectively select several parts. Habitat selection is an important thing for wildlife because they can move easily from one habitat to another to get food, water, reproduction or occupy a new place that is profitable.

4.1. Habitat Selection based on Vegetation Index
Vegetation index is an algorithm that is applied to digital images, intended to highlight aspects of vegetation such as aspects of vegetation density. Transformed image is used as a reference in determining the level of neatness of vegetation which is referred to as the Normalized Differential

Vegetation Index (NDVI). The chlorophyll element in plants is absorbed by the Near Infrared band (NIR) through the Landsat remote sensing satellite sensor. Practically, this vegetation index is a mathematical transformation involving multiple channels at the same time on Landsat-8 images, namely spectrum 2, spectrum 3, spectrum 4, and spectrum 5, and produce new images that are more representative in presenting the phenomenon of vegetation **[14]**.

The behavior of Javan rhinos does not use all existing forest areas as their habitat but only selectively selects several parts, namely: availability of feed, avoiding competitors, and avoiding predators **[15]**. Interpretation of Landsat-8 imagery for vegetation density is shown in figure 3, then the overlay process between the image and the location of the appearance of rhinos in the national park area is used to determine the relationship between the two. Overlay analysis obtained the fact that the total or 100% distribution of Javan rhino was in medium to low density forests, these areas had a type of land cover in the form of scrub and secondary dryland forest. This indicates that Javan rhinos like both areas as their habitat.

In discussing habitat for Javan rhinos related to vegetation conditions and along with the rate of technological advancement in geospatial fields, Landsat imagery continues to improve its reliability in observing objects on the Earth's surface 40 years ago. Specifically, reliability in vegetation observation on the earth's surface from Landsat imagery products continues to grow from increasing spatial resolution and wavelength. On the 8th generation Landsat compared to its predecessor, the 7th generation Landsat has a more tight red (R) and near infrared (NIR) wavelength. The implications of the update on this aspect of wavelength are the measurement of hyperspectral data, especially when identifying the grassland. In order to compare the differences between the quantitative interpretation results between the 7th generation Landsat (slid in 1999) and the 8th, the linear regression model in R software was applied and the measured hyperspectral data field by Xu and Guo (2014) in the grassland area [16]. Xu and Guo (2014) explained that the quantitative value of NDVI on Landsat-8 was greater than Landsat-7 at the same weeding location. Because of the large amount of dead material in the mixed grasslands of the study area, the high absorption in red bands in the spectrum of mixed grasslands is as clear as that of tall grassroots prairie and forest, it means that Landsat-8 NDVI is higher than Landsat-7 NDVI in mixed grasslands [16].

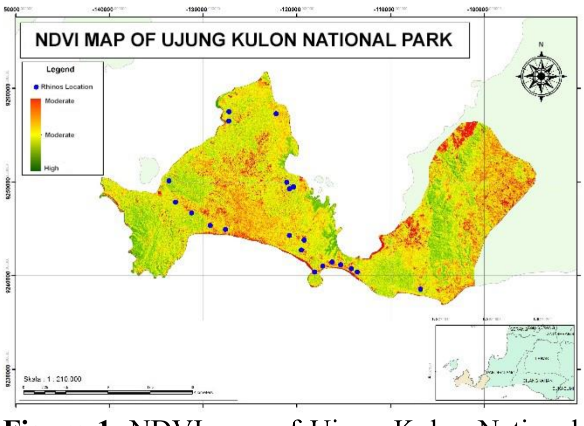

Figure 1. NDVI map of Ujung Kulon National Park and Rhino spots.

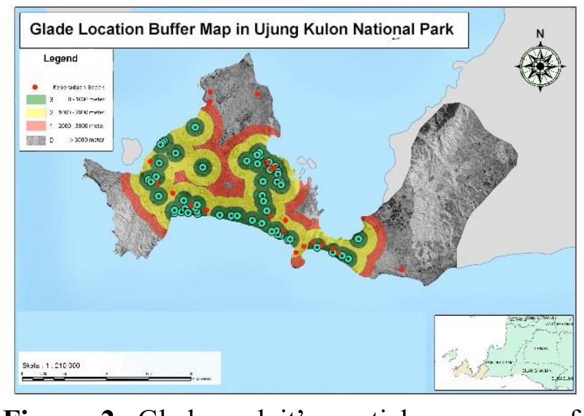

Figure 2. Glade and it’s spatial aura map of Ujung Kulon National Park (overlay with Rhino spots).

Interpretation results that identify crossing points are shown in Figure 4. Spatial analysis of overlay techniques and location points of Javan rhino distribution on the ridges in the Ujung Kulon peninsula are assisted by spatial aura analysis, which illustrates the zones that have the most proximity and influence on the points (in this case glade) help show that from 21 points the Javan rhinoceros population, the highest frequency is at a distance of 0-1000 meters (61.9%), followed by 1000-2000 meters (19.04%) and more distance from 2000 meters (19.04%). Based on this data, Javan rhinos use habitats that are closer to the rift, which is 0-1000 meters. The Javan rhino chose to keep the area adjacent to the rift as a niche for its habitat **[17]**. Spatial aura analysis is a very appropriate choice related to the determination of the habitat of Javan rhino species, the home range. Home range is an area that individual animals explore in their normal activities to get food **[18]**. In general, wild animals, including Javan rhino, do not move randomly to all distribution areas, but limit their motion to certain areas.

4.2. Habitat Selection based on Altitude and Physiography

The selection of Javan rhino habitat with physical parameters is closely related to the geological and geomorphological conditions of the region. At the Ujung Kulon National Park area geologically it is strongly influenced by the presence and presence of the western Java plate with Banten Block tectonic activity [19]. Furthermore, many literarurs explain the geological linkages between the islands of Java and Sumatra. The existence of Krakatoa and Sunda Strait Volcano gave clues to the existence of plate activity in this region, and it was in agreement with Bemmelen (1949) that this region had a mutually influential relationship with Bayah Dome [19].

The geological structure that developed in the study area was in the form of stocky with the dominant direction northwest-southeast giving an explanation of the origin of geomorphological expression in the Ujung Kulon National Park region. Geological structures in the form of faults are well identified through remote sensing technology. Landsat-8 Satellite Imagery with multispectrum 6-5-7 illustrates both the direction of the stance and the fault slope [20] showed in figure 5. The geological phenomenon causes a normal or graben fault. At the end of the miocene sub-volcanic activity arose which gave birth to Honje Volcanic. Exogenous activities that are more dominant cause the process of erosion, erosion, and weathering to take place more intensively, thus creating a structural form of the remaining volcanic mountains with 3 large groups of morphological units. That is the plain in the north and south, the sloping hills in the central region, and the steep hills with strong denudation in the eastern and western regions (figure 3).

Genesis and geomorphological processes that have formed place heights are one of the physical components of habitats that can affect wildlife, including Javan rhinos. The tendency of Javan rhinos to occupy lowland areas rather than mountains especially when heading to the highlands has steep slopes. Javan rhino occupies more of the lowland area because the area tends to be more fertile by vegetation which is the forage for rhinoceros and the availability of more water sources. This is thought to have something to do with the availability of resources or welfare factors for rhinos such as the availability of food, drink, puddles and mineral salts [10].

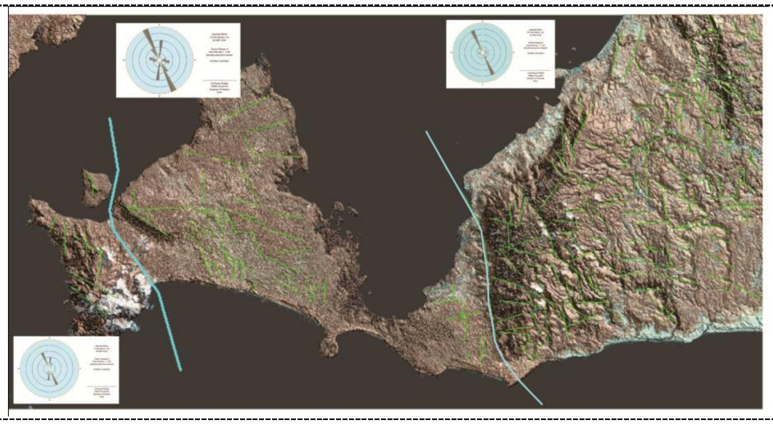

Figure 3. Landsat-8 imagery with a spectrum of 6-5-7 are able to visualize geological processes and expressions expressly. Stump is shown on the following map with the direction and direction of the slope. In addition, the larger scale shows the graben as examined by Usman et al (2017).

Javan rhino distribution maps at various heights are presented in figure 6, the process in making altitude maps is an interpretation with ASTER Global Digital Elevation Model (DEM) imagery. The results of overlay analysis between location points of Javan rhino distribution in the Ujung Kulon peninsula to altitude from sea level indicate that from 21 points the highest frequency of the Javan rhinoceros population is in the altitude of 0-50 masl (95.23%), followed by altitude 50-100 masl (4.7%).

Meanwhile at a distance of more than 1000 meters there was no Javan Rhino population. The use of lowlands by Javan rhinos mainly occurs when Javan rhinos live together (sympathetic) with the Sumatran rhinoceros (*Dicherzorhinus sumatrensis*) which is more adapted to the mountainous environment. However, if there is only a Javan rhino in an area such as in Java, the Javan rhino is also able to occupy mountainous habitats [21]. Thus, elevation is not a limiting factor for the distribution of utilization by Javan rhinos.

The height of a place is identified as not a limiting factor for the distribution of Javan rhino which is very significant even though all the Javan rhinos found appearing in the national park area are only at the altitude limits below 100 meters, but the altitude has a strong correlation with the slope. Through the process of interpreting the DEM image, data extraction shows that most of the Ujung Kulon Peninsula region reaches 72.2% of the total area. While other regions have flat to gentle slope levels of 0 to 15%, slope is rather steep at 16.3%, steep at 7.8%, and slope of> 40% (very steep) only covers 3.7% of total area, namely in the area of Mount Payung [10]. If in the previous discussion altitude is not a barrier, if the frequency is observed through the overlay between the points of Javan rhino distribution in the Ujung Kulon peninsula, the slope shows that from 21 points the most Javan rhinoceros population is in areas with flat slope to slope or slope angle 0-5% (90.47%), followed by a slope of 5-15% (9.5%). Meanwhile, at a slope of more than 15%, no Javan rhinoceros population was found. Javan rhino distribution maps on slope slopes are presented in figure 4 and altitude map shown in figure 5. Spatial interrelation helps explain the relationship between environmental conditions, especially geomorphology, affecting specific species of living things that reside in them. Java rhino has a weight of> 2ton so it will be very difficult to go to steep or steep areas. Even according to previous literature studies on the behavior of Javan rhinos that have been done, rhinos will come to rather steep areas (15-25%) by rotating parallel to the contour and not perpendicular to the contour. This indicates that the slope is one of the factors that influence the distribution of habitat utilization by Javan rhinos in a habitat.

4.3. Habitat Selection based on Temperature and Puddle

Habitat selection based on environmental temperature illustrates how the environment affects living things that live in it. In particular, those related to this condition are natural factors in the form of tropical environment temperature and rhino body morphology factors, specifically also affecting the behavior of the rhino itself. Condition land surface temperature on a complex field is always not evenly distributed. But many are influenced by the direction of the slopes such as mountainous areas (geomorphological) and vegetation condition. The use of space by Javan rhinos related to environmental temperature factors is influenced by the characteristics of thick and gray skin and speckled uneven skin texture, so that it can be classified in thick-skinned animals (*pachyderm*). The thickness of Javan rhino skin results in folds in several parts of the body, for example on the neck, shoulders / shoulders and the upper part of the hind legs so that the Javan rhino looks like it is divided into 3 parts [21]. Thick skin also causes mosaic patterns on the surface of the skin. The mosaic pattern on the skin further strengthens the appearance of the Javan rhino as an ancient animal [22].

In relation to the characteristics of rhinoceros skin, this has implications for the overheat effect. Benedict et al (1925) conducted a study of 3 mammals with skin that were almost as thick as quantitative, among them elephants, rhinos, and hippopotamus. According to observations at the same room temperature of 30^{o}C in each species, their initial assumption is that elephants will experience an overheat effect because elephant animals do more activities and move [23]. This of course has implications for the body's metabolism and producing heat, so that the elephant is thought to have greater body heat than rhinos and hippos. However, the fact is that the temperature of rhino skin is higher than that of elephants and even hippopotamus. Higher heat is also identified in the folds of rhinoceros skin. Recent epidermology research says that Elephants have a body cooling system by removing heat by evaporative heat loss via non-sweating through the vascular network system in the ears [24] [25]. While hipopotamus has a subdermal on the skin and helps to cool the skin [26]. Study Review shows that Rhinos have 45mm thick skin, while elephants are 17mm thick and 10m thick on hypopotamus [23] [27], meanwhile the Rhino’s skin study found that vascular components concentrated in the superficial dermis up to a depth of about 700 µm and speculated that the capillary networks may be compensated for the lack of other cooling mechanisms like a high concentration of sweat glands. This condition will give special behavior to rhinos related to their living area.

The habitat of Javan rhinos in the lowlands and open areas has caused the area of residence of the Javan rhino to have a fairly high ambient temperature. According to literature studies, Javan Rhino occupies many open areas (rhizomes), so that the ambient temperature is high. The relationship between altitude and ambient temperature allows Javan Rhino animals to choose cooler places. However, as discussed earlier, aspects of physical condition have limited the space for rhinos. The results of the extraction of Landsat-8 satellite data with spectrum 10 and spectum 11 are able to visualize well the distribution of land surface temperature at the research location shown in figure 6. The high temperature environment will make the rhinoceros overheat. To deal with that condition, rhinos adapt by showing special behavior to cool the skin or the temperature of their skin due to daily activities that are also driven by high ambient temperature conditions. The behavior to cool Javan Rhino skin is by mud wallowing.

Wallow is one of the most important physical components for Javan Rhino. According to Amman (1985), the main function of wallowing is to keep the rhinoceros skin moist, regulate body temperature and to reduce the rate of infection by parasites [28]. The reservoir for Javan rhinos has a very close function in the process of adjusting to some changes in environmental conditions. Rhinos wallow in mud pools to cool off during the heat of the day. The duration of rhino wallowing time is 28.48% in adult males and 33.11% at night. Meanwhile, Javan rhino and mother and child (male) do not wallow at night. The time they spent wallowing during the day was 38.41% and 28.97% [29], in addition based on literature review shows adult male rhinos spend more time wallowing at night [30]. This is because individual adult males tend to live solitary. Javan rhinos spend a lot of time wallowing and resting in puddles where this activity is useful for maintaining the stability of the rhinoceros body temperature. Female rhinos tend to spend more time wallowing during the day because they tend to be more comfortable to monitor children from interference and teach various things about behavior or activity of rhinos [31]

Application of Landsat-8 imagery can also be used in addition to identification of vegetation through chlorophille which is reflected by an infrared sensor can also identify the pools. Landsat-8 to identify mud puddles is by identifying the image with a blank quantitative value or no vegetation cover in wave 7 which has the function to improve moisture content of soil. In areas with this value normally rocks, bare soil and soil crust, or appear very clearly when capturing the body of water, all will be black or no data. A number of data on mud puddle locations are shown in figure 8. In addition, Amman (1980) explained that the area of the Javan rhino pool was hidden and was surrounded by plants that were quite dense such as copo stands (*Eugenia sp*.) And kibeusi (*Diospyros pendula*) [28].

The overlay between the Javan Rhino distribution points in the Ujung Kulon peninsula against the distance to the puddle shows that from 21 points of the Javan rhinoceros population, the highest frequency is at a distance of 0-1000 meters (42.8%), followed by a distance of 1000-2000 meters (23.8%), then a distance of 2000-3000 meters (23.8%) and a distance of more than 3000 meters (9.5%). Meanwhile, at a slope of more than 15%, no Javan rhinoceros population was found. This indicates that the distance to the puddle is a factor that affects the distribution of habitat utilization by Javan rhinos in a habitat.

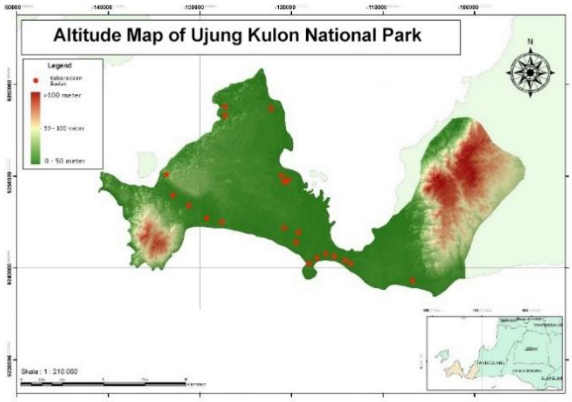

Figure 4. Altitude Map of Ujung Kulon National Park based on DEM data interpretation.

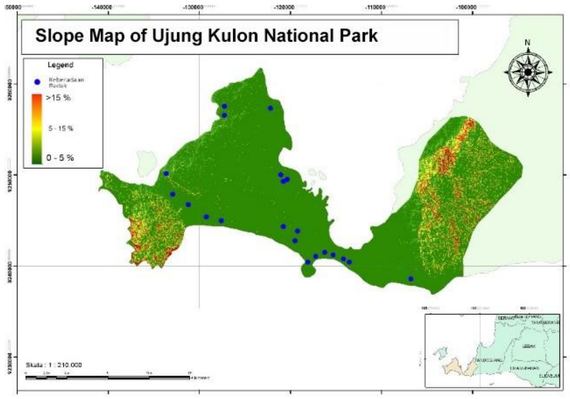

Figure 5. Slope Map of Ujung Kulon National Park based on DEM data interpretation.

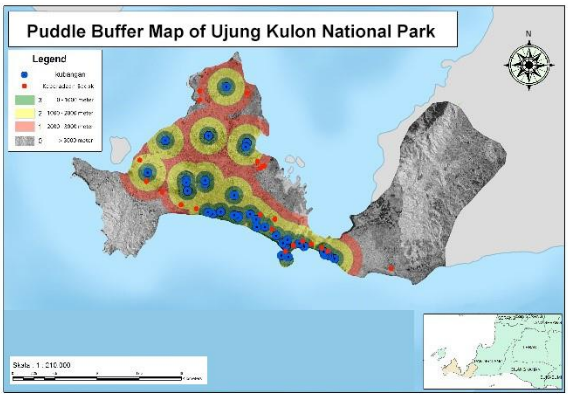

Figure 7. Puddle buffer map to indicate where the Javan Rhino spent the time for mud wallowing

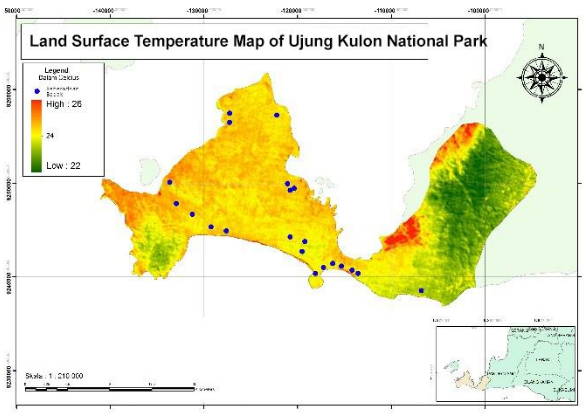

Figure 6. Land surface temperature map extracted from Landsat-8 Satellite imagery

4.4. Habitat Selection based on Beach Distance

Javan rhino requires mineral salt in its life. Javan rhino requires mineral salts, especially sodium, an element rarely found in plants [28]. Activities of Javan rhino that visit many beaches, swamps, or puddles that have brackish water in order to meet the needs of mineral salt. This is not much different from other herbivorous animals. Another animals such as deer and bulls every day visit salting places on water sources on the beach. The animal is also actively looking for alternative mineral salt sources or called salt drives [32] [33].

Recent research shows that Javan rhinos favor vegetation types at a distance of 0-400 m and 400 m-600 m from the shore [10]. This is related to the condition of vegetation in the coastal area which tends to be low because of its open condition. Relatively open areas will be more washed on the soil surface when it rains, causing the soil pH to fall (acid). Based on the results of the intersect between the meeting points of the Javan rhino from the coast, the highest distribution was at a distance of 0-1000 meters from the coast (61.9%), followed by a distance of 1000-2000 meters (33.3%) and the last was at a distance of 2000- 3000 meters (9.5%) as presented in figure 8. This indicates that the distance from the beach.

4.5. Habitat Selection based on River Distance

Javan rhino uses water for drinking, and bathing [32] [21] [30] [34]. The distance from the river with the distribution of the use of Javan rhino is a representation of the needs of Javan rhinos for fresh water for drinking and bathing. In addition to the sufficient numbers, Javan rhinos also need clean water [34]

[32]. The results of this study indicate that the Javan rhino chose to make the area adjacent to the river as a habitat niche considering the benefits of inhabiting the area outweigh the losses. Distribution of resource utilization by Javan rhinos has a significant relationship with distance from the river. Distribution of utilization by Javan rhino based on distance from the river is at a distance of 0 - 1000 m (47.61%) followed by a distance of 1000 - 2000 m (28.57%), a distance of more than 3000 m (19%) and the last distance is 2000- 3000 meters (4.7%) as presented in figure 9. This indicates that the distance from the river is one of the factors that influence the distribution of utilization by Javan rhinos in a habitat.

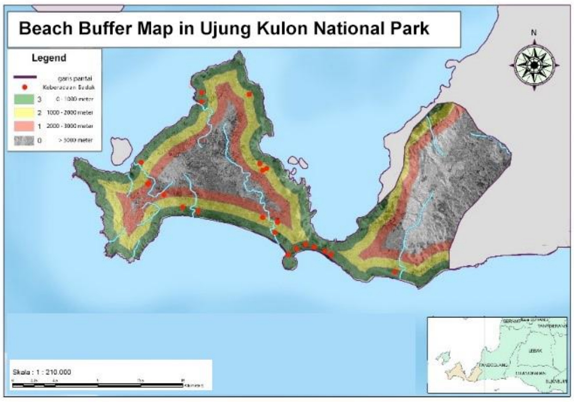

Figure 8. Beach distance of Ujung Kulon National Park based on Spatial Aura Analysisi (Buffer Technique).

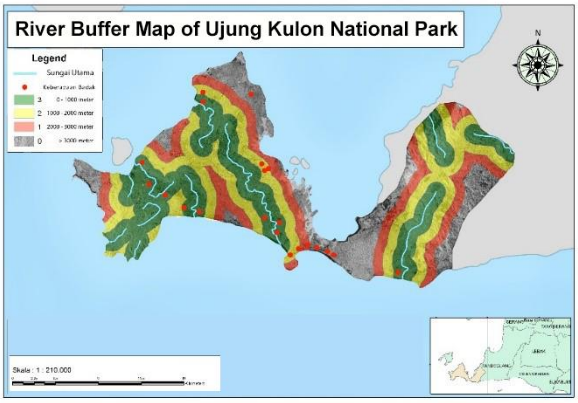

Figure 9. River distance of Ujung Kulon National Park based on Spatial Aura Analysisi (Buffer Technique).

5. GIS Analysis

Geographic information system (GIS) has emerged as a powerful tool for storing, analyzing, and displaying spatial data and using these data for decision making in several areas including engineering and environmental fields. The use of GIS technology has greatly simplified the assessment of natural resources and environmental concerns, including habitat study. In Specific habitat study, GIS is commonly used for site suitability analyses, managing site inventory data, and estimation of environtmental characteristic to species sustainability.

Habitat suitability model is not a definite effort to predict the presence or absence of animals in a habitat, but rather an effort to identify which area or block of forest area should be prioritized in its management. This habitat suitability model uses several variables that are known to have a relationship with the distribution of utilization by Javan rhinos in a particular habitat. The biophysical thematic maps are derived through the interpretation of satellite data i.e., glade, NDVI, altitude, slope, puddle, temperature, river, and beach were digitized, edited and saved as shape files (.shp) in GIS software.

By integrating all these maps in GIS, after going through the scoring stages that produce scores and classifications of each variable on the suitability of the Javan rhino habitat, the final step is to analyze the geographic information overlay or overlay the map to get a new map. The highest score and lowest score is based on the results of the calculation of the scores among variables that most influence the formation of suitable habitat, namely slope, place height, crown closure index, ambient temperature , distance to puddles, rivers, beaches, and ramps. The suitable maps were digitized were reclassify and saved as polygon coverage. The maps then projected to a common UTM projection system so as to subsequently superimpose in GIS softwere using to weighted overlay sub-module to demarcate habitat prospect zones based on above themes. Thus, the Javan Rhino prospective zones are obtained for the study area was represented in the figure 10. The map was presented by overlaying result with the Javan Rhino location to show how accurate is the spatial model. Validation is used to determine the suitability of the maps obtained from the reality in the field. Validation is intended to determine the level of trust in the model being built. The data used in the model validation is the direct encounter data of the 2016 video trap inventory in Ridwan's (2016) study. The video trap used in the form of an infrared camera was installed in 90% of the predicted area suitable for the habitat of the Javan rhino. Validation test results show that the habitat suitability model of Javan rhino has a high suitability.

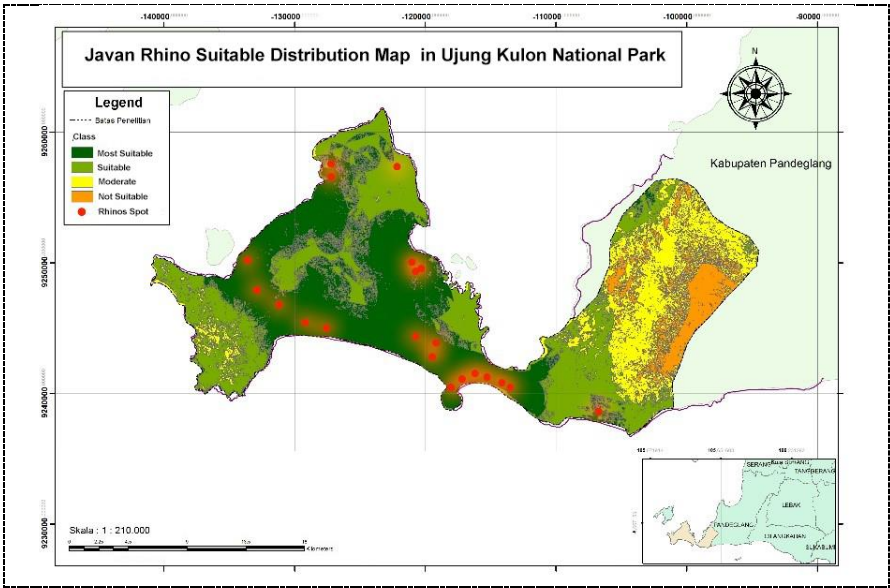

Figure 10. Javan Rhino Suitable Distribution Map Overlayed with Rhinoceros location to Visualize Spatial Model Accuracy.

6. Conclusions

Through the spatial simulation resuts model, Landsat-8 satellite imagery with various wavelengths to extract various data needed to identify biophysical characteristics of Javan rhinoceros habitat including; NDVI, glade, land surface tempreture, slope, altitude, distance from the beach, river, and puddle. Spatial approach in the form of spatial is able to explain the relationship between habitat conditions and the presence of rhinos.

References

[1] R. Dirzo, H. Young, M. Galetti and G. Ceballos, "Defaunation in the Anthropocene," *Science Journal,* pp. 401- 406, 2014.

[2] J. Rybicki and I. Hanski, "Species–Area Relationships and Extinctions Caused by Habitat Loss and Fragmentation," *Ecol.Lett Journal,* no. 16, pp. 27-38, 2013.

[3] M. Vila, J. Espinar and M. Hejda, "Ecological impacts of invasive alien plants: a meta-analysis of their effects on species, communities and ecosystems," *Ecol. Lett. Journal,* no. 14, pp. 702-708, 2011.

[4] G. Wittemyer, J. Northrup, J. Blanc, I. Douglas-Hamilton, P. Onondi and K. Burnham, "Illegal killing for ivory drives global decline in African elephants," *Proc. Natl. Acad. Sci. Journal,* no. 111, pp. 13117-13121, 2014.

[5] C. Moritz dan R. Agudo, “The future of species under climate change: resilience or decline?,” *Science Journal,* no. 341, pp. 504-508, 2013.

[6] R. Setiawan, B. D. Gerber, U. M. Rahmat, D. Daryan, A. Y. Firdaus, M. Haryono, K. O. Khairani, Y. Kurniawan, B. Long, A. Lyet, M. Muhiban, R. Mahmud, M. Aom, E. Parastuti, W. S. Ramono, D. Subrata dan S. Sunarto, “Preventing Global Extinction of the Javan Rhino: Tsunami Risk and Future Conservation Direction,” *Conservation Letters Journal,* vol. 11, no. 1, pp. 1-19, 2017.

[7] W. I. Foundation, “WWF,” 2011. [Online]. Available: http://awsassets.wwf.or.id/downloads/factsheet_javanrhino_english.pdf. [Diakses 14 September 2017].

[8] M. Indrawan, B. Richard dan S. Jatna, Biologi Konservor Indonesia (Edisi Revisi), Jakarta: Yayasan Obor Indonesia, 2007.

[9] G. Caughney, “Directions in Conservation Biology,” *Journal of Animal Ecology,* vol. 2, no. 63, pp. 215-244, 1994.

[10] U. M. Rahmat, “Spatial Distribution and Habitat Suitable Model of Javan Rhino (Rhinnoceros sondaicus) in Ujung Kulon National Park,” Disertation, Institut Teknologi Bandung, 2012.

[11] Hastuti, “Giographical Approach and its Dynamic,” *Jurnal Geomedia,* vol. 4, no. 2, pp. 1-12, 2006.

[12] T. M. Lillesand dan R. W. Kiefer, Remote Sensing and Satellite Imagery Interpretation, Yogyakarta: Gadjah Mada University Press, 2007.

[13] C. Lo, Applied Remote Sensing, Jakarta: Universitas Indonesia Press, 1996.

[14] A. Arnanto, “The Utilization of Transformationof Normalized Difference Vegetation Index (NDVI) LANDSAT-TM Image for Zoning The Vegetation in The Southern of Merapi Slope,” *Jurnal Geomedia,* vol. 11, no. 2, pp. 155-170, 2013.

[15] D. Morris, “Test of Density Dependent Habitat Selection in a Patchy Environtment,” *Ecological Monograph,* vol. 57, no. 4, pp. 269-281, 1987.

[16] D. Xu dan X. Guo, “Compare NDVI Extracted from Landsat 8 Imagery with that from Landsat 7 Imagery,” *Amerirican Journal of Remote Sensing,* vol. 2, no. 2, pp. 10-14, 2014.

[17] S. Ezhilmathi, “Foraging Behaviour of The Microchiropteran bat, Hipposideros ater on Chosen Insect Pets,” *Journal of Biopepticides,* vol. 3, no. 1 (Special Issue), pp. 68-73, 2010.

[18] W. Burt, “Territoriality and Home Range Concepts as Applied to Mammals,” *Journal of Mammalogy,* vol. 24, pp. 346-352, 1943.

[19] R. Van Bemmelen, The Geology of Indonesia Vol.IA : General Geology of Indonesia and Adjacent Archipelagoes, The Hague: Government Printing Office, 1949.

[20] D. N. Usman, N. Sulaksana, F. Hirnawan, I. Haryanto dan N. S. BahrI, “Structure Analysis Hefty Late Miocene Zones of Gold MIneralization,” *Science and Technology,* vol. 7, no. 2, pp. 392-397, 2017.

[21] A. Hoogerwerf, Udjung Kulon: The LAnd of The Last Javan Rhinoceros, with Local and General Data on the Most Important Faunal Species and Their Preservation in Indonesia, Leiden: E.J. Brill, 1970.

[23] F. G. Benedict, E. L. Fox dan M. L. Baker, “The Surface Temperature of The Elephant, Rhinoceros and Hipopotamus,” *American Journal of Physiology,* vol. 56, no. 3, pp. 464-474, 1921.

[24] R. Spearman, “The Epidermis and it's Keratinisation in the African Elephatnt,” *Zoologica Africana,* vol. 5, pp. 327-533, 1970.

[25] A. Fuller, D. Mitchell, S. Maloney dan R. Hetem, “Towards a Mechanistic Understanding of the Response of Large Terrestrial Mammals to Heat and Aridity Associated with Climate Change,” *Climate Change Response,* vol. 3, no. 10, 2016.

[26] C. Stommel, H. Hover dan M. S. J. S. L. East, “The Effect of Reduced Water Availability in the Great Ruaha River on the Vulnerable Common Hippopotamus in the Ruaha National Park, Tanzania,” *PloS One,* vol. 11, 2017.

[27] J. H. Plochocki, S. Ruiz, J. R. Rodriguez-Soza dan M. I. Hall, “Histological study of white rhinoceros integument,” *PLoS ONE,* vol. 12, no. 4, 2017.

[28] H. Amman, *Contribution to The Ecology and Sociology of The Javan Rhinoceros (Rhinoceros sondaicus Desm., 1822),* Inangural Dissertation: Naturwissenschaften Fakultat der Universitat Basel. Econom-Druch A.G. Basel, 1985.

[29] N. J. Sitorus, Y. Santosa dan A. H. Mustari, "Wallowing Behaviours of Javan Rhinoceros (Rhinoceros sondaicus) in Ujung Kulon National Park," *Media Konservasi,* vol. 15, no. 2, pp. 66-69, 2010.

[30] R. Schenkel dan L. Schenkel-Hulliger, "The Javan Rhinoceros (Rhinoceros sondaicus Desm. 1822) in Udjung Kulon Nature Reserve, its Ecology and Bahavior. Field Study 1967 and 1968," *Acta Tropica Separantun,* vol. 26, pp. 97-134, 1969.

[31] Chandradewi, *Wallowing behavior and typology of Javan rhinoceros (Rhinoceros Sondaicus) in Ujung Kulon National Park,* Master Thesis: Graduate School of Bogor Agricultural University, 2011.

[32] U. M. Rahmat, Y. Santosa dan A. Kartono, "Habitat Preference Analysis of Javan Rhino (Rhinoceros sondaicus Desmarest 1822) in Ujung Kulon National Park," *Manajemen Hutan Tropika,* vol. 14, no. 3, pp. 115-124, 2008.

[33] H. Alikodra, Wild Fauna Treatment Management, Bogor: Department of Education and Culture of Republic Indonesia, 2002.

[34] H. Muntasib, *Habitat Typology Analysis of Javan Rhino (Rhinoceros sondaicus Desm. 1822) in Ujung Kulon National Park,* Dissertation Faculty of Forestry, Bogor Agricultural Institute, 2002.

[35] H. R. Putro, "Heterogenitas Habitat Badak Jawa di Taman Nasional Ujung Kulon," *Media Konservasi Kehutanan IPB,* vol. Special Edition, pp. 17-40, 1997.

[36] M. Neteler, "Estimating Daily Land Surface Temperatures in Mountainous Environtment by Reconstructed MODIS LST Data," *MDPI Journal Remote Sensing,* vol. 2, pp. 333-351, 2010.

[37] U. Rahmat, Y. Santosa dan A. Kartono, "Habitat Preference Analysis of Javan Rhino (Rhinoceros sondaicus Desmarest 1822) in Ujung Kulon National Park," *Manajemen Hutan Tropika,* vol. 14, no. 3, pp. 115-124, 2008.

[38] U. M. Rahmat, *Habitat Typology Analysis of Javan Rhino (Rhinoceros sondaicus Desmarest 1822) in Ujung Kulon National Park,* Master Thesis: Graduate Program of Bogor Agricultural Institute, 2007.