Determining the Optimal Location of Endangered Species Habitats Using Remote Sensing and Species Distribution Models to Protect Biodiversity in Indonesia

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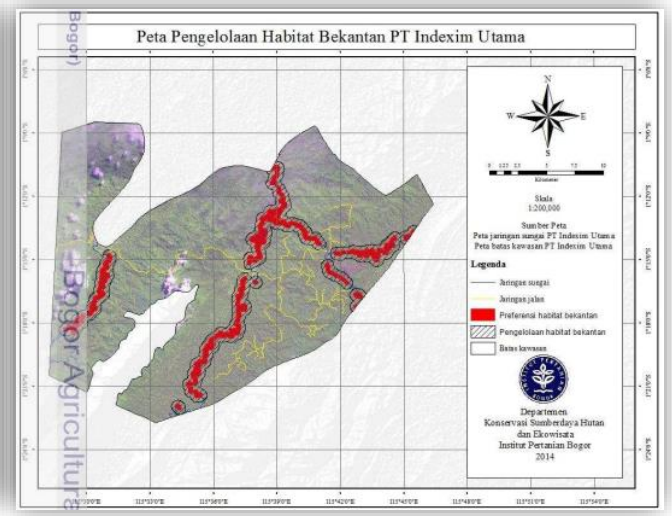
1. INTRODUCTION

1.1 Background Study

- **The role of humans has reached unprecedented levels in destroying nature** leading to uncontrolled declines in wildlife populations (Briggs, 2020).
- In addition, Borneo's most endangered endemic animal, **the proboscis monkey, is in danger of extinction** (Jemadu, 2022).
- One of the **main factors causing habitat destruction is deforestation**, this is related to the rate of deforestation of Indonesia's forests which is **ranked as the 4th largest deforestation in the world** (Kusnandi, 2020).
- Deforestation results in habitat loss for many species, fragmentation, and isolation of species within and between conservation areas. As a result, interior species are isolated in narrow habitats which can result in species that have large ranges such as **proboscis monkeys having difficulty moving from one area to another** (Prasetyo, 2017).

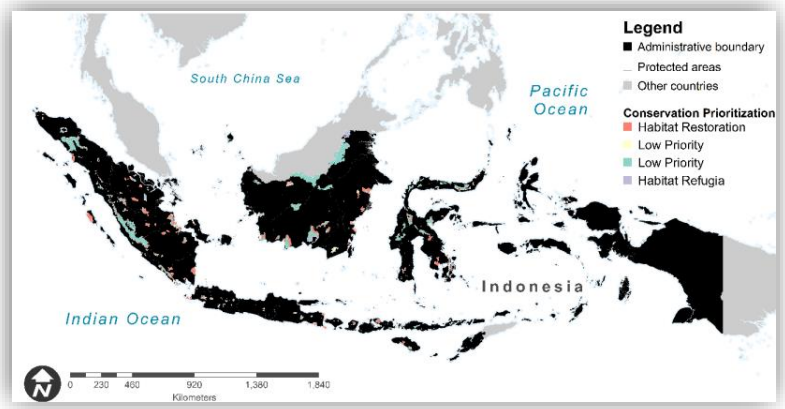
1.2 Common Technology



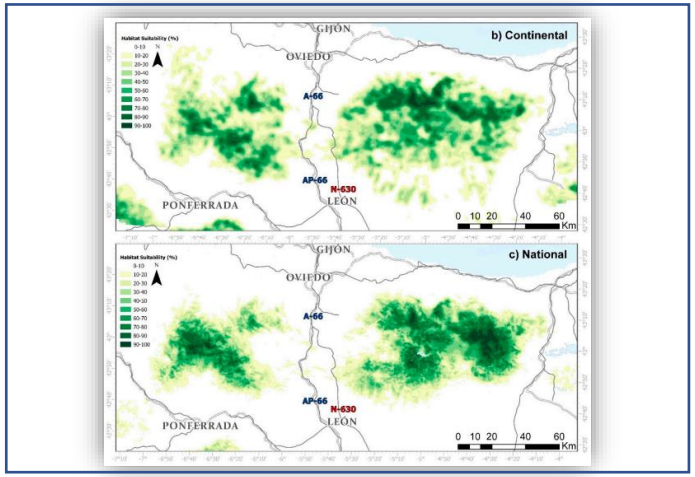
- In the study of Matsuda, et al. (2020), the movement of proboscis monkeys was observed **by conducting direct surveys to examine** the population trends of proboscis monkeys in each sub-population.
- **Remote sensing data** in the form of Landsat imagery was **only used as a data source for vegetation cover** digitization.

- Although the previous study has led to protected and endangered habitats, **many external ecological factors are dynamic**.
- Therefore, it is **necessary to analyze the potential of the site by examining the habitat features of the proboscis to be able to evaluate the existing habitat conditions**.
- Thus, strategic steps for the potential enhancement of the ecosystem can be identified as part of an endangered animal conservation effort.

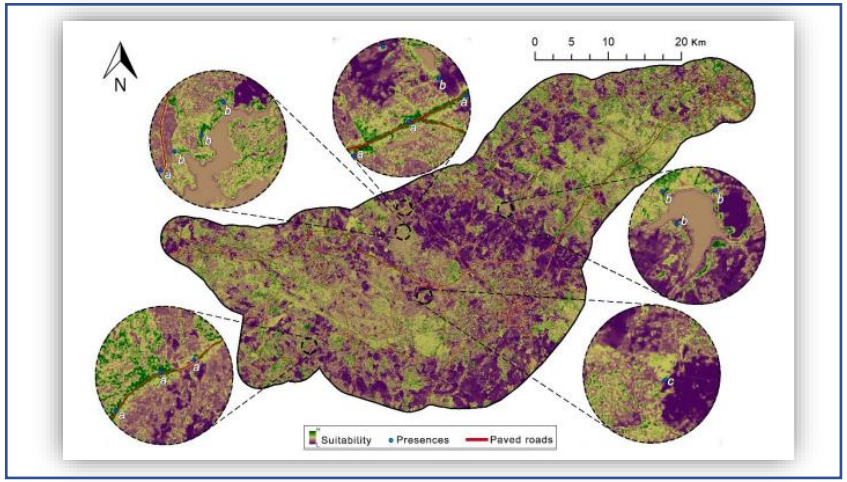
1.3 Previous Studies



Predicting Hotspots & Prioritizing Protected Areas for Endangered Primate Species in Indonesia under Changing Climate
(Condro, et al., 2021)



Predicting Hotspots and Prioritizing Protected Areas for Endangered Primate Species in Indonesia under Changing Climate
(Cisneros-Araujo, et al., 2021)



Predicting Microhabitat Suitability for an Endangered Small Mammal Using Sentinel-2 Data
(Valerio, et al., 2020)

- **There are gaps in protected areas creating connectivity within the habitat patches** that will be crucial for biodiversity conservation of the tropical ecosystem in Indonesia.
- The next lack is **Satellite data may be limited in many cases to understand precise habitat–species associations**, which requires high thematic resolution besides fine spatial detail.
- So, the characterize the complex habitat of the proboscis monkey **has not been studied so further understanding of the form of the relationship between ecological parameters**. These analyses are necessary as the adapted form chosen by the monkey proboscis.
- As a result, **the optimum location for the monkey proboscis habitat is produced using machine learning analysis**.

1.4 Objectives Study

Integration of detailed remote-sensing data into species distribution models for linking species occurrences to environmental conditions at functionally relevant Spatio-temporal scales, which is a central issue in ecology and conservation.

1. **Determining the optimal location of endangered species habitats** and **area of suitable and unsuitable habitats** in Kalimantan Island based on the integration of remote sensing and Machine Learning.
2. **Analyze each ecological conditions as predictor variables** at functionally relevant Spatio-temporal scales by matrix correlation.

1.5 Research Contribution (Novelty)

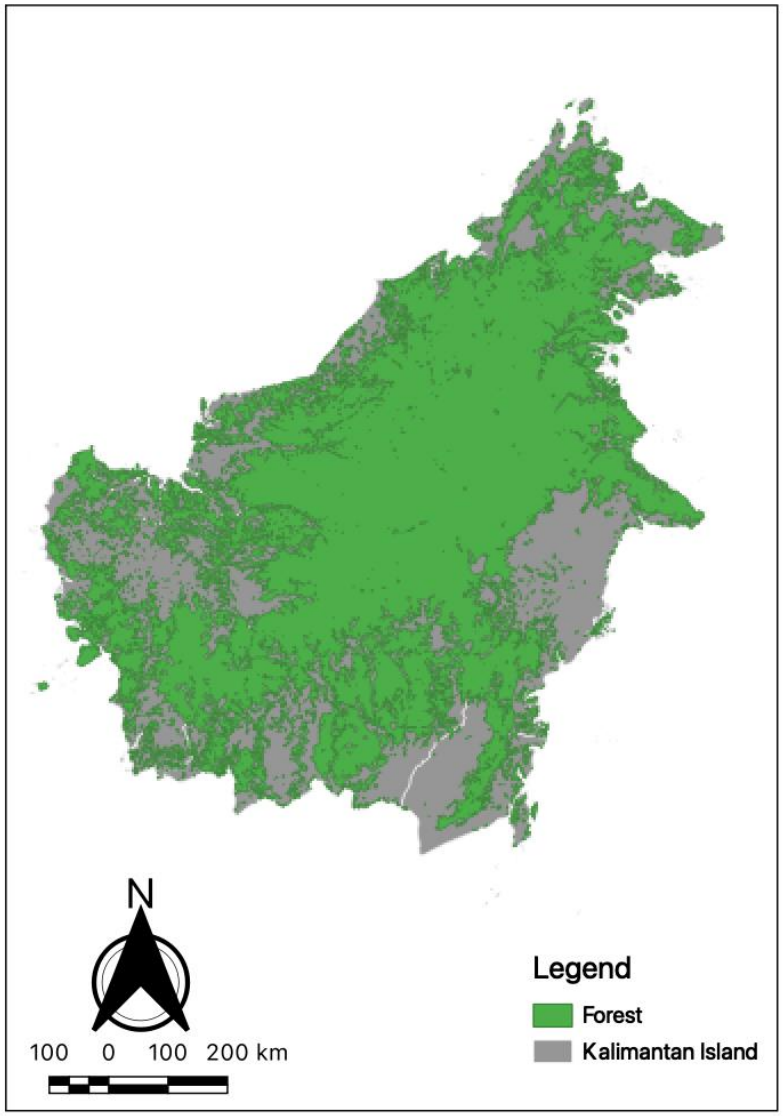
The first study to integrate remote sensing data with cloud computing-based machine learning to determine optimal habitat. Also produces an analysis of ecological variables as a consideration in assessing the characteristics of proboscis monkey habitat in its adaptation to a dynamic environment.

1.6 Strategic Impact of Research

The results of the study can be taken into consideration to formulate potential win-win solutions and strategies for restoration measures that can avoid negative impacts of policy responses such as paying attention to conflicts between nature reserves and tourism areas so as not to weaken other SDGs targets.

2. Data and Methods

2.1 Area Study



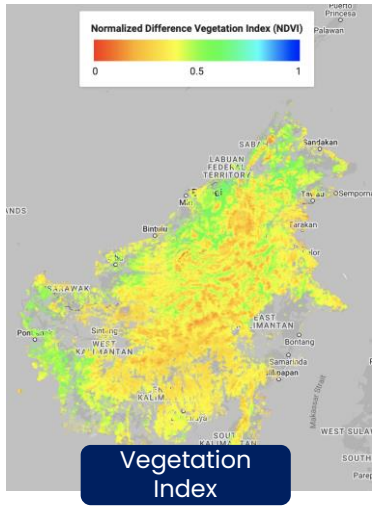
Kalimantan is **known as the lungs of the world** and is also **rich in biodiversity**, which is demonstrated by the high level of endemism for its flora and a variety of endemic animals.

It has been predicted by the National Coordinator of the Mining Advocacy Network, Merah Johansyah, **that some flora and fauna in East Kalimantan are endangered due to habitat loss due to the IKN development** mega project (Santoso & Pramudita, 2020).

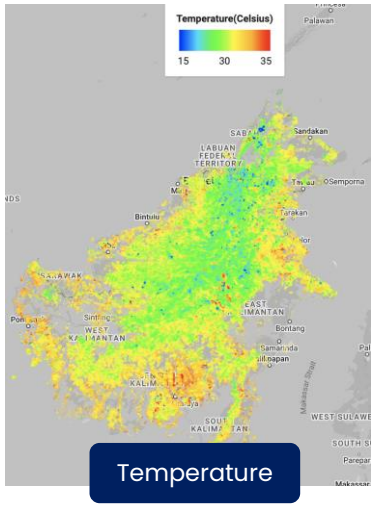
2. Data and Methods

2.2 Data

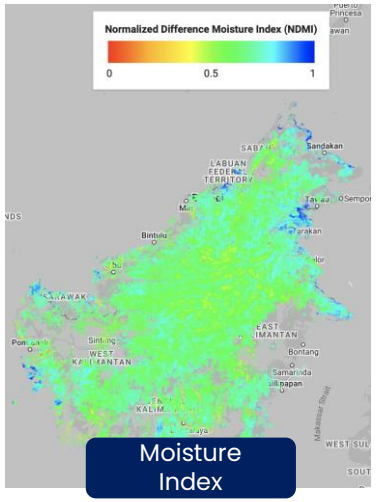
Ecological parameters as predictor variables



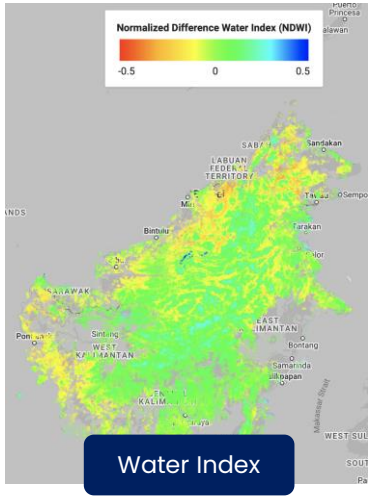
Vegetation Index



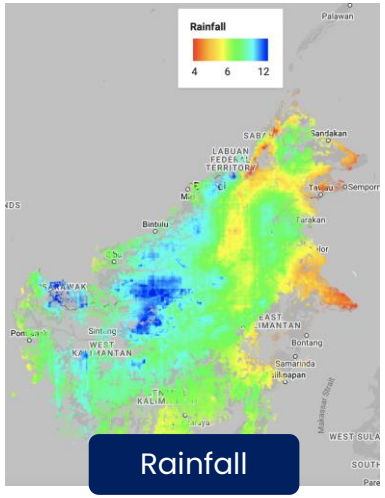
Temperature



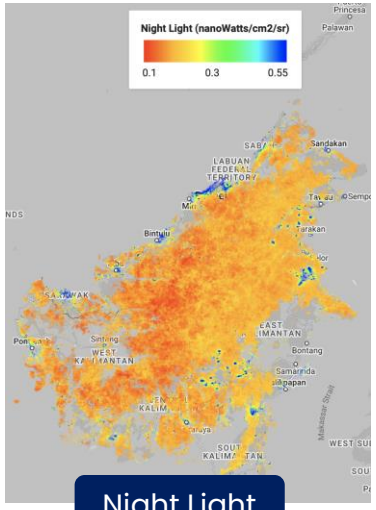
Moisture Index



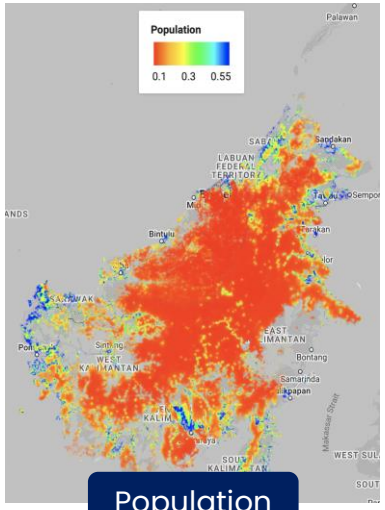
Water Index



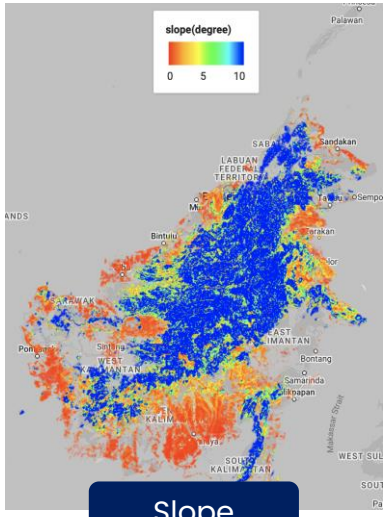
Rainfall



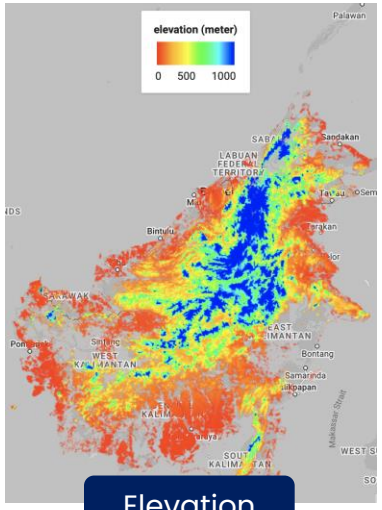
Night Light



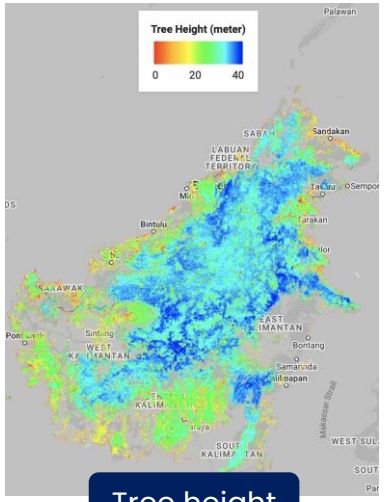
Population



Slope

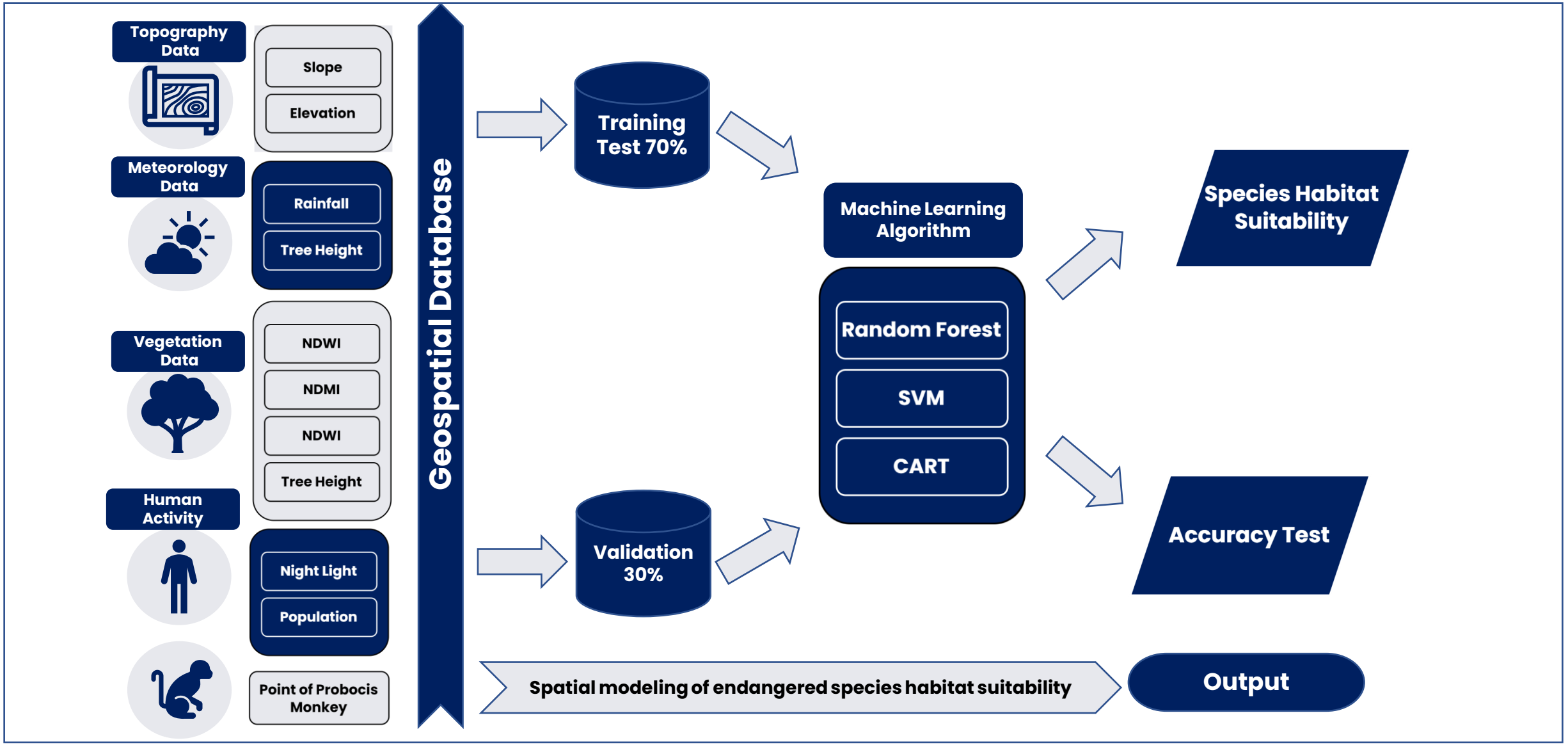


Elevation



Tree height

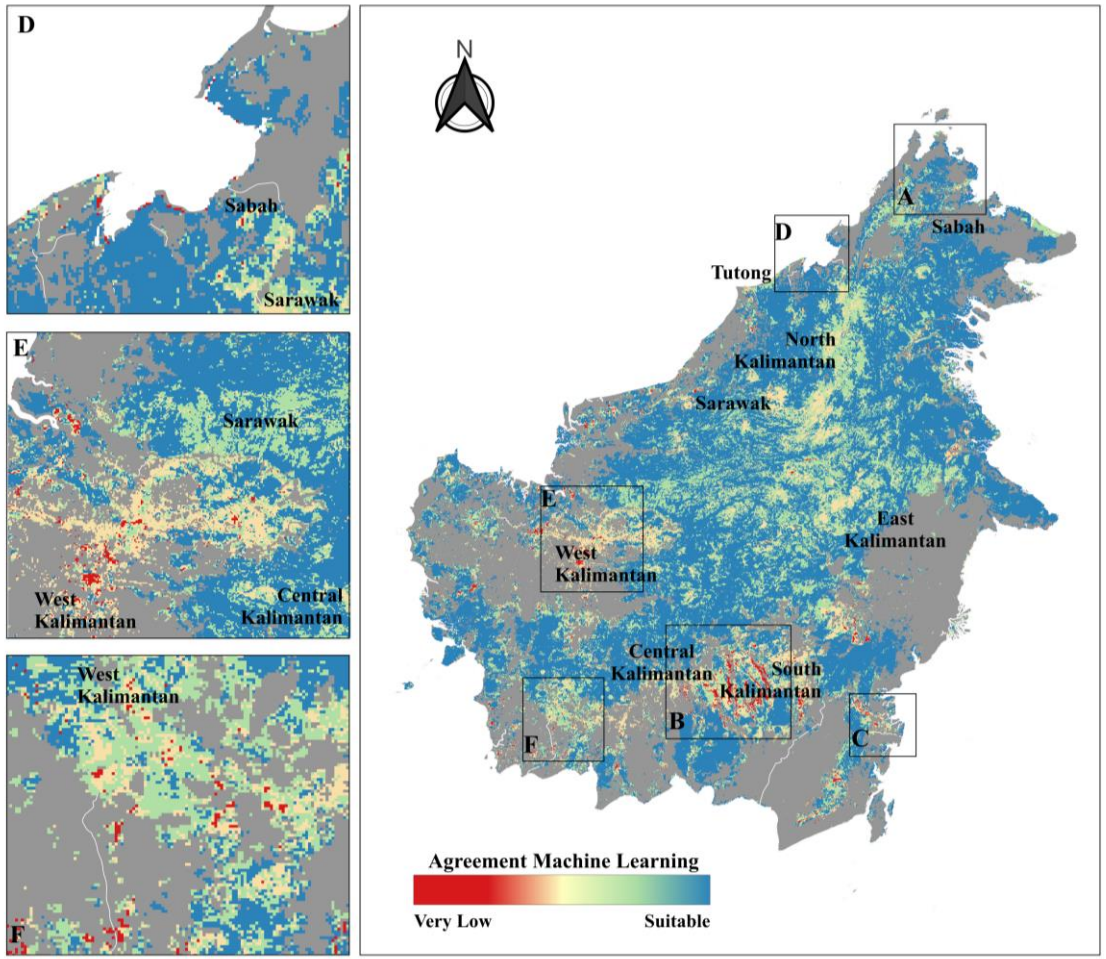
2.3 Methodology

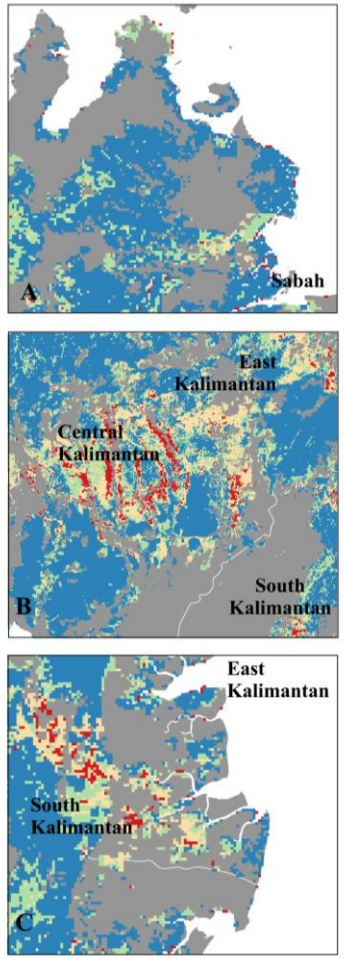


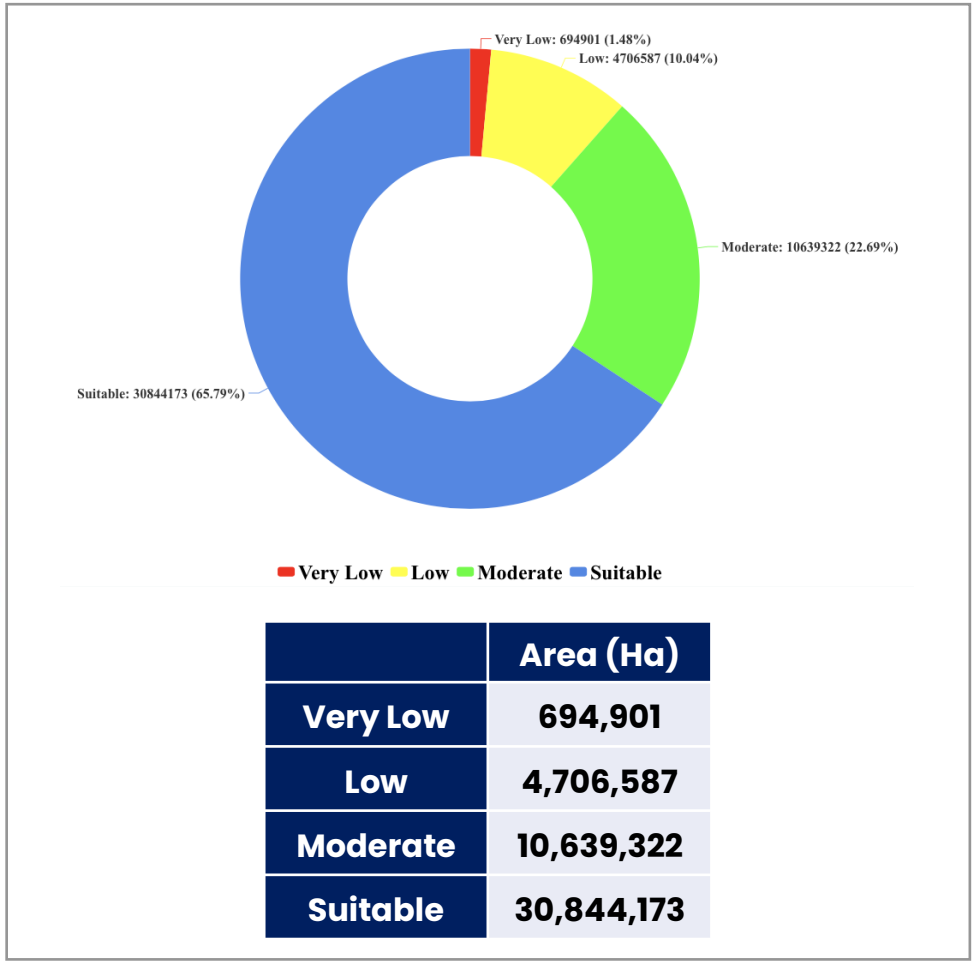
Data processing and analysis in this study utilized a machine learning algorithm which produce species habitat suitability and accuracy test

3. Results

3.1 Agreement Class Of All Machine Learning





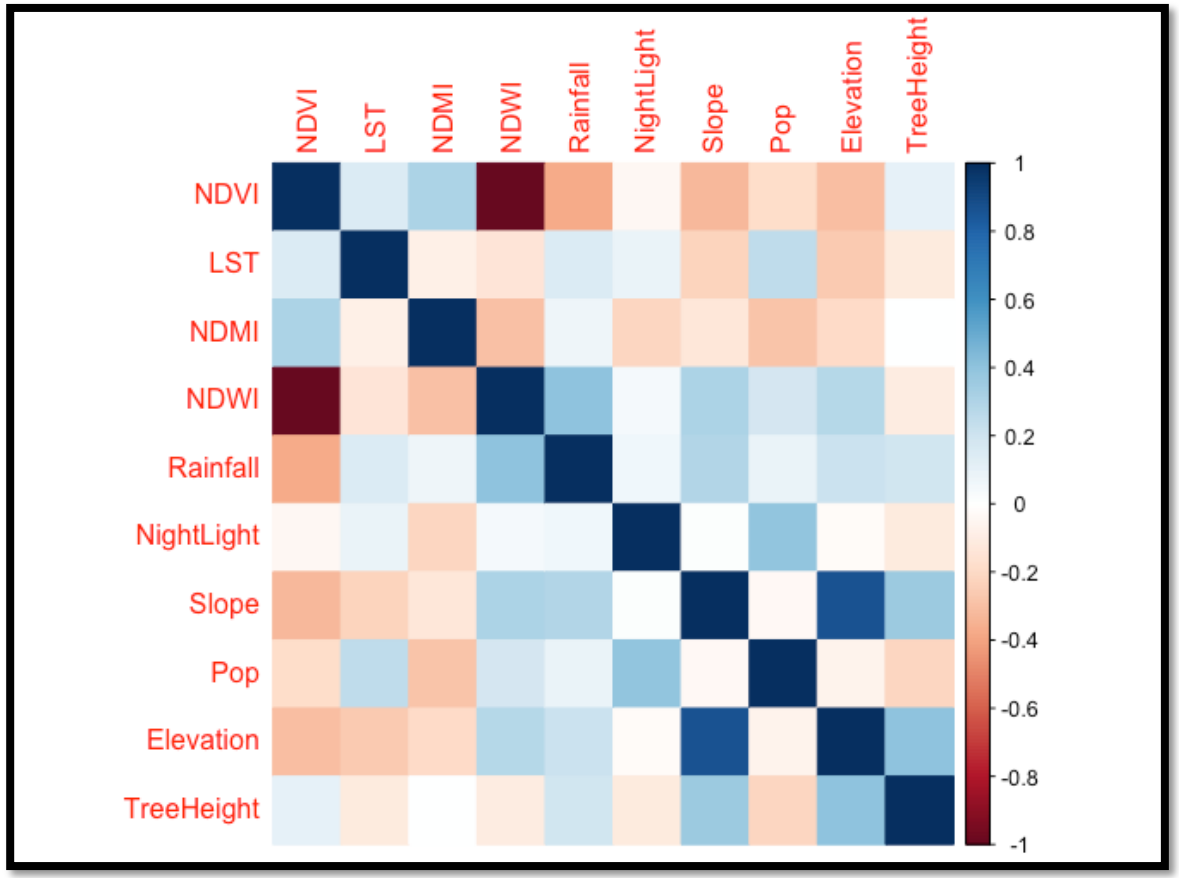


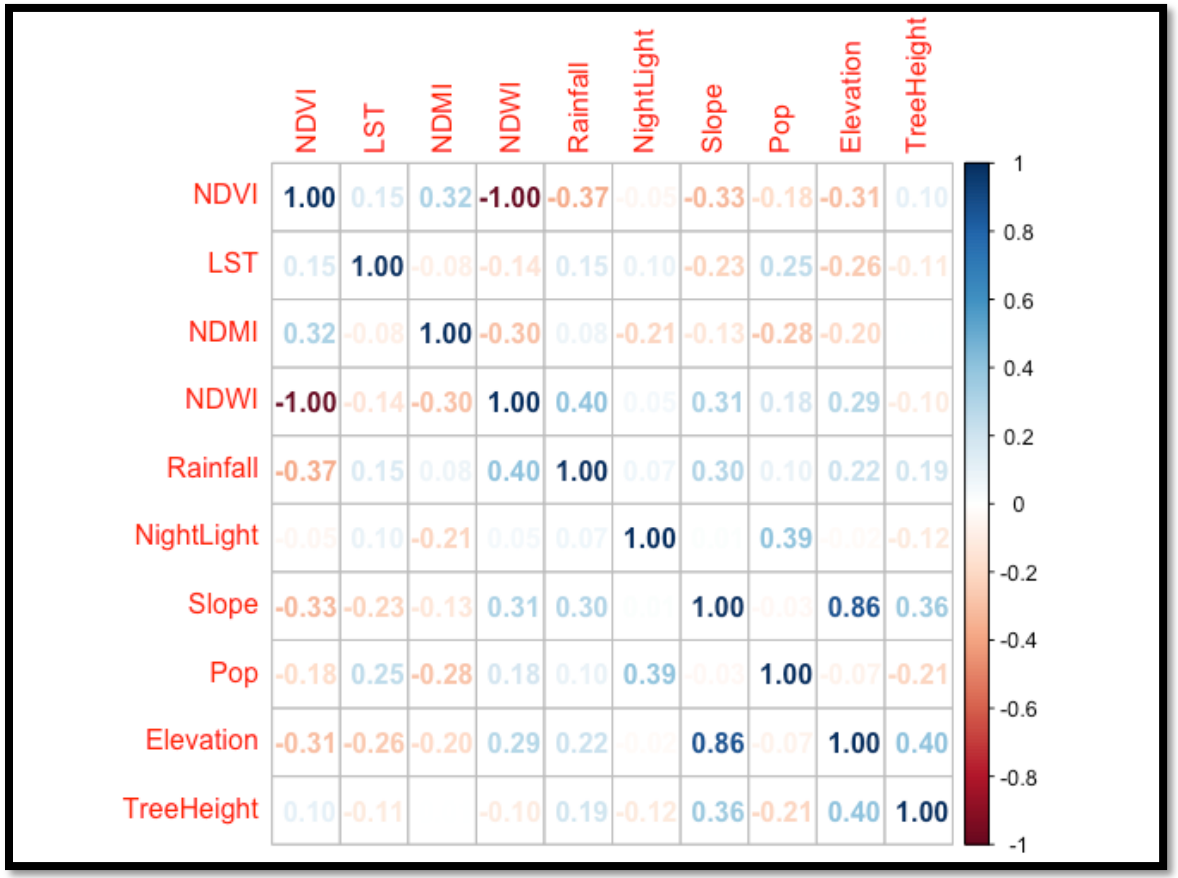
	Area (Ha)
Very Low	694,901
Low	4,706,587
Moderate	10,639,322
Suitable	30,844,173

Based on the agreement of 3 machine learning algorithms, it is found that there are **almost 66% of suitable areas for proboscis monkey habitat**.

3. Results

3.2 Matrix Correlations

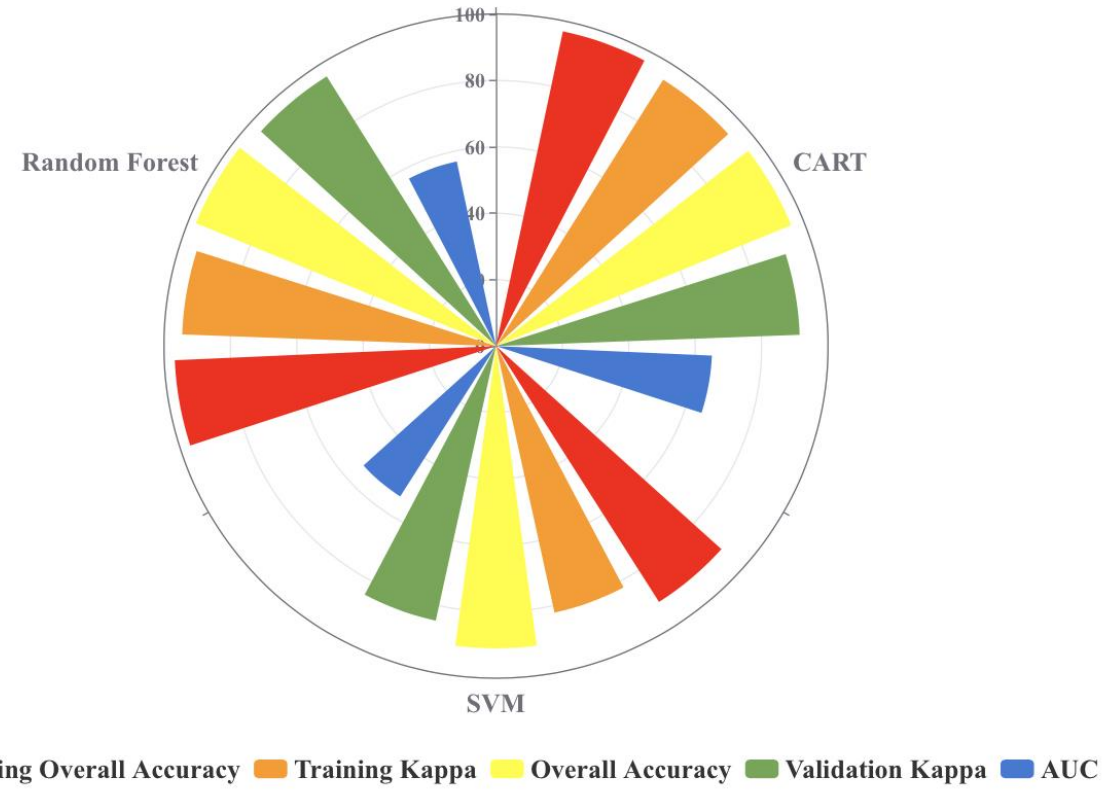




There are 21 out of 45 Pearson correlation values (46%) **that show a moderate relationship** so that the parameters have a relationship that is either linear or inversely proportional.

4. Discussions

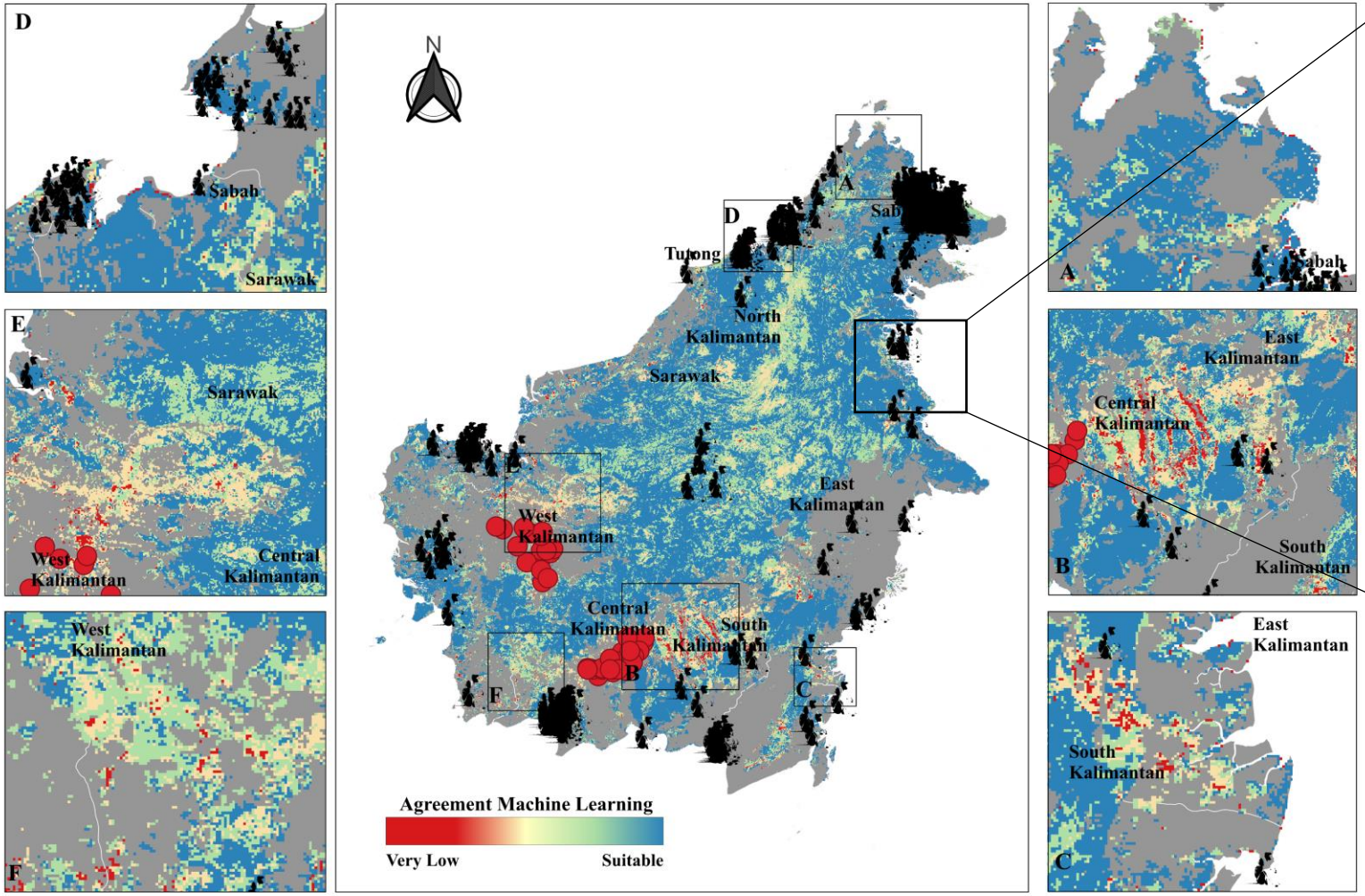
4.1 Accuracy

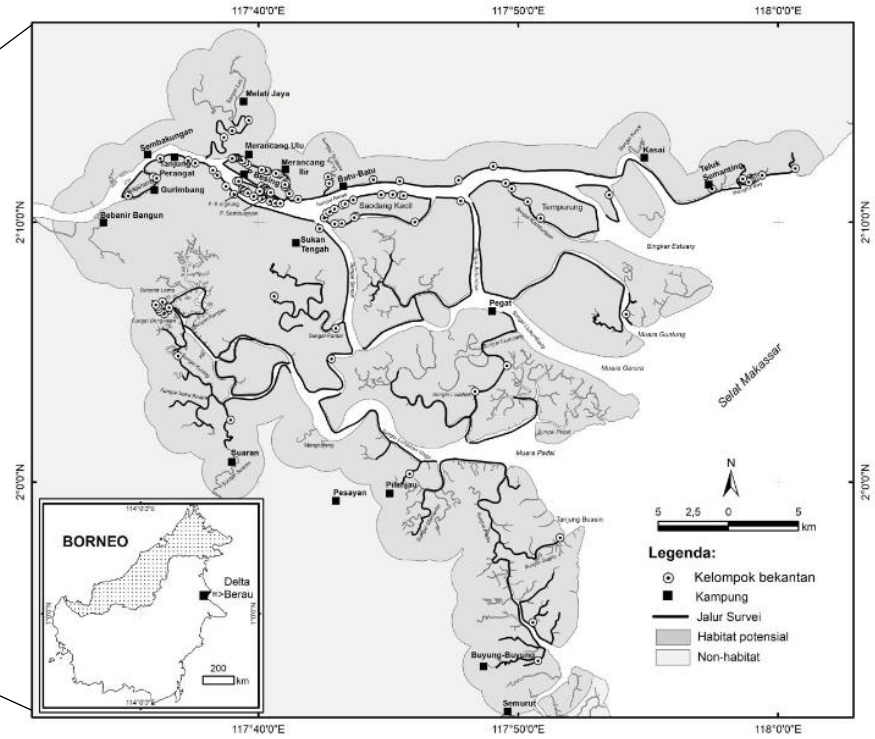


	Training Overall Accuracy (%)	Training Kappa (%)	Overall Accuracy (%)	Validation Kappa (%)	AUC (%)
Random Forest	96.9	94.72	96.07	91.53	65.09
SVM	91.36	82.17	91.03	84.63	53.7
CART	96.85	94.59	97.67	95.9	56.84

4. Discussions

4.2 Validation





The Population and Distribution of Proboscis Monkey (Nasalis larvatus) in Berau Delta (Atmoko, et al., 2020). They said further research is needed on population and habitat suitability.

4. Discussions

4.3 Limitations of Study as Development Study Suggestions

Further consideration has not been given to the threshold distance of the species' occurrences point to the river so as to provide a comprehensive picture of morphological parameters.

5. CONCLUSION

1. The **optimal location** of endangered species **habitats are Central and North Kalimantan**. The **area of suitable habitats** in Kalimantan Island based on the integration of remote sensing and Machine Learning is 30.844.173 ha or **65.79% of forest area**.

2. Each ecological condition as predictor variable at functionally relevant Spatio-temporal scales by matrix correlation resulted **in a moderate class**. With this matrix, we can also **see the pattern of relationships between parameters** so that it can **show the protection area of proboscis monkeys that can be carried out by local indigenous people** in harmony with efforts to protect the surrounding aquatic resources.


THANK YOU
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1920
"Nature doesn't need aphorisms, it needs action"