Comparison of Potential Habitat of Genus Anadendrum and Apoballis in Kelantan based on Different Qualitative Methods

By

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DECLARATION

I declare that this thesis entitled "Comparison Of Potential Habitat Of Genus Anadendrum and Apoballis in Kelantan based on Different Qualitative Method"is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name : Muhammad Zakil Bin Abdullah

Date :

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In the of name of Allah, The Most Merciful, The Most Compassionate. I praise Allah The Almighty, for giving me health, peace of mind and strength, great people on my side, and strengthen my effort and will to success.

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ABSTRACT

This study shows the distribution of selected genus Anadendrum and Apoballis in Kingdom of Plantae in Kelantan. These two genus had been predicted by using Ecological Niche Modelling for its coordinated, suitable habitat distribution. The aimed for this study are to generate the potential map distribution of Anadendrum and Apoballis in Kelantan and make a comparison of the percentage of the distribution genus Anadendrum and Apoballis with Estimating Extent of Occurrence (EOO) and Area of Occurrence (AOO). The locality data of the species *Anadendrum microstachyum* and *Apoballis mutata* that had been obtained from a previous study and Herbarium collection. The environmental variables will be layered with the data. Next, these climatic variable data will show the annually, mean, temperature and precipitation of the place. Then, the data was run in MAXENT and ARC-view software. All of this software important to determine and generate the distribution map of the selected species and the factor that affecting the rate of distribution of the species. The results showed the selected species that the higher probabilities distribution of Anadendrum and Apoballis genus in Kelantan was located at Gua Musang district. Gua Musang had been listed as the district that most suitable area for these two species to growth this state has the higher probabilities of these two selected species to exhibited and the uncertainty regarding the selected species can be minimizes by referring the previous predicted distribution model.

Perbandingan Habitat Potensi Genus Anadendrum dan Apoballis di Kelantan berdasarkan Kaedah kualitatif yang berbeza

ABSTRAK

Kajian ini menunjukkan pengagihan genus yang dipilih adalah Anadendrum dan Apoballis dalam Kingdom Plantae di Kelantan. Kedua-dua genus yang telah diramalkan dengan menggunakan Ecological Niche Modelling untuk koordinasi, habitat yang diperlukan dan pertumbuhan yang optimum. Tujuan kajian ini adalah untuk menjana pengagihan peta potensi Anadendrum dan Apoballis dalam Negeri Kelantan dan membuat perbandingan antara peratusan daripada genus pengedaran *Anadendrum* dan *Apoballis* dengan Menganggarkan Takat Kejadian (EOO) dan Kawasan Kejadian (AOO). Data lokaliti spesies *Anadendrum microstachyum* dan *Apobalis mutata* yang telah diperolehi daripada kajian sebelumnya dan koleksi Herbarium. Pembolehubah alam sekitar akan dimasukkan dengan data. Seterusnya,data ini akan menunjukkan setiap tahun, min, suhu dan hujan tempat itu. Kemudian, data ini akan dimasukkan ke dalam MAXENT dan perisian ARC-VIEW. Semua perisian ini penting untuk menentu dan menjanakan peta taburan spesies yang dipilih dan faktor yang mempengaruhi kadar taburan spesies. Keputusan telah menunjukkan kebarangkalian yang tertinggi untuk species yang dipilih iaitu Anadendrum dan Apoballis genus di Kelantan terletak di daerah Gua Musang. Jadi, Gua Musang telah disenaraikan daerah yang mempunyai nilai yang tinggi kehadiran untuk kedua-dua spesies yang dipilih dan ketepatan terhadap spesies ini dapat dikurangkan degan merujuk kepada distribusi model yang lepas.

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LIST OF ABBREVIATIONS

EOO	Estimating Extent of Occurrence
AOO	Area of Occupancy
MAXENT	Maximum Entropy
SMD	Simple Modelling Distribution
IUCN	International Union for Conservation of Nature
SRTM	Shuttle Radar Topography Mission
NASA	The National Aeronautics and Space Administration
DEM	Data Elevation Model
HWSD	Harmonized World Soil Database
FRIM	Forest Research Instituion Malaysia
AUC	Area Under Curve

LIST OF SYMBOLS

%	Percentage
km^2	Kilometers per square

CHAPTER 1

INTRODUCTION

1.1 Background of study

Malaysia has been known as the country that has the largest diversity of plant and wildlife. Approximately, 75 % of land in Malaysia covered with forest (CEMD, 2006). Malaysia consists of several types of forest such as montane-Oak, montane-ericaceous, upper dipterocarp, hill dipterocarp, lowland dipterocarp and peat swamp

Araceae only can grow depend on the availability of water and its also influence atmospheric humidity. Aroids cannot grow in arid, cold and extreme environment because they're structured and physiologically not well adapted. They were the most abundant and diverse in the species (Mayo *et al*., 1997). Araceae can be found in Malaysia tropical rainforest. This family has a vriety of habits such as scrambling shrubs, climber species and herbs or epiphytes.

The family of araceae is the monocotyledonous flowering plant that was third largest family after orchids, grasses and sedges. This family consists of 118 genera and 3500 species (Boyce and Croat, 2011). The largest genus is Anthurium with over 700 species. It easily can be found in tropical areas that have the suitable temperature for it to mature. It has specialized leaf that connect with reproductive structure that are flowery and cone scale. Aroids can be categorized into three types that are hermaphrodite, monoecious or dioecious.

1.2 Problem Statement

The State of Kelantan were been selected to generated the distribution of Anadendrum and Apoballis because they are exotic and spontaneous species. These two genus should be conserved because of Anadendrum and Apoballis are rare and remain unknown (Boyce, 2009). The distrubution data of these genus were a little in Kelantan region, thus make the data existed are not completed with proper distribution data and map. This genus might be distributed among our forest, but it becomes disappeared due to geological changes through a period of time.

Environmental data of genus *Anadendrum* and *Apobalis* had been used on Maximum Entropy software and ecological niche modelling likes Area of Occupancy and Extent of Occurrence. This might show the other regions in Kelantan that might be appeared of this two genus. MAXENT software will be able to predict the potential distribution regarding of the species from the previous and also upcoming species on that particular area. Other than that, it also will act as the important tools for the use for the future research.

1.3 Objectives

There are two objectives of this study that are:-

i. To generate the potential map distribution of the genus *Anadendrum* and *Apoballis* in Kelantan by using MAXENT, EOO and AOO

ii. To compare the percentage of the *Anadendrum* and *Apoballis* distributions by using Extent of Occurrence (EOO) and Area of Occupancy (AOO) in Kelantan.

1.4 Significance of study

In this study, there will be potential map of the distribution of genus *Anadendrum* and *Apoballis* in Kelantan will be generated. The percentage of these two genus will be compared with the Extent of Occurrence and Area of Occupancy.

By using Maximum Entropy (MAXENT) method, this can add some distribution map for the genus Anadendrum and Apoballis in this area. This method can find the potential place that mostly contained these two species by using the environmental factor as our variable to determine what needed for the plant to distribute or growth.

The potential habitat for this species also will be discovered. What condition needed for this species to maintain their maturity. Anadendrum usually growth in shady wet areas or often on small trees, meanwhile for Apabollis growth in stream galley and open areas (Hamzah et al. 2011).

1.5 Scope of study

There are 12 species of genus Anadendrum and Apoballis in Peninsular Malaysia, but for this study, there are two species were selected. These species are *Anadendrum microstachyum* and *Apoballis mutata*. The locality data of these two species were obtain from previous study. The data can be analysed using software and predict the distribution map of the species in Kelantan.

CHAPTER 2

LITERATURE REVIEW

2.1 Tropical rainforest

Tropical rainforest was covered almost 60% of total region of the forest area and it was the most deciduous and dry forest forest each calculated 15% and mountain forest 10% (FAO 2001). This forest was located in the broad zone outside of the equator and its mean the climate of this forest is hot. Southeast Asia holds the status as the world largest tropical forest. The temperature and the humidity of this forest was constantly warm and also rainfall (Lim, 2009).

Tropical forest in Asia had been blessed with the richness of diversity of flora and fauna. A biome for this forest consists of the vary distinctive plant and animal that can accommodated with its particular environment. The trees have grown with branchless and grow with only trunks in 100 feet or more.

Tropical rainforest divided with four layers, that are emergent, canopy, understory and forest floor. Each of this layer can found different species of animal and plant. For Araceae species, it lives under canopy layer and they make interaction with the tree to do vegetation in tropical rainforest.

2.2 Araceae family for genus *Anadendrum* and *Apoballis* in general

All the plant in Araceae family is Monocots. It had been called as monocotyledonous flowering plant because the flower becomes borne of the inflorescence called a spadix (Das et al, 2014 **).** This family had been grouped into nine subfamilies, 106 genera and 3200 species**.** Most of the Arum or Araceae species growing in tropical forest. Some of Areceae specie can thrive well in the forest floor if the place has a good canopy layer.

In Araceae family, genus Anadendrum had been classified as the flowering plants. There are 13 species of Anadendrum in worldwide. however, in Peninsular Malaysia, there are five species that can be found, such as, *A.latifolium*, *A.marginatum*, *A.microstachyum*, *A.ellipticum* and *A.angustifolium* (http://www.eol.org). The habitat of *Anadendrum* species is near shady wet areas and often on the small trees (Hamzah, 2011).

Genus Apoballis was listed as one of the major groups of Angiosperms or flowering plants (http://www.theplantlist.org). There are two species *Apoballis* that can found in Malaysia, that is, *A.brevipes* and *A.mutata*. The habitat of this species is stream gallery and open areas.

Figure 2.2.1 : **The *Anadendrum microstahcyum***

Retrieved from: www.aroid.org/genera/anadendrum

Figure 2.2.2: The *Apoballis mutata*

Retrieved from: www.aroid.org/genera/apoballis

2.3 Maximum Entropy (MAXENT)

16 methods were use in the Simple Modeling Distributions, but only one is the most suitable to get the accurate occurrence of the species distribution that is MAXENT. MAXENT is software that modelling the Species distribution by only used presence only-data (Phillips *et al*. 2006). The minimum data requirement for this model for working is just only 1. This software can be downloaded on the website (www.cs.princeton.edu/~schapire/maxent). MAXENT can mingle with GIS software such as Arc device by making input data and the output can be easily predictable.

There are advantages and disadvantages using this software. The advantage is the data that we provide will accurately give the results for the distribution of the species in that area. The disadvantage is the giving the precision of the point about the actual quantity of the species that I will modeling for (Phillips *et al*. 2006).

2.4 Shuttle Radar Topography Mission (SRTM)

SRTM is the data that produced by the National Aeronautics and Space Administration (NASA) or the National Geospatial-Intelligence Agencies (NGA). This data can lead us to generate the most complete high-resolution digital topographic database of Earth. The data have a variety of uses in scientific disciplines by giving information based on hydrology, geology and archaeology to the ecology and studies of urban development and its impact on the environment. Meanwhile, it can generate the Data Elevation Model from the earth by using radar interferometry. When the Space Shuttle is operating, remote sensing missions from lower earth orbit will conduct and generated the new digital elevation model set know as digital elevation model (DEM).

2.5 Harmonized World Soil Database (HWSD)

HWSD is the world soil database that we can download it from the internet (http://www.arcgis.com). It provides information about on soil, quantity of nutrient in the soil, capacity of organic carbon and the size of the soil particle distribution. Standardized data structure and processing data of the soil to from the different sources.

2.6 Ecological Niche Modelling (ENM)

ENM or Ecological Niche Modelling is a method that modelling approaches related known occurrences of species to landscape features to discover ecological properties and predict the geographic (Eterson, 2001).

In other case, the utility of ENM recognizes the area for biogeographic analyses, there are some factor has been arise regarding the species delimitation and to date as no empirical evaluation had been conducted. So, this can take into account as a advantages for using ENM. This modeling method is able to provide allopatric conditions of populations as well as can detect divergent ecological niches between interested species.

Next, ENM also used as a tool to estimate suitability habitat know or unknown to be filled with the species or not. It also can detect the changes in the suitability of habitat with the given specific conditions of environmental changing (Warren & Seifert, 2011).

ENM enable to be act as a simple recognition of the area endemism. Endemism is the ecological state of a species being unique to a defined geographic location, such as an island, nation, country or other defined zone, or habitat type; organisms that are indigenous to a place are not endemic to it if they are also found elsewhere. This could happen if the localities of the species rare and this tool can become the most suitable application to provide the distribution (Raxworthy *et al.*, 2003).

2.7 Model Validation Map

Model validation map can be use by using the value of Area under the Curve (AUC) that will show the presence-only data that should be interpret as a negative example of all the grid cells with no localities (Phillips, 2004). Its plotted as a true positive interger that against of the false positive rate for each line on the graph.

2.8 IUCN Red List Categories and Criteria

The IUCN categories and criteria is the data or system that can be as the key for an objective framework in the classification of the species according to their extinction. It can provide a necessaries system that can be used by a a different people consistently. it can be used to provide the people how to assess the different factors that affect the extinction risk of the species. Besides that, this system will allow the people using the threatened species list had been categorized (IUCN, 2011).

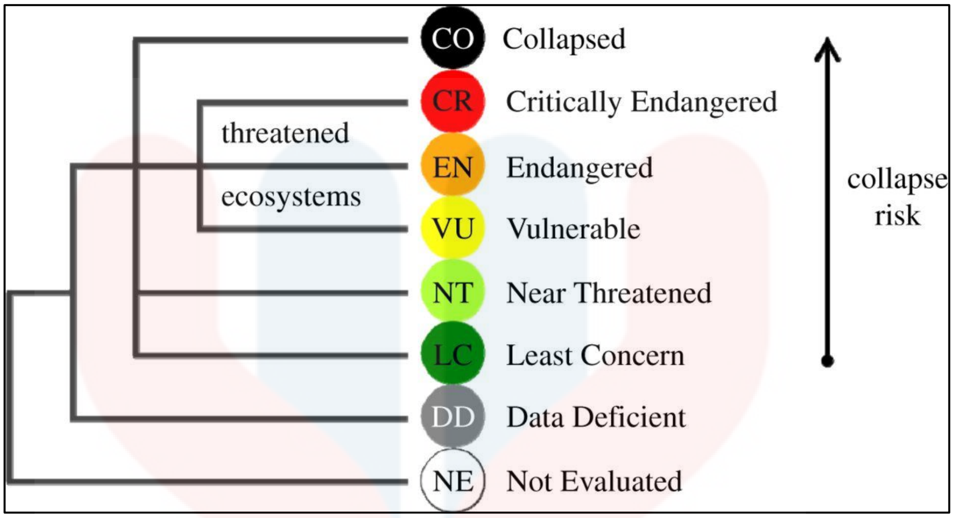

Figure 2.8.1 : The structure IUCN Redlist Criteria and categories

Source: IUCN Red List Categories And Criteria: Version 3.1 (2001)

CHAPTER 3

MATERIALS AND METHODS

3.1 Study Area

Kelantan rich with natural resources, there deforestation occurs on the tropical forest in the state of Kelantan and the changing of the land use in Kelantan. This state covered about 1,502,200 ha and area and its located 5.2500° N, 102.0000° E (Kelantan Timber Industry, 2012)

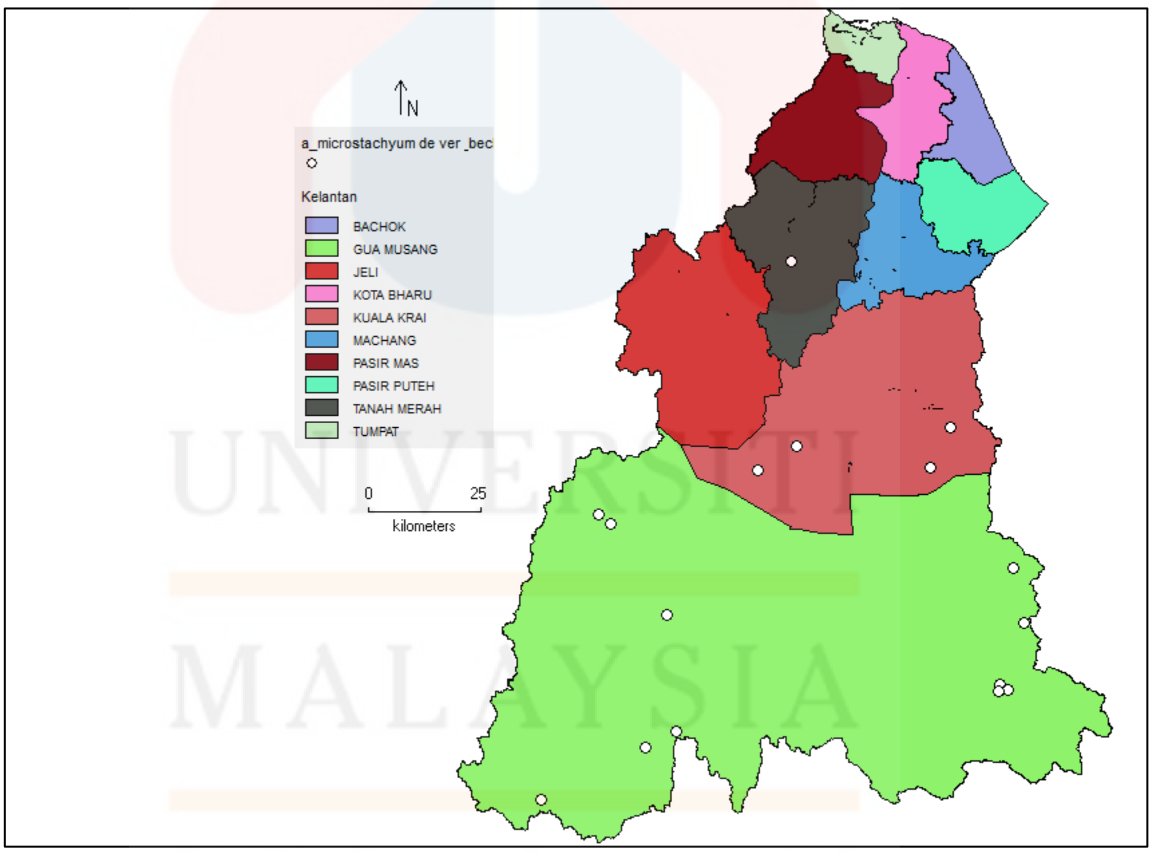

Figure 3.1: Map of Kelantan state

3.2 Study species

Previous studies had shown there were 140 species from 28 genera had been listed in Peninsular Malaysia (Mashhor et al. 2011). There are 12 type of *Anadendrum* that had been found on earth that are *A.affine* ,*A.angustifolium*, *A.badium*, *A.cordatum*, *A.ellipticum*, *A.griseum*, *A. latifolium*, *A.marcesovaginatum*, *A.marginatum*, *A.microstachyum*, *A.montanum* and *A.superans*. They were a climbing herbs that have shape of the leave in distichous. They petioles shape geniculate apically, sheated in apex, persistent or marcescent.

For *Apoballis* genus, they consist of 12 species , that are *Apoballis acuminatissima*, *Apoballis belophylla*, *Apoballis brevipes*, *Apoballis grandiflora*, *Apoballis hastifolia*, *Apoballis javanica*, *Apoballis longicaulis*, *Apoballis mutate*, *Apoballis okadae*, *Apoballis ovata*, *Apoballis rupestris*, *Apoballis sagittifolia.* This genus had been categorized as a small or moderate herbs. Their stem's structure as pleionanthic, epigeal and erect to decumbent. This type of genus doesn't have too many leaves that attach to it, but, the leaves often clustering terminally on the shoot. But, for this study, distribution of *Anadendrum microstachyum and Apoballis mutata* in Kelantan had been choosed.

3.3 MAXENT

Maximum Entropy (MAXENT) had been used to calculate the distribution and potential habitat for these two species. This software can be downloaded from (www.cs.princeton.edu). Locality data must be used to calculate the species distribution and the guide with environmental data included precipitation, temperature, altitude and soil (Maycock et al., 2012). MAXENT can give us a perfect result, in order to get the distribution of these two species. MAXENT requires only use presence–only data. It will show the map of the distribution of the species in the area that want to know. Both EOO and AOO are not included Environmental Variables, hence the estimation of species distribution will either underestimate or overestimate. This is because EOO and AOO only use the polygon shape on the map to show the distribution.

Figure 3.2 shows the interface of MAXENT model that will use it in this research. This software just requires only two sample data that is Sample species and the environmental layer including properties of soils, elevation and geological of the plants.

In figure 3.3, its showing the potential distribution of species that is run by MAXENT software. The red colour shown the region, which has the highest potential occurrence of species in that map, meanwhile the blue colour shown the region, which has the lowest probability of the species that want to observed.

MAXENT software had been use a tool to generate the potential distribution map of the two selected species that is *Anadendrum microstachyum* and *Apoballis mutata*. The locality data that had been gives will inserted into the MAXENT software. Then the locality data will run with the 19 bioclimatic data, including Harmonized World Soil Database (HWSD) and SRTM

The first run will use full training test of locality data in order to estimate the distribution of the species. The second and the third run will use the random selection of 75% and 25% of the locality data. These both of data had been run to make in order to make the model validated. The average data from the result were being chosen to determine the exact distribution place and predict the optimum place for the plant growth. Area under curve (AUC) will be chosen in order to complete the validation process.

The color gives main role in order to choose the place that has the higher probability of distribution. The red color will shows the higher possibility for the species to growth. The green color is the typical conditions and the blue color is the low probability of the species that had been predicted.

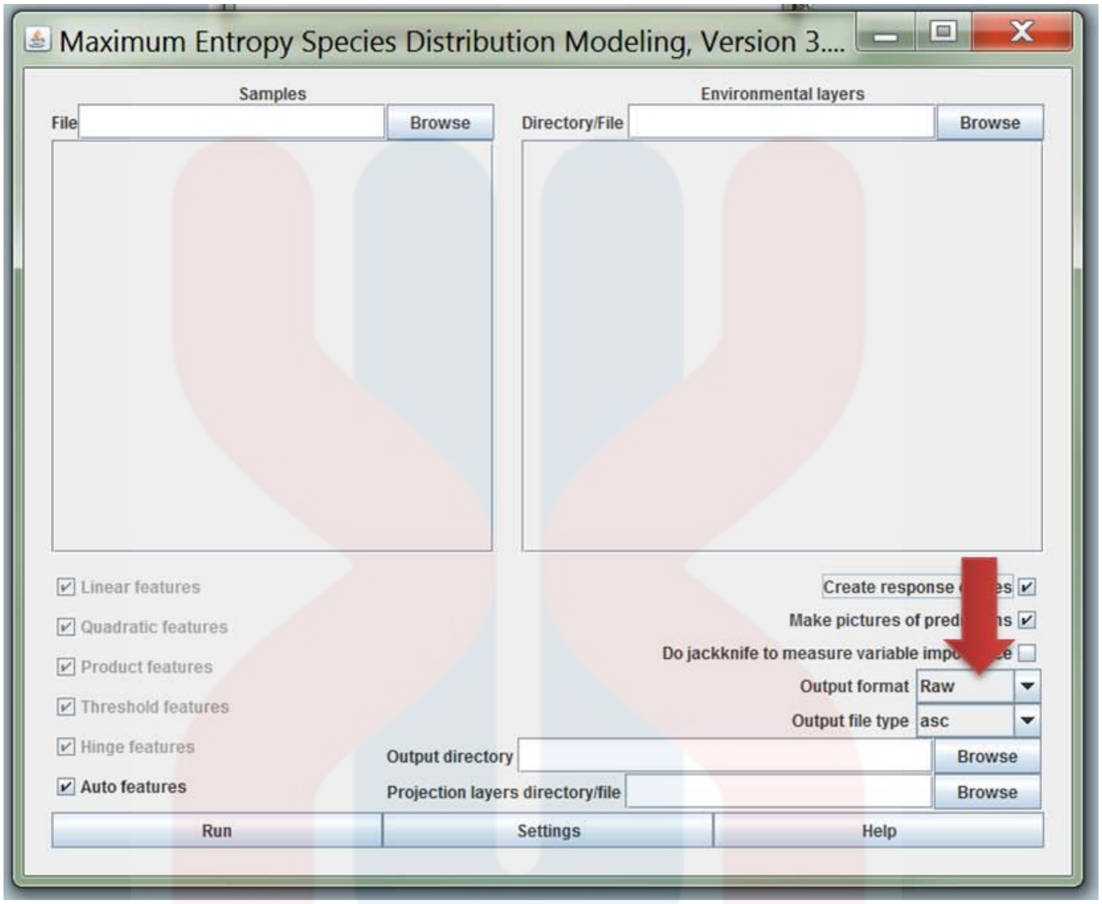

Figure 3.3.1: Maximum Entropy User Interface

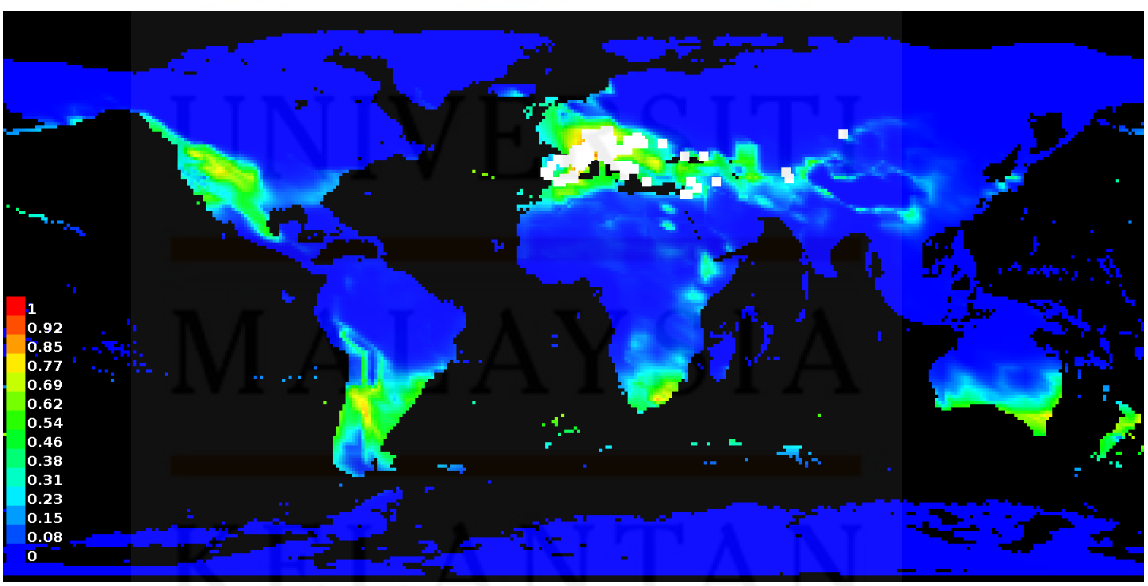

Figure 3.3.2: Example of modelling maps and potential region by using MAXENT.

3.4 Shuttle Radar Topography Mission (SRTM)

Shuttle Radar Topography Mission (SRTM) use in the way to describe the species elevation from sea-level, soil characteristics, the location, slope and vegetation of the species. The different elevation of the species from the sea-level can cause the different species of this two genus. This method can give the actual of the elevation, location, soil characteristics and the slope from the Data Elevation Model (DEM).

3.5 Harmonized World Soil Database (HWSD)

The Harmonized World Soil Database can be downloaded on (http://www.fao.org/soils-portal/soil-survey/soil-maps-and-databases/harmonized-world-soil-database-v12/en). This data used to visualize and aim the geographical layer of the database. The layer can be read directly and imported by GIS and Remote sensing software.

3.6 Locality data collection

The data that had been used in this study obtained from the past research that had been done by En. Zulhazman Hamzah. This data had been called as secondary data. The containing the locality of the longitude and latitude for the *Anadendrum Microstahyum* and *Apoballis mutata* species. This can be used into MAXENT and ARC-VIEW to estimate or plot the coordination of the species inside the map.

The data from En. Zulhazman Hamzah will show the existence of these two species in the map.The secondary data will not force us to do site trip to coordinated the species one by one in Kelantan.

3.7 Environmental Data

This environmental data or bioclimate data can be downloaded by click on WORLDCLIM (http://www.worldclim.org)**.** This information needed to be used in the MAXENT software if you want to obtain the result of this study. In order to achieve optimum environmental condition of the species, this data was the main causes.

BIOCLIM	**Environmental Variables**
BIO1	Annual Mean Temperature
BIO2	Mean Diurnal Range (Mean of monthly (max temp - min temp))
BIO3	Isothermally (BIO2/BIO7/)(*100)
BIO4	Temperature Seasonality (Standard deviation *100
BIO5	Max Temperature of Warmest Month
BIO6	Min Temperature of Coldest Month
BIO7	Temperature Annual Range (BIO5-BIO6)
BIO8	Mean Temperature of Wettest Quarter
BIO9	Mean Temperature of Driest Quarter
BIO10	Mean Temperature of Warmest Quarter
BIO11	Mean Temperature of Coldest Quarter
BIO12	Annual Precipitation
BIO13	Precipitation of Wettest Month
BIO14	Precipitation of Driest Month
BIO15	Precipitation of Seasonality (Coefficient of Variation)
BIO16	Precipitation of Wettest Quarter
BIO17	Precipitation of Driest Quarter
BO18	Precipitation of Warmest Quarter
BIO19	Precipitation of Coldest Quarter

3.8 Method Assessment IUCN Redlist And Criteria

The method of IUCN is by transferring the database about the species and will be imported to GIS. The map of the distribution can be generated and plotted by software ArcView version 3.3. This software can customized the to get what requirements of the suitable to apply to the Redlist Criteria. The species coordinated had been plotted enable to construct the images of the convex polygon. The EOO can be measured, and AOO can be obtained from generated grids (Wills et al, 2003).

CHAPTER 4

RESULTS AND DISCUSSION

4.1 The value of AUC on these two species

The classification and range of value AUC of the *Anadendrum microstachyum* and *Apoballis mutata* in different run by random selection of the locality data in MAXENT was referred to Yang et. al (2015) in Table 4.1.

Table 4.1 : The AUC classification and Range (Yang *et* al., 2015)

RANGE	CLASSIFICATION
≥ 0.9	EXCELLENT
0.8-0.9	GOOD
0.7-0.8	FAIR
0.6-0.7	WORTHLESS
≤ 0.6	NOT GOOD

Table 4.2 showed the value of AUC with and without HWSD for *Anadendrum microstachyum* and *Apoballis mutata* using three different training data. For distribution of *A. microstachyum,* the full run training data value including HWSD showed lower value than without HWSDwhich was 0.894 and 0.887 respectively. This is because the growth of *A.microstachyum* not depends on the soil to grow. Meanwhile, the distribution of *A.mutata* showed that the full run training data value with HWSD was 0.92, which was higher than without HWSD data. The growth of *A. mutata* depends on the availability of soil to grow in the area.

Table 4.2 : Area under the curve (AUC) for each selected *Anadenrum microstachyum* and *Apoballis mutata*

Species		With HWSD	Without HWSD
Anadendreum microstachyum	Full Run Training Data	0.887	0.894
	25% Testing Data	0.758	0.747
	75% Testing Data	0.795	0.804
Apoballis mutata	Full Run Training Data	0.920	0.917
	25% Testing Data	0.915	0.913
	75% Testing Data	0.770	0.746

4.2 Distribution of *Anadendrum microstachyum*

The predicted distribution of *A. microstahcyum* that had been generated by the MAXENT software version 3.3.3. Figure 4.1(a) showed the result of predicted distribution of the species by using 20 environmental layers including HWSD while, Figure 4.1(b) showed the predicted distribution using same environmental layers and not including the HWSD factor.

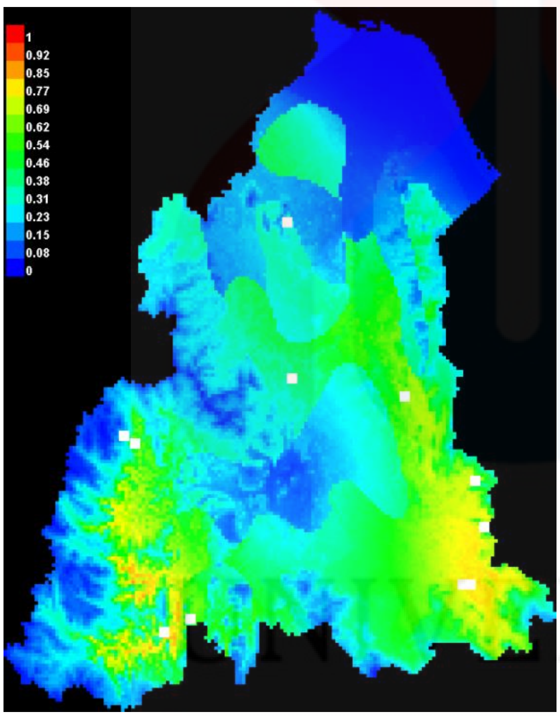

Figure 4.1(a)

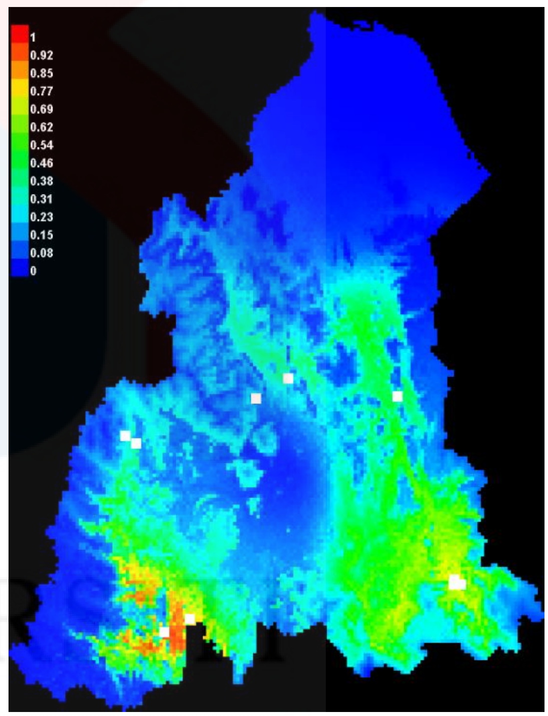

Figure 4.1(b)

Comparison between predicted distributions of *Anadendrum microstachyum* with (a) and without (b) HWSD data using MAXENT software.

Table 4.3: Percentage contribution of environmental variable of *Anadendrum microstachyum* in Kelantan

Variables	Percentage Distribution (%)	
	Include HWSD	**Without HWSD**
Bioclim 1	3.7	1.6
Bioclim 2	8.3	10.4
Bioclim 3	1.2	1.8
Bioclim 4	0.7	0.5
Bioclim 5	1.8	2.3
Bioclim 6	1.6	1.6
Bioclim 7	0.5	1.1
Bioclim 8	1.6	1.5
Bioclim 9	0.3	0.3
Bioclim 10	5.1	7.2
Bioclim 11	2.1	2.1
Bioclim 12	**10.2**	12.2
Bioclim 13	5.5	4.7
Bioclim 14	5.9	6
Bioclim 15	1.8	1.7
Bioclim 16	12	**14.1**
Bioclim 17	3.9	6.5
Bioclim 18	1	2.1
Bioclim 19	5.2	4.7
HWSD	13.5	

Table 4.3 shows the presented factors that affect the distribution of *Anadendrum microstachyum* in Kelantan. The highest environment factor contributed to the distribution of *A. microstachyum* when including HWSD was BIOCLIM 12 which was annual precipitation that is 10.2%. If without HWSD, 14.1% of wettest quarter factor was the highest factor contribute to the map.

Based on the map at had been generated, the possible distribution of species *Anadenrum microstachyum* was in Gua Musang, Tanah Merah and Kuala Krai. Gua Musang gives the higher probabilities of the species distribution with the area 6667.30km^2.

4.3 Distribution of *Apoballis mutata*

The predicted distribution of *A. mutate* that had been generated by the MAXENT software version 3.3.3. Figure 4.2(a) showed the result of predicted distribution of the species by using 20 environmental layers including HWSD while, Figure 4.2(b) showed the predicted distribution using same environmental layers and not including the HWSD factor.

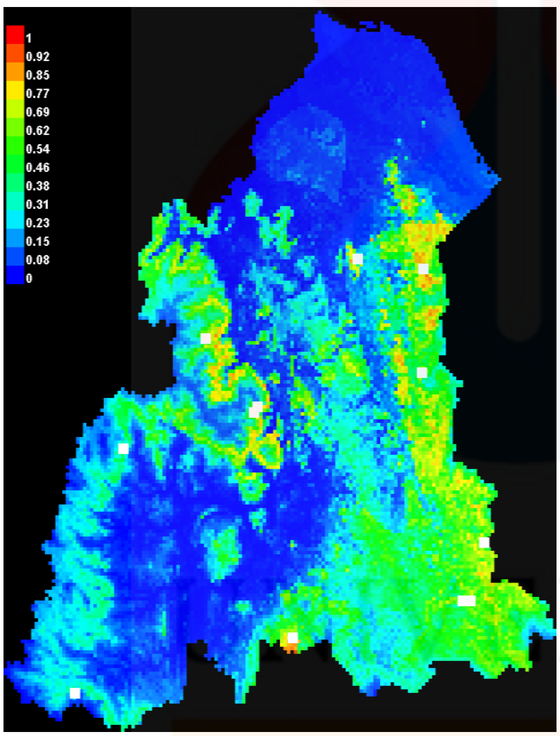

Figure 4.2(a)

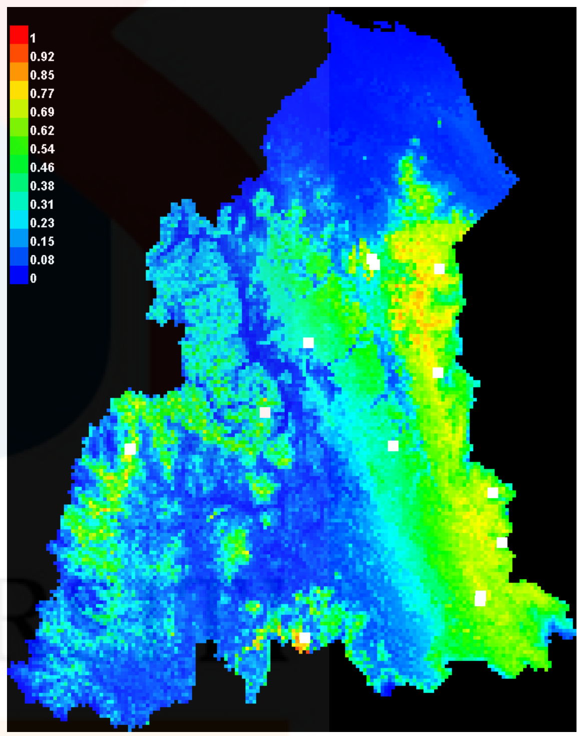

Figure 4.2(b)

Comparison between predicted distributions of *Anadendrum microstachyum* with (a) and without (b) HWSD data using MAXENT software.

Table 4.4: Percentage contribution of environmental variable of *Apoballis mutata* in Kelantan.

Variables	Percentage Distribution (%)	
	With HWSD	Without HWSD
Bioclim 1	1.8	0
Bioclim 2	3.1	2.2
Bioclim 3	1	0.1
Bioclim 4	1.7	4.1
Bioclim 5	**20.3**	20.6
Bioclim 6	0.3	0
Bioclim 7	5.1	0.1
Bioclim 8	0.2	0
Bioclim 9	0.5	0
Bioclim 10	0.1	0
Bioclim 11	1.5	0
Bioclim 12	4.5	15.5
Bioclim 13	13.6	10.5
Bioclim 14	3.7	**22.6**
Bioclim 15	3.3	7.8
Bioclim 16	18.9	6
Bioclim 17	3.4	0
Bioclim 18	0.1	0
Bioclim 19	1.7	0
HWSD	6.5	0

Table 4.4 shows the presented factors that affect the distribution of *Apoballis mutate* in Kelantan. The highest environment factor contributed to the distribution of *A. mutata* when including HWSD was BIOCLIM 5 which was max temperature of warmest month that is 20.3%. If without HWSD, 22.6% of precipitation of driest month factor was the highest factor contribute to the map.

Based on the map at had been generated, the possible distribution of species *Apoballis mutata* was in Gua Musang, Tanah Merah and Kuala Krai. Gua Musang gives the higher probabilities of the species distribution with the area 6667.30km^2.

4.4 Comparison of Ecological Niche Modeling (ENM) with Area of Occupancy (AOO) and Extent of Occurrence (EOO)

4.4.1 *Anadendrum microstachyum*

Figure 4.3 the Extent of Occurrence (EOO) and Area of Occupancy (AOO) of *A. microstachyum* in Kelantan. The distribution area for *Anadendrum microstachyum* is mainly located at southern part of Kelantan.

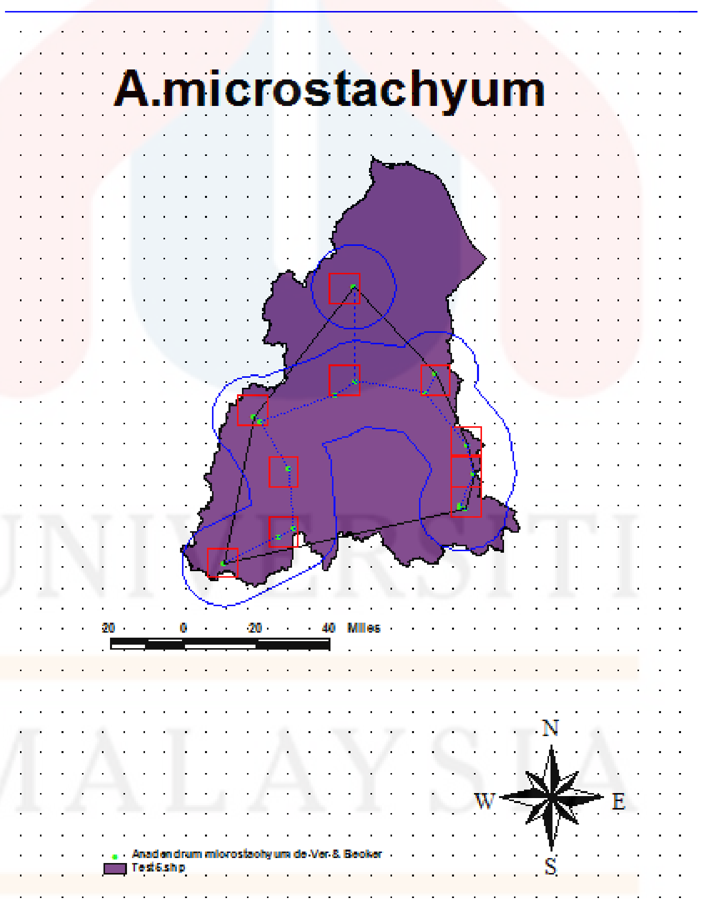

Figure 4.3: The result for EOO and AOO for genus *A. microstachyum* by using Arc-view

4.4.2 *Apoballis mutata*

Figure 4.4 the Extent of Occurrence (EOO) and Area of Occupancy (AOO) of *A. mutata* in Kelantan. The distribution area for *Apoballis mutata* is mainly located at southern part of Kelantan.

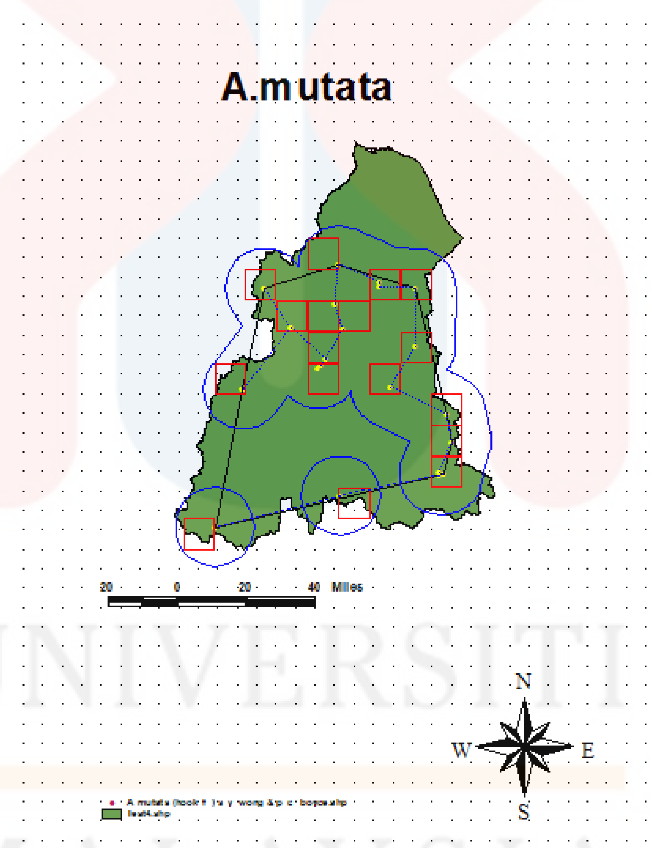

Figure 4.4: The result for EOO and AOO for genus *A.mutata* by using Arc-view

4.5 The Area of species distribution

Table 4.5 shows the comparison of areas and the percentage of the species *A. microstaychum* and *A. mutata* by using Arc-GIS for Ecological Niche Modelling (ENM), Extent of Occurrence (EOO) and Area of Occupancy (AOO). The intermediate value had been choosed in order to show the suitable percentage and area of species by using different qualitative methods.

Table 4.5 : Area of *Anadendrum microstahcyum* and *Apoballis mutata*

Species	**ENM**		**AOO**		**EOO**	
	Area (Km^2)	**Percentage (%)**	**Area (Km^2)**	**Percentage (%)**	**Area (Km^2)**	**Percentage (%)**
Anadendrum microstachyum	6667.30	44.38	40.00	0.27	7841.98	52.20
Apoballis mutata	8497.34	56.57	68.00	0.45	9263.12	61.66

The area for each species also had been calculated by using 3 different qualitative method. The area that had been calculated give the different result for that 3 method. The area genus *A. microstachyum*, that suitable is 6667.30km^2 for the value from ENM. The status of the species is under the category of possibly near threatened. For the genus *A.mutata*, the best result was on ENM that is 8497.34 km^2. The status of the species is under the category of possibly near threatened.

Table 4.6 showed the percentage distribution of the both species was evaluated using 3 different method methods. Based on the methods, EOO showed an overestimated value, while AOO showed the very minor percentage of area. Therefore, the intermediate value showed from ENM was choosed as it showed the reluctant percentage of distribution for both species.

Table 4.6 : The percentage of the species distribution

Species	**ENM**	**AOO**	**EOO**
	Percentage(%)	**Percentage (%)**	**Percentage (%)**
A. microstachyum	44.38	0.27	52.20
A. mutata	56.57	0.45	61.66

CHAPTER 5

CONCLUSSION AND RECOMMENDATIONS

5.1 Conclusion

The distribution of these two selected species that are *Anadendrum microstachyum* and *Apoballis mutata* were located around Tanah Merah, Pasir Mas, Gua Musang and Kuala Krai. Gua Musang showed the most suitable area for these two species to grow because of all of this state has the higher probabilities of these two selected species to grow.

The growth factor that affects the species to spread was determined. For *Anadendrum microstachyum,* that it depends on the annual precipitation. It is due to this species only lives on the wet and shady area. *Apoballis mutata,* this species depends on the maximum termperature of the max temperature of warmest month of Kelantan. This show that this type of species can survive in extreme environments.

By using the ArcView version 3.3, the Extent of Occurrence (EOO) and Area of Occupancy (AOO) map were generated. The EOO and AOO were the approach for conducting IUCN Red List assessment on estimating a species (IUCN, 2006). Unfortunately, the approach was not suitable for accessing the estimating species as the EOO and AOO method was overestimates the distribution of species (Solano and Feria, 2007).Therefore, ENM models was more choosen as it is more accurate on predicting species and widely used for plant conservation.

5.2 Recommendation

Several receommendation should be practice on estimation the distribution of the species by ground activity based on the map distribution predicted for their availability. The doubt or uncertainty regarding the selected species can be minimizes by referring the previous predicted distribution model. More information of the selected species also should be taken for the types of soil, the area of surrounding and others. This information can be used for the future research regarding this species. The accuracy of the species can be approved by using Ecological Niche Modelling (ENM)

Next, the uses of ENM is able to predict the habitat loss and the conservation status of threated species. The ENM will act as the rapid assessment tools for conservation to scheme the protected area. Therefore, the data regarding the species will be able to act as preliminary data for the researcher to conserve the species that near to threated.

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APPENDIX

Appendix 1: Bioclimatic variables from WORLDCLIM

(http://www.worldclim.org/bioclim)

BIOCLIM	Variables
BIO1	Annual mean Temperature
BIO2	Mean Diurnal Range (Mean of monthly(max temp – min temp))
BIO3	Isothermality (BIO2/BIO7)(*100)
BIO4	Temperature Seasonality (standard deviation *100)
BIO5	Max Temperature of Warmest Month
BIO6	Min Temperature of Coldest Month
BIO7	Temperature Annual Range (BIO5-BIO6)
BIO8	Mean Temperature of Wettest Quarter
BIO9	Mean Temperature of Driest Quarter
BIO10	Mean Temperature of Warmest Quarter
BIO11	Mean Temperature of Coldest Quarter
BIO12	Annual Precipitation
BIO13	Precipitation of Wettest Month
BIO14	Precipitation of Driest Month
BIO15	Precipitation Seasonality (Coefficient of Variation)
BIO16	Precipitation of Wettest Quarter
BIO17	Precipitation of Driest Quarter
BIO18	Precipitation Warmest Quarter
BIO19	Precipitation Coldest Quarter