SUITABILITY ASSESSMENT FOR OIL PALM AND PARA RUBBER PLANTING IN PHANG-NGA PROVINCE

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Thematic Paper
entitled

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SUITABILITY ASSESSMENT FOR OIL PALM AND PARA RUBBER PLANTING IN PHANG-NGA PROVINCE

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ABSTRACT

This study used GIS applications to study para rubber and oil palm plantations in Phang-nga Province. The physical factors of the study areas were analyzed by using GIS applications with Potential Surface Analysis. Spatial data, which included slope, soil depth, soil texture, soil drainage, land use, annual rainfall, and temperature were used for analysis. The Weighting-Rating method was used for qualitative data analysis, together with spatial data factors. Suitable factors were shown by weighting score and rating score for growth factors.

The results of this study indicated that most areas of Phang-nga province had not suitability for planting of para rubber and oil palm trees. Regarding the suitability of areas for para rubber trees, highly suitable areas were 1.94 percent of the total area, moderately suitable areas were 23.13 percent of the total area, marginally suitable areas were 3.12 percent of the total area, and not suitable areas were 71.81 percent. Regarding the suitability of areas for oil palms, highly suitable areas were 5.36 percent of the total area, moderately suitable areas were 2.59 percent of the total area, marginally suitable areas were 19.85 percent of the total area, and not suitable areas were 71.82 percent of the total area.

KEY WORDS: GIS/ SUITABILITY ASSESSMENT /PARA RUBBER/
OIL PALM/ PHANG-NGA PROVINCE

69 pages

การเปรียบเทียบพื้นที่เหมาะสมในการปลูกยางพาราและปาล์มน้ำมัน
SUITABILITY ASSESSMENT FOR OIL PALM AND PARA RUBBER PLANTING IN PHANG-NGA PROVINCE

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บทคัดย่อ

งานวิจัยนี้เป็นการประยุกต์ใช้ระบบสารสนเทศภูมิศาสตร์เพื่อประเมินพื้นที่เหมาะสมในการปลูกยางพาราและปาล์มน้ำมันในจังหวัดพังงา ซึ่งทำการวิเคราะห์โดยใช้ปัจจัยทางกายภาพของพื้นที่และทางอุตุนิยมวิทยามาวิเคราะห์ข้อมูลสารสนเทศทางภูมิศาสตร์ โดยใช้ข้อมูลเชิงพื้นที่ที่ประกอบด้วย ความลาดชัน, ความลึกของหน้าดิน, เนื้อดิน, การระบายน้ำ, การใช้ประโยชน์ที่ดิน, ปริมาณน้ำฝน, อุณหภูมิ และวิเคราะห์ข้อมูลเชิงคุณภาพโดยให้ค่าคะแนนน้ำหนักแสดงความเหมาะสมของปัจจัยและค่าน้ำหนักคะแนนระดับของปัจจัยที่มีผลต่อการเจริญเติบโตของพืชทั้งสองชนิด

ผลการศึกษาพบว่าพื้นที่ส่วนใหญ่ของจังหวัดพังงา เป็นพื้นที่ที่มีศักยภาพ ไม่เหมาะสมสำหรับการปลูกยางพาราและปาล์มน้ำมัน โดยพื้นที่เหมาะสมในการปลูกยางพารา พบว่า มีพื้นที่ศักยภาพสูงร้อยละ 1.94 ของเนื้อที่ทั้งหมด พื้นที่ศักยภาพปานกลางร้อยละ 23.13 ของเนื้อที่ทั้งหมด พื้นที่ศักยภาพน้อยร้อยละ 3.12 ของเนื้อที่ทั้งหมดและมีพื้นที่ศักยภาพไม่เหมาะสมร้อยละ 71.81 ในส่วนของพื้นที่เหมาะสมในการปลูกปาล์มน้ำมัน พบว่า มีพื้นที่ ศักยภาพสูงร้อยละ 5.36 ของเนื้อที่ทั้งหมด พื้นที่ศักยภาพปานกลางร้อยละ 2.59 ของเนื้อที่ทั้งหมด พื้นที่ศักยภาพน้อยร้อยละ19.85ของเนื้อที่ทั้งหมด และมีพื้นที่ศักยภาพไม่เหมาะสมร้อยละ71.82 ของพื้นที่ทั้งหมด

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Abbreviation	Term
kg	Kilogram
Sq.Km	Square Kilometer
mm	Millimeter
cm	Centimeter
ann.	Annual
°C	Celsius (degree of temperature)
$\overline{X}$	Mean
SD	Standard Deviation
%	Percent
R	Rating Score
W	Weighting Score
S	Summation

CHAPTER I
INTRODUCTION

1.1 Background and Statement of Problems

Most areas in Thailand are agricultural areas as people in Thailand mainly cultivate plants and raise animals. Therefore, agriculture is an importance base for country development. In Phang-nga province, there are agricultural areas and economic plants cultivation areas. Phang-nga province was divided into eight parts. In 2007-2008, people increasingly used areas for cultivating fruits and perennial plants and raising animals because areas for vegetables and flora gardens, plants areas, other areas, vacant areas, dwelling areas, and farm areas were used more considerably. In 2008, there were 803,757 rai of areas used for cultivating fruits and perennial plants (96.10% of agricultural areas or 30.83% of the province areas. There were 13,091 rai of areas used for building dwellings (1.57% of agricultural areas or 0.50% of the province area). [1]

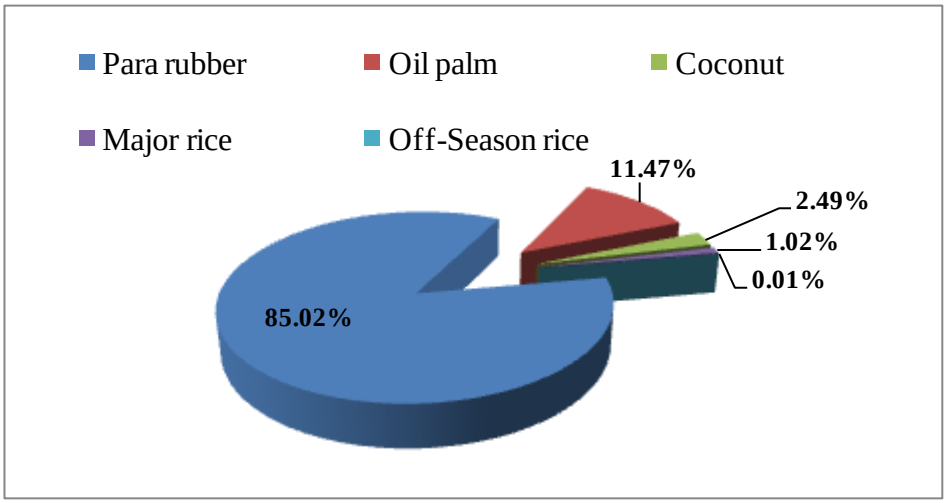

Figure 1-1. Economic plants cultivation areas of Phang-nga province in 2008

According to the Figure, in 2008, Phang-nga province had areas used for cultivating economic plants: para rubber, palm, coconut, major rice, and off-season rice. Para rubber was most cultivated in 757,025 rai of areas (85.02% of all cultivation areas). There were 102,158 rai of areas used for cultivating palm (11.47% of all cultivation areas. There were 76 rai of areas used for cultivating off-season rice. (0.01% of all cultivation areas)

Table 1-1. Important plants production in Phang-nga province in 2006 – 2009 [1]

Kinds of plants	Cultivation areas (rai)					Yields per rai (kg)			
	2006	2007	2008	2009	Proportion Country	2006	2007	2008	2009
Para rubber (flesh cut)	541,029	525,936	531,571	526,428	4.62	286	265	292	297
Oil palm (Flesh yielding fruit)	66,356	77,901	81,740	88,882	2.78	2,440	2,191	2,738	2,492
Mangosteen (Flesh yielding fruit)	12,442	12,787	12,987	N/A	3.28	451	720	299	N/A
Rambutan (Flesh yielding fruit)	11,029	10,298	7,487	N/A	1.89	453	750	493	N/A
Durian (Flesh yielding fruit)	7,759	7,284	7,333	N/A	1.10	732	771	613	N/A
Major rice	8,973	9,170	9,315	N/A	0.02	308	324	328	N/A
Coffee (Flesh yielding fruit)	1,470	1,335	1,269	1,245	0.32	83	119	116	129

According to Table 1.1, para rubber and oil palm were main economic plants of Phang-nga province. Areas were most used for cultivating para rubber and oil palm, respectively. It was found that there was decrease in para rubber cultivating areas every year as follows; There were 541,029 rai of para rubber cultivating areas in 2006. There were 525,936 rai of para rubber cultivating areas in 2007. There were 531,571 rai of para rubber cultivating areas in 2008. There were 526,428 rai of para rubber cultivating areas in 2009. However, areas were increasingly used for cultivating oil palm as follows; there were 66,356 rai of palm cultivating areas in 2006. There were 77,901 rai of palm cultivating areas in 2007. There were 81,740 rai of palm cultivating areas in 2008. And there were 88,882 rai of palm cultivating areas in 2009. In conclusion, agriculturists in Phang-nga province decreasingly cultivate

para rubber but increasingly cultivate oil palm although cultivation of para rubber considerably created yields per rai when compared with yields throughout the country.

As the climate in Phang-nga province has several limitations and conditions to receive yields of para rubber and oil palm such as frequent rainfall, agriculturists are not able to receive para rubber yields as it should be. And local people increasingly cultivate oil palm. Therefore, agriculturists are not confident that what plants they should cultivate.

If the factors of areas and climate are analyzed to find suitability of areas, agriculturists will know that their areas are most suitable for cultivation of para rubber or oil palm.

1.2 Objective of study

1.2.1 To compare to find suitability value of cultivating para rubber and oil palm.

1.3 Scopes of work

The scopes of work are as following:

1.3.1 To study in Phang-nga province.

1.3.2 To suitable for cultivation of para rubber or oil palm.

1.4 Expected Results

1.4.1 Agriculturists in Phang-nga province are able to know that their areas are suitable for cultivation of para rubber or oil palm.

CHAPTER II
LITERATURE REVIEW

2.1 The studied area

2.1.1 General characteristics

Phang-nga province is situated in the southern part on the upper part of the coast. In the west, it is adjacent to Andaman Sea. It is between Latitude of 8 degrees 27 lipda 52.3 north philipda and Longtitude of 98 degrees 32 East Lipda, far from Bangkok about 788 kilometers, with total areas of 4,170.885 squares kilometers or 2,606,803.125 rai. [2]

2.1.2 Nearby areas

In the north, Phang-nga is adjacent to Ranong province and Surat Thani province. In the south, Phang-nga is adjacent to Phuket province and Andaman Sea. In the east, Phang-nga is adjacent to Surat Thani province and Krabi province. In the west, Phang-nga is adjacent to Andaman Sea and Indian Ocean. [2]

2.1.3 Topographical characteristics

Phang-nga province is full of complicated mountains from the north to the south. Its coast is 239.25 kilometers long. It has forest areas: evergreen forest, hill evergreen forest, tropical rain forest, and mangrove forest. The plains will slope down from the east to the west to Andaman Sea. Most mangrove forests are along the coast. There are 105 islands in the province. Important marine tourist attractions are Similan Island, Surin Island, Khao Lak Beach, Koh Khor Khao, Kho Phra Thong, Phang-nga Bay, Koh Pan Yi, Khao Ta Pu, Khao Phing Gan, Phung Chang Cave, Wat Suwankhuha, tsunami memorial.[2]

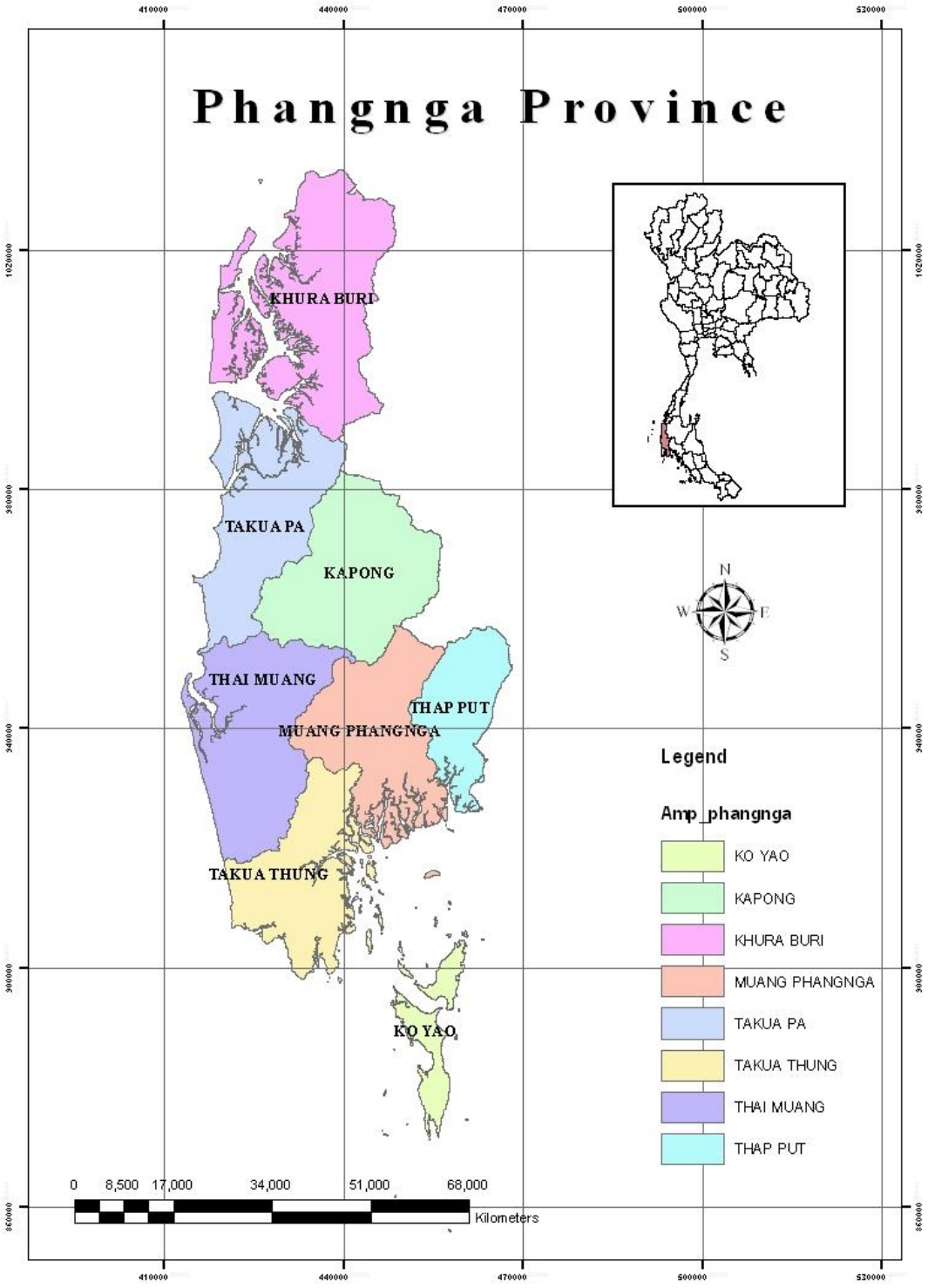

Figure 2-1. Phang-nga province's boundary

2.1.4 Climate characteristics

Climate in Phang-nga province is tropical monsoon receiving influence of the south- west monsoon and the north- east monsoon. There are two seasons: Summer starts from January to April. The rainy season starts from May to December.

Due to tropical monsoon, temperature in each season is slightly different between 29-36 °C. Annual average rainwater is about 3,654 mm. [2]

2.1.5 Number of populations in Phang-nga province

As of 31 December 2009, there were 251,657 people divided into 126,273 males and 125,384 females. [3]

2.1.6 Administrative agencies

Phang-nga province divides administration into eight districts, 48 sub-district, 321 villages, two city municipalities, eight sub-district municipalities, and 41 sub-district administrative organizations. [2]

2.2 Para Rubber Tree

Para rubber tree (Hevea brasiliensis), Common name is Para Rubber. It is originated from Tapajos plateau in the tropical region of Amazon River basin, South America. It is widely planted in Para state, northern Brazil. Its capital city is Belem, a center for transport of agricultural products especially Para rubber. [4]

2.2.1 Botanical Characteristics of Para Rubber Tree

Para rubber tree is a middle to large size perennial plant. It is a Dicotyledon in family euphorbiaceae, scientific name is Hevea brasiliensis[5]. It has Tap Root system. When the tree is 3 year old, the tap root will reach 2.5 meters depth, and secondary and tertiary roots will extend to 7-10 meters to the sides. It can grow to the height of 30-40 meters. Rubber seedlings grow rapidly making trunk sections longer. Rubber tree's leaves originate from its stems. The leaves are spiral and have a distinguished leaf storey. Para rubber is a deciduous plant and loses its leaves in the

dry season. In the South, the trees lose their leaves between March and May. For the eastern region, the leaves fall in February or April. Fruits of rubber tree are in a form of capsule; generally have 3 seeds which resemble Castor bean. [6]

2.2.2 Para Rubber Tree Growth's Standard

Para rubber tree's growth is a process of storage and accumulation of new cells or generation of new parts, or an increasing volume in a given time. Growth patterns are different depending on internal features (genetic features), and external influences (environmental factors). Critical factors controlling rubber tree's growth are plant nutrients, rock content in soil (which obstructs penetration of the roots), as well as the plot's environment, soil properties, and caring during seedling period. When considering rubber tree's growth, girth increment is measured. Rubber tree's growth is first measured when a tree is 2 years old, and once every six months, or twice a year around June and December. Data from the June measurement represents growth in the dry season, while data from December measurement represents growth in the wet season. The measured position is around the trunk of the tree 130, 150, or 170 cm above the ground both before and after tapping begins.

Rubber tree' s growth in the rainy season has statistically significant difference from that of the dry season as during rainy season from May to September there is a lot of rain which is favorable condition for rubber tree's growth. On the other hand, in the dry season, there is no rain and the weather is dry creating an unsuitable condition which rubber tree's growth is paused, therefore the extensive difference exists. While the Phuket's plot experienced consistent rains throughout the year resulting in an almost similar growth rates of the wet and the dry seasons, Surin's plot encountered the lowest growth rate of 5 cm per annum, especially during the dry season it was only 1.1 cm. per six months. However the growth rates during 6 ½ years of Buriram, Nongkhai, and Phuket provinces were merely slightly disparate since the rate during rainy season in Buriram and Nongkhai were higher than that of Phuket while during dry season it was vice versa. That means rubber tree's growth rate in arid zone is more fluctuated than the normal rubber plantation area. In other words, growth rate consistency will be dispersed when rubber trees are 30 months, and the

circumference will be not at least 13 cm. However the relationship between rubber tree's age and growth rate (Variety RRIM 600) in the northeastern was linear [7]

2.3 Oil Palm

2.3.1 Botanical Characteristics of Oil Palm

The oil palms comprise two species of the Arecaceae, or palm family. The African Oil Palm Elaeis guineensis is native in West Africa, occurring between Angola and Gambia, while the American Oil Palm Elaeis oleifera is native in tropical Central America and South America.

Mature trees are single-stemmed, and grow to 20 m tall. The leaves are pinnate with 3-5 meter length. A young tree produces about 30 leaves a year. Established trees over 10 years produce about 20 leaves a year. The flowers are produced in dense clusters; each individual flower is small, with three sepals and three petals. The fruit takes five to six months to mature from pollination to maturity; it comprises an oily, fleshy outer layer (the pericarp), with a single seed (kernel), also rich in oil. Unlike is relative, the Coconut Palm, the oil palm, the oil palm does not produce offshoots; propagation is by sowing the seeds. Oil palm breed is the Tenera that is most economically important. [8]

Oil palms are grown for their clusters of fruit, which can weigh 40-50 kgs. Upon harvest, the drupe, pericarp and seeds are used for production of soap and edible vegetable oil; different grades of oil quality are obtained from the pericarp and the kernel, with the pericarp oil used mainly for cooking oil, and the kernel oil used in processed foods. Some varieties have even higher productivities which have led to their consideration for producing the vegetable oil needed for biodiesel. [8]

2.4 Geographic Information System

Geographic information system is a tool using computer system to help input, save, prepare, modify, correct, manage, analyze, and show spatial data according to specified objectives. (Geo-Informatics and Space Technology Development Agency, 2009). Geographical Information System comprises data/information divided into two categories: spatial data and non-spatial data or attribute data saved by referring geographic coordinates. Input or code values determined by user may be arranged as relationship of spatial data and attribute data in the saving system called spatial topology in order to analyze by geographical information system as follows; [9]

2.4.1 Spatial Analysis

Spatial analysis is to sequence area suitability to support area development and utilization of various activities and use as basic data to determine guidelines of developing each level of areas by the methods of Sieve Mapping, Potential Surface Analysis and other suitable methods such as Buffer, Overlay, Intersect, Union, Merge, Dissolve. As for spatial analysis, it is necessary to use various techniques. Statistical data analysis by geographical information system is to manage GIS database to be able to link with attribute data and related spatial data by using relationship and saving data. Spatial data can be jointly analyzed with characteristic data, causing required analysis to have complexity and able to be suitably applied. [10]

2.4.2 Analysis of Attribute Data

Data processing by geographical information system uses the following processes;

- Correction of attribute data is able to search, examine, and change data, including linking and combining tables.
- Asking attribute data is to search data in database related to conditions which users use to impose questions and ask questions by using various methods.

- Statistical process for calculating statistical values from data tables.

- After that spatial analysis can be jointly made with analysis of attribute data. This creates more efficient information system. It may be jointly used with other programs, creating more perfect working of geographical information system.

2.4.3 Potential Surface Analysis: PSA

Potential Surface Analysis is used in analyzing area development potential by considering readiness of areas for various activities. It is a guideline to select location, potential, and readiness of areas affecting use of that land by thinking of factors or indices which will determine rating factor and weighting factor for each factor necessary and related to determination of location of each type of activities. It is mathematic method averaging importance for use in calculating mean of areas for the crossing part of map scope or combination of map unit to reduce redundancy of data. According to criteria, much importance creates high values. Little importance creates low values. The equation is as follows; [11]

$$S = (R_1 \times W_1) + (R_2 \times W_2) + (R_3 \times W_3) + \ldots + (R_n \times W_n)$$

S = Potential surface

W = Scores of weighting factor

R = Scores of rating factor

After that the researcher showed values of factors on the map and could apply potential surface analysis with Sieve Mapping which is to translate data of potential surface into digital data from PSA to graphic. Pictures on the map have color difference values, causing people to clearly know potential of each surface and able to correctly calculate results of analyzing data in each subject according to the specified objectives.

CHAPTER III
MATERIALS AND METHODS

3.1 Material

In this study, computer hardware and software are used for data collection and analyses. The details are as the following:

3.1.1 Software

3.1.1.1 Operating System

- Microsoft Windows XP Professional Version 2002

3.1.1.2 Geographic Information System

- ArcGIS v9.3

3.1.1.3 Database Management System Application

- Microsoft Excel

3.1.1.4 Statistical Analysis System

- SPSS v16

3.1.2 Hardware

3.1.2.1 Asus A8E series (Notebook)

- Intel(R) Core i5-4 60M, 2.53 GHz
- 4.0 GB memory
- 320 GB hard drive

3.1.2.2 Printer

- HP Deskjet 2050 All-in-One Printer

3.2 Methodology

The researcher applied geographical information system with potential surface analysis and overlay analysis to analyze and evaluate potential surface suitable for cultivation of para rubber and oil palm in Phang-nga province.

3.2.1 Determination of factors

The researcher determined basic factors affecting cultivation of para rubber and oil palm by referring to research documents of Land Development Department and private and state agencies researches on cultivation of para rubber and oil palm, that affect the cultivation reviews of various studied [12], [13], [14], [15], [16] and [17] showed that there are seven factors

Para rubber: Slope[17], Soil Depth[15], [17], Soil Texture[16], Soil Drainage[16], Land use[17], Annual Rainfall (mm.)[15], [17] and Temperature (°c)[15], [17]

Oil palm: Slope[13], [17], Soil Depth[13], [17], Soil Texture[12], [14], Soil Drainage[12], [14], Land use[13], [17], Annual Rainfall(mm.)[15], [17] and Temperature(°c)[17].

3.2.2 Data collection and preparation

The researcher collected data on basic factors affecting cultivation of para rubber and oil palm in Phang-nga province, both on spatial data and non-spatial data of report, research document, and map of various related agencies. Data model and data were corrected for analysis with geographical information system. Data on basic factors affecting growth of teak wood were collected with details as follows;

1) Collection of data from soil map for 2004 with scales 1:100,000 and 1:50,000 from Department of Environmental Quality Promotion
2) Data on annual average rainfall and temperature were derived from collection of data on average rainwater and temperature in the past 10 years during 2000-2010 from Meteorological Department.
3) Data on slope with scale of 1:50,000 from Department of Environmental Quality Promotion

4) Map of using land in 2007 with scale of 1:50,000 derived from Department of Land Development

3.2.3 Determination of values of rating and weighting factors

The researcher determined values of weighting factors and rating factors for use in evaluating potential surface suitable for cultivation of para rubber and oil palm by referring criteria of determining values of weighting factor and rating factor of research document or asking opinion of experts.

Table 3-1. Weighting and rating scale each of factor for evaluate suitable cultivation of para rubber and oil palm

Factor	Para rubber			Oil palm		
	W	Scale	R	W	Scale	R
Slope	4	1.1) 0-12 1.2) 12-20 1.3) 20-30 1.4) >30	3 2 1 0	4	1.1) 0-5 1.2) 6-12 1.3) 13-20 1.4) >21	3 2 1 0
Soil Depth (cm.)	3	2.1) >150 2.2) 100-150 2.3) 50-100 2.4) <50	3 2 1 0	3	2.1) >150 2.2) 100-150 2.3) 50-100 2.4) <50	3 2 1 0
Soil Texture	5	3.1) Loam to Clay 3.2) Sandy Loams 3.3) Sandy Loams to Sand 3.4) Other	3 2 1 0	5	3.1) Loam to Clay 3.2) Sandy Loams 3.3) Sandy Loams to Sand 3.4) Other	3 2 1 0
Soil Drainage	2	4.1) Rather Fast, Rather slow 4.2) Fast, Slow 4.3) Very fast , Very slow 4.4) Other	3 2 1 0	2	4.1) Rather Fast, Rather slow 4.2) Fast, Slow 4.3) Very fast , Very slow 4.4) Other	3 2 1 0
Land use		5.1) Agricultural land 5.2) Miscellaneous land 5.3) Forest land 5.4) Urband & Built-up land,Water	yes yes no no		5.1) Agricultural land 5.2) Miscellaneous land 5.3) Forest land 5.4) Urband & Built-up land,Water	yes yes no no
Ann. Rainfall (mm.)	6	6.1) 1500-2500 6.2) 2500-3500,1200-1500 6.3) 3500-4000, 1100-1200 6.4) >4000, <1100	3 2 1 0	6	6.1) 2000-3000 6.2) 3000-4000, 1800-2000 6.3) 4000-5000, 1500-1800 6.4) >5000, <1500	3 2 1 0
Temperature (°C)	1	7.1) 26-28 7.2) 28-34, 25-23 7.3) 20-22 7.4) >34, <20	3 2 1 0	1	7.1) 24-28 7.2) 28-32, 23-22 7.3) 33-34, 21-20 7.4) >34, <20	3 2 1 0

Source: From the study (12, 13, 14, 15, 16 and 17)

W=Weighting Score, R=Rating Score

Remark: Scoring rating factor to evaluate factors suitable for cultivation of rubber and oil palm

Very suitable	Value of rating factors	4
Moderately suitable	Value of rating factors	3
Rather little suitable	Value of rating factors	2
Little suitable	Value of rating factors	1

3.2.3.1 Factors used for study

The factors used in this study are consisted of 7 factors Slope, Depth, Texture, Drainage, Land use, Annual Rainfall and Temperature.

1) Slope

Regarding to potential are for para rubber and oil palm, , the range of slope and terrain has been classified into 4 levels; slightly flat to slightly undulating with slope of 0-10%, undulating with slope of 10-20%, rolling to hilly with slope of 20-30%, and steep slope higher than 30%.[13], [17]

2) Depth

Regarding to potential area for para rubber and oil palm, the rage of soil depth information has been classified into 4 levels; higher 150 centimeter, 100 to 150 centimeter, 50 to 100 centimeter and less than 50 centimeter or no data. [15], [13], [17]

3) Soil texture

Regarding to potential area for para rubber and oil palm, the rage of soil texture has been classified into 4 levels; loam to clay, sandy loams, sandy loams to sand and other. [12], [14], [16]

4) Drainage

Regarding to potential area for para rubber and oil palm, the rage of soil drainage has been classified into 4 levels; rather fast and rather slow, fast and slow, very fast and very slow and other. [12], [14], [16]

5) Land use

Land use in the study area has been classified into; agricultural area, miscellaneous, forest area and urban area. [13], [17]

6) Annual Rainfall

6.1) Para rubber

Regarding to potential area for para rubber, the rage of rainfall has been classified into 4 levels; higher 4,000 and less than 1,100 millimeter per year, 3,500 to 4,000 millimeter per year and 1,100 to 1,200 millimeter, 2,500 to 3,500 millimeter per year and 1,200 to 1,500 millimeter per year, 1,500 to 2,500 millimeter per year. [15], [17]

6.2) Oil palm

Regarding to potential area for oil palm, the rage of rainfall has been classified into 4 levels; higher 5,000 and less than 1,500 millimeter per year, 4,000 to 5,000 millimeter per year and 1,500 to 1,800 millimeter, Annual Rainfall 3,000 to 4,000 millimeters per year and 1,800 to 1,200 millimeter per year, 2,000 to 3,000 millimeter per year. [15], [17]

7) Temperature

7.1) Para rubber

Regarding to potential area for para rubber and oil palm, the rage of temperature has been classified into 4 levels; 26 to28°C, 28 to 34°C and 25 to 23°C, 20 to 22°C, higher 34°C and less than 20°C. [15], [17]

7.2) Oil palm

Regarding to potential area for para rubber and oil palm, the rage of temperature has been classified into 4 levels; 26 to28°C, 28 to 34°C and 25 to 23°C, 20 to 22°C, higher 34°C and less than 20°C.). [17]

3.2.4 Analysis and evaluation of potential surface suitable for cultivation of para rubber and oil palm

The researcher analyzed and evaluated potential surface suitable for cultivation of para rubber and oil palm oil in Phang-nga province by jointly applying geographical information system, potential surface analysis, overlay analysis with data on basic factors collected according to equation.

$$S = (R_1 \times W_1) + (R_2 \times W_2) + (R_3 \times W_3) + (R_4 \times W_4) + (R_5 \times W_5) + (R_6 \times W_6)$$

S = Potential surface
R_1 = Rating scores of slope
W_1 = Weighting scores of slope
R_2 = Rating scores of soil surface depth
W_2 = Weighting scores of soil surface depth
R_3 = Rating scores of texture
W_3 = Weighting scores of texture
R_4 = Rating scores of drainage
W_4 = Weighting scores of drainage
R_5 = Rating scores of annual average rainfall
W_5 = Weighting scores of annual average rainfall
R_6 = Rating scores of annual average temperature
W_6 = Weighting scores of annual average temperature

3.2.5 Classification of suitability for cultivation of para rubber and oil palm

Data on outcomes derived from evaluation of potential surface suitable for cultivation of para rubber and oil palm in Phang-nga province were statistically classified into four levels: Very suitable, Moderately suitable, Little suitable, and Unsuitable. The researcher mainly used mean ($\bar{x}$) of data and used data distribution value (SD) to determine width of each level.

Chart showing steps of evaluating suitability for cultivation of para rubber and oil palm by applying geographical information system.

Determination of factors

- Determining basic factors affecting cultivation of para rubber and oil palm by referring research document of state and private agencies.

↓

Data collection and preparation

- Collecting data on basic factors affecting cultivation of para rubber and oil palm in Phang-nga province from report, research document, and maps of various related private and state agencies and corrected data and data model for analysis with geographical information system.

↓

Determination of values of rating factors and weighting factors

- Determining values of weighting factors and rating factors for use in evaluating potential surface suitable for cultivation of para rubber and oil palm by referring criteria of determining values of weighting and rating factors of research document or asking opinion of experts.

↓

Analysis and evaluation of surface suitable for cultivation of para rubber and oil palm

- Analyzing and evaluating potential surface suitable for cultivation of para rubber and oil palm in Phang-nga province and by jointly applying geographical information system with potential surface analysis, overlay analysis, and data on basic factors collected according to the equation. If rating score is zero will not analysis that area.

$$S = (R_1 \times W_1) + (R_2 \times W_2) + \ldots + (R_n \times W_n)$$

↓

Classification of suitability suitable for cultivation of para rubber and oil palm

- Classifying suitability suitable for cultivation of para rubber and oil palm by mainly using mean ($\bar{x}$) of data and using data distribution value (SD) to determine width of each level.

↓

Clip suitability area with landuse area (Miscellaneous and Agriculture area)

CHAPTER V
RESULTS AND DISCUSSIONS

The analysis on suitable area for para rubber and oil palm in Phang-nga province was conducted through the GIS application together with influenced on environmental factors towards selection of suitable area. The evaluation on land suitable area was also applied. The study of 6 factors effect on considering of suitable in Phang-nga province will be as following procedures:

4.1 Suitability area for para rubber and oil palm

4.1.1 Factors used for study

The factors used in this study are consisted of 6 factors Slope, Depth, Texture, Drainage, Annual Rainfall and Temperature.

1) Slope

1.1) Para rubber

The results of the study indicated that the major terrains in Phang-nga province is flat area the slope 0-12% covered the area of 4893.627885 square kilometers or 77.54964% of the areas. Slope 12-20% covered the area of 259.7091193 square kilometers or 4.115627%, Slope 20-30% covered the area of 262.1876887 square kilometers or 4.154905% of the areas. Slope more than 30% covered the area of 894.7921613 square kilometers or 14.17983% of the areas.

Table 4-1. Slope for para rubber information

Slope	Area	
	Sq.Km	**Percentage**
R(3) 0-12%	4893.627885	77.54964
R(2) 12-20%	259.7091193	4.115627
R(1) 20-30%	262.1876887	4.154905
R(0) >30%	894.7921613	14.17983
Total	**6310.316854**	**100**

1.2) Oil palm

The results of the study indicated that the major terrains in Phang-nga province is flat area the slope 0-5% covered the area of 4352.694002 square kilometers or 68.97742% of the areas. Slope 6-12% covered the area of 540.9338836 square kilometers or 8.572214% of the areas. Slope 13-20% covered the area of 259.7091193 square kilometers or 4.115627% of the areas. Slope less than >21% covered the area of 1156.97985 square kilometers or 18.33473% of the areas.

Table 4-2. Slope for oil palm information

Slope	Area	
	Sq.Km	**Percentage**
R(3) 0-5%	4352.694002	68.97742
R(2) 6-12%	540.9338836	8.572214
R(1) 13-20%	259.7091193	4.115627
R(0) >21%	1156.97985	18.33473
Total	**6310.316854**	**100**

2) Soil depth

The results of the study indicated that the majority of soil depth information in Phang-nga province is less than 50 centimeter covered the areas of 2712.523594 square kilometers or estimated 69.26234% of the total areas. Soil depth more than 150 centimeter covered the areas of 107.1612202 square kilometers or estimated 2.736285% of the total areas. Soil depth 100-150 centimeter covered the areas of 1075.970561 square kilometers or estimated 27.47413% of the total areas. Soil depth 50-100 centimeter covered the areas of 20.64836028 square kilometers or estimated 0.527241% of the total areas.

Table 4-3. Soil depth information

Soil depth	Area	
	Sq.Km	**Percentage**
R(3) >150 cm.	107.1612202	2.736285
R(2) 100-150 cm.	1075.970561	27.47413
R(1) 50-100 cm.	20.64836028	0.527241
R(0) <50 cm.	2712.523594	69.26234
Total	**3916.303736**	**100**

3) Soil texture

The results of the study indicated that the majority of soil texture in Phang-nga province is other covered the areas 3238.984115 square kilometers or estimated 82.70513% of the total areas. Soil texture is loam to clay covered the areas of 386.9232205 square kilometers or estimated 9.879806% of the total areas. Soil texture is sandy loams covered the areas of 189.6906856 square kilometers or estimated 4.843615% of the total areas. Soil texture is sandy loams to sand covered the areas of 100.7057157 square kilometers or estimated 2.571448% of the total areas.

Table 4-4. Soil texture information

Soil texture	Area	
	Sq.Km	**Percentage**
R(3) Loam to Clay	386.9232205	9.879806
R(2) Sandy Loams	189.6906856	4.843615
R(1) Sandy Loams to Sand	100.7057157	2.571448
R(0) Other	3238.984115	82.70513
Total	**3916.303736**	**100**

4) Soil drainage

The results of the study indicated that the soil drainage in Phang-nga province is other drainage covered the areas of 2712.523594 square kilometers or estimated 69.26234% of the total areas. Soil rather fast and rather slow drainage covered the areas of 589.5279905 square kilometers or estimated 15.05317% of the total areas. Soil fast and slow drainage covered areas of 525.9185465 square kilometers or estimated 13.42895% of the total areas. Soil very fast and very slow

drainage covered the areas of 88.33360479 square kilometers or estimated 2.255535% of the total areas.

Table 4-5. Soil drainage information

Soil drainage	Area	
	Sq.Km	**Percentage**
R(3) Rather Fast, Rather slow	589.5279905	15.05317
R(2) Fast, Slow	525.9185465	13.42895
R(1) Very fast, Very slow	88.33360479	2.255535
R(0) Other	2712.523594	69.26234
Total	**3916.303736**	**100**

5) Land use

The results of the study indicated that the major land use in Phang-nga province was Forest covered the areas of 1993.440068 square kilometers or estimated 50.92083% of the total areas, Agriculture covered the areas of 1528.037354 square kilometers or estimated 39.03249% of the total areas, Miscellaneous covered the areas of 195.7252341 square kilometers or estimated 4.999644% the total areas, Urban covered the areas of 197.5808246 square kilometers or estimated 5.047043% of the total areas.

Almost of Forest and Urban in Phang-nga province cannot cultivate. Components of Forest; Disturbed evergreen forest, Dense Evergreen forest, Disturbed mangrove forest, Dense mangrove forest and Dense forest Plantation. Components of Urban; City, Town, Commercial, Village, Village/Mixed orchard, Institutional land, Harbour, Road, Factory, Recreation area and Golf course.

This research crop area specific of Agriculture and Miscellaneous in Phang-nga province only for analysis suitable area on all factor; follow in Table 4-6. Land use information.

Table 4-6. Land use information

Land use	Area	
	Sq.Km	**Percentage**
Agriculture	1528.037354	88.64546455
Miscellaneous	195.7252341	11.35453545
Forest	-	-
Urban , Water	-	-
Total	**1723.762588**	**100**

6) Annual rainfall

6.1) Para rubber

The results of the study indicated that the majority of annual rainfall in Phang-nga province is from 2,500 to 3,500 millimeter per year and 1,200 to 1,500 millimeter per year covered the areas of 3157.69595 square kilometers or estimated 80.74156% of the total areas. Annual rainfall 1,500 to 2,500 millimeter per year covered the areas of 394.1425879 square kilometers or estimated 10.07814% of the total areas. Annual rainfall 3,500 to 4,000 millimeter per year and 1,100 to 1,200 millimeter per year covered the areas of 359.0294205 square kilometers or estimated 9.1803% of the total areas.

Table 4-7. Annual rainfall for para rubber information

Annual Rainfall (mm./year)	Area	
	Sq.Km	**Percentage**
R(3) 1500-2500 mm.	394.1425879	10.07814
R(2) 2500-3500, 1200-1500 mm.	3157.69595	80.74156
R(1) 3500-4000, 1100-1200 mm.	359.0294205	9.1803
R(0) >4000, <1100 mm.	-	-
Total	**3910.867959**	**100**

6.2) Oil palm

The results of the study indicated that the majority of annual rainfall in Phang-nga province is from 2000-3000 millimeter per year covered the areas of 2153.177193 square kilometers or estimated 55.05576% of the total areas. Annual rainfall 3,000 to 4,000 millimeter per year and 1,800 to 2,000 millimeter per

year covered the areas of 1757.725169 square kilometers or estimated 44.94424% of the total areas.

Table 4-8. Annual rainfall for oil palm information

Annual Rainfall (mm./year)	Area	
	Sq.Km	**Percentage**
R(3) 2000-3000 mm.	2153.177193	55.05576
R(2) 3000-4000, 1800-2000 mm.	1757.725169	44.94424
R(1) 4000-5000, 1500-1800 mm.	-	-
R(0) >5000, <1500	-	-
Total	**3910.902361**	**100**

7) Temperature

7.1) Para rubber

The results of the study indicated that the majority of temperature in Phang-nga province is from 26 to 28°C covered the area of 3887.820772 square kilometers or estimated 99.41024% of the total areas. The minority of temperature in Phang-nga province is from 28 to 34°C and 25 to 23°C covered the area of 23.06491833 square kilometers or estimated 0.589762% of the total areas.

Table 4-9. Temperature for para rubber information

Temperature	Area	
	Sq.Km	**Percentage**
R(3) 26-28	3887.820772	99.41024
R(2) 28-34, 25-23	23.06491833	0.589762
R(1) 20-22	-	-
R(0) >34, <20	-	-
Total	**3910.88569**	**100**

7.2) Oil palm

The results of the study indicated that the majority of temperature in Phang-nga province is from 24 to 28°C covered the area of 3887.820772 square kilometers or estimated 99.41024% of the total areas. The minority of temperature in Phang-nga province is from 28 to 32°C and 23 to 22°C

covered the area of 23.06491833 square kilometers or estimated 0.589762% of the total areas.

Table 4-10. Temperature for oil palm information

Temperature	Area	
	Sq.Km	**Percentage**
R(3) 24-28	3887.820772	99.41024
R(2) 28-32, 23-22	23.06491833	0.589762
R(1) 33-34, 21-20	-	-
R(0) >34, <20	-	-
Total	**3910.88569**	**100**

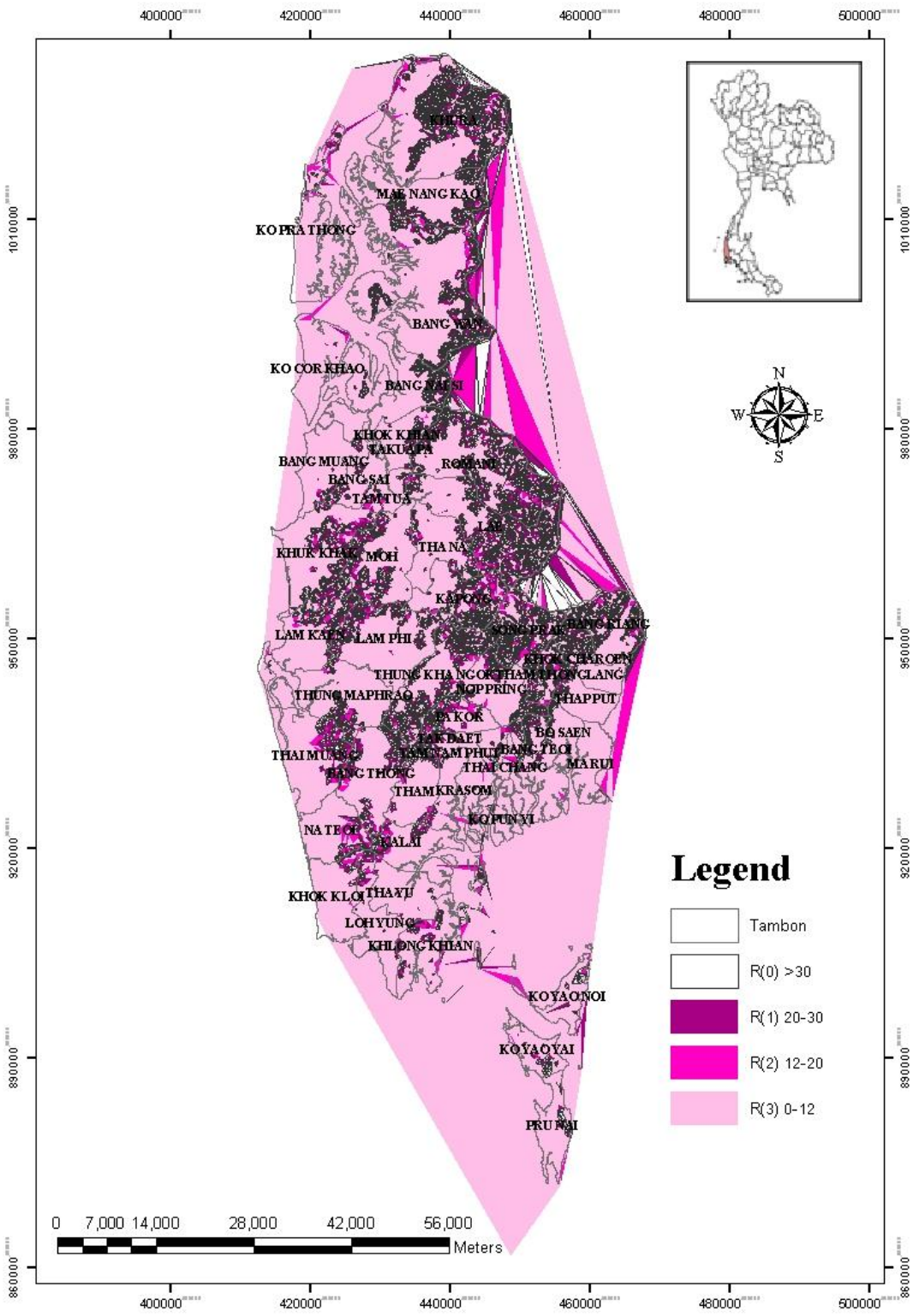

Figure 4-1. Slope for para rubber map of Phang-nga

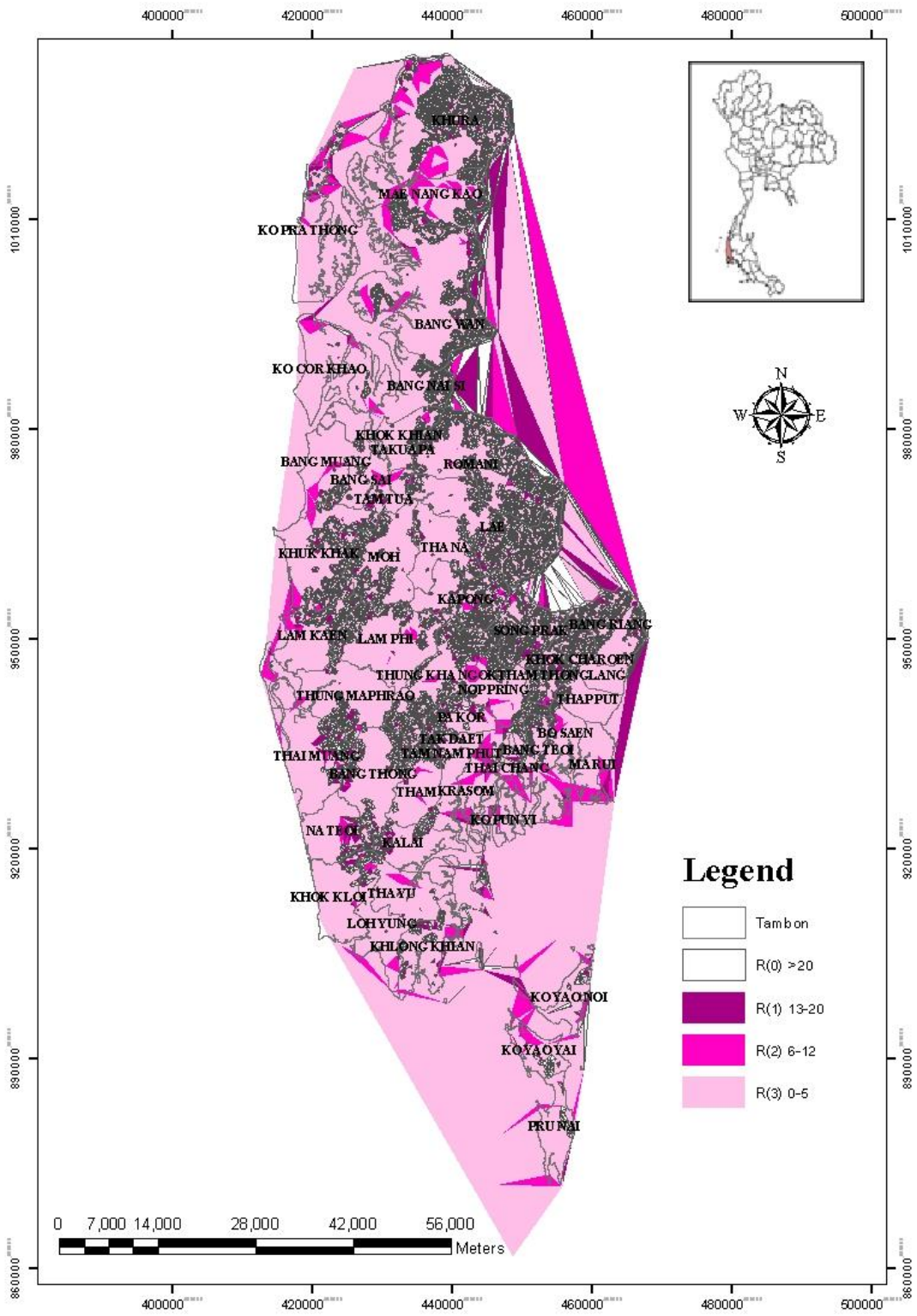

Figure 4-2. Slope for oil palm map of Phang-nga

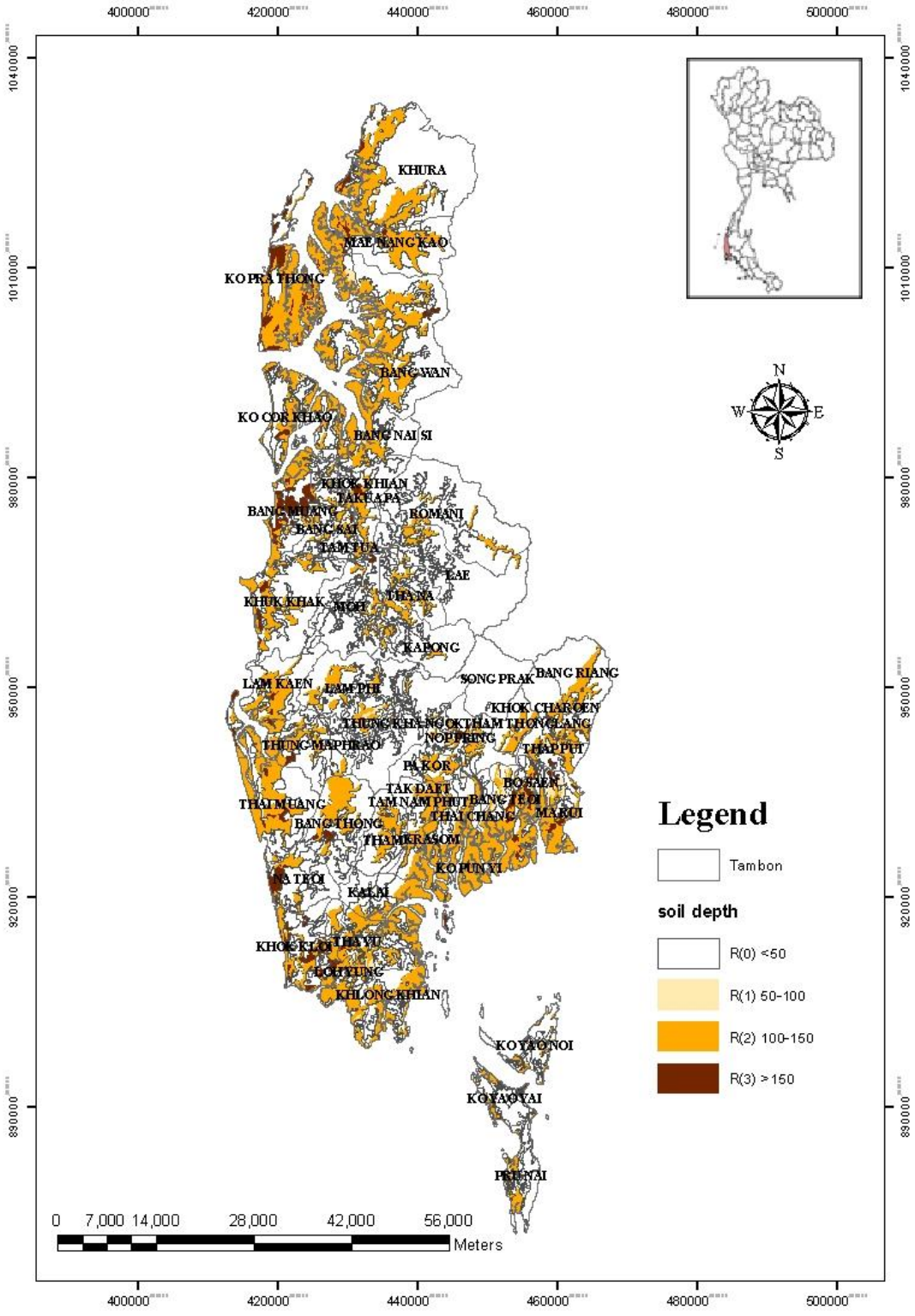

Figure 4-3. Soil Depth map of Phang-nga

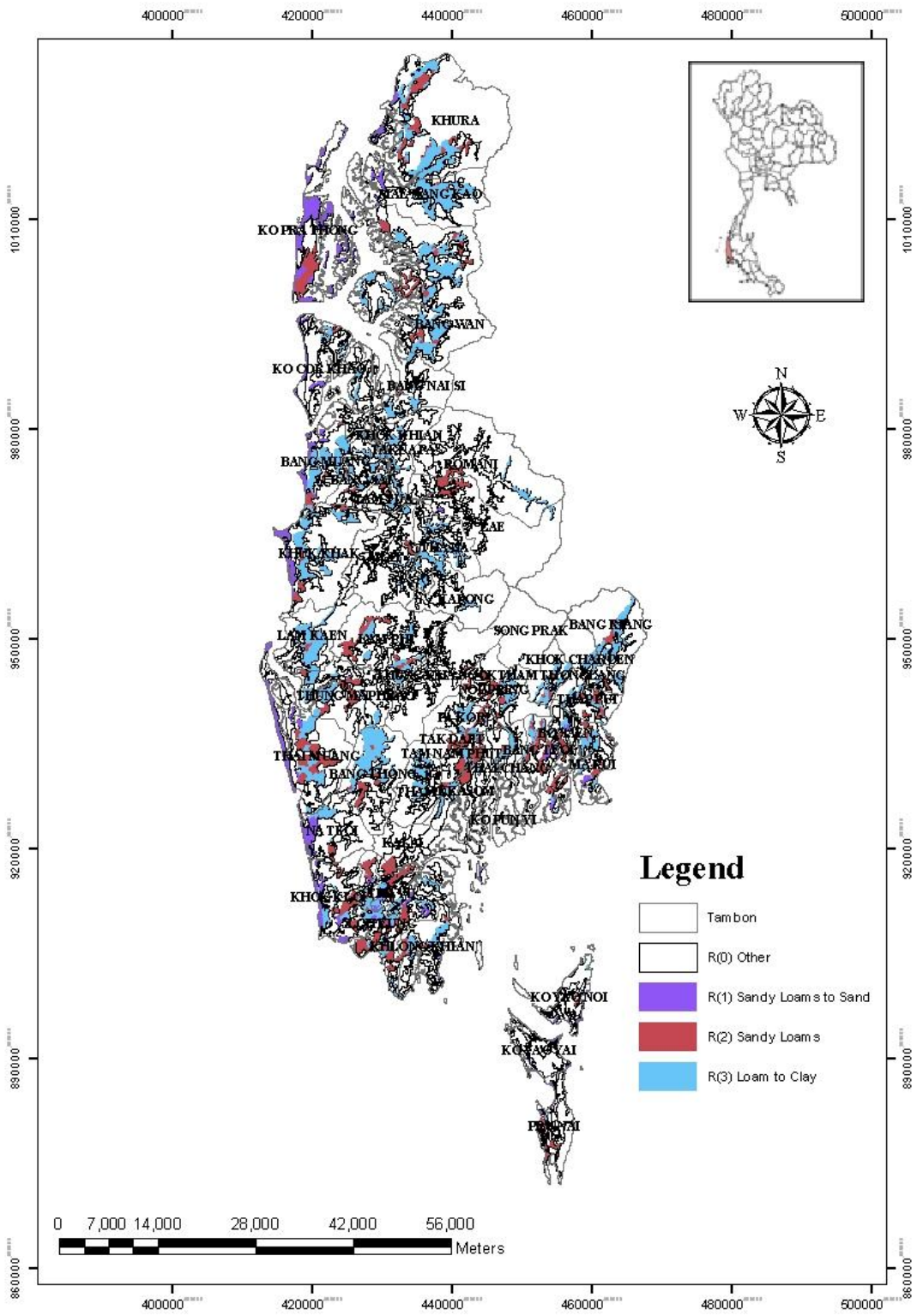

Figure 4-4. Soil Texture map of Phang-nga

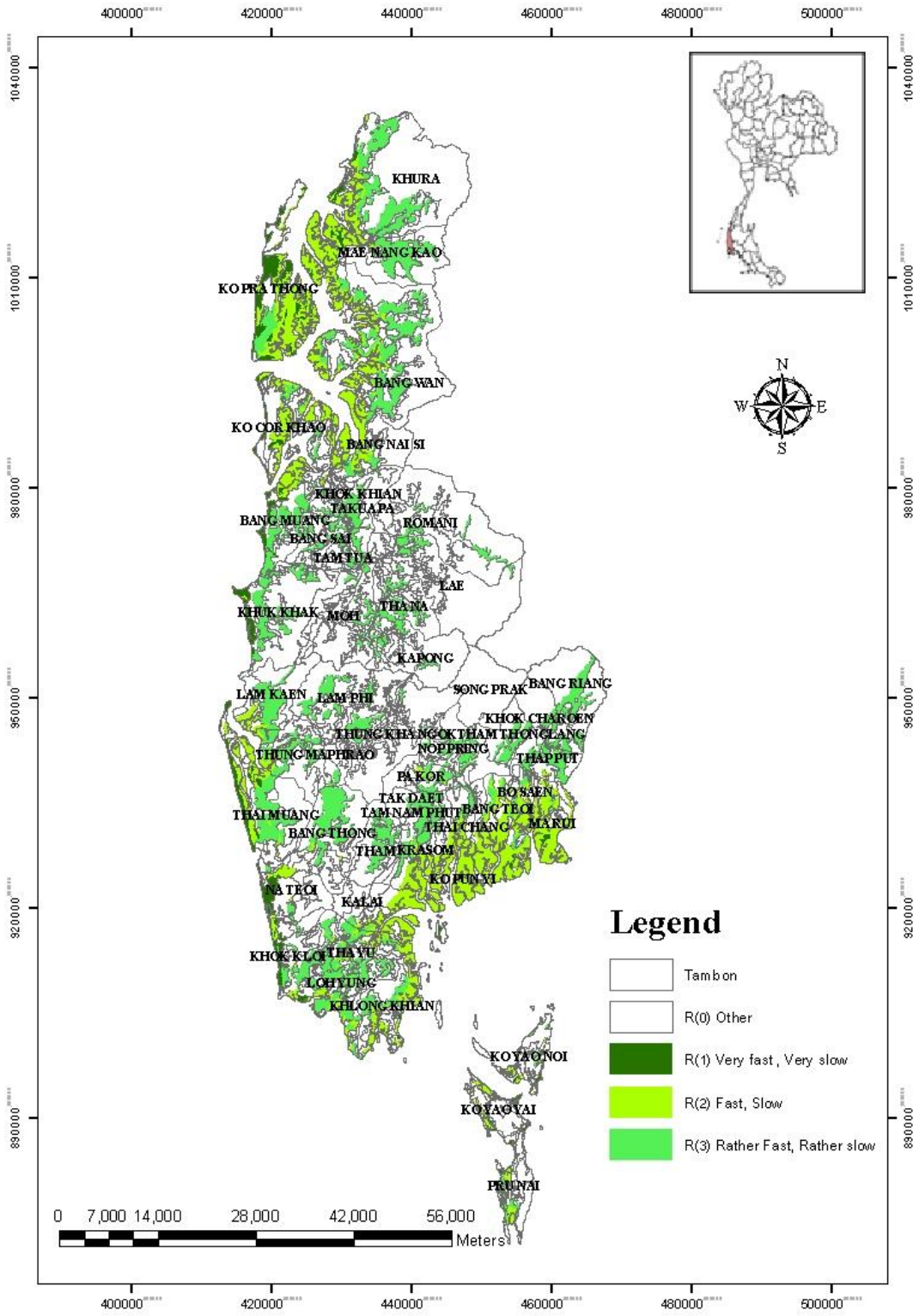

Figure 4-5. Drainage map of Phang-nga

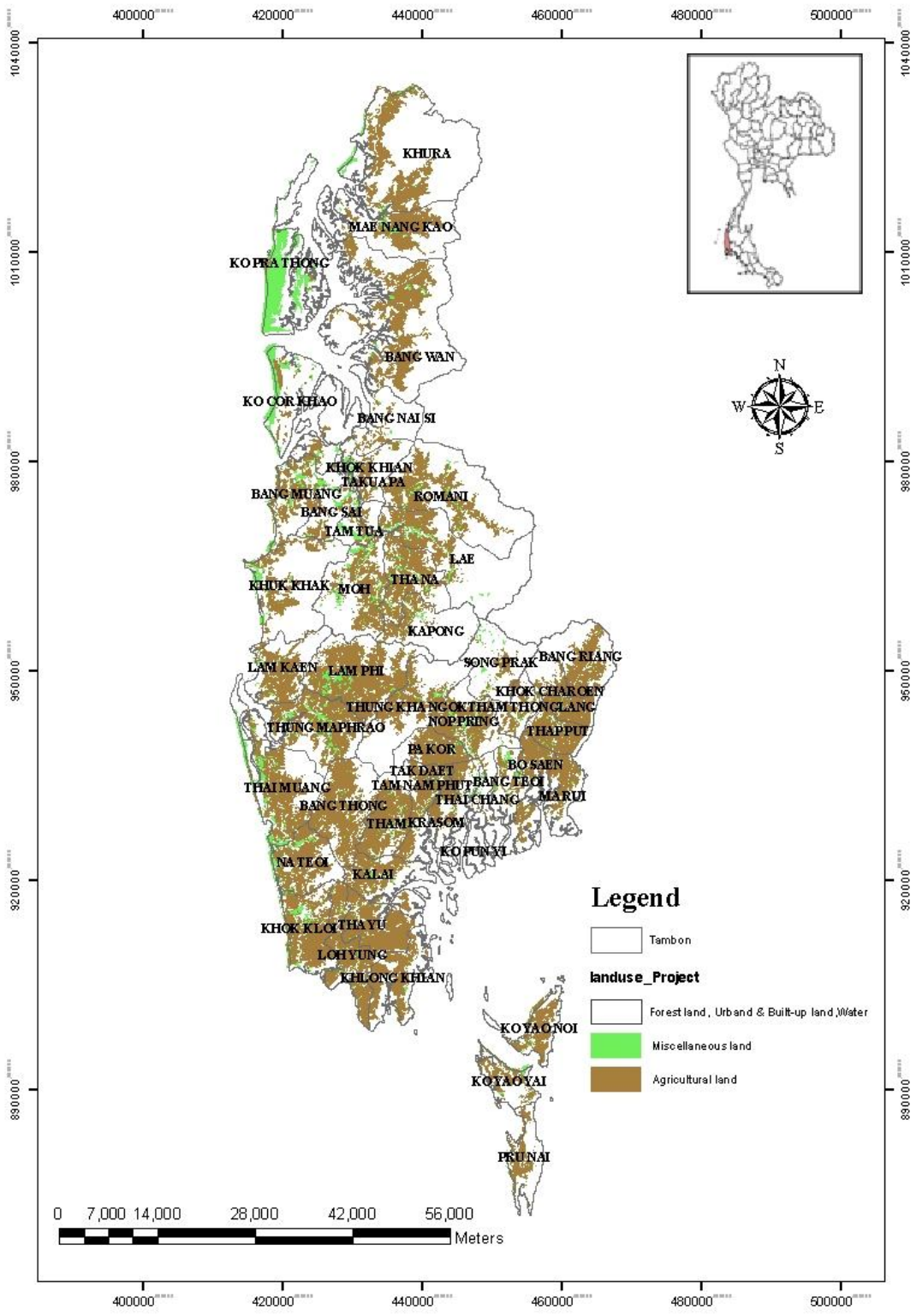

Figure 4-6. Land use map of Phang-nga

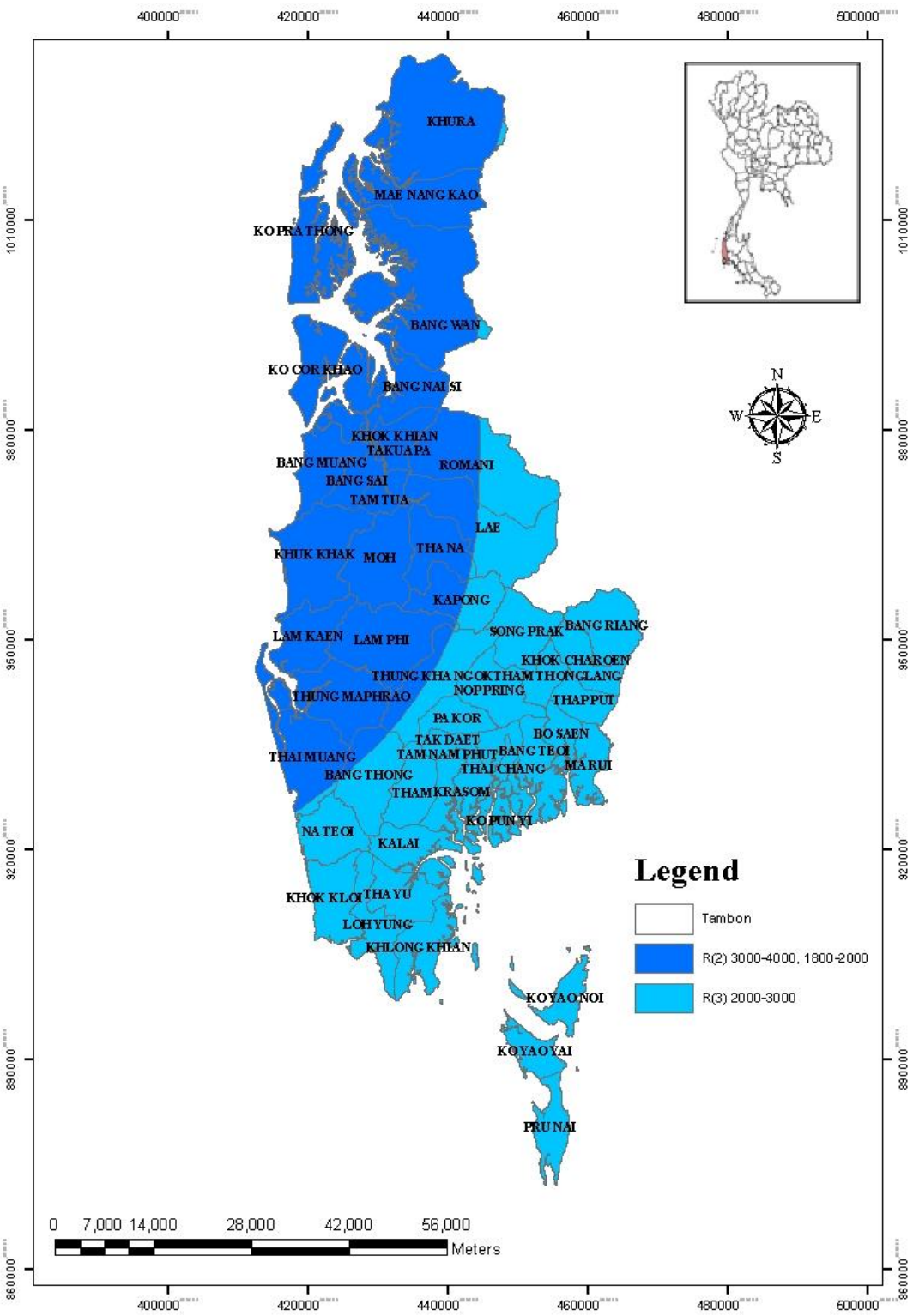

Figure 4-7. Rainfall map for oil palm

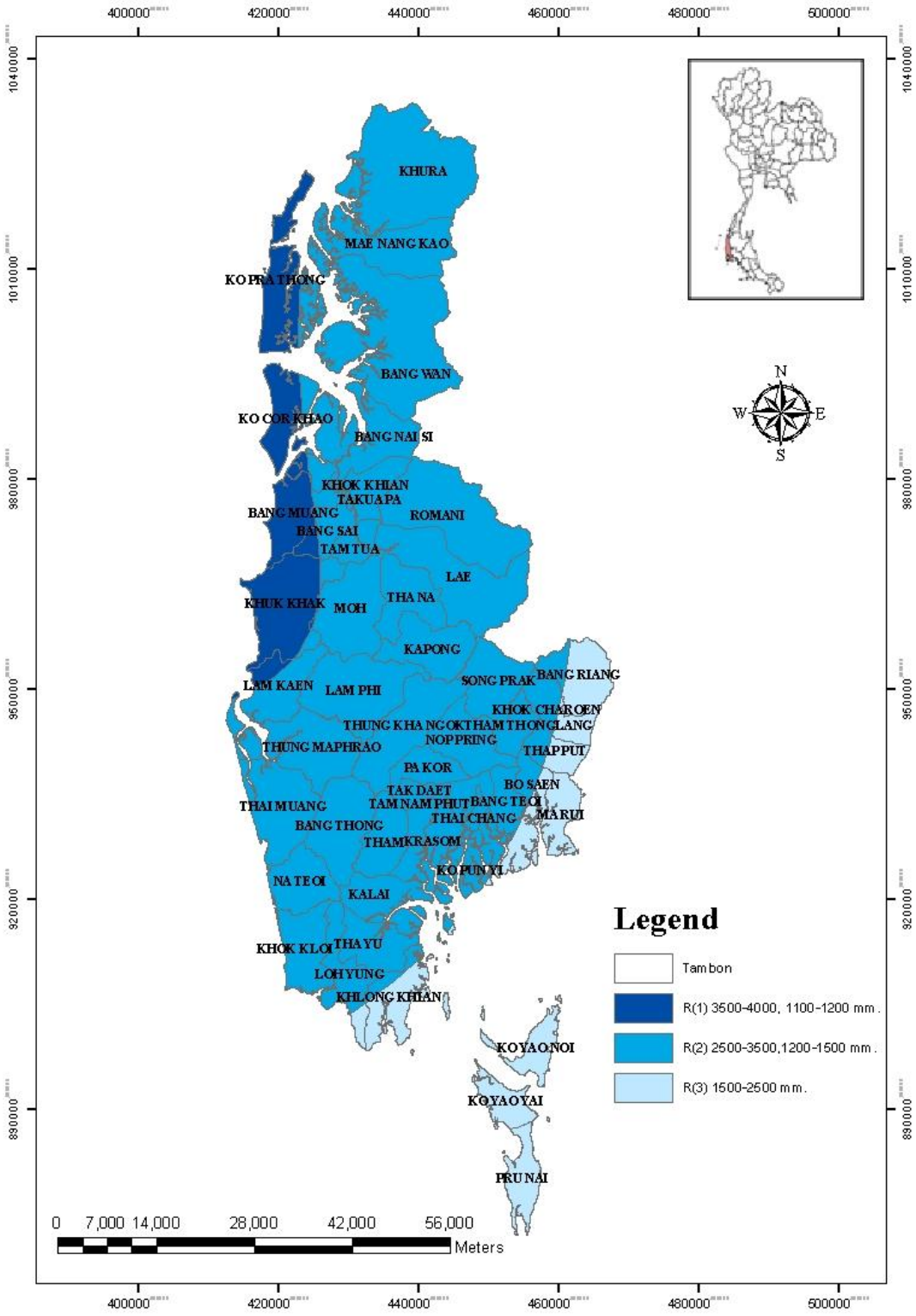

Figure 4-8. Rainfall map for para rubber

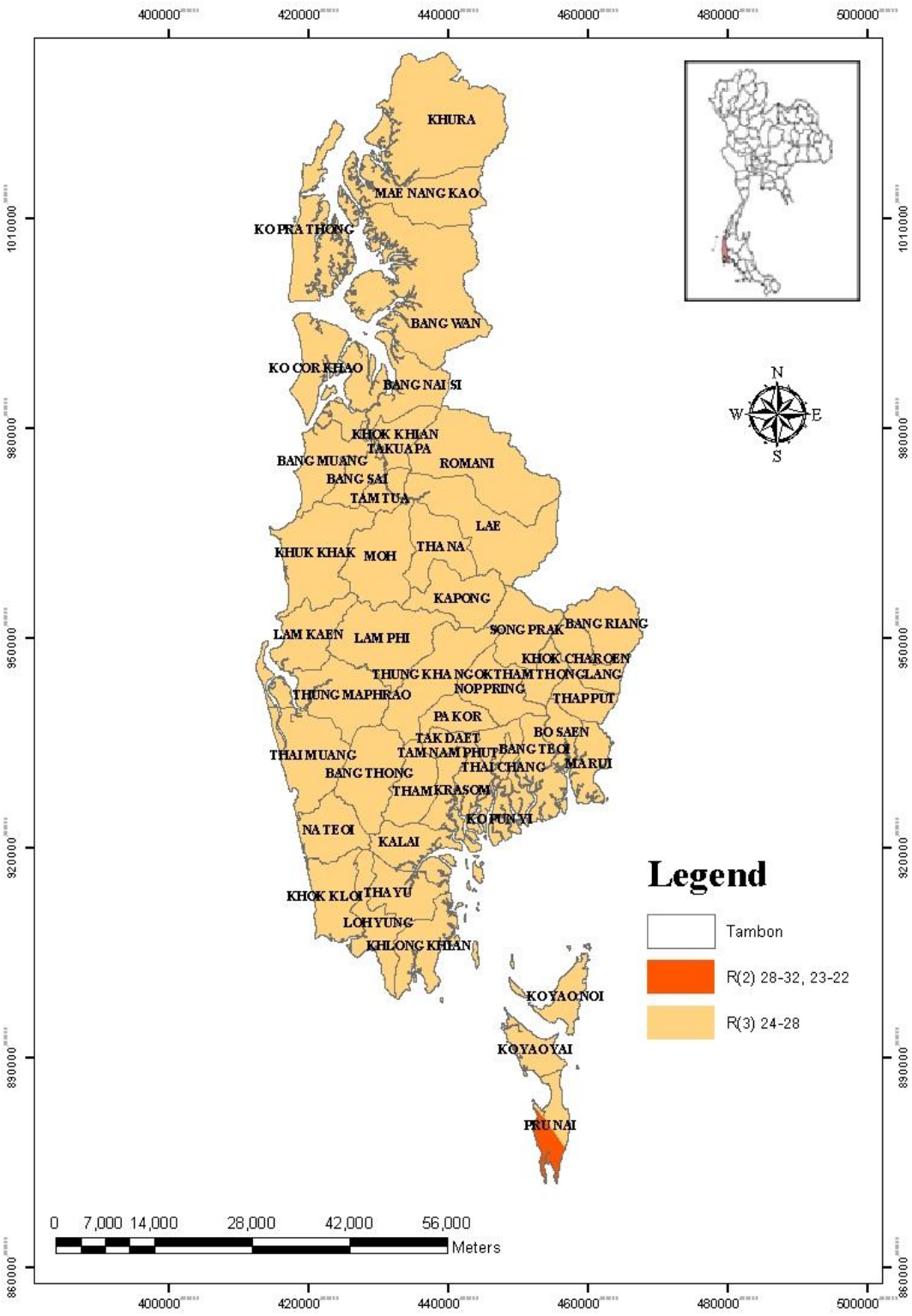

Figure 4-9. Temperature map for oil palm

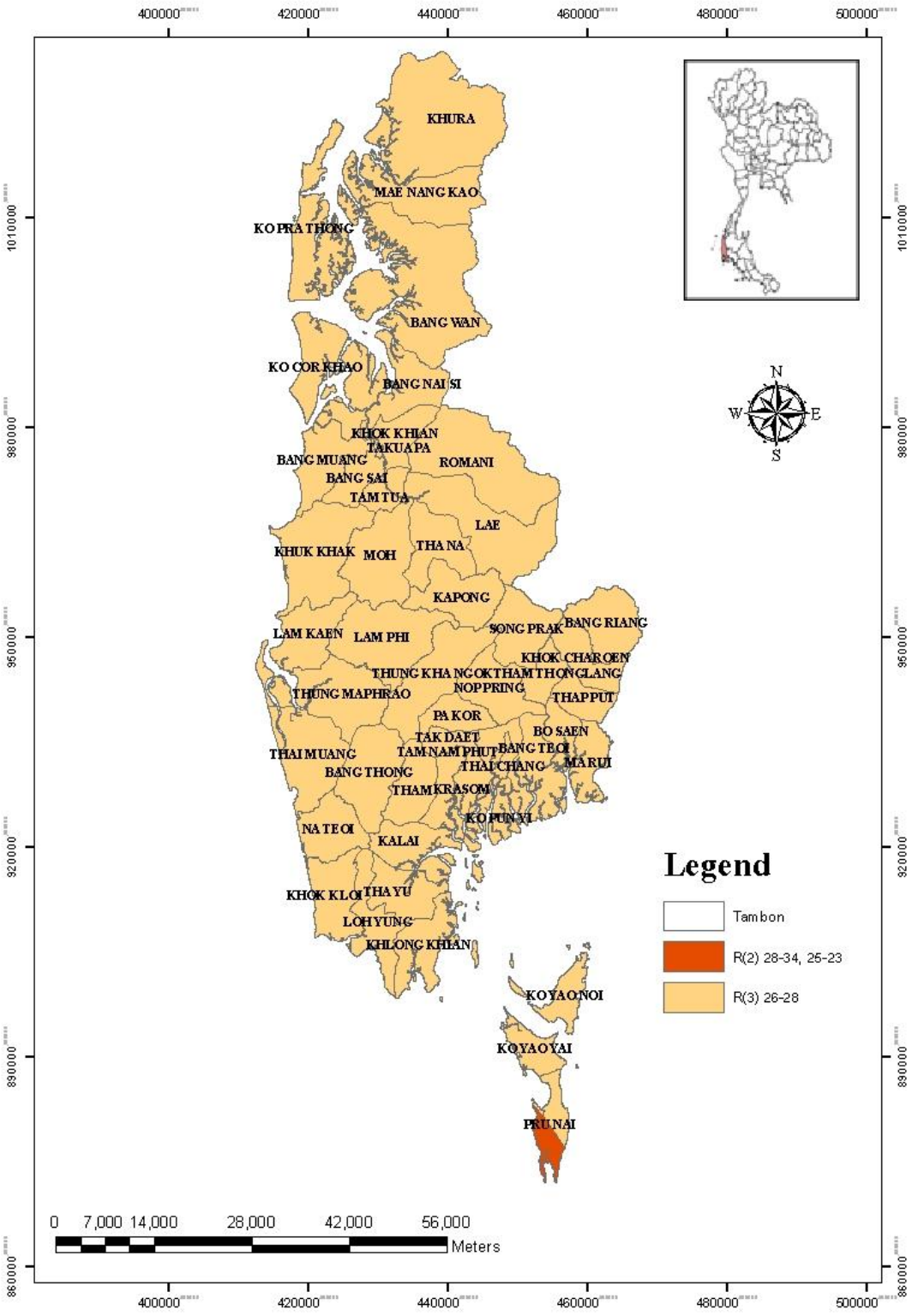

Figure 4-10. Temperature map for para rubber

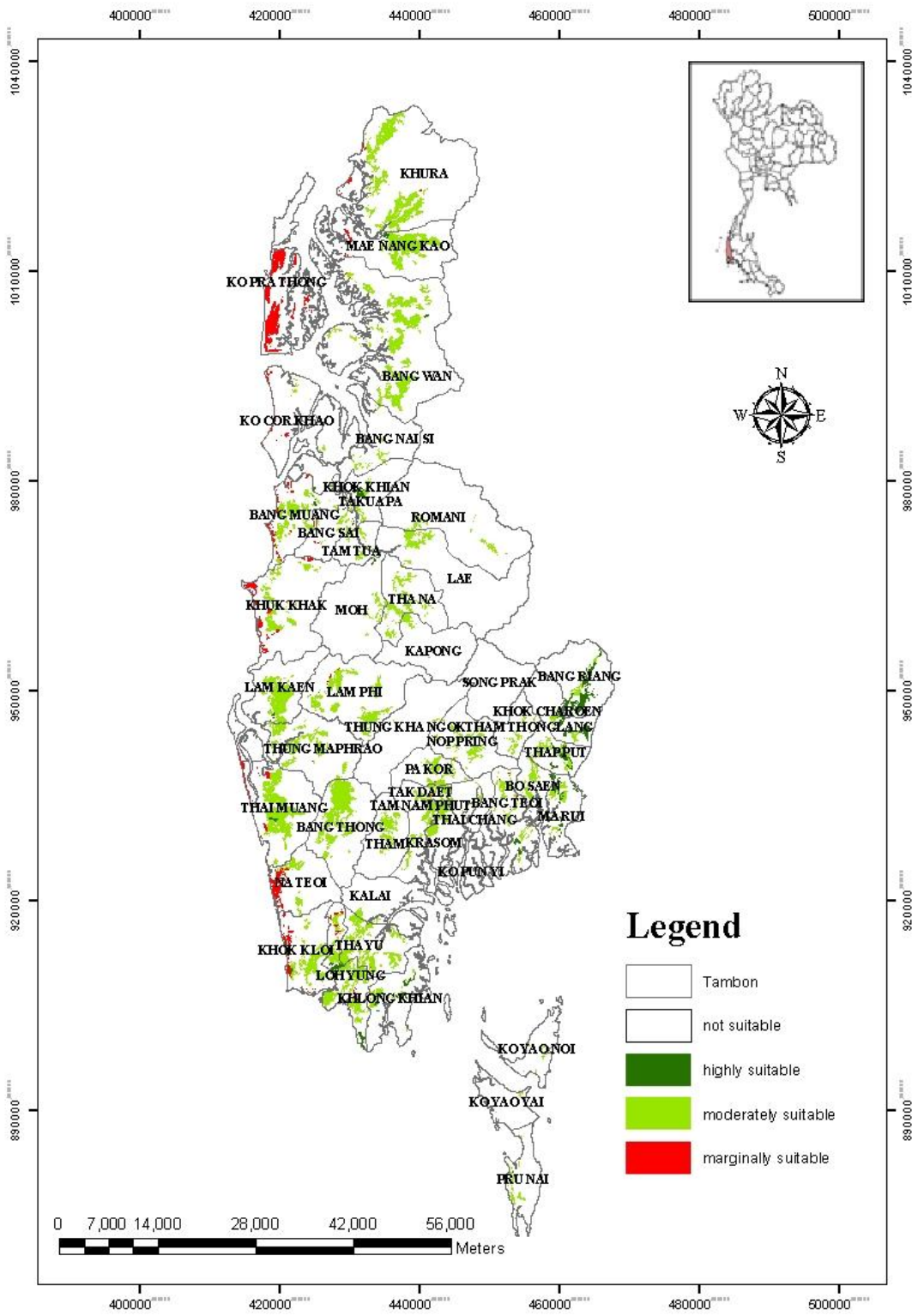

Figure 4-11. Para rubber suitability area

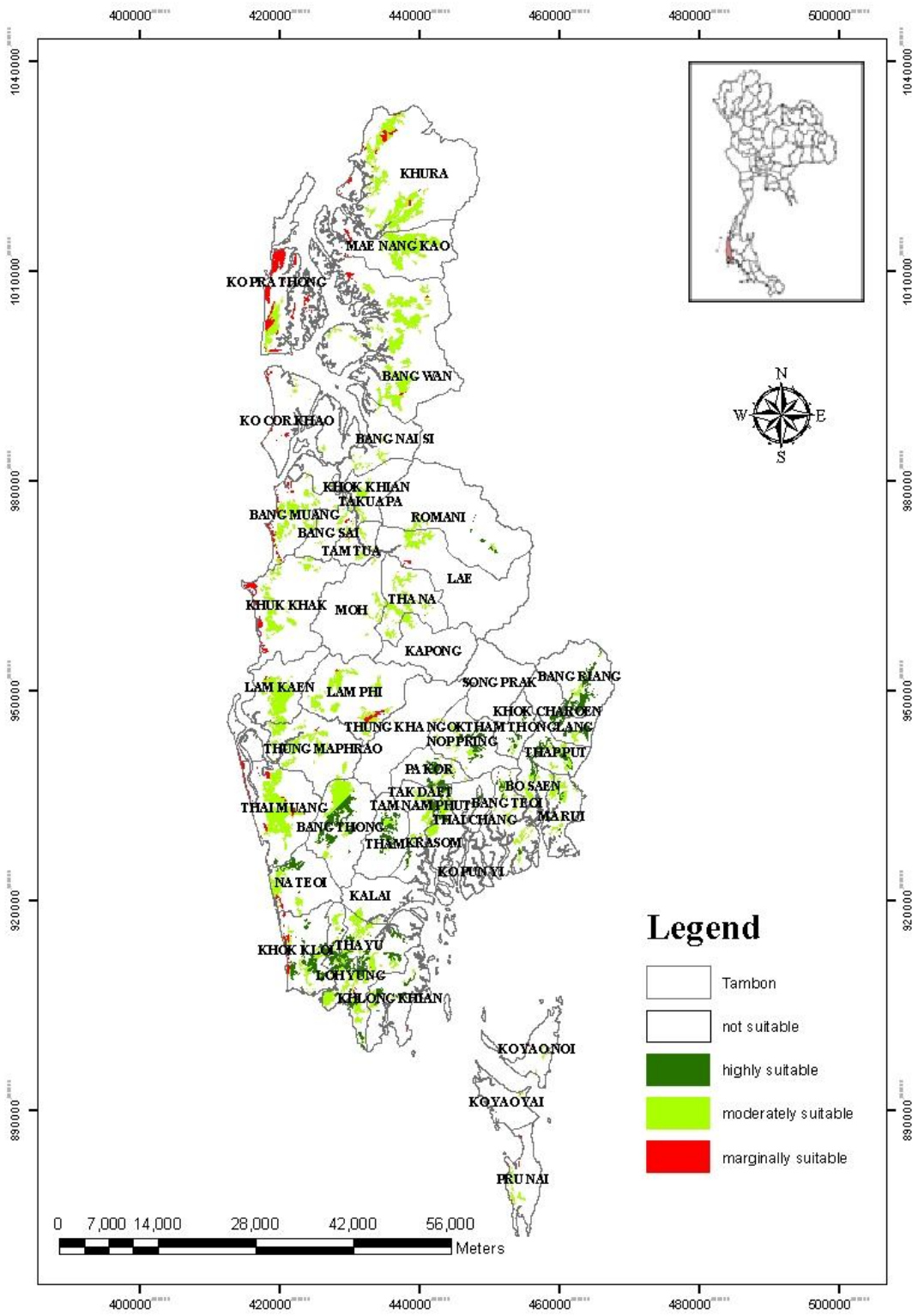

Figure 4-12. Oil palm suitability area

4.1.2 Potential Areas for para rubber and oil palm

When the data were overlay with all 6 factors for the suitable area for para rubber and oil palm. The results of masking areas of suitability area for para rubber showed in **Table 4-11.** and **Figure 4-10.** and oil palm showed in **Table 4-12.** and **Figure 4-11.**

Table 4-11. The suitability area for para rubber information

Potential area for oil palm	Area		
	Sq.Km	Compare with Phang-nga area (%)	Compare with *Land use area (%)
Highly suitable	33.36107373	0.853852394	1.935363603
Moderately suitable	398.6315696	10.20268481	23.12566547
Marginally suitable	53.80466758	1.377091295	3.121350234
Not suitable	3421.326912	87.5663715	71.81762069
Total	**3907.124223**	**100**	**100**

***Land use area;** Agricultural land and Miscellaneous land

Table 4-12. The suitability area for oil palm information

Potential area for oil palm	Area		
	Sq.Km	Compare with Phang-nga area (%)	Compare with *Land use area (%)
Highly suitable	92.30782306	2.362785145	5.35501952
Moderately suitable	44.617782	1.142072568	2.588394847
Marginally suitable	342.1531603	8.758026976	19.84920445
Not suitable	3427.659148	87.73711531	72.20738118
Total	**3906.737913**	**100**	**100**

1) Suitability area for para rubber

The results of the study indicated that the not suitable area for para rubber were found in all Phang-nga province. This result was due to most of study areas were flat terrains with the climate condition matching to para rubber. However, the classes of soil suitability are mostly Not suitable class. The area of Phang-nga province was highly suitable class area for para rubber plantation. Most area in Tumbon Bang Riang, Amphoe Thap Put was highly suitable area at

8.494954045 square kilometers. Moderately suitable area was located mostly in Tumbon Khura, Amphoe Khuraburi, total area of 35.49858363 square kilometers. The study also found that the most area in Tumbon Ko Pra Thong, Amphoe Khuraburi was marginally suitability, at total area of 18.91805385 square kilometers. Suitability area for para rubber were showed in table 4-13.

Table 4-13. Suitability areas for para rubber information

Amphoes / Tumbon	Area (Sq.Km)	Class suitable Area (Sq.Km)			
		Highly Suitable	Moderately Suitable	Marginally Suitable	Not Suitable
KAPONG	**614.3583155**	**0.71779439**	**30.32620745**	**0.030125242**	**583.2841884**
KAPONG	82.54093478	-	1.982010226	-	80.55892455
LAE	161.3484853	-	9.849062828	0.030125242	151.4692973
MOH	110.4309751	0.71779439	3.203045262	-	106.5101355
ROMANI	183.7936439	-	3.702166054	-	180.0914779
THA NA	76.24427633	-	11.58992308	-	64.65435325
KHURA BURI	**760.0988273**	**0.911143172**	**90.25580539**	**21.57120979**	**647.3606689**
BANG WAN	272.0487752	0.197824812	35.07500408	0.118197564	236.6577488
KHURA	251.6072887	0.045925473	35.49858363	1.56029888	214.5024808
KO PRA THONG	118.7441839	-	-	18.91805385	99.82613005
MAE NANG KAO	117.6985794	0.667392887	19.68221768	0.974659497	96.37430931
KO YAO	**126.7149072**	**0.318904764**	**4.67871384**	-	**121.7172886**
KO YAO NOI	41.15620889	0.119448949	0.983497644	-	40.05326229
KO YAO YAI	38.80067351	-	0.612789789	-	38.18788373
PRU NAI	46.75802477	0.199455815	3.082426407	-	43.47614254
MUANG PHANGNGA	**520.0139992**	**1.342245945**	**37.48368257**	**0.555893275**	**480.6321774**
BANG TEOI	83.62506122	1.342245945	8.070124508	0.323014542	73.88967623
KO PUN YI	34.84736812	-	-	-	34.84736812
NOP PRING	74.93074375	-	8.543222725	0.068718923	66.3188021
PA KOR	41.89375098	-	6.730580563	0.085943624	35.07722679
SONG PRAK	76.45271552	-	-	-	76.45271552
TAK DAET	56.03352763	-	12.32394199	0.078216186	43.63136945
TAM NAM PHUT	33.03503884	-	0.784970418	-	32.25006842
THAI CHANG	4.447196467	-	0.693225969	-	3.753970498
THUNG KHA NGOK	114.7485967	-	0.337616393	-	114.4109803
TAKUA PA	**530.4077122**	**2.392218862**	**37.48421869**	**14.01628844**	**476.5149862**
BANG MUANG	71.07300469	0.430276168	13.82033994	4.416979508	52.40540907
BANG NAI SI	136.7104296	0.13985388	3.309424397	0.037126136	133.2240251
BANG SAI	39.52323938	0.240353806	3.452192801	0.113426128	35.71726665
KHOK KHIAN	46.28518975	1.426599556	2.418959099	-	42.43963109
KHUK KHAK	136.4819329	-	10.14583608	6.025991942	120.3101049
KO COR KHAO	67.34601	-	0.67226799	3.422764728	63.25097728

Amphoes / Tumbon	Area (Sq.Km)	Class suitable Area (Sq.Km)			
		Highly Suitable	Moderately Suitable	Marginally Suitable	Not Suitable
TAKUA PA	3.378463104	0.155135452	0.57420151	-	2.649126142
TAM TUA	29.60944281	-	3.090996868	-	26.51844594
TAKUA THUNG	**461.6783587**	**5.647394715**	**74.81342684**	**5.758159363**	**375.4593778**
KALAI	79.49804371	-	2.950240845	-	76.54780286
KHLONG KHIAN	71.59705436	2.368132296	3.722371698	0.136167015	65.37038335
KHOK KLOI	74.5369106	0.664350269	12.07737018	4.28633245	57.5088577
KRASOM	41.32135289	-	6.559552916	-	34.76179997
LOH YUNG	65.38381168	2.59961219	20.6077898	1.299303059	40.87710663
THA YU	67.79017123	0.01529996	21.26353694	0.036356839	46.47497749
THAM	61.55101428	-	7.632564457	-	53.91844982
THAI MUANG	**607.2907488**	**0.641888291**	**101.4037835**	**11.85196461**	**493.3931124**
BANG THONG	99.67836103	-	24.63842559	-	75.03993543
LAM KAEN	92.73429378	0.234775618	15.55782147	0.717297847	76.22439885
LAM PHI	133.354958	-	17.14411849	0.329367575	115.881472
NA TEOI	68.36157194	-	4.579409101	6.373817269	57.40834557
THAI MUANG	108.9675204	0.407112674	23.27532353	4.419307385	80.86577683
THUNG MAPHRAO	104.1940436	-	16.20868529	0.01217453	87.97318375
THAP PUT	**286.5613545**	**21.38948359**	**22.18573131**	**0.021026855**	**242.9651127**
BANG RIANG	77.64284314	8.494954045	2.056558334	-	67.09133076
BO SAEN	32.81197803	0.801076296	4.698463066	0.021026855	27.29141181
KHOK CHAROEN	54.19657108	4.533064565	2.7373961	-	46.92611042
MA RUI	47.26776474	4.891795541	4.346072783	-	38.02989641
THAM THONGLANG	34.49543213	-	2.692297564	-	31.80313457
THAP PUT	40.14676537	2.668593145	5.654943461	-	31.82322877
Grand Total	**3907.124223**	**33.36107373**	**398.6315696**	**53.80466758**	**3421.326912**

2) Suitability area for oil palm

The results of the study indicated that not suitable areas for oil palm were found in all Phang-nga provinces. This result was due to most of study areas were flat terrains with the climate condition matching to oil palm. However, the classes of soil suitability are mostly not suitable class. The area of Phang-nga province was highly suitable class area for para rubber plantation. Most area in Tumbon Bang Thong, Amphoe Thai Muang was highly suitable area at 12.64362699 square kilometers. The moderately suitable area was located mostly in Tumbon Bangwan, Amphoe Khuraburi, total area of 34.18450154 square kilometers. The study also found

that the most area in Tumbon Ko Pra Thong, Amphoe Khuraburi was marginally suitability, at total area of 12.28443669 square kilometers. Suitability area for para rubber were showed in table 4.14

Table 4-14. Suitability areas for oil palm information

Amphoes/Tumbon	Area (Sq.Km)	Class suitable Area (Sq.Km)			
		Highly suitable	Moderately suitable	Marginally suitable	Not suitable
KAPONG	**613.9736042**	**1.028949468**	**28.58007475**	**0.502665365**	**583.8619146**
KAPONG	82.54093478	-	1.938293624	-	80.60264115
LAE	161.3226712	-	9.410346566	0.443027417	151.4692973
MOH	110.0720779	-	3.561942457	-	106.5101355
ROMANI	183.7936439	1.028949468	2.209897324	0.033960089	180.520837
THA NA	76.24427633	-	11.45959478	0.025677859	64.75900369
KHURA BURI	**760.0988273**	-	**92.96837805**	**19.27721123**	**647.853238**
BANG WAN	272.0487752	-	34.18450154	1.206524914	236.6577488
KHURA	251.6072887	-	31.86447896	4.747759944	214.9950498
KO PRA THONG	118.7441839	-	6.633617159	12.28443669	99.82613005
MAE NANG KAO	117.6985794	-	20.28578039	1.038489679	96.37430931
KO YAO	**126.7149072**	**0.115203828**	**3.758232447**	**1.124182329**	**121.7172886**
KO YAO NOI	41.15620889	0.111071886	0.819281256	0.172593452	40.05326229
KO YAO YAI	38.80067351	-	0.416458451	0.196331338	38.18788373
PRU NAI	46.75802477	0.004131943	2.52249274	0.755257539	43.47614254
MUANG PHANGNGA	**520.0124006**	**13.46554958**	**24.62764892**	**0.170470793**	**481.7487313**
BANG TEOI	83.6234626	2.147394627	7.167699889	0.170470793	74.13789729
KO PUN YI	34.84736812	-	-	-	34.84736812
NOP PRING	74.93074375	4.264199746	4.259798739	-	66.40674526
PA KOR	41.89375098	3.855876426	2.346663795	-	35.69121076
SONG PRAK	76.45271552	-	-	-	76.45271552
TAK DAET	56.03352763	2.415721486	9.908220504	-	43.70958564
TAM NAM PHUT	33.03503884	0.124007135	0.575076889	-	32.33595482
THAI CHANG	4.447196467	0.658350154	0.032572714	-	3.756273599
THUNG KHA NGOK	114.7485967	-	0.337616393	-	114.4109803
TAKUA PA	**530.4077122**	-	**41.33535967**	**12.39636936**	**476.6759832**
BANG MUANG	71.07300469	-	14.71694991	3.938191788	52.41786299
BANG NAI SI	136.7104296	-	3.486404413	-	133.2240251
BANG SAI	39.52323938	-	3.385573374	0.357948788	35.77971722
KHOK KHIAN	46.28518975	-	3.845558654	-	42.43963109
KHUK KHAK	136.4819329	-	11.80965285	4.290804185	120.3814759
KO COR KHAO	67.34601	-	0.634247621	3.44606362	63.26569876
TAKUA PA	3.378463104	-	0.729336962	-	2.649126142
TAM TUA	29.60944281	-	2.727635885	0.363360983	26.51844594
TAKUA THUNG	**461.6783587**	**36.98937862**	**44.93805076**	**2.719149579**	**377.0317798**

Amphoes/Tumbon	Area (Sq.Km)	Class suitable Area (Sq.Km)			
		Highly suitable	Moderately suitable	Marginally suitable	Not suitable
KALAI	79.49804371	0.038096373	2.912144472	-	76.54780286
KHLONG KHIAN	71.59705436	3.002710528	2.706306734	0.115614145	65.77242295
KHOK KLOI	74.5369106	8.835187759	6.135257798	2.057607341	57.5088577
KRASOM	41.32135289	2.726509494	3.775887344	-	34.81895605
LOH YUNG	65.38381168	8.88056414	14.26380345	0.408912318	41.83053177
THA YU	67.79017123	7.235856716	13.91966427	0.137015775	46.49763447
THAM	61.55101428	6.270453608	1.22498669	-	54.05557398
THAI MUANG	**607.2907488**	**16.31213248**	**88.0748176**	**8.427733343**	**494.4760654**
BANG THONG	99.67836103	12.64362699	11.53361542	0.05915068	75.44196793
LAM KAEN	92.73429378	-	15.47040517	0.856957012	76.4069316
LAM PHI	133.354958	-	15.51767914	1.626439352	116.2108396
NA TEOI	68.36157194	3.189902479	7.121632136	0.641691755	57.40834557
THAI MUANG	108.9675204	0.478603008	22.36905044	5.09724455	81.02262243
THUNG MAPHRAO	104.1940436	-	16.0624353	0.146249994	87.98535828
THAP PUT	**286.5613545**	**24.39660909**	**17.87059813**	-	**244.2941473**
BANG RIANG	77.64284314	8.238013296	1.68054428	-	67.72428557
BO SAEN	32.81197803	1.871272726	3.626113383	-	27.31459192
KHOK CHAROEN	54.19657108	5.661122478	1.157366776	-	47.37808183
MA RUI	47.26776474	2.310848395	6.927019929	-	38.02989641
THAM THONGLANG	34.49543213	1.828500229	0.680654786	-	31.98627712
THAP PUT	40.14676537	4.486851968	3.798898977	-	31.86101443
Grand Total	**3906.737913**	**92.30782306**	**342.1531603**	**44.617782**	**3427.659148**

4.2 Financial analysis for para rubber and oil palm

4.2.1 Average product per rai of para rubber and oil palm

Table 4-15. Average Product/ Rai in 2010 of Para rubber and Oil palm

Amphoes/Tumbon	Para rubber	Oil palm
	Average Yield (kg)/Rai	Average Yield (kg)/Rai
KAPONG	**270**	**3200**
KAPONG	270	3200
LAE	270	2950
MOH	270	2900
ROMANI	270	2950
THA NA	270	2000
KHURA BURI	**260**	**3200**
BANG WAN	265	3300
KHURA	265	2950
KO PRA THONG	245	2900
MAE NANG KAO	265	3300
KO YAO	**260**	**2950**
KO YAO NOI	260	2950
KO YAO YAI	260	2950
PRU NAI	260	3200
MUANG PHANGNGA	**260**	**3000**
BANG TEOI	260	2950
KO PUN YI	250	2950
NOP PRING	265	3500
PA KOR	265	3500
SONG PRAK	270	3200
TAK DAET	265	2900
TAM NAM PHUT	265	2900
THAI CHANG	-	3200
THUNG KHA NGOK	265	-
TAKUA PA	**260.875**	**3200**
BANG MUANG	260	1800
BANG NAI SI	260	3450
BANG SAI	265	3500
KHOK KHIAN	265	2950
KHUK KHAK	265	3000
KO COR KHAO	250	3200
TAKUA PA	262	2900
TAM TUA	260	3200
TAKUA THUNG	**267.8571429**	**2950**
KALAI	265	3500
KHLONG KHIAN	270	2500

Amphoes/Tumbon	Para rubber	Oil palm
	Average Yield (kg)/Rai	Average Yield (kg)/Rai
KHOK KLOI	270	3500
KRASOM	265	2950
LOH YUNG	270	2000
THA YU	270	2900
THAM	265	-
THAI MUANG	**264.1666667**	**3200**
BANG THONG	265	3150
LAM KAEN	260	3200
LAM PHI	270	2900
NA TEOI	260	2950
THAI MUANG	265	3200
THUNG MAPHRAO	265	3200
THAP PUT	**264.1666667**	**3300**
BANG RIANG	265	2900
BO SAEN	260	3000
KHOK CHAROEN	265	2950
MA RUI	260	-
THAM THONGLANG	270	2900
THAP PUT	265	3000

Calculate Average Product/Rai is highly product, moderately product and marginally product by finding the percentage of Percentiles 25, 50 and 75 to represent the output is the highly suitability product, moderately ability product and marginally cost product, value will be as follows.

Para rubber

Table 4-16. Percentiles Product of Para rubber per rai

AvergProduct

N	Valid	45
	Missing	3
Minimum		1800
Maximum		3500
Percentiles	25	2900.00
	50	2950.00
	75	3200.00

- Percentiles of 25 was 260 instead of para rubber product in marginally suitable
- Percentiles of 50 was 265 instead of para rubber product in moderately suitable
- Percentiles of 75 was 270 instead of para rubber product in highly suitable

Table 4-17. Frequency Product of Para rubber per rai each Tumbon in Phang-nga province

AvergProduct

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	245	1	2.1	2.1	2.1
	250	2	4.2	4.3	6.4
	260	11	22.9	23.4	29.8
	262	1	2.1	2.1	31.9
	265	20	41.7	42.6	74.5
	270	12	25.0	25.5	100.0
	Total	47	97.9	100.0	
Missing	System	1	2.1		
Total		48	100.0		

Oil palm

Table 4-18. Percentiles product of oil palm per rai from SPSS program

AvergProduct

N	Valid	45
	Missing	3
Minimum		1800
Maximum		3500
Percentiles	25	2900.00
	50	2950.00
	75	3200.00

- Percentiles of 25 was 2900 instead of oil palm product in marginally suitable
- Percentiles of 50 was 2950 instead of oil palm product in moderately suitable
- Percentiles of 75 was 3200 instead of oil palm product in highly suitable

Table 4-19. Frequency Product of Oil palm per rai each Tumbon in Phang-nga province

AvergProduct

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1800	1	2.1	2.2	2.2
	2000	2	4.2	4.4	6.7
	2500	1	2.1	2.2	8.9
	2900	9	18.8	20.0	28.9
	2950	11	22.9	24.4	53.3
	3000	3	6.2	6.7	60.0
	3150	1	2.1	2.2	62.2
	3200	9	18.8	20.0	82.2
	3300	2	4.2	4.4	86.7
	3450	1	2.1	2.2	88.9
	3500	5	10.4	11.1	100.0
	Total	45	93.8	100.0	
Missing	System	3	6.2		
Total		48	100.0		

4.2.2 Financial analysis results of investment to grow oil palm and para rubber in case study.

Analysis results of investment to grow oil palm and para rubber are as follows; Growing both plants creates high remunerations. However, if people have to choose to grow one of these plants, they have to analyze difference of remunerations which may increase or reduce to see that they should grow oil palm or para rubber.

Table 4-20. Financial analysis results of investment to grow oil palm in Tha Kharm Sub-district, Phun Phin District, Surat Thani province for the year 2003

Age of oil palm (year)	Present values of remunerations (Baht)	Present values of cost (Baht)	Present values of net remunerations (Baht)
1	-	951,300.90	-951,300.90
2	-	16,230.76	-16,230.76
3	-	16,065.14	-16,065.14
4	65,525.76	25,167.36	40,358.40
5	68,454.88	25,173.92	43,280.96
6	72,868.41	26,306.29	46,562.12
7	94,666.97	30,258.31	64,408.66
8	135,968.98	41,128.88	94,840.10
9	155,800.44	45,380.10	110,420.34
10	131,085.63	39,928.60	91,157.03
11	125,556.48	56,689.92	68,866.56
12	127,696.07	38,806.25	88,889.82
13	127,158.98	38,816.38	88,342.60
14	148,583.36	42,911.22	105,672.14
15	135,762.48	40,346.46	95,416.02
16	99,906.37	35,581.22	64,325.15
17	98,672.04	34,960.17	63,711.87
18	97,506.86	34,637.15	62,869.71
19	84,915.53	32,329.08	52,586.45
20	552,897.34	30,472.53	522,424.81
NPV (Baht)	**2,323,026.58**	**1,602,490.66**	**720,535.93**
BCR			**1.45**
IRR (%)			**4.43**

Table 4-21. Financial analysis results of investment to grow para rubber in Tha Kharm Sub-district, Phun Phin District, Surat Thani province for the year 2003

Age of oil palm (year)	Present values of remunerations (Baht)	Present values of cost (Baht)	Present values of net remunerations (Baht)
1	0	926,501.40	-926,501.40
2	0	24,304.00	-24,304.00
3	0	24,056.00	-24,056.00
4	0	23,808.00	-23,808.00
5	0	23,584.80	-23,584.80
6	0	23,022.48	-23,022.48
7	110,651.70	134,490.40	-23,838.70
8	118,790.10	68,998.87	49,791.24
9	134,063.69	75,308.12	58,755.58
10	150,890.65	81,563.13	69,327.53
11	211,518.72	114,767.74	96,750.98
12	261,084.02	129,419.51	131,664.51
13	274,396.95	132,390.99	142,005.96
14	279,574.68	131,626.56	147,948.12
15	375,439.05	170,838.76	204,600.29
16	287,767.26	134,395.33	153,371.93
17	276,456.42	130,521.22	145,935.20
18	256,764.86	120,936.60	135,828.26
19	240,167.42	114,503.94	125,663.48
20	943,808.23	99,777.95	844,030.28
NPV (Baht)	**3,921,373.74**	**2,684,815.78**	**1,236,557.96**
BCR			**1.46**
IRR (%)			**5.38**

Financial analysis results of investment to grow oil palm compared with investment to grow para rubber are as follows; Oil palm faster yields than para rubber by yielding from the fourth year onwards while para rubber yielding from the seventh year onwards. Therefore, oil palm faster creates remunerations in the initial period. When para rubber begins to yield, oil palm begins to create less remunerations than para rubber due to higher price of para rubber. At the end of the project, people are able to cut the rubber wood as additional remunerations. As for remunerations, the researcher found that para rubber creates higher remunerations than oil palm. As for the cost, oil palm uses higher cost in the first year. After financial analysis of investment to grow oil palm compared with investment to grow para rubber, the researcher found that net

present values (NPV) are -516,022.03 baht, which are negative values. Project remunerations rate (IRR) is 8.50%, indicating that IRR is higher than investment's opportunity cost. However, change from investment to grow para rubber to investment to grow oil palm causes decrease in present values of benefits at the amount of 1,598,347.16 baht. Meanwhile, the present values of additional costs reduce by 1,082,325.13 baht, causing present values of net remunerations to reduce by 516,022.03 baht. This indicates that present values of benefits are less than present values of cost. Therefore, change from investment to grow para rubber to investment to grow oil palm is not worth investment, indicating that investment to grow oil palm creates less remunerations than investment to grow para rubber [18].

CHAPTER VI
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The GIS application was applied to study on suitability area for para rubber and oil palm in Phang-nga province.

5.1.1 Suitability area for para rubber and oil palm

This study on suitability areas for para rubber and oil palm was considered on 7 factors affected to crop plantation. These factors were slope, soil surface depth, texture, drainage, land use, annual average rainfall, and annual average temperature.

1) Para rubber

The suitability areas in Phang-nga province for para rubber. High suitable areas were 33.36107373 square kilometers or 1.935363603% of the total areas. Moderate suitable areas were 398.6315696 square kilometers or 23.12566547% of the total areas. Marginally suitable areas were 53.80466758 square kilometers or 3.121350234% of the total areas. Not suitable areas were87.5663715 square kilometers or 71.81762069% of the total areas.

2) Oil palm

The suitability areas in Phang-nga province for oil palm. High suitable areas were 92.30782306 square kilometers or 5.35501952% of the total areas. Moderate suitable areas were 44.617782 square kilometers or 2.588394847% of the total areas. Marginally suitable areas were 342.1531603 square kilometers or 19.84920445% of the total areas. Not suitable areas were 3427.659148 square kilometers or 72.20738118% of the total areas.

Table 5-1. Suitability area for para rubber and oil palm

Suitable Area		Para rubber	Oil palm
Highly	**Area (Sq.Km)**	33.36107373	92.30782306
	%	1.935363603	5.35501952
Moderately	**Area (Sq.Km)**	398.6315696	44.617782
	%	23.12566547	2.588394847
Marginally	**Area (Sq.Km)**	53.80466758	342.1531603
	%	3.121350234	19.84920445
Not Suitable	**Area (Sq.Km)**	3421.326912	3427.659148
	%	71.81762069	72.20738118

5.2 Recommendation

1) Regarding the study on suitability area for para rubber and oil palm. The factors were considered only the influence factors. These factors could be used for initial consideration on suitability area. However, there were other factors affected to their growth, i.e., PH, moisture. Therefore, these factors should be considered to use in further study.

2) Financial analysis on para rubber and oil palm for farmer household consumption were worthy investment. Therefore, farmers could decide to invest in both para rubber and oil palm. However, farmer should consider on characters of plants before investing. For example, rara rubber should be harvested after 7 years old, oil palm should be harvested after 4 years old.

5.2.1 Strengths and weaknesses of growing para rubber and oil palm

Table 5-2. Weaknesses and strengths of growing para rubber

Strengths	Weaknesses
1. Para rubber is an economic plant with high price and will receive good response from the market in the future. 2. People are able to sell rubber wood after the end of harvest at the high price. 3. The government has the policy to encourage para rubber growing by providing subsidy for new agriculturists in the new growing area of 800,000 rais. 4. At present, para rubber is also grown in areas of the north east and the north with cheap wages. 5. People are able to grow other plants while waiting to harvest yields such as pineapple, bean, corn, water melon, tapioca, marigold, chili, and pumpkin.	1. Growing para rubber uses high costs. 2. Before harvest, it takes seven years for para rubber to grow. 4. Agriculturists have to stop cutting para rubber producing new leaves. 5. People are unable to cut the rubber when it rains at night because the rubber face will be damaged. Therefore, people in Phang-nga province where there is rain throughout the year are able to cut the rubber about 120 days per year. 6. Labor wages rate in 70/30 for selling water in Phang-nga province indicates that the owners receive 70% while the hirelings receive 30%. As for the ratio of 60/40 for selling the rubber sheet, the owners receive 60% while the hirelings receive 40%.

Table 5-3. Weaknesses and strengths of growing oil palm

Strengths	Weaknesses
1. People are able to sell palm trees to resorts or golf field after the end of harvest. 2. Oil palm is an economic plant with the high price and will receive good response from the market. 3. The government encourage people to grow oil palm to be alternative energy plant in the future. 3. It is easy for people to take care of this plant. And people are able to harvest this plant twice a month. 4. The government have the policy to support oil palm growing in the empty spaces. 5. Oil palm requires a lot of water. However, as oil palm is a high plant, it is easily fallen in the soft soil. People try to grow oil palm in organic soils by developing oil palm to have shorter stalks. 6. People are able to grow other plants while waiting to harvest yields such as pineapple, bean, corn, water melon, tapioca, marigold, chili, and pumpkin.	1. Most agriculturists destroy the oil palm after harvest season because it is not worth spending to transport plywood or furniture or people are not able to find other purchasers. 2. Before harvest, It takes four years for this plant to grow. 3. People are able to harvest yields twice a month or 24 times a year. 4.Frequency of harvesting oil palm empty bunch - During the drought, people harvest about 15 days per time. - During the rainy season, people harvest about 10 days per time. 6. Labor wages rate in 80/20 in Phang-nga province indicates that the owners receive 80% while the hirelings receive 20%.

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APPENDICES

APPENDIX A
DATA FROM THAI METEOROLOGICAL DEPARTMENT

stn_name	Rainfall 2000-2010	Temperature 2000-2010	Latitude	Longitude	wmo index
Chumphon*	162.5938462	27.50923077	10.29.0	99.11.0	517201/48517
Ranong*	336.6192308	27.66124031	9.59.0	98.37.0	532201/48532
Surat Thani*	102.2566038	27.11698113	9.8.8	99.9.7	551201/48551
Ko Samui*	158.0715385	27.87076923	9.28.0	100.3.0	551203/48550
Nakhon Si Thammarat*	216.1869231	27.48692308	8.32.16	99.56.50	552201/48552
Chawang	153.7815385	27.36	8.25.55	99.30.43	552401/48557
Phuket Airport*	211.1738462	28.03769231	8.8.42	98.18.52	564202/48565
Ko Lanta*	180.4945313	28.2300813	7.32.0	99.3.0	566201/48566
Krabi*	158.3075758	26.98030303	8.3.0	98.54.0	566202/48563
Takua Pa*	311.0884	27.64643	8.41.3	98.15.8	561201/48561

stn_name	Rainfall 2000-2010	Temperature 2000-2010	UTM_Easting (x)	UTM_Northing (y)
Chumphon*	162.5938462	27.50923077	520062.1391	1158858.153
Ranong*	336.6192308	27.66124031	457985.9528	1103594.132
Surat Thani*	102.2566038	27.11698113	516694.5747	1009842.392
Ko Samui*	158.0715385	27.87076923	615264.1187	1046619.932
Nakhon Si Thammarat*	216.1869231	27.48692308	604246.3323	943878.745
Chawang	153.7815385	27.36	556355.6104	932087.4041
Phuket Airport*	211.1738462	28.03769231	424477.5275	900391.8977
Ko Lanta*	180.4945313	28.2300813	505516.0441	832708.0152
Krabi*	158.3075758	26.98030303	488981.4227	889826.7818
Takua Pa*	311.0884	27.64643	417736.4707	417736.4707

APPENDIX B

แบบสอบถามผู้เชี่ยวชาญเรื่อง

การเปรียบเทียบพื้นที่เหมาะสมในการปลูกยางพาราและปาล์มน้ำมันในจังหวัดพังงา

.....

เรียน ท่านผู้ตอบแบบสอบถาม

เนื่องด้วยข้าพเจ้า นางสาวกติกา ศรีทอง นักศึกษาปริญญาโท สาขาเทคโนโลยีการจัดการระบบสารสนเทศ คณะวิศวกรรมศาสตร์ มหาวิทยาลัยมหิดล กำลังสารนิพนธ์เรื่อง การเปรียบเทียบพื้นที่เหมาะสมในการปลูกยางพาราและปาล์มน้ำมัน ในจังหวัดพังงา ในการนี้ข้าพเจ้ามีความจำเป็นที่ต้องการทราบข้อมูลใน การให้น้ำหนักคะแนนของปัจจัย (Weight Factor) เพื่อนำมาวิเคราะห์หาระดับศักยภาพเหมาะสำหรับการปลูกยางพาราและปาล์มน้ำมัน

ซึ่งในทางปฏิบัติการพิจารณาให้ค่าความเหมาะสมของแต่ละช่วงปัจจัยนั้น จะเป็นการพิจารณาการกำหนดค่าโดยผู้ที่มีความรู้ ความเชี่ยวชาญและผู้ที่มีประสบการณ์ด้านปัจจัยต่างๆ เหล่านั้น เพื่อให้ผลลัพธ์ที่ออกมานั้นถูกต้องตามหลักวิชาการ ข้าพเจ้าจึงใคร่ขอความอนุเคราะห์จากท่านผู้ตอบแบบสอบถามในการให้คะแนนต่างๆ ดังกล่าวในครั้งนี้ด้วย

จึงเรียนมาเพื่อขอความอนุเคราะห์ในการตอบแบบสอบถามดังกล่าวเพื่อประโยชน์ในการศึกษาวิจัยครั้งนี้ จักเป็นพระคุณยิ่ง

ขอขอบพระคุณอย่างสูง

กติกา ศรีทอง

แบบสอบถาม

การให้ค่าคะแนนสำหรับผู้เชี่ยวชาญในแต่ละสาขาที่เกี่ยวข้อง

เพื่อประกอบการศึกษาวิจัย

เรื่อง

เทคโนโลยีสารสนเทศภูมิศาสตร์เพื่อการเปรียบเทียบพื้นที่เหมาะสมในการปลูกยางพาราและปาล์มน้ำมัน ในจังหวัดพังงา

จัดทำโดย

นางสาวกติกา ศรีทอง

สาขาเทคโนโลยีการจัดการระบบสารสนเทศ

คณะวิศวกรรมศาสตร์ มหาวิทยาลัยมหิดล

ชื่อ-นามสกุล.....ตำแหน่ง.....

ระดับ.....สถานที่ปฏิบัติงาน.....

ฝ่าย.....กอง.....

กรม.....กระทรวง.....

การให้ค่าน้ำหนักของปัจจัยที่เกี่ยวข้องกับการหาพื้นที่ที่มีศักยภาพที่เหมาะสำหรับการปลูกยางพารา

1-7 หมายถึง ปัจจัยที่มีความเหมาะสมต่อการปลูกยางพารามากขึ้นตามลำดับ

ปัจจัยที่ใช้ในการศึกษา	**ความสำคัญของปัจจัยที่ใช้ในการศึกษา**	**ค่าน้ำหนัก (0-10)**
1. ความลาดชัน (Slope)	ลักษณะความลาดชันของพื้นที่เป็นลักษณะทางกายภาพที่สำคัญอย่างหนึ่งที่ควบคุมลักษณะการใช้ประโยชน์ที่ดิน เช่น บริเวณพื้นที่ราบ อาจนำมาใช้ปลูกพืชได้หลายชนิด แต่ในบางครั้งบริเวณพื้นที่ราบอาจเกิดมีปัญหาด้านการระบายน้ำของดิน หรือการแช่ขังของน้ำบนผิวดิน	.....
2. ความลึกของหน้าดิน (Depth)	ความลึกของหน้าดิน มีผลต่อการยึดเกาะรากของพืช หน้าดินยิ่งลึกรากก็จะสามารถยึดเกาะลำต้นกับหน้าดินได้ดี สามารถทรงตัวได้ดี ไม่ล้มง่ายในกรณีที่เกิดพายุ	.....
3. คุณลักษณะของดิน (Texture)	คุณลักษณะของดินสำหรับพืชในแต่ละชั้นความเหมาะสมจะช่วยพิจารณาถึงข้อจำกัดของดินที่มีอิทธิพลต่อการเจริญเติบโตของพืช ซึ่งจะส่งผลถึงปริมาณผลผลิตที่จะได้รับ	.....
4. การระบายน้ำ/อากาศของดิน (Drainage)	การระบายน้ำและอากาศของดิน หากการระบายน้ำดีเกินไปก็จะไม่สามารถดูดซับน้ำไว้ได้ หากการระบายน้ำช้าเกินไปก็อาจทำให้เกิดภาวะน้ำท่วมขังในกรณีที่ฝนตกหนักๆได้	.....
5. การใช้ประโยชน์ที่ดิน (Land Use)	ปัจจัยด้านการใช้ประโยชน์ที่ดินมีความจำเป็นในการนำมาพิจารณาความเหมาะสมของพื้นที่ เนื่องจากสามารถบอกประสิทธิภาพในการใช้พื้นที่ว่ามีความเหมาะสมของที่ดินหรือไม่ หากมีความสอดคล้องกับศักยภาพของที่ดิน และมีการปลูกพืชเหมาะสมกับศักยภาพของพื้นที่ก็จะช่วยให้การบำรุงรักษาและการลงทุนน้อยลงและได้ผลผลิตที่มีประสิทธิภาพ	.....

ปัจจัยที่ใช้ในการศึกษา	ความสำคัญของปัจจัยที่ใช้ในการศึกษา	ค่าน้ำหนัก (0-10)
6. ค่าปริมาณน้ำฝน (Ann. Rainfall (mm.))	ปริมาณน้ำฝนมีอิทธิพลต่อการปลูกยางพาราเป็นอย่างยิ่ง โดยเฉพาะพื้นที่นอกเขตชลประทาน ซึ่งต้องอาศัยน้ำฝนพื้นที่ที่มีปริมาณน้ำฝนมากจะให้ผลผลิตดีกว่าพื้นที่ที่มีปริมาณน้ำฝนน้อย	.....
7. อุณหภูมิ (Temperature (c))	ค่าอุณหภูมิเฉลี่ยสำหรับการปลูกพืช มีอิทธิพลต่อการออกดอกของพืชและมีส่วนสัมพันธ์กับขบวนการสังเคราะห์แสง ซึ่งจะส่งผลต่อการเจริญเติบโตของพืช	.....

การให้ค่าน้ำหนักของปัจจัยที่เกี่ยวข้องกับการหาพื้นที่ที่มีศักยภาพที่เหมาะสำหรับการปลูกปาล์มน้ำมัน

0 หมายถึง ปัจจัยที่ไม่มีความเหมาะสมสำหรับการปลูกปาล์มน้ำมัน
1-9 หมายถึง ปัจจัยที่มีความเหมาะสมต่อการปลูกปาล์มน้ำมันมากขึ้นตามลำดับ
10 หมายถึง ปัจจัยที่มีความเหมาะสมต่อการปลูกปาล์มน้ำมันมากที่สุด

ปัจจัยที่ใช้ในการศึกษา	**ความสำคัญของปัจจัยที่ใช้ในการศึกษา**	**ค่าน้ำหนัก (0-10)**
1. ความลาดชัน (Slope)	ลักษณะความลาดชันของพื้นที่เป็นลักษณะทางกายภาพที่สำคัญอย่างหนึ่งที่ควบคุมลักษณะการใช้ประโยชน์ที่ดิน เช่น บริเวณพื้นที่ราบ อาจนำมาใช้ปลูกพืชได้หลายชนิด แต่ในบางครั้งบริเวณพื้นที่ราบอาจเกิดมีปัญหาด้านการระบายน้ำของดิน หรือการแช่ขังของน้ำบนผิวดิน	.....
2. ความลึกของหน้าดิน (Depth)	ความลึกของหน้าดิน มีผลต่อการยึดเกาะรากของพืช หน้าดินยิ่งลึกรากก็จะสามารถยึดเกาะลำต้นกับหน้าดินได้ดี สามารถทรงตัวได้ดี ไม่ล้มง่ายในกรณีที่เกิดพายุ	.....
3. คุณลักษณะของดิน (Texture)	คุณลักษณะของดินสำหรับพืชในแต่ละชั้นความเหมาะสมจะช่วยพิจารณาถึงข้อจำกัดของดินที่มีอิทธิพลต่อการเจริญเติบโตของพืช ซึ่งจะส่งผลถึงปริมาณผลผลิตที่จะได้รับ	.....
4. การระบายน้ำ/อากาศของดิน (Drainage)	การระบายน้ำและอากาศของดิน หากการระบายน้ำดีเกินไปก็จะไม่สามารถดูดซับน้ำไว้ได้ หากการระบายน้ำช้าเกินไปก็อาจทำให้เกิดภาวะน้ำท่วมขังในกรณีที่ฝนตกหนักๆได้	.....
5. การใช้ประโยชน์ที่ดิน (Land Use)	ปัจจัยด้านการใช้ประโยชน์ที่ดินมีความจำเป็นในการนำมาพิจารณาความเหมาะสมของพื้นที่ เนื่องจากสามารถบอกประสิทธิภาพในการใช้พื้นที่ว่ามีความเหมาะสมของที่ดินหรือไม่ หากมีความสอดคล้องกับศักยภาพของที่ดิน และมีการปลูกพืชเหมาะสมกับศักยภาพของพื้นที่ก็จะช่วยให้การบำรุงรักษาและการลงทุนน้อยลงและได้ผลผลิตที่มีประสิทธิภาพ	.....

ปัจจัยที่ใช้ในการศึกษา	ความสำคัญของปัจจัยที่ใช้ในการศึกษา	ค่าน้ำหนัก (0-10)
6. ค่าปริมาณน้ำฝน (Ann. Rainfall (mm.))	ปริมาณน้ำฝนมีอิทธิพลต่อการปลูกปาล์มน้ำมันอย่างยิ่งโดยเฉพาะพื้นที่นอกเขตชลประทาน ซึ่งต้องอาศัยน้ำฝนพื้นที่ที่มีปริมาณน้ำฝนมากจะให้ผลผลิตของปาล์มน้ำมันดีกว่าพื้นที่ที่มีปริมาณน้ำฝนน้อย	.....
7. อุณหภูมิ (Temperature (c))	ค่าอุณหภูมิเฉลี่ยสำหรับการปลูกพืช มีอิทธิพลต่อการออกดอกของพืชและมีส่วนสัมพันธ์กับขบวนการสังเคราะห์แสง ซึ่งจะส่งผลต่อการเจริญเติบโตของพืช	.....

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