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TEMPERATURE CHANGES IN CLOUD FOREST OF KHAO NAN NATIONAL PARK, SOUTHERN THAILAND DURING 2000 - 2015

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ABSTRACT

Khao-Nan National Park(KNNP) is a part of the Nakhon Si Thammarat mountain range, which is the one of the cloud forest southern Thailand. The characteristic of cloud forest is a plenty of flora especially epiphyte and the presence of clouds even in the dry season. The aim of this study was to investigate temperature pattern and variation at Khao Nan. We downloaded data, for land surface temperatures recorded by MODIS EARTH Satellites every eight days from 2000-2015 in square kilometers grid boxes covering Khao-Nan National Park, to investigate time series of temperature variation. The cubic spline modeling was used for fitting a pattern of LST among day time from satellite image at Khao-Nan National Park. Otherwise, we used GEE for parameter estimate. The result was shown the temperature has similar pattern and variation around Khao-Nan National Park during 2000-2015. Eventually, the conclusion is the temperature have changed during 2000-2005, 2006-2009 and 2010-2015 by using GEE.

Key words **:** *Temperature changes, cloud forest, Khao Nan National Park*

INTRODUCTION

Cloud forest

Cloud forest is regularly appearance of fog and moss Stadtmuller**[1]**. There are the special features of the cloud forest are highly density of moss, ferns, orchids which are creeper along trees and rocks. Height what can be found the cloud forests, varies among areas. Usually, the cloud forest is founded at an altitude of 1,200-1,500 meters above sea level, but it may experience a "cloud forest" in height more or less than this. The most famous cloud forest near Thailand is the Mountains Dakota - Kinabalu, the Sabah, Malaysia. In Thailand, except the Doi Inthanon National Park National Park, **Khao Nan, Nakhon Si- Thammarat**, also can be found "cloud forests" were at an altitude of 1,400 meters above sea level.

Study area

Khao nan National Park is a part of Noppitam, Thasalar and Sichol District which is laying in Nakhon Sri Thammarat Province Thailand consisting 8.41-8.58 N Latitude and Lontitude 99.30-99.99 E. The highest mountain is about 1,438 meters above sea level Wittaya[2]. The park is 409.79 square kilometers what consists of complicated mountain range along north and south. There are 3 high mountains, namely Khao Nan Yai, San Yean and Khao Tao. Most of the area is productive rainforest which is the source of the important rivers in the province. There also is the rich source of minerals such as tin, barite and wolfram.There are valuable floras and wonderful natures as Nam Tok Khao Nan,Nam Tok Krungnang and Nam Tok Klongpean.

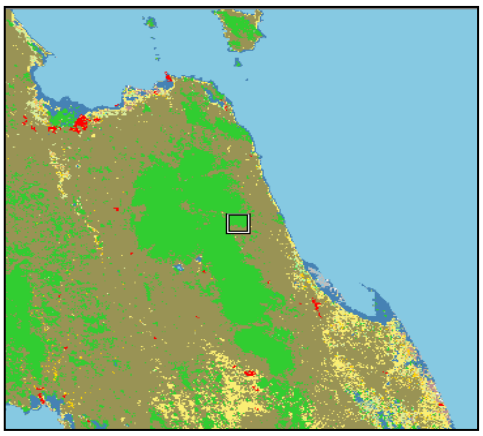

Figure 1. Study Area

METHODOLOGY

Data

Our data is secondary data therefore we downloaded data for land surface temperature(LST) recorded by MODIS Earth Satellites; http://daac.ornl.gov/cgi-bin/MODIS/GLBVIZ_1_Glb/modis_subset_order_global_col5.pl and then select the area at Khao Nan National Park by 3*3 Kilomrters encompassing the center location.

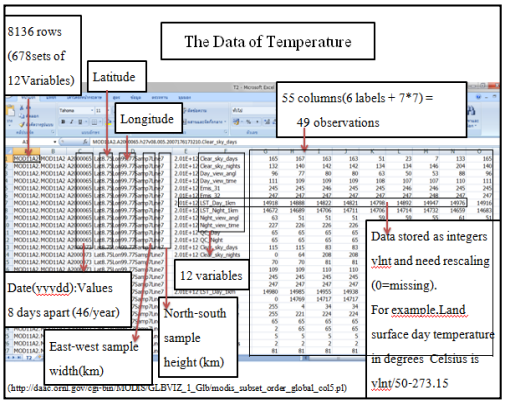

Figure 2. The data of LST recored by MODIS Earth Satellites

Data Management

After we got the data file as **figure 2**. We selected variable LST_Day_1km and observations in columns 7-55. This gave a data table of integers with 678 rows & 49(7*7) columns. Since the data is large and complicated we managed by simplify these data to take binary values 0 (if 0) or 1 (if greater than 0) and then select days>169 of 2000 to days<177 of 2015 , so we have 671 rows. The data was plotted these data each 8 days (with 671 observations over the 15-year period) and fit natural cubic spline functions (with 464 observations over 46 times per years). We combined the data each year during 2000-2015 plotting these data as Time series (with 464 observations over the 16-year period) and fit natural cubic spline functions to these time series. The last we used GEE for parameter estimate.

Data Analysis and Statistics

- Fit **natural cubic spline functions** to these time series by simply using **Linear regression** for predicting temperature and vegetation index.
- The data was plotted as **time series** (with 464 observations over the 16 year period) for pattern of temperature during 2000 - 2015.
- **GEE (general estimated equation) or a mixed linear models:GEE** A common method used to estimate the parameters . When the data is long-term data. It was measured in duplicate . when the sample data is correlation **Hanley JA[3],.Venables WN[4].**

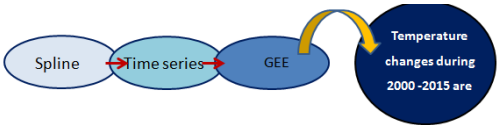

Figure 3. Data Analysis and Statistics framework

RESULT

The climate in southern Thailand are 2 seasons such as dry and rain, the dry season is started around day 65 and the highest temperature is around on day 95 which is at the beginning of april.The maximum and minimum temperature are 38.2 and 13.9 respectively over the 15-year period. The average temperature is 26.5 degrees.

Temperature pattern

We plotted these data as time series every eight days over the 15-year period and fit natural cubic spline functions with knots 20 ,50,80 ,130 ,180 ,230 ,280 and 320.

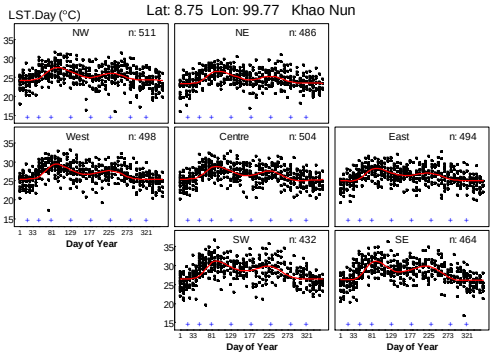

Figure 4. Temperature pattern in all of seven selected pixels.

Temperature variation

As we knew our data is large so we needed to devide as 2000-2005, 2006-2009 and 2010-2015 and then applied GEE for parameter estimate with Wald test**.**

Table 1. Analyzing the data as Exchangeable of General Estimated Equation (GEE)

		General Estimated Equation (GEE) Exchangeable			
Year	**Variable**	**Estimate**	**Standard Error**	**Wald**	**Pr>|Z|**
2000-2005	Intercept	26.2217	0.4754	3042.02	< 2e-16 ***
	Obs	0.0009	0.002	19.28	0.0000113 ***
2006-2009	Intercept	26.059727	0.352312	5471.2	< 2e-16 ***
	Obs	0.001369	0.000409	11.2	0.00083 ***
2010-2015	Intercept	26.087645	0.510286	2613.6	< 2e-16 ***
	Obs	0.001462	0.000291	25.3	0.0000005 ***

CONCLUSION

This study investigated temperature pattern and variation at Khao Nan. The temperature have same pattern in all of seven selected pixels. The temperature have changed as following :

The equation of temperature change during 2000-2005 :

$$T_{2000-2005} = 26.2217 + 0.0009Obs$$

The equation of temperature change during 2006-2009 :

$$T_{2006-2009} = 26.0597 + 0.0014Obs$$

The equation of temperature change during 2010-2015 :

$$T_{2000-2005} = 26.0877 + 0.0015Obs$$

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