# EFFECTS OF ENSO PHENOMENON ON AVERAGE RAINFALL DATASET

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**KEY WORDS**: ENSO, average rainfall, Kriging interpolation, GIS, Phuket Province

**Abstract:** This study aims to investigate an appropriate range of average rainfall in Phuket Province, Thailand for using in GIS applications. Kriging interpolation technique was used in the study. Rainfall data and Historical of ENSO phenomenon between 2002 and 2011 were collected from Meteorology Department, Royal Irrigation Department and NOAA (National Oceanic and Atmospheric Administration), respectively. Three average rainfall data ranges were compared by one-way ANOVA technique including 1) Average rainfall during El Nino period 2) Average rainfall during La Nina period and 3) Average rainfall during Normal period. The results show that the average rainfall was significantly different at 0.05 level. The use of average rainfall in Phuket area should be covered La Nina phenomenon El Nino phenomenon and Normal periods for further related studies.

## INTRODUCTION

Currently, global climate change issue is the important problem. These changes impact ecosystems and the human life such as an increase in the areas affected by drought and flooding, increased tropical storms activity and increased incidence of extreme high sea level. Changes have been observed in the amount, intensity, frequency, and type of precipitation (Thomas et al, 2009).

Phuket is located in South of Thailand (Figure 1). The main source of water supply comes from rainfall which falls almost in the rainy season (May-October). The main mechanism of rainfall is the southwest monsoon from the Indian Ocean which brings vapor and moisture becomes to rainfall over the province (Thai meteorological department, n.d.). The abundance of rainfall supports the growing crops. However, in some years, the monsoon brings excessive rains and causes floods and destruction. The opposite way, in some years, there is only sparse rainfall. The result is a drought and crop damage. The causes of variation in southwest monsoon depend on many factors. One of the interesting factors is the El Nino Southern Oscillation (ENSO) phenomenon (Wonlee et al, 2006; citing Miyagawa et al, 1985; Nawata, 1997).

ENSO's inner workings are complicated and important consequences for weather around the globe (Catherine and Jason, 2009). Pacific is characterized by sea surface temperature anomalies and associated changes in the atmospheric circulation (Philippine Institute for Development Studies, 2005; Dijkstra, 2006). The rotation of the Earth causes trade winds in low latitudes to blow hard from the east, pushing warm surface water in the tropical Pacific Ocean westward near the northern coast of Australia like a snow plow. As the warm water pools, it works in tandem with intense solar rays to heat the surrounding air. The hot air then rises like a balloon, creating a zone of low air pressure. As the air ascends, it cools and condenses, forming cotton-ball clouds that burst with rain. That air then travels east and descends near the coast of Peru and Ecuador. Sinking air piles on the Earth's surface, forming a high pressure zone that acts like a vice. The pressure difference squeezes air in the east toward the west, where it fills the void created by the hot, rising air.In this way, a large circular pattern known as the Walker circulation is completed. Although the Walker circulation is always in motion, its movement is tuned by El Nino and La Nina events, which regulate sea surface temperatures and wind speed. During El Nino events, the trade winds slacken, enabling an eastward migration of warm water. The center of rain follows, moving east to the middle of the Pacific Ocean near Tahiti. La Nina events behave in the opposite way; the trade winds intensify and stack the warm surface water in the west even more than in normal years, the waters near Australia are often five feet higher than the ocean surface in the east during La Nina episodes. The area of intense rainfall is dragged back toward Australia (Zack, 2010). The effects of ENSO phenomenon Cause abnormal rainfall in the equatorial region.

This study aims to investigate an appropriate range of average rainfall in Phuket Province. The data used in hydrology such as water balance modeling, soil water modeling, rainfall-runoff modeling.

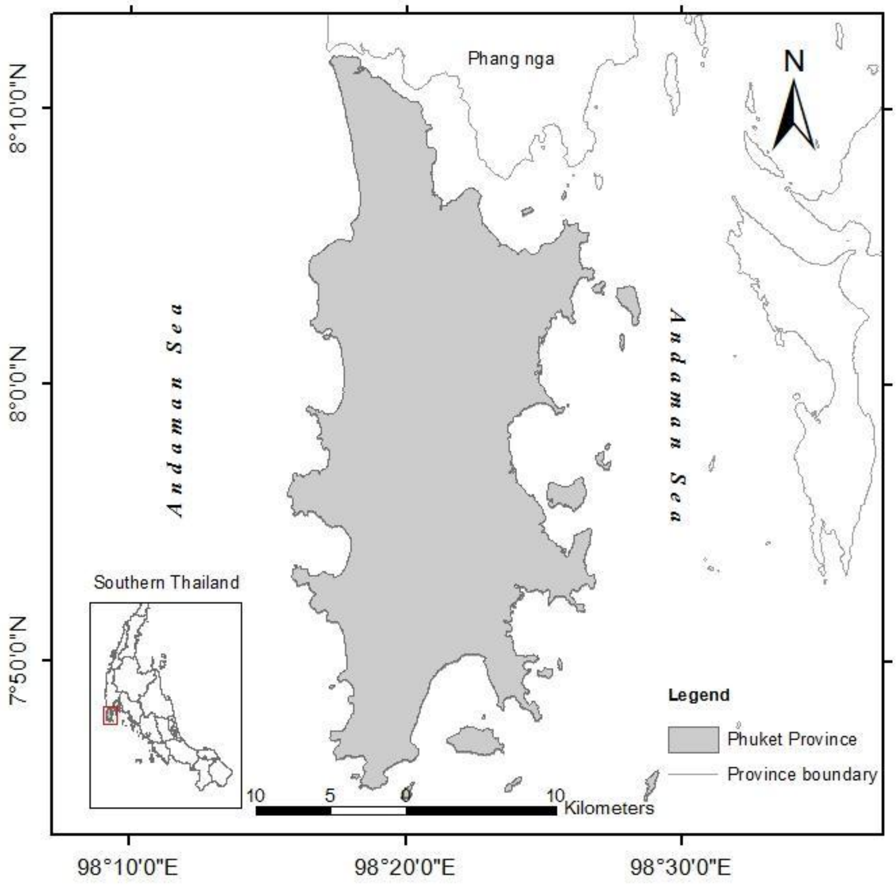


**Figure 1:** The study area

## DATA AND METHODS

### *Data*

1. Rainfall data

Phuket province is a small island. The Island is mostly mountainous with a mountain range in the west of the island from the north to the south, tropical climate, more specifically a tropical monsoon climate, with a dry season from November to April and a rainy season from May to October (Phuket Provincial Administrative Organization, 2011). The average monthly rainfall of Phuket Province is shown in Figure 2.

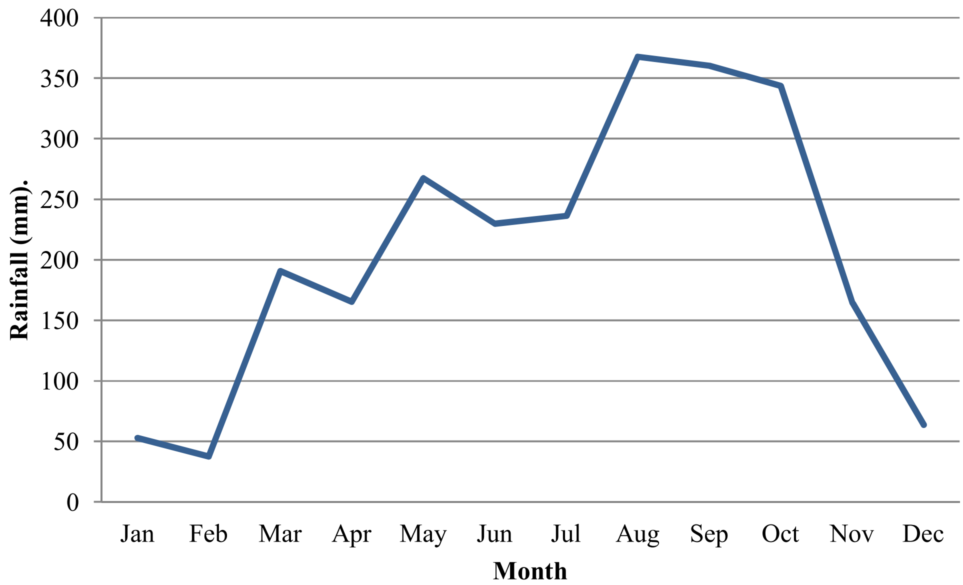


**Figure 2:** Average monthly rainfall of Phuket Province between 2007 and 2011 from Thai Meteorological Department and Royal Irrigation Department.

In this study, the daily rainfall data between 2002 and 2011 are collected from Thai Meteorological Department and Royal Irrigation Department. There were 5 and 4 observed rain gauge stations, respectively. Figure 3 shows the locations of 9 observed rain gauge stations.

**Table 1:** Locations of rain gauge stations in this study; modified from (Hydrology and Water Management Center for Southern Region, n.d.).

| No. | Station name | Province | Coordinate | |
|---|---|---|---|---|
| | | | X | Y |
| 1 | Bangniewdum | Phuket | 426424.00 | 880903.00 |
| 2 | Bang wad | Phuket | 426600.00 | 872614.00 |
| 3 | Ko Lanta | Krabi | 505516.00 | 832708.00 |
| 4 | Krabi | Krabi | 488981.00 | 889826.00 |
| 5 | Moung | Phuket | 432247.00 | 872112.00 |
| 6 | Phuket Airport | Phuket | 424477.00 | 900391.00 |
| 7 | Phuket | Phuket | 433860.00 | 871447.00 |
| 8 | Takua Pa | Phang nga | 417736.47 | 960015.00 |
| 9 | Thalang | Phuket | 426572.00 | 887844.00 |

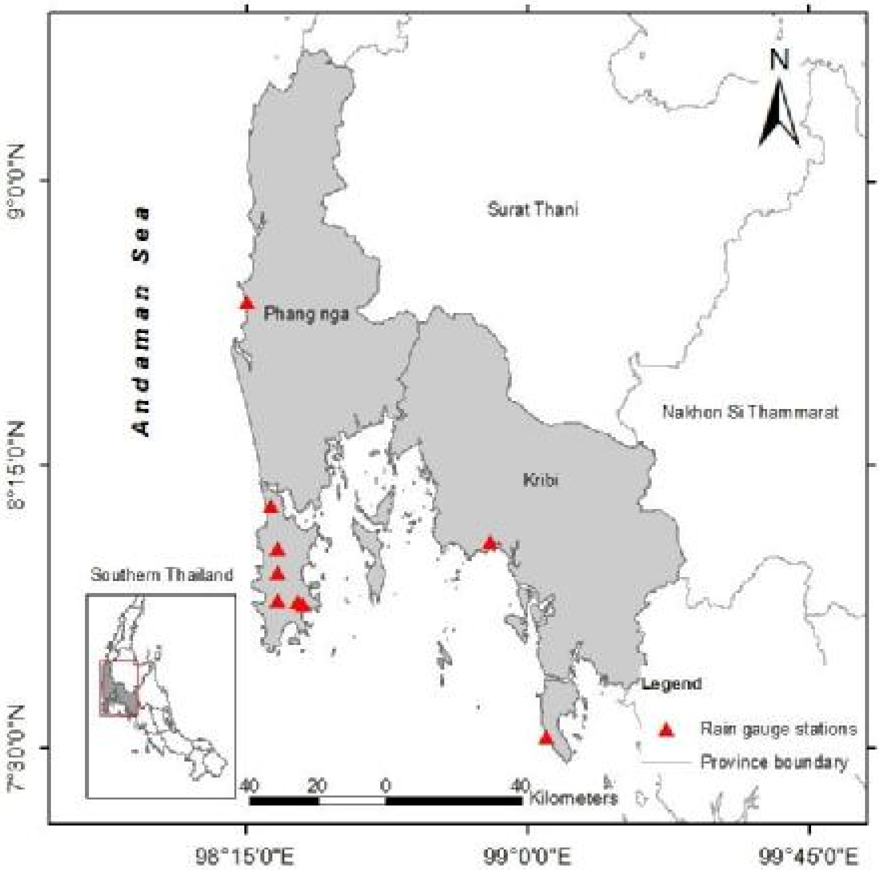


**Figure 3:** Locations of rain gauge stations

2. Historical of El Nino and La Nina phenomena between 2002 and 2011 were taken from NOAA (Table 2).

**Table 2:** Historical of El Nino La Nina and Normal rainfall period; modified from (NOAA, n.d.).

| Phenomena periods | Year |
|---|---|
| El Nino | 2002, 2004, 2006, 2009 |
| La Nina | 2007, 2010, 2011 |
| Normal | 2003, 2005 |

***Methodology***

Interpolation technique in which the surrounding measured values are weighted to derive a predicted value for an unmeasured location. Weights are based on the distance between the measured points, the prediction locations, and the overall spatial arrangement among the measured points. Kriging is unique among the interpolation methods in that it provides an easy method for characterizing the variance, or the precision, of predictions. Kriging is based on regionalized variable theory, which assumes that the spatial variation in the data being modeled is homogeneous across the surface. That is the same pattern of variation can be observed at all locations on the surface (Environmental Systems Research Institute, n.d.). Two main processes were 1) estimate the average weekly rainfall data. 2) compare the difference of average weekly rainfall each phenomenon by one way ANOVA technique. Figure 4 shows processing outline of this study.

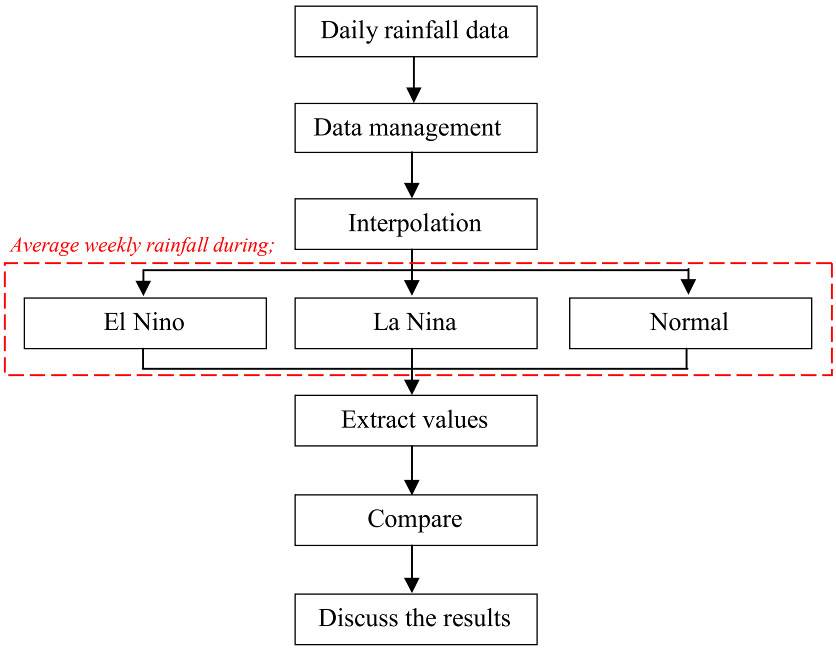


**Figure 4:** Processing outline of this study

**RESULTS**

Selected average rainfall period distributions including El Nino, La Nina and Normal periods are shown in Figure 5. Kriging interpolation technique was used to interpolate the average weekly rainfall from 9 rain gauge stations. Samples of Kriging interpolation results during each period are shown in Figure 6.

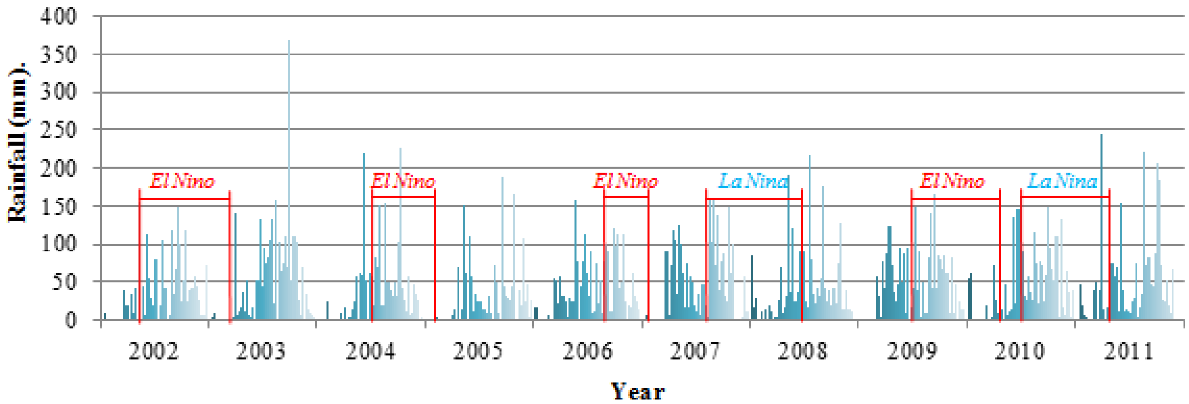


**Figure 5:** Selected average rainfall distribution in the study

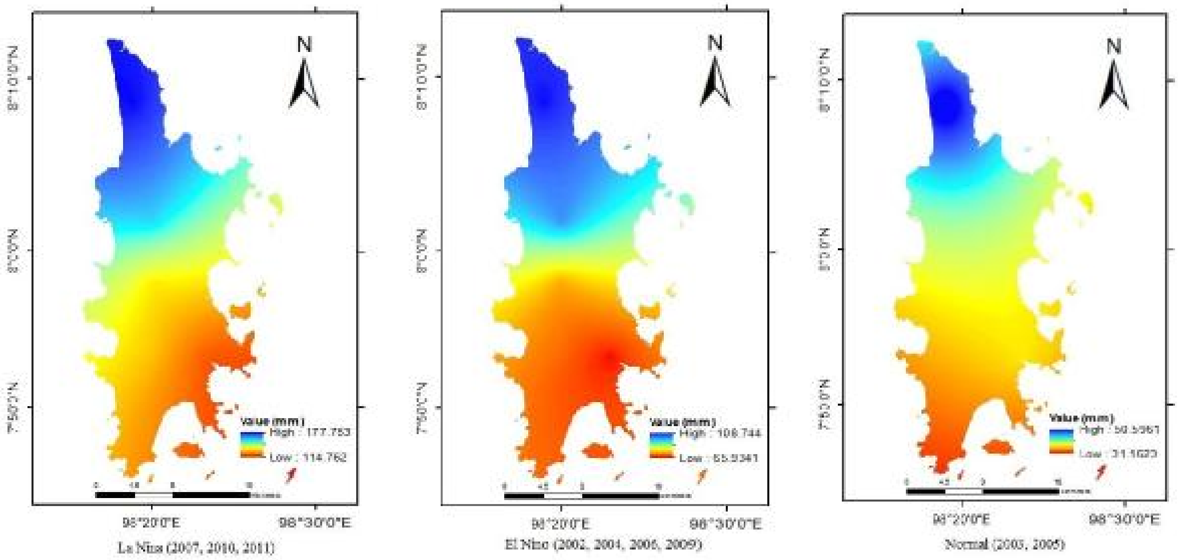


**Figure 6:** Samples of Kriging interpolation results in Week 34 during each period

An examination of the relationship between averaged weekly rainfall during the El Nino, La Nina and Normal periods are shown in Table 3. The independency of datasets was tested with one-way ANOVA. The results showed that average rainfall from each phenomenon were significantly different from each other at the 0.05 level.

**Table 3**: Compare the average weekly rainfall by one-way ANOVA technique.

| phenomena(I) | phenomena (J) | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval Lower Bound | 95% Confidence Interval Upper Bound |
|---|---|---|---|---|---|---|
| El Nino | La Nina | -5.16* | .78 | .00 | -6.69 | -3.63 |
| | Normal | 1.63* | .78 | .04 | .1 | 3.16 |
| La Nina | El Nino | 5.16* | .78 | .00 | 3.63 | 6.69 |
| | Normal | 6.79* | .78 | .00 | 5.26 | 8.31 |
| Normal | El Nino | -1.63* | .78 | .04 | -3.16 | .1 |
| | La Nina | -6.79* | .78 | .00 | -8.31 | -5.26 |

*. The mean difference is significant at the 0.05 level.

**DISCUSSION**

From the results, all average rainfall was different from each other. Moreover, average rainfall during La Nina phenomenon was higher than average rainfall during El Nino phenomenon and during Normal respectively. This results corresponding with the period studies (Wonlee et al, 2006; Khanitta, 2009). Conversely, the interest was the average rainfall during El Nino phenomenon was higher than the Normal. This is not consistent with the fact that during normal rainfall period was higher than during El Nino.

*The results may be caused as follows;*

1) It might be because of the results of the influence of the southwest monsoon.

2) Weekly analysis is overly detail as the number of week might be not relevant on the average rainfall.

3) As this study assumed that the selected years were represented of each phenomenon, the selected period should be concerned to get the correct period of phenomenon.

**CONCLUSIONS & RECOMMENDATIONS**

Recently, the patterns of rainfall distribution are very important on related applications such as hydrological/climate change modeling. Since the variation of the rainfall distribution pattern has been changed from the past and it should not be used for specific purposes. The selection of average rainfall is an important for representing spatial distribution in GIS applications. In this study attempted to find out the suitable period for further hydrological studies in Phuket area. The average rainfall during El Nino (2002, 2004, 2006 and 2009), La Nina (2007, 2010 and 2011) and Normal periods (2003 and 2005) in Phuket province was compared using One-Way ANOVA analysis and the results showed the selected average rainfall during each phenomenon was significantly differences at 0.05 levels. The average rainfall period should be covered the ENSO phenomenon period as the selected periods could not be the descriptive of rainfall pattern distribution in the study area. The results are possibly useful for further studies in Phuket province related rainfall pattern distribution for climate and hydrological modeling.

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