The effect of climate change on dengue cases in Muang Nakhon Si Thammarat

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ABSTRACT

This study investigated climatic change in El Niño, Normal and La Niña group affecting dengue cases and house index in Nakhon Si Thammarat, Thailand. We randomly selected 5 households in Princess Chulabhorn Science High School, and collected mosquito larvae from indoor and outdoor water containers. We identified *Aedes* larvae up to species level under microscope. We compared dengue cases between El Niño, Normal and La Niña group during 2011-2016. The results showed that Dengue cases in Muang Nakhon Si Thammarat between groups were different ($_{F2,36}=9.422$, P<0.05). The Tukey HSD statistics showed that number of dengue incidences in El Niño range were higher than Normal and La Niña range. In El Niño range, showed highest dengue incedences in January, Febuary and December, Normal range was showed March April and May and La Niña range showed gangue incedences lowest than other. From the mosquito larva data collected in November 2016, Princess Chulabhorn Science High School had house index of 100.00% for *Ae*. larvae. This indicated that Princess Chulabhorn Science High School is the dengue high risk area according to the WHO standard for dengue risk area.

Keywords: El Niño, La Niña, dengue patients and Muang Nakorn Si Thammarat, Thailand

Research Questions

- 1. How does climate change correlate with the number of dengue cases in Muang Nakhon Si Thammarat?
- 2. How do the El Niño and La Niña influence the dengue cases in Muang Nakhon Si Thammarat?

Introduction and review of literature

Dengue is a mosquito-borne viral disease that is transmitted by female mosquitoes mainly of the species Aedes aegypti and Ae. albopictus. This mosquito also transmits chikungunya, yellow fever and Zika infection. Dengue is widespread throughout the tropics, with local variations in risk influenced by rainfall, temperature and unplanned rapid urbanization (WHO, 2016). The actual numbers of dengue estimate indicates 390 million dengue infections per year (95% credible interval 284-528 million) (Bhatt S, Gething PW, Brady OJ, Messina JP, Farlow AW, Moyes CL et.al., 2017.), Another study of the prevalence of dengue, estimates that 3.9 billion people, in 128 countries, are at risk of infection with dengue viruses (Brady OJ, Gething PW, Bhatt S, Messina JP, Brownstein JS, Hoen AG et al., 2012). The year 2015 was characterized by large dengue outbreaks worldwide, with the Philippines reporting more than 169 000 cases and Malaysia exceeding 111 000 suspected cases of dengue, representing a 59.5% and 16% increase in case numbers to the previous year, respectively (WHO, 2016). Thailand is a country affected by dengue fever. In 2015 shows the highest number of patients in 20 years, there were 142,925 cases and 141 deaths. (Bureau of sexually transmitted disease by insects, Department of Disease Control, the Ministry of Health, Thailand. 2017)

The transmission of dengue viruses is climatic sensitive for several reasons. Mosquitoes have a capable adaptation to live on climate change phenomena. Several studies examined the role of El Niño Southern Oscillation (ENSO) in dengue incidence. The studies have implied that cold temperature can limits its lifecycle, then acting as an influencing factor on its distribution (Beebe et al., 2009). Then increases in temperature, as well global warming, can potentially increase mosquito populations and dengue incidence (Reiter, 1996; Hsieh & Chen, 2009). The report showed that climate variables can increase the predictive power of dengue models (WHO, 2004). Increased temperature has been associated with dengue cases in Thailand, Indonesia, Singapore, Mexico and Puerto Rico while rainfall has been found to correlate with dengue cases in Indonesia, Trinidad, Venezuela, Barbados and

Thailand (LUZ, 2008). In year 2016, there were 63,310 cases of Dengue Hemorrhagic Fever (DHF) in Thailand, with 61 deaths (Bureau of sexually transmitted disease by insects, Department of Disease Control, the Ministry of Health, Thailand 2017). In 2015, 2418 dengue cases were reported in Nakhon Si Thammarat with 318 and 658 dengue cases at Muang Nakhon Si Thammarat district in 2015 and 2016 (Figure 1) (Province Health Office 2016). The previous report showed Dengue cases in Muang Nakhon Si Thammarat in the wet season were higher than in the dry season (Phuwadon Noradin, Thanayot Moungkaew and Thiranai Keatpimol, 2016 Virtual Science Fair)



Figure 1. Monthly dengue cases in wet and dry seasons at Muang Nakhon Si Thammarat, Thailand for January 2011- January 2016 (Phuwadon Noradin et.al. 2016).

The objectives of this study are (1) to study climate change affecting dengue cases in Muang Nakhon Si Thammarat, Thailand and (2) to determine whether Muang Nakhon Si Thammarat is the dengue risk area influenced by El Niño and La Niña based on the house index.

Materials and Methods

Study site

The study site was located at Princes Chulabhorn Science High School, Muang Nakhon Si Thammarat, southern Thailand (8.415097 °N and 99.965727 °E) (Figure 1). This district is one of most dengue outbreaks in southern Thailand. This area is about 520.249 km² with 830 populations (Princes Chulabhorn Science High School 2017).



Figure 1 Map of Princes Chulabhorn Science High School, Muang Nakhon Si Thammarat, Thailand.

Data Collection

Dengue cases in January 2011-December 2016 were obtained from the Vector-Borne Disease Control Centre laboratory 11. Nakhon Si Thammarat atmospheric data were collected from Meteorological Department of Thailand during January 1987-December 2016. Nakhon Si Thammarat atmospheric data were collected from the automatic weather station located at Princess Chulabhorn College Nakhon Si Thammarat during January 2017-March 2017.

The effect of El Nino – La Nina data from National Weather Service Climate Prediction Center during 1987-2017. We collected daily rainfall, rainy days, relative humidity,mean/min/max temperature and El nino - La nina data. We collected daily rainfall, rainy days, relative humidity,mean/min/max temperature and El nino - La nina data. We separated dengue cases from January2011-January 2016 into year of El Nino-La Nina and normal year.

Sea Surface Temperature (SST) data from : http://www.cpc.ncep.noaa.gov/data/indices/sstoi .indicesduring, January 1987 to January 2017. We collected SST data using data from Nino3.4 index. This information indicates the state and severity of sea surface temperature at each time period, whether hot or cold. And indicate the birth about El Niño and La Niña phenomena (Y. Xue, T. M. Smith, and R. W. Reynolds, 2003)

Dengue cases in January 2011-Febuary 2017 were obtained from the Vector-Borne Disease Control Centre laboratory 11.2 Nakhon Si Thammarat.

Data analysis

House index was calculated as the number of positive households divided by the total number of households inspected. Household locations with the number of mosquito larvae were visualised as the 3D overlaid on Google Earth. Descriptive statistics were calculated. Independent sampled t-test was used to test the mean differences of dengue cases and climatic factors are influenced by El Nino-La Nina and normal using the amount of rainfall, relative humidity, the number of rainy days and local temperature index. Pearson correlations were used to test the association between dengue cases and climatic factors. The significant tests were one-tailed with significant level at P < 0.05.

Results

Number of Dengue cases and Local Temperature Index

The ENSO index used in this study is the Nino3.4. Nino3.4 is the difference between monthly average SST for the area between 5° N, 5° S, 120° W and 170° W and the average for that value for the years 1987–2016. ENSO events are defined as overlapping 4-month periods at or above the + 0.5° SST anomaly for warm (El Niño) events and at or below the - 0.5 anomaly for cold (La Niña) events. We observed El Niño events in 2015–2016, Normal events in 2013–2014 (Fig. 2) And La Niña event occurred in 2011–2012(Fig. 2).



Figure 2. The relationship between Number of Dengue in Muang Nakhon Si Tammarat and Local Temperature Index.

The average (±SD) of dengue cases in El Niño, normal range and La Niña were 23.69±15.14, 18.00±9.10 and 4.41±1.22. The comparation of Dengue cases in Muang

Nakhon Si Thammarat between groups were different ($_{F2,36}=9.422$, P<0.05, Figure 2). The Tukey HSD statistics showed that number of dengue incidences in El Niño range were higher than Normal and La Niña range as showed in Figure 3.



Figure 3. The Comparation of Dangue incidences in El Niño, Normal and La Niña groups

Climatic factors and dengue cases in El Niño times.

Mean Temperature (°C) and Relative Humidity (%) were positively correlated with dengue cases in Muang Nakhon Si Thammarat in El Niño times, in Normal and La Niña times, the climatic factors were not significantly correlated with dengue cases (Table 1).

Table 1	earson	correlation	coefficient	of dengue	cases	and El N	liño's d	climatic	factors
(N=13)									

	Rainfall (mm)	Rainy days (days)	Mean Temperature (°C)	Relative Humidity (%)
El Niño time				
Pearson Correlation	0.434	0.300	-0.803	0.761
Sig (1-tailed)	0.690	0.159	0.000	0.001
La Niña time				
Pearson Correlation	0.343	-0.309	0.151	-0.419
Sig (1-tailed)	0.125	0.152	0.311	.077
Normal time				

	Deinfell (mm)	Rainy days	Mean	Relative Humidity (%)	
	Kainiali (mm)	(days)	Temperature (°C)		
Pearson Correlation	-0.092	0.107	0.433	0.125	
Sig (1-tailed)	0.383	0.364	0.070	0.342	

House index at Muang Nakhon Si Thammarat and El Niño - La Niña range.

House index was correlated with the number of dengue cases in Muang, Nakhon Si Thammarat during the El Niño - La Niña phenomenon. The During the El Nino time (Feb-16). House index and dengue cases Muang, Nakhon Si Thammarat less than during the La Nina time (Nov-16) (Table 4).

Table 4: Relationship between HI(%) and number of dengue patients during El Nino-La Nina times.

	Ae. mosquito larvae	
Feb-16(El Nino)		
No. of households	32	
No. of positive households	26	
House Index (%)	81.25	
Nov-16(La Nina)		
No. of households	5	
No. of positive households	5	
House Index (%)	100.00	

From the households collected in March 2016 (El Niño time) and November 2016 (**La Niña time**) the number of *Aedes* larvae collected at each household was displayed on Google Earth (Figure 4). House indices for *Ae*. were very high (Table 4). WHO classified dengue high risk area as the house index is a greater than 5%. This indicates that Muang Nakhon Si Thammarat is a dengue high risk area.

Discussion

Climate change is affected by **El Niño - La Niña phenomenon** influencing dengue cases and local climate variables such as temperature and rainfall, and the risk of occurrence of dengue epidemics has varied according to the strength of ENSO (Shahera Banu1, et.al.2015. Hales, S. et.al. 1999, Tipayamongkholgul, M.,et.al. 2009, Hu, W., Clements, et.al, 2010, Brunkard, J. M.,et.al. 2008, Earnest, A.,et.al. 2012, Cazelles, B., 2005). Temperature variation also influenced the vector efficiency of *Aedes*. Larvae. Beacure this effects on

parasitism comprise, Temperature, humidity, rainfall, and wind speed affect the incidence of dengue, either through changes in the duration of mosquitoes and parasite life cycles or through their influences on human, vector, or parasite behaviour (Gubler et al. 2001, Wongkoon et al. 2013). Our results showed that temperature and relative humidity were strongly correlated with dengue cases on **El Niño** time in Muang Nakhon Si Thammarat, Thailand. In figure 3, indicates that mosquito eggs tend to be more viable in high temperature than normal cold season, it mean that on El Niño time in December, January and Febuary, Local weather should be warmer than normal cold and provide baseline information for identifying longer-term effects of on dengue expected.

This study clearly demonstrates that dengue cases were higher in the **El Niño time** than in **La Niña and normal time**. The present of dengue cases were clearly showed that it was an increase in the number of dengue cases in the rainy season that was influenced by the El Niño phenomenon. The temperature increases while the humidity is moderate caused to high egg hatching rates. Many studies have reported increases in temperature , more humid weather can affect the dengue density and transmission (Foo et al., 1985, WHO, 1998, Hales et al., 1996, Xiaodong Huang, et.al.,2015). And also estimated the warm weather encouraged mosquitoes to become more aggressive and have a shorter-than-usual life cycle (Dawn H. Gouge, et.al.,2016).

Larval surveillance during this study was important to find out the extent of prevalence of vectors in a locality. House index was used in this study to help stratifying DHF risk areas for further control and monitoring of the vector population in defined areas. House index from our study indicated a high risk of DHF transmission. The WHO standard for high DHF risk areas was 5 % house index. This indicates a high risk of DHF transmission in Nakhon Si Thammarat Province, Thailand. Our results showed 81.25 % house index for *Ae. aegypti* larvae in **El Niño effect** and 100% house index for *Ae.* in **La Niña effect** at Muang Nakhon Si Thammarat. Promprou et al. (2007) studied six districts in Nakhon Si Thammarat. Promprou et al. (2007) studied six districts in Nakhon Si Thammarat and found that all six districts had higher house index than WHO standard for high DHF risk areas. As we are GLOBE students, we should launch some campaign to raise some awareness on mosquito larvae in the area. And Be aware of **El Niño effect** during the rainy season.

Acknowledgements

We thank Assoc. Teacher Kanokrat Singnui and Dorian Janney(GPM) for helping with give an advice experimental design, data analysis and manuscript preparation. This work was supported in part by Princess Chulabhorn's College Nakhon Si Thammarat and The faculty and staff of the Walailak University.

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