Seasons and Climatic Factors Affecting Dengue Cases in Muang Nakhon Si Thammarat, Thailand

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ABSTRACT

This study investigated climatic factors affecting dengue cases and house index in Nakhon Si Thammarat, Thailand. We randomly selected 32 households, and collected mosquito larvae from indoor and outdoor water containers. We identified *Aedes aegypti*, and *Ae. albopictus* larvae up to species level under microscope. We compared dengue cases between wet and dry seasons during 2011-2015. The results showed that dengue cases in the wet season were higher than in the dry season. Relative humidity was positively correlated with dengue cases in this area. From the mosquito larva data collected in March 2016, Muang Nakhon Si Thammarat had house index of 59.38% for *Ae. aegypti* larvae and 62.50% for *Ae. albopictus* larvae. This indicated that Muang Nakhon Si Thammarat is the dengue high risk area according to the WHO standard for dengue risk area.

Keywords: dengue cases, atmospheric measurement, GLOBE, Thailand, Nakhon Si Thammarat

1. Introduction

Dengue fever is a viral illness caused by infection dengue virus that is carrying and transmitting diseases by mosquitoes. The nearly 700 million people are affected with diseases transmitted by mosquitoes (Caraballo 2014). Different kinds of natural (tree-holes, bamboo, leaf axils, rock-pools, etc.) and man-made/artificial (water tanks, bottles, tires, flower vases, etc.) habitats are used as mosquito breeding sites (Service 1995, Wongkoon et al. 2005, 2007, Preechaporn et al. 2006; Thangamathi 2014). *Ae. aegypti*, *Ae. albopictus* and *Culex quinquefasciatus* prefer to breed in different kinds of water containers (Vezzani 2007).

The transmission of dengue viruses is climatic sensitive for several reasons. Mosquitoes have a capable adaptation to live on climate change phenomena. 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). Accordingly, temperature could be accompanied with increases in the population of the *Aedes* species and dengue fever infections. Furthermore, mosquito population dynamics vary for different geographic regions where dengue is transmitted suggesting that the influence of climate on dengue may be site-specific (Scott 2003). An important observation related to dengue transmission in tropical areas like Philippines, and Thailand is an increase in dengue cases during the rainy season (i.e. July–November) (Forattini et al. 1993).

In year 2015, there were 11,162 cases of Dengue Hemorrhagic Fever (DHF) in southern Thailand, with 12 deaths (Bureau of Epidemiology, Department of Disease Control, the Ministry of Health, Thailand 2016). In 2015, 2128 dengue cases were reported in Nakhon Si Thammarat with 455 and 318 dengue cases at Muang Nakhon Si Thammarat district in 2014 and 2015 (Figure 1) (Province Health Office 2016).

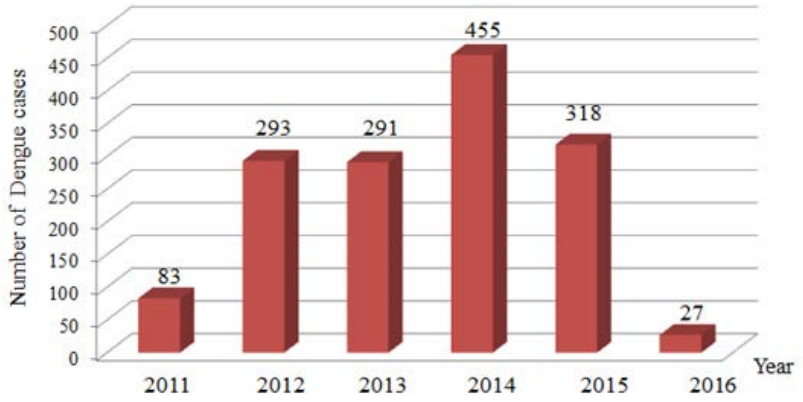


Figure 1. Dengue cases reported in Muang Nakhon Si Thammarat, Thailand during January 2011-January 2016

The objectives of this study are (1) to study climatic factors affecting dengue cases in Muang Nakhon Si Thammarat, Thailand and (2) to determine whether Muang Nakhon Si Thammarat is the dengue risk area based on the container index.

2. Materials and Methods

Study site

The study site was located at Muang Nakhon Si Thammarat, southern Thailand (8.415097 °N and 99.965727 °E) (Figure 2). This area is one of most dengue outbreaks in southern Thailand. This district is about 520.249 km^2 with 23 sub-districts, 125 villages, 84070 houses, and 266,619 populations (Muang Nakhon Si Thammarat District Register Office 2009).

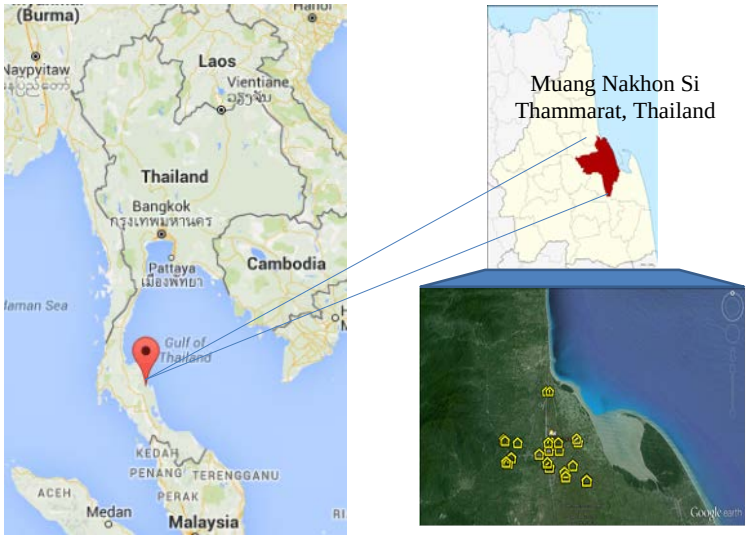


Figure 2. Map of Thailand and study site at Nakhon Si Thammarat province, Thailand

Data Collection

Dengue cases in January 2014-January 2016 were obtained from the Vector-Borne Disease Control Centre laboratory 11.2 Nakhon Si Thammarat. Atmospheric data were collected from the automatic weather station located at Princess Chulabhorn College Nakhon Si Thammarat during January 2014-February 2016. We collected daily rainfall, rainy days, relative humidity and mean/min/max temperature. We separated dengue cases from 2011-2015 into wet and dry seasons. Wet seasons started from August and ended in December. Dry seasons started from January and ended in May.

There were 16 subdistricts in Muang Nakhon Si Thammarat. We randomly selected two households per subdistricts and collected mosquito larvae based on the GLOBE mosquito protocols with a total of 32 households. Household latitude, longitude and elevations were collected using smartphone App. Mosquito larva and atmospheric data were reported to the GLOBE website under Princess Chulabhorn College Nakhon Si Thammarat. Mosquito larvae were collected from all water containers by using fishnets with 0.55 mm mesh size from both indoor and outdoor containers during 5-6 March 2016. All mosquito larvae in each water container were placed in a plastic bag and tied the bag with a rubber band (Chumsri et al. 2015). We preserved mosquito larvae in 70% alcohol in the laboratory and identified them up to *Ae. aegypti* and *Ae. albopictus* using Rattanarithikul and Panthusiri's keys (Rattanarithikul et al. 1994). Other mosquito larvae were not used in this study. All preserved mosquito larvae were kept at Princess Chulabhorn College Nakhon Si Thammarat laboratory.

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 between wet and dry seasons. Pearson correlations were used to test the association between dengue cases and climatic factors. The significant tests were one-tailed with significant level at $P<0.05$.

3. Results

Dengue cases in wet and dry seasons

The average (±SD) dengue cases in wet and dry seasons were 32.16±28.65 and 17.72±14.70. Dengue cases in Muang Nakhon Si Thammarat in the wet season were higher than in the dry season ($t_{35.823}$=2.242, P<0.05, Figure 3).

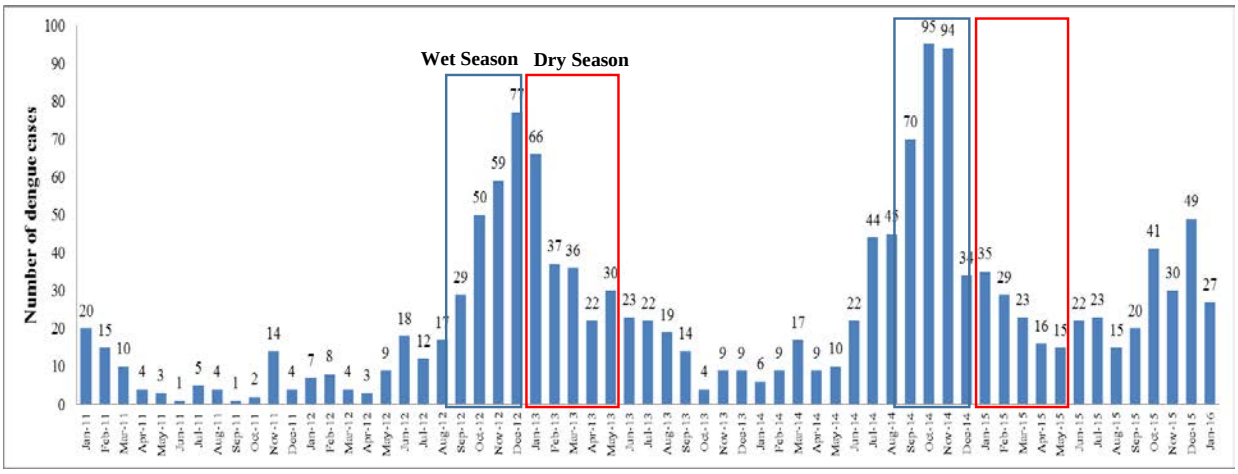


Figure 3. Monthly dengue cases in wet and dry seasons at Muang Nakhon Si Thammarat, Thailand for January 2011- January 2016.

Climatic factors and dengue cases

Relative humidity was positively correlated with dengue cases in Muang Nakhon Si Thammarat but the amount of rainfall, the number of rainy days and mean/min/max temperature were not significantly correlated with dengue cases (Table 1).

Table 1 Pearson correlation coefficient of dengue cases and climatic factors (N=18)

	Rainfall (mm)	Relative Humidity (%)	Rainy days (days)	Temperature (°C)		
				Mean	Maximum	Minimum
Pearson Correlation	0.306	0.448	0.351	-0.364	-0.295	0.209
Sig (1-tailed)	0.108	0.031	0.076	0.690	0.117	0.202

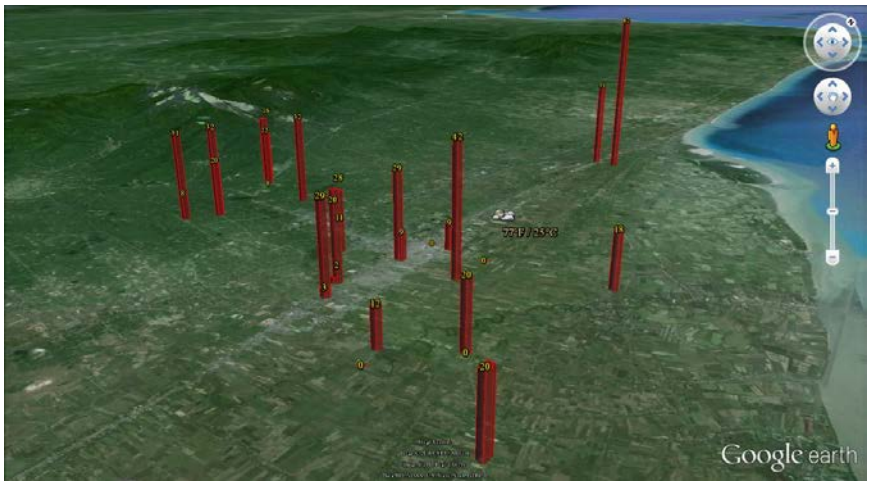
House index at Muang Nakhon Si Thammarat

Table 2. Positive households and house index for *Ae. aegypti* and *Ae. albopictus* mosquito larvae in March 2016 at Muang Nakhon Si Thammarat, Thailand

	***Ae. aegypti* mosquito larvae**	***Ae. albopictus* mosquito larvae**
No. of households	32	32
No. of positive households	19	20
House Index (%)	59.38	62.50

From 32 households collected in March 2016, the number of *Aedes* larvae collected at each household was displayed on Google Earth (Figure 4a). House indices for *Ae. aegypti* and *Ae. albopictus* were very high (Table 2). 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.

(a)



(b)

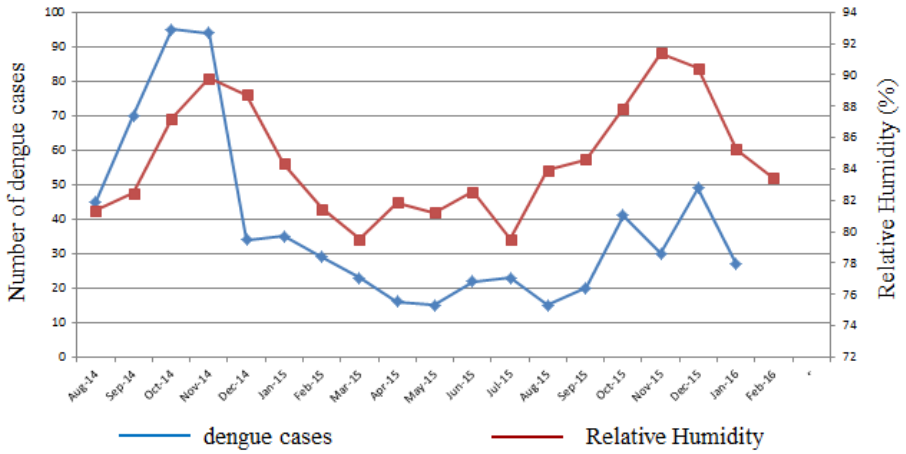


Figure 4. (a) The number of *Aedes* larvae collected at each household and (b) monthly reports of dengue cases and relative humidity (%) in Muang Nakhon Si Thammarat, Thailand from August 2014 to February 2016.

4. Discussion

Climatic factors influencing dengue cases comprise of monthly average rainfall, vapour pressure and maximum, minimum and mean temperatures (Hales et al. 2002). 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 relative humidity was strongly correlated with dengue cases in Muang Nakhon Si Thammarat, Thailand. This indicates that mosquito eggs tend to be more viable in high humidity. Local community should be warned during dengue high risk period as relative humidity increases.

This study clearly demonstrates that dengue cases were higher in the wet season than in the dry season. The possible explanation is that the number of *Aedes* larvae might also be higher in the wet season than in the dry season. Many studies have reported the same this in many countries such as Thailand (Thavara et al. 2001, Strickman et al. 2003), Fiji (Raju 2003) and the U.S. (Hoeck et al. 2003). Long rainy seasons, with peculiar water use patterns of the residents, create favourable conditions leading to a high number of *Aedes* larvae in the rainy season. People living in Nakhon Si Thammarat prefer rain- and well water to piped water for drinking and cooking purposes, and, for this reason, rain- and well water are always stored in water containers in and around the house.

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 59.68% house index for *Ae. aegypti* larvae and 62.50% house index for *Ae. albopictus* at Muang 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.

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