Aedes Aegypti Larval Survey Vector and Analysis Risk Area for Dengue Hemorrhagic Fever

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Abstract

Dengue Hemorrhagic Fever (DHF) is a major health problem in Thailand. The primary vector is the mosquito Aedes aegypti. Causes of the disease pandemic are including lack of a better understanding of local people in DHF surveillance and control, poor water supply and waste water management. The purposes of this research were to investigate existing larval vector households in the study area, and to apply geographic information systems (GIS) for dengue hemorrhagic fever risk area identification during three outbreak periods (pre seasonal, seasonal, and post seasonal). The dengue vector indices (HI, CI, BI) of visual larval were employed for existing larval households identification. The larvae were mostly found in usable water containers in all 3 periods. The dengue vector indices (HI, CI, and BI) were higher than normal value in seasonal outbreaks. The dengue hemorrhagic fever risk area identification using GIS program showed the boundary of breeding area of Aedes aegypti within 30 and 60 meters. The Aedes aegypti larva was distributed covering all area. The highest risk of DHF transmission was found in seasonal outbreaks and still remains high in post seasonal outbreaks. GIS is an alternative method to predict the breeding location of dengue mosquito and DHF and apply for decision supporting system, surveillance, and epidemiological control of DHF.

1. Background

Dengue Hemorrhagic Fever (DHF) has been a crucial health problem for more than 40 years around the world (Thara, 2001), especially in the tropical countries. The vector of dengue hemorrhagic fever in Thailand is primarily *Aeds aegypti* (Thavara et al., 1995, Thavara et al., 2001 and Luemoh et al., 2003). Previous studies have shown that key breeding sites of *Aedes aegypti* (i.e., locations of high larval abundance) comprise of cement tanks, and potteries inside and outside household dwellings (Preechaporn et al., 2006, Gould et al., 1970, Scanlon and Esah, 1965, Ansari and Razdan, 1998, Dieng et al., 2002, Wongkoon et al., 2005 and Kittayapong and Strickman, 1993). Other factors influencing DHF epidemiology include difference types of water storage, seasonal and climate variations. The House Index (HI), Container Index (CI), and Breteau Index (BI) are widely-used to predict for DHF (Preechaporn et al., 2006). Previous pandemics, population, and human sanitation play the important roles in the spread of this disease. In Thailand, the DHF cases have been varied every year from 20,000 to more than 100,000 cases annually (Bureau of Epidemiology, Department of Disease Control, Ministry of Public Health, 1997), whereas the mortality rate has recently been significantly decreased.

Ubon Ratchathani province is known as one of the highest incidence of DHF. The DHF case has reported approximately forty-six cases (per 100,000 populations) in 2005, as well as, thirty-three cases (per 100,000 populations) in 2006 respectively (Department of Public Health, Ministry of Public Health, 2005 and 2006). The main causes of the disease pandemic are indicated poor understanding of DHF surveillance and control of the local people, and a poor environment regarding water supply and waste water management. It was also indicated that Pakhuaiwangnong village is the most common area facing up these problems. In our study, GIS was used to predict breeding area of DHF, decision supporting system, surveillance, and control DHF in Pakhauiwangnong village, Ubon Ratchathani province. This village was chosen, because it has been reported to be an endemic area of DHF. In addition, it is also surrounded with several water resources which are preferable environment for mosquito species. To control the DHF in Thailand, geographic information system (GIS) was used as an analysis tool to mapping the distribution of DHF. It was done by creating an overlay of epidemiological and digitized province data over a NOAA normalized difference vegetation index image (Sithiprasasna, 1997).

In addition, the Global Positioning System (GPS) was used to locate the distribution of DHF cases (Chaikoolvatana, 2008) and transfer into GIS database. Recently, they have been many papers regarding the use of GIS in dengue mosquito and hemorrhagic fever surveillance (WHO, 1972, Focks and Chadee, 1997, Chandaeng et al., 1997, Russo and McCai, 1979, Crovello, 1972, WHO, 1985, Russo and McCausland, 1983, Singhasivanon, 2003 and Goh, 1997). Thus, the research aims to investigate the larva vector situation and to apply GIS for dengue hemorrhagic fever identification to determine breeding site prediction, decision support system, surveillance, and DHF control.

2. Methods
2.1 Study Area
Pakhauiwangnong is located at $15^\circ 14' 23.32''$ north and $104^\circ 53' 5.65''$ eastern part of Ubon Ratchathani, Thailand. A major river called Moon and a Haui Wang Nong irrigation canal run and through the city area. The average monthly rainfall is 169.6 mm in 2007.

2.2 Larval Vector Survey
2.2.1 Containers
The households were randomized 70% of all. The dengue vector indices (House index (HI), Container index (CI), Breteau index (BI)) were collected by using WHO standard method; the Visual Larval Survey (WHO, 1972) to indicate the density of mosquitoes. These indices are the indicators of association between household, containers, and are considered to be the most informative measures of mosquito density levels. For the containers, all of the natural and artificial containers in every household either indoor or outdoor were inspected to determine the presence or absence of *Aeds aegypti*

2.3 Period of Study
The data survey was divided into 3 periods: Pre seasonal outbreak (February – April 2007), Seasonal outbreak (June – September 2007) and Post seasonal outbreak (October – January 2008)

2.4 Vector analysis
For analyze dengue vector indices, they were calculated by using these equations;

$$\text{House Index (HI)} = \frac{\text{a number of houses found mosquito larvae x 100}}{\text{A total number of houses}}$$

Equation 1

$$\text{Container Index} = \frac{\text{a number of containers found mosquito larvae x 100}}{\text{A total number of containers}}$$

Equation 2

$$\text{Breteau Index (BI)} = \frac{\text{a number of containers found mosquito larvae x 100}}{\text{A total number of houses}}$$

Equation 3

2.5 Software analysis
The risk area for DHF was analyzed by using ArcView software 9.2. The position of house in Pakhuaiwangnong village used the GPS tool. The relation of field data between spatial data and attribute data was created. The database of DHF defined the boundary of breeding place of *Aeds aegypti* by creating buffer of 30 meters and 60 meters of point and compared to the differences in 3 time periods.

3. Results
3.1 Larval Indices
In pre seasonal outbreaks, the larvae were found in 31 from 206 households. The mosquito larvae were found in 52 from 815 containers as shown in Table 1. In seasonal outbreaks, the larvae were found in 91 from 204 households. The mosquito larvae were found in 140 from 981 containers. For post seasonal outbreaks, the survey revealed that the larvae were found in 62 from 198 households. The containers that found larvae were 88 containers from 821 containers. For the analysis of dengue vector indices, we found that the HI, CI, and BI were 15.05, 6.38, and 25.24 respectively in pre seasonal outbreaks. In seasonal outbreaks, the dengue vector indices were increased. The HI, CI, and BI were 44.61, 14.20, and 68.63 respectively. Meanwhile, in post seasonal outbreak, the HI, CI, and BI were 31.31, 10.72, and 44.44 respectively (Figure 1).
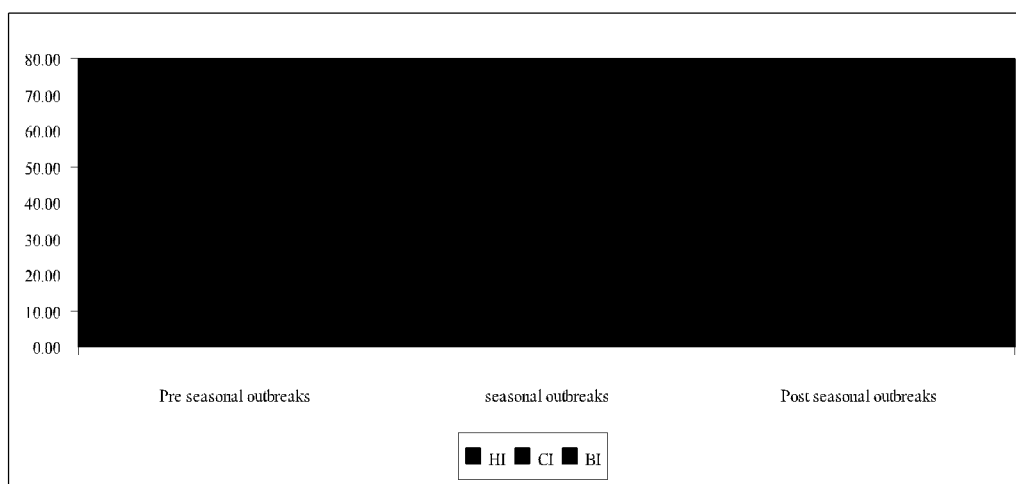
Figure 1: The value of dengue vector indices including HI, CI and BI.

Figure 2: The risk area of mosquito and DHF in pre seasonal outbreaks

Table 1: The total number of houses and containers found dengue larvae

Period of study	Houses		Containers	
	House surveyed	Houses found larvae	Containers surveyed	Containers found larvae
Pre seasonal outbreaks	206	31	815	52
Seasonal outbreaks	204	91	986	140
Post seasonal outbreaks	198	62	821	88

3.2 DHF risk area

The risk area of mosquito and DHF were analyzed using GIS application. The data of dengue vector indices in each household that found larvae considered to become bleeding and spread out area of *Aedes aegypti*. The area of epidemic larvae and DHF has shown in Table 2. From the Table 2 they found that the flied radius of dengue mosquito within 30 and 60 meters covers the total area of 59,095.16 and 90,811.94 m^2, respectively (Figure 2). In seasonal outbreaks, the flied radius of dengue mosquito within 30 and 60 meters covers the total area of 126,734.64 and 232,703.69 m^2, respectively (Figure 3). For post seasonal outbreaks, the flied radius of dengue mosquito within 30 and 60 meters covers the total area of 99,405.75 and 108,527.34 m^2 respectively (Figure 4).

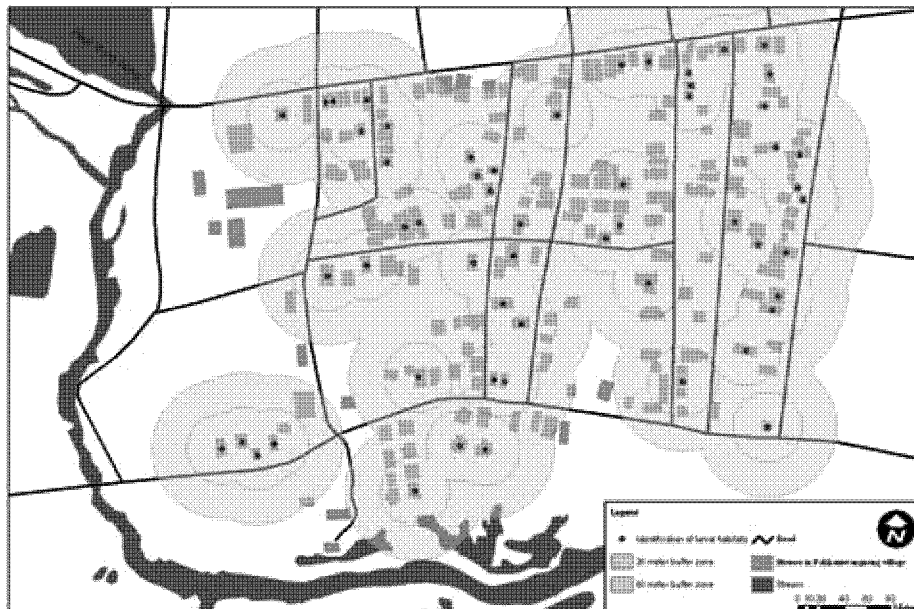Figure 3: The risk area of mosquito and DHF in seasonal outbreaks

Figure 4: The risk area of mosquito and DHF in post seasonal outbreaks

Table 2: The boundary area of epidemiology of larvae and DHF

Distance of bleeding place	Size area (m²)			Total
	Pre seasonal outbreaks	Seasonal outbreaks	Post seasonal outbreaks	
Space 30 m	59,095.16	126,734.64	99,405.75	285,235.55
Space 60 m	90,811.94	232,703.69	108,527.34	432,042.97
Total	149,907.10	359,438.33	207,933.09	717,278.52

4. Discussion

In seasonal outbreaks, the Aedes aegypti larva was found in 140 containers. It indicates that the high density of Aedes aegypti mosquito the high incidence of DHF cases which is correlated with rainfall factor. It caused flood in the large numbers of containers. In addition, this season had shown the high relative humidity that was 80% of season [27]. It related with the measurement the number of dengue virus in each season in Myanmar and Singapore. They found that rainy season had shown the high relative humidity (90%) that found most of dengue virus (Thu et al., 1988). Thus, in seasonal outbreak, dengue mosquito population and DHF cases had been increased. In addition, the surrounding area of Pakhauiwangnong village was consisted of water resource which caused optimal growth of mosquito. We can conclude that the breeding site could be found in all 3 seasons. In pre seasonal outbreak or summer, a large number of containers which found the larvae (Table 1), more increased than in seasonal outbreak (rainy season) and become lower in post seasonal outbreak (winter). The National Institute of Communicable Diseases (National Institute of Communicable Diseases, 2001) defined high risk of DHF transmission when BI was ≥50, or HI was ≥10, and low risk of transmission when BI was ≥5, or HI was ≥1. From this study, it was indicated a low risk of DHF transmission in Pakhauiwangnong village in pre seasonal outbreak. In spite of, in seasonal outbreak, all larval indices indicated a high risk of DHF transmission and in post seasonal outbreaks still high risk of DHF transmission. From this data, it was indicated that the highest risk of DHF transmission could be found in seasonal outbreak and still high risk of DHF transmission in post seasonal outbreak. Thus, the government organization could make a consideration to use this research to predict, planning and operate the surveillance and control the transmission of DHF. For the risk area of dengue mosquito and DHF, the boundary area (buffer point) of risk area was determined by the radius of flied mosquito. The flied mosquito had been reported in narrow phase within 30 - 400 meters (Joshi and Sharma, 2001) and various characteristics of flied circle.

Thus, this study determined the buffer point between 30 and 60 meters which identified the area for finding food of the mosquito and also caused DHF. Since the characteristic of this village was identified as close community so the household which clarified as the bleeding site of mosquito was widely covered in all 3 periods. It could be indicated the households within the DHF risk area. The GIS could be considered to become the tool to point out the position of household for breeding area and its environment that supported for the outbreak. Thus, the GIS could play an efficiency role of the system which supported for decision making, surveillance, and control of mosquito and DHF. However, the promotion of the knowledge concerning surveillance and control of DHF are always important and needed.

5. Conclusion

The larvae were mostly found in seasonal outbreak. The HI, CI, and BI value were higher than the standard in seasonal outbreak meanwhile HI was also high in post seasonal outbreak. From this data, it was indicated that the highest risk of DHF transmission was found in seasonal outbreak and still high risk of DHF transmission in post seasonal outbreak. The breeding area of Aedes aegypti mosquito and DHF was identified between 30 and 60 meters and cover the overall area of Pakhauiwangnong village. This could be done by using GIS. It was indicated that the households in Pakhauiwangnong village was shown the risk of DHF in all 3 periods. Thus, the GIS could be consider to be an efficiency system to support for decision making, surveillance and control of mosquito and DHF.

Acknowledgement

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