

# Use of GIS to Find the Risk Area of Leptospirosis, Nakornratchasima, Thailand

Sitthisak Moukomla<sup>1</sup>, Siam Lawawirojwong<sup>1</sup>,

Wijitr Fungladda<sup>2</sup>, Jaranit Kaewkungwal<sup>2</sup>, Kamolnetr Okanurak<sup>2</sup>

<sup>1</sup> Geo-Informatics and Space Technology Development Agency

<sup>2</sup> Faculty of Tropical Medicine, Mahidol University

Email: sittisak@gistda.or.th

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## ABSTRACT

During the past decade--Leptospirosis--one of the fatal diseases, caused lost in not only the human resources but also the socio-economic of the country. To find out the tendency of the Leptospirosis outbreak and to evaluate its risk area, the Geo-informatics technology was applied. The feasibility study has been conducted under the collaboration of Geo-informatics and Space Technology Development Agency (GISTDA) and Faculty of Tropical Medicine (FTM), Mahidol University. The serologic survey was conducted by FTM during the year 2004 – 2006 on a cohort of 2,207 persons in Nakornratchasima, Thailand. The very high resolution satellite imagery, IKONOS, has been used to extract and map the existing affected area at village level. GIS and GPS technologies were utilized to evaluate related geographic parameters and define risk area of Leptospirosis outbreak. The result of potential site analysis has shown as the thematic map of Leptospirosis's risk area and the risk analysis were categorized into very high, high, moderate, slight, and low which covering 39.8, 58.2, 8.7, 5.2, and 3.1 square kilometers, respectively.

## 1 .INTRODUCTION

Causing by the bacterial genus *Leptospira*, Leptospirosis is currently one of the fatal bacterial disease. The outbreaks of leptospirosis are usually caused by exposure to water contaminated with the urine of infected animals. Although many different kinds of animals carry the bacterium; they may occasionally have no symptoms. *Leptospira* organisms have been found in cattle, pigs, horses, dogs, rodents, and wild animals. Nevertheless, human beings become infected through contact with water, food, or soil containing urine from those infected animals. This may happen by swallowing contaminated food or water or through skin contact, especially with mucosal surfaces, such as the eyes or nose, or with broken skin. The disease is not known to be spread from person to person. The severe symptoms mostly caused in human including high fever, severe headache, chills, muscle aches, and vomiting, and may include jaundice (yellow skin and eyes), red eyes, abdominal pain, diarrhea, or a rash. If the disease is not treated, the patient could develop kidney damage, meningitis (inflammation of the membrane around the brain and spinal cord), liver failure, and respiratory distress. However, in rare cases death occurs. Those symptoms can be mistaken for other diseases. To confirm that the patient affected Leptospirosis or not, laboratory testing of a blood or urine sample is required ( [http://www.cdc.gov/ncidod/dbmd/diseaseinfo/leptospirosis\\_g.htm](http://www.cdc.gov/ncidod/dbmd/diseaseinfo/leptospirosis_g.htm), 2005)

The study of Leptospirosis surveillance in Thailand, conducted by P.Phraisuwan et al. (1999), had shown that Leptospirosis is highly occurred in the rainy season. The several observed cases have increasing in August and decreasing in November while the peak number

of cases occurs in October. The most infections occur in agrarians who work in paddy-field. This is because infection in humans occurs by contact of skin or mucous membranes with water or moist soil which contaminated with urine of infected animals. Therefore, the human activities including going without shoes; washing in streams; and occupations such as farming, working in sewers, mining, working with animals, and participating in military activities have all been implicated in human infection. Furthermore, the geographic factors such as flooding area, antecedent outbreak area as well as livestock domesticated area are also indicated as the Leptospirosis risk factors. To find out the relation between geographic factors and disease characters, geo-informatics technology has introduced for analysis risk area and develop outbreak model in this study. Furthermore, GIS technology associated with geo-spatial database can be provided details for analysis of spatial patterns of disease outbreak. Nevertheless, in the rapid changing world, the high and very high resolution satellites imageries have also played an important role in mitigation and surveillance of the disease. Not mention to the medium and low resolution imageries which can be extracted geographic parameters such as land cover, geomorphology, and human activities. In the epidemiological veterinary applications, plus, geo-informatics technology allows geo-informatics scientists to identify affected areas and surrounding environments which may one of the accelerated factors of the outbreak. However, the field data are also very important for develop the specific surveillance model of the disease. Thus, the aim of this study then is focusing on the implementation of the medical factor and geographical parameters by using GIS to find the risk area of Leptospirosis, in Nakornratchasima, Thailand.

## **2. OBJECTIVES**

2.1. To mapping existing affected area of Leptospirosis in Nakornratchasima, Thailand at village's level.

2.2. To understand the surrounding environment of affected area.

2.3. To find the risk area of Leptospirosis in Nakornratchasima, Thailand base on geographic factors.

## **3. METHODOLOGY**

as has been mentioned earlier that this collaboration are under Geo-informatics and Space Technology Development Agency (GISTDA) and Faculty of Tropical Medicine (FTM), Mahidol University. Therefore, the methods of this study were divided into three parts namely serologic survey, geographic survey and developing model.

### **3.1 Study Area**

Locating approximate 300 kilometers from Bangkok, the study area is covering roughly 115 square kilometers in Pra-thai and Chum-pung district, Nakornratchasima, north eastern part of Thailand where once was well known as the most severe of Leptospirosis outbreak area.

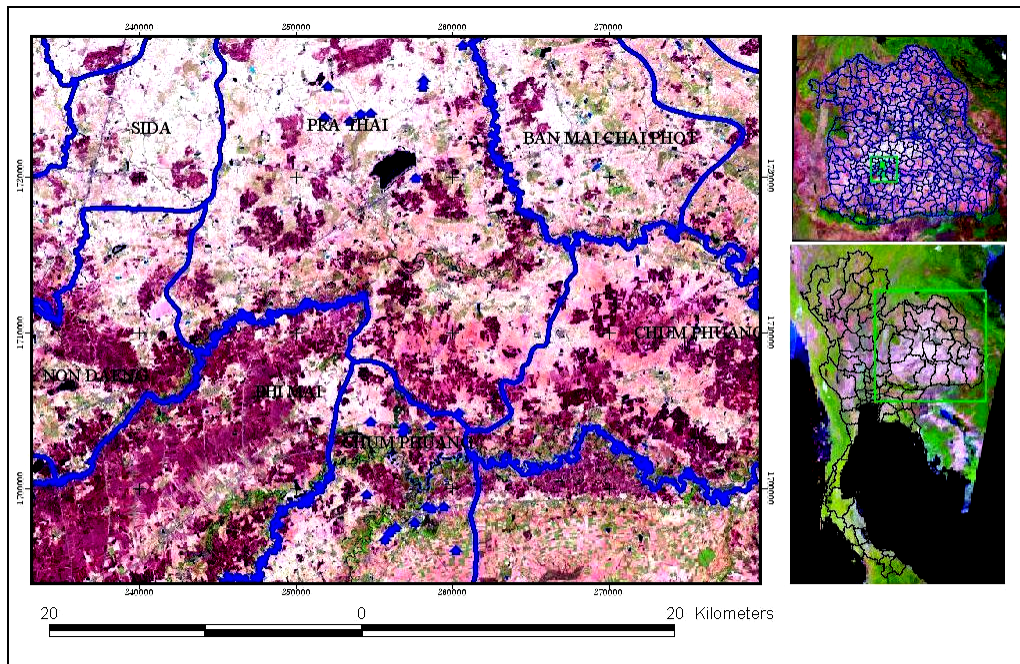


Figure 1 The study area is locating in Pra-thai and Chum-pung district, Nakornratchasima.

### 3.2 Serologic Survey

The serologic survey was conducted by Faculty of Tropical Medicine (FTM), Mahidol University with 2,207 villagers among age ranked from 18 to 70 years. The majority of the respondents were involved in agricultural occupations. In 2004, the survey was performed among the participants every three months, during March, June, September, and December for microscopic agglutination test (MAT). Serological surveys using a MAT titre cut-off point of 1:50, and urine cultures for leptospires were performed in buffaloes, cattle, pigs, and dogs, with 100 animals in each group. Leptospiral infections in rodents were detected by cultivations of leptospires from the kidneys of 1,126 trapped rodents.

### 3.3 Affected Area Mapping

One meter resolution satellite imagery, IKONOS which acquired on December 27, 2000 was used to extract the existing affected area of village level. GIS and GPS technologies were utilized to evaluate related geographic parameters and define risk area of Leptospirosis outbreak. The evaluation of risk factor was derived by correlation analysis on the serologic survey data, and its geographic features using expert system. The relevant socio-economics data were also integrated with other Geo-databases for the purpose of visualization on the internet.

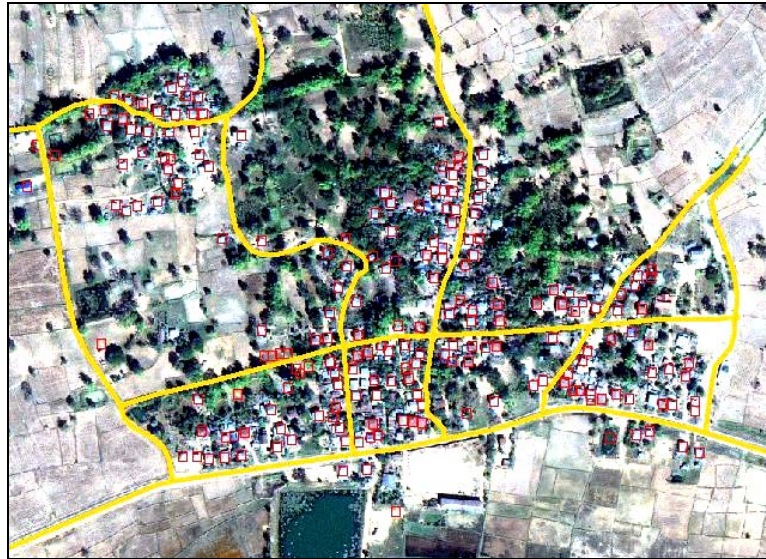


Figure 2 very high resolution satellite imageries were utilized to support the serologic survey.

### 3.4 Risk Area Assessments

Besides the social and behavior causes, the geographic features were also considered as the influent causes of Leptospirosis disease. Therefore, in this study, the criteria of risk area were based on surrounding geographic environment. Analyzed by using expert systems, however, Leptospirosis's risk area had been assessed as thematic maps. The simple potential site analysis equation can be described as follow:

$$PSA = G_1W_1 + G_2W_2 + \dots + G_nW_n$$

Where

W = weighted coefficient

G = geographic parameter

## 4. RESULTS

Geographically, the characteristic of this area is very unique. Flooding by the Moon meandering river every year, thus, this area is defined as flood plain. Land use categories follow the Land Development Department classification scheme, the land use map of study area was updated by using Landsat-5 TM imageries. The majority land activity is used for agriculture. The geographic parameters of risk area analysis had extracted from geo-database which is flooded area, soil drainage, landform, existing land use while weighted coefficient had rated by expert committees.

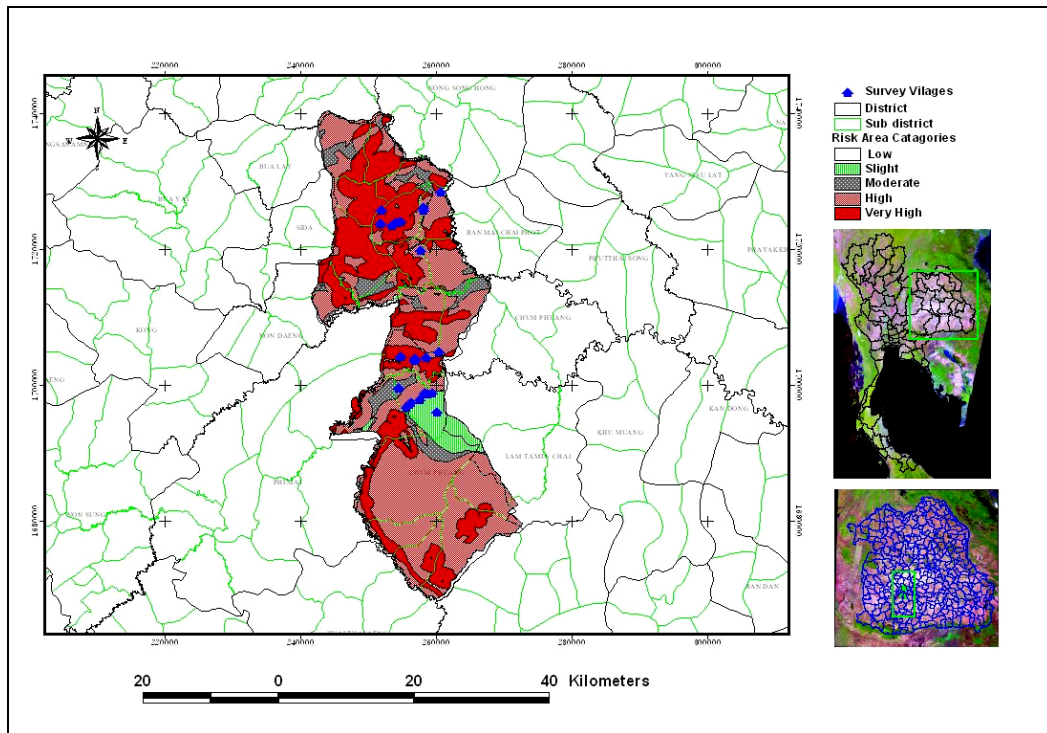


Figure 3 Thematic map of Leptospirosis's risk area.

The result has shown as the thematic map of Leptospirosis's risk area in figure 3 and the categories of analysis were showed in Table 1.

Table 1 Leptospirosis's risk area category

Categories	Area(SqKm)
Very High	39.8
High	58.2
Moderate	8.7
Slight	5.2
Low	3.1
<b>Total</b>	<b>115.0</b>

## 5. CONCLUSIONS

From this study, the conclusions are as follows :

5.1 The study to find out Leptospirosis's risk area by utilize geo-informatics technology in Nakornratchasrima, Thailand was conducted by GISTDA and Faculty of Tropical Medicine (FTM), Mahidol University.

5.2 The study area covers roughly 115 square kilometers in Pra-thai and Chum-pung district, Nakornratchasrima, north eastern part of Thailand

5.3 The serologic survey was conducted by Faculty of Tropical Medicine (FTM), Mahidol University with 2,207 villagers among ages ranked from 18 to 70 years.

5.4 The Leptospirosis's risk area maps analyzed by using expert systems and potential site analysis as thematic map.

5.5 The result of potential site analysis has shown as the thematic map of Leptospirosis's risk area and the categories of analysis were very high, high, moderate, slight, and low which covering 39.8, 58.2, 8.7, 5.2, and 3.1 square kilometers, respectively.

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