Paper presented at the 22nd Asian Conference on Remote Sensing, 5 - 9 November 2001, Singapore.

PROVINCIAL RISK MAPS FOR HIGHEST TENDENCY RANKING EPIDEMIOLOGICAL SURVEILLANCE DISEASES IN AYUTTHAYA PROVINCE, THAILAND

Soutthanome KEOLA, Mitsuharu TOKUNAGA
Space Technology Applications and Research (STAR), Asian Institute of Technology (AIT),
P.O.Box 4, Khlong Luang, Pathumthani, 12120, Thailand.
Tel: (66-2) 524-5579 Fax: (66-2) 524-6349 Email: keola@ait.ac.th
THAILAND

KEY WORDS: Epidemiological surveillance disease, Geographic Information System (GIS), Highest Tendency Ranking Epidemiological Surveillance (HTRES) diseases.

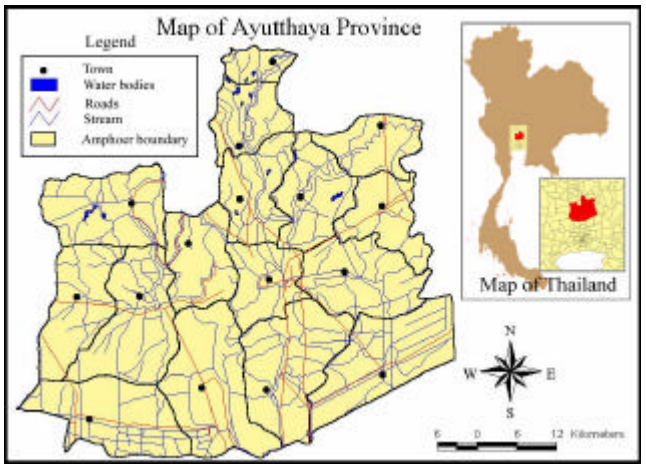
ABSTRACT: Ayutthaya province is located in the Chao Phraya basin, central part of Thailand. The topographical features include mostly plains drained by many rivers, which may affect disease spread. Public health researchers did several epidemiological surveys in this area. However there are no study using geo-informatic technologies. The application of these technologies, particularly GIS to epidemiological research would produce a better understanding of the disease pattern. Incidence ranking of epidemiological surveillance diseases across the districts was found using statistical and spatial analysis of the public health data. The triangular model of human ecology was used to identify main factors, associated with the high incidence diseases. Based on those finding, associated risk factor maps were generated on a GIS platform. Finally, the provincial risk maps for highest tendency ranking of epidemiological surveillance diseases were generated, and alternative prevention options were proposed.

1. INTRODUCTION

In the past ten years, after Ayutthaya was registered in 1991 to become a World Heritage city, urban facility and infrastructure were built for tourism promotion. Therefore, the cultural and living conditions changed leading to possible changes in disease pattern. Thus a time trend study of surveillance disease is needed. One important issue for this study is to identify rising incidence of any disease, so as to provide understanding of the causes, associated factors, diffusion and prevention of this disease.

2. THE STUDY AREA

2.1 TOPOGRAPHY INFORMATION



Ayutthaya is the 11th largest province, out of 24 Central region provinces with an area of 2,547.62 sq. km. Located in the latitude 14° 6' 33"N and longitude 100° 14' 53"E at the sea elevation of 3.50 meters and near the Gulf of Thailand. Listed clockwise, bordering on Ayutthaya are Ang Thong, Lop Buri and Saraburi on the north, Saraburi on the east, Nonthaburi and Pathumthani on the south and Suphanburi on the west (Ayutthaya provincial Annual Report, 1999). The topographical features are mostly plain regions with many rivers and canals; no forest and mountainous land exist in this province. (Figure 1). Ayutthaya province is administratively divided into 16 districts, 209 sub districts and 1467 villages and 2 Urbans (Phra Nakhon and Sena districts)

Figure 1. Map of the study area, Ayutthaya province

2.2 THE HEALTH CARE NETWORK

Ayutthaya is the first place in Thailand to have been established the Community Health Service Center (CHCSC) in 1990. It is one kind of the integrated health care system. This community aims to reduce patient density in the central hospital. The main task is to provide primary health care services. With a growing

population, one CHCSC responds for 200.000 people. There are 16 hospitals, 205 local clinics, private clinics and some traditional clinics. (The report of seeking behavior to Community Health Care Service Center, 1996)

3. METHODOLOGY

The summarized flowchart of the methodology of the study is illustrated as shown in Figure 2 below.

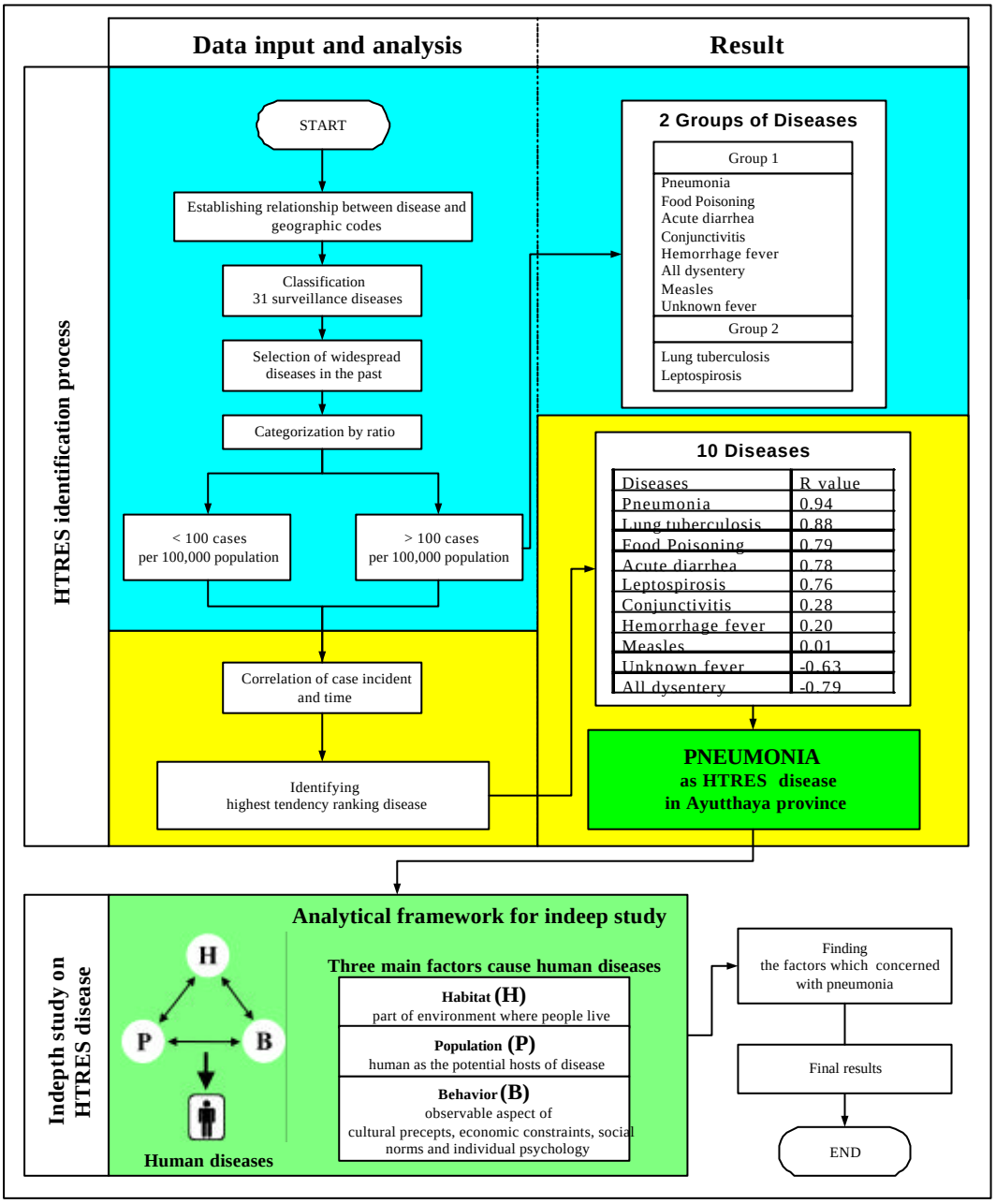


Figure 2: The research methodology

4. RESULT AND DISCUSSION

4.1 THE GENERAL PNEUMONIA DESCRIPTION

Pneumonia is one kind of infection disease. The pneumonia incidences per 100,000 in 1998 were 243.27 and the number of death is 1.94. Fatality rate is 100 per 0.80. Pneumonia causes the highest death among epidemiological surveillance disease in Thailand. The sickness ratio is 1.60-2.29 per 100,000 (Annual Epidemiological surveillance Report, 1998). The highest epidemiological surveillance disease in Ayutthaya is Pneumonia, and its causes and factors are described in the section below.

4.2 THE SEASONAL CHARACTERISTICS OF PNEUMONIA

The climate pattern in Thailand falls into three seasons. The cold season started from October - February, hot season (February - May), rainy season (May - October). Observation to the epidemiological characteristics of diseases will follow in three seasons. Due to unavailability of the epidemiological surveillance data in from 1991-1995, this research used data from 1996-2000, which was provided by provincial health care department in Ayutthaya.

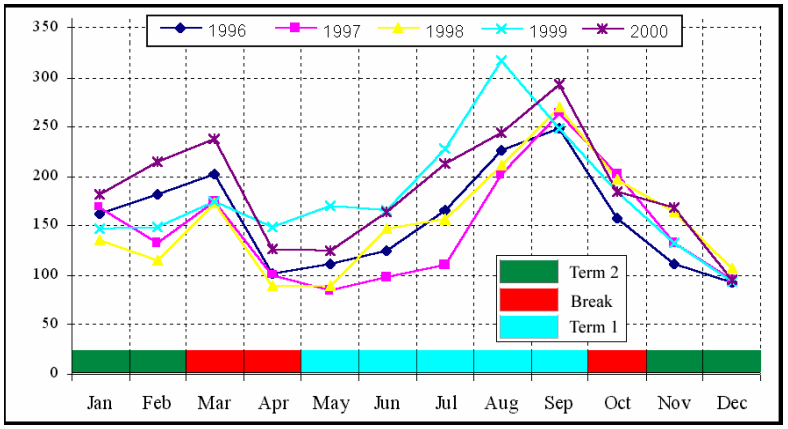


Figure 3 - The distribution of pneumonia in the period of 1996 – 2000
Source: the provincial health care in Ayuthaya

The distribution of pneumonia in last five years 1996-2000 is shown in Figure 3. In this Figure, it shows that pneumonia incidence case was highest in rainy season. It increased every year. Moreover in year 2000, pneumonia has also increased during in the season. The pneumonia distribution in whole Thailand has highest incidence in rainy season and it is similar to this pattern (Annual Epidemiological Surveillance Report, 1998).

The observation from academic term of playground and primary school children showed that cases of pneumonia increased during the starting period of new academic term, then it decreased during the term break (Figure 3). The most of pneumonia patients, from age 1-5 years old occupied 71.9 % from total cases incidence. (Average in five years).

4.3 THE LOCATION QUOTIENT OF THE PNEUMONIA

The quotient is a calculated ratio between the local observed data (district) and the observed data of some reference unit (province) (see Eq. 1). This ratio is calculated for all districts to determine whether or not the local observed data has a greater share of that reference unit. The location quotient (LQ) is an index for comparing an area's share of a particular activity with the area's share of some basic or aggregate phenomenon. (G. William Page. Carl V. Patton, 1991)

$$LQ = \frac{\frac{N_{District}}{P_{District}}}{\frac{N_{Province}}{P_{Province}}} \qquad \text{(Eq. 1)}$$

Here, N and P represent the Number of incident cases and Population of the district and province, respectively. The result of location quotient can be considered in to two cases, such as:

LQ < 1 indicates the activity is less concentrated in the region
LQ > 1 indicates the activity is more concentrated in the region

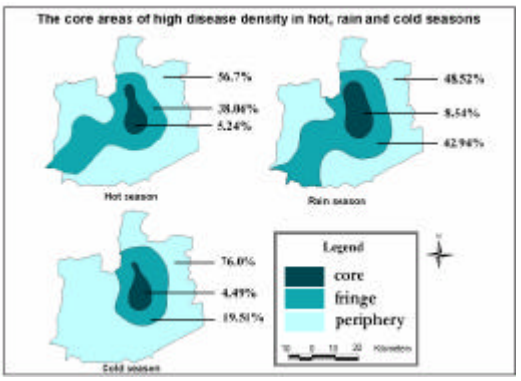


Figure 4 – The core pneumonia area in three seasons

The result of LQ calculation is shown in Figure 4. Using LQ, core area can be identified, which is varied by seasons and cover 51.48% of the province. Here, the core areas cover three districts for 8.2% (Phra Nakhon Si Ayutthaya, Bang Pa in and Bang Pa Han). The highest case incidence is in rainy season. These areas are well served in terms of medical personnel, hospitals and clinics. Anyway, other social and environmental factors may also be the possible factors of high pneumonia incidence in the area.

4.4 RAINFALL AS AN INFLUENCE FROM ENVIRONMENTAL TO PNEUMONIA INCIDENCE

According to the results above, the cause of pneumonia perhaps is related with the rainfall. The table 1 demonstrates that in the rainy season, humidity is high and as well as number of pneumonia cases.

Table 1 - The summary of monthly average of humidity, temperature and rainfall in five years

Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	26.7	28.0	30.1	30.3	30.0	29.3	29.0	28.8	28.2	28.3	27.1	25.9
Humidity (%)	61.2	61.1	63.3	68.6	70.3	71.4	72.5	72.4	75.9	74	69.2	62.3
Rainfall (mm)	29.9	33	61	449.5	815.3	669.5	675.9	850.8	959.4	676.4	107.8	0
Pneumonia (cases)	159.4	158.6	192.4	113.4	116.2	140.2	174.6	240.6	265	185.6	141.8	96.8

Source: Report of Meteorological Department of Thailand in five years (1996-2000)

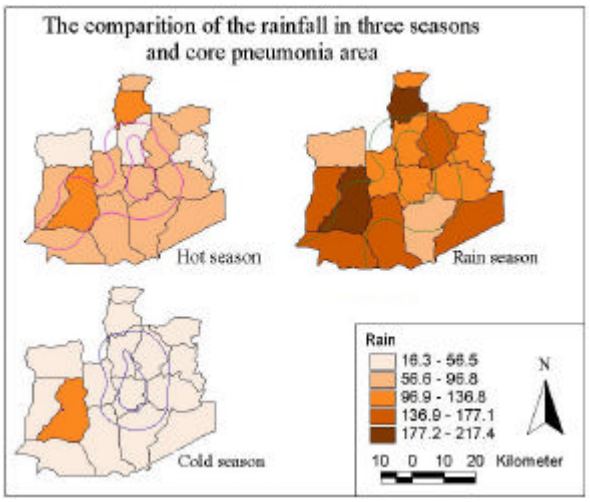


Figure 5 - The distribution of rainfall density in core pneumonia area

In Table 1 shows that in September, rainfall, humidity and pneumonia incidence are highest than in other months The Pearson correlation and two tail tests were implemented to prove the relationship of each variable. The answer is correlation of pneumonia to rainfall and humidity was significant at the 0.01 level (2-tailed), or 99.9% significant. Moreover the rainfall and humidity is also significant at the 0.01 level (2-tailed). In term of spatial distribution of pneumonia and rainfall density, it shows that high density of rainfall area causes pneumonia incidence cases to increase in term of increasing of rainfall (Figure 5).

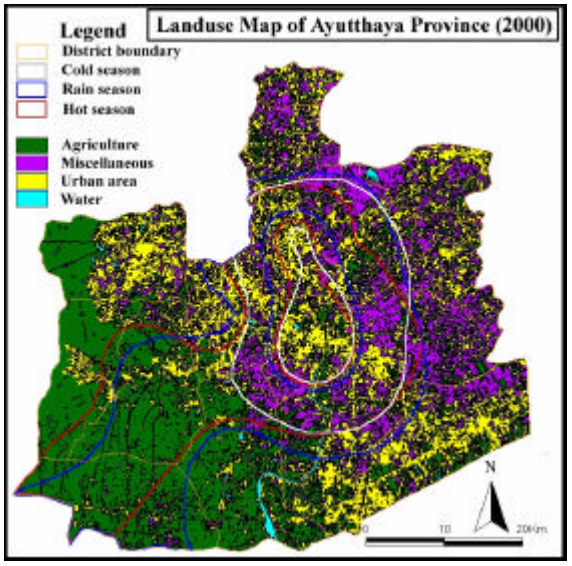
4.5 LIVING PATTERN AND MALNUTRITION AS AN INFLUENCE FROM SOCIAL ECONOMICAL TO PNEUMONIA INCIDENCE

Several local physicians have mentioned three main reasons. One is the uncontrolled antibiotic use in influenza; it possibly caused some antibiotic resistance. The second one is living pattern change. Most of people trend to bring their kids to playgrounds or schools at early age. The children could not manage themselves properly in term of sanitation. The last reason that was mentioned is parents have to work outside; mother lost their opportunities to breast-feeding their children. They had to rely on powdered milk. The feeding pattern would diminish the immunity of young children 0-1 years old and possibly contribute to the incident cases of pneumonia. Malnutrition found nearly 50% among children 0-4 years old; it shows in table 2. The correlation value between pneumonia and malnutrition is 0.93, which means malnutrition is the main factor for pneumonia. Since annual malnutrition data was available only, it is not possible to find out the relationship between pneumonia and malnutrition in the district level.

Table 2 - The relationship between pneumonia and malnutrition among children (age 0-4 years old)

Years	$JH - HDLVRG		
	&KLOGUHQ	0 DOQXWULWLRQ	3QHXPRQLD
1996	6.90	3.22	2.50
1997	10.9	2.84	1.73
1998	6.9	3.02	2.67
1999	6.64	3.516	3.27
2000	6.55	4.19	3.37

5. APPLICATION OF REMOTE SENSING TO URBAN AREA CHANGE DETECTION



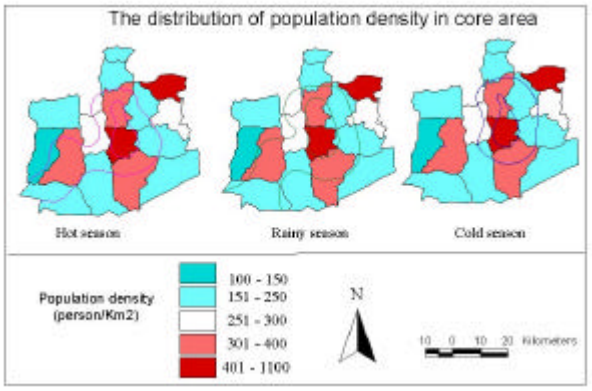
Application of remote sensing is useful to identify landuse classification, in particularly, the urban area change in Ayutthaya province. In this study, the remote sensing data of year 2000 were used to compare with the landuse data of 1993. The result shows that in the period of 1993 – 2000, the urban area has drastically increased about 61.52%, while the agriculture area has drastically reduced (Table 4). This change can lead to the change of the disease pattern. Natural soil was replaced by concrete; people can not adjust to the new environment. Most of foods produce from factories rather than by natural and traditional methods. All of these facts lead to the disease incidence, which is a common problem in developing countries. The change from paddy fields to urban area may also cause Leptospirosis, which is bringing by mice to humans.

Figure 6 – Landuse map of Ayutthaya province in year 2000

Table 4 - The comparison of land use in 1993 and 2000

Area/year	Year 1993 P	Year 2000 P	&KDQJH P	&KDQJH	
Agriculture	2,237,043,673	962,099,822.3	-1,274,943,850	-132.51	Decreased
Urban	231,097,391	600,604,027.8	369,506,637	61.52	Increased
Water body	67,962,222	56,078,065.6	-11,884,157	-21.19	Decreased
Misc.	10,250,714	927,572,084.3	917,321,370	98.89	Increased

5.1 POPULATION DENSITY



According to the result shown in Figure 7 Four districts have high population density, and among them have pneumonia incidence. That's mean high-density area can be the cause of pneumonia incidence. The result from the application of remote sensing data, implemented in section 5 by landuse classification, also shows that pneumonia incidence happened in high density area.

Figure 7 - The distribution of population density

6. CONCLUSION

6.1 INFLUENCING FROM WEATHER CONDITION

Epidemiological pneumonia is widely spreads 51.49% in the rainy seasons, and mainly in the area with high rainfall density. The pneumonia incidence gradually reduced by rainfall pattern. But pneumonia still exists in three districts, which are located in the core area for all years. From this point, finding the other associated factors such as socio-economical factors is needed.

6.2 INFLUENCING FROM SOCIO-ECONOMICAL CONDITIONS

Since the cases of pneumonia increased during the starting period of new academic term, then it decreased during the term break, as discussed in section 4.2, the academic terms are still long as well as pneumonia incidence is increasing by the long period of time, thus possible to cause of pneumonia incidence in children 3-5 years old. Moreover the living pattern changed, parent sent their kids to schools in early age less than 2.5 years old. It is obviously that, some of them could not take care themselves properly in term of sanitation, thus pneumonia may happen and spread easily at schools. According to the difficult economical condition, milk powder started to be widely used instead of breastfeeding. Mothers have to go to work outside home and spend less time with their children, more over some mothers leave their kids with elder persons, who can not take care properly both children and housework. (Prathumvan, 1999). Thus, this condition diminished children immunity and then, it is easy to get disease infection. This is the main factor for causing pneumonia incidence in children 0-2 years old

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to ASEAN Foundation for financially supports this research. I am also very grateful to Dr Mitsuharu TOKUNAGA for support, guidance

REFERENCE

Ayutthaya Provincial Annual Report, 1999. Introduction part. Provincial Health Care Department, pp. 3.
Page, G. William and Patton, Carl V., 1991. Quick Answers to Quantitative Problems. Chapter 14 Location Quotient, pp. 173-177.
Prathumvan, 1999. Master thesis, Diarrhea Pattern in Bang Pa In district, Mahidol University, pp. 50
The Report of Seeking Behavior to Community Health Care Service Center, 1996. Health Care Reform Project in Ayutthaya province, pp. 13-14.