A SPATIAL ANALYSIS OF LIVER FLUKE DISEASE DISTRIBUTION USING GIS IN KHON KAEN PROVINCE, THAILAND

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Abstract: Liver Fluke (Opisthorchis viverrini) disease remains a major public health concerning especially in the Northeast of Thailand. To understand how the disease spread out, the objectives of the study were to investigate the environmental factors influencing to the distribution, and to build a model using Multiple Regression Analysis with Geographic Information Systems (GIS) on environment and climate data. A number of patients information from from 2006 – 2011 including rainfall, soil, land use, altitude, and water body data were used to discover relationship among them. Analysis results will be verified with field surveys data to make sure that the relationship and the model are validated. Disease distribution maps will be created with the model that embedded within GIS software package. Therefore, with this study, predicted disease distribution map may help in identifying areas where vulnerability is high for decision-making and planning in order to prevent or control the spread out of the disease in the future.

INTRODUCTION

Liver Fluke disease remains a major public health concerning especially in the Northeast of Thailand. Because the disease is not expressed in the first and second stage. It affects on the economy and society development of Thailand both of the countryside and urban. Helminthes infection will directly affects to the lives of those infected and finally it will impact on people health. Not only the economic loss is by the illness, but also significantly impacts on occupation and income. Otherwise the disease is on children , it will affect to the growth of them in kind of the development of intelligence. It was also found that the liver fluke has many causes that are associated with Cholangiocarcinoma Opisthorchis viverrini (Banchob Sripa et al., 2007). The main cause of the liver fluke is a parasite that lives in the cholangiocarcinoma of human and animal including dogs and cats. The disease connects to people only way of inappropriate preparing with uncooked (or raw) fish especially Koi Pla, Lab Pla and Pla Som (Department of Disease Control, 1985). Behavior of uncooked (or raw) fish of people brings about the parasites infection. According to Opisthorchiasis viverrini, this consumption is the first stage made of infection (Sithithaworn P and Haswell-Elkins M, 2003).

Thailand still has been found in the high prevalence of helminthes infection in many areas especially in remote countryside. Both of the most of poor people with low income and the poorly health system services are main factors. According to the survey report of parasitic infection situation by Thailand of Department of Disease Control, Ministry of Public Health at 1957, 1981, 1991, 1996 and 2001 found the prevalence of parasitic infection was 62.9%, 54.7%, 41.7%, 35.0 and 22.5 respectively, and it was found the Northeast with helminth infection rate is higher than other regions such as opisthorchis viverrini, taenia and echinostoma (Praphasri Jongsuksuntigul, 2002). Reported by a survey of Bureau of Epidemiology of helminthes infection found 18.1% of total in 2009. The Northeast found as 26% and North as 17.7% put together the infection of liver fluke found in the Northeast as 16.6% and North as 10%. It concluded that the Northeast was found the highest rate of the others.(Office of Permanent Secretary, 2011)

In addition, the report of the surveillance system database between 2006-2011 from Epidemiological Unit, the office of Disease Prevention and Control, Khon Kaen province. The highest infection rate of liver fluke of patients found in Khon Kaen province at 16.62% per thousands of population.

Furthermore, the intensity of helminth infection depends on many factors such as health beliefs, tradition and health behavior. The causes are from uncooked (or raw) fish which is inappropriate and unhygienic, poor sanitation and environment, insanitary of the toilet, bare feet without shoes on the ground, and eating with half cooked. These are resulted of the parasitic infected distribution. If the disease is so chronic helminth's opportunity to be cholangiocarcinoma and finally death . (Department of Disease Control, 2007). This disease remains in the major problem of public health crisis of Thailand where is rarely reported of the disease incidence on spatial analysis. To make better understanding of the prevalence and distribution of the disease to different area, we

should study of the spatial dimension of relationship among factors that are influence to diffuse of the disease by Geographic Information System (GIS). Because GIS is the effective tool to study the phenomena of the disease distribution on spatial analysis together with layers data. It will make the awareness of the disease situations; moreover, the major factors which are influence to the disease distribution on spatial are planned and guided to control, monitor, prevention in actual situations in the future.

METHODS AND EQUATION

Study area

Khon Kaen province located on the central in Northeast of Thailand between 15° N to 17° N latitude and 101° E to 103° E longitude. Total area approximate is 10,886 square kilometers (6.8 million hectares) or at 6.5 percent of total's Northeast area. The terrain is plateau that is interspersed of the undulate height in the west that is parallel to Phu Kradueng and Phetchabun mountains. But the east and southeast are interspersed high and almost plain. There is the alluvial plain by Chi river that flows from the west to east pass Nampong, Ubonrat, Muang district at the elevation average at 200 meter.
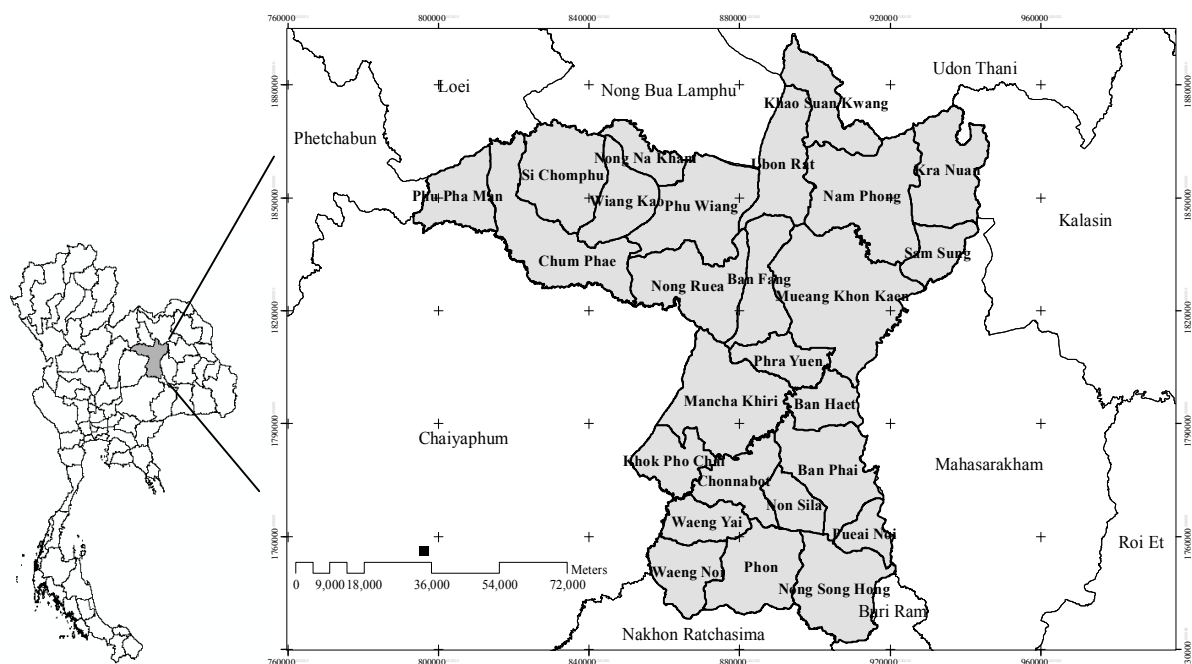

Figure 1: Khon Kaen Province Map by districts.

Data source

Data collection between 2006-2011 recorded from surveillance system databases by Epidemiological Unit, the office of Disease Prevention and Control, Khon Kaen province. The patients data of liver fluke disease were recorded, and it is analyzed in a number of cases of patients reported in each district and each year.
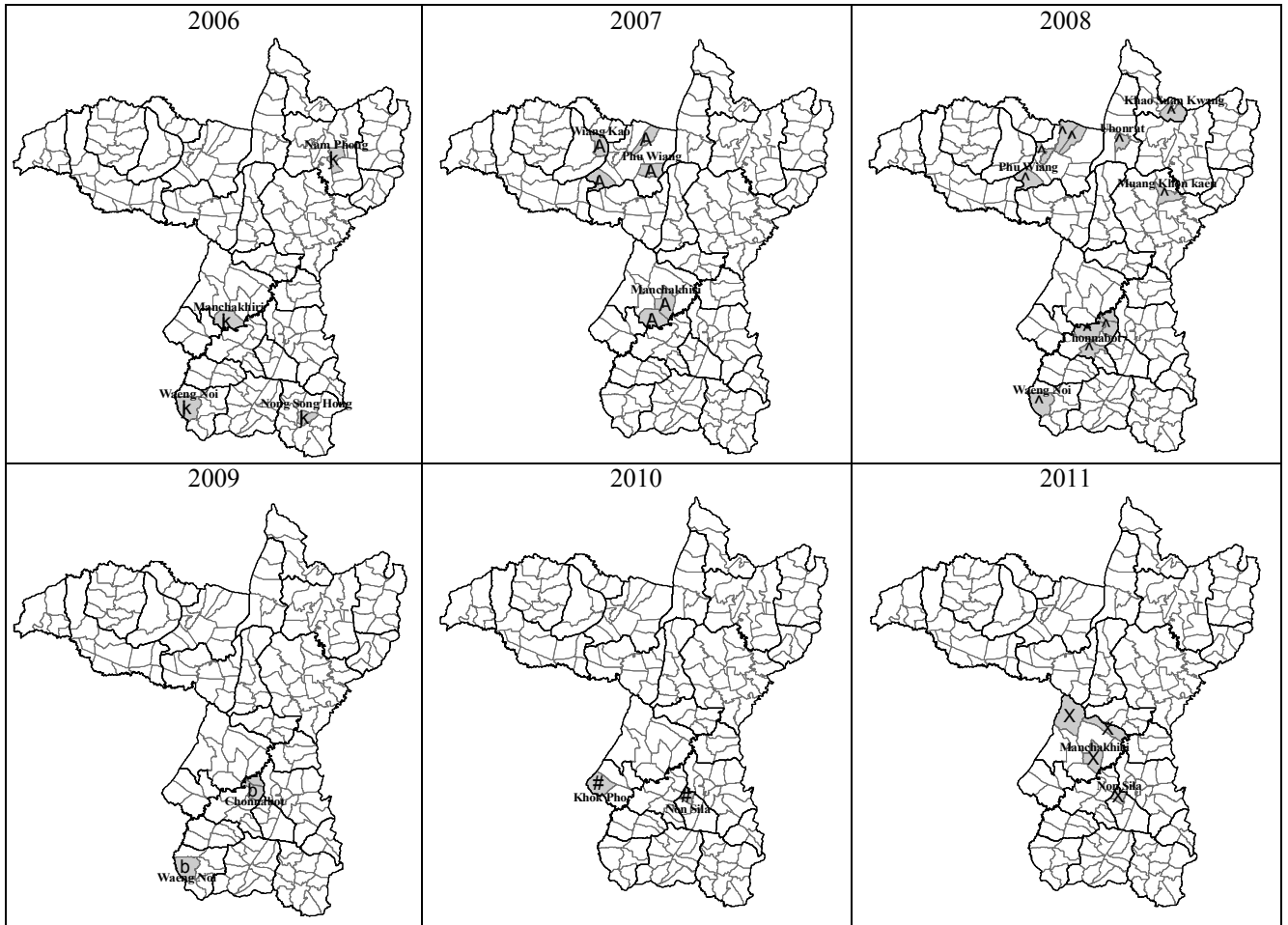
Figure 2: Patients distribution data of Liver Fluke Disease between 2006-2011.
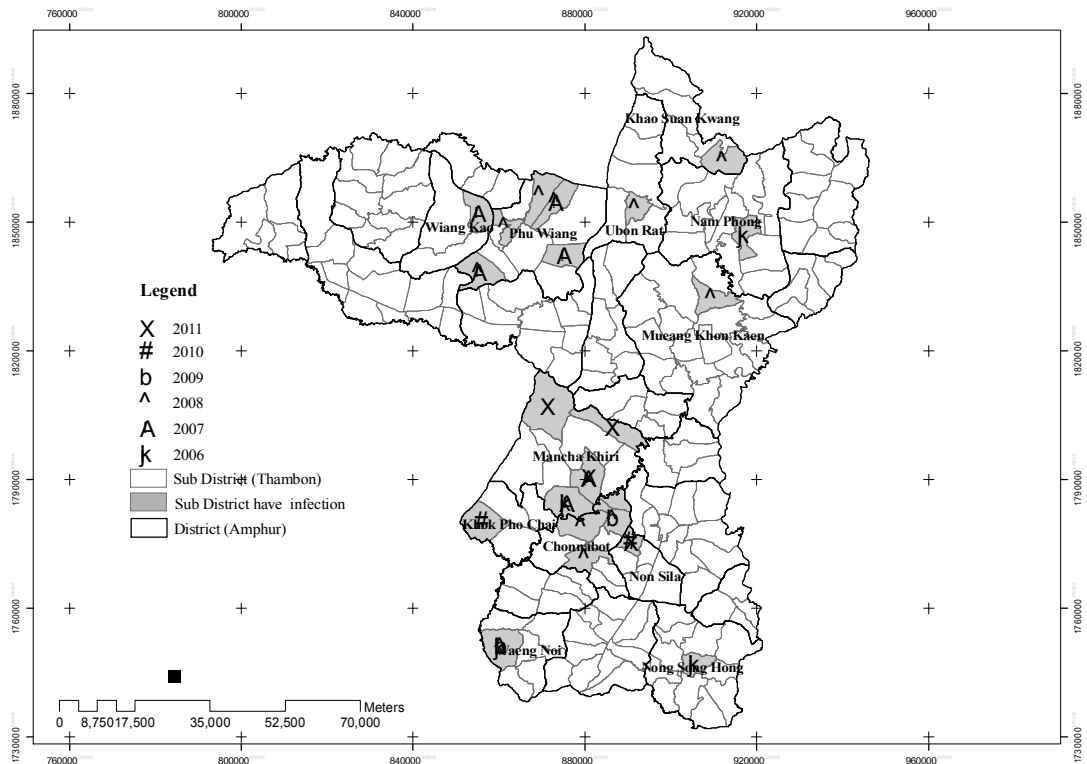

Figure 3: Distribution of Liver Fluke in each year in Khon Kaen Province by Tambon

Environmental data

The factors are rainfall and temperature recorded by the Northeastern Meteorological Center (Upper center). The collection data between 2006-2011 from automatic weather stations in Khon Kaen province and neighboring provinces. These data is the accumulation average annual rainfall, and average annual temperature by interpolation of the disease area.

The factor of soil type recorded by Land Development Department, Ministry of Agriculture and Cooperatives. This data reported by Thailand soil survey map and classified into 6 classes that are Clay, Clay Loam, Loam, Loamy Sand, Sandy Clay Loam and Sandy Loam.

The factor of salty soil surface recorded by Land Development Department, Ministry of Agriculture and Cooperatives. and recorded by salty soil surface distribution map with classified into 6 classes such as >50%, 10 - 50%, 1 - 10 % , < 1%, no salty surface and underground rock salt.

The factor of land use recorded by Land Development Department, Ministry of Agriculture and Cooperatives. The land use map is used in 2011 and the land use classification in level 3rd defined in 23 classes. (Table 1)

Table 1: Land Use Classification in level 3rd

| LU_Code	Description	LU_Code	Description
A0	Integrated farm/Diversified farm	M2	Marsh and Swamp
A1	Paddy field	M3	Mine, pit
A2	Field crop	M4	Others
A3	Perennial	U1	City, Town , Commercial
A4	Orchard	U2	Village
A5	Horticulture	U3	Institutional land
A7	Pasture and farm house	U4	Transportation,Communication and Utility
A9	Aquacultural land	U5	Industrial land
F1	Evergreen forest	U6	Others
F2	Deciduous forest	W1	Natural water body
F5	Forest Plantation	W2	Reservoir (Built-up)
M1	Rangeland		

Statistical analyses

The relationship between liver fluke and environmental factors using statistic analysis by Multiple Correlation and significant at p value at 0.05, then using Multiple Regression Analysis for correlation and prediction the disease distribution by linear regression equation. The results can validate by R square. The coefficient of the determination is commonly use statistic to evaluate fit model.

RESULTS

Spatial data distribution of the patients of liver fluke infection between 2006-2011 found that in 2007 the patients have decreased from 2006 at 66.67 % of total and 2008 increased at 73.33% of total. By 2009 a number of patients was found less at 98.08% of total. Because the continuous surveillance and campaign about the inappropriate cooking (uncooked or raw) and consumption of food were success . Thus, a number of patients is reduced.

The rate of infection in male at 57.04% and female at 42.96% of total. The male has a liver fluke disease more than female. Mostly were found at 50-59 years old, more than 60 years old , and 40-49 years old were 28.18%, 27.49% and 25.77% respectively. During February found the highest infection rate at 41.72%. Between October and March, it were found at 22.07% and 12.76% respectively. Moreover, agricultural occupation is effective factor of the liver fluke infection rate because the farmers' living
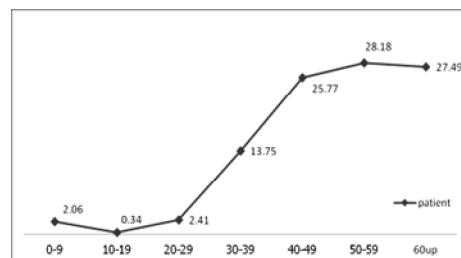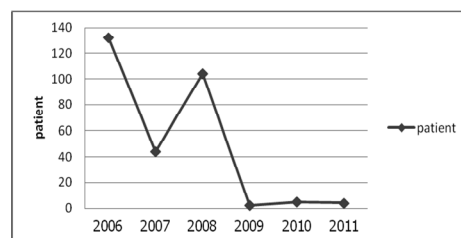
close to the source of the disease. They can catch the fish then uncooked or eating raw, it makes them to easily infect the disease.

The relationship of the environmental factors by statistical analysis of a number of patients of liver fluke infection found that rainfall and temperature were not correlation with the liver fluke disease distribution. Soil types factor have significantly correlation between loam and liver fluke disease distribution at 0.01 level. Salty soil surface factor has correlation with the liver fluke disease distribution at significant 0.05 level. In addition, land use has correlation to the horticulture and rangeland according to the liver fluke disease distribution at significant 0.05 level (Table 2). The multiple regression analysis method was used by equations to predict the distribution of liver fluke.
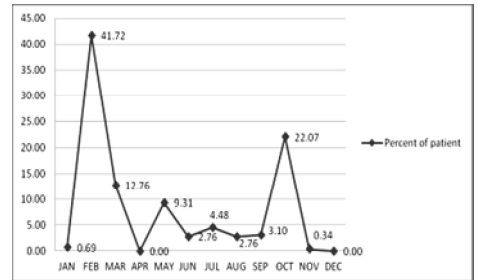
Equation:

$$OV = -9.310 + 2070.925(Horticulture) + 3.737(Rangeland) + 0.142(No\ salty\ soil\ surface)$$

OV is the patients of liver fluke infection, and $R^2 = 0.443$ (Table 3). By GIS analysis found tambon Lahanna, amphoe Waeng Noi has distribute of the disease in the highest of Khon Kaen province. Due to 2006, a number of patients at tambon Lahanna is high along with the high distribution. By observation at Phu Wiang district found 5 villages, Mancha Khiri district found 4 villages, and Chonnabot district 3 village where all were correlated to the disease distribution.

The z-score value showed that the distribution of the disease occurred in 10 tambons such as Lahanna, Puayyai, Nonpayom, Kudkao, Suanmon, Nachumsaeng, Nongkungsern, Banrua, Kaonoi and Tungchompoo. The high disease distribution was in Chonnabot district. The medium disease distribution was 11 tambons such as tambon Dondung, Huaykae, Sub Somboon, Thasala, Kamkan, Wathong, ThungPong, Kammuang, Saimoon and Samran. Comparison by z-score from geographic Information Systems analysis found that it was oppositional results in other areas. By equation, it was found horticulture, rangeland and salty soil surface were effect on the disease dispersion. However, Khon Kaen province has horticulture and no salty soil surface were not found the disease. According to z-score was inconsistent to z-score of Khon Kaen province.

Table 2: Correlation between Patients of Liver Fluke and Environment Factors by Multiple Correlation analysis

		Landuse				Salt	Soil
		Paddy field	Horticulture	Pasture and farm house	Rangeland	No surface salt	Loam
patients from 2006 – 2011	Pearson Correlation	.649**	.506*	.838**	.464*	.488*	.603**
	Sig. (2-tailed)	.001	.019	.000	.034	.025	.004
	N	21	21	21	21	21	21

**. Correlation is significant at the 0.01 level (2-tails).
*. Correlation is significant at the 0.05 level (2-tails).

Table 3: Correlation between Patients of Liver Fluke and Environment factors by Multiple Regression analysis

Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	-9.310	9.801		-.950	.355
Horticulture		2070.925	868.806	.464	2.384	.029
Rangeland		3.737	2.827	.390	1.322	.204
No surface salt		.142	.794	.055	.179	.860

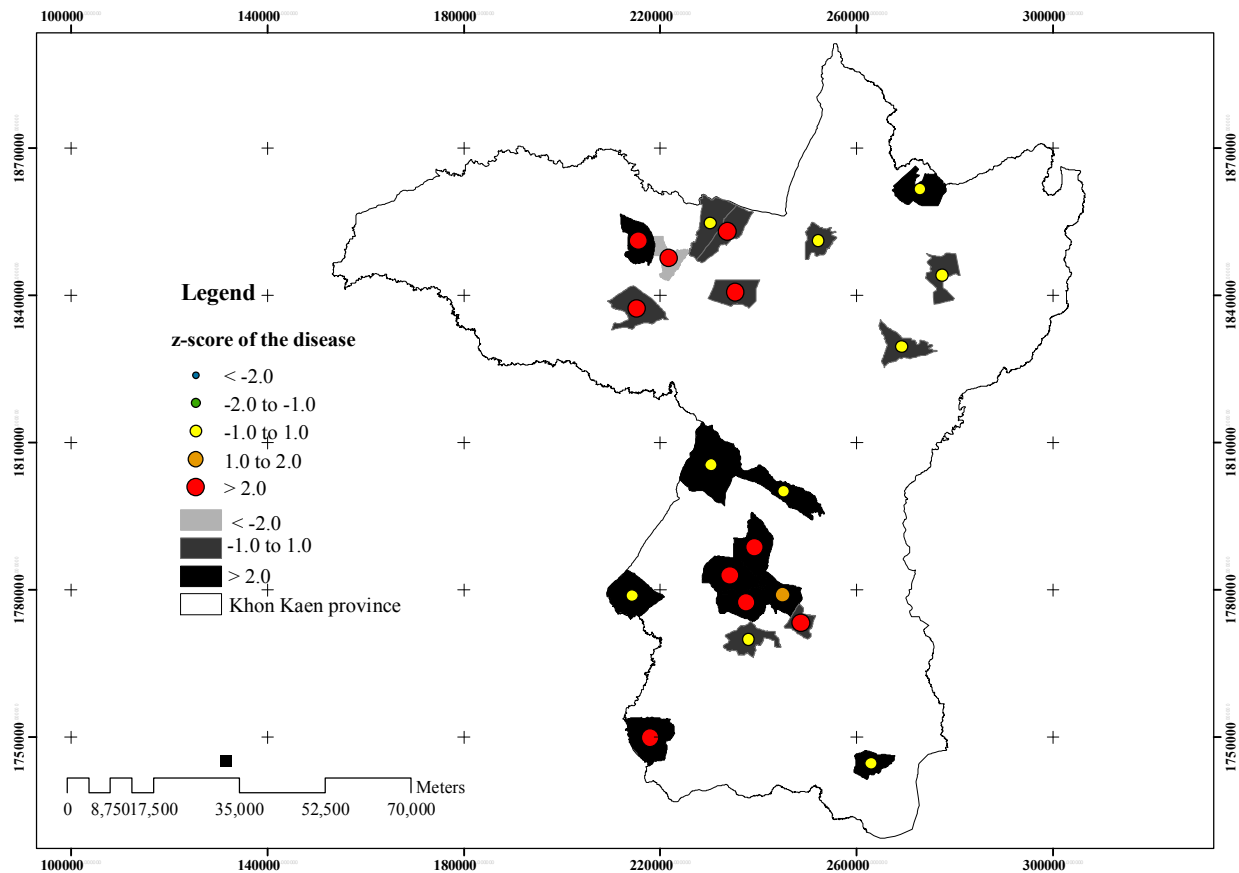$SE_{est} = 28.738$, R= 0.665, $R^2 = 0.443$

Figure 4: Patients of Liver Fluke Disease Related to the Salty Soil Surface and Land Use factor.

DISCUSSIONS

The relationship study between the geographical environmental factors associated with the liver fluke disease by data collection , it was shown the prevalence of the disease cycle starting to the feces. It brought to directly infect to the patients. It was caused to admit to hospital in long term treatment with high compensation to cure. The monitor of the disease cannot do in every areas because of lack of enough money to survey or record data. The research used random method only the area with a high incidence of the disease. In this study, a number of patients were collected by the surveillance system database from which Epidemiological Unit, the office of Disease Prevention and Control, Khon Kaen province, and from some of reports by hospitals in Khon Kean where recorded these admitted patients of the liver fluke disease. The data used in the study was not enough. It assumed that some of amphoes may still have the patients of the liver fluke disease. Although the patients' data found that mostly were Opisthorchiasis viverrini; otherwise, the disease did not show the symptoms in the first stage. So, the patients had no symptoms and they were not know before defection the liver fluke. (The major cause was Cholangiocarcinoma). This study found that these factors associated with liver fluke distribution. By GIS analysis of the factors found that no salty soil surface has correlated to liver fluke disease distribution significant at 0.05 level. It related to the results of the study about density of salty soil surface and distribution of snail Bithynia goniomphalos that is the first host of liver fluke. Therefore, it was found that Bithynia goniomphalos was negatively correlated with salty soil surface (Apiporn S. et al., 2011). Landuse factor by horticulture, rangeland have been correlated in significant at 0.05 level. But it was different from the study of Suwannachai who found the farmland and forest area were highly related to the infection (Suwannachai Wattanayingcharoenchai et al.,2011). However, the study found that the pasture and farmland have been correlated significantly at 0.01 level. It should be studied more about the prevalence data, Cholangiocarcinoma and other related factors for studying in the future.

CONCLUSIONS & RECOMMENDATIONS

The results of this study showed that these factors including rainfall and temperature, soil type, salty soil surface ,and landuse were not enough to spatial analysis. Because these factors related to traditional eating

behavior of patients without uncooked (or raw) fish. However, the situation of the liver fluke infection in Khon Kaen province has a number of patients of the liver fluke infection that was higher than other provinces . Data analysis of the spatial relationships using GIS was to study the distribution of the disease in different areas. The trendy relationship of physical factors effected on the disease distribution. Other effective factors were the migration of the population that could not be recorded. The factors were vary to a number of patients that can be made to be reduced or increased by equations.

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