

**THE APPLICATION OF GIS TO IDENTIFY RISK AREAS
FOR PULMONARY TUBERCULOSIS:
AMPHOE SELAPHUM, ROI- ET**

The seal of Mahidol University is a large, circular emblem in the background. It features a central golden chakra (wheel) with a tiered umbrella (parasol) above it. The entire emblem is set against a light blue circular background. The outer ring of the seal contains the university's name in Thai script: "มหาวิทยาลัยมหิดล" (Mahavithayalai Mahidol) at the top and "วิทยาเขตศาลายา" (Witayalai Sallaya) at the bottom.

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OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE
(TECHNOLOGY OF INFORMATION SYSTEM MANAGEMENT)
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY
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Thematic Paper
entitled
**THE APPLICATION OF GIS TO IDENTIFY RISK AREAS
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AMPHOE SELAPHUM, ROI-ET**

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THE APPLICATION OF GIS TO IDENTIFY RISK AREAS FOR PULMONARY TUBERCULOSIS: AMPHOE SELAPHUM, ROI-ET

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ABSTRACT

Pulmonary Tuberculosis (TB) is a contagious disease and is a major public health problem. Thailand is one of the 22 countries that WHO has determined as having a high incidence of TB. Thailand is ranked 18th out of 22 such countries. The Ministry of Health announced that the tuberculosis situation urgently needs to be resolved. In the past 10 years, TB case in Amphoe Selaphum, Roi-ET found that increase, respectively. The study applied the geographical information system (GIS) for analysis of risk areas for tuberculosis. The study used the Delphi technique to identify risk factors and Hot Spot Analysis to analyze the distribution patterns of TB.

The study found that four tambons (22.22%) were high risk areas, which included 60 villages, 42,575 people; seven tambons (38.89%) were moderate risk areas, which included 101 villages, 58,301 people; and seven tambons (38.89%) were low risk areas, which include 74 villages, 52,516 people. From Hot Spot analysis the distribution patterns of TB (Hot Spot areas), showed correlation between the incidence rate, the 2 year increase and the decrease pattern in the following years.

KEY WORDS: PULMONARY TUBERCULOSIS / GIS / RISK AREA /
HOT SPOT ANALYSIS / DELPHI TECHNIQUE

128 pages

การประยุกต์ใช้ระบบภูมิสารสนเทศเพื่อวิเคราะห์หาพื้นที่เสี่ยงในการเกิดโรควัณโรค
กรณีศึกษา อำเภอเสลภูมิ จังหวัดร้อยเอ็ด

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บทคัดย่อ

โรควัณโรคปอดคือโรคติดต่อที่เป็นปัญหาทางด้านระบบสาธารณสุขในปัจจุบัน ประเทศไทยเป็น 1 ใน 22 ประเทศที่องค์การอนามัยได้ระบุว่าเป็นประเทศที่มีการระบาดของโรควัณโรคสูง และจัดอยู่ในลำดับที่ 18 จากทั้งหมด 22 ประเทศที่ต้องทำการแก้ไข กระทรวงสาธารณสุขจึงกำหนดให้โรควัณโรคเป็นภาวะเร่งด่วนที่ต้องทำการแก้ไข โดยมีการระบาดของโรคมามากที่อยู่ในภาคเหนือของประเทศไทย และลำดับ 2 คือภาคตะวันออกเฉียงเหนือ จังหวัดร้อยเอ็ดจัดว่ามีจำนวนผู้ป่วยมากเป็นอันดับที่ 3 ของภาคตะวันออกเฉียงเหนือ โดยระยะเวลา 10 ปี ที่ผ่านมาพบว่าแนวโน้มจำนวนผู้ป่วยโรควัณโรคเพิ่มมากขึ้น การศึกษานี้จึงมีการประยุกต์ใช้ระบบภูมิสารสนเทศเพื่อใช้ในการวิเคราะห์หาพื้นที่เสี่ยงในการเกิดโรควัณโรค โดยใช้วิธี Delphi Technique ในการวิเคราะห์หาปัจจัยเสี่ยงในการเกิดโรควัณโรค เพื่อนำไปวิเคราะห์หาพื้นที่เสี่ยง และใช้วิธี Hot Spot Analysis ในการวิเคราะห์หารูปแบบการกระจายของโรค

จากการศึกษาทำการแบ่งพื้นที่เสี่ยงออกเป็น 3 พื้นที่ โดยมีพื้นที่เสี่ยงสูง 4 ตำบล (22.22%) 60 หมู่บ้าน มีประชากร 42,575 คน พื้นที่เสี่ยงปานกลาง 7 ตำบล (38.89%) 101 หมู่บ้าน มีประชากร 58,301 และพื้นที่เสี่ยงต่ำ 7 ตำบล (38.89%) 74 หมู่บ้าน มีประชากร 52,516 คน และจากการวิเคราะห์รูปแบบการกระจายของโรควัณโรคพบว่า มีความสัมพันธ์กับจำนวนผู้ป่วย มีการกระจายของโรคต่อเนื่องกัน 2 ปี และมีแนวโน้มลดลงในปีถัดไป

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CHAPTER I

INTRODUCTION

1.1 Background and Problem Statement

From the fact that Pulmonary Tuberculosis (TB) is chronic disease that come back a major public health problem. Because situation of AIDS, poverty and migrate difficult of growth technology. Cause epidemic of TB on the situation will be even more intense. World Health Organization (WHO) has declared that “TB is a global emergency in the world ” and strategies required Directly Observed Treatment Short Course (DOTS) used control of disease in 1992 [1].

WHO reported 1 in third worlds of people have infection. The prevalence rate 14.6 million, incident rate 8.8 million in 2005 and nearly half of patient has spreading. The death rate of TB has 1.7 million/year and people of death rate are in poor country. [1]. WHO has ranking 22 countries with serious TB problem used 80% of patient live in country. Thailand is ranked in 18 from among 22 countries of the world, as show the 22 countries have ranked by WHO in figure 1.1.

	POPULATION	MORTALITY*			PREVALENCE			INCIDENCE			HIV PREVALENCE IN INCIDENT TB CASES (%)		
		BEST*	LOW	HIGH	BEST	LOW	HIGH	BEST	LOW	HIGH	BEST	LOW	HIGH
Afghanistan	28 150	11	7.1	15	94	43	160	53	43	64	—	—	—
Bangladesh ^d	162 221	83	60	110	690	320	1 100	360	300	440	0.2	0.1	0.3
Brazil	193 734	4.5	2.2	8.4	100	36	180	87	72	100	12	11	12
Cambodia	14 805	10	7.4	14	100	47	170	65	56	76	6.4	4.5	8.3
China	1 345 751	150	100	220	1 800	740	3 000	1 300	1 100	1 500	1.5	0.9	2.2
DR Congo	66 020	50	36	67	430	200	690	250	200	300	8.4	6.4	11
Ethiopia	82 825	54	38	75	480	220	790	300	240	360	12	8.8	15
India	1 198 003	280	170	430	3 000	1 300	5 000	2 000	1 600	2 400	6.4	3.9	9.8
Indonesia	229 965	62	36	95	660	270	1 100	430	350	520	2.8	1.7	4.3
Kenya	39 802	6.2	3.0	12	110	45	190	120	99	150	44	42	46
Mozambique	22 894	8.8	6.3	12	86	43	130	94	76	110	58	58	58
Myanmar ^e	50 020	29	18	43	300	130	490	200	160	240	11	7.7	14
Nigeria	154 729	110	89	140	830	380	1 400	460	370	550	19	19	19
Pakistan	180 808	60	36	93	640	270	1 100	420	340	500	1.5	1.0	2.2
Philippines	91 983	32	21	45	480	450	510	260	210	310	0.5	0.3	0.8
Russian Federation	140 874	25	17	38	190	65	320	150	120	180	8	7	9
South Africa	50 110	23	10	44	380	160	650	480	400	590	60	54	65
Thailand	67 764	12	7.2	18	130	57	210	93	75	110	17	12	22
Uganda	32 710	9.3	3.9	17	91	39	170	96	78	120	56	39	73
UR Tanzania	43 739	4.0	1.5	9.2	72	27	130	80	75	85	47	33	61
Viet Nam	88 069	32	18	50	290	130	510	180	130	230	4.2	2.9	5.8
Zimbabwe	12 523	10	7.5	14	96	48	150	93	76	110	52	51	52
High-burden countries	4 297 498	1 100	930	1 200	11 000	8 900	14 000	7 600	7 100	8 100	12	11	13

Figure 1.1 TB ranking by WHO [1].

WHO reported of epidemiology and estimated there are 40,000 patients had positive sputum (equivalent to 63/100,000 population). Department of disease control, Ministry of Public Health report are patients with TB 30 - 40%, in 2005 have TB patient in Thailand total 58,691. The new patients sputum positive have 30,109, recurrence patient 1,784, TB patients sputum negative have 19,167 and TB outside the lung 7,631 [2].

The situation of TB in Amphoe Selaphum Roi – ET past in 10 year (2001 - 2010) patients have been register 140 -160 cases /year, in 2007 TB patients have been register 227 cases by patients sputum positive 87 cases, in 2008 TB patients have 153 cases by patient sputum positive 91 cases and in 2009 have patients Multi Drug Resistant (MDR) at least 2 cases and TB patient sputum positive missing in 2009 are 3.53%. The situation TB in Amphoe Selaphum has severe and large number of TB [3].

The patients 40 % were in spread stage, treatment by not have DOTS and don't treatment the WHO criteria. The missing patients at risk of MDR an appointment, symptom of medicines allergic reaction and more died from TB.

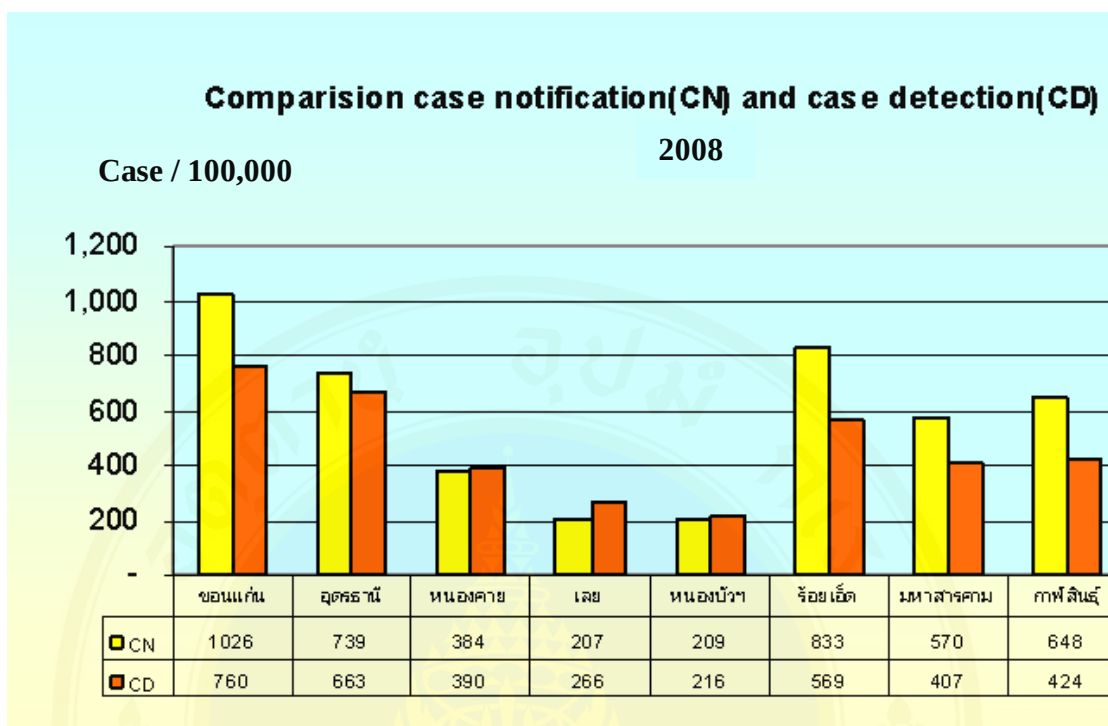


Figure 1.2 Comparison case notification (CN) and case detection (CD) of TB patient (TB 07) in 2008 [3].

Table 1.1 TB situation at Selaphum hospital in 2007- 2010 [3].

Fiscal Year	2007	2008	2009	2010
No. of suspects examined (case)	628	565	2,154	447
No. of smear positive patients (case)	78	90	76	64
Sputum Positivity rate (%)	12.42	15.93	3.53	14.31

The operation successful TB control goal is the TB clearance to go away completely and not a public health problem, but this goal take many years and cooperation the multidisciplinary team including all relevant sectors and continuous quality. But if neglected of it operation the TB situation it is becoming and increasing severe.

WHO has guidelines for operation explicitly Based on results from apply research.

1. TB control is the patient transmission phase best treatment and to cure least 85%.

2. The find TB patient in the community. When the patient to cure more and patient transmission phase best treatment in the future the severity of TB problem not a public health problem again.

The Selaphum hospital have guideline and policies of TB control since 1997, but not control TB case, because of restriction like, risk areas unknown, TB clinic have only one person responsible.

1.2 Research Objectives

1. To identify risk areas of TB disease.
2. To identify distribution pattern of Hot Spot area TB disease.

1.3 Scope of the Study

This research identifies the scope of the study as follows:

1. The foundation data area in Amphoe Selaphum by the Public Works and City Map in Roi- ET.
2. The data of TB patients in January 2006 – December 2010 have sputum positive and patient at diagnosis from the doctor as TB disease, data from Selaphum hospital.
3. The use questionnaires from 17 experts about risk factors of TB.

1.4 Expected Result

1. The officer to find new TB patients in high risks area and into patients to receive treatment.
2. The officer to find patterns, incidence rate of TB disease and planning to prevent spread of tuberculosis.



CHAPTER II

LITERATURE REVIEW

2.1 Geographic Information System

Geographic information system (GIS) is consists of:

1) Information system refers to gathering or collecting data store analyze and display to decision support.

2) Geographic refers to descript about everything on the earth.

Federal Interagency Coordinating committee [19]: A system of computer, hardware, software, and procedure design to support the capture, management, manipulation, analysis, modularly and display of spatially reference data for solving complex planning and management problem.

Department of Environment: Integrated computer system for capturing, storing, checking, analyzing and displaying data which are geographically reference to earth surface. Geographic information system is tool which manipulate, storing, analyzing, retrieve and display information. GIS is database system which management spatial and attribute data. The result can decision support.

GIS is tool of computer system which can be use to manipulation, analysis, retrieve and displaying geographic data. Spatial and attribute data relate and join to information, which use for decision support system management.

2.1.1 Component of geographic Information System

Geographic information system consists of five components the following, show in figure 2.5.

1. Data
2. Software
3. People
4. Hardware
5. Approaches

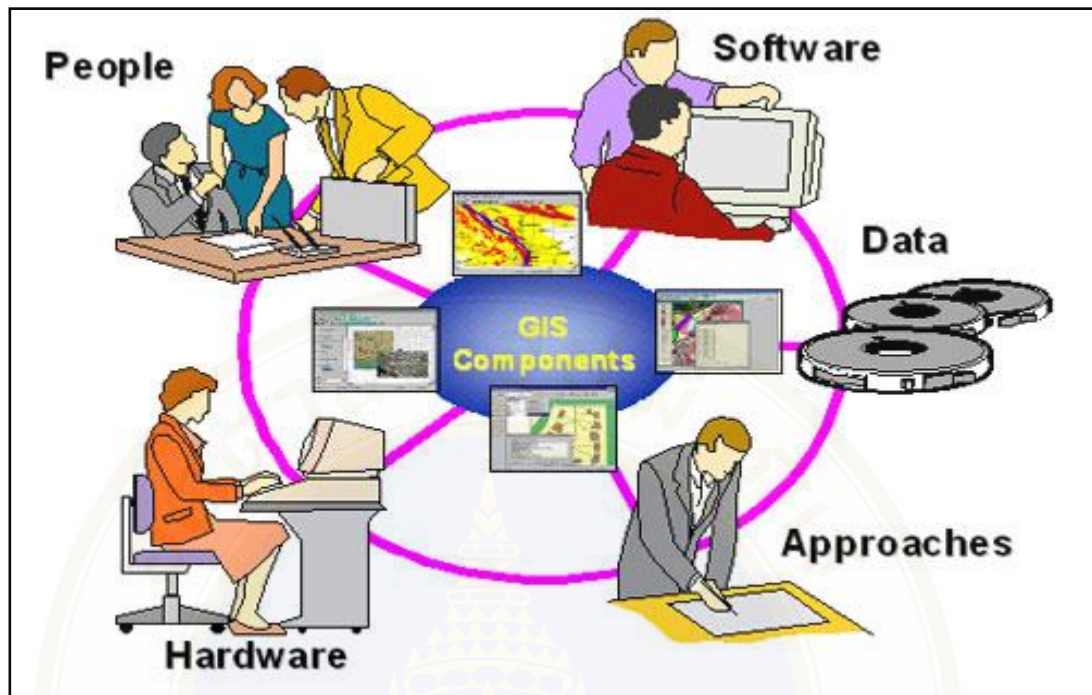


Figure 2.1 Component of Geographic Information System [21].

1. Data

Application of GIS, IT is efficiency depending on data and information. Geographic data is divided into two characteristics.

Attribute characteristic or non-spatial characteristic is to identify features of nature, including man-made features. Attribute may be continuous data such as contour, terrain elevation, or discontinuous data such as number of inhabitants, land cover types. Spatial characteristics are geo-reference points which consist of:

Point features describe position data for data examples: province, temple, etc.

Linear features describe straight line features, curve features, width and length of transport, river, etc.

Area features or polygons describe boundaries of areas such as forest area, administrative boundaries.

2. Software

Software means a program that is used in system administration and command, for hardware system works or call use the data stored in database system.

to work to follow the objective , generally the instruction set or a program of information geography system compose the division imports the data the division collects data and data administration the division analyses the division modifies the data the division shows and the division retort with the user .

3. People

People will be composed the analyst or build the system (analyst) and information user (User) by system user or the experienced person something. GIS must have the expert in the duty and have train come to like already good to fully can work with all one's ability. Generally system user is will person choose hardware system and the software for straight follow the objective , and respond the requirement of an institute , user information part (user) be extremely plan or the authoritarian decides (Decision-maker) for lead the data comes to use in all remedy.

4. Hardware

Computer altogether call that hardware system compose computer lead equipment reaches such as Digitizer, Scanner Global Positioning System (GPS) the equipment reads the data keep the data and show the data such as , Printer Plotter etc. which each kind equipment will dare to that and different quality go out.

5. Approaches

Data management is important in Geographic information system which recreated redundancy data. Information system was designed to share data in organization with overlays technique. Application of Geographic need a lot of factor, layer to model environment analysis data system or applies to multi – display.

2.2 Spatial Statistics

Spatial analysis or spatial statistics includes any of the formal techniques which study entities using their topological, geometric, or geographic properties. The phrase properly refers to a variety of techniques, many still in their early development, using different analytic approaches and applied in fields as diverse as astronomy, with its studies of the placement of galaxies in the cosmos, to chip fabrication engineering, with its use of 'place and route' algorithms to build complex wiring structures. The phrase is often used in a more restricted sense to describe techniques applied to structures at the human scale, most notably in the analysis of geographic data. The phrase is even sometimes used to refer to a specific technique in a single area of research, for example, to describe geostatistics [21].

Complex issues arise in spatial analysis, many of which are neither clearly defined nor completely resolved, but form the basis for current research. The most fundamental of these is the problem of defining the spatial location of the entities being studied. For example, a study on human health could describe the spatial position of humans with a point placed where they live, or with a point located where they work, or by using a line to describe their weekly trips; each choice has dramatic effects on the techniques which can be used for the analysis and on the conclusions which can be obtained. Other issues in spatial analysis include the limitations of mathematical knowledge, the assumptions required by existing statistical techniques, and problems in computer based calculations.

Classification of the techniques of spatial analysis is difficult because of the large number of different fields of research involved, the different fundamental approaches which can be chosen, and the many forms the data can take.

Applications can be found in crime analysis, epidemiology, voting pattern analysis, economic geography, retail analysis, traffic incident analysis, and demographics. Some examples include the following:

Where is the disease outbreak concentrated?

Where are kitchen fires a larger than expected proportion of all residential fires?

Where should the evacuation sites be located?

2.2.1 Hot spot analysis considerations

There are three things to consider when undertaking any hot spot analysis:

What is the Analysis Field (Input Field)? The hot spot analysis tool assesses whether high or low values (the number of crimes, accident severity, or dollars spent on sporting goods, for example) cluster spatially. The field containing those values is your Analysis Field. For point incident data, however, you may be more interested in assessing incident intensity than in analyzing the spatial clustering of any particular value associated with the incidents.

In that case, you will need to aggregate your incident data prior to analysis. There are several ways to do this:

If you have polygon features for your study area, you can use the Spatial Join tool to count the number of events in each polygon. The resultant field containing the number of events in each polygon becomes the Input Field for analysis.

Use the Create Fishnet tool to construct a polygon grid over your point features. Then use the Spatial Join tool to count the number of events falling within each grid polygon. Remove any grid polygons that fall outside your study area. Also, in cases where many of the grid polygons within the study area contain zeros for the number of events, increase the polygon grid size, if appropriate, or remove those zero count grid polygons prior to analysis.

Alternatively, if you have a number of coincident points or points within a short distance of one another, you can use Integrate with the Collect Events tool to (1) snap features within a specified distance of each other together and then (2) create a new feature class containing a point at each unique location with an associated count attribute to indicate the number of events/snapped points. Use the resultant ICOUNT field as your Input Field for analysis.

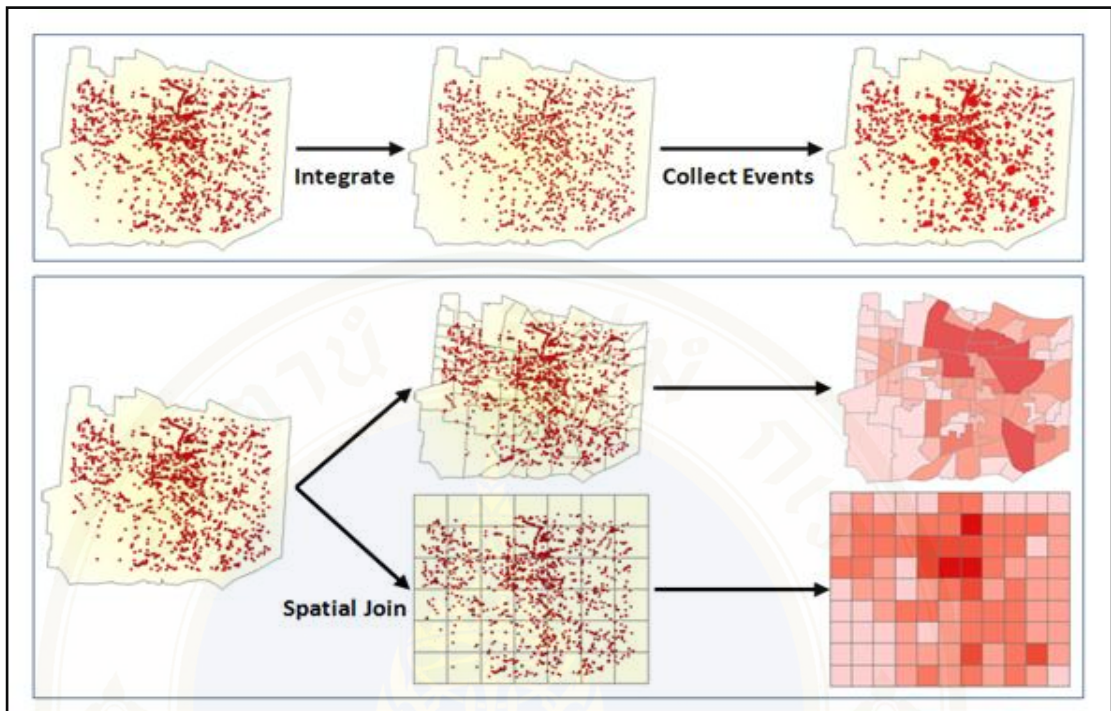


Figure 2.2 Strategies for aggregating incident data [21].

Which Conceptualization of Spatial Relationships is appropriate? What Distance Band or Threshold Distance value is best?

The recommended (and default) Conceptualization of Spatial Relationships for the Hot Spot Analysis (Getis-Ord G_i^*) tool is Fixed Distance Band. Zone of Indifference, Contiguity, K Nearest Neighbor, and Delaunay Triangulation may also work well. For a discussion of best practices and strategies for determining an analysis distance value, see Selecting a Conceptualization of Spatial Relationships and Selecting a Fixed Distance.

2.2.2 Calculations

The Getis-Ord local statistic is given as:

$$G_i^* = \frac{\sum_{j=1}^n w_{i,j} x_j - \bar{X} \sum_{j=1}^n w_{i,j}}{S \sqrt{\frac{n \sum_{j=1}^n w_{i,j}^2 - \left(\sum_{j=1}^n w_{i,j} \right)^2}{n-1}}} \quad (1)$$

where x_j is the attribute value for feature j , $w_{i,j}$ is the spatial weight between feature i and j , n is equal to the total number of features and:

$$\bar{X} = \frac{\sum_{j=1}^n x_j}{n} \quad (2)$$

$$S = \sqrt{\frac{\sum_{j=1}^n x_j^2}{n} - (\bar{X})^2} \quad (3)$$

The G_i^* statistic is a z-score so no further calculations are required.

Figure 2.3 Calculations the Getis-Ord G_i^* statistic [21].

2.2.3 Output

This tool creates a new Output Feature Class with a z-score and p-value for each feature in the Input Feature Class. If there is a selection set applied to the Input Feature Class, only selected features will be analyzed, and only selected features will appear in the Output Feature Class. This tool also returns the z-score and p-value field names as derived output values for potential use in custom models and scripts.

When this tool runs in ArcMap, the Output Feature Class is automatically added to the table of contents with default rendering applied to the z-score field.

The hot to cold rendering applied is defined by a layer file in <ArcGIS>/ArcToolbox/Templates/Layers. You can reapply the default rendering, if needed, by importing the template layer symbology. Given a set of weighted features, identifies statistically significant hot spots and cold spots using the Getis-Ord G_i^* statistic, shown in figure 2.4.

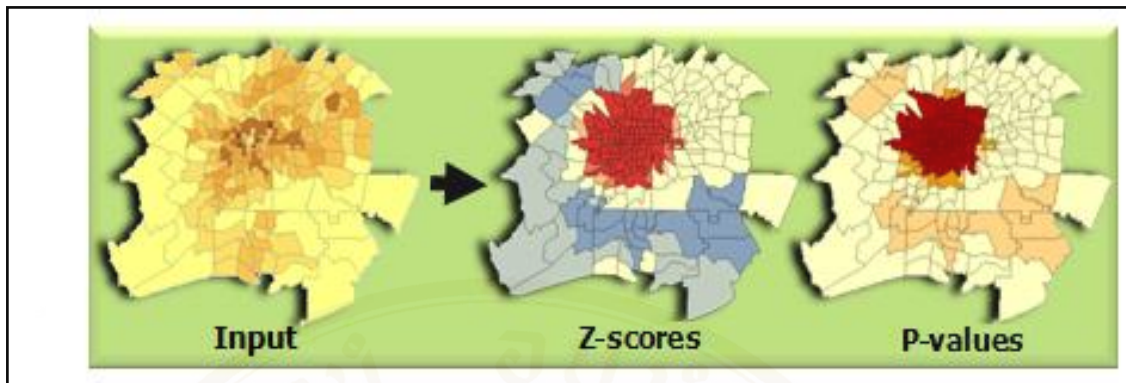


Figure 2.4 Calculates G_i^* statistics and applies a cold-to-hot type of rendering to the output z scores [21].

The Hot Spot Analysis tool calculates the Getis-Ord G_i^* statistic (pronounced G-i-star) for each feature in a dataset. The resultant z-scores and p-values tell you where features with either high or low values cluster spatially. This tool works by looking at each feature within the context of neighboring features. A feature with a high value is interesting but may not be a statistically significant hot spot. To be a statistically significant hot spot, a feature will have a high value and be surrounded by other features with high values as well. The local sum for a feature and its neighbors is compared proportionally to the sum of all features; when the local sum is very different from the expected local sum, and that difference is too large to be the result of random chance, a statistically significant z-score result.

2.2.4 Interpretation

The G_i^* statistic returned for each feature in the dataset is a z-score. For statistically significant positive z-scores, the larger the z-score is, the more intense the clustering of high values (hot spot). For statistically significant negative z-scores, the smaller the z-score is, the more intense the clustering of low values (cold spot). For more information about determining statistical significance.

2.3 Delphi Technique

The Delphi technique is a research approach that is based on a structured process for collecting and distilling knowledge from a group of experts. This is carried out through a series of questionnaires in a controlled environment by Norman Dalkey of the Rand Corporation in 1950. Delphi technique is undertaken by giving individual in the group in a series of questionnaire surveys, usually two or three. Results are translated into statistical analysis in terms of means, median or standard deviations. Delphi technique is used today in business, education, governmental policy making and the social sciences for a number of applications, including management decision making, evaluation and program planning [12].

2.3.1 Advantage and Disadvantages of Delphi technique.

The Delphi technique is methodology research both advantages and disadvantages following.

1. Advantage

The Delphi technique is based on opinion of from varying locations without the individuals meeting. The basic information that is obtainable is the judgment of individuals. What is gained is purely the knowledge gathered from experts' responses. This form of information collection becomes time-consuming and can lack clarity because of the high level of question asked.

2. The opinion of information from expert is subject to change of opinion and political climate.

The opinion of experts can alter according to individual beliefs.

Opinion of answer are considered many times in each panel round

The experts express individual opinion and are not constrained by working within a group of expert with more dominant knowledge or experience.

3. Researchers were collecting limited opinions of experts such as location, number of experts and within a wide geographic area.

4. The Delphi technique is efficient, flexible and specially in light of modern communication technology such e-mail and internet.

Disadvantages

1. The panel has on clear Knowledge of the subject.
2. Researchers are not part of the penal.
3. Research can be less than carefully with information gathering opinion of expert and do not analyses results.
4. The questionnaires can be lost or not responded for completion in each round [12].

2.3.2 Characteristics of research using Delphi technique

Characteristics of research using Delphi technique are as follows

1. One problem research does not fully answer for questions.
2. Subjective judgment collection from expert variety of discipline provides a wide ranked of knowledge.
3. Research can be complex many opinions collected in responses to the experience and knowledge of each expert.
4. More effective information collect is achieved clue to information technology rather than the more information one - to – one question process.
5. Time and cost make frequent group meeting infeasible.

2.3.3 The step of Delphi technique method.

Delphi technique methodology research must use questionnaire. Research can descript the following step for the Delphi technique:

The subject selection to research the problem is not away answer clearly. Most of the Delphi technique problem researches include the following:

- 1) The preference check.
- 2) Perception of current situation.

Selection of panel is the most important step. This is because characteristic of Delphi technique include the opinion of expert. So, research should select expert having knowledge and experience. The Delphi technique guidelines recommend that the panel size should be higher than seventeen experts.

Development of Delphi questionnaire should provide expert with three-four round response.

Round one:

One questionnaire proposes to collect experts' opinions. The researches allow time of collection response around two weeks.

Round two:

The research collect all response obtains in the initial survey. Obvious repetition eliminated, though similarities remain. The research design the second round of question and forward them to the expert. The questionnaires include a rating scale using a Likert type model, to allow the expert to explain their choices. Analysis in second round respond in term of median, mode and interquartile range.

Round Three:

After obtaining second round respond researches translate it into statically analysis. If result of inter-quartile range in the close level, opinion of expert reach of options. But wide inter-quartile rang level show that opinion of expert do not reach a consensus of opinions. The research design three questionnaire that have the same information gained of the seconded round and mark position median scare and inter-quartile range of each expert. This allows the showing of different response.

Round Four:

The research continues future round similar to round three. If result analysis show consensus opinions, research stop of procedure. If the responses remain difference research should develop four more questionnaires. Major research using the Delphi technique usually stops in three round [13].The represents a basic diagram of the complete Delphi process in figure 2.5.

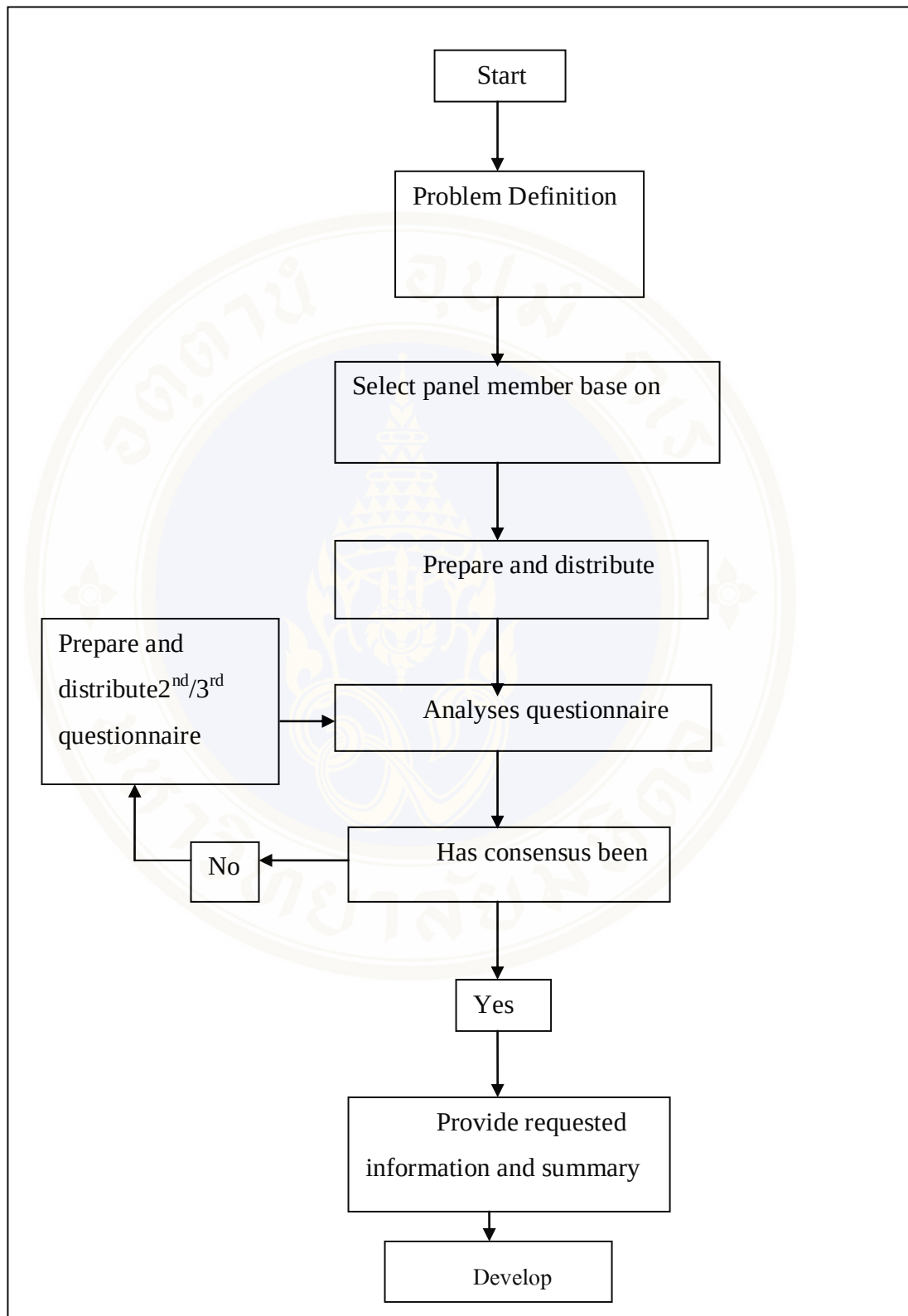


Figure 2.5 Delphi Method Flow Charts [14].

2.4 Pulmonary Tuberculosis

Pulmonary tuberculosis (TB) is a contagious bacterial infection that mainly involves the lungs, but may spread to other organs [1].

2.4.1 Causes of pulmonary tuberculosis (TB)

All cases of TB are passed from person to person via droplets. When someone with TB infection coughs, sneezes, or talks, tiny droplets of saliva or mucus are expelled into the air, which can be inhaled by another person.

Once infectious particles reach the alveoli (small saclike structures in the air spaces in the lungs), another cell, called the macrophage, engulfs the TB bacteria.

Then the bacteria are transmitted to the lymphatic system and bloodstream and spread to other organs occurs.

The bacteria further multiply in organs that have high oxygen pressures, such as the upper lobes of the lungs, the kidneys, bone marrow, and meningitis the membrane-like coverings of the brain and spinal cord. When the bacteria cause clinically detectable disease, you have TB.

People who have inhaled the TB bacteria, the disease is controlled, are referred to as infected. Their immune system has walled off the organism in an inflammatory focus known as a granuloma. They have no symptoms, frequently have a positive skin test for TB, yet cannot transmit the disease to others. This is referred to as latent tuberculosis infection.

Risk factors for TB are as the following:

1. HIV infection
2. Low socioeconomic status
3. Alcoholism
4. Homelessness
5. Crowded living conditions,
6. Diseases that low immune system,
7. Migration from countries with a high number of cases.

2.4.2 Symptoms of pulmonary tuberculosis (TB)

You may not notice any symptoms of illness until the disease is quite advanced. Even then the symptoms -- loss of weight, loss of energy, poor appetite, fever, a productive cough, and night sweats might easily be blamed on another disease.

Only about 10% of people infected with *Mycobacterium tuberculosis* ever develop tuberculosis disease. Many of those who suffer TB do so in the first few years following infection, but the bacillus may lie dormant in the body for decades.

Although most initial infections have no symptoms and people overcome them, they may develop fever, dry cough, and abnormalities that may be seen on a chest X-ray. This is called primary pulmonary tuberculosis.

Pulmonary tuberculosis frequently goes away by itself, but in 50%-60% of cases, the disease can return. Tuberculosis pleuritis may occur in 10% of people who have the lung disease from tuberculosis. The pleural disease occurs from the rupture of a diseased area into the pleural space, the space between the lung and the lining of the abdominal cavity.

These people have a nonproductive cough, chest pain, and fever. The disease may go away and then come back at a later date.

In a minority of people with weakened immune systems, TB bacteria may spread through their blood to various parts of the body.

This is called miliary tuberculosis and produces fever, weakness, loss of appetite, and weight loss. Cough and difficulty breathing are less common.

Generally, return of dormant tuberculosis infection occurs in the upper lungs. Symptoms include common cough with a progressive increase in production of mucus and coughing up blood. Other symptoms include the following: fever, loss of appetite, weight loss, and night sweats.

About 15% of people may develop tuberculosis in an organ other than their lungs. About 25% of these people usually had known TB with inadequate treatment. The most common sites include the following: lymph nodes, genitourinary tract, bone and joint sites and tuberculosis that the lungs, shown in figure 2.6 – 2.7 [4].

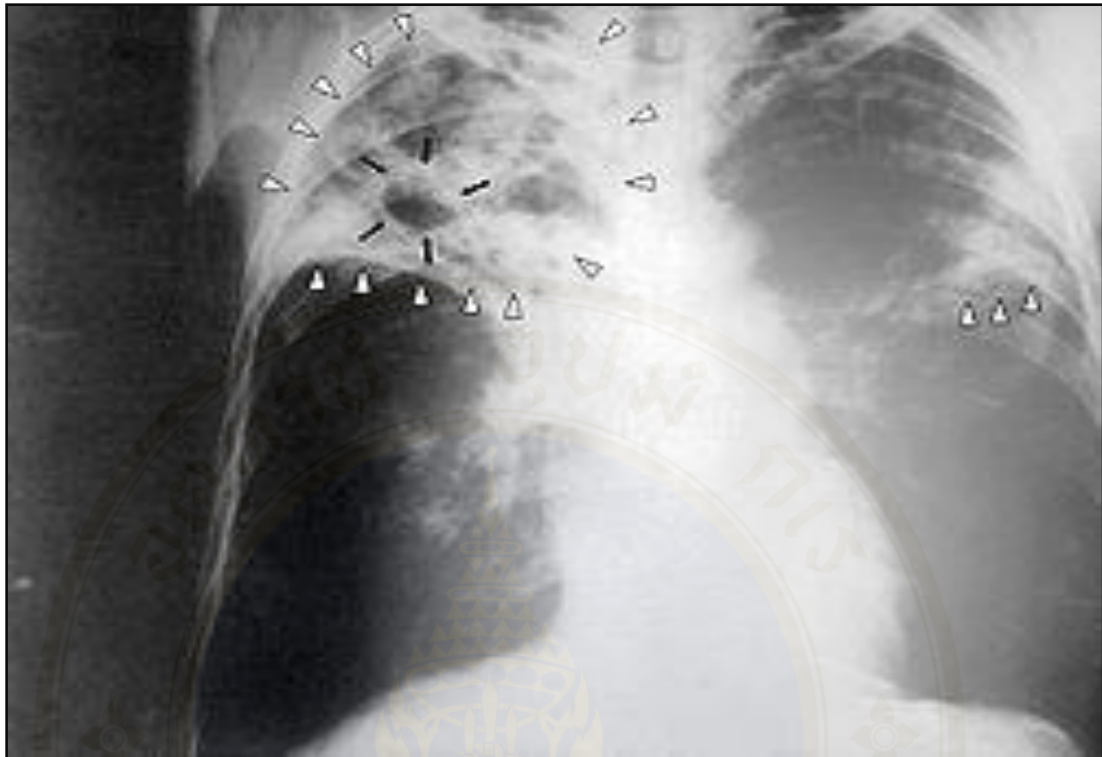


Figure 2.6 Show infected with tuberculosis at lungs [5].

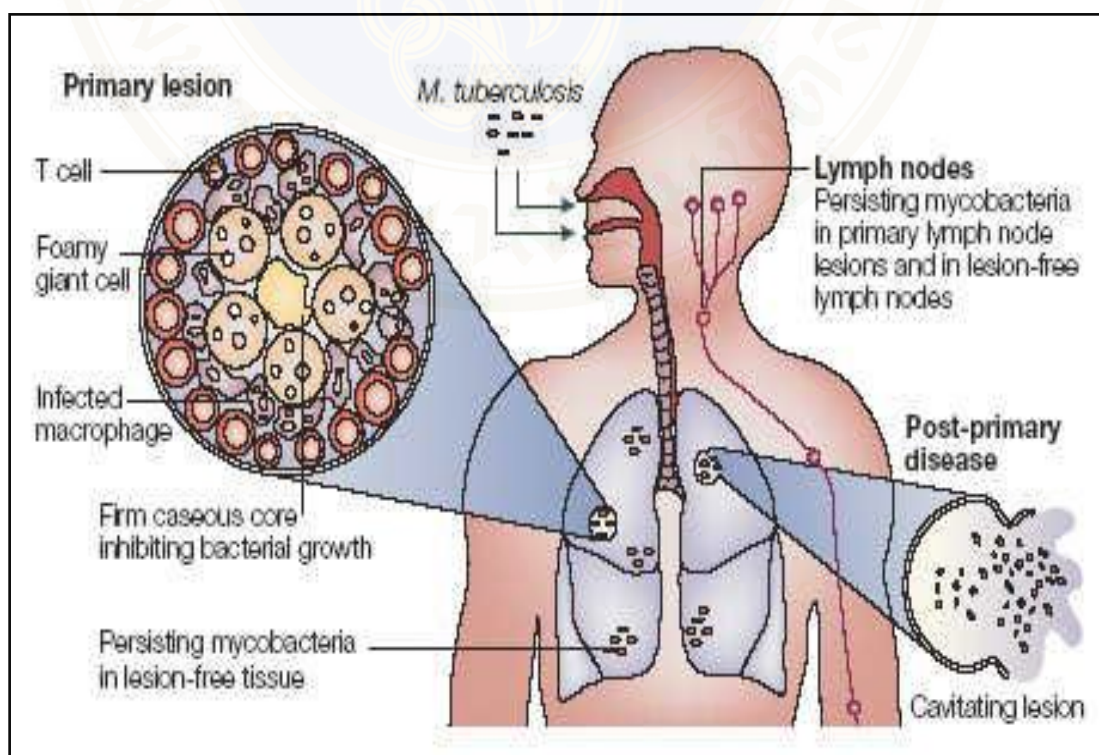


Figure 2.7 Show infected at lungs tissue [5].

2.4.3 Transmission

When people suffering from active pulmonary TB coughs, sneeze, speak, or spit, they expel infectious aerosol droplets 0.5 to 5 μm in diameter. A single sneeze can release up to 40,000 droplets. Each one of these droplets may transmit the disease, since the infectious dose of tuberculosis is very low and inhaling fewer than ten bacteria may cause an infection. People with prolonged, frequent, or intense contact are at particularly high risk of becoming infected, with an estimated 22% infection rate. A person with active but untreated tuberculosis can infect 10–15 other people per year. Others at risk include people in areas where TB is common, people who inject drugs using unsanitary needles, residents and employees of high-risk congregate settings, medically under-served and low-income populations, high-risk racial or ethnic minority populations, children exposed to adults in high-risk categories, patients immunocompromised by conditions such as HIV/AIDS, people who take immunosuppressant drugs, and health care workers serving these high-risk clients.

2.4.4 Diagnosis

Tuberculosis [1] is diagnosed definitively by identifying the causative organism (*Mycobacterium tuberculosis*) in a clinical sample (for example, sputum or pus). When this is not possible, a probable – although sometimes inconclusive – diagnosis may be made using imaging (X-rays or scans) and/or a tuberculin skin test .

The main problem with tuberculosis diagnosis is the difficulty in culturing this slow-growing organism in the laboratory (it may take 4 to 12 weeks for blood or sputum culture). A complete medical evaluation for TB must include a medical history, a physical examination, a chest X-ray, microbiological smears, and cultures. It may also include a tuberculin skin test, a serological test. The interpretation of the tuberculin skin test depends upon the person's risk factors for infection and progression to TB disease, such as exposure to other cases of TB or immunosuppressant.

The currently, latent infection is diagnosed in a non-immunized person by a tuberculin skin test, which yields a delayed hypersensitivity type response to an extract made from *M. tuberculosis*. Those immunized for TB or with past-cleared infection will respond with delayed hypersensitivity parallel to those currently in a

state of infection, so the test must be used with caution, particularly with regard to persons from countries where TB immunization is common. Tuberculin tests have the disadvantage of producing false negatives, especially when the patient is co-morbid with sarcoidosis, Hodgkins lymphoma, malnutrition, or most notably active tuberculosis disease. The newer interferon release assays (IGRAs) overcome many of these problems. IGRAs are in vitro blood tests that are more specific than the skin test. IGRAs detect the release of interferon gamma in response to mycobacterial proteins such as ESAT-6. These are not affected by immunization or environmental mycobacteria, so generate fewer false positive results. There is also evidence that the T-SPOT.TB IGRA is more sensitive than the skin test. The new TB tests have been developed that are fast and accurate. These include polymerase chain reaction assays for the detection of bacterial DNA. One such molecular diagnostics test gives results in 100 minutes and is being currently offered to 116 low and middle-income countries at a discount with support from WHO and the Bill and Melinda Gates foundation.

2.4.5 Treatment

Treatment for TB uses antibiotics to kill the bacteria. Effective TB treatment is difficult, due to the unusual structure and chemical composition of the mycobacterial cell wall, which makes many antibiotics ineffective and hinders the entry of drugs. The two antibiotics most commonly used are isoniazid and rifampicin. However, instead of the short course of antibiotics typically used to cure other bacterial infections, TB requires much longer periods of treatment (around 6 to 24 months) to entirely eliminate mycobacteria from the body. Latent TB treatment usually uses a single antibiotic, while active TB disease is best treated with combinations of several antibiotics, to reduce the risk of the bacteria developing antibiotic resistance. People with latent infections are treated to prevent them from progressing to active TB disease later in life. The drug-resistant tuberculosis is transmitted in the same way as regular TB. Primary resistance occurs in persons infected with a resistant strain of TB. A patient with fully susceptible TB develops secondary resistance (acquired resistance) during TB therapy because of inadequate treatment, not taking the prescribed regimen appropriately, or using low-quality medication. The drug-resistant TB is a public health issue in many developing

countries, as treatment is longer and requires more expensive drugs. Multi-drug-resistant tuberculosis (MDR-TB) is defined as resistance to the two most effective first-line TB drugs: rifampicin and isoniazid. Extensively drug-resistant TB (XDR-TB) is also resistant to three or more of the six classes of second-line drugs [4].

The DOTS (Directly Observed Treatment Short-course) strategy of tuberculosis treatment recommended by WHO was based on clinical trials done in the 1970s by Tuberculosis Research Centre, Chennai, India. The country in which a person with TB lives can determine what treatment they receive. This is because multidrug-resistant tuberculosis is resistant to most first-line medications, the use of second-line antituberculosis medications is necessary to cure the patient. However, the price of these medications is high; thus poor people in the developing world have no or limited access to these treatments [5].

2.4.6 Prevention

The TB prevention and control takes two parallel approaches. In the first, people with TB and their contacts are identified and then treated. The identification of infections often involves testing high-risk groups for TB. The second approach, children are vaccinated to protect them from TB. No vaccine is available that provides reliable protection for adults. However, in tropical areas where the levels of other species of mycobacteria are high, exposure to nontuberculous mycobacteria gives some protection against TB. The World Health Organization (WHO) declared TB a global health emergency in 1993, and the stop TB partnership developed a global plan to stop tuberculosis that aims to save 14 million lives between 2006 and 2015. Since humans are the only host of *Mycobacterium tuberculosis*, eradication would be possible. This goal would be helped greatly by an effective vaccine [4].

2.5 Relevant Research

Aritsara Jaruenpanyanet studied application of GIS analysis outbreak malaria in Thai- Myanmar, Amphoe Muang, Mae Hong Son District found that the factor affected to dispersible malaria. Factor analysis divides 2 case physical factors, physical –economic and social factor. Result of study high risk area of physical factor has relate elevation. Physical, economic social factor has important dispersible malaria as same as every factor, economic an social factor. Comparing result some area did not the same result or consistency because of population movement, clandestinely way, temporary center of war etc. [24].

Frank C Tanser and David le Sueur studied the application of geographic information system to important public health problems in Africa that has survival problems so to make GIS useful in Africa health management by imitate spatial data. It support to understand the infection disease transformed weathers relate to spatial data. While GIS can analyze relate infectious disease factor and can solve the Africa's health problems by efficiency [25].

Passakorn Rattanadechsakul studied about information system not a science that develops to go up , design for manage in area manner , by lead information system comes in to help in the lead reaches of the data for , see splitting relation of cancer larger intestine patient and the anus and the data in area manner , make an institute has where to relate can appreciate the data quickly , use engage in business decide in laying plans operates for the supervision and protect the cancer the larger intestine and the anus [26].

Daisuke Onozuka and Akihito Hagihara studied the spreading education of the disease the tuberculosis , by do the education 109 from a village , province , Fukuoka , Japan by have relation education between Space-time scan statistic , with patient tuberculosis amount , from the education meets that , the area that have a lot of patient tuberculosis that majority amount s are will in the part that are a fungus and the industrial factory stay greatly from the education can make to know the area where has spreading of the disease makes can lay plans to protect and control spreading have of the disease [27].

Kistemann studied the relationship between tuberculosis and risk factors of HIV infection in urban areas using GIS. The study collected basic data on the incidence of tuberculosis during in 1986 to 1997, divide by age group, migration of the population in eastern Germany not a factor to apply increased morbidity. Concluded that the effect on the rate of increase of TB. The patients more than 60 years age group as factors that cause tuberculosis rate increase and HIV infection does not apply to be the main rate of tuberculosis increased in the age group of 30-49 years [28].

Chan-yeung M. research in population and social geography that affects the spread of TB in Hong Kong using GIS apply to study with patients from 1999 to 2002 living in Hong Kong, the study of molecular components. Mycobacterium tuberculosis was isolated from the sputum of patients with RFLP method of living space characteristic of the patient to be linked with GIS was number 2332 TB patients who live in Hong Kong. Demographic related significantly to the statistical significance of TB is. Housing characteristics of low-income elderly, low but not related to population density and no paint job [29].

Tiwari studied of tuberculosis patients in India use the principles of statistics to study the spread of TB, compared with geography and its statistical analysis of spatial data. The information related to the duration of the spread of tuberculosis. The found that distribution of tuberculosis with primary and secondary were significantly related with the reliability of more than 95 percent. The spread of TB in the three amphoe. The conclusion we can use geographic analysis to determine the statistical relationship for the distribution of the TB [30].

Marian R. Passannante et, al studied an initial questionnaire presented three scenarios describing persons with significant exposure to MDR-TB and with new tuberculin skin test reactions more than 15 mm (except one anergic patient) without evidence of disease. Panelists were asked to suggest possible preventive therapy regimens. During a second round survey, the panel members were asked to review the suggested regimens provided for each scenario and to rank them from one to nine as extremely inappropriate to extremely appropriate. Results of this second survey were tabulated and shared with the members of the panel who were then asked to rerank each regimen in light of the previous cumulative panel responses. No specific regimen achieved initial positive consensus by predefined criteria. In two of

the three scenarios the no treatment option, however, was deemed clearly inappropriate. The data were also analyzed by what percentage of respondents who ranked a regimen as at all appropriate (ie, six or more on the nine point scale). For scenarios involving a nurse, an HIV-positive tuberculin reactor, and a patient who was anergic HIV-positive, treatment with pyrazinamide 1,500 mg daily with ciprofloxacin 750 mg twice a day for 4 months received a somewhat appropriate rating from more than 50 percent of respondents [31].

Patrick K Moonan et, al studied about currently in the U.S. it is recommended that tuberculosis screening and treatment programs be targeted at high-risk populations. While a strategy of targeted testing and treatment of persons most likely to develop tuberculosis is attractive, it is uncertain how best to accomplish this goal. In this study we seek to identify geographical areas where on-going tuberculosis transmission is occurring by linking Geographic Information Systems (GIS) technology with molecular surveillance. This cross-sectional analysis was performed on data collected on persons newly diagnosed with culture positive tuberculosis at the Tarrant County Health Department (TCHD) between January 1, 1993 and December 31, 2000. Clinical isolates were molecularly characterized using IS6110-based RFLP analysis and spoligotyping methods to identify patients infected with the same strain. Residential addresses at the time of diagnosis of tuberculosis were geocoded and mapped according to strain characterization. The Generalized estimating equations (GEE) analysis models were used to identify risk factors involved in clustering. The evaluation of the spatial distribution of cases within zip-code boundaries identified distinct areas of geographical distribution of same strain disease. We are identified these geographical areas as having increased likelihood of on-going transmission. Based on this evidence we plan to perform geographically based screening and treatment programs [32].

Dolores Acevedo-Garcia this study examined zipcode-level risk factors associated with very high tuberculosis (TB) rates among non-Hispanic Whites, African Americans, Hispanics, and Asians in New Jersey(1985–1992). The exposure indices (poverty,crowded housing, and dilapidatedhousing) and segregation indices (contact with immigrants, isolation, and density) were used to characterize zip codes. A Boolean-logic methodology was used to determine which configurations of risk

factors significantly distinguish zip codes where TB rates are very high from other zip codes. For Whites and Asians, risk factors were rare in zip codes with very high TB rates. In agreement with the distribution of TB cases by age and foreignborn status, this suggests that cases among Whites may be caused by reactivation, whereas cases among Asians may be imported. In contrast, Hispanics and African Americans were exposed to risk factors that may facilitate TB transmission. Among Hispanics, high contact with immigrants was an important factor. African Americans were the group most frequently exposed to multiple risk factors [33].

A van Rie et al studied the epidemiology of childhood tuberculosis (TB) in a developing country. The setting- two urban communities of Cape Town, South Africa with a TB case notification rate of 1149/100 000. The design-Retrospective descriptive study using the national population census (1991), 10 year official TB notification records, and a geographical information system. The case notification rate of TB in children 0-5 years old was 3588 cases/100 000 children aged 0-5 years, 3.5 times the case notification rate in adults. The children (0-14 years) accounted for 39% of the total case load. Childhood TB case notification rate correlated with parental education, annual household income, and crowding [34].

Wutjanun Muttitanon, et al studied Spatial and temporal dynamics of Dengue Hemorrhagic Fever Epidemics (Nakhon Pathom province, Thailand). The study aimed to describe the spatio-temporal dynamics of event, or it is for a sub district reaching a significantly higher than expected (epidemic) level of transmission of DHF. Several environmental factors modulate the distribution of dengue fever (DF) such as rainfall when the transmission peaks occur during the higher rainfall months, temperatures that reduce the mosquito extrinsic cycle duration, the human population density in urban areas, and the vector density. In order to take into account which variable. A Geographic Information Systems (GIS) has been built to create links between georeferenced data including medical records, socio-economic data, and environmental data. When applied to an epidemic-retrospective analytical study of DHF epidemics in Nakhon Pathom province (1997-2001). The method is applied to the study of two phenomena, 1) the occurrence epidemic sub district of cluster during one month and, 2) the spread of the epidemic from one month to the next one. This result indicates that these epidemics were likely to be due to the spread of a new or

rare virus serotype in areas with a limited immune protection against the dengue virus for serotype differential level of specific herd immunity [35].

2.6 Study Area

Amphoe Selaphum is the border of the Roi-ET is in at location $16^{\circ} 2' 0''$ N, $103^{\circ} 56' 2''$ E has a population of 120,896 in 2009, population of density 152.58 people/km². Amphoe Selaphum is in the east of a province, there are the boundary contacts with administrative adjacent district as follows.

North boundary is close to Amphoe Phonchai, Phontong and Nongpok.

South boundary is close to Amphoe kudchum, Zaimoon and Yasoton.

East boundary is close to Amphoe Panumphi.

West boundary is close to Amphoe Artsamart, Tawatburi and Tungkualuag.

The study area is shown in figure 2.8.

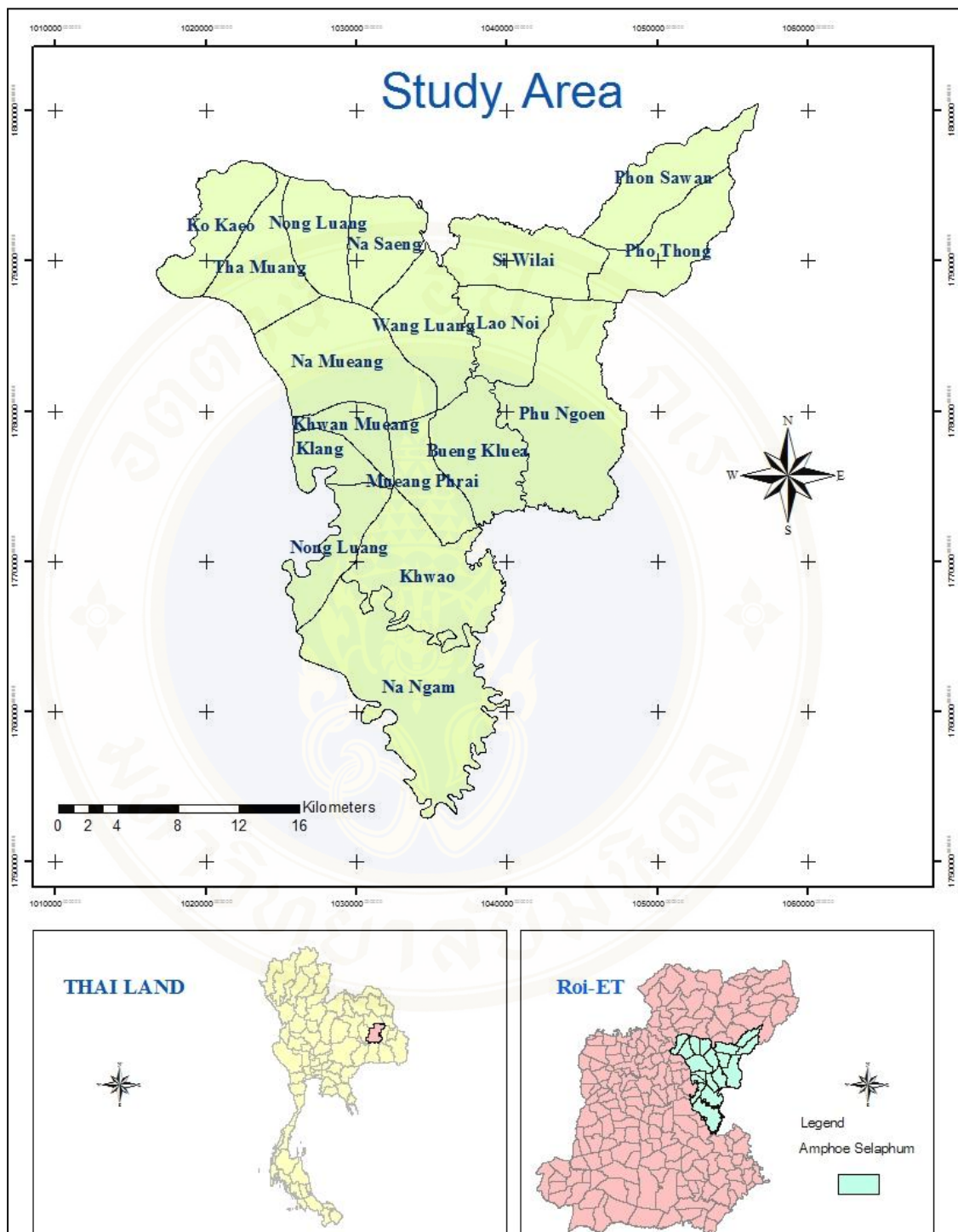


Figure 2.8 The study area in Amphoe Selaphum.

The people 120,896 of Amphoe selaphum the mountain not a person majority people earns a living the agriculture does the farms which there are the income shares in the people almost low galingale education.

Table 2.1 Number of population and number of villages by tambon in Amphoe Selaphum, Roi- ET [4].

No	Tambon	No. of Village	Population
1	Klang	11	9,403
2	Na Ngam	16	8,711
3	Mueang Phrai	14	6,561
4	Na Saeng	14	5,861
5	Na Mueang	20	9,193
6	Wang Luang	18	6,465
7	Tha Muang	11	5,052
8	Khwaio	16	9,403
9	Pho Thong	14	8,044
10	Phu Ngoen	18	11,879
11	Ko Kaeo	14	7,388
12	Na Loeng	10	5,032
13	Lao Noi	10	11,044
14	Si Wilai	11	4,740
15	Nong Luang	9	3,178
16	Phon Sawan	9	4,322
17	Khwan Mueang	11	4,228
18	Bueng Kluea	9	6,226

2.7 Selaphum Hospital

Selaphum hospital is a hospital under the Ministry of Health, Selaphum-Roi Et. Governance is a network hospital size 60 bed medical services with local people and neighborhood. The current staff consists of physicians and nurses were divided into [6].

1. One physician
2. One obstetrician - gynecologist
3. 4-5 general practitioners
4. 68 nurses
5. More than 80 health professional

The current landscape plant hospital route open tuberculosis clinic with medical staff as a people, three nurses. Characteristic of the original work is set to wait for patients to receive treatment themselves but the current behavior is more aggressive with home visits. The educated of patients and closely related to the anti-tuberculosis as place of TB clinic in Selaphum Hospital, shown in figure 2.2.



Figure 2.9 Selaphum Hospital, Amphoe Selaphum, Roi- ET [8].

CHAPTER III

MATERIAL AND METHODOLOGY

The research is designed and analysis areas risk of tuberculosis in Amphoe Selaphum, Roi- ET by using Geographic Information System (GIS) as an analytical tool. The application of GIS to analyze the areas in Amphoe Selaphum, Delphi technique as a tool in the analysis of risk factors that cause tuberculosis and spatial statistics analysis to analyze hot spot areas of tuberculosis. The data analysis consists of many parts. This chapter is divided into 2 main section, following.

3.1 Material

3.1.1 Data Source

3.1.2 Spatial data management tools.

3.2 Methodology

3.2.1 Data management

3.2.2 Data manipulation

3.2.3 Analysis Method Using GIS

3.1 Material

This research identified the necessary data. This section describes about the data source, spatial data management tools.

3.1.1 Source of data

3.1.1.1 Geographic data of Amphoe Selaphum in scale 1: 50,000 from the Ordnance Survey Department and Amphoe Selaphum.

3.1.1.2 Registration information of TB patients in 2006 – 2010 from Selaphum hospital.

3.1.1.3 Population data in Amphoe Selaphum from Amphoe Selaphum.

3.1.1.4 Village location information of Amphoe Selaphum from Department Of Provincial Administration.

3.1.1.5 Risk factors of TB from experts 17 by Delphi Technique.

3.1.1.6 Average income from Amphoe Selaphum Roi- ET.

3.1.2 Spatial data management tools.

3.1.2.1 Headwear

- Microcomputer 32 bit for Window XP
- Printer

3.1.2.2 Software

- ArcGIS 9.3
- Microsoft word 2007
- Microsoft Excel 2007
- Microsoft Access 2007

3.2 Methodology

The research study area Amphoe Selaphum Roi Et. Amphoe Selaphum there are 18 tambons, 187 villages. The total population 120,896 people. The people have career farmers is majority. The data contents for study is polygon and point, shown in table 3.1.

Table 3.1 The spatial data is used in this study

Type	Data	Description
Polygon	Amphoe Selaphum, Roi- ET area	The boundary of Amphoe Selaphum area
Point	location of village and Location of TB patient	Location information of village and TB patient in Amphoe Selaphum

3.2.1 Data management

The data management is scattered around everywhere in the format we can view the data, add data, edit it and delete data. The methods of data collection include:

3.2.1.1 Update changes in the database of patients tuberculosis, risk factors, study areas and morbidity of patients tuberculosis are format file DBMS by Microsoft Access 2007.

3.2.1.2 Choose the area you want to learn and make it in a format that works with ArcGIS.

3.2.2 Data manipulation

The process is customizing data, data appropriate and data management is in the same scale by configure of TB database, study areas, risk factors and Spatial database are record in Shape file format and type name is “shp”.

3.2.3 Analysis Method Using GIS

The methodology used in this studied consists of 3 main sections, flowing.

3.2.3.1 The Hot Spot Analysis

3.2.3.2 The Delphi Technique

3.2.3.3 The Weighting Rating Model

This chapter is divided into 3 main sections, following show in work flow diagram, figure 3.1.

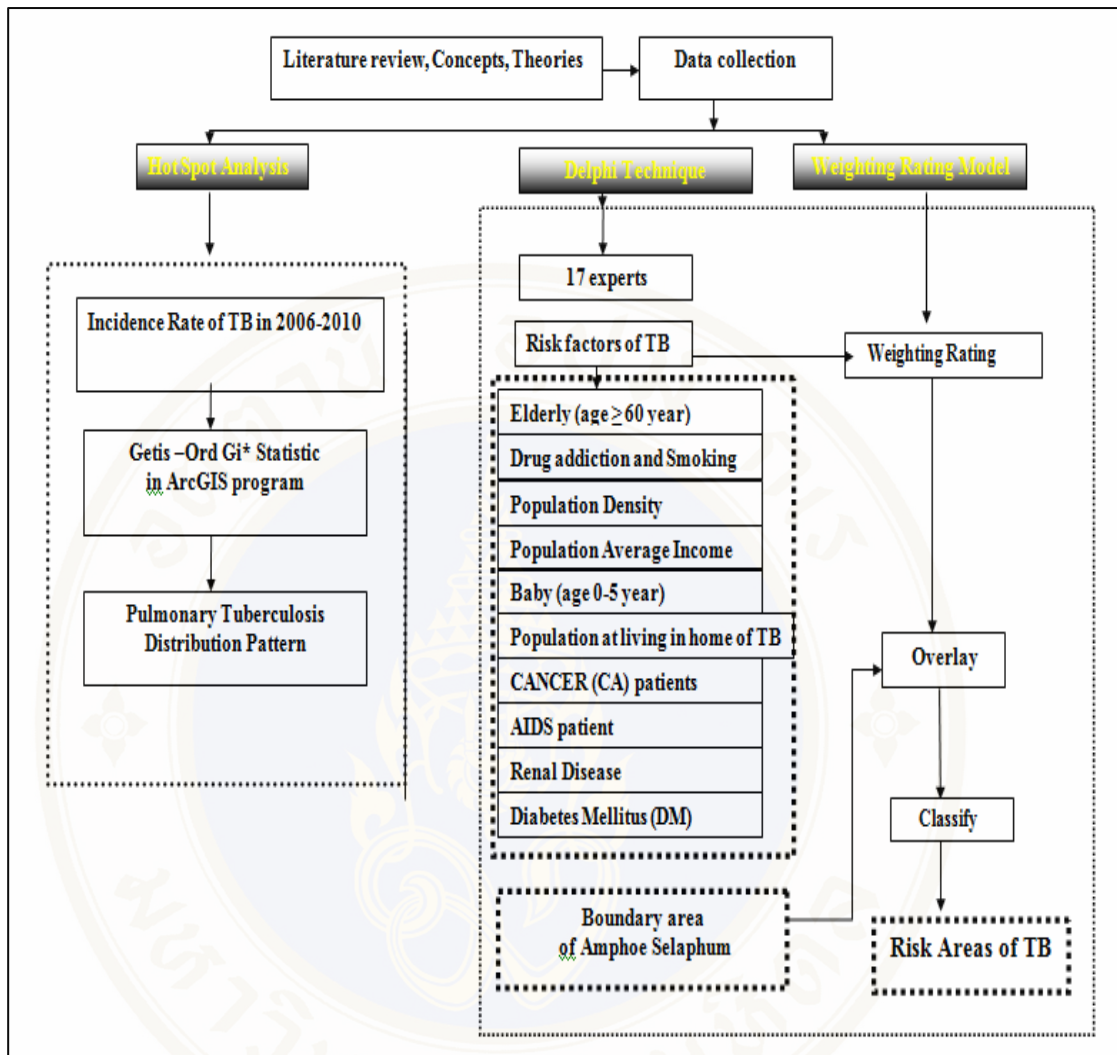


Figure 3.1 Flow Chart.

3.2.3.1 The Hot Spot Analysis

The analysis to Hot Spot tuberculosis disease occurrence by statistics technique Getis-Ord Gi* in a program ArcGIS. The determine relationship of morbidity rate and location or situation analysis of TB disease in the community and the distribution pattern of tuberculosis, consists of 5 sections.

- Calculate the incidence rate of tuberculosis cases per 100,000 population in 2006 - 2010, then linked with the map data in Amphoe Selaphum.

$$\text{Incidence rate of TB} = \frac{\text{Number of new patients} \times 100,000}{\text{Population mid year}}$$

- Calculate the distance (d)

Using Getis-Ord Gi * tools, and Calculate Distance Band from Neighbor count in Arc Toolbox (ArcGIS), to determine the distance of the area around each district.

- Analysis Hot Spot

Using Hot Spot Analysis tool (Getis-Ord Gi *) in Arc Toolbox, to find the Hot Spot or Cold Spot of the area, to show the areas with high morbidity rate or low morbidity rate of tuberculosis patients form z-score.

- Group z-score value using the Z-score Rendering in Arc Toolbox.

- Analysis and Interpretation

The show the spatial data group of morbidity rate tuberculosis in 2006- 2010, if have spatial autocorrelation, result is the z-score is positive or negative.

3.2.3.2 The Delphi Technique

The analysis of risk factors for TB disease using the Delphi Technique.

- The study the step and the way of Delphi technique, review the literary and theory that relate
 - The set property of an experts and contact are cooperation in doing research. The property of experts:
 - There are the educational background doesn't lower the bachelor's degree.
 - Who are having an experience side tuberculosis disease work doesn't lower 10 year.
 - The working side public health such as doctors, nurses, the public health and epidemiologists.
 - The experts are choosing and not less than 17 experts.

The development of questionnaire. The researcher should provide expert with three-four round response.

- Round one:

The open-ended questionnaire proposes to collect experts' opinions. The researches allow time of collection response around two weeks.

- Round two:

The data collection and the content from a question round that 1 by do the analysis like content analysis technique.

The questionnaire includes a rating scale using a Likert type model, by defined weight is as 5 levels to allow the expert to explain their choices. Analysis in second round responds in term of median, mode and interquartile range.

The weighting and rating point were estimated by using mean values.

The weighting is set between 1 to 5.

- 1 = non – appropriate factor
- 2 = low appropriate factor
- 3 = more appropriate factor
- 4 = high appropriate factor
- 5 = highly appropriate factor

The set rate of class each factors

This is study the data type (class) of each factor will receive a score (rating) according to the priority of the data. The study has determined that the rate of the data value is between 1 to 5. Types of valuable data points indicate that type of information is critical and involves a lot of TB disease.

The rating set between 1 to 5.

- 1 = lowest
- 2 = low
- 3 = medium
- 4 = high
- 5 = highest

- Round Three:

After obtaining second round respond researches translate it into statically analysis. If result of inter-quartile range in the close level, Opinion of expert reach of options. The research design three questionnaire that have the same information gained of the seconded round and mark position median score and inter-quartile range of each expert.

The set of factors and the weighted scores of the data in this research. The used of guidelines based on past research by scholars of the experts using Delphi Technique. The rate of the score factors derived from the statistics of events that occurred then be held rang and part of literature review.

3.2.3.3 The Weighting Rating Model

Analysis at risk areas for TB disease using the Weighting Rating Model. The result from weighting and rating evaluate TB risked area and use Overlay technique by Linear combination method in equation:

$$S = W_1R_1 + W_2R_2 + \dots + W_nR_n$$

Then S = Total point of risk area factor

W_n = Weighting at n series

R_n = Rate at n series

The calculated using the equation interval to final score came out. The total scores into grouped opportunity at risk of risk areas by using the average of mean scores. Then the distribution of data values standard deviation to determine the range of scores in each range of opportunities. Considering the wide range of levels by the following principles, set points in the risk assessment.

$$\text{The interval score} = \frac{(\text{Maximum score} - \text{Lowest score})}{\text{Interval scale}}$$

The results from analysis of the model to find the level of risk of tuberculosis led to the proposed map show the level of risk TB in Amphoe Selaphum, Roi- ET. The TB risk area was classified into three levels.

- High risk area of TB epidemic
- Moderate risk area of TB epidemic
- Low risk area of TB epidemic



CHAPTER IV

RESULTS

This research was studies to fine the risk areas of Pulmonary Tuberculosis (TB) in Amphoe Selaphum, Roi-ET by Geographic Information System (GIS), and Hot Spot Analysis to TB. The risk areas of TB disease are 3 levels, high risk areas, moderate risk areas and low risk areas. Results for research were divided into 2 sections.

4.1 The Risk Areas of Pulmonary Tuberculosis (TB)

4.2 Pulmonary Tuberculosis distribution Patterns: Hot Spot Analysis

4.1 The Risk Areas of Pulmonary Tuberculosis (TB)

The results using of Delphi technique include the risk factors of tuberculosis, risk factors of tuberculosis consist:

- 4.1.1 Elderly (age ≥ 60 year)
- 4.1.2 Baby (age 0-5 year)
- 4.1.3 Drug addiction and Smoking
- 4.1.4 Population Density
- 4.1.5 Population Average Income (people/year)
- 4.1.6 Population at Living in Home of TB Patient
- 4.1.7 CANCER (CA) patients
- 4.1.8 Renal Disease
- 4.1.9 AIDS patient
- 4.1.10 Diabetes Mellitus (DM) patient

This research divided into risk areas of TB, studied form 10 factors. The fine factors by use Delphi technique. The Delphi technique is a research approach that is base on a structured process for collecting and distilling knowledge from a group of experts. Researchers select experts from working; knowledge and experience with TB

in difference location and researcher select all 17 experts. Researcher designed questionnaire for interview and sent E-mail to experts. This questionnaire was design by theory of TB, interview of experts. This questionnaire quality was verified by number of experts. The researcher should provide expert with three round response. The factors affecting of TB consists 10 factors: 1) elderly 2) baby (age 0-5 year old) 3) AIDS/HIV patients 4) diabetes mellitus (DM) patients 5) cancer (CA) patients 6) renal disease 7) population average at living in home of TB 8) drug addiction and smoking 9) low income 10) population density.

The factors were then sent to experts for weighting and rating. The experts identified factors as being of highly appropriate factor and have important of TB: 1) AIDS/HIV patients 2) diabetes mellitus (DM) patients 3) cancer (CA) patients 4) renal disease 5) population average at living in home of TB, high appropriate factor: 1) elderly 2) baby (age 0-5year) 3) population density and more appropriate factor: 1) drug addiction and smoking 2) low income.

The combined result of weighting and rating form experts and sent result to for analysis using overlay technique of GIS program. Therefore its show factors influencing risk area of TB on map.

4.1.1 The elderly (age ≥ 60 year) in Amphoe Selaphum at tambon level during 2006-2010

The data on elderly in Amphoe Selaphum at tambon level during 2006-2010 from Statistics data from National Statistical Office and Selaphum Public Health Association, from elderly people (age ≥ 60 year) in 2006-2010 to calculate the average of elderly, as data shown in table 4.1.

Table 4.1 Average number of elderly (age ≥ 60 year) in Amphoe Selaphum.

Tambon_Code	Tambon	Elderly (age ≥ 60 year)
450901	Klang	1517
450911	Ko Kaeo	426
450917	Khwan Mueang	1517
450902	Khwao	723
450903	Tha Muang	580
450905	Na Ngam	427
450904	Na Saeng	731
450906	Na Mueang	1222
450912	Na Loeng	616
450918	Bueng Kluea	695
450916	Phon Sawan	326
450907	Pho Thong	612
450908	Phu Ngoen	1422
450909	Mueang Phrai	817
450910	Wang Luang	1226
450914	Si Wilai	351
450915	Nong Luang	220
450913	Lao Noi	316

The data from the average of elder, classify by using Equal interval was divide the data into five groups: lowest, low, medium, high and highest: as data shown in table 4.2.

Table 4.2 Elderly (age ≥ 60 year) class.

Class	No. of elder	No. of tambon
Lowest	220-479	6
Low	480-739	3
Medium	740-998	4
High	999-1258	2
Highest	1259-1517	3

After analysis was found that the average of elderly people there are in group of 220-479 has 6 tambon is Si Wilai, Nong Luang, Phon Sawan, Lao Noi, Ko Kaeo and Na Ngam group of 480-739 has 3 tambon there are Nong Luang, Khwao and Bueng Kluea, group of 740-998 has 4 tambon there are Tha Muang, Na Saeng , Mueang Phrai and Pho Thong, group of 999-1258 has 2 tambon there are Wang Luang and Na Mueang, group of 1259-1517 has 3 tambon there are Khwan Mueang, Phu Ngoen and Klang: as data show in figure 4.1.

The data about elderly (age ≥ 60 year) at tambon level during 2006-2010 of all five groups were used as factor in GIS analysis to find tambon with TB risk in Ampoe Selaphum, Roi-ET.

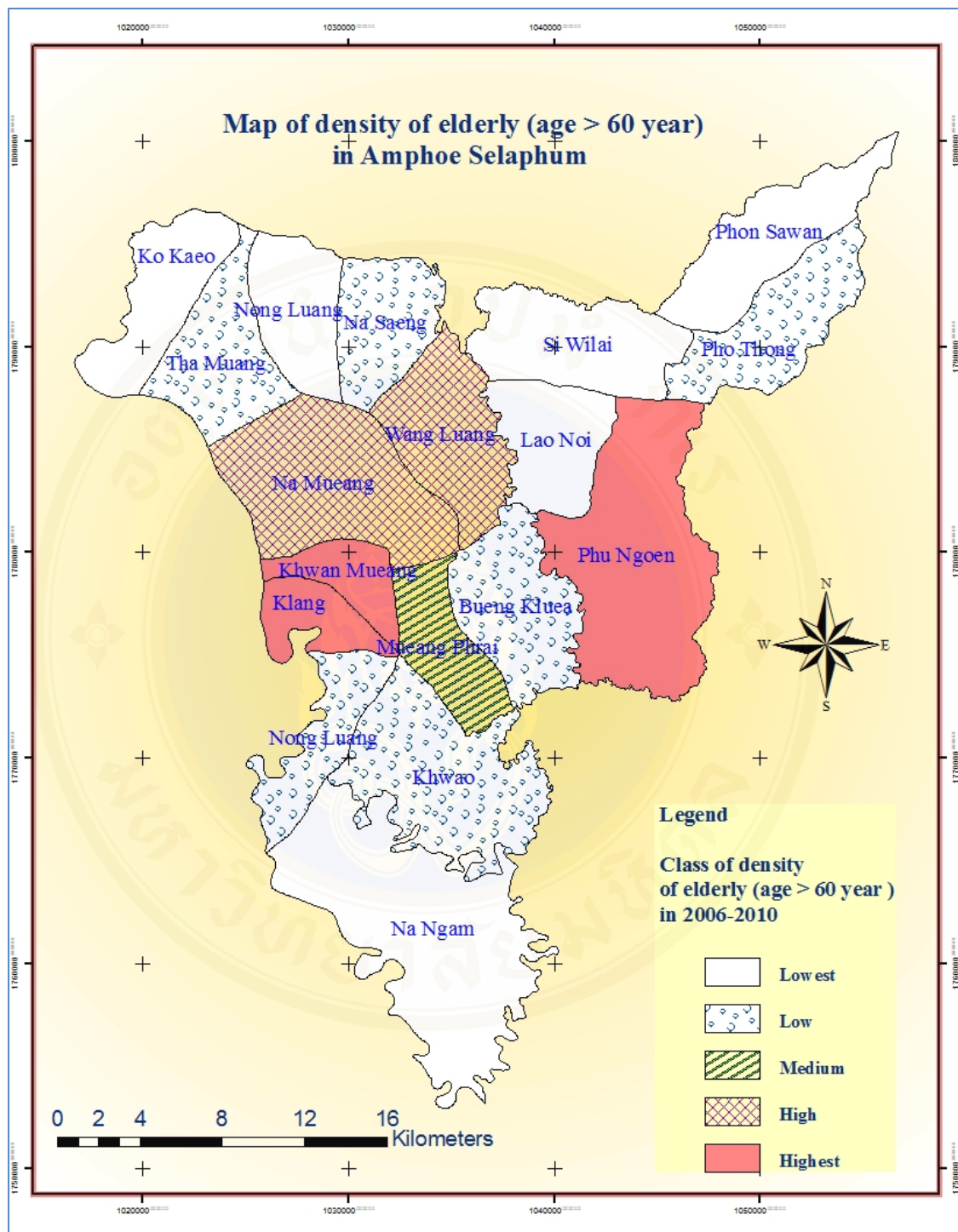


Figure 4.1 Map of density of elderly (age ≥ 60 year) in Amphoe Selaphum.

4.1.2 The baby (age 0-5 years)

The data on baby (age 0-5 year) at tambon level during 2006-2010 from Sub district Administrative Organization of Amphoe Selaphum total 18 tambon, from data of baby in 2006-2010 to calculate the average of baby, as data shown in table 4.3.

Table 4.3 Average number of baby (age 0-5 year) in Amphoe Selaphum.

Tambon_Code	Tambon	Baby (age 0-5 year)
450901	Klang	130
450911	Ko Kaeo	160
450917	Khwan Mueang	130
450902	Khwao	147
450903	Tha Muang	100
450905	Na Ngam	120
450904	Na Saeng	75
450906	Na Mueang	186
450912	Na Loeng	30
450918	Bueng Kluea	80
450916	Phon Sawan	52
450907	Pho Thong	134
450908	Phu Ngoen	130
450909	Mueang Phrai	150
450910	Wang Luang	80
450914	Si Wilai	110
450915	Nong Luang	100
450913	Lao Noi	70

From the average of baby, classify by using Equal interval was divide the data into five groups: lowest, low, medium, high and highest, data shown in table 4.4.

Table 4.4 Baby (age 0-5 year) class.

Class	No. of baby (age 0-5 year)	No. of tambon
Lowest	30-61	2
Low	62-92	4
Medium	93-124	4
High	125-155	6
Highest	156-186	2

After analysis was found that the average of baby (age 0-5 year) there are in group of 30-61 has 2 tambon there are Na Loeng and Phon Sawan, group of 62-92 has 4 tambon there are Na Saeng ,Wang Luang, Lao Noi and Bueng Kluea, groups of 93-124 has 4 tambon there are Tha Muang, Nong Luang,Si Wilai and Na Ngam, groups of 125-155 has 6 tambon there are Klang, Khwan Mueang, Khwao, Mueang Phrai, Phu Ngoen and Pho Thong, groups of 156-186 has 2 tambon there are Na Mueang and Ko Kaeo: as data shown in figure 4.2.

The data about baby at tambon level during 2006-2010 of all five groups were used as factor in GIS analysis to find tambon with TB risk in Ampoe Selaphum, Roi-ET.

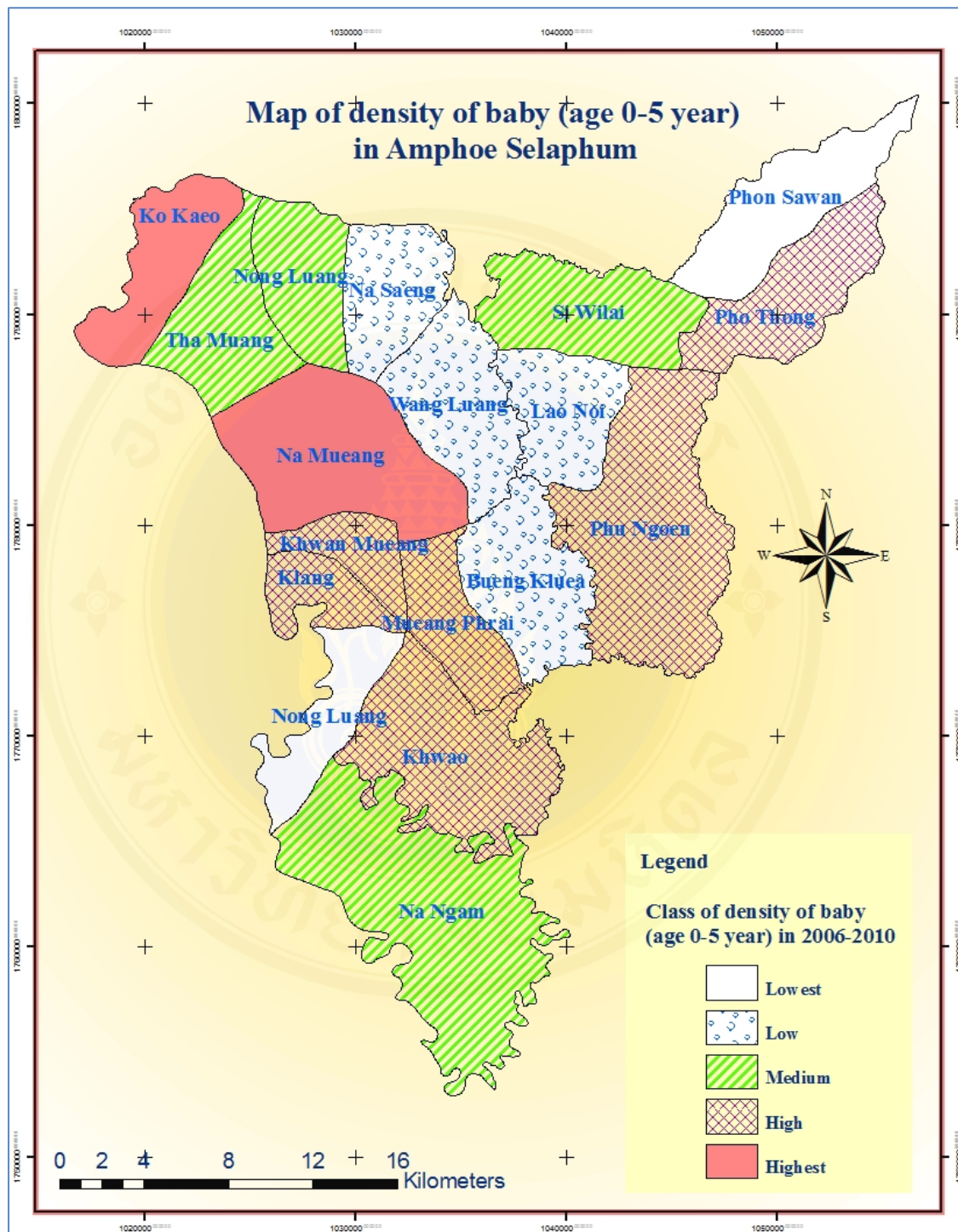


Figure 4.2 Map of density of baby (age 0-5 year) in Amphoe Selaphum.

4.1.3 The drug addiction and Smoking at tambon level during 2006-2010

The data on drug addiction and smoking at tambon level during 2006-2010 from Public Health Organization Amphoe Selaphum, Roi- ET, from data drug addiction and smoking in 2006-2010 into calculation the prevalence rate, shown as table 4.5.

Table 4.5 Prevalence rate of drug addiction and smoking in Amphoe Selaphum.

Tambon_Code	Tambon	Prevalence Rate (Case/ 100,000)
450901	Klang	14
450911	Ko Kaeo	4
450917	Khwan Mueang	14
450902	Khwaao	13
450903	Tha Muang	16
450905	Na Ngam	4
450904	Na Saeng	13
450906	Na Mueang	4
450912	Na Loeng	3
450918	Bueng Kluea	6
450916	Phon Sawan	12
450907	Pho Thong	16
450908	Phu Ngoen	13
450909	Mueang Phrai	9
450910	Wang Luang	2
450914	Si Wilai	2
450915	Nong Luang	1
450913	Lao Noi	4

From data prevalence rate of drug addiction and smoking, classify by using Equal interval was divide the data into five groups: lowest, low, medium, high and highest, shown as table 4.6.

Table 4.6 Drug addiction and smoking class.

Class	No. of drug addiction and smoking	No. of tambon
Lowest	1-3	5
Low	4-6	5
Medium	7-9	1
High	10-14	1
Highest	15-16	6

After analysis was found that the average of drug addiction and smoking there are in group of 1-3 Phon Sawan, Pho Thong, Mueang Phrai, Nong Luang and Khwan Mueang, groups of 4-6 has 5 tambon there are Na Mueang, Bueng Kluea, Wang Luang, Khwao and Phu Ngoen, groups of 7-9 have 1 tambon there is Si Wilai, groups of 10-14 have 1 tambon there is Ko Kaeo, groups of 15-16 has 6 tambon there are Klang, Na Ngam, Nong Luang, Tha Muang, Na Saeng and Lao Noi, shown as figure 4.3.

The data about drug addiction and smoking at tambon level during 2006-2010 of all five groups were used as factor in GIS analysis to find tambon with TB risk in Ampoe Selaphum, Roi-ET.

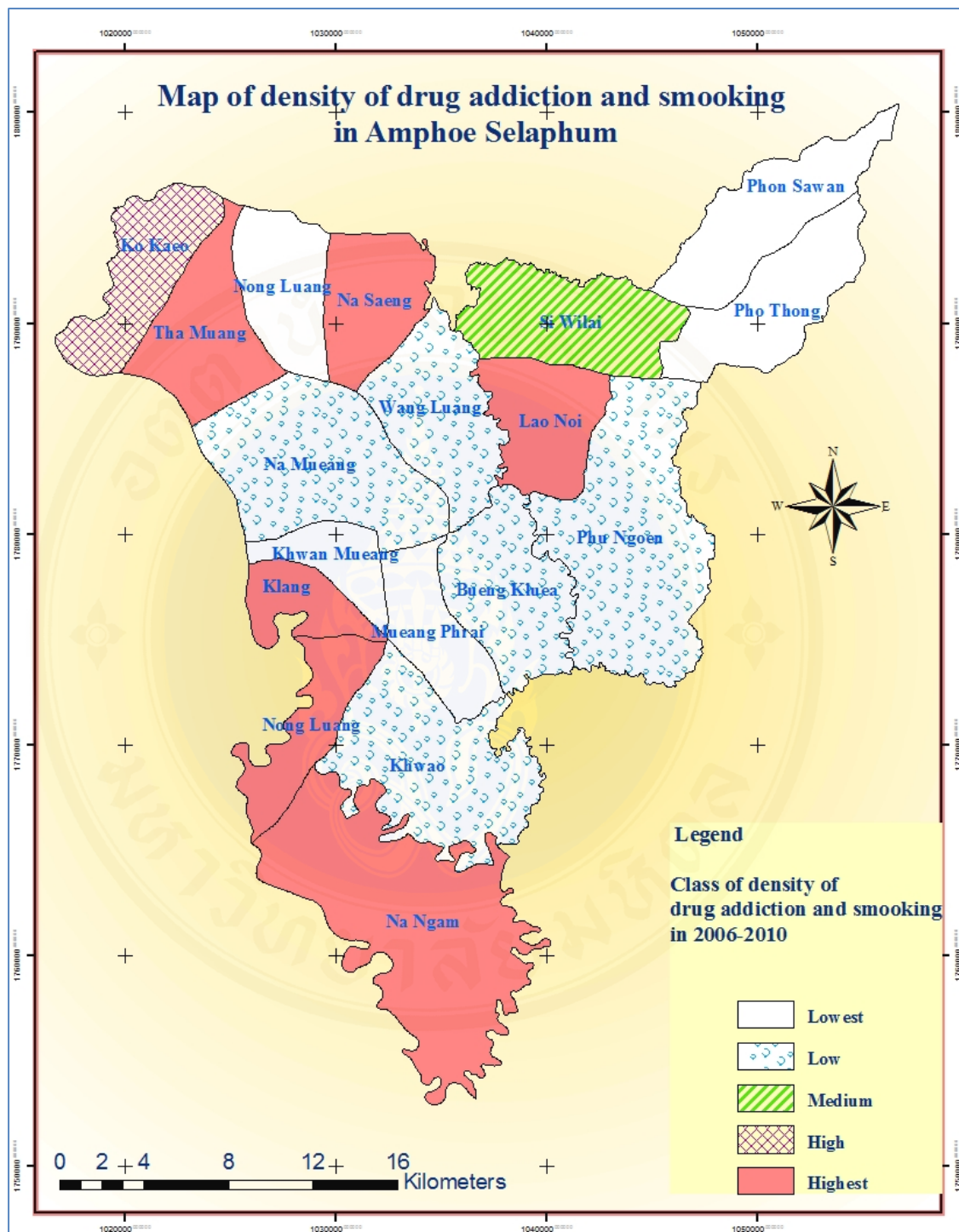


Figure 4.3 Map of density of drug addiction and smoking in Amphoe Selaphum.

4.1.4 The population density at tambon level during 2006-2010

The data on population density (people/km²) in Amphoe Selaphum at tambon level during 2006- 2010 from Statistics data from National Statistical Office and Sub district Administrative Organization Amphoe Selaphum total 18 tambon, from data of population density in 2006-2010 into calculate find average of population density, as data shown in table 4.7.

Table 4.7 Average number of population density (people/km²) in Amphoe Selaphum.

Tambon_Code	Tambon	Population Density(people/km ²)
450901	Klang	418
450911	Ko Kaeo	139
450917	Khwan Mueang	418
450902	Khwao	231
450903	Tha Muang	135
450905	Na Ngam	115
450904	Na Saeng	139
450906	Na Mueang	175
450912	Na Loeng	181
450918	Bueng Kluea	323
450916	Phon Sawan	117
450907	Pho Thong	300
450908	Phu Ngoen	90
450909	Mueang Phrai	137
450910	Wang Luang	203
450914	Si Wilai	173
450915	Nong Luang	131
450913	Lao Noi	138

From data average of population density, classify by using Equal interval was divide the data into five groups: lowest, low, medium, high and highest, shown as table 4.8.

Table 4.8 Population density (people/km²) class.

Class	No. of population density	No. of tambon
Lowest	0.00-90	1
Low	91-167	9
Medium	167-251	5
High	251-334	1
Highest	334-418	2

After analysis was found that the average of population density there are in group of 0.00-83.60 have 1 tambon there is Pho Thong, groups of 83.61-167.2 has 9 tambon there are Ko Kaeo, Tha Muang, Nong Luang, Na Saeng, Lao Noi, Phon Sawan, Phu Ngoen, Mueang Phrai and Na Ngam, groups of 167.3-250.8 has 5 tambon there are Si Wilai, Wang Luang, Na Mueang, Wang Luang, Nong Luang and Khwao, groups of 250.9-334.4 have 1 tambon there is Bueng Kluea, groups of 334.5-418.0 has 2 tambon there are Khwan Mueang and Bueng Kluea: as data shown in figure 4.4.

The data about population density at tambon level during 2006-2010 of all five groups were used as factor in GIS analysis to find tambon with TB risk in Ampoe Selaphum, Roi-ET.

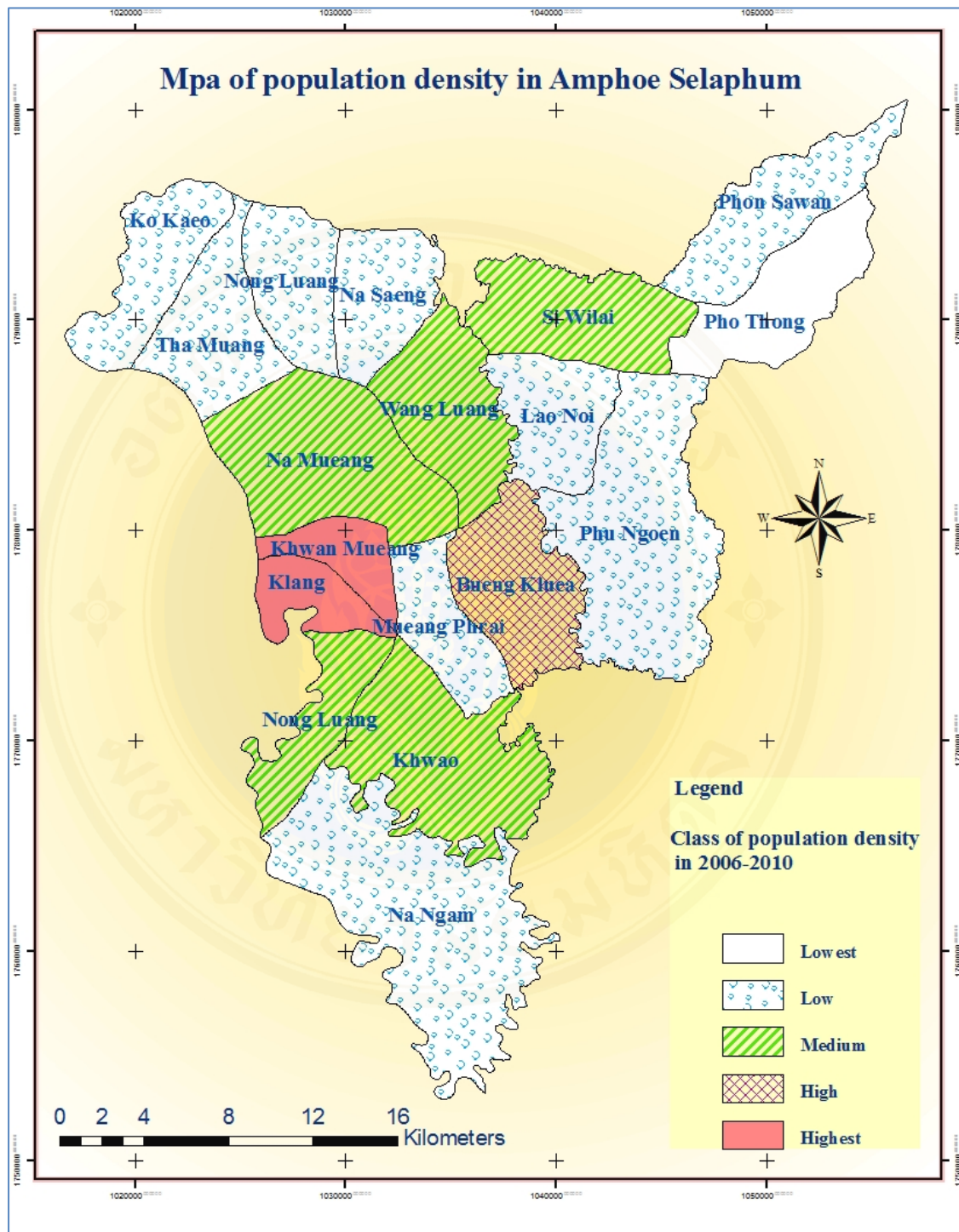


Figure 4.4 Map of population density in Amphoe Selaphum.

4.1.5 The average income (bath) at tambon level during 2006-2010

The data on population average income in Amphoe Selaphum at tambol level during 2006- 2010 from Statistics data from National Statistical Office and Sub district Administrative Organization Amphoe Selaphum total 18 tambon, from data of population average income into calculate find average, as data shown in table 4.9.

Table 4.9 Average income in Amphoe Selaphum.

Tambon_Code	Tambon	Average Income (baht)
450901	Klang	78000
450911	Ko Kaeo	35000
450917	Khwan Mueang	78000
450902	Khwao	49620
450903	Tha Muang	24000
450905	Na Ngam	31427
450904	Na Saeng	412200
450906	Na Mueang	44950
450912	Na Loeng	27000
450918	Bueng Kluea	23000
450916	Phon Sawan	45591
450907	Pho Thong	24500
450908	Phu Ngoen	35100
450909	Mueang Phrai	47202
450910	Wang Luang	32317
450914	Si Wilai	24000
450915	Nong Luang	22000
450913	Lao Noi	23200

From data population average income, classify by using Equal interval was divide the data into five groups: lowest, low, medium, high, and highest, as data shown table 4.10.

Table 4.10 Average income (baht) class.

Class	No. of average income (baht)	No. of tambon
Lowest	0.00-82,440	17
Low	82,441-164,880	0
Medium	164,881- 247,320	0
High	247,321- 329,760	0
Highest	329,761- 412,200	1

After analysis it was found that the population average income there are in groups of 0-82,440.000 has 17 tambon there are Klang, Ko Kaeo, Khwan Mueang, Khwao, Tha Muang, Na Mueang, Nong Luang, Bueng Kluea, Phon Sawan, Pho Thong, Phu Ngoen , Mueang Phrai, Wang Luang, Si Wilai, Nong Luang and Lao Noi, groups of 329,760.01-412,200.00 have 1 tambon there is Na Saeng: as data shown in figure 4.5.

The data about population average income at tambon level during 2006-2010 of all five groups were used as factor in GIS analysis to find tambon with TB risk in Ampoe Selaphum, Roi-ET.

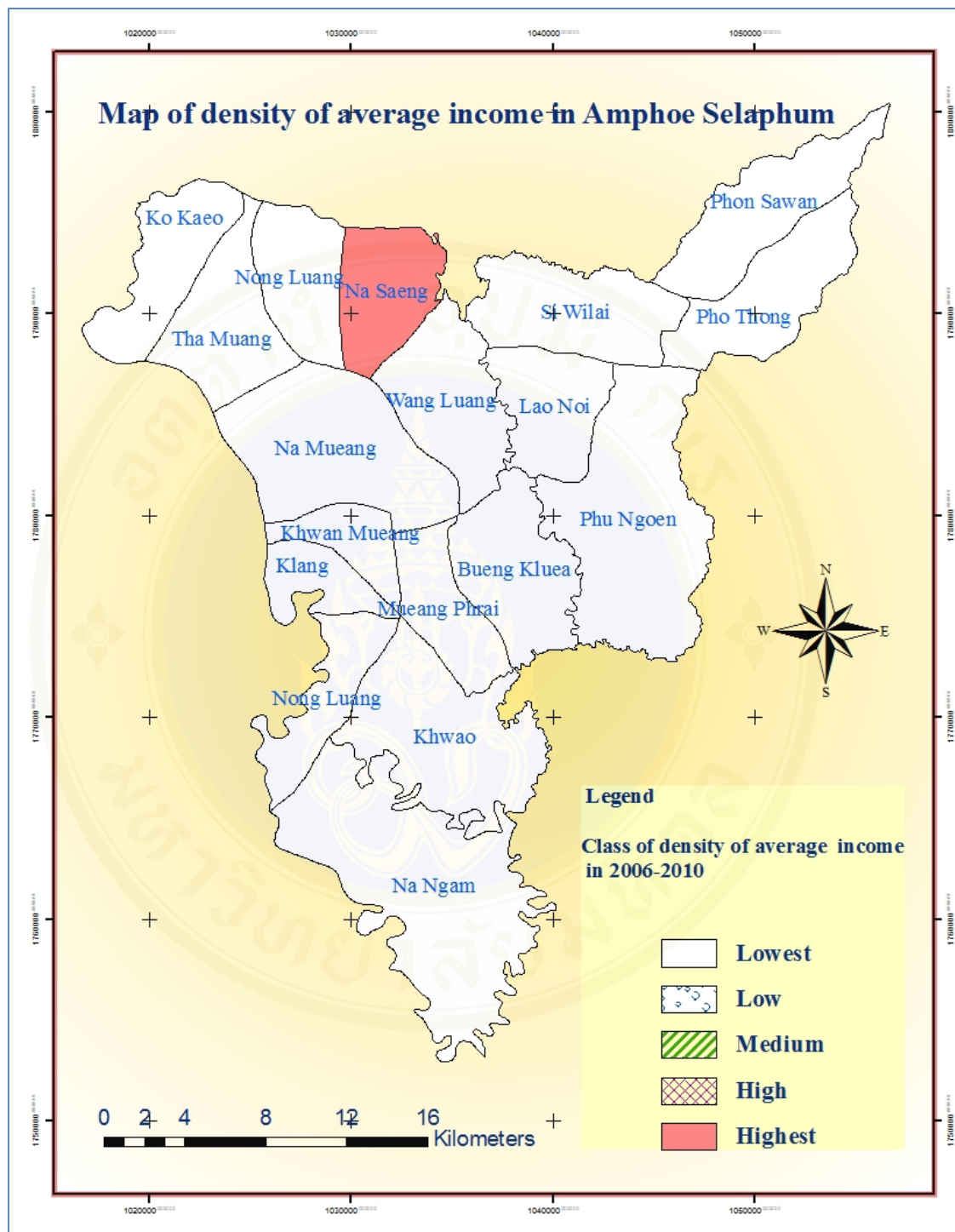


Figure 4.5 Map of density of average income in Amphoe Selaphum.

4.1.6 The people surrounded by potential cases of TB at tambon level during 2006-2010

The data on people surrounded by potential cases of TB at tambon level during 2006-2010 from Public Health Organization Amphoe Selaphum, Roi- ET, from data average people surrounded by potential cases of TB in 2006-2010 into calculation the average, shown as table 4.11.

Table 4.11 Average numbers of people surrounded by potential cases of TB in Amphoe Selaphum.

Tambon_Code	Tambon	People surrounded by potential cases of TB
450901	Klang	24
450911	Ko Kao	8
450917	Khwan Mueang	24
450902	Khwa	60
450903	Tha Muang	0
450905	Na Ngam	15
450904	Na Saeng	32
450906	Na Mueang	28
450912	Na Loeng	25
450918	Buang Kluea	20
450916	Phon Sawan	16
450907	Pho Thong	36
450908	Phu Ngoen	44
450909	Mueang Phrai	70
450910	Wang Luang	40
450914	Si Wilai	12
450915	Nong Luang	5
450913	Lao Noi	10

From data people surrounded by potential cases of TB, classify by using Equal interval was divide the data into five groups: lowest, low, medium, high and highest, as data shown table 4.12.

Table 4.12 People surrounded by potential cases of TB class.

Class	No. of people surrounded by potential cases of TB	No. of tambon
Lowest	0-14	6
Low	15-28	7
Medium	29-42	2
High	43-56	1
Highest	57-70	2

After analysis was found that the population people surrounded by potential cases of TB patient there are in groups of 0-14 has 6 tambon there are Na Ngam, Ko Kaeo, Khwan Mueang, Bueng Kluea, Phon Sawana and Pho Thong, groups of 15-28 has 7 tambon there are Klang, Mueang Phrai, Phu Ngoen, Wang Luang, Na Mueang, Ko Kaeo and Tha Muang, groups of 29-42 has 2 tambon there are Nong Luang and Nong Luang, groups of 43-56 have 1 tambon there is Lao Noi, groups of 57-70 has 2 tambon there are Na Saeng and Si Wilai: as data shown in figure 4.6.

The data about people surrounded by potential cases of TB patient at tambon level during 2006-2010 of all five groups were used as factor in GIS analysis to find tambon with TB risk in Ampoe Selaphum, Roi-ET.

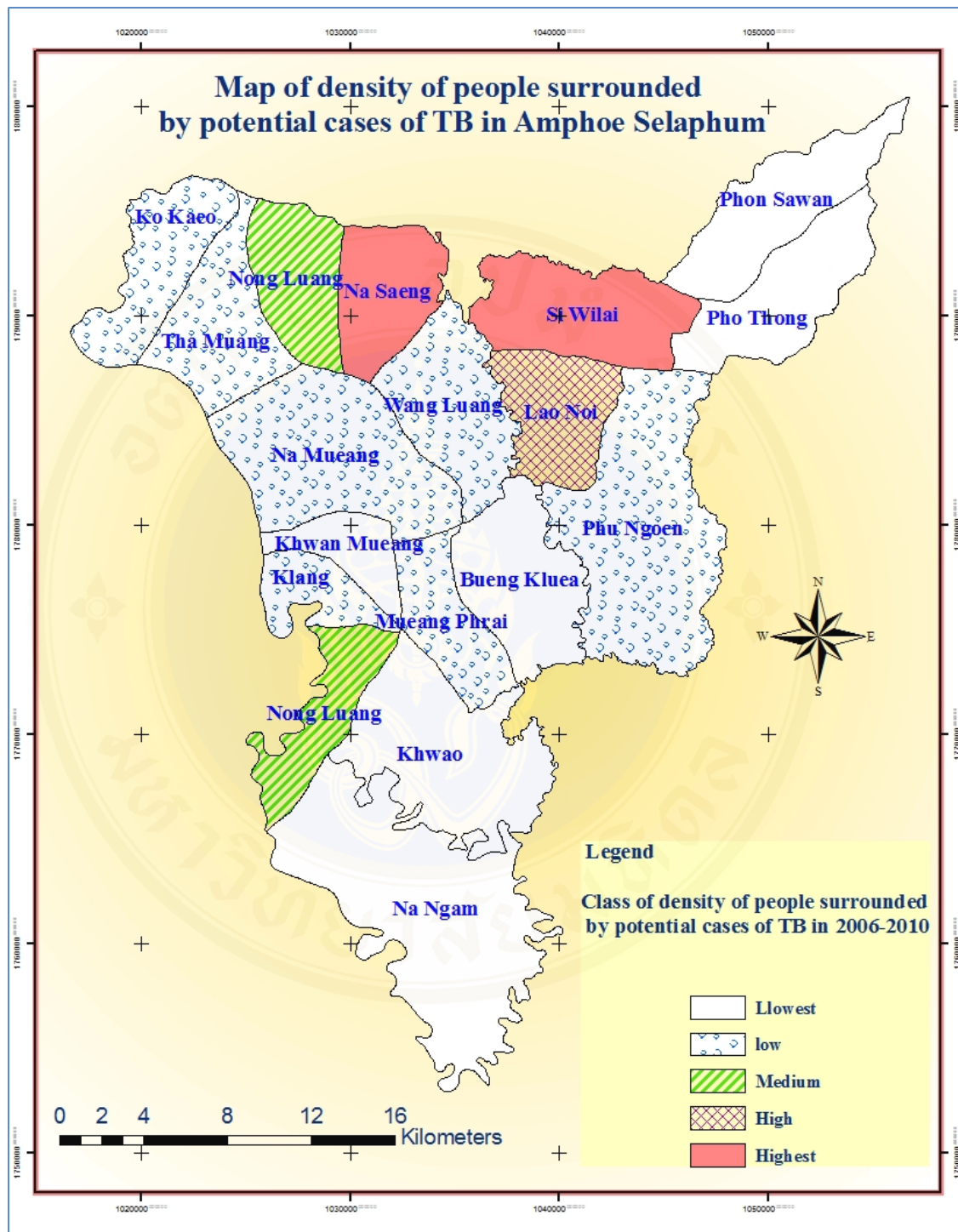


Figure 4.6 Map of density of people surrounded by potential cases of TB in Amphoe Selaphum.

4.1.7 The cancer (CA) patients at tambon level during 2006-2010

The data on CA patient at tambon level during 2006-2010 from Public Health Organization Amphoe Selaphum, Roi- ET, from data of CA patients in 2006-2010 to calculate the prevalence rate, as data shown in table 4.13.

Table 4.13 Prevalence rate of CA patients in Amphoe Selaphum.

Tambon_Code	Tambon	CA patient (Case/100,000)
450901	Klang	17
450911	Ko Kaeo	3
450917	Khwan Mueang	26
450902	Khwaao	13
450903	Tha Muang	2
450905	Na Ngam	15
450904	Na Saeng	22
450906	Na Mueang	25
450912	Na Loeng	12
450918	Bueng Kluea	7
450916	Phon Sawan	9
450907	Pho Thong	9
450908	Phu Ngoen	21
450909	Mueang Phrai	13
450910	Wang Luang	22
450914	Si Wilai	5
450915	Nong Luang	8
450913	Lao Noi	3

From data prevalence rate of CA patients, classify by using Equal interval was divide the data into five groups: lowest, low, medium, high and highest as data shown table 4.14.

Table 4.14 CA patients class.

Class	No. of CA patient	No. of tambon
Lowest	2-7	4
Low	8-12	1
Medium	13-16	7
High	17-21	2
Highest	22-26	4

After analysis was found that the CA patients there are in groups of 2-7 has 4 tambon there are Ko Kaeo, Tha Muang, Si Wilai and Lao Noi, groups of 8-12 have 1 tambon there is Bueng Kluea, groups of 13-26 has 7 tambon there are Na Ngam, Klang, Na Loeng, Mueang Phrai, Nong Luang, Phon Sawan and Pho Thong, groups of 17-21 has 2 tambon there are Klang and Phu Ngoen , groups of 22-26 has 4 tambon there are Na Saeng, Khwan Mueang, Wang Luang and Na Mueang: as data shown in figure 4.7.

The data about prevalence rate of CA patients at tambon level during 2006-2010 of all five groups were used as factor in GIS analysis to find tambon with TB risk in Ampoe Selaphum, Roi-ET.

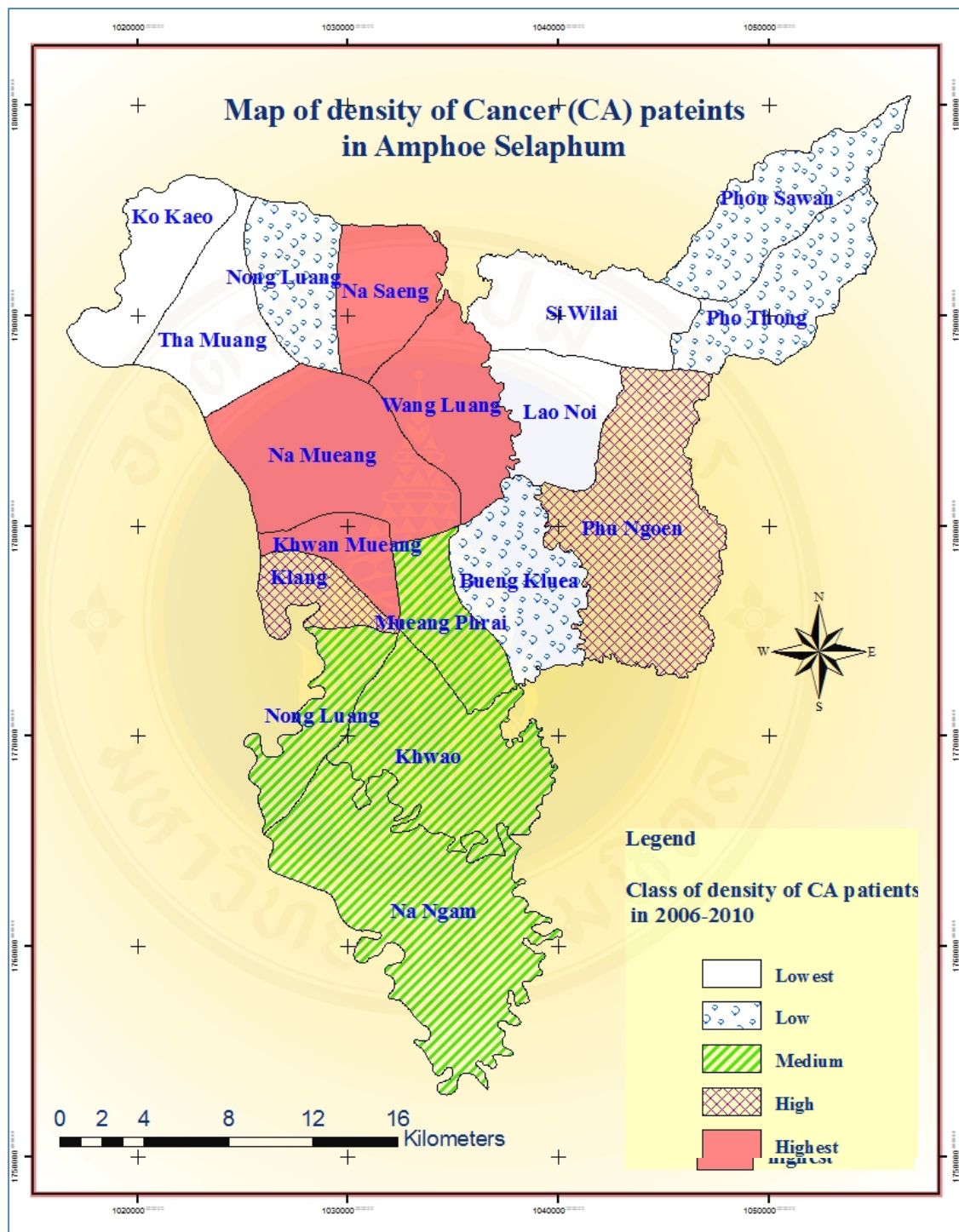


Figure 4.7 Map of density of CA patients in Amphoe Selaphum.

4.1.8 The renal disease patients at tambon level during 2006-2010

The data on renal disease patients at tambon level during 2006-2010 from Public Health Organization Amphoe Selaphum, Roi- ET, from data of renal disease patients in 2006-2010 to calculate the prevalence rate, as data shown in table 4.15.

Table 4.15 Prevalence rate of renal disease patients in Amphoe Selaphum.

Tambon_Code	Tambon	Renal disease patients (Case/100,000)
450901	Klang	71
450911	Ko Kaeo	22
450917	Khwan Mueang	50
450902	Khwaio	109
450903	Tha Muang	23
450905	Na Ngam	116
450904	Na Saeng	66
450906	Na Mueang	185
450912	Na Loeng	62
450918	Bueng Kluea	82
450916	Phon Sawan	38
450907	Pho Thong	55
450908	Phu Ngoen	118
450909	Mueang Phrai	96
450910	Wang Luang	60
450914	Si Wilai	40
450915	Nong Luang	25
450913	Lao Noi	52

From data renal disease patients, classify by using Equal interval was divide the data into five groups: lowest, low, medium, high and highest, as data shown table 4.16.

Table 4.16 Renal disease patients class.

Class	No. of renal disease	No. of tambon
Lowest	22-55	7
Low	56-87	6
Medium	88-120	4
High	121-152	0
Highest	153-185	1

After analysis was found that the renal failure patients there are in groups of 22-55 has 7 tambon there are Ko Kaeo, Tha Muang, Nong Luang, Khwan Mueang, Lao Noi, Si Wilai and Phon Sawan, groups of 56-87 has 6 tambon there are Na Loeng, Klang, Bueng Kluea, Wang Luang, Na Saeng and Pho Thong, groups of 88-120 has 4 tambon there are Na Ngam, Khwao, Mueang Phrai and Phu Ngoen, groups of 121-152 no have, groups of 153-185 have 1 tambon there is Na Mueang: as data shown in figure 4.8.

The data about prevalence rate of renal failure patients at tambon level during 2006-2010 of all five groups were used as factor in GIS analysis to find tambon with TB risk in Ampoe Selaphum, Roi-ET.

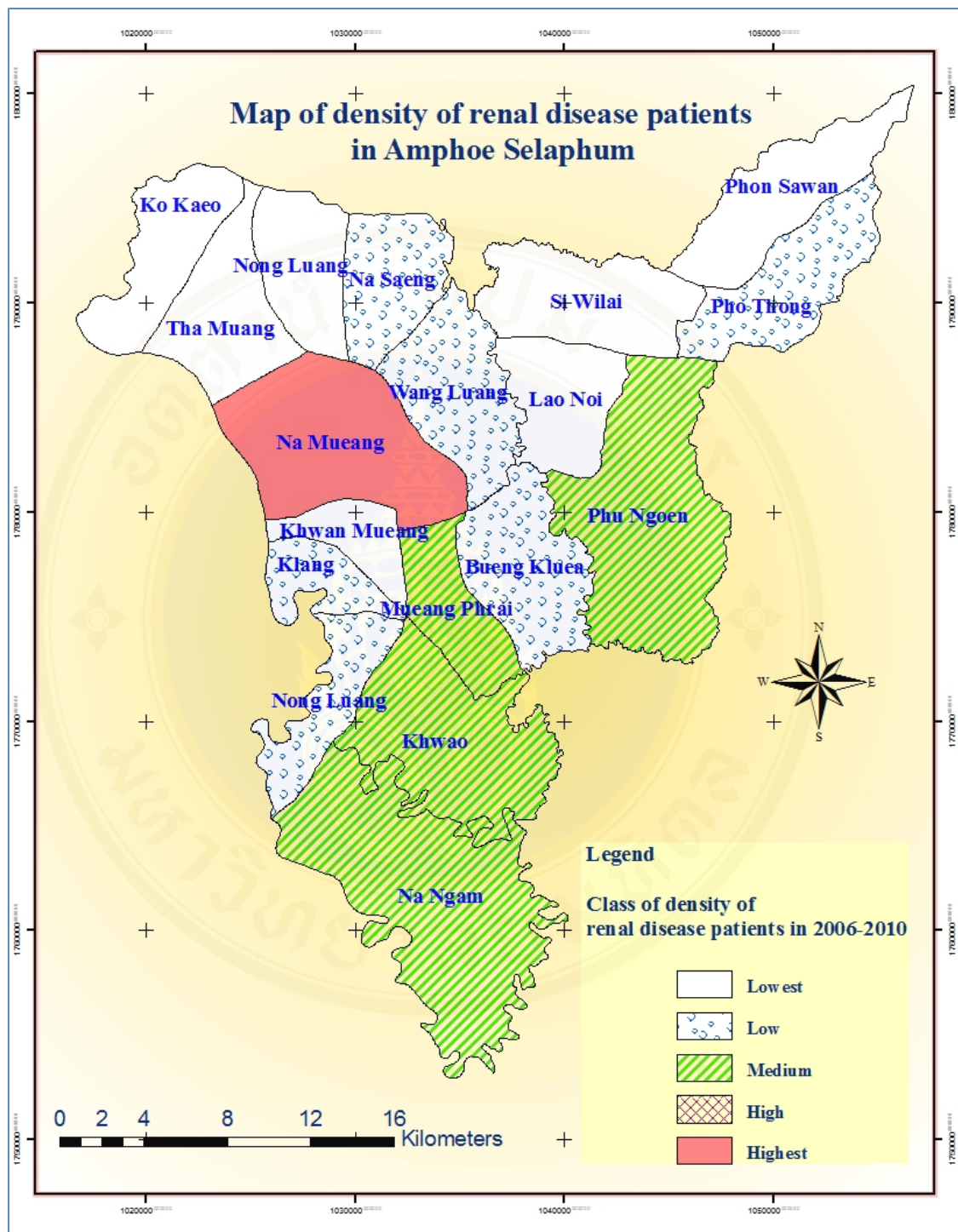


Figure 4.8 Map of density of renal disease patients in Amphoe Selaphum.

4.1.9 The AIDS patient at tambon level during 2006-2010

The data on AIDS at tambon level during 2006-2010 from Public Health Organization Amphoe Selaphum, Roi- ET, from data of AIDS patients in 2006-2010 to calculate the prevalence rate, as data shown in table 4.17.

Table 4.17 Prevalence rate of AIDS patients in Amphoe Selaphum.

Tambon_Code	Tambon	AIDS patients (Case/100,000)
450901	Klang	24
450911	Ko Kaeo	9
450917	Khwan Mueang	17
450902	Khwao	18
450903	Tha Muang	5
450905	Na Ngam	21
450904	Na Saeng	7
450906	Na Mueang	17
450912	Na Loeng	12
450918	Bueng Kluea	14
450916	Phon Sawan	3
450907	Pho Thong	25
450908	Phu Ngoen	15
450909	Mueang Phrai	36
450910	Wang Luang	14
450914	Si Wilai	16
450915	Nong Luang	3
450913	Lao Noi	12

From data AIDS patients, classify by using Equal interval was divide the data into five groups: lowest, low, medium, high and highest, as data shown table 4.18.

Table 4.18 AIDS patients class.

Class	No. of AIDS patients	No. of tambon
Lowest	3-9	5
Low	10-16	6
Medium	17-23	4
High	24-29	1
Highest	30-36	2

After analysis was found that the AIDS patients there are in groups of 3-9 has 5 tambon there are Ko Kaeo, Tha Muang, Nong Luang, Na Saeng and Phon Sawan , groups of 10-16 has 6 tambon there are Na Loeng, Bueng Kluea, Phu Ngoen, Lao Noi, Wang Luang and Si Wilai, groups of 17-23 has 4 tambon there are Na Ngam, Khwao, Khwan Mueang and Na Mueang, groups of 24-29 have 1 tambon there is Klang, groups of 30-36 has 2 tambon there are Mueang Phrai and Pho Thong, as data shown figure 4.9.

The data about prevalence rate of AIDS patients at tambon level during 2006-2010 of all five groups were used as factor in GIS analysis to find tambon with TB risk in Ampoe Selaphum, Roi-ET.

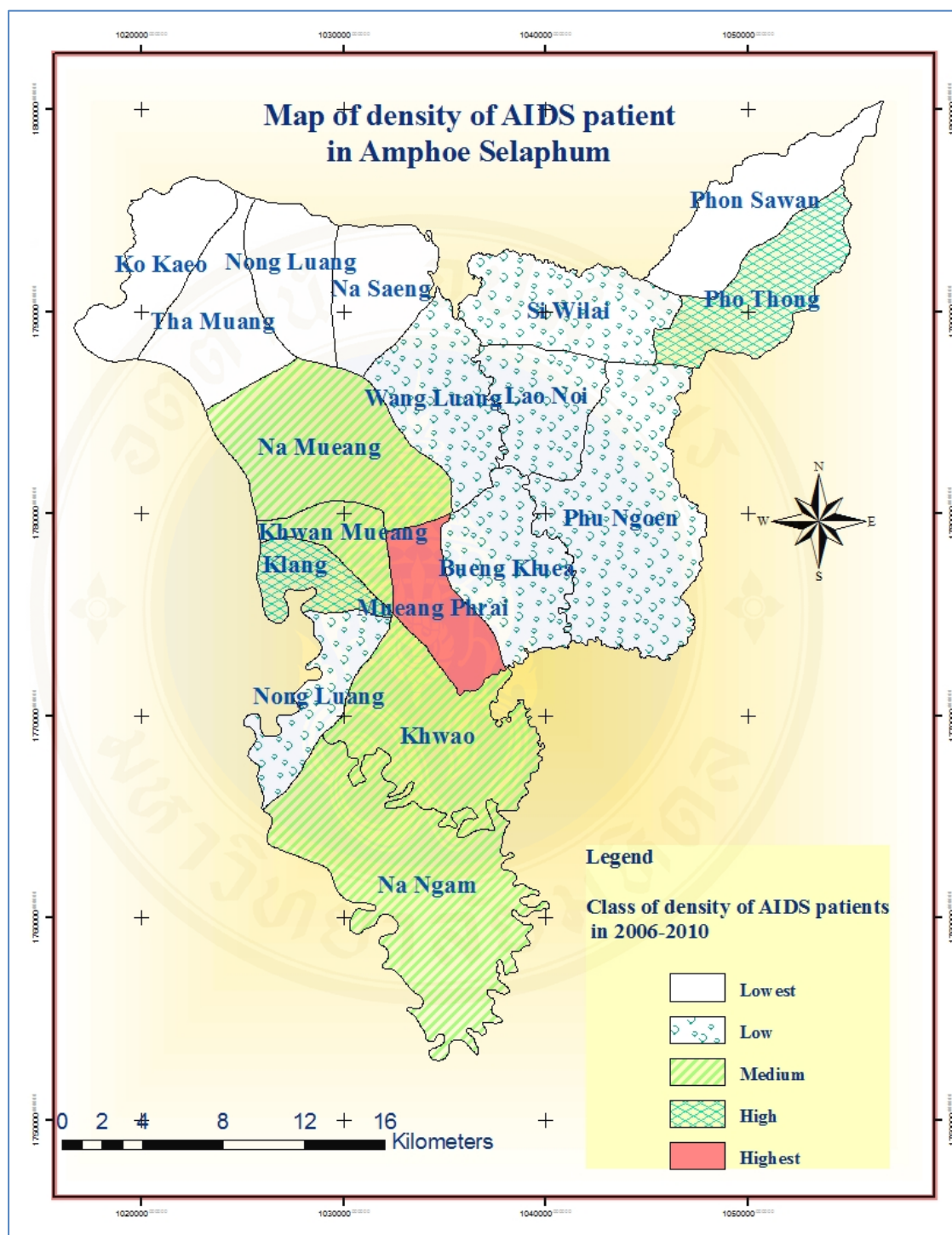


Figure 4.9 Map of density of AIDS patients in Amphoe Selaphum.

4.1.10 The Diabetes Mellitus (DM) patient at tambon level during 2006-2010

The data on DM patient at tambon level during 2006-2010 from Public Health Organization Amphoe Selaphum, Roi- ET, from data of DM patients in 2006-2010 to calculate the prevalence rate, as data shown in table 4.19.

Table 4.19 Prevalence rate of DM patients in Amphoe Selaphum.

Tambon_Code	Tambon	DM patients (Case/100,000)
450901	Klang	310
450911	Ko Kaeo	21
450917	Khwan Mueang	259
450902	Khwao	299
450903	Tha Muang	57
450905	Na Ngam	281
450904	Na Saeng	159
450906	Na Mueang	395
450912	Na Loeng	0
450918	Bueng Kluea	211
450916	Phon Sawan	94
450907	Pho Thong	180
450908	Phu Ngoen	383
450909	Mueang Phrai	0
450910	Wang Luang	168
450914	Si Wilai	0
450915	Nong Luang	81
450913	Lao Noi	157

From data DM patients, classify by using Equal interval was divide the data into five groups: lowest, low, medium, high and highest, as data show table 4.20.

Table 4.20 DM patients class.

Class	No. of DM patients	No. of tambon
Lowest	0-79	2
Low	80-158	4
Medium	159-237	3
High	238-316	7
Highest	317-395	2

After analysis was found that the DM patients there are in groups of 0-79 has 2 tambon there are Na Loeng and Mueang Phrai, groups of 80-158 has 4 tambon there are Ko Kaeo, Tha Muang, Si Wilai and Pho Thong, groups of 159-237 has 3 tambon there are Nong Luang, Lao Noi and Phon Sawan, groups of 238-316 has 7 tambon there are Klang, Khwan Mueang, Khwao, Na Ngam, Na Saeng, Wang Luang and Bueng Kluea, groups of 317-395 has 2 tambon there are Phu Ngoen and Na Mueang: as data show in figure 4.10.

The data about prevalence rate of DM patients at tambon level during 2006-2010 of all five groups were used as factor in GIS analysis to find tambon with TB risk in Ampoe Selaphum, Roi-ET.

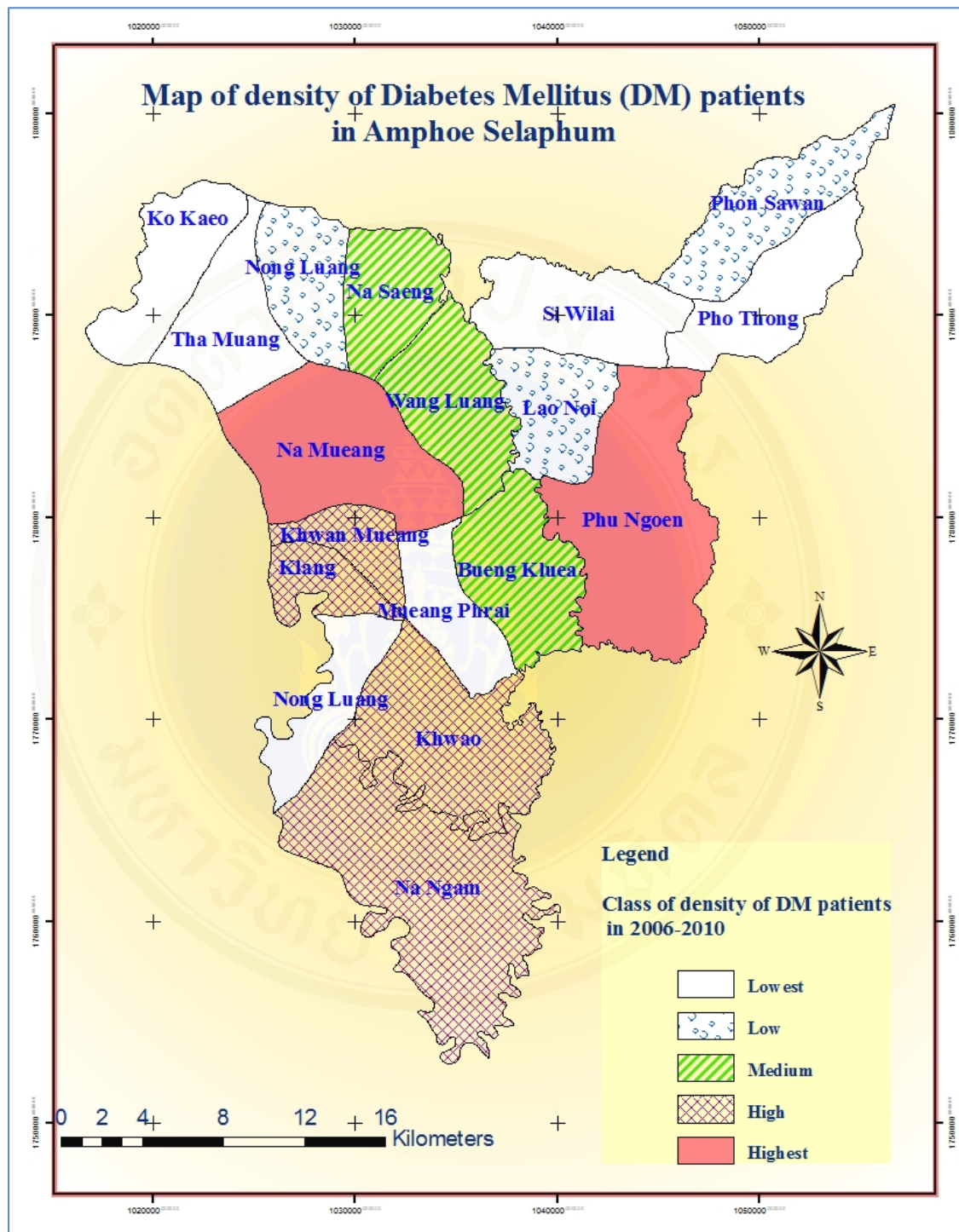


Figure 4.10 Map of density of DM patients in Amphoe Selaphum.

4.1.11 The Pulmonary tuberculosis (TB) Risk area in Amphoe Selaphum, Roi-ET

In this study the researcher had ask 17 experts in TB to assign weight of main factors, assign weight of sub-factors by use equal interval. Their medians were used for evaluation of TB risk area. The results of each factor obtained by using overlay technique. It showed that the lowest and highest points between 61 and 164, receptively. The TB risk areas were divided into three levels, as show in table 4.21.

Table 4.21 Weighting and Rating point of TB risk area in Amphoe Selaphum, Roi-ET.

TB risk area was classified into three levels.	Total Point
low risk area of TB epidemic	61-89
moderate risk area of TB epidemic	90-118
high risk area of TB epidemic	119-146

The result of each factor found the lowest TB risk tambon between 61- 89 covered 7 tambon (38.89%), moderate TB risk tambon between 90-118 covered 7 tambon (38.89%), high TB risk tambon between 119-146 covered 4 tambon (22.22%), as shown in table 4.22 and figure 4.11.

Table 4.22 Percentage of risk areas in Amphoe Selaphum, Roi-ET.

Risk tambon level	Total point	No. of tambon	Percentage
low risk tambon	79-109	7	38.89
moderate risk tambon	110-139	7	38.89
high risk area tambon	140-169	4	22.22
Total		18	100

RISK AREAS OF PULMONARY TUBERCULOSIS IN AMPHOE SELAPHUM, ROI-ET

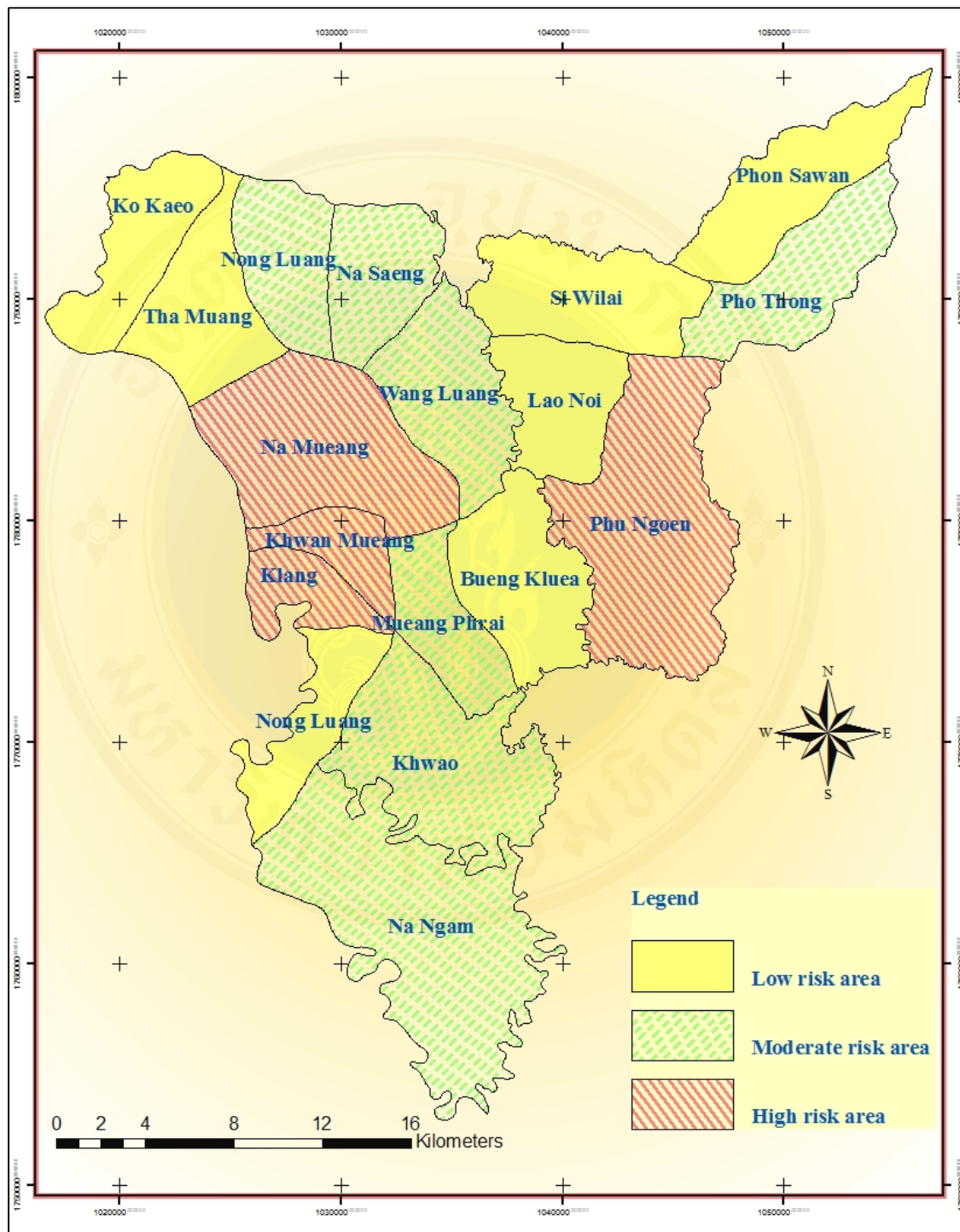


Figure 4.11 Risk areas of Pulmonary Tuberculosis in Amphoe Selaphum, Roi-ET.

From above table, details of tambon, villages and households are following:

4.1.11.1 Low risk areas

The study found that 7 tambons were low risk areas, there are; Ko Kaeo, Tha Muang, Phon Sawan, Lao Noi, Si Wilai, Bueng Kluea and Na Loeng, which included 74 villages, 52,516 people.

4.1.11.2 Moderate risk areas

The study found that 7 tambons were moderate risk areas, there are; Na Ngam , Mueang Phrai, Wang Luang, Khwao, Pho Thong, Na Saeng and Nong Luang, which include 101 villages, 58,301 people.

4.1.11.3 High risk areas

The study found that 4 tambons were high risk areas, there are; Klang, Phu Ngoen, Na Mueang, Khwan Mueang, which include 60 villages, 42,575 people.

4.2 Pulmonary Tuberculosis Distribution Patterns: Hot Spot Analysis

The data on TB incidence rate at tambon in 2006-2010 from Public Health Organization Amphoe Selaphum, Roi-ET, found that incidence rate in 2006-2010 per 100,000 populations the number of patients increasing in some areas and decreased has some areas, shown in table 4.26.



Table 4.23 TB incidence rate by tambon level during 2006-2010 in Amphoe Selaphum, Roi-ET.

Tambon_Code	Tambon	Incidence Rate				
		2006	2007	2008	2009	2010
450901	Klang	71	142	53	18	73
450911	Ko Kaeo	13	53	69	21	32
450917	Khwan Mueang	126	284	64	40	26
450902	Khwao	32	139	71	141	85
450903	Tha Muang	20	81	19	12	0
450905	Na Ngam	36	147	103	71	53
450904	Na Saeng	35	211	82	88	162
450906	Na Mueang	125	184	133	67	86
450912	Na Loeng	0	143	162	75	67
450918	Bueng Kluea	98	263	132	113	66
450916	Phon Sawan	0	68	96	0	133
450907	Pho Thong	38	138	38	61	92
450908	Phu Ngoen	0	134	58	53	138
450909	Mueang Phrai	66	202	168	107	117
450910	Wang Luang	64	178	126	66	151
450914	Si Wilai	0	107	21	115	53
450915	Nong Luang	66	66	35	82	21
450913	Lao Noi	123	53	71	13	41

Found that incidence rate up to 3 ranking in 2006 found that the tambon Na Mueang has incidence rate 154, Khwan Mueang has incidence rate 126 and Lao Noi has incidence rate 123.

The result incidence rate up to 3 ranking in 2007 found that Khwan Mueang has incidence rate 284, Bueng Kluea has incidence rate 263, Na Saeng has incidence rate 211.

The result incidence rate up to 3 ranking in 2008 found that Na Loeng has incidence rate 162, Na Mueang has incidence rate 133, Bueng Kluea has incidence rate 132.

The result incidence rate up to 3 ranking in 2009 found that Na Saeng has incidence rate 141, Khwan Mueang has incidence rate 115, Wang Luang has incidence rate 113.

The result incidence rate up to 3 ranking in 2010 found that Na Saeng has incidence rate 162, Wang Luang has incidence rate 151, Phu Ngoen has incidence rate 138.

When calculate to find hot spot areas using the Getis-Ord G_i^* statistics in ArcGIS program. To study the distribution pattern of tuberculosis in the form of the disease at higher or lower than average. The distance d is 16,721 m covering an area of TB disease in amphoe. The results tambon in form Z-score if there is spatial autocorrelation will be positive or negative. The analysis found each year has different of a hot spot following.

The results were analyzed in 2006, statistically significant positive Z-scores and more intense the clustering of high values (Hot Spot), the TB found Z-score that are more than 2 standard deviations has 2 tambon, there are Wang Luang, Khwan Muean ,show in figure 4.12.

Table 4.24 Incidence rate and Z- score in 2006.

Tambon Code	Tambon	Incidence rate (2006)	Z-score (2006)
450901	Klang	71	1.83664
450911	Ko Kaeo	13	-0.816025
450917	Khwan Mueang	126	2.14076
450902	Khwao	32	-0.049129
450903	Tha Muang	20	0.103054
450905	Na Ngam	36	-1.20864
450904	Na Saeng	35	0.721537
450906	Na Mueang	125	2.14076
450912	Na Loeng	0	0.26407
450918	Bueng Kluea	98	1.66984
450916	Phon Sawan	0	-1.67602
450907	Pho Thong	38	0.721537
450908	Phu Ngoen	0	1.10006
450909	Mueang Phrai	66	1.42877
450910	Wang Luang	64	2.52827
450914	Si Wilai	0	-0.663413
450915	Nong Luang	66	2.52827
450913	Lao Noi	123	-0.049129

Table 4.25 Z-score class in 2006

Class	Z-score	No. of tambon
Cold Spot	$< -2 \text{ SD}$	0
Low	$-2 - -1 \text{ SD}$	2
Medium	$-1 - 1 \text{ SD}$	8
High	$1 - 2 \text{ SD}$	6
Hot Spot	$>2 \text{ SD}$	2

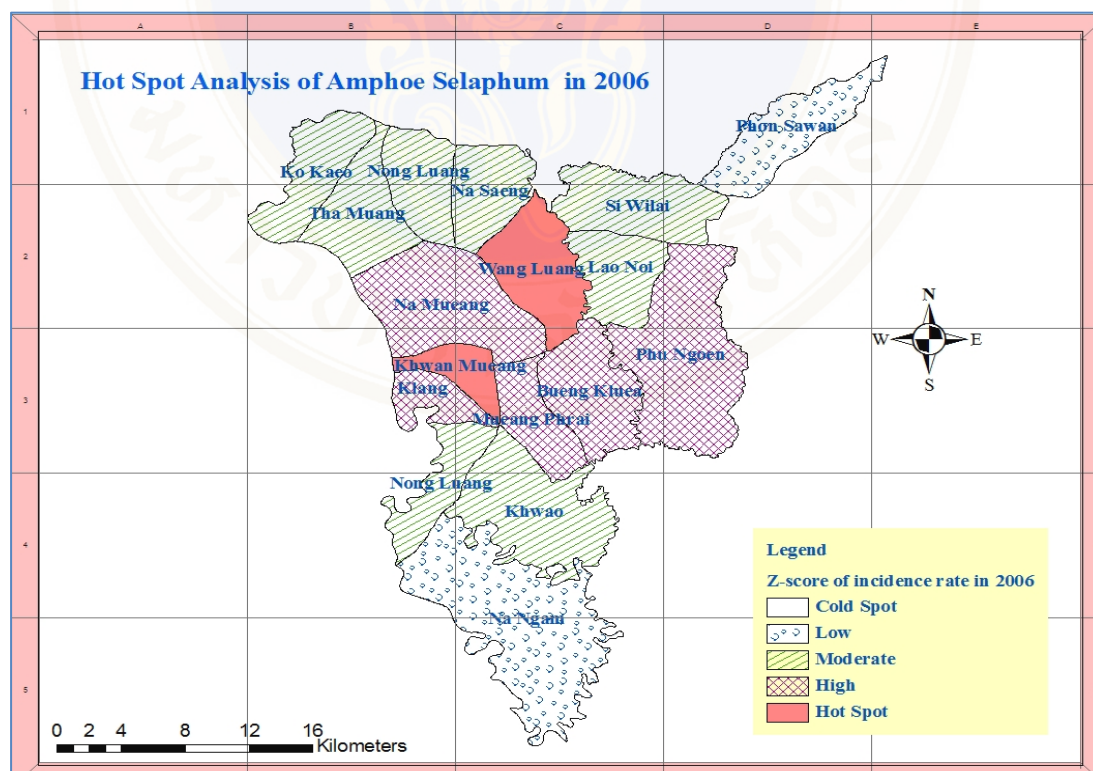


Figure 4.12 Hot Spot analysis in 2006.

The results were analyzed in 2007, statistically significant positive Z-scores and more intense the clustering of high values (Hot Spot), the TB found Z-score that are more than 2 standard deviations has 3 tambons, Khwan Muean, Klang, Mueang Phrai, show in Figure 4.13.

Table 4.26 Incidence rate and Z-score in 2007.

Tambon_Code	Tambon	Incidence rate (2007)	Z-score (2007)
450901	Klang	142	2.28878
450911	Ko Kaeo	53	-2.07036
450917	Khwan Mueang	284	2.56387
450902	Khwao	139	1.35374
450903	Tha Muang	81	-1.19844
450905	Na Ngam	147	0.033346
450904	Na Saeng	211	-1.11027
450906	Na Mueang	184	1.19783
450912	Na Loeng	143	1.50825
450918	Bueng Kluea	263	1.819
450916	Phon Sawan	68	-1.19284
450907	Pho Thong	138	1.35374
450908	Phu Ngoen	134	0.692057
450909	Mueang Phrai	202	2.45155
450910	Wang Luang	178	1.60236
450914	Si Wilai	107	-0.719272
450915	Nong Luang	66	-0.879768
450913	Lao Noi	53	0.687181

Table 4.27 Z-core class in 2007.

Class	Z-score	No. of tambon
Cold Spot	$< -2 \text{ SD}$	1
Low	$-2 - -1 \text{ SD}$	3
Medium	$-1 - 1 \text{ SD}$	6
High	$1 - 2 \text{ SD}$	5
Hot Spot	$> 2 \text{ SD}$	3

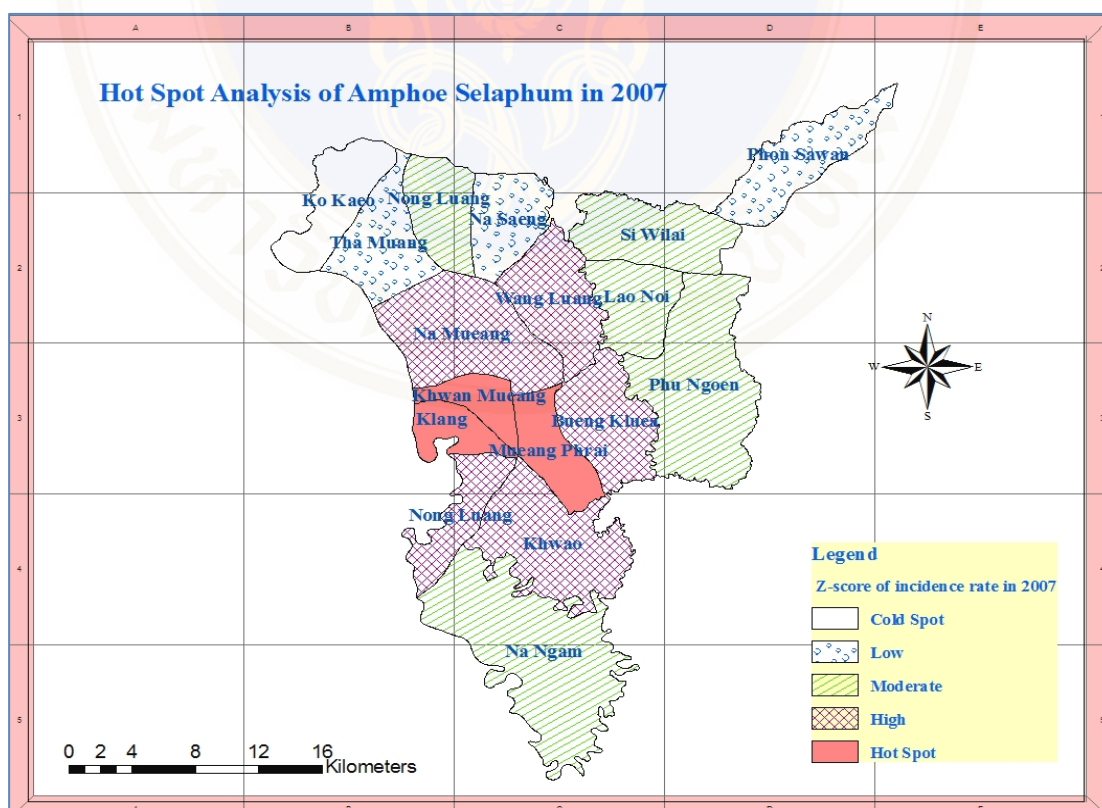


Figure 4.13 Hot Spot analysis in 2007.

The results were analyzed in 2008 the TB statistically significant positive Z-scores, the larger Z-score is, the more intense the clustering of high values (Hot Spot) has 2 tambons, Khwan Muean, Mueang Phrai, shown in figure 4.14.

Table 4.28 Incidence rate and Z-score in 2008.

Tambon_Code	Tambon	Incidence rate (2008)	Z-score (2008)
450901	Klang	53	1.95766
450911	Ko Kaeo	69	-1.897
450917	Khwan Mueang	64	2.55607
450902	Khwao	71	1.92548
450903	Tha Muang	19	-1.08965
450905	Na Ngam	103	1.08263
450904	Na Saeng	82	-1.25047
450906	Na Mueang	133	-0.080143
450912	Na Loeng	162	1.17649
450918	Bueng Kluea	132	0.58715
450916	Phon Sawan	96	-0.898374
450907	Pho Thong	38	-0.590399
450908	Phu Ngoen	58	1.0551
450909	Mueang Phrai	168	2.05678
450910	Wang Luang	126	0.61685
450914	Si Wilai	21	-0.391157
450915	Nong Luang	35	-0.590399
450913	Lao Noi	71	-0.295562

Table 4.29 Z-score class in 2008.

Class	Z-score	No. of tambon
Cold Spot	$< -2 \text{ SD}$	0
Low	$-2 - -1 \text{ SD}$	3
Medium	$-1 - 1 \text{ SD}$	8
High	$1 - 2 \text{ SD}$	5
Hot Spot	$>2 \text{ SD}$	2

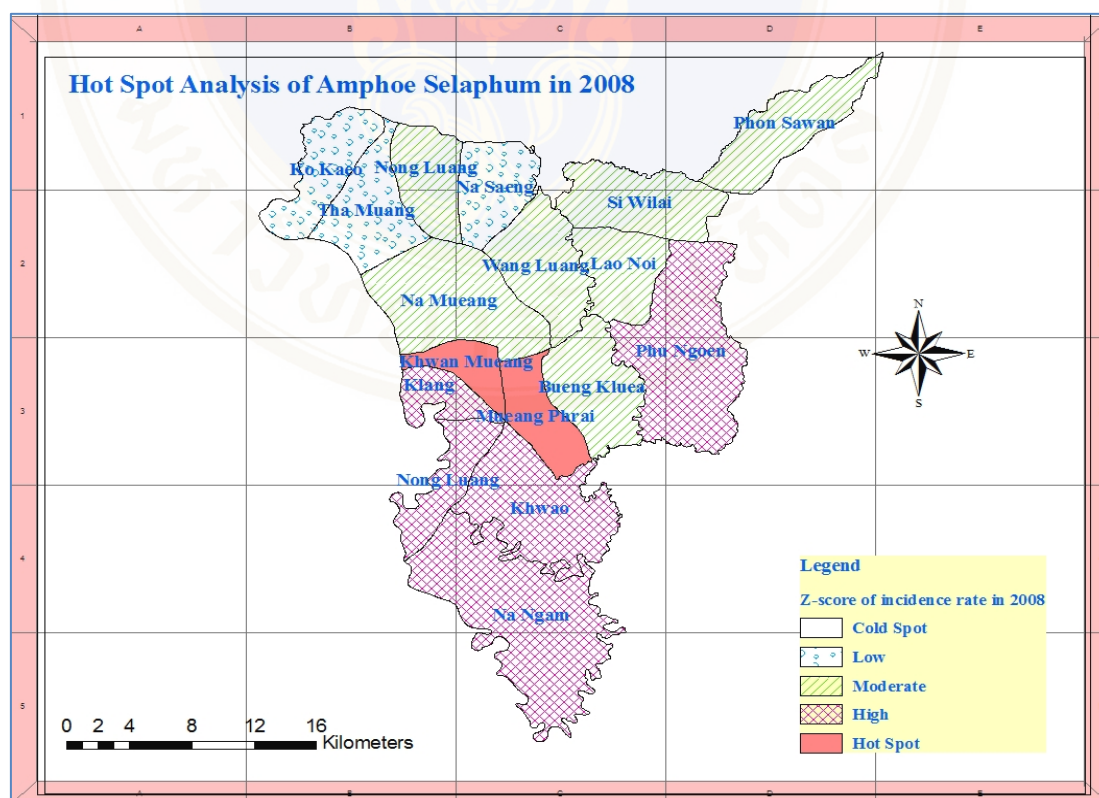


Figure 4.14 Hot Spot analysis in 2008.

The results were analyzed in 2009, statistically significant positive Z-scores and more intense the clustering of high values (Hot Spot), the TB found Z-score that are more than 2 standard deviations has 2 tambons, Wang Luang, Lao Noi, show in figure 4.15.

Table 4.30 Incidence rate and Z-score in 2009.

Tambon_Code	Tambon	Incidence rate (2009)	Z-score (2009)
450901	Klang	18	0.113707
450911	Ko Kaeo	21	-1.0277
450917	Khwan Mueang	40	1.21212
450902	Khwao	141	-1.26568
450903	Tha Muang	12	0.274168
450905	Na Ngam	71	-1.41586
450904	Na Saeng	88	1.86447
450906	Na Mueang	67	0.888527
450912	Na Loeng	75	1.68785
450918	Bueng Kluea	113	0.560159
450916	Phon Sawan	0	-0.327935
450907	Pho Thong	61	0.888527
450908	Phu Ngoen	53	0.393778
450909	Mueang Phrai	107	0.76854
450910	Wang Luang	66	3.11076
450914	Si Wilai	115	1.32055
450915	Nong Luang	82	0.888527
450913	Lao Noi	13	2.32944

Table 4.31 Z-score class in 2009.

Class	Z-score	No. of tambon
Cold Spot	$< -2 \text{ SD}$	0
Low	$-2 - -1 \text{ SD}$	3
Medium	$-1 - 1 \text{ SD}$	8
High	$1 - 2 \text{ SD}$	5
Hot Spot	$>2 \text{ SD}$	2

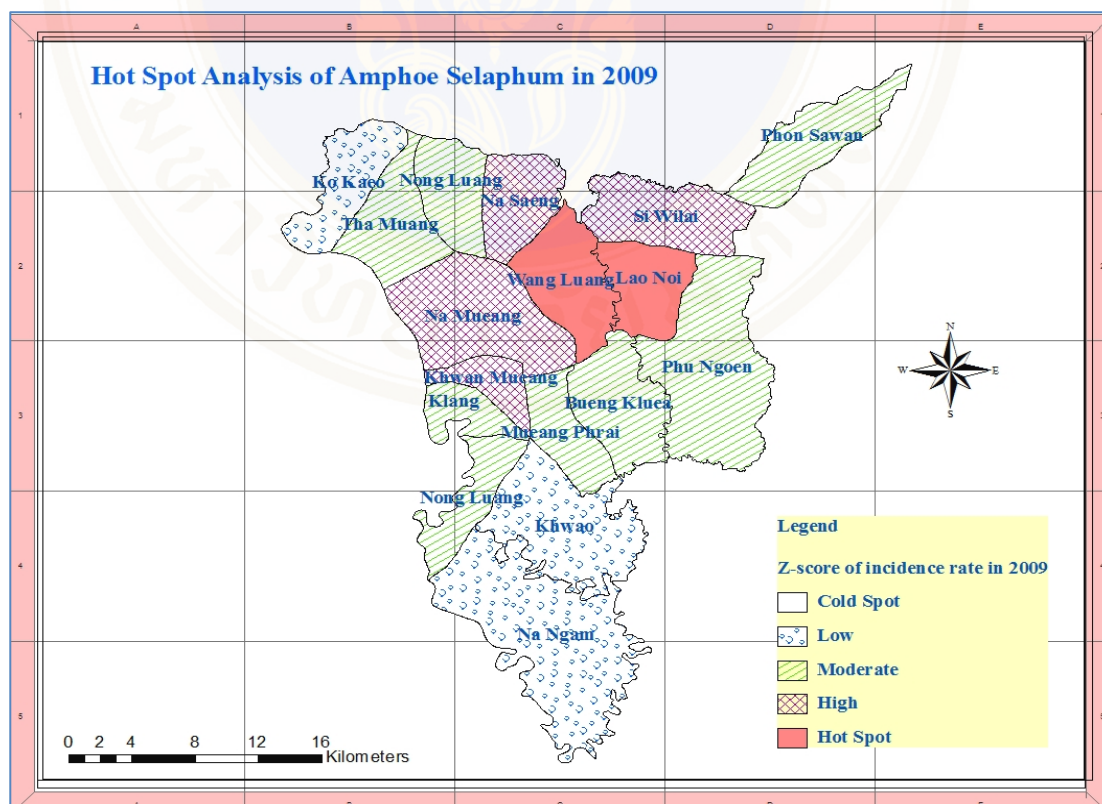


Figure 4.15 Hot Spot analysis in 2009.

The results were analyzed in 2010, statistically significant positive Z-scores and more intense the clustering of high values (Hot Spot), the TB found Z-score that are more than 2 standard deviations has 3 tambons, Si Wilai, Lao Noi, Meang Phri shown in Figure 4.16.

Table 4.32 Incidence rate and Z-score in 2010.

Tambon_Code	Tambon	Incidence rate (2010)	Z-score (2010)
450901	Klang	73	-0.170163
450911	Ko Kaeo	32	-2.31524
450917	Khwan Mueang	26	0.495285
450902	Khwao	85	0.010417
450903	Tha Muang	0	-0.897778
450905	Na Ngam	53	-0.329093
450904	Na Saeng	162	-0.23223
450906	Na Mueang	86	0.226326
450912	Na Loeng	67	-0.409784
450918	Bueng Kluea	66	0.833306
450916	Phon Sawan	133	0.501478
450907	Pho Thong	92	0.226326
450908	Phu Ngoen	138	0.652009
450909	Mueang Phrai	117	1.18728
450910	Wang Luang	151	0.328483
450914	Si Wilai	53	1.71132
450915	Nong Luang	21	-0.409784
450913	Lao Noi	41	1.57176

Table 4.33 Z-score class in 2010.

Class	Z-score	No. of tambon
Cold Spot	$< -2 \text{ SD}$	1
Low	$-2 - -1 \text{ SD}$	1
Medium	$-1 - 1 \text{ SD}$	6
High	$1 - 2 \text{ SD}$	7
Hot Spot	$>2 \text{ SD}$	3

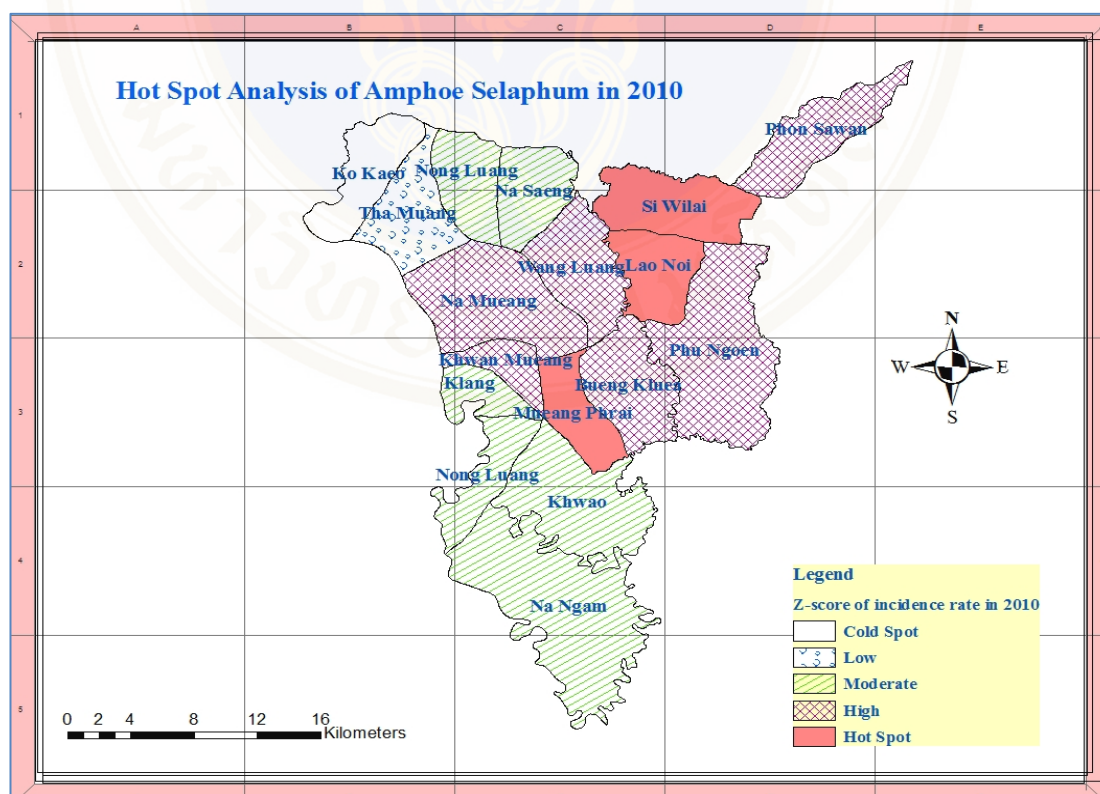


Figure 4.16 Hot Spot analysis in 2010.

CHAPTER V

DISCUSSION AND CONCLUSION

The purpose of this research the application of GIS to identify the risk area of mycobacterium tuberculosis: case study was in Amphoe Selaphum, Roi-ET to find risk areas and distribution patterns of TB, by using GIS technique and Hot Spot analysis in GIS program.

5.1 Discussion

5.1.1 Risk areas of pulmonary tuberculosis (TB)

From risk areas of TB are divided to three groups: high, moderate and low.

The study found that 4 tambons (22.22%) were high risk areas, there are Klang, Phu Ngoen, Na Mueang, Khwan Mueang and show correlation between the risk factors, 5 factors which include 1) elderly 2) baby 3) CA patients 4) DM patients 5) AIDS/HIV patients.

The study found that 7 tambons (38.89%) were moderate risk areas, there are Na Ngam, Mueang Phrai, Wang Luang, Khwao, Pho Thong, Na Saeng, Nong Luang and show correlation between the risk factors, 3 factors which include 1) population average at living in home of TB 2) population density 3) low income.

The study found that 7 tambons (38.89%) were low risk areas, there are Ko Kaeo, Tha Muang, Phon Sawan, Lao Noi, Si Wilai, Bueng Kluea, Na Loeng and show correlation between the risk factors, 3 factors which include 1) population average at living in home of TB 2) population density 3) average income.

5.1.2 Hot Spot analysis to analyze the distribution patterns of TB

From incidence rate of TB at tambon level in 2006-2010, Amphoe Selaphum, Roi-ET, using Getis-Ord Gi *. The results show form z-score.

From Hot Spot analysis the distribution patterns of TB (Hot Spot areas), showed correlation between the incidence rate of TB, the 2 year increase and the decrease pattern in the following years.

5.1.3 Comparison risk areas and distribution patterns of pulmonary tuberculosis

From result of studies researches find the high risk areas have 4 tambons: Klang, Phu Ngoen, Na Mueang and Khwan Mueang. There are three tambons have correlations with distribution patterns of pulmonary tuberculosis; Klang, Na Mueang and Khwan Mueang. There is one tambon not has correlation with distribution patterns of pulmonary tuberculosis; Phu Ngoen. Because the study used Delphi technique methodology and use questionnaire to identify risk factors, a research approach that is base on analyze in the future from experts, study this have 10 risk factors but dot have number of TB (incidence rate) factor. Therefore from result of studies researches find dot correlation between the risk areas and distribution patterns of pulmonary tuberculosis in Phu Ngoen.

5.1.4 Restrictions

The studies have restrictions.

1. The risk factors are combined result from 17 experts use Delphi technique. The result may be false or does not match the theory of area at studies, if experts not intend to answer questionnaires.
2. The inaccuracy of statistics into studies, because data not update or real time.
3. Research can be complex many opinions collected in responses to the experience and knowledge of each expert.

5.2 Conclusion and Recommendations

5.2.1 Conclusion

This research was studies to fine the risk areas of Pulmonary Tuberculosis (TB) in Amphoe Selaphum, Roi-ET by applied using Geographic Information System (GIS), and Hot Spot Analysis to identify the distribution pattern of TB.

The result analysis makes to identify risk areas of TB and identify distribution pattern of Hot Spot area TB. The officer to find new TB patients in high risks area and into patients to receive treatment and to find patterns, incidence rate of TB disease, planning to prevent spread and save budget.

5.2.2 Recommendations

- 1) Should be studied of other risk factors as knowledge of TB disease, occupation, culture to take effect the disease.
- 2) Should be use of statistical reliability and accuracy in analysis of results study.
- 3) Should be selection experts of tuberculosis knowledge and experience in community.
- 4) The results should be compared actual area of tuberculosis outbreak.
- 5) GIS should be used to find risk map of other disease.

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APPENDIX A

LIST NAME OF EXPERTS AND QUESTIONNAIRE

รายชื่อผู้เชี่ยวชาญในการวิเคราะห์หาปัจจัยเสี่ยงในการเกิดโรควันโรคและกำหนดค่าน้ำหนักความสำคัญของปัจจัย (Weighting)

1. นายแพทย์อุปทิน รุ่งอุทัยศิริ นายแพทย์ระดับ 9 ผู้อำนวยการโรงพยาบาลเสลภูมิ อำเภอสลภูมิ จังหวัดร้อยเอ็ด
2. นายแพทย์ฐิติพัฒน์ รัชตะนันท์ นายแพทย์ระดับ 9 แพทย์ประจำหน่วยโรคทางเดินหายใจและหัวหน้าฝ่ายวิชาการ มหาวิทยาลัยแพทยศาสตร์กรุงเทพมหานครและวชิรพยาบาล
3. นายแพทย์ปกาศิต โอวาทกานนท์ นายแพทย์ระดับ 9 ผู้อำนวยการโรงพยาบาลทรายมูล อำเภทรายมูล จังหวัดยโสธร
4. นายแพทย์กิตติศักดิ์ พนมพงศ์ นายแพทย์ระดับ 8 แพทย์เฉพาะทางหน่วยโรคทางเดินหายใจ โรงพยาบาลเสลภูมิ อำเภอสลภูมิ จังหวัดร้อยเอ็ด
5. นายประดิษฐ์ ศิริสอน นักวิชาการสาธารณสุขชำนาญการ ฝ่ายงานป้องกันและควบคุมโรค สำนักงานสาธารณสุขจังหวัดร้อยเอ็ด
6. นางวิลาวัลย์ ปากวิเศษ นักวิชาการสาธารณสุข ระดับชำนาญการ ฝ่ายป้องกันและควบคุมโรค สำนักงานสาธารณสุขจังหวัดร้อยเอ็ด
7. นางอุบลรัตน์ อินทวัน เจ้าหน้าที่สาธารณสุขชำนาญการ งานป้องกันและควบคุมโรค สำนักงานสาธารณสุขจังหวัดร้อยเอ็ด
8. นางสุริรัตน์ แสงสุริ พยาบาลวิชาชีพ ระดับชำนาญการ ฝ่ายงานโรคเอดส์ โรงพยาบาลเสลภูมิ อำเภอสลภูมิ จังหวัดร้อยเอ็ด
9. นางชนิษฐ์นาฏ จุริมาศ พยาบาลวิชาชีพ ระดับชำนาญการ ฝ่ายการพยาบาล โรงพยาบาลเสลภูมิ อำเภอสลภูมิ จังหวัดร้อยเอ็ด
10. นางมณี อุปนแก้ว พยาบาลวิชาชีพชำนาญการ ระดับ 7 ฝ่ายงานเวชปฏิบัติครอบครัวและชุมชน โรงพยาบาลเสลภูมิ อำเภอสลภูมิ จังหวัดร้อยเอ็ด
11. นางลำปาง กำหอม พยาบาลวิชาชีพ ระดับชำนาญการ ฝ่ายงานคลินิกผู้ป่วยโรคเรื้อรัง โรงพยาบาลเสลภูมิ อำเภอสลภูมิ จังหวัดร้อยเอ็ด

12. นางเครือวัลย์ ดิษเจริญ พยาบาลวิชาชีพ ระดับชำนาญการ ฝ่ายงานคลินิกผู้ป่วยวันโรค โรงพยาบาลเสลภูมิ อำเภอสลภูมิ จังหวัดร้อยเอ็ด
13. นางสาวธราทิพย์ พลเทียน พยาบาลวิชาชีพ ระดับชำนาญการ ฝ่ายการพยาบาล โรงพยาบาลเสลภูมิ อำเภอสลภูมิ จังหวัดร้อยเอ็ด
14. นางสาวรุ่งทิพย์ พงษ์เจริญวรรณ พยาบาลวิชาชีพระดับ 7 วช ฝ่ายการพยาบาลหออภิบาลอายุรกรรม มหาวิทยาลัยแพทยศาสตร์กรุงเทพมหานคร และวชิรพยาบาล
15. นางเพ็ญศิริ แก้วกลกิจ พยาบาลวิชาชีพระดับ 7 วช ฝ่ายการพยาบาลประจำหน่วยโรคติดเชื้อ มหาวิทยาลัยแพทยศาสตร์กรุงเทพมหานครและวชิรพยาบาล
16. นางสาวดุชนี ดวงมณี พยาบาลวิชาชีพระดับ 7 วช ฝ่ายการพยาบาล ประจำหน่วยโรคติดเชื้อ มหาวิทยาลัยแพทยศาสตร์กรุงเทพมหานครและวชิรพยาบาล
17. นางสาวรพีพรรณ จันทนลาซ พยาบาลวิชาชีพ ระดับ 7 วช ฝ่ายการพยาบาล ประจำหน่วยโรคติดเชื้อ มหาวิทยาลัยแพทยศาสตร์กรุงเทพมหานครและวชิรพยาบาล

รายชื่อผู้เชี่ยวชาญในการตรวจสอบคุณภาพแบบสอบถาม

1. นายแพทย์อุปทิน รุ่งอุทัยศิริ นายแพทย์ระดับ 9 ผู้อำนวยการโรงพยาบาลเสลภูมิ อำเภอสลภูมิ จังหวัดร้อยเอ็ด
2. นายแพทย์ฐิติพัฒน์ รัชตะนันท์ นายแพทย์ระดับ 9 แพทย์ประจำหน่วยโรคทางเดินหายใจและห้วหน้าฝ่ายวิชาการ มหาวิทยาลัยแพทยศาสตร์กรุงเทพมหานคร วชิรพยาบาล
3. นายประดิษฐ์ ศิริสอน นักวิชาการสาธารณสุขชำนาญการ ฝ่ายงานป้องกันและควบคุมโรค สำนักงานสาธารณสุขจังหวัดร้อยเอ็ด



แบบสอบถามผู้เชี่ยวชาญ

การกำหนดปัจจัยเสี่ยงที่มีผลต่อการเกิดโรคฉี่หนู
เพื่อประกอบการทำสารนิพนธ์

เรื่อง

การประยุกต์ใช้ระบบสารสนเทศภูมิศาสตร์
เพื่อวิเคราะห์หาพื้นที่เสี่ยงในการเกิดโรคฉี่หนู
กรณีศึกษา เขตพื้นที่อำเภอเสลภูมิ จังหวัดร้อยเอ็ด

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คณะวิศวกรรมศาสตร์

มหาวิทยาลัยมหิดล

ผู้เชี่ยวชาญ

แบบสอบถามชุดที่.....1.....

ชื่อ – สกุล

ตำแหน่ง.....ระดับ.....

สถานที่ปฏิบัติงาน.....

ที่อยู่.....

ฝ่าย/งาน.....กอง.....

กรม.....กระทรวง.....

วันที่ตอบแบบสอบถาม...../...../.....

แบบสอบถามนี้สร้างขึ้นโดยผู้วิจัย จากการทบทวนวรรณกรรมเกี่ยวกับปัจจัยเสี่ยงที่มีผลต่อการเกิดโรคหัวใจ เพื่อหาทราบถึงปัจจัยเสี่ยงที่มีผลต่อการเกิดโรคหัวใจ

ปัจจัยเสี่ยง (Risk Factor)

ปัจจัยเสี่ยง หมายถึง องค์ประกอบด้านกายภาพ สังคม พฤติกรรมเสี่ยง หรือสถานการณ์ที่อาจก่อให้เกิดอันตรายต่อสุขภาพ ชีวิต หรือทรัพย์สิน และส่งผลให้บุคคลนั้นมีโอกาสเกิดโรคได้ง่ายกว่าผู้ที่ไม่มีความเสี่ยงเลย

คำชี้แจง ในการตอบแบบสอบถาม แบ่งเป็น 1 ส่วน

1. การกำหนดปัจจัยที่มีผลต่อการเกิดโรคหัวใจ

จากการทบทวนวรรณกรรมของผู้วิจัยพบว่าปัจจัยเสี่ยงที่มีผลต่อการเกิดโรคหัวใจมีทั้งหมด 10 ปัจจัย

- ในกรณีที่ผู้เชี่ยวชาญเห็นด้วยกับปัจจัยใดให้ทำเครื่องหมาย ☒ ในช่องข้อความเห็นด้วย
- ในกรณีที่ผู้เชี่ยวชาญไม่เห็นด้วยกับปัจจัยใดให้ทำเครื่องหมาย ☒ ในช่องข้อความไม่เห็นด้วย
- หากผู้ผู้เชี่ยวชาญมีความเห็นเพิ่มเติมสามารถแสดงความคิดเห็นได้

ตารางที่ 1 การกำหนดปัจจัยเสี่ยงที่มีผลต่อการเกิดโรควัณโรค สำหรับการศึกษาปัจจัยเสี่ยงที่มีผลต่อการเกิดโรควัณโรคของประชากร

ปัจจัยเสี่ยง	เห็นด้วย/ เหตุผล	ไม่เห็นด้วย/เหตุผล
1. ผู้สูงอายุ อายุ ≥ 60 ปี	☒ เหตุผล ภูมิด้านทานต่ำ ขาดคนดูแลเอาใจใส่	☐ เหตุผล
2. เด็กอ่อน อายุ 0- 5 ปี	☒ เหตุผล ภูมิด้านทานทำงานไม่ เต็มที่ -ไม่สามารถสื่อสารกับผู้อื่นได้	☐ เหตุผล
3. ผู้ป่วย HIV / AIDS	☒ เหตุผล ภูมิด้านทานอ่อนแอ	☐ เหตุผล
4. ผู้ป่วยเบาหวาน	☒ เหตุผล ภูมิด้านทานอ่อนแอ เห็นด้วย/เหตุผล	☐ เหตุผล

ปัจจัยเสี่ยง		ไม่เห็นด้วย/เหตุผล
5. ผู้ป่วยโรคมะเร็ง	☒ เหตุผล มักได้รับยากเคมีคุ้มกัน	☐ เหตุผล
6. ผู้ป่วยโรคไต End stage renal disease	☒ เหตุผล มักได้รับยากเคมีคุ้มกัน	☐ เหตุผล
7. ผู้ที่อยู่ใกล้ชิด ผู้ป่วย	☒ เหตุผล มีโอกาสได้รับเชื้อมากถ้า มีคนในบ้านเป็นวัณโรค	☐ เหตุผล
8. ผู้ที่ติดยาเสพติด ผู้ที่สูบบุหรี่	☒ เหตุผล มักมีร่างกายอ่อนแอ	☐ เหตุผล

ปัจจัยเสี่ยง	เห็นด้วย/ เหตุผล	ไม่เห็นด้วย/ เหตุผล
9. ผู้ที่มีรายได้น้อย	☒ เหตุผล มีคุณภาพชีวิตที่ไม่ดี ไม่ ใส่ใจสุขภาพ	☐ เหตุผล
10. ความหนาแน่น ของประชากร	☒ เหตุผล การที่มีจำนวนประชากร หนาแน่นทำให้การระบายอากาศ ได้ไม่ดี มีการอยู่อย่างแออัด	☐ เหตุผล

ปัจจัยเสี่ยง	เห็นด้วย/เหตุผล	ไม่เห็นด้วย/เหตุผล
11.	เหตุผล.....	เหตุผล.....
12.	เหตุผล.....	เหตุผล.....
13.	เหตุผล.....	เหตุผล.....
14.	เหตุผล.....	เหตุผล.....

ข้อเสนอแนะเพิ่มเติม



แบบสอบถามผู้เชี่ยวชาญ

การกำหนดปัจจัยเสี่ยงที่มีผลต่อการเกิดโรคฉี่หนู
เพื่อประกอบการทำสารนิพนธ์

เรื่อง

การประยุกต์ใช้ระบบสารสนเทศภูมิศาสตร์
เพื่อวิเคราะห์หาพื้นที่เสี่ยงในการเกิดโรคฉี่หนู
กรณีศึกษา เขตพื้นที่อำเภอเสลภูมิ จังหวัดร้อยเอ็ด

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มหาวิทยาลัยมหิดล

ผู้เชี่ยวชาญ

แบบสอบถามชุดที่.....2.....

ชื่อ – สกุล

ตำแหน่ง.....ระดับ.....

สถานที่ปฏิบัติงาน.....

ที่อยู่.....

ฝ่าย/งาน.....กอง.....

กรม.....กระทรวง.....

วันที่ตอบแบบสอบถาม...../...../.....

คำชี้แจง

ตามที่ท่านกรุณารับเป็นผู้เชี่ยวชาญสำหรับการวิจัยและได้ให้ความเห็นในการวิจัยครั้งนี้ผ่านรอบที่ 1 เป็นที่เรียบร้อยแล้ว ผู้วิจัยได้ทำการประเมินความคิดเห็นของผู้เชี่ยวชาญทุกท่านเข้าด้วยกันและจัดเป็นข้อคำถามสำหรับสร้างแบบสอบถาม ฉบับนี้ขึ้น รวม ...10.....ข้อ กำหนดค่าถ่วงน้ำหนัก (Weighting) ของแต่ละตัวแปร และค่าระดับคะแนน(Rating) ประเภทข้อมูลของแต่ละตัวแปร ด้วยวิธีการจัดลำดับความสำคัญ (Prioritized Weighting and Rating Scale) เพื่อให้ท่านผู้เชี่ยวชาญได้แสดงความคิดเห็นเป็นครั้งที่ 2 เมื่อได้รับแบบสอบถามคืนจากท่านเป็นที่เรียบร้อยแล้ว ผู้วิจัยจะนำคำตอบและความคิดเห็นของท่านผู้เชี่ยวชาญ มาหาค่ามัธยฐาน (Median) และพิสัยอินเทอร์ควอเตอร์ (Interquartile Range) ของแต่ละข้อ ของแต่ละข้อ เพื่อจัดทำเป็นแบบสอบถามรอบที่ 2 ต่อไป

อย่างไรก็ตามหากความเห็นของผู้เชี่ยวชาญทุกท่านสอดคล้องกันมาก การสอบถามก็จะยุติลงในครั้งนี้ ซึ่งผู้วิจัยจะได้นำมาสรุปเป็นผลการวิจัยต่อไป

สำหรับตัวเลขที่แสดงความหมายของท่านผู้เชี่ยวชาญในแบบสอบถามฉบับนี้จำแนกได้ดังนี้คือ

- 5 หมายถึง ปัจจัยนั้นมีความสำคัญมากที่สุดและเห็นด้วยอย่างยิ่ง
- 4 หมายถึง ปัจจัยนั้นมีความสำคัญมากและเห็นด้วย
- 3 หมายถึง ปัจจัยนั้นมีความสำคัญปานกลาง
- 2 หมายถึง ปัจจัยนั้นมีความสำคัญน้อย
- 1 หมายถึง ปัจจัยนั้นมีความสำคัญน้อยที่สุด

ความร่วมมือและความกรุณาของท่านผู้เชี่ยวชาญในการตอบแบบสอบถามทุกครั้ง เป็นสิ่งจำเป็นและสำคัญที่สุดต่อความเที่ยงตรงในการวิจัย ผู้วิจัยขอกราบขอบพระคุณในความกรุณาของท่านเป็นอย่างสูง ซึ่งคำตอบของท่านผู้วิจัยจะไม่นำไปเปิดเผยเป็นรายบุคคลแต่ประการใด และขอความกรุณาให้ท่านตอบคำถามอย่างสมบูรณ์ด้วยจักเป็นพระคุณอย่างสูง และขอขอบพระคุณมา ณ โอกาสนี้

ปัจจัยเสี่ยง (Risk Factor)

ปัจจัยเสี่ยง หมายถึง องค์ประกอบด้านกายภาพ สังคม พฤติกรรมเสี่ยง หรือสถานการณ์ที่อาจก่อให้เกิดอันตรายต่อสุขภาพ ชีวิต หรือทรัพย์สิน และส่งผลให้บุคคลนั้นมีโอกาสเกิดโรคได้ง่ายกว่าผู้ที่ไม่มียปัจจัยเสี่ยงเลย

คำชี้แจง ในการตอบแบบสอบถามรอบที่ 2 เป็นการกำหนดค่าความสำคัญให้กับปัจจัยเสี่ยงที่มีผลต่อการเกิดโรควัณโรค

จากการตอบแบบสอบถามของผู้เชี่ยวชาญทั้งหมด 17 ท่าน ผู้วิจัยได้ทำการเก็บรวบรวมข้อมูลและเนื้อหาจากคำถามรอบที่ 1 โดยทำการวิเคราะห์แบบ content analysis คือ การวิเคราะห์ความเหมือนกันของเนื้อหา คล้ายกัน หรือแปลความหมายเหมือนกันนำมารวมกัน โดยหลักจากการวิเคราะห์ทำให้ได้ปัจจัยเสี่ยงทั้งหมด 10 ปัจจัย

โดยให้ผู้เชี่ยวชาญให้นำน้ำหนักคะแนนตามความคิดเห็นของท่าน โดยลำดับคะแนนความหมายดังนี้

- 5 หมายถึง ปัจจัยนั้นมีความสำคัญมากที่สุดและเห็นด้วยอย่างยิ่ง
- 4 หมายถึง ปัจจัยนั้นมีความสำคัญมากและเห็นด้วย
- 3 หมายถึง ปัจจัยนั้นมีความสำคัญปานกลาง
- 2 หมายถึง ปัจจัยนั้นมีความสำคัญน้อย
- 1 หมายถึง ปัจจัยนั้นมีความสำคัญน้อยที่สุด

- ในกรณีที่ผู้เชี่ยวชาญเห็นด้วยกับปัจจัยใดให้ทำเครื่องหมาย ☒ ในช่องคะแนนที่ท่านเห็นว่ามีค่าสำคัญ
- ในกรณีที่ผู้เชี่ยวชาญไม่เห็นด้วยกับปัจจัยใดให้แสดงเหตุผลในช่องข้อคิดเห็น โดยไม่ต้องลงคะแนน

ตารางที่ 1 การกำหนดค่าน้ำหนักความสำคัญของปัจจัยเสี่ยงที่มีผลต่อการเกิดโรควันโรค สำหรับการศึกษาปัจจัยเสี่ยงที่มีผลต่อการเกิดโรควันโรคของประชากร

ปัจจัยเสี่ยง	ความคิดเห็น (ให้คะแนนน้ำหนักของปัจจัย)					ข้อคิดเห็น
	5	4	3	2	1	
1. ผู้สูงอายุ						
2. เด็กอ่อน						
3. ผู้ป่วย HIV/ AIDS						
4. ผู้ป่วยเบาหวาน						
5. ผู้ป่วยโรคมะเร็ง						
6. ผู้ป่วยที่ได้รับการปลูกถ่ายอวัยวะ						
7. ผู้ป่วยโรคไตวาย (end stage renal disease)						
8. ผู้ที่อยู่ใกล้ชิดกับผู้ป่วยวันโรค						

ปัจจัยเสี่ยง	ความคิดเห็น (ให้คะแนนน้ำหนักของปัจจัย)					ข้อคิดเห็น
	5	4	3	2	1	
9. อุณหภูมิ, ความชื้นของอากาศ						
10. ผู้ต้องขัง						
11. ผู้ที่ไม่มีที่อยู่อาศัย						
12. ผู้ที่สูบบุหรี่						
13. ผู้ที่มีรายได้น้อย						
14. ผู้ที่ติดยาเสพติด						
15. ความหนาแน่นของประชากร						

ข้อเสนอแนะเพิ่มเติม



แบบสอบถามผู้เชี่ยวชาญ

การกำหนดปัจจัยเสี่ยงที่มีผลต่อการเกิดโรคฉี่หนู
เพื่อประกอบการทำสารนิพนธ์

เรื่อง

การประยุกต์ใช้ระบบสารสนเทศภูมิศาสตร์
เพื่อวิเคราะห์หาพื้นที่เสี่ยงในการเกิดโรคฉี่หนู
กรณีศึกษา เขตพื้นที่อำเภอเสลภูมิ จังหวัดร้อยเอ็ด

โดย

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คณะวิศวกรรมศาสตร์
มหาวิทยาลัยมหิดล

ผู้เชี่ยวชาญ

แบบสอบถามชุดที่.....3.....

ชื่อ – สกุล

ตำแหน่ง.....ระดับ.....

สถานที่ปฏิบัติงาน.....

ที่อยู่.....

ฝ่าย/งาน.....กอง.....

กรม.....กระทรวง.....

วันที่ตอบแบบสอบถาม...../...../.....

คำชี้แจง

ตามที่ท่านกรุณารับเป็นผู้เชี่ยวชาญสำหรับการวิจัยและได้ให้ความเห็นในการวิจัยครั้งนี้ผ่านรอบที่ 2 เป็นที่เรียบร้อยแล้ว ผู้วิจัยได้ทำการประเมินความคิดเห็นของผู้เชี่ยวชาญทุกท่าน โดยแบบสอบถามรอบที่ 3 มีจุดมุ่งหมาย 3 ประการคือ

1. เพื่อให้ผู้เชี่ยวชาญแต่ละท่านได้ทราบความเห็นรวมของผู้เชี่ยวชาญทั้งกลุ่ม
2. เพื่อให้ผู้เชี่ยวชาญแต่ละท่านได้ตรวจสอบคำตอบของตนเองในรอบที่ 2 หากผู้เชี่ยวชาญต้องการเปลี่ยนคำตอบใหม่ก็สามารถเปลี่ยนได้ในรอบที่ 3 นี้
3. เพื่อให้ผู้เชี่ยวชาญที่ยังคงยืนยันคำตอบเดิม ได้แสดงเหตุผลยืนยันคำตอบเหล่านั้นเป็นรายชื่อ

คำชี้แจง

ในแบบสอบถามรอบที่ 3 นี้ในแต่ละข้อของแบบสอบถามผู้วิจัยได้แสดงค่าที่ได้จากการคำนวณของผู้เชี่ยวชาญทั้งกลุ่มในรอบที่ 2 ไว้ดังนี้

ค่ามัธยฐาน (Median) ซึ่งหมายถึง ค่าเฉลี่ยกลางของผู้เชี่ยวชาญทั้งกลุ่ม

ค่าพิสัยอินเทอร์ควอไทล์ (Interquartile Range) หมายถึง ช่วงความเห็นที่สอดคล้องกันของผู้เชี่ยวชาญทั้งกลุ่ม

ผู้วิจัยขอความกรุณาให้ท่านผู้เชี่ยวชาญได้ทบทวนคำตอบของท่านในรอบที่ 2 ทั้งหมด 10 ข้อ อีกครั้ง หากท่านต้องการเปลี่ยนแปลงคำตอบก็สามารถทำได้โดยทำเครื่องหมาย ☒ ลงในช่องความเห็นตามค่าดังที่ทำในรอบที่ 2

หากท่านไม่ประสงค์จะเปลี่ยนแปลงเพราะเหตุผลใดเหตุผลหนึ่งดังต่อไปนี้

1. คำตอบของท่านสอดคล้องกับความเห็นของกลุ่มอยู่แล้ว ท่านก็ไม่จำเป็นต้องทำเครื่องหมายใดๆทั้งสิ้น
2. คำตอบของท่านไม่สอดคล้องกับความเห็นของกลุ่มแต่ท่านยังคงยืนยันคำตอบเดิม ท่านก็ไม่จำเป็นต้องทำเครื่องหมายใดๆเช่นกัน แต่ขอความกรุณาระบุเหตุผลท้ายข้อความนั้นด้วยว่าเพราะเหตุผลใด

ผู้วิจัยขอกราบขอบพระคุณในความกรุณาของท่านเป็นอย่างสูง ในการให้ความร่วมมือในการตอบแบบสอบถามครั้งนี้

ตารางที่ 1 การกำหนดค่านำหนักความสำคัญของปัจจัยเสี่ยงที่มีผลต่อการเกิดโรคฉับ โรค แสดงความสอดคล้องของข้อความ

ปัจจัยเสี่ยง	ความคิดเห็นของท่าน		ข้อคิดเห็น
	ค่ามัธยฐานของข้อความแต่ละข้อ (Median)	ค่าพิสัยอินเทอร์ควอไทล์ (Interquartile Range) ของข้อความแต่ละข้อ	
1. ผู้สูงอายุ อายุตั้งแต่ 60 ปี ขึ้นไป	4	1	
2. เด็กอ่อน อายุ 0-5 ปี	4	1.5	
3. ผู้ป่วย HIV/ AIDS	5	1	
4. ผู้ป่วย เบาหวาน	5	1	
5. ผู้ป่วย โรคมะเร็ง	5	1	

ปัจจัย	ความคิดเห็นของท่าน		ข้อคิดเห็น
	ค่ามัธยฐานของ ข้อความแต่ละ ข้อ(Median)	ค่าพิสัยอินเทอร์ควอไทล์ (Interquartile Range) ของข้อความแต่ละข้อ	
6.ผู้ป่วยโรคไตวาย (end stage renal disease)	5	1	
7.ผู้ที่อยู่ใกล้ชิดกับผู้ป่วย วัณโรค	5	1	
8.ผู้ที่สูบบุหรี่,ผู้ที่ดื่มน้ำ แอลกอฮอล์	3	0.5	
9.ผู้ที่มีรายได้น้อย	3	1.5	
10.ความหนาแน่นของ ประชากร	4	1	

หมายเหตุ

ค่ามัธยฐาน 4.50-5.00 กลุ่มผู้เชี่ยวชาญเห็นว่าข้อความนั้นมีความสำคัญมากเห็นด้วย
อย่างยิ่งและมีความสอดคล้องกัน

ค่ามัธยฐาน 3.50-4.49 กลุ่มผู้เชี่ยวชาญเห็นว่าข้อความนั้นมีความสำคัญมากเห็นด้วย
และมีความสอดคล้องกัน

ค่ามัธยฐาน 2.50-3.49 กลุ่มผู้เชี่ยวชาญเห็นว่าข้อความนั้นไม่แน่ใจ
หรือมีความสอดคล้องกัน

ค่ามัธยฐาน 1.50-2.49 กลุ่มผู้เชี่ยวชาญเห็นว่าข้อความนั้นไม่เห็นด้วย
หรือไม่มีความสอดคล้องกัน

ค่ามัธยฐาน 0.50-1.49 กลุ่มผู้เชี่ยวชาญเห็นว่าข้อความนั้นไม่เห็นด้วยอย่างยิ่ง
หรือไม่มีความสอดคล้องกันอย่างยิ่ง

โดยกำหนดค่ามัธยฐานไม่ต่ำกว่า 3.5 ในการแปลผลความสอดคล้องของข้อความ (จุมพล, 2535)

ค่าพิสัยอินเทอร์ควอไทล์ (Interquartile Range)

ของข้อความแต่ละข้อความ

1. ข้อความใดมีค่า quartile range มีค่าไม่เกิน 1.50 แสดงว่าผู้เชี่ยวชาญมีความคิดเห็น
สอดคล้องกัน
2. ข้อความใดมีค่า quartile range มีค่ามากกว่า 1.50 แสดงว่าผู้เชี่ยวชาญมีความคิดเห็นไม่
สอดคล้องกัน

ข้อเสนอแนะเพิ่มเติม

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Risk Factors	Weighting and Rating Scale	
	Weighting Value	Rating Point
1. ผู้สูงอายุ (อายุตั้งแต่ 60 ปี ขึ้นไป)	(4)	
220-479		1
480-739		2
740-998		3
999-1258		4
1259-1517		5
2. เด็กอ่อน(อายุ 0- 5 ปี)	(4)	
30-61		1
62-92		2
93-124		3
125-155		4
156-186		5
3. ผู้ป่วย HIV/ AIDS	(5)	
3-9		1
10-16		2
17-23		3
24-29		4
30-36		5
4. ผู้ป่วยเบาหวาน	(5)	
0-79		1
80-158		2
159-237		3
238-316		4
317-395		5

Risk Factors	Weighting and Rating Scale	
	Weighting Value	Rating Point
5. ผู้ป่วยโรคมะเร็ง	(5)	
2-7		1
8-12		2
13-16		3
17-21		4
22-26		5
6. ผู้ป่วยโรคไตวาย (end stage renal disease)	(5)	
22-55		1
56-87		2
88-120		3
121-152		4
153-185		5
7. ผู้ที่อยู่ใกล้ชิดกับผู้ป่วยวัณโรค	(5)	
0-14		1
15-28		2
29-42		3
43-56		4
57-70		5
8. ผู้ที่ติดยาเสพติดและผู้สูบบุหรี่	(3)	
1-3		1
4-6		2
7-9		3
10-14		4
15-16		5

Risk Factors	Weighting and Rating Scale	
	Weighting Value	Rating Point
9. ผู้ที่มีรายได้น้อย	(3)	
0-82,440		5
82,441-164,880		4
164,881- 247,320		3
247,321- 329,760		2
329,761-412,200		1
10.ความหนาแน่นของประชากร (คนต่อ ตารางกิโลเมตร)	(4)	
0.00-8		1
84-167		2
163-250		3
251-334		4
335-418		5

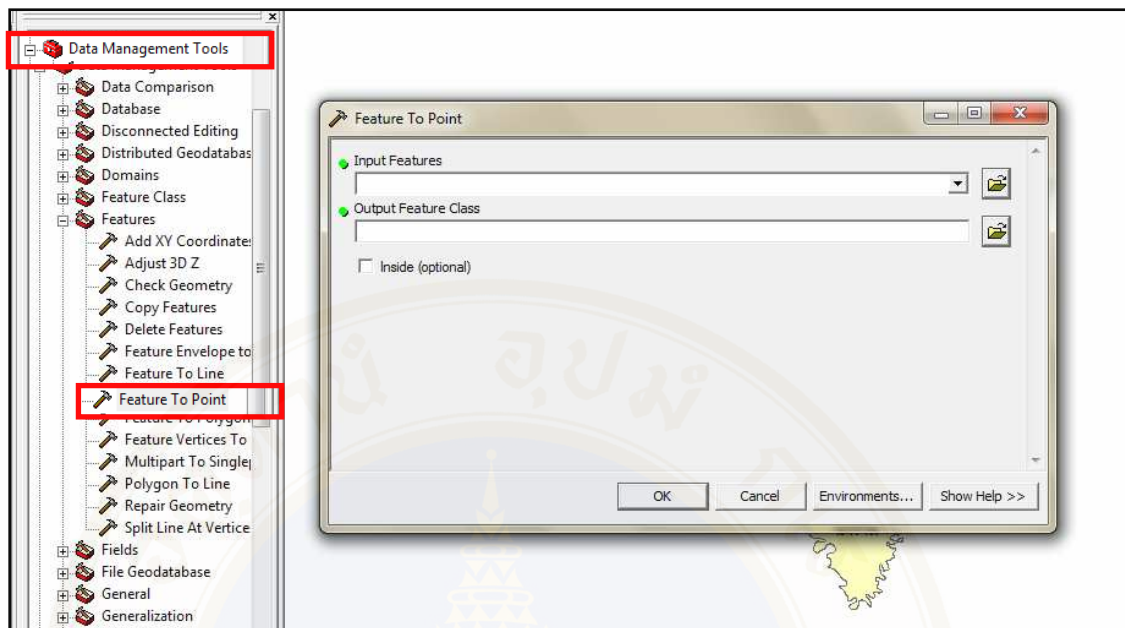
APPENDIX B

HOT SPOT ANALYSIS

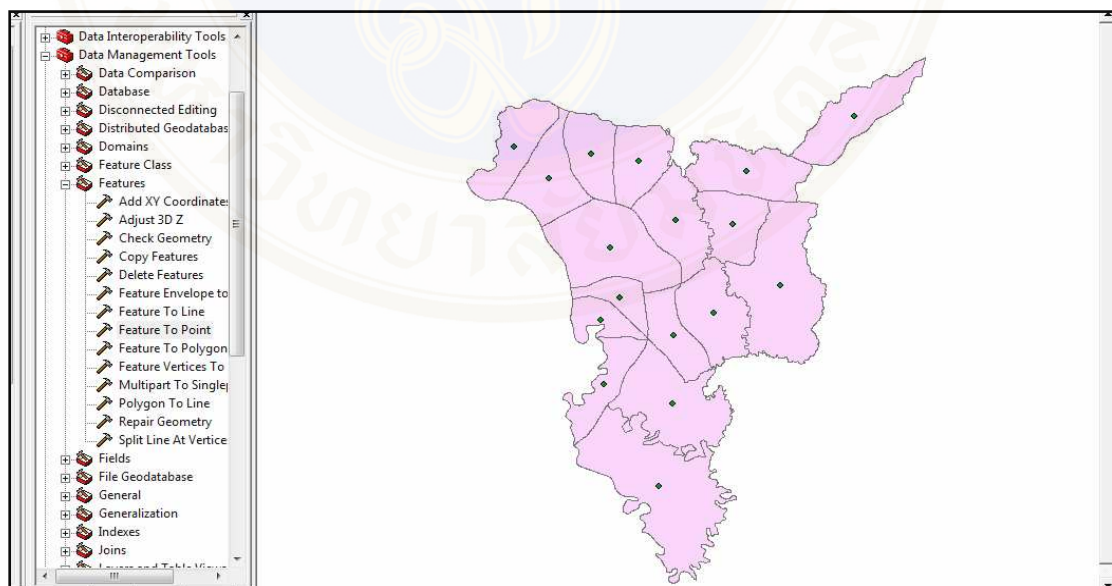
ขั้นตอนการวิเคราะห์ Hot Spot (Hot Spot Analysis)

- 1) นำข้อมูลผู้ป่วยรายใหม่เสมหะบวกมาวิเคราะห์หาอัตราป่วยของโรควัน โรคต่อประชากร 100,000 คน โดยทำการแยกเป็นรายตำบล
- 2) นำผลอัตราการป่วยที่ได้มาจัดทำเป็นฐานข้อมูลโดยใช้ Access 2007
- 3) ตั้งชื่อผลลัพธ์ (Output) จากการเชื่อมโยงข้อมูลในตาราง เป็น “CASE”
- 4) การคำนวณระยะทาง (d) ของสมการ Getis-Ord G_i^* เพื่อความถูกต้องแม่นยำในการคำนวณ ให้ทำการแปลงข้อมูลขอบเขตตำบลที่แสดงอยู่ในรูปหลายเหลี่ยม (Polygon) เป็นข้อมูลจุด (Point) ด้วยคำสั่งใน Arc Toolbox ดังนี้

Data Management Tool ⇒ Feature ⇒ Feature To Point



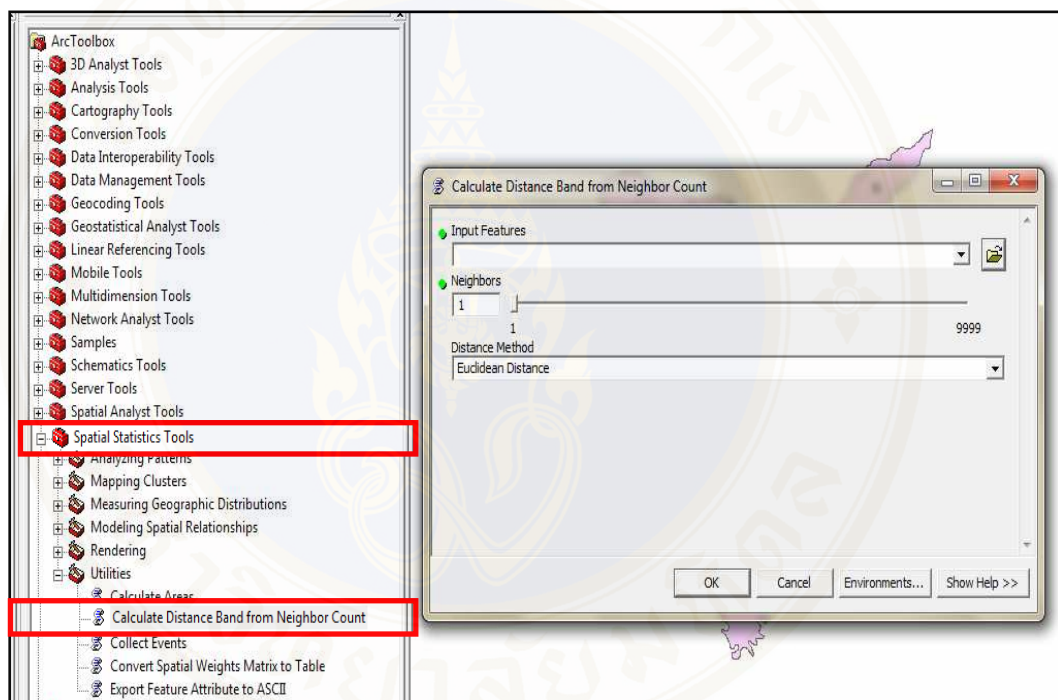
5) จากข้อมูลดังกล่าวทำให้ได้ข้อมูลจุดแสดงศูนย์กลางของแต่ละตำบลดังรูป

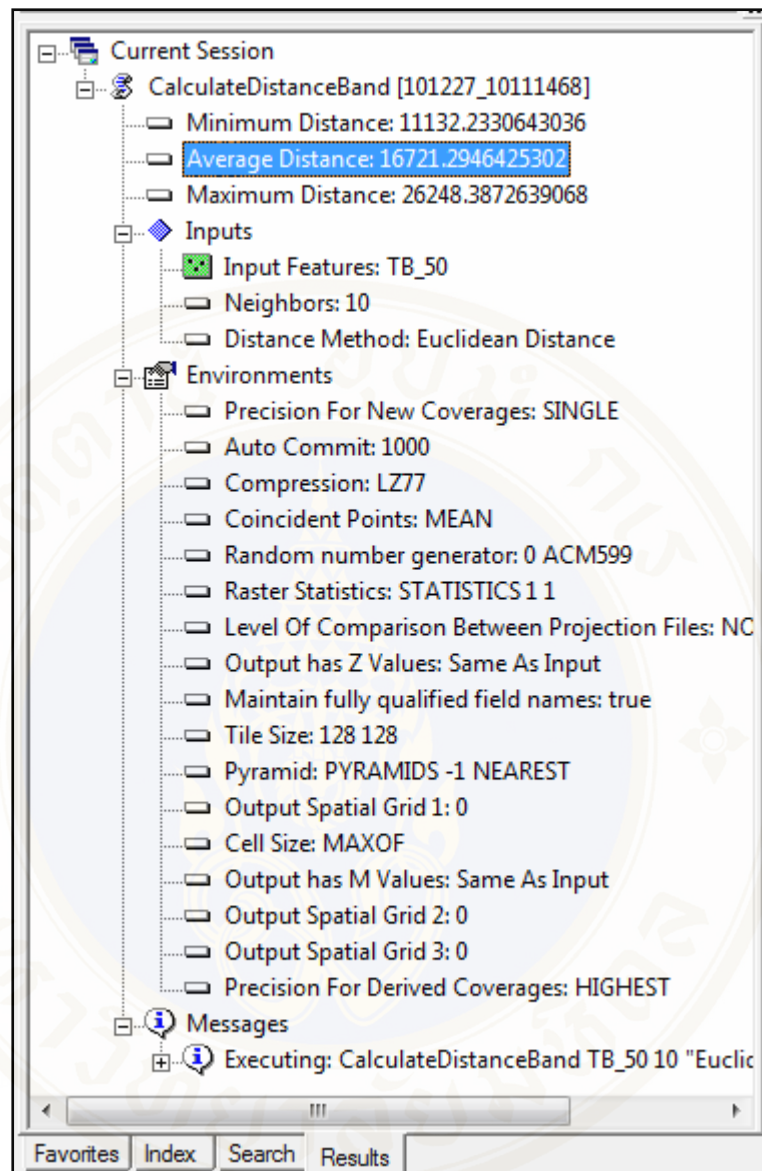


6) จากนั้นทำการคำนวณระยะทาง (d) ด้วยคำสั่งใน Arc Toolbox ดังนี้

Spatial Statistics Tool ⇒ Utilities ⇒ Calculate Distance Band from Neighbor Count

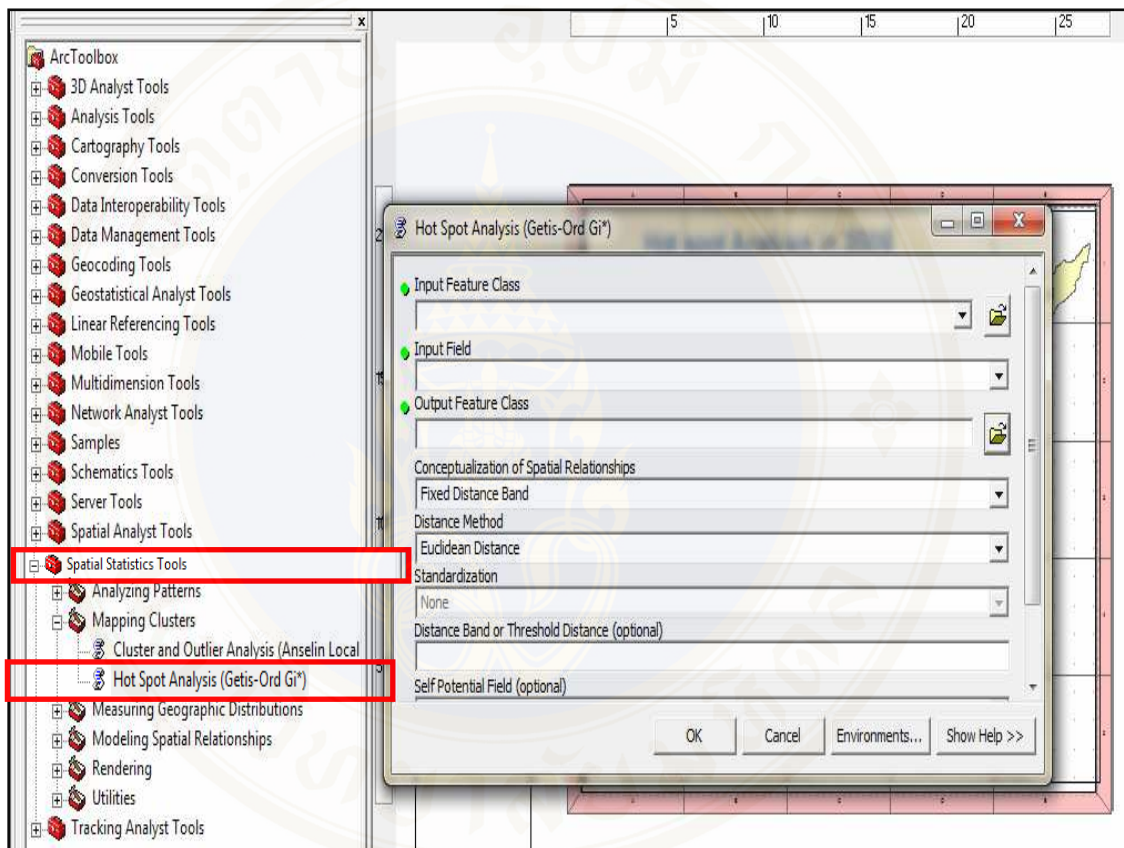
7) จากขั้นตอนที่ 6 ทำให้ได้ค่าระยะทาง (d) ระหว่างตำบล เลือกใช้ค่าเฉลี่ยระยะระหว่างตำบล โดยมีค่าเท่ากับ 16,721 เมตร





8) วิเคราะห์ Hot Spot ด้วยเครื่องมือ Hot Spot Analysis (Getis-Ord Gi*)
ใช้คำสั่งใน Arc Toolbox ดังนี้

Spatial Statistics Tool ⇒ Mapping Clusters ⇒ Hot Spot Analysis (Getis-Ord Gi*)



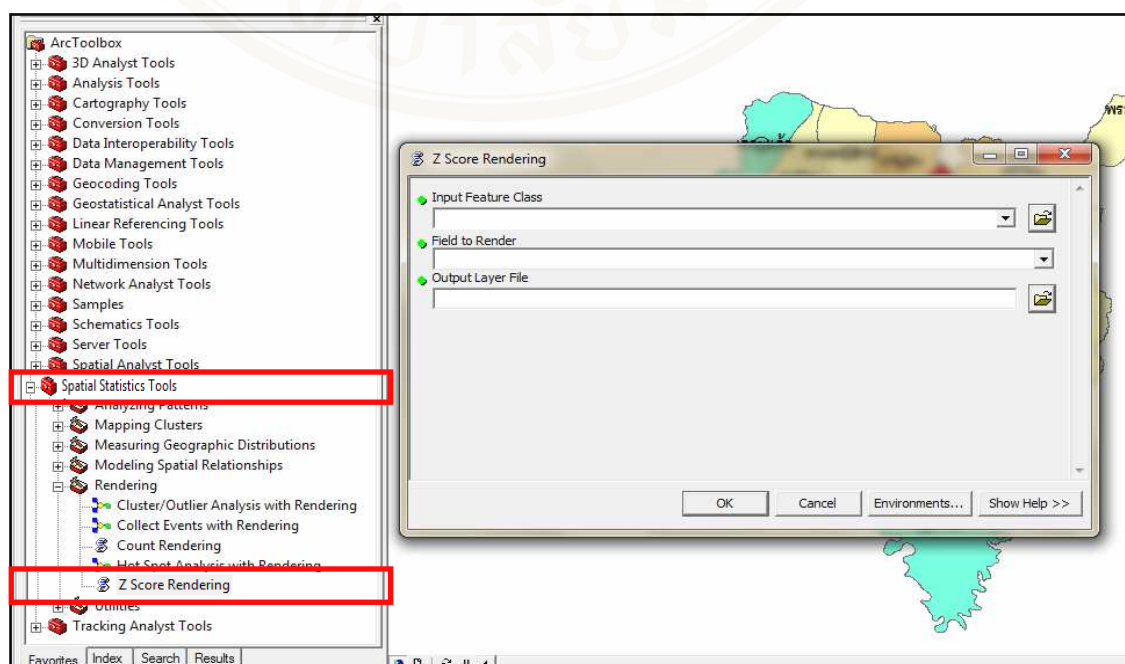
9) จากขั้นตอนที่ 8 จะได้ค่า G_i^* ปรากฏในตารางของ “HOT” ชื่อสมมก

“GiZScore” แสดงในรูปของตาราง Z-scores

ORIG_FID	GiZScore	GiPValue
0	.113707	.909470
1	-1.26568	.205627
2	.274168	.783956
3	1.86447	.062256
4	-1.41586	.156815
5	1.68785	.091440
6	.393778	.693745
7	.768540	.442167
8	3.11076	.001866
9	-1.0277	.304091
10	-8.56681	.391621
11	2.32944	.019836
12	1.32055	.186652
13	.888527	.374258
14	-3.27935	.742961
15	1.21212	.225468
16	.560159	.575371

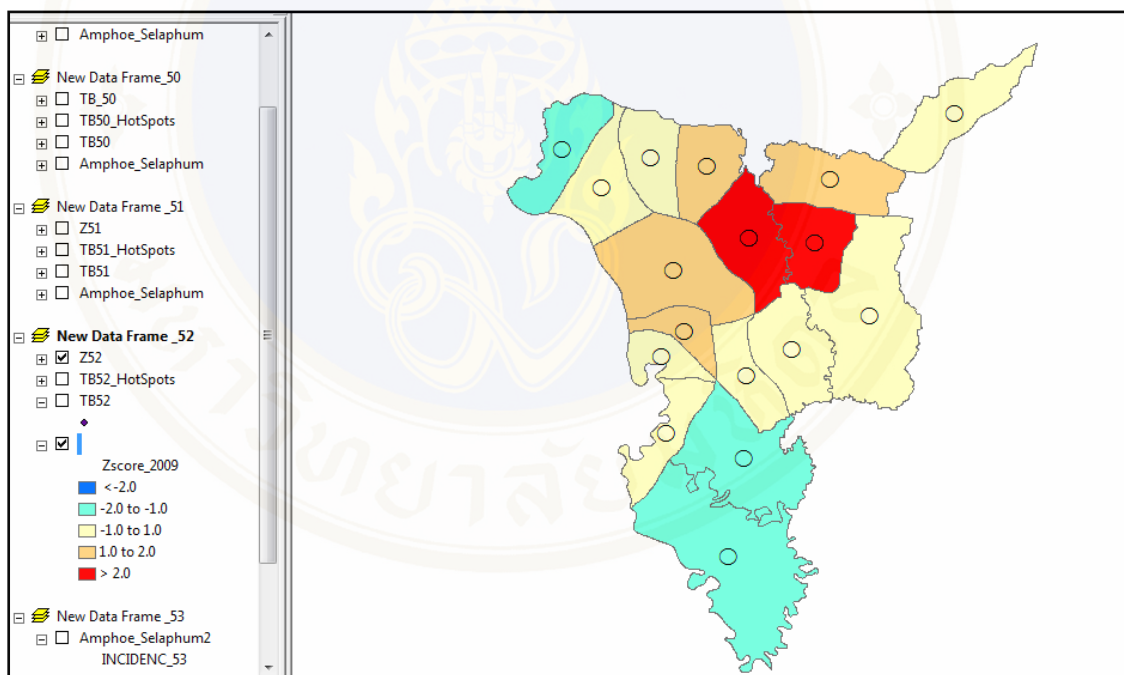
10) นำข้อมูลในสมมก “GiZ-score” มาทำการจกกลุ่มค่า Z-scores ด้วยคำสั่งใน Arc Toolbox ดังนี้

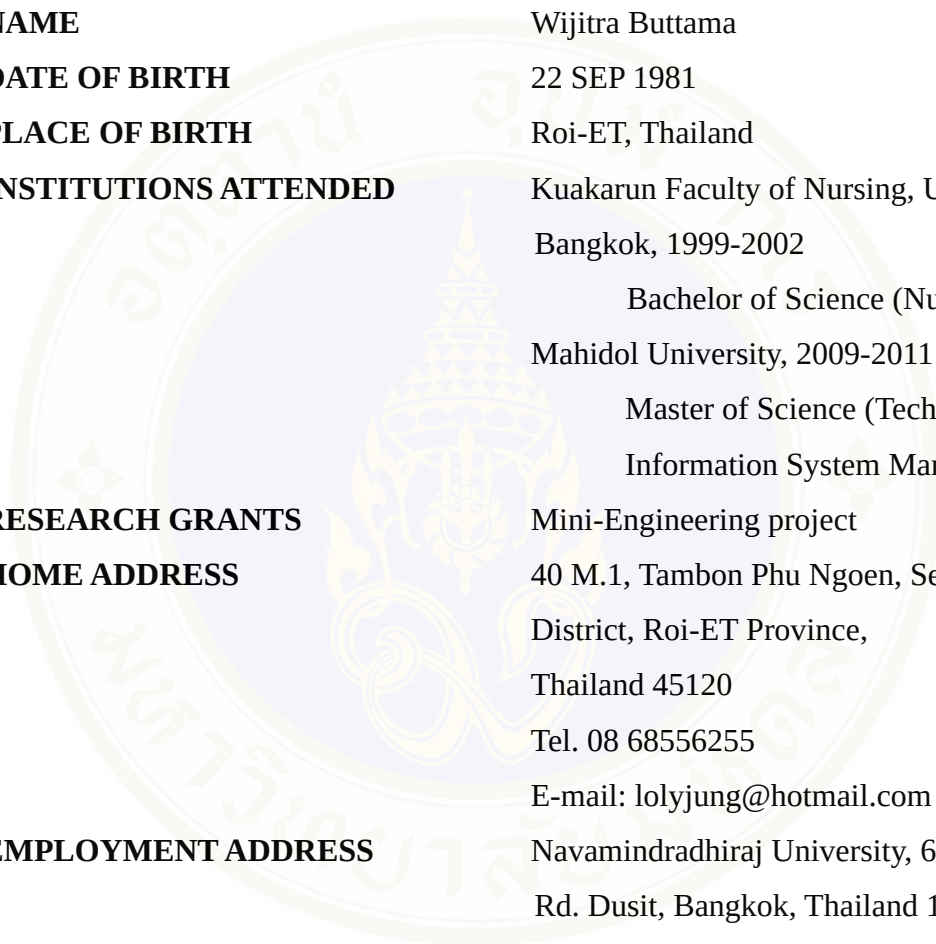
Spatial Statistics Tool ⇒ Rendering ⇒ Z-score Rendering



11) ผลลัพธ์ที่ได้จะถูกจัดกลุ่ม ตามเกณฑ์ ที่ใช้ในการจัดค่า Z-score สามารถจัดกลุ่มได้ดังนี้

- ค่า Z-Score ต่ำกว่า -2 Standard deviations แสดงด้วยสีน้ำเงิน
- ค่า Z-Score อยู่ระหว่าง -2 ถึง 2 Standard deviations แสดงด้วยสีฟ้า
- ค่า Z-Score อยู่ระหว่าง -2 ถึง 2 Standard deviations แสดงด้วยสีเหลือง
- ค่า Z-Score อยู่ระหว่าง 1 ถึง 2 Standard deviations แสดงด้วยสีส้ม
- ค่า Z-Score มากกว่า 2 Standard deviations แสดงด้วยสีแดง



BIOGRAPHY

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