THE ENVIRONMENTAL LAND USE PLANNING FOR URBAN EXPANSION: A CASE STUDY OF AMPHOE MUANG PHITSANULOK

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THE ENVIRONMENTAL LAND USE PLANNING FOR URBAN EXPANSION: A CASE STUDY OF AMPHOE MUANG PHITSANULOK

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ABSTRACT

The research has two objectives: first, to study land use pattern changes in Amphoe Muang Phitsanulok during 1994-2002; second, to identify appropriate areas for residential, commercial and industrial uses. The factors used for an area assessment analysis were physical, environmental and socio-economic factors. These were flood areas, streams, built up areas, conservation area, environment, accessibility, land price, recreation area, elementary schools, slopes, soil, and commercial areas. These factors were derived from the literature review and environmental experts' evaluation and calculation using Potential Surface Analysis and Geographical Information System technology. Arcview program version 3.1 was used in an analysis process. The results of the analysis are;

The residential section was 74.70 square kilometers in 1994 and 113.46 square kilometers in 2002, an increase representing 5.11 percent of the study area. The commercial section was 5.25 square kilometers in 1994 and was 29.84 square kilometers in 2002, an increases representing 3.24 percent of the study area. In 1994, there was no big industrial area, but there were small industrial sites. This area was not counted in 1994. In 2002, the industrial section was 0.49 square kilometers, an increases representing 0.65 percent of the study area. There was a large expansion in residential, commercial and industrial area use but this expansion was scattered in several areas.

Nearby 76.36 square kilometers or 10.06 percent of the study area was suitable for residential expansion being mostly connected to the old community, market, schools and other facilities.

Approximately 65.46 square kilometers or 8.60 percent of the study area had potential for business use being located close to the old commercial area.

Approximately 75.72 square kilometers or 10.00 percent of the study area had high potential for industrial expansion The industrial location is far away from residential and commercial area. The land price is low, and it situated not very far from transportation center.

The result from this study is valuable for preliminary management of residential, commercial and industrial area in Amphoe Muang Phitsanulok to support the urban expansion in the future and environmental impact reduction.

KEY WORDS : PLANNING / URBAN EXPANSION / PHITSANULOK

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การวางแผนการใช้ที่ดินในเชิงสิ่งแวดล้อมเพื่อรองรับการขยายตัวของเมือง: กรณีศึกษา อำเภอเมือง จังหวัดพิษณุโลก (THE ENVIRONMENTAL LAND USE PLANNING FOR URBAN EXPANSION: A CASE STUDY OF AMPHOE MUANG PHITSANULOK)

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บทคัดย่อ

การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อที่จะศึกษาการเปลี่ยนแปลงการใช้ประโยชน์ที่ดินของพื้นที่อำเภอเมือง จังหวัดพิษณุโลก ระหว่างปี พ.ศ. 2537 ถึง พ.ศ. 2545 และคัดเลือกพื้นที่ที่เหมาะสมสำหรับ ที่อยู่อาศัย พาณิชกรรม และอุตสาหกรรม โดยใช้ปัจจัยทางด้านสิ่งแวดล้อมและปัจจัยที่มีอิทธิพลต่อการพัฒนาพื้นที่อยู่อาศัย พาณิชกรรม และอุตสาหกรรมที่ได้มาจากการทบทวนเอกสารและสอบถามผู้เชี่ยวชาญ การวิเคราะห์ค่าความเหมาะสมของปัจจัยต่างๆ ทางสิ่งแวดล้อมกายภาพที่ได้จากการวิเคราะห์โดยผู้เชี่ยวชาญ การศึกษาได้กำหนดค่าปัจจัยพื้นฐาน และจัดทำแผนที่แสดงศักยภาพของปัจจัยพื้นฐานต่างๆ และให้ค่าน้ำหนักของปัจจัยพื้นฐานตามวิธีการของ Potential Surface Analysis (PSA) แล้วจึงวิเคราะห์ข้อมูลต่างๆ ด้วยเทคโนโลยีระบบสารสนเทศภูมิศาสตร์ด้วยชุดโปรแกรม Arcview ผลการศึกษาสรุปได้ดังนี้

ผลจากการวิเคราะห์เปรียบเทียบการใช้ประโยชน์ที่ดิน ระหว่างปี พ.ศ. 2537 พบว่า มีการใช้ประโยชน์ที่อยู่อาศัย 74.70 ตร.ก.ม.และในปี พ.ศ. 2545 มีพื้นที่ 113.46 ตร.กม.เพิ่มขึ้นร้อยละ 5.11 ของพื้นที่ ส่วนพื้นที่พาณิชกรรมในปี พ.ศ.2537 มีพื้นที่ 5.25 ตร.กม. และในปี พ.ศ. 2545 มีพื้นที่ 29.84 ตร.กม.เพิ่มขึ้นร้อยละ 3.24 ของพื้นที่ และพื้นที่อุตสาหกรรมในปี พ.ศ.2537 ไม่พบพื้นที่อุตสาหกรรมขนาดใหญ่มีแต่อุตสาหกรรมขนาดเล็ก แต่ในปี พ.ศ. 2545 มีพื้นที่ 0.49 ตร.กม.เพิ่มขึ้น ร้อยละ 0.65 ของพื้นที่ ซึ่งมีการขยายตัวของพื้นที่ ที่อยู่อาศัย พาณิชกรรม และอุตสาหกรรม อย่างไม่เป็นระเบียบเท่าที่ควร

พื้นที่ที่มีศักยภาพเหมาะสมสำหรับที่อยู่อาศัยมากที่สุด พื้นที่ดังกล่าวมีจำนวน 76.36 ตร.กม. หรือร้อยละ 10.06 ของพื้นที่ ซึ่งต่อเนื่องกับชุมชนเดิม นอกจากนี้ยังไม่ห่างจากศูนย์กลางธุรกิจ การศึกษา และสิ่งอำนวยความสะดวกต่างๆ

พื้นที่ที่มีศักยภาพสำหรับการพัฒนาใช้ที่ดินในเชิงพาณิชกรรมมากที่สุด พื้นที่ดังกล่าวมีจำนวน 65.46 ตร.กม. หรือร้อยละ 8.6 ของพื้นที่ ยังคงต่อเนื่องกับศูนย์กลางธุรกิจเดิม และถนนสายหลักที่เป็นเส้นทางเชื่อมต่อกับพื้นที่ใกล้เคียง

พื้นที่ที่มีศักยภาพสำหรับการพัฒนาการใช้ที่ดินในด้านอุตสาหกรรม มากที่สุด พื้นที่ดังกล่าวมีจำนวน 75.72 ตร.กม. หรือร้อยละ 10 ของพื้นที่ ซึ่งเป็นพื้นที่ที่ อยู่ห่างไกลจากย่านธุรกิจและชุมชน รวมทั้งมีราคาที่ดินไม่แพง แต่ก็ไม่ห่างไกลจากศูนย์กลางทางคมนาคมมากจนเกินไปนัก

ผลการศึกษาที่ได้ในครั้งนี้จะช่วยในการวางแผนการจัดการพื้นที่ ด้านอยู่อาศัย พาณิชกรรม และอุตสาหกรรม เบื้องต้นในจังหวัดพิษณุโลก เพื่อรองรับการขยายตัวของเมืองในอนาคตและมีผลกระทบต่อสิ่งแวดล้อมน้อยที่สุด

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CHAPTER 1
INTRODUCTION

1.1 Background Information and State of the Problem

The 9th national economic and society development plan (A.D. 2002-2006) are planning Thailand to become a transportation hub of Southeast Asia connecting countries by road network, railway, harbors and airports (1). Phitsanulok province is an important province because it is a metropolis of the lower northern part of Thailand. It is also a center of transportation to connect three regions of Thailand (upper northern, middle and north eastern region of Thailand) and neighboring countries (Cambodia, Vietnam, China, Myanmar, Laos) by railways, roads, airways and waterways. Moreover, the plan has seen the role of Phitsanulok province as a center of agriculture, economic and education of the lower northern part.

Beside that, Phitsanulok province is part of Hexagons Economic project that is a commercial project cooperation with neighboring countries;. Cambodia, Vietnam, China, Myanmar, Laos. There is a motor route No. 12, a four lane road, Tak-Sukhothai-Phitsanulok-Phetchaboon, be connected to the neighboring countries in Hexagons Economic project from Bangkok through other part of Thailand. The strategy that weave the motor route network to develop the country to became a center of transportation, economic, industry and tourism in South East Asia would involve a lot with Photsanulok province. The entire factors above accelerate urban growth in Phitsanulok province.

From the study of Office of Evironmental Information that found the growth of Phitsanulok urban area is rapidly developed. In 1982 the urban area was cover 8,819.514 rais, in 1992 the growth expanded to 23,617.664 rais and in 1996 was 28,133.313 rais this is enough to be presented that urban area of Phitsanulok town grew more than 3 time within 14 years and show potential to spread continually through the future that impact on environment, communities, irrigation areas and

agriculture areas. So there should have a study of urban growths planning for sustainable land use of the area. (2)

1.1.1 State of problems

The Environmental Division region 9 with the local government in Phitsanulok province seminar 2543 reported the environment problems of Phisanulok province as follow:

1.1.1.1 Forest resource: there are trespasses forests and forest areas were decline.

1.1.1.2 Soil resource and land use: there is soil deterioration, soil erosion and improper of land.

1.1.1.3 Water pollution: wastewater from communities, agriculture, industries and farms did not have water sanitation well enough.

1.1.1.4 Water resource problems such as sufficient water resource, decline of water quality, drought and flooding problem in lowland.

1.1.1.5 Garbage and excretion pollution such as a lot of rubbish and the lack of efficiencies sanitation.

1.1.1.6 Noise and air pollution such as dust from transportation, smelt and noise from small and medium scale factories.

1.1.1.7 Hazard waste pollution without appropriate treatment such as hazardous waste and chemical from agriculture contaminated in soil and water resource.

1.1.1.8 Community's environment: there are not enough public facilities for rapid population growth.

1.1.1.9 Natural environment: environmental deterioration and over utilization of environmental capability.

1.1.1.10 Cultural Heritage: the lack of foster for conservation and community concern.

1.1.1.11 Mineral resource: there are mountains explosion and irregular stone grinding factor especially in Amphoe Neunmapang. (3)

The problem from above are deteriorated more and mores because there is not the environmental land use planning that deal with urban growth specifically.

Concerning to the recently and future problem. The environmental land use planning is important for managing and solving environmental problems; it should define the potential and now potential land for lack activity for long-term environmental provisions.

It is very difficult for local governments to update the database for managing their cities by traditional surveying and mapping methods, which are both cost and time consuming. Geographic Information System may provide more advance alternative methods.

Land use morphology would be change continually caused by the competition between demand and supply of land for different activities in order to gain highest productivity and profitability. During that change, many problems arise such as environmental damage, inadequate infrastructure, and population pressure which urban land use planning and management would face. The question how to control the urban growth will challenge the planner among that context. Moreover, database containing information about urban environment requires frequently updating to support best decision making in urban planning. The arrangements of spatial land use need the inventory not only on the physical data on location but also on its properties such as population, social-economic or the other statistic. The linking between two kinds of data will be expected through using the integration of Geographic Information System as an advance tool.

The Geographic Information System should be applied for developing better data to planning that could help reduces time and men in data analysis and mapping process. Therefore the Geographic Information System technology for study urban growth and assessing land use potential for urban planning in Amphoe Muang Phitsanulok by this technological analysis to find suitable land use for better land development for the environmental effect will be supplied and presented in the form of environmental land use map.

1.2 Conceptual framework of this study

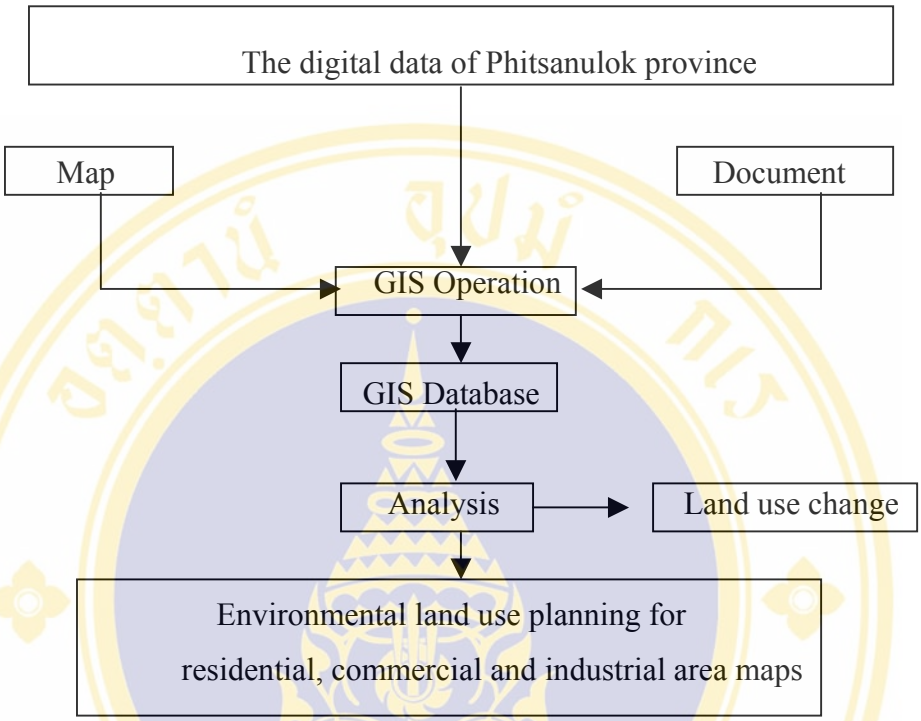


Figure 1.1 Conceptual framework of this study

1.3 Objectives

1.2.1. To study the land use pattern change of Amphoe Muang Phitsanulok between years 1994-2002.

1.2.2. To select the environmental land use for resident area commercial area and industry area of Amphoe Muang Phitsanulok by using GIS technique.

1.4 Scope of study

This research require to study an application of geographic information system as a tools for studying urban growth and assessing land use potential for urban planning in Amphoe Muang Phisanulok by there are scope of study as:

1.4.1. Phitsanulok province is located between latitudes 16^{o} 21'to 17^{o} 44'' north and longitudes 99^{o} 52' to 101^{o} 00' east (4). The Phisanulok capital is approximately 146,718 rai (5). By regulation, the number of sub districts located

inner city reached to Twenty is Aranyig, Ban-Khlong, Ban-Krang, Banpa, Bungphra, Chomtong, Donthong, Hou-Raw, Makhamsung, Muang Phitsanulok, Nglu Ngam, Pakthok, Phai Chum Phon, Samo Khaae, Thapho, Thathong, Wang Nam Khu, Wat Chan, Wat Phrik.

1.4.2. Scope of issue in this research is follow as:

1.4.2.1 Study land use pattern change of Amphoe Muang Phitsanulok between years 1994-2002.

1.4.2.2 Data characteristic is digital data and secondary data.

1.4.2.3 Study pattern of spatial spread of Amphoe Muang Phitsanulok using GIS technique between years 1994-2002.

1.5 Hypothesis

The geographic information system is an actual powerful tool for analysis in providing the environmental land use for residential, commercial and industrial area of Amphoe Muang Phitsanulok.

1.6 Definition

1.6.1. Environmental urban land use planning: mean the planning of land concern to the environmental problems such as flooding, suitable of soil and land resource.

1.6.2. Geographic Information System: mean the data entry of spatial information into computer database management, by to use of software for graphic production and the computer hardware for multiple layers display or overlay techniques in evaluation for planning and solving the problem and management. (6)

1.6.3. Amphoe: District

1.6.4. Tambon: Sub district

1.6.5. Urban land: Layout of road, public open spaces, utility service lines, plots and building, etc.

1.6.6 Suitable of soil: mean soil which is suitable for agriculture.

1.6.7 Stream: river, canal, and other surface water.

1.7 Target of study

1.7.1. To study the land use pattern change between years 1994-2002 and the environmental land use problems of Amphoe Muang Phitsanulok .

1.7.2. To build the environmental land use maps for residential, commercial and industrial area of Amphoe Muang Phitsanulok by using of GIS technique.

1.8 Benefit of study

1.8.1. To obtain the environmental land use potential maps for residential, commercial area and industrial area of Amphoe Muang Phitsanulok by the process that can be applied for similar areas in Thailand.

1.8.2. The consequence of this GIS study could be used to stipulate the policy for urban planning which emphasis on the environmental problems of Amphoe Muang Phitsanulok .

1.8.3. To obtain the knowledge about the land use pattern change of Amphoe Muang Phitsanulok .

1.8.4. To obtain the local database for urban land use planning in the future.

CHAPTER 2
LITERATURE REVIEW

2.1 The physical description of the study area

This part presents an analysis of the study are by the discussion focusing mainly on the physical development, demographic and land use pattern change in Phitsanulok province and the study area. All the following information and data were collected during the field trips and from statistics of the local offices.

2.1.1 Location of Phitsanulok province

Phitsanulok province is center of south northern area form economic and society. Phitsanulok province is center of south northern area from economic and society. Phitsanulok province is located between latitude 16^{o} 31' -17^{o} 44' north and 99^{o} 52'-101^{o} 04' east. Phitsanulok province is 337 km far from Bangkok and 80-90 meters high from sea. Phitsanulok province is approximately 10,815.854 sq. km or approximately 6,759 rai. The number of districts reached to nine districts.

2.1.2 Natural environment

2.1.2.1 Topography

There are mountain range and valley plain in East and North East of Phitsanulok in Nakornthai, Chattakarn, Wangthong, Nuen-maphang, Watboot. Middle area and South of Phitsanulok; Phompiram, Amphur muang, Bangkratoom, Bangrakam, Wangthong and some part of Nuenmapang, are low land plain especially around Nan river and Yom river that are important area for agriculture of Phitsanulok

2.1.2.2 Climate

The climate in the study area is tropical wet Savannah type with the average temperature of 27.32 ^{o}C, maximum of around 31 ^{o}C in April and a minimum of less than 20 ^{o}C in January and December. Three seasons are distinguishable:

2.1.2.2.1 Rainy season from May to October

2.1.2.1.2 Cold season from November to January

2.1.2.1.2 Hot season from February to April

Table 2.1 Climate of Phitsanulok province

Climate	Unit
Average temperature	27.32 ^{o}C
Highest temperature (April)	31 ^{o}C
Lowest temperature (January)	24 ^{o}C
Rainfall all year	13330 mm.
Month highest rainfall (August)	254 mm.
Month lowest rainfall (December)	6 mm.
Humidity all year	72 %
Climate	Unit
Month highest humidity (September)	82 %
Month lowest humidity (April)	63 %

Source: Office of Environmental Information , 2542(2)

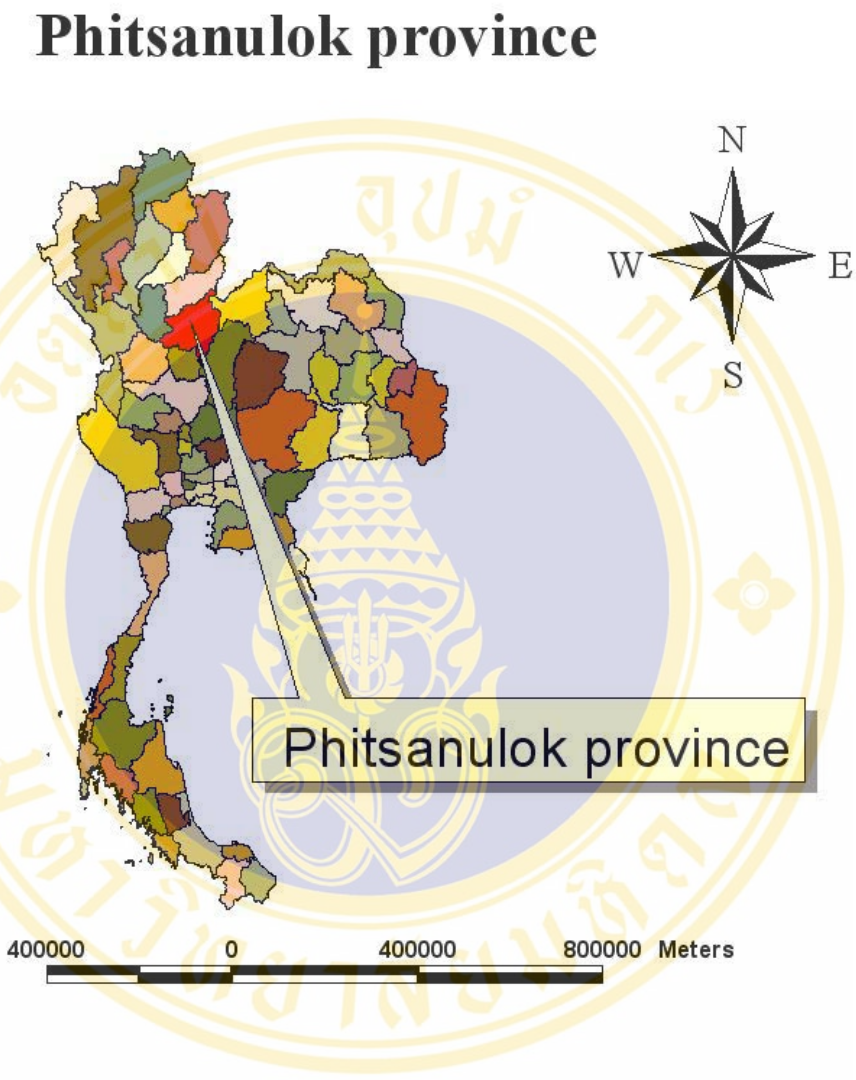


Figure 2.1 Location of Phitsanulok province

Source: Department of Lands Development, 2002

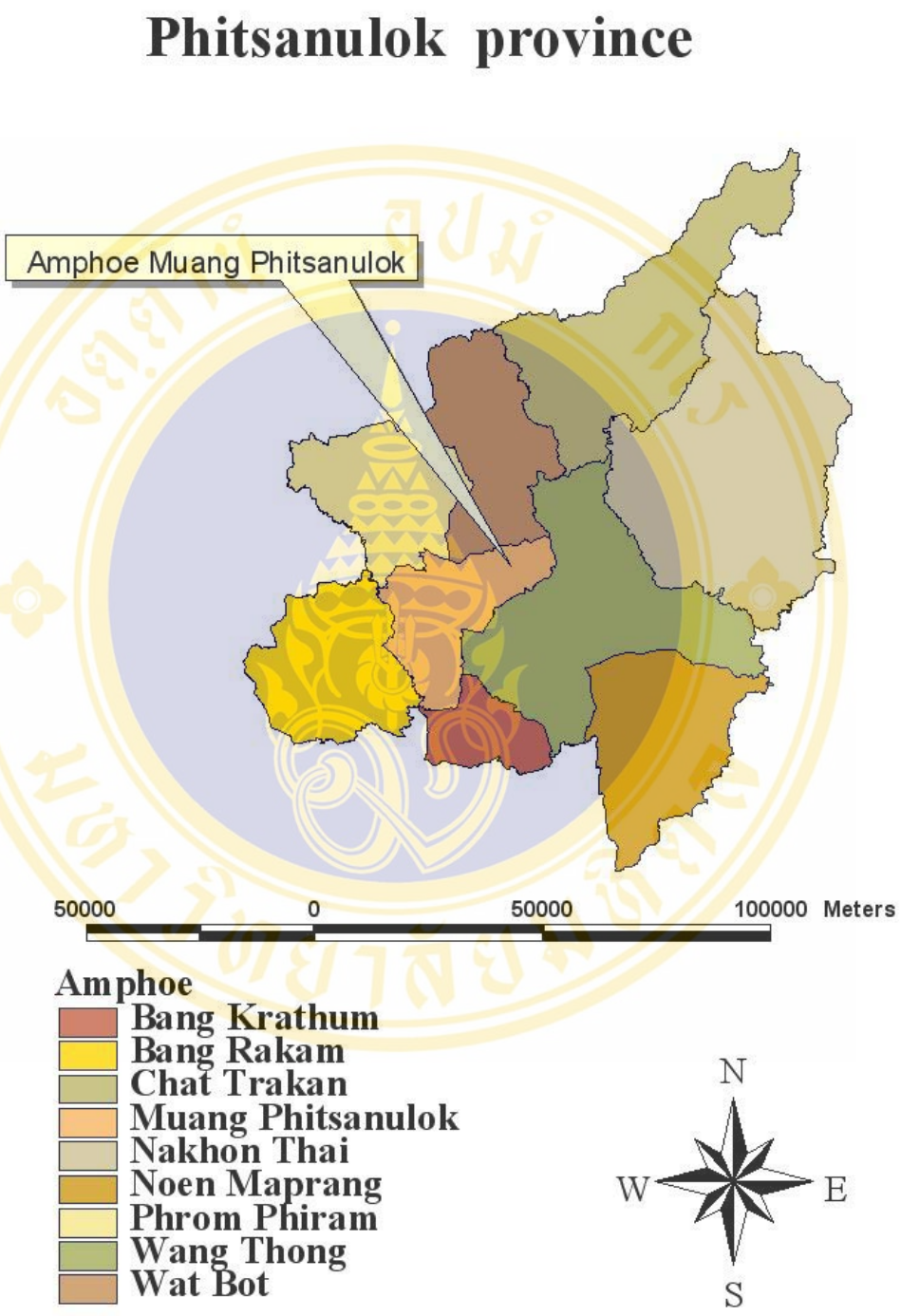


Figure 2.2 Location of Amphoe Muang Phitsanulok

Source: Department of Lands Development, 2002

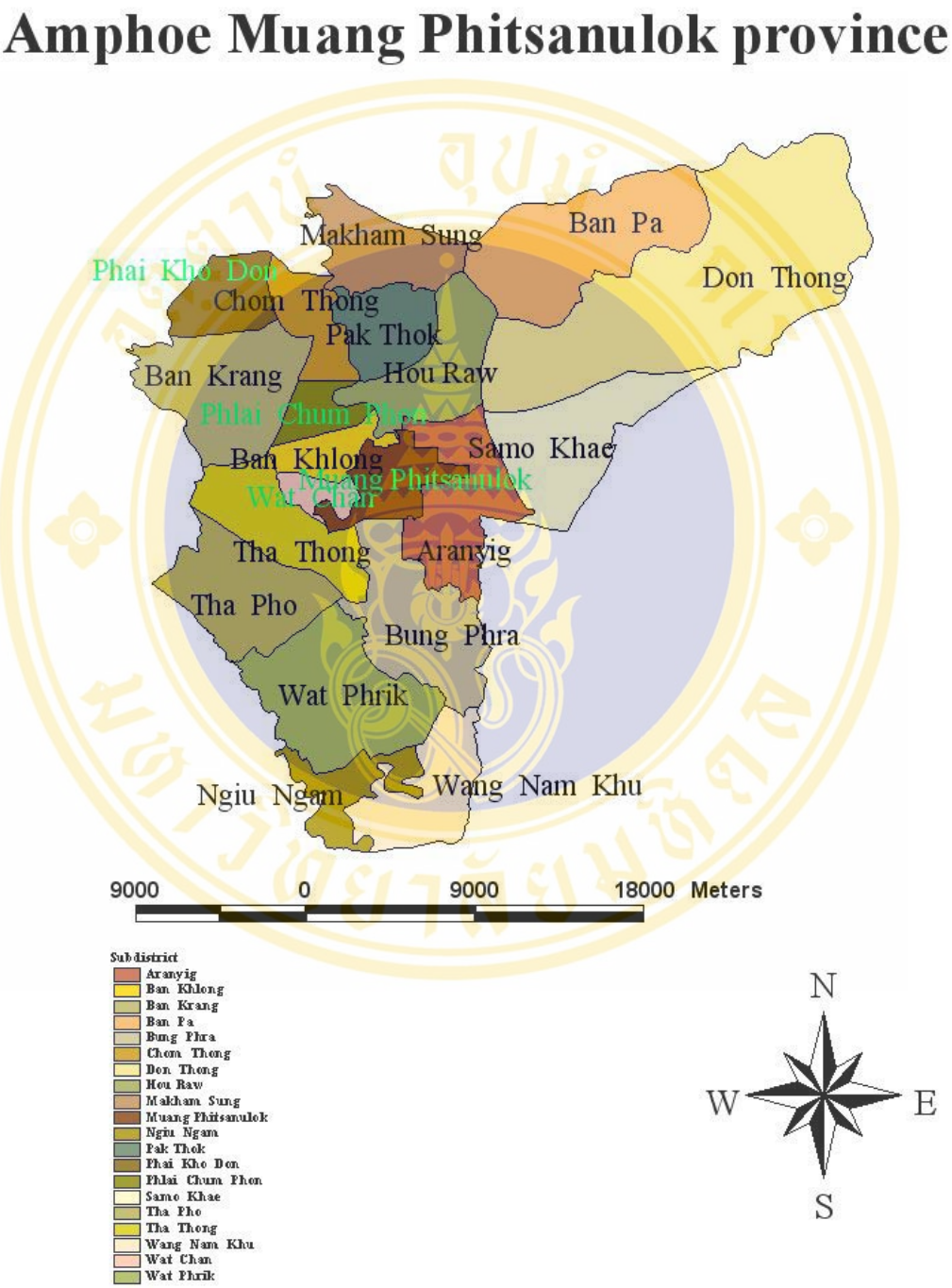


Figure 2.3 Study area

Source: Department of Lands Development, 2002

2.1.2.3 Soil

Table 2.2 Soil series of Phitsanulok province

Soil series	Area (%)
Slope Complex	38.42
Hang Chat series: Hc	3.30
Uttaradit series: Utt	3.17
Kamphaeng Saen and Kamphaeng Saen moderately well drained variant soil: Ks & Ks-mw	2.78
Sandstone-derived soil complex: SsC	2.57
Korat series: Kt	2.34
Roi-Et series: Re	2.23
Chiang Rai series: Cr	2.07
Dan Sai and Khao Yai soil: Ds & Ky	1.88
Ratchaburi series: Rb	1.84
Kamphaeng Saen series: Ks	1.67
That Phanom series: Tp	1.59
Rock Land: RL	1.59
Mae Sai series: Ms	1.33
Saraburi series: Sb	1.29
Alluvail Complex: AC	1.28
Nakhon Pathom series: Np	1.27
Hang Dong series: Hd	1.16
Tha Yang/Lat Ya association: Ty/Ly	1.12
Lampang series: Lp	1.10
Phimai series: Pm	1.06
Other soil series (there area less than 1 %)	24.94

Source: Office of Environmental information, 2542(2)

2.1.2.4 Transportation

2.1.2.4.1 Road

2.1.2.4.1 There are many roads to connect Phitsanulok and other provinces.

Table 2.3 The connection of Phitsanulok province to other province

Road	Length (kilometer)
Bangkok – Phitsanulok highway	377
Phitsanulok – Lomsuk highway	130
Phitsanulok – Sukhothai highway	60
Phitsanulok – Wangthong – Khaothong highway	95

Source: Office of Evironmental information, 2542(2)

2.1.2.4.2 Road to connect between Amphoe in Phitsanulok province.

Table 2.4 Road to connect between Amphoe in Phitsanulok province.

Road	Length (kilometer)
Phitsanulok-Bangrakam road	18
Phitsanulok-watboot road	28
Phitsanulok – Nakornthai – Chattrakarn road	145
Phitsanulok – Phombhiram road	32
Phitsanulok – Nuen-maphang road	75

Source: Office of Evironmental information, 2542(2)

2.1.2.4.2 Train

There are coach trains 23 times per day and carrier train 14 times per day. Trains are throughout 3 Amphoe are Amphoe Bangkrathum, Amphoe Mueng-Phitsanulok and Amphoe Phombhiram.

2.1.2.4.3Waterway

There are two rivers for use to be waterway is Nan River and Yom river but it can’t use in dry season because it are low water in the river.

2.1.2.4.4 Air

There are one airport go to Bangkok, Chaingmai and other province in north two time per day.

2.1.2.5 Land use

Land use in the study area is highly mixed of rural and urban uses, it is apparent that almost all-residential, educational land and market is along the main road.

The study area contains a wide range of housing types. Apartments, townhouses, and dormitories are all visible merely by

2.1.3 Social

2.1.3.1 Population

Table 2.5 Population of Phitsanulok province

Tumbol	Men	Women	Total
Nai Muang	44685	50378	95063
Ngiw Ngam	1676	1724	3400
Chom Thong	1389	1508	2897
Don Thong	6204	6497	12701
Tha Thong	5625	5764	11389
Tha Pho	4458	4547	9005
Ban Khlong	7035	5012	12047
Ban Pa	1925	2070	3995
Bung Phra subdistrict	8480	8950	17430
Pak Thok subdistrict	1812	2026	3838
Phai Kho Don subdistrict	1780	1899	3679
Phlai Chum Phon subdistrict	2027	2113	4140
Makham Sung	2313	2471	4784
Wang Num Khu	2581	2758	5339
Wat Chan	3070	2813	5883
Wat Phrik	3575	3780	7355
Samo-khae	6445	5944	12389

Tumbol	Men	Women	Total
Hou Raw	7328	7729	15057
Tumbol	Men	Women	Total
Aranyig	15962	13176	29138
Ban Krang	5758	5578	11335
Total	134,127	136,737	270,864

Source : Data and statistic information division, Thailand statistic department, 2001 (7)

2.2 The literature review about urban studies

E.C. Barrett and L. F. Curtis (8) through urban centers have been described as complex associations of population concentrations, intensive activities, and diverse lifestyles. One of the principal tasks that must be undertaken in order that cities might be made more attractive and convenient places in which to live is the compilation of an adequate fund of information on cityscapes as they appear today.

2.2.1 Urban and Rural Settlement

George Gordon and William Dick (9) are group settlements into major types, urban and rural. On the basis of size a simple guideline would be that settlements smaller than towns were rural and those the size of, or larger than, a town, urban. But as we have seen that definition can range from 200 to 10000 people as the dividing line between rural and urban settlements. Rural settlements are associated with the land and activities such as farming, fishing and forestry wheals urban centers are inhabited by people engaged in manufacturing and service activities (shops and offices).

2.2.2 Pattern and change of land use

2.2.2.1 Overview

There are great differences in the size of these countries and length of urban histories in consequences of land being taken for urban use in general term.

2.2.2.2 Land use change

Prevailing land use change is to concern conversion from rural land to urban land as worried by authorities. In United State, between 1967-1975 there was a

huge and accelerating loss of farmland, resulting in 354,000 ha. Rate of conversion of land to urban uses was increasing in the 1970s. Between 1961-1971, urban area increased by following amounts each year.

West Germany	35.9
Italy	28.9
France	25.4
United Kingdom	19.2

Despoiling of urban society into rural land is increasing leads naturally to a consideration of the future availability of land to sustain a variety of urban activities. Attitude in studying trend of land use change is to explain in term of land use pattern in recent years has been connected with transportation developments. Also mention that the impact of transport can be seen to have profoundly affected land use.

2.2.2.2 Causes in urban change process

As evaluated by Philip (10), land use pattern of western city have undergone widespread change both in term of the continued outward expansion and internal patterning and organization of space.

As researched in Toronto, Bourne (1976) identified four main processes controlling urban land use change below

2.2.2.2.1 The extension of urban edge or sub-urbanization

2.2.2.2.2 The renewal of the central area

2.2.2.2.3 The expansion of infrastructure, especially, transport

2.2.2.2.4 The growth or decline of nucleation such as removal center in the suburbs.

Bourne(1976) led to his conclusion as the major demographic impact on land use in many cities has just come not from population growth rather from its restructuring. If in the case where the population has increased overall, urban expansion varies but the ratio has often exceeded unity. An example showing by Italy every 1% of population increase between 1961-1971 prompted an extension of urban area by 3.78%.

Belgium	1.07	Luxembourg	2.14
Denmark	0.99	Netherlands	0.69
France	1.00	United Kingdom	2.09
Ireland	2.09	United State	0.77
Italy	3.78		

2.2.3 Decision tree of development alternative

Decision theory is a formalization of the problem involved in making optimal choice in a given situation (Arrow, 1964). Though the strict application of decision theory to urban planning is somewhat problematical, its conceptual framework is useful because it helps to clarify the requirements for decision making, both for the planning process as a whole, and for its various constituent parts. Broadly, then, decision theory makes clear the need for three positions to be defined: (i) a position of knowledge as to possible options; (ii) a definition of values associated with those options;(iii) a way of dealing with uncertainty.

The single most widely used model framework is the decision tree. Assume an urban system comprising just two elements, such as land use and transportation, and that there exist just three new development possibilities for urban expansion, (i) continuous expansion, (ii) nucleated expansion and (iii) star-shaped expansion, and two possibilities for transportation: (i) a radial highway pattern and (ii) a grid highway pattern. The whole development situation can be summarized as fig. 2.4, and the decision tree describing these various possibilities can be readily set out.(11)

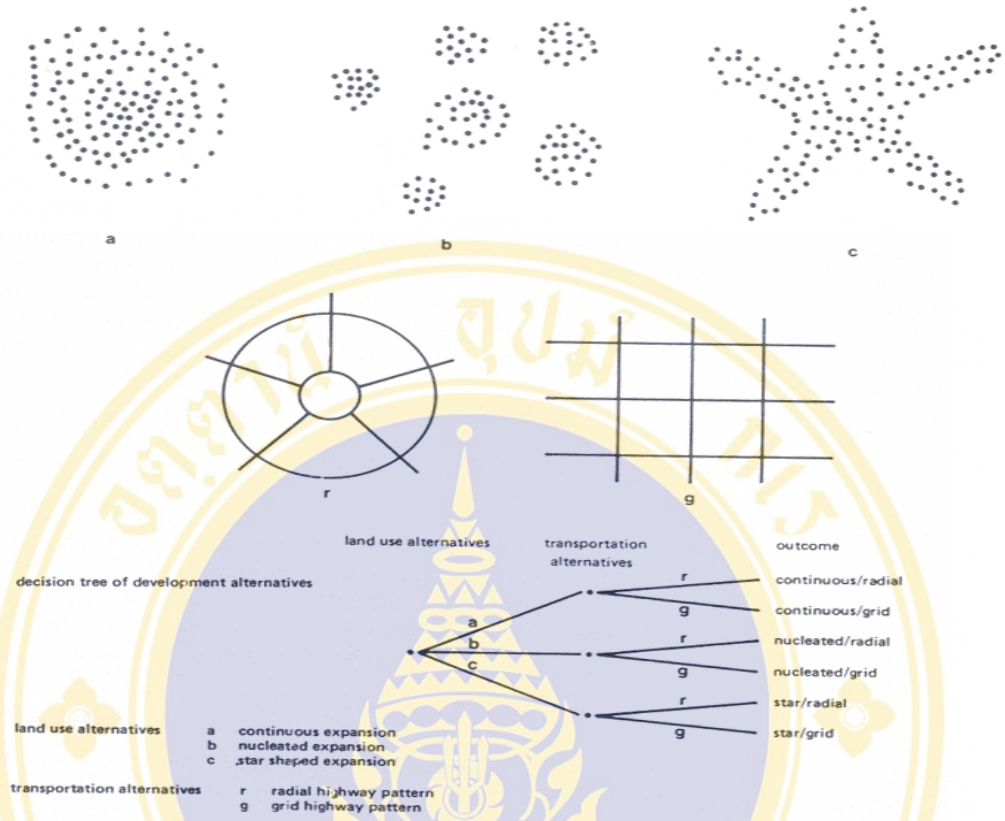


Figure 2.4 Decision tree of development alternative
Source: Krueckeberg and Silvers refer in Ian Bracken (11)

2.2.4 Models of Urban structure

E.W. Burgess refer in Ian Bracken (11), an American sociologist, proposed the concentric model of urban structure show in Figure 2.5. Burgess argued that competition between different land uses resulted in an orderly pattern of zones. The model was a generalization from a study of Chicago (Figure 2.5). Of course, many factors complicate the pattern in reality. Thus the eastern portions of the circles in the case of Chicago were absent because of Lake Michigan.

Burgess simplifies the situation by assuming a flat area with equal accessibility in all directions and a logical method of competition for sites, e.g. rent-paying ability. Change started at the center and spread outwards through the zones. Shops and offices would invade the next zone and when they became dominant the stage of succession was reached. In the same way other zones could extend outward.

The importance of planning, changes in accessibility in cities and the role of local authority housing are all major additional features in British cities which are not present in the Burgess model. It could also be argued that attitudes about the way sites should be allocated can differ from the situation which is assumed in the model. Of course, it would be difficult to construct an international model which would allow economic considerations to be dominant in some situations and religious or planning factors to be decisive in other.

Two other simple patterns have been suggested: sectors and multiple-nuclei.

Figure 2.5 The concentric model of urban structure

Source: E. Burgess refer in Ian Bracken (8)

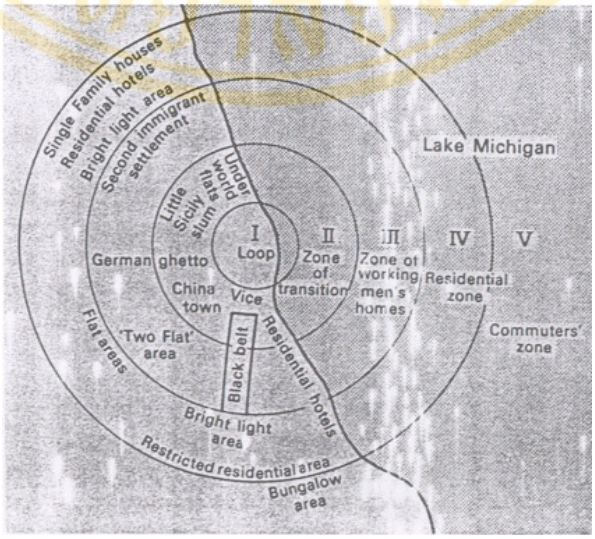


Figure 2.6 Urban zones in Chicago in the 1920s

Source : E. Burgess refer in Ian Bracken (8)

In a study of American cities, H. Hoyt found that the structure resembled sectors rather than concentric circles. In outlining the sector model (Figure 2.7) Hoyt stressed the important role of high value housing districts in shaping the overall structure. It was recognized that topography can affect the pattern with high value housing seeking attractive locations. The notion that a particular type of housing could extend to the edge of the settlement appears to be closer to the real situation than the idea that the outer zone consisted of middle-class housing. However, if the outer zone is described as an area of modern low density housing the concentric concept could also approximate to the general structure of many cities.

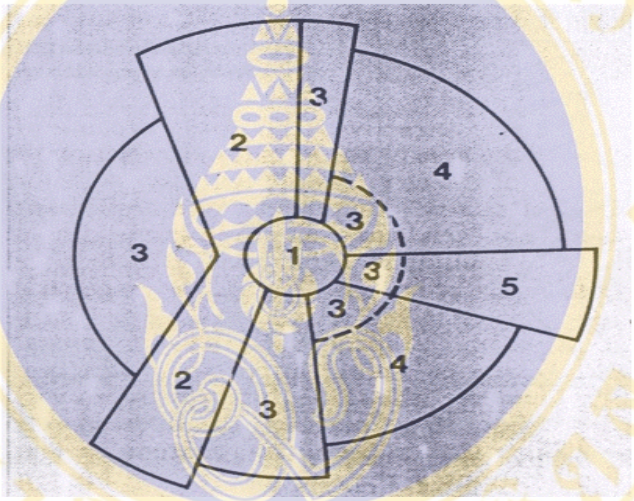


Figure 2.7 Sector model of urban structure
Source : H. Hoyt refer in Ian Bracken (11)

Another suggestion is that settlements consist of various focal points or nuclei (Figure 2.7). The multiple nuclei model does not stress the role of the C.B.D. or of high value housing as major influential zones. Instead a wide range of factors are recognized which encouraged the production of a pattern of functional areas. Harris and Ullman suggested that special site requirements, rent-paying ability, attraction of similar land uses, repulsion of opposed land uses and various other factors (which could include planning or religious attitudes) would all be involved in creating the pattern. In this model the settlement consists of various nuclei which attract particular land uses or associations of land uses.

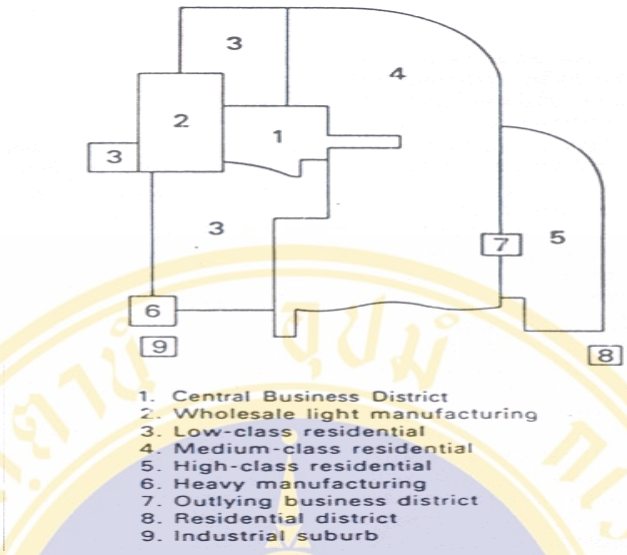


Figure 2.8 Multiple nuclei model of urban structure

Source : C. Harris and E. Ullman refer in Ian Bracken (11)

A composite model (Figure 2.8) has been developed by P.H. Mann. This includes concentric zone and sectors. In addition he further shaped the pattern by introducing the influence of the direction of the prevailing wind. Mann argued that high value housing would seek locations away from the outfall zones of wind-borne pollution. The model is useful in British context but it is doubtful if it is any more appropriate than the concentric, sector or multi-nuclei models as a generalization of the structure of cities such as Calcutta or Tehran.

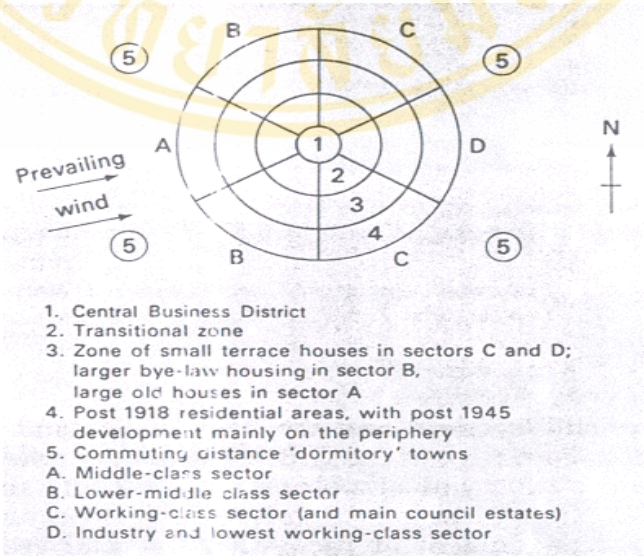


Figure 2.9 The structure of the British industrial city

Source : P. Mann refer in Ian Bracken (11)

2.2.5 The Central Business District (C.B.D.)

This area has traditionally been the center of the transport network, a fact which gives considerable centrality to locations in the C.B.D. As a result certain activities are attracted to the area. The principle characteristics of the C.B.D. are:

2.2.5.1 It is the focal point of the transport system.

2.2.5.2 There is a concentration of department stores, variety stores and specialist shops.

2.2.5.3 There are distinct clusters of administrative, commercial and professional offices.

2.2.5.4 Competition for sites will encourage multistory developments giving a vertical component to the area.

2.2.5.5 The core is surrounded by transport termini and car parks.

2.2.5.6 Some industries are present such as fashion clothing and newspaper publication but they are situated away from the principle shopping streets.

2.2.5.7 Few houses exist apart from the flats of caretakers and small clusters of high cost housing(Mayfair, London).

2.2.5.8 There is distinct population geography with a vast daytime population but few people at night.

2.2.5.9 A number of functional zones occur which relate to factors such as land values and accessibility (Figure 2.10)

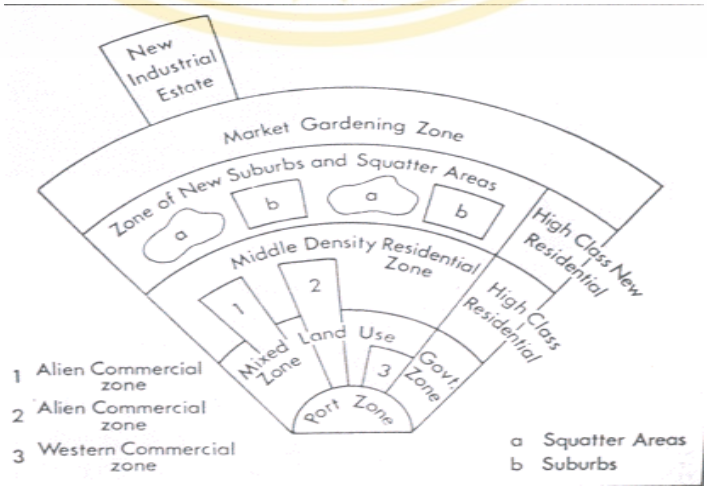


Figure 2.10 Model of the structure of a socialist city

Source : A. Dawson refer in Ian Bracken (11)

2.3 Planner' s Requirement

During time designing certain land use planning for better development, planners require accuracy in current spatial data, which is associated with geographic entities.

Mark A. Jadkowski et al. (1990)(12) discussed "local planning of urban and suburban development require timely and accurate information on existing land use and land cover". It also requires a basic understanding and trends in land use change. In urban land use planning aspect. David et al. (1993) mentioned "Planner must have assess to that describe the urban system in abstract physical, social, economic term". Given information for this task, current land use map is the most important. Moreover, the ancillary information stored in GIS is efficient source to clearly understanding the situation.

2.4 Definition of Geographic Information System (GIS)

Geographic Information System (GIS) is a system of hardware, software, and procedures designed for collecting, storing, retrieving, managing, analyzing, modeling and displaying spatial data from the real world for a particular set of purpose (13)

Geographic Information System (GIS) consist of computer software, hardware and peripheral that transform geographically referenced spatial data information on locations, spatial interactions and geographic relations of the fixed and dynamic entities that occupy space in the natural and built environment. (14).

Geographic Information System (GIS) mean the data entry of spatial information into computer database management, by use software for graphic production and the computer enable for multiple layers displaying or overlay techniques evaluation for planning and solving the problem and management. (5)

A GIS provides four basic technical elements, namely data input, data management, data manipulation and analysis, and output.

2.4.1 Data input

Analog information (e.g., hard copy map data) is converted to digital domain by digitization process for GIS input. Methods of data capture are by manual or hard tracing digitizing (e.g., tablet or table digitizers) and automatic digitizing (drum or laser beam scanners). An integral part of both methods is a connected display system

that enables an operator to edit the data for erroneous values and to recapture omissions. Data already in digital form (e.g., satellite images) usually have to be reformatted and scaled to match the geometry of GIS reference map projection.

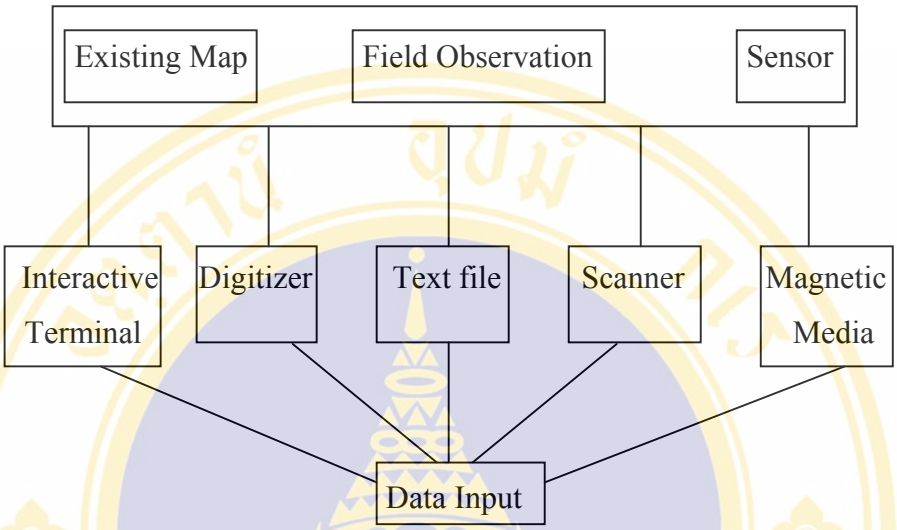


Figure 2.11 Data Input
Source: Burrough (13)

2.4.2 Data Management

Data management is extremely important for the successful and efficient operation of a GIS. The management system consists of a series of computer programs to perform all data entry, storage, retrieval, and maintenance tasks.

2.4.3 Data Manipulation and Analysis

The data manipulation and analysis function determine the information that can be generated by the GIS. A list of required capabilities should be defined as part of the system requirements. In order to determine the way in which the data in a GIS will be analyzed, it is required that the users be involved in specifying the necessary functions and performance levels.

2.4.4 Data output

The output for reporting functions of GIS varies more in quality, accuracy and ease of use rather than in the available capability. Report may be in the form of map, table of values, or text in hard copy (e.g., an electronic file). The function needs are

determine by the users needs, and so, user involvement is important in specifying the output requirements (11)

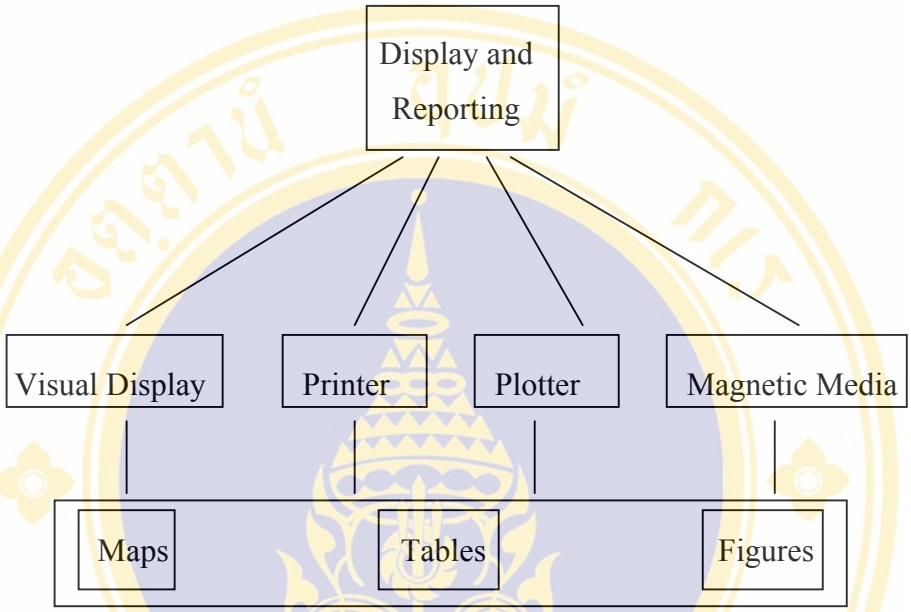


Figure 2.12 Display and Reporting
Source: Burrough (11)

2.4.5 Criteria conducts Evaluation alternatives

Criteria as "regional growth information is used to asses and project the cumulative impacts of changing land use pattern on affected municipalities"(12)

2.4.6 The cost/benefit study.

In comparison cost and benefit in local government with/without GIS for short term, one can use time saved for each mapping activity. But for long term, one can use baseline drawing into two dimension as thousands US$ for Y axis and time period for X axis.

Williame E. Huxhold (1991) have explained "The cost/benefit study of a Geographic Information System is no different from the analysis of cost and benefit of any computer application in local government-the cost of hardware, software, application programs and converting the data to digital form"(15)

2.5 Previous study and reports of GIS and Urban planning

Puttachad Kittipongpattana (16) study "A selection of residential settlement by Geographic information systems: A case study Suphanburi Province" to designed in order to select suitable areas for residential settlement by utilizing factors that influence the development of residential areas. These analysis factors, obtained from documentary reviews and expert consultation, include topography, geology, soil, hydrology, watershed class, hydrogeology, conservation area, existing land use and transportation. The analyses were performed to determine the suitability of each physical-environmental factor analyzed by the experts, and the importance of factors by using statistical techniques. The data were then stored in the computer using a geographic information systems (GIS) program, ARC/INFO, which is capable of storing, organizing, and analyzing the data with an overlay analysis technique in the multiple regression equation ($S=W_1R_1+W_2R_2+\ldots+W_nR_n$). The use of this geographic information system tremendously increases the efficiency in analyzing and updating the data.

Vu Duc Huan (17) study "Application of Remote Sensing and Geoinformation system for evaluating urban development in the Northern Corridor of Bangkok, Pahtum Thani Province" and find the rapid urban growth in most countries has been characterized by significant land use changes in the areas surrounding the cities. The Northern Corridor of Bangkok Metropolitan Region is one example of this. The lack of up-to-date information on trends in land use changes obstruct effective planning in such areas. Multi-sensor data such as Landsat, SPOT, and ERS-1 SAR ERS-1 SAR images and meteorological data were used to monitor the environment change in the "green belt" of Bangkok. Some techniques for data fusion of different sensor imagery are developed and implemented using the SPOT and ERS-1 SAR images. The results of the classification of these images are evaluated by field checks and local land information that provide a satisfactory accuracy of land use identification and monitor the physical development of the region. The research demonstrates a complete approach of combining multi-sensor satellite image with GIS analysis to intensively extract urgently needed information as a powerful tool for regional planners.

Yupayong U-Charoen (18) study "Application of remote sensing and GIS for land cover mapping/changes of mangrove forest: a case study of Koh Lanta, Krabi

province" aims to making a updating mangrove forest cover map and studying environmental changes in Koh Lanta, Krabi during 1990 and 1999 (10 years) by using remote sensing, GIS technique, and field survey

Mubushar Hussian (19) study "Assessment of land use pattern and urban fringe dynamics using remote sensing and Geographic Information System: A case study of Lahor Metropolitan, Pakistan". Hussian (1995) reported The assessment of land use pattern and urban fringe dynamics is very much import and inevitable for planning and monitoring the urban environment, particularly for a metropolis like Lahore. The study is aimed to investigate land use and spatial growth of Lahore Metropolitan with an attempt to explore the application of two emerging technologies of Remote Sensing and Geographic Information System (GIS) for these purposes. SPOT satellite date of 06 May 1986 and 23 Oct 1994 in the form of photo images are used, and an in-depth interpretation and analysis of these images is performed by visual approach. A GIS model prepared to store, manipulate, analyse and presentation of useful information; using satellite data, exogenous data and field surveys (ground truthing) as the input.

Zhang Weimin (20) Study mainly focuses on mapping urban and rural fringe environment change caused by industrialization and urbanization by means of integration of remote sensing techniques and geographic information system (GIS). In this study, the ERS-1 Synthetic Aperture Radar and the Lansat Thematic Mapper data were assessed for single synergistic data (microwave and visible infrared), a visible infrared (VIR) and thermal infrared (TIR) data, a single frequency but milti-track microwave data were evaluated to acquire information contents and capacity of discrimination. The results indicated that the change detection, the integrated multi-sensor (synergistic), muliti-spectral and multi-temporal data with GIS provided more information and higher accuracy than remote sensing data alone, especially single sensor, single frequency. An noticeable results is that thermal infrared band of Thematic Mapper was applied in the land use/land cover mapping by means of Prince Components Analysis which extracted the thermal information and improved the resolution, some specific classes identified due to the contribution of Thermal Infrared band.

2.6 Previous study and reports of Phitsanulok Province

Kotchakon Suponpichit (21) studies the patterns of commercial and service land use in the Phitsanulok Municipality including factors influencing on the patterns. It was hypothesized that the physical factors had more influence on the patterns of commercial and service land use than the cultural factor. Data from documents, maps and interviews of 292-sample size were analyzed in terms of percentage and presented in the form of maps and description. The findings of this study indicated that the patterns of commercial and service land use were expanded along the river and the railroad in the past and along the main roads in the present. From the land use map in 1991, the patterns were according to the multiple nuclei theory. The newly small nucleuses were created far away from the central business district in the past.

Chaichana Seangsaweang (22) study "A study for Guidelines in Land Use Planning of the Phitsanuloke Urban Community" to plan the physical development of Phitsanuloke urban community. Its objective is to study the role and significance of Phitsanuloke urban community, the condition and the problems of land use from the part to date (1974) and its occurring problems, including to study the possibilities and the trend of the future urban expansion by used various techniques , i.e. Geometric & Share Extrapolation for prediction of the population in the future, Shift and Share Analysis and Location Quotient for selecting the leading factors on economic of the province and economic base of community, PSA, SPSS, and Goal Achievement Matrix for selecting the land use alternatives in Phitsanuloke urban community.

Thanee Pak-Uthai (23) study "An application of geographic information system for integrated agricultural development planning in rain fed agricultural area Phitsanulok province" aims to study the agricultural production system, the agricultural production potential, agricultural production problems and selected area potential for crop-animal integrated agricultural development planning. The tool use

in this research is an analysis. The map databases are Agricultural Landuse Map, Soil Suitability for Economic Crop Map, Watershed Map and Provincials Map.

Pirat Tosawat (24) study "The impact study of large scale irrigation project: case study of Phisanulok Irrigation Project" find the Phitsanulok Irrigation Project has changed the pattern of land utilization. The paddy fields can be expanded and farming can be done twice a year. More people want to be farmers, resulting in more land

rental for that purpose. New technology is introduced and accepted. More co-operatives among farmers create the mutual assistance in their profession. The governmental aid is quicker because of the improved transport. Finally, the farmers have the positive attitudes to the irrigation.

However, since the Phitsanulok Project covers the very large area, there is a problem of development inequality. Such inequality has been caused by both of the irrigation engineering system and the management. The latter is the in appropriation in the governmental services, such as the agricultural and co-operative promotion, and the financial credit.

Nattakit Meesiri (25) study "The management guidelines for raft community on Nan Riverside, Muang Phitsanulok" aim to study the organizational make-up of the Nan River Raft Community, its evolution in both economic and social terms as well as how these have interrelated with the Phitsanulok city community. It also was to study current community conditions, problems and their affect on the Nan River environment. Following this analysis, the study provides recommendations for changes and adjustments to the community which will best harmonize with current and future situations.

The research studied the professions, or livelihoods, the raft construction and their utilities and public services provided by the municipal government. Problems they are now facing include disposal of refuse, wastewater and other harmful materials directly in the river. To alleviate these, the local government prepared a location on land to move the community. Still, 133 families living on household rafts remain on the river in the same vicinity. Thus, the researcher studied this raft community to find acceptable means of disposal of human waste and refuse.

Results of this study showed that financial action under the beneficiary pay principle shall cost a family living on a raft an average of 100 bath per month. This money must then be used to solve the problems with proper techniques for collection according to type as well as economics and the raft communities social make-up and lifestyles.

Boonchai ngow (26) study "Development guidelines for the south-west suburb of Phitsanulok due to the expansion of Naresuan University" The result of this study shows the rapid expansion of community in Tha-pho Sub-district due to the policy of

higher education to develop Naresuan University as the education center of the Lower Northern Region. The development of Naresuan University effects to the role and relationship between phitsanulok urban areas and Tha-pho Sub-district, whereas the agricultural suburban areas changed the role to support higher education center of Phitsanulok. The economic activity around the campus was expanded rapidly to serve the university population, such as cafeterias, shops, dormitories etc. It was found that, most of university populations spend money in the area around the campus about 21.61% of the expenditure per month. It is forecasted that in 2007, the agricultural land around the campus will be changed by increasing the commercial areas such as cafeterias, restaurants, shops, dormitories, rented rooms. Naresuan University will increase their population about 26,875 persons and this will induce the population workforce of 4,893 persons in Tha-pho Sub-district. The demand of lands will be 554 rai.

The rapid expansion of community areas in Tha-pho Sub-district caused many problems. The areas was the agricultural land adjustment so it could not development for community growth. The result of this study proposed to support and promote the role of education center of the area and to cancel the status of land consolidation for 2,725 rai to be service areas to support the communities and university expansion in Tha-pho Sub-district. The land in Tha-pho Sub-district are divided into 3 zones; they are medium density residential areas in the core area. The zone around campus should be allocated to be low-density residential areas and the rest to be agricultural areas. Moreover, land regulations are proposed to guide and control community expansion in accordance to community growth, and Phitsanulok Comprehensive plan, including the infrastructure improvement and the environment prevention to support community growth in the future.

CHAPTER 3
RESEARCH METHODOLOGY

The general methodology of "The environmental land use planning for urban expansion: case study Amphoe Muang Phitsanulok" is to apply GIS for land use planning to the study area. With the said objectives, the research methodology consists of the main steps presented in figure 3.1

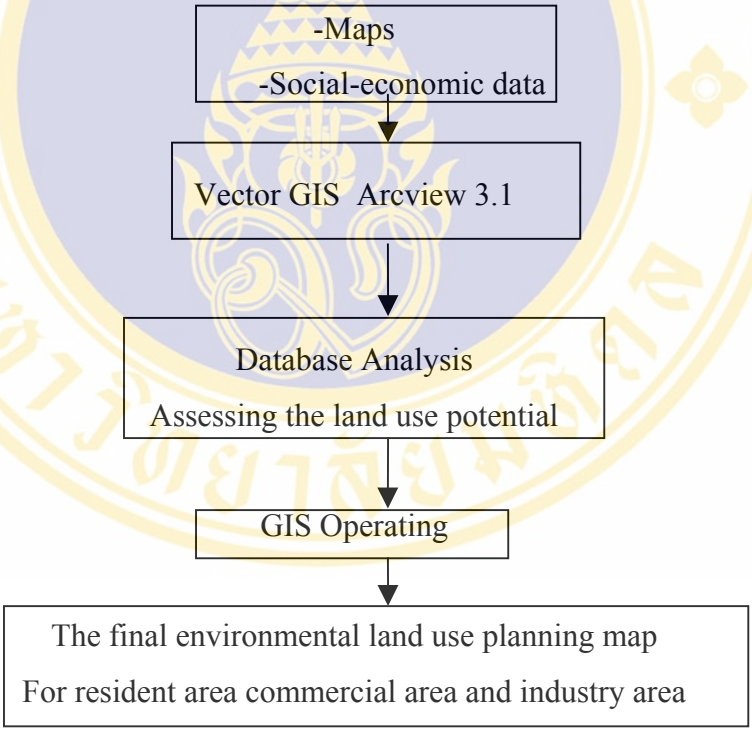


Figure 3.1 Flowchart of general methodology

3.1 Data collection

For purpose of the environmental land use planning for urban expansion: case study Amphoe Muang Phitsanulok, the data requirement should be considered as satellite image and relevant information in term of that study.

3.1.1 Digital data

3.1.1.1 Digital data from data base of Department of Lands Development.

3.1.1.2 Digital data from data base of Bangkok City Planning Department.

3.1.2 Maps

Table 3.1 List of maps

Map	**Source**
Topographic map	Ordnance Surway Department
Drainage system maps	Department of Lands Development
Land value maps	Department of Lands
Road network maps	Municipality of Amphoe Muang Phitsanulok
Soil maps	Department of Lands Development
Master plan for Phitsanulok province	Phitsanulok Urban Planning Department

3.1.3 Documents

3.1.3.1 Reports such as environmental impact assessment of Phitsanulok province, Report of regulation master plan of Phitsanulok province, Report of pollution of Hanoi urban environment.

3.1.3.2 Population growth for Phitsanulok province

3.1.3.3 Strategies in urban development for Phitsanulok province

3.1.4 Software and facilities

3.1.4.1 Software

3.1.4.1.1 Arcview Version 3.1

3.1.4.1.2 Microsoft office 2000, word, Excel

3.1.4.2 Facilities

3.1.4.2.1 PC Thunderbird 1.2 GB

3.1.4.2.2 Digitizer

3.1.4.2.3 Inkjet printer Canon BJC 3000

3.1.4.2.4 Diskette 3.5 inch capacity 1.44 MB

3.2 Factor in this research

3.2.1 Natural Factor

3.2.1.1 Suitable of soil

Suitable of soil is the important factors for determine activity of land of people.

Table 3.2 Suitable of soil

Character of area	Raw score	K	Resident area	Commercial area	Industry area
Suitable area	0	0	2.43	5.86	6
Not suitable area	1	10			

3.2.1.2 Flood Area

Benefit of production and safety of human living is impacted by the flooding condition. During rainy season, flood is hazard for both human living in the inner city and human living offshore Nan River. The minus value was given for whole land use accompanying with consideration of impact.

Table 3.3 Flood Area

Factor	Raw score	K	Weighting		
Character of area		K	Resident area	Commercial area	Industry area
Swamp	0	0	6.86	6.86	6.43
Low land	1	5			
Other area	2	10			

3.2.1.3 Stream

The Buffer of stream was accordance to ability of discharge wasted water and garbage from resident area or some working area as factories, offices, etc. into the stream. (27)

3.2.1.3.1 Length from stream less than 200 m.

3.2.1.3.2 Length from stream between 201- 400 m.

3.2.1.3.3 Length from stream between 401- 600 m.

3.2.1.3.4 Length from stream between 601 – 800 m.

3.2.1.3.5 Length from stream between 801 – 1,000 m.

3.2.1.3.6 Length from stream more than 1,000 m.

Table 3.4 Stream

Factor	Raw score	K		Weighting	
Length			Resident area	Commercial area	Industry area
<200	5	10	7	8.14	8.14
201-400	4	8			
401-600	3	6			
601-800	2	4			
801-1000	1	2			
>1000	0	0			

3.2.1.4 Slope

Slope of land is an importance natural factor to decide to develop settlement area. In the study area, there are five slope ranking that is sorted according to the physical condition. (28)

3.2.1.4.1 Flat or almost lat area that there are slope between 0-5 %

3.2.1.4.2 Undulating that there are slope between 5-10 %

3.2.1.4.3 Rolling that there are slope between 10-15 %

3.2.1.4.4 Hilly or Moderately steep that there are slope between 15-30 %

3.2.1.4.5 Steep that there are slope more than 30 %

Table 3.5 Slope

Factor	Raw score	K		Weighting	
Slope			Resident area	Commercial area	Industry area
0-5	4	10	6	6.29	5.71
5-10	3	7.5			
10-15	2	5			
15-30	1	2.5			
>30	0	0			

3.2.2 Establishment for infrastructure

3.2.2.1 Conservation area

Conservation area is the important area for conservation which does not suitable for develop land for other land use that is forest area, Cultural Heritage and region area.

Table 3.6 Conservation area

Factor	Raw score	K	Weighting		
Conservation area			Resident area	Commercial area	Industry area
Conservation area	0	0	6.57	6	5.29
Land control area	1	5			
Other area	2	10			

3.2.2.2 Built up Area

Built up area is determine from Built area in the study area by used land use map year 2004.

Table3.7 Built up Area

Factor	Raw score	K	Weighting		
Built up area			Resident area	Commercial area	Industry area
0-25	3	10	6	6.14	5.17
26-50	2	6.7			
51-75	1	3.3			
76-100	0	0			

3.2.2.3 Environment

Urban land is need a good environmental and don't have pollution from industry.

Table3.8 Environment

Factor	Raw score	K	Weighting		
Length from industry (m.)			Resident area	Commercial area	Industry area
0-200	0	10	6.29	5.43	6
201-400	1	7.5			
401-600	2	5			
601-800	3	2.5			
> 800	4	0			

3.2.3 Social variable

3.2.3.1 Accessibility

Accessibility to the main road was sorted in accordance of simulation of distance from the main road. Distance of 100 m., 200 m., 300 m., 400 m., 500 m., and over have been used for determining the area by making buffer.

Table3.9 Accessibility

Factor			Weighting		
Length (m.)	Main road		Resident area	Commercial area	Industry area
	Raw score	K	6.57	8.14	6.17
0-100	5	10			
101-200	4	8			
201-300	3	6			
301-400	2	4			
401-500	1	2			
>500	0	0			

3.2.3.2 Commercial district

Commercial district is an important factor for determines land settlement of people because people are wants accessibility to buy goods.

Table 3.10 Commercial district

Factor	Raw score	K	Weighting		
Length from market place (m.)			Resident area	Commercial area	Industry area
<400	8	10	6.86	7.86	5.43
401-800	7	8.8			
801-1200	6	7.5			
1201-1600	5	6.3			
1601-2000	4	5			
2001-2400	3	3.8			
2401-2800	2	2.5			
2801-3200	1	1.3			
>3200	0	0			

3.2.3.3 Elementary School

School is a social factor for education of people and factor for shoot a settlement especially elementary school because it is an education standard of Thailand.

Table 3.11 Elementary School

Factor	Raw score	K	Weighting		
Length from school			Resident area	Commercial area	Industry area
0-200	5	10	6.71	5.86	5.29
201-400	4	8			
401-600	3	6			
601-800	2	4			
801-1000	1	2			
>1000	0	0			

3.2.3.4 Land price

Land price is economy factor for determine settlement because resident area don't want high price of land.

Table 3.12 Land price

Factor					Weighting		
Land price	Commercial area		Resident area and Industry area		Resident area	Commercial area	Industry area
(Baht/m^2)	Raw score	K	Raw score	K			
< 1 0 0 0	0	10	0	10	5.43	8.29	5.57
1000-2000	1	3.3	1	3.3			
2000-3000	2	6.7	2	6.7			
> 3 0 0 0	3		3				

3.2.3.5 Recreation area

Recreation area is a factor for support people to determine resident area. This study is determining the length of resident to public garden: 2.8 km far from small recreation area.

Table 3.13 Recreation area

Factor	Raw score	K	Weighting		
Length from Recreation area			Resident area	Commercial area	Industry area
0-700	4	10	6.29	6.71	5.57
701-1400	3	7.5			
1401-2100	2	5			
2101-2800	1	2.5			
>2800	0	0			

3.3 The factors rating

The factors as rating is very complicated because each factor is not have in the same normalization standard. In this study, the ranting has been using rank between 0-10 that is using formula as follow. (29)

$$P^*ij = \frac{Pij \times K}{Pi}$$

P^*ij = K

Pij = Raw score in Factor j

Pimax = The maximum score in factor i

K = 10

3.4 Weighting Systems

3.4.1 Checklist of Criteria is using ordinal scale.

3.4.2 Cost Benefit Analysis is assessing the benefit and cost of Factor.

3.4.3 Delphi is asked the important of factors from the planner.

3.4.4 Correlation Coefficients is looking for coefficients of each factors.

In this study choose Delphi technique that asked from 10th planner. The value scale of factors weighting is 1 to 10 as follow.

1 = The less important factors

10 = The most important factors

Table 3.14 Weighting of Factor for Resident area, Commercial area and Industry area

Factors	Resident area	Commercial area	Industry Area
Stream	7	8.14	8.14
Environment	6.57	6	5.29
Suitable of soil	5.43	5.86	6
Flood Area	6.86	6.86	6.43
Conservation area	6.57	6	5.29
Built up Area	6	6.14	5.71
Accessibility	6.57	8.14	6.71
Commercial area	6.86	7.86	5.43
Elementary School	6.71	5.86	5.29
Land value	5.43	8.29	5.57
Recreation area	6.29	6.71	5.57
Slope	6.57	6.57	5.86

3.5 Compilation and analysis data of study area.

3.5.1 Rating in this study are divide three levels: low, moderate and high by instead low = 1, moderate = 2, high = 3 and up.

3.5.2 Weighting in this study is considers from weighting which give by 3 professors.

3.5.3 An analysis area study is divide suitable level by use potential survey analysis (PSA). The mathematical aspect of the PSA reflects the relation between measurement of the factors and the weight as following equation:

$$S_k = W_iR_1 + W_2R_{2k} + W_3R_{3k} + \ldots + W_nR_{nk}$$

$$S_k = \sum_{i=1}^{n} W_iA_{ik}$$

S_k = land potential of zone k

W_i = weight representing the importance of factor i

R_{ik} = value of factor i in zone k

Source: Sami refer in Edward J. Kaiser, 1995.(30)

3.6 Overlay function in GIS

Applying overlay function in Arcview 3.1 version did combination between variables. These functions generate to make satisfaction for whole criteria in assessing land use potential in urban planning for Phitsanulok province.

This study were groups land use potential for 3 groups:

3.6.1 The most land use potential

3.6.2 The moderate land use potential

3.6.3 The less land use potential

Table 3.15 Factors that was used for evaluating land use potential.

Factors	Resident area	Commercial area	Industry Area
Stream	*	*	*
Environment	-	-	-
Suitable of soil	*	*	*
Flood Area	*	*	*
Conservation area	*	*	*
Built up Area	*	*	*
Accessibility	*	*	*
Market Place	*	*	-
Elementary School	*	-	-
Land value	*	*	*
Recreation area	*	-	-
Slop	*	*	*

CHAPTER 4
RESULT

The study of "The environmental land use planning for urban expansion: case study Amphoe Muang Phitsanulok" is analysis by use the objective of this study as follow as:

4.1 To study land use pattern change of Amphoe Muang Phitsanulok province between years 1994-2002.

4.2 To select the environmental land use for residential, commercial and industrial area of Amphoe Muang Phitsanulok by using GIS technique

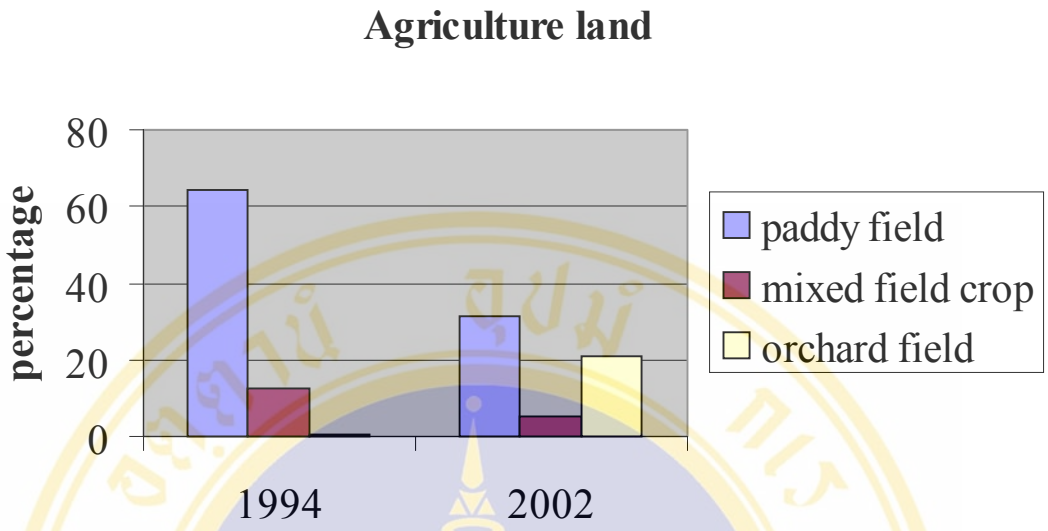
4.1 The result of the study land use pattern change of Amphoe Muang Phitsanulok between years 1994-2002.

4.1.1 pattern change of Amphoe Muang Phitsanulok between years 1994-2002.

From the study land use pattern change of Amphoe Muang Phitsanulok between years 1994-2002 can conclusion as follow:

4.1.1.1 Agriculture land

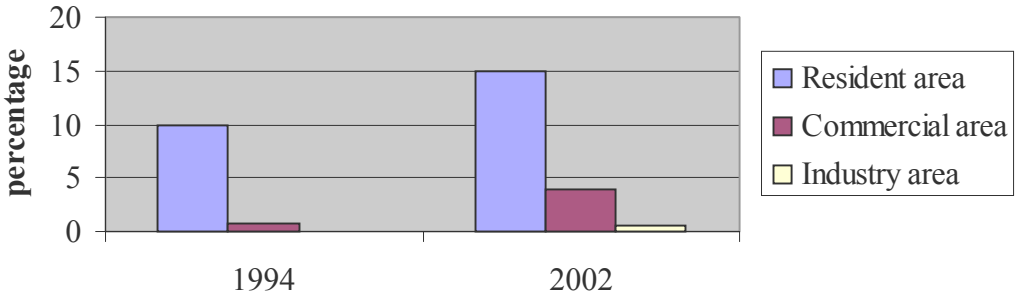
Agriculture lands have 3 classify paddy field, mixed field crop and orchard field from the study the paddy field in year 1994 was 486.92 km^2 (64.17 %) and in year 2002, the area was 249.34 km^2 (32.86 %) decreased 31.31 %. The mixed field crop in year 1994 was 95.71 km^2(12.61 %) and in year 2002 was 40.49 km^2 (5.33 %). The orchard in year 1994 was 5.15 km^2 (0.68 %) and in year 2002 was 21.11 km^2 (2.78 %).



Graph 4.1 Show graph of agriculture land change between years 1994-2002

4.1.1.2 Residential, commercial and industrial area

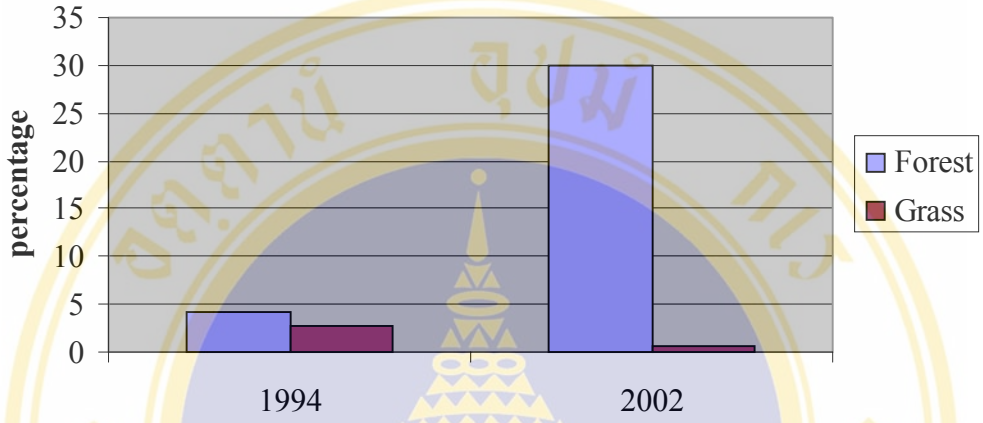
The study showed, in year 1994 the residential areas was 74.70 km^2 (9.84 %). In year 2002, the area was 113.46 km^2 (14.95 %) 38.76 km^2 increased (5.11 %). The commercial area in year 1994 was 5.25 km^2 (0.69 %) and in year 2002 was 29.84 km^2 (3.93 %) 24.59 km^2 increased (3.24 %). For the industrial areas, in year 1994 large industrial area was not found, only small industrial area. In year 2002, the industrial area found to be 0.49 km^2 (0.65%).



Graph 4.2 Show graph of residential, commercial and industrial area change between years 1994-2002

4.1.1.3 Forest and grass

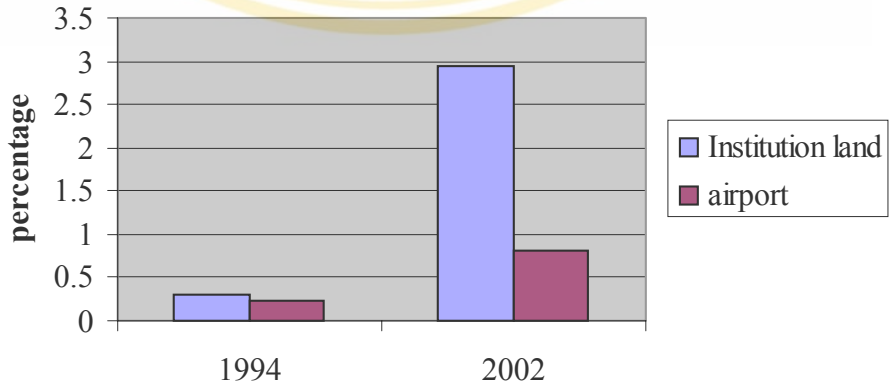
The study showed, in year 1994 forest was 32.36 km^2 (4.27 %) and in year 2002 was 212.05 km^2 (30 %). Grass in year 1994 was 20.97 km^2 (2.76 %) and in year 2002 was 4.19 km^2 (0.55 %).



Graph 4.3 Show graph of forest and grass area change between year 1994-2002.

4.1.1.4 Institutional land and airport

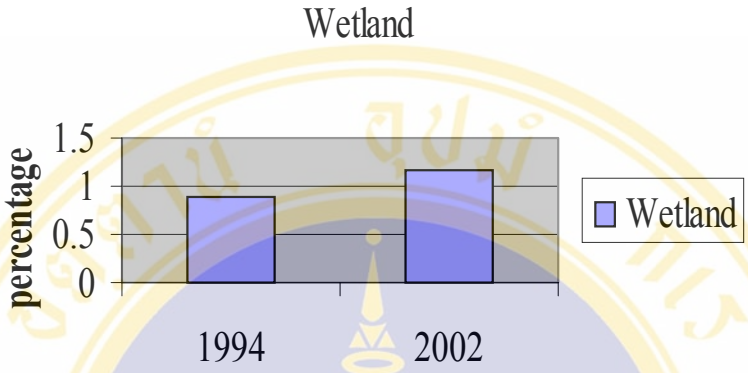
Institutional land is government land and education land. The institutional land in year 1994 was approximate 2.22 km^2 (0.29 %) and in year 2002 was approximate 22.32 km2 (2.94 %). The airport area in year 1994 was approximate 1.83 km^2 or 0.24 % and in year 2002 was 6.06 km^2 (0.80%).



Graph 4.4 Show graph of Institutional land and airport area change between years 1994-2002.

4.1.1.5 Wetland

In year 1994, there are wetland approximate 6.82 km^2 or 0.90 % and year 2002 there are wetland 8.82 km^2 or 1.16 %



Graph 4.5 Show graph of wetland area change between year 1994-2002.

4.1.1.6 Other land use

Other land use are land use that have not in year 1994 as follow as reservoir 0.69 km^2 or 0.09 %, golf course 0.86 km^2 or 0.11% recreation area 1.04 km^2 or 0.14% allocated land project 2.95 km^2 or 0.39%

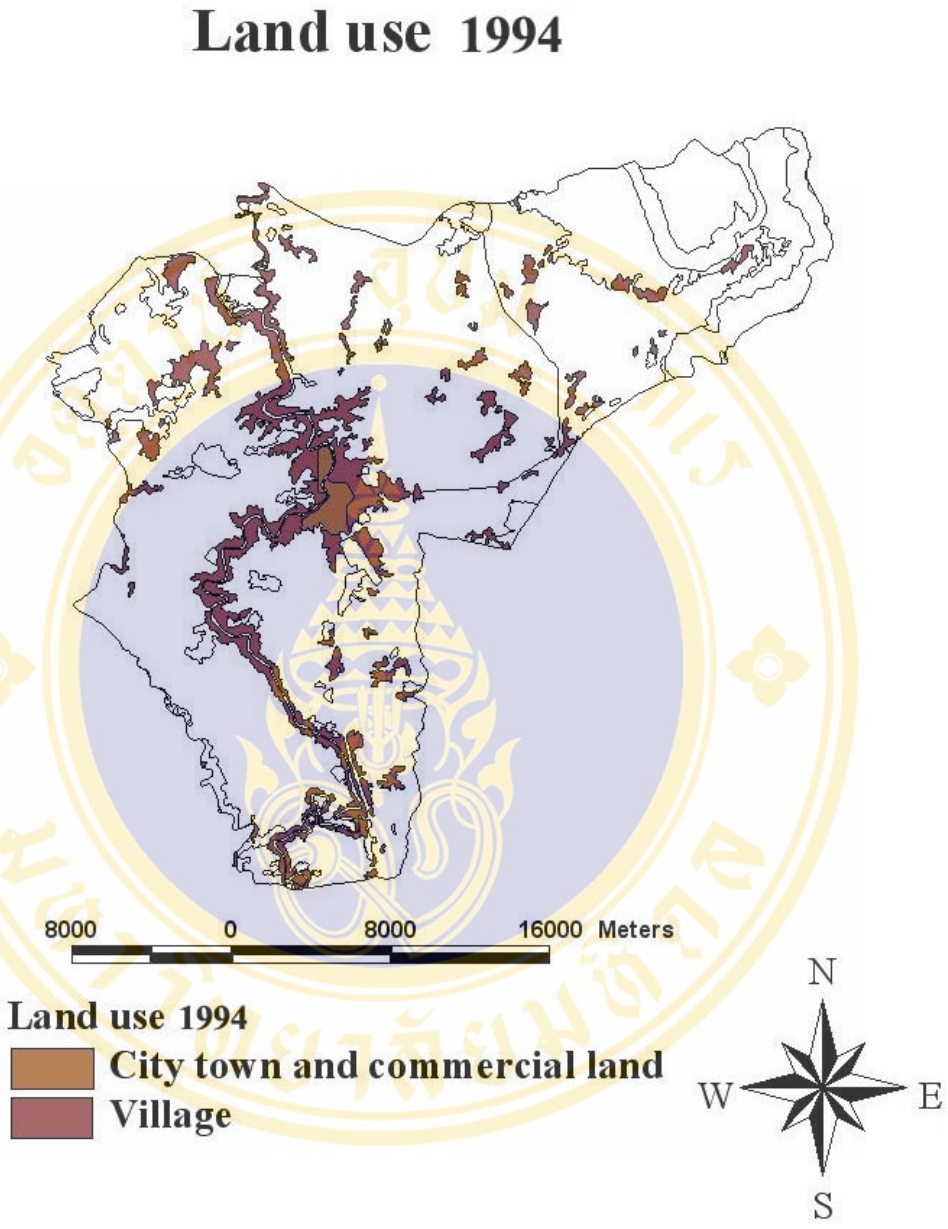


Figure 4.1 Land use of Amphoe Muang Phitsanulok 1994

Source : Department of Lands Development, 1994

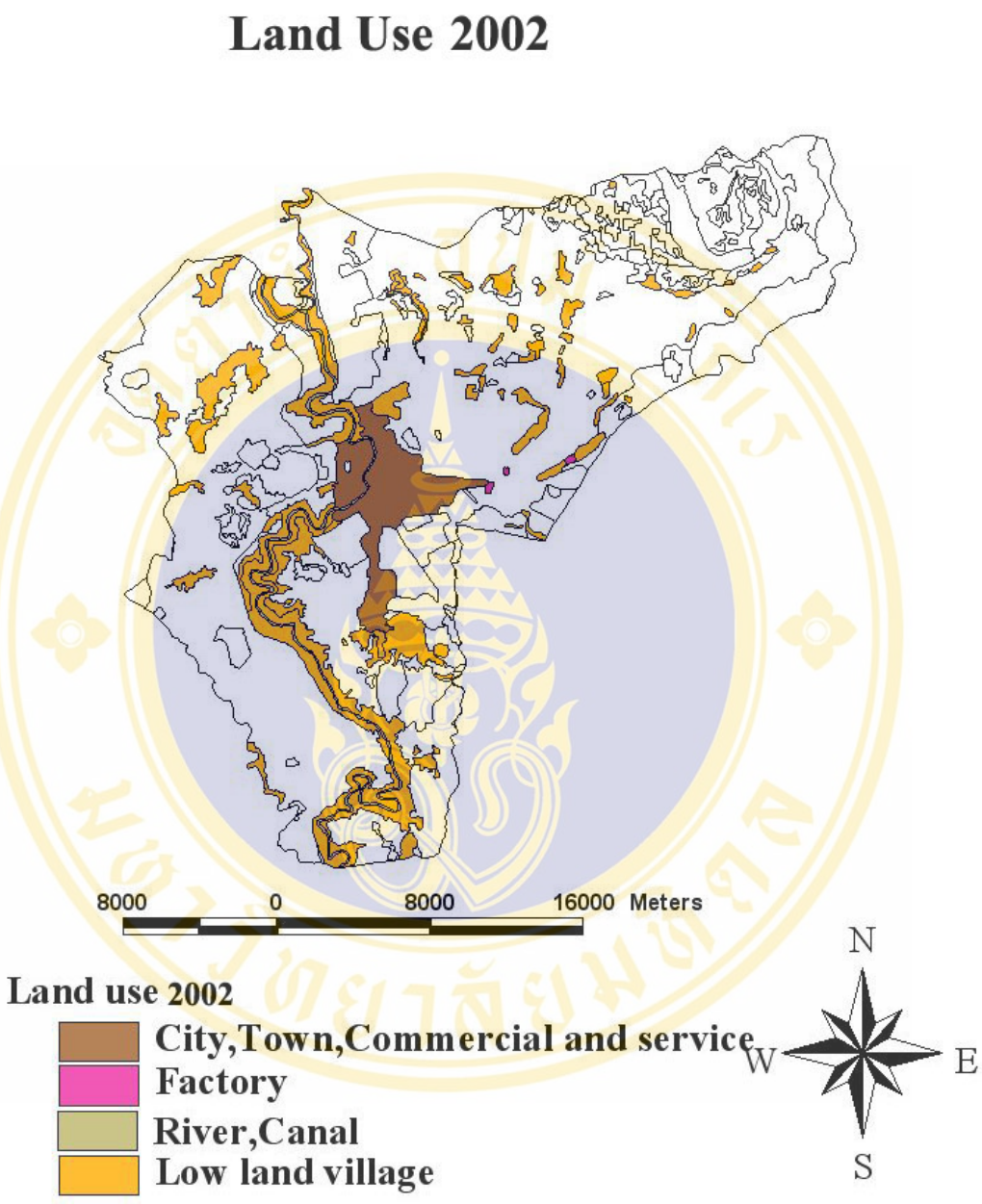


Figure 4.2 Land use of Amphoe Muang Phitsanulok Province 2002

Source : Department of Lands Development, 2002

4.1.2 Urban expansion analysis

4.1.2.1 Trend and direction of the Amphoe Muang Phitsanulok urban expansion.

4.1.2.1.1 Northern area expansion was from Tumbol Nai mueng to Tumbol Hue Roa along Dhammabucha Road and Ekhadhossarot Road, and from Tumbol Nai mueng to Tumbol Play Chum Pol along Chong Faa Road and Wad Taal Road.

4.1.2.1.2 Eastern area expansion was from Tombol Nai Mueng to Tumbol Samor Khae along Mitraphap road. The establishing of industries, Big C and Lotus supercentre might be main affect for community expansion.

4.1.2.1.3 South western expansion was from Tumbol Nai Mueng to Tumbol Aranjik along Chon Ko and Buransiwong.

4.1.2.1.4 Western expansion was from Tumbol Nai Mueng to Tumbol Baan Clong, but this is the less expansion area.

4.1.2.1.5 South western expansion was from Tumbol Nai Mueng to Tumbol Wat Jan, Tumbol Taa Tong and Tumbol Taa Poh along 17th main road, Wang Jan road and Buddhabucha.

4.1.2.1.6 Southern expansion was from Tumbol Nai Mueng to Tumbol Bueng Pra along 1064th main road and Sridhammatripidhok

4.1.2.2 The study of communication network development.

Communications network development would affect to community settle and expansion in Amphoe Muang Phitsanulok because of the communication between closed areas was more comfortable. People would start to move from Naan river coast to settle along Tumbol main road. The roads network development that affect to potential land changing and community settled was as follow

4.1.2.2.1 The 117th main road construction (Phitsanulok – Nakonsawan – Uttradit)

117th main road construction (Phitsanulok – Nakonsawan connected to Uttradit to joint to Myanmar) and increased traffic to 4

lanes road would created Phitsanulok look like gateway connect between Pichit, Nakonsawan and other province in central region included Bangkok and be communication route to Uttradit, Chiang Rai to connected to Myanmar to respond Indochina square project.

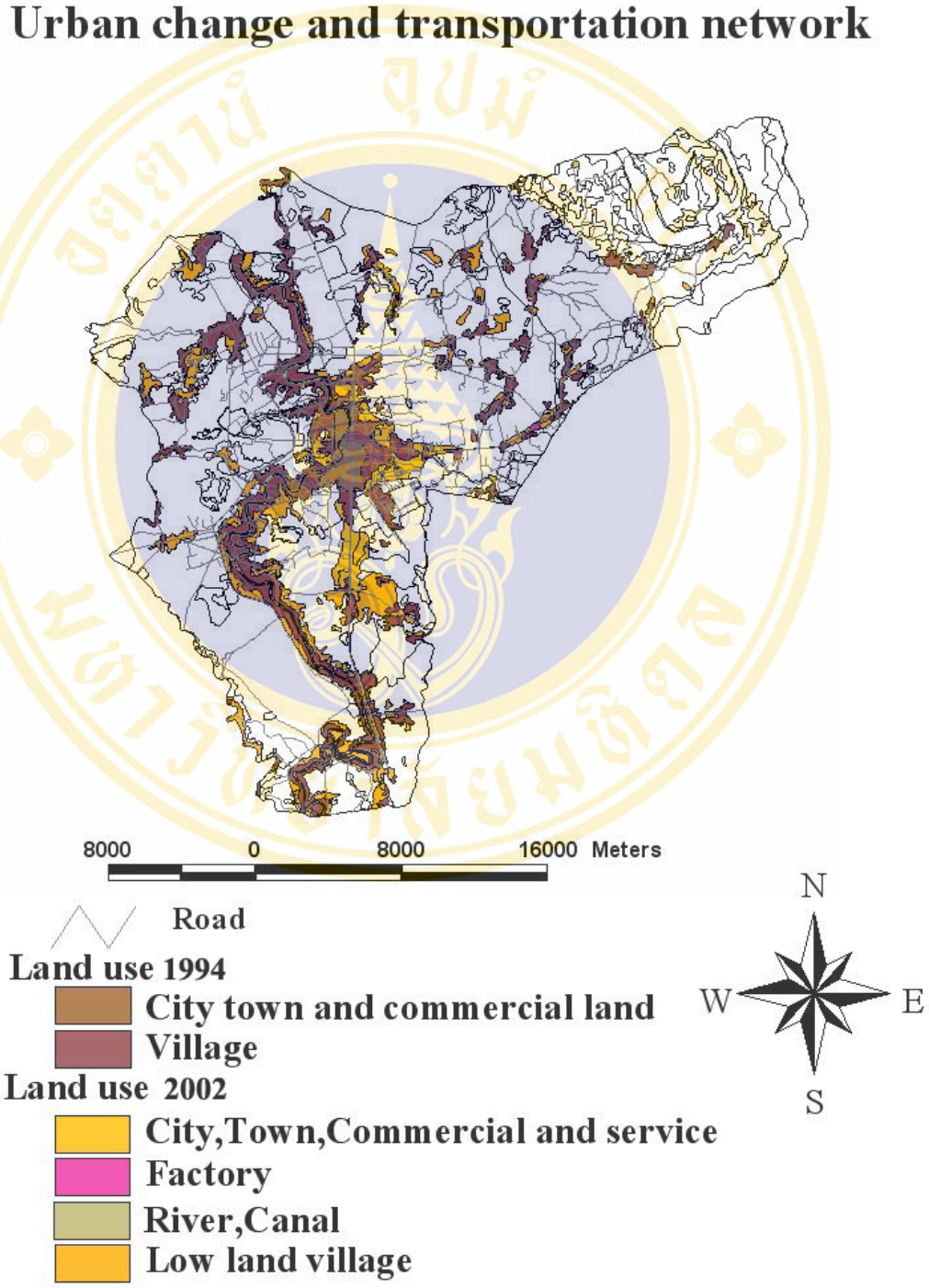


Figure 4.3 Urban change and transportation network map

Source : Bangkok City Planning Department, 2002

4.1.2.2.2 The 12th main road construction (Round about route)

The 12th main road (Round about route) has 2 lanes link 117th main road part through northern part of Tumbol Taa Poh 1 kilometer away in the northern part of Naresuan University through Tumbol Taa Tong, Tumbol Baan Clong, Tumbol Plaay Choom Pol, Tumbol Baan Graang, Tumbol Jom Thong, Tumbol Parg Tok, Tumbol Huo Roa and Tumbol Don Thong connected to Mitraphap road of old 12th main road.

4.1.2.2.3 The 1063rd main road expansion (Pitsanulok-Banggratoom)

The 1063rd main road expansion (Pitsanulok-Banggratoom) connected to Baromtrilokanad that was the important communication route for Pitsanulok community expansion was through Tumbol Taa to Amphoe Banggratoom. At the moment, the 1063rd main road in the area of Pitsanulok city to corner of southern round about route was increased to 4 lanes.

4.1.2.2.4 Pitsanulok-Sukhothai-Taak route expansion

This project would respond to traffic developmental to next to country for communication comfortable.

4.1.2.3 Institution lands developmental

Pitsanulok suburb was a trend to move government centre to suburb areas. The study showed almost of the education institution has a plan to move to suburb area such Pitsanulok Pittayacom school, Piboonsongkram Rajabhat University: Tung talaykaew campus, Pitsanulok technical collage and Naresuan University.

4.2 The result of potentiality analyzed of appropriate area in resident, commercial and industrial area by using environmental factor.

In this research is using Arcview software (Geographic information system program) to overlay all factors and selected factors by using PSA technique to analyzed potentiality of appropriate area in residential, commercial and industrial area by using environmental factor and trend of urban expansion to presented land use plan guideline for Amphoe Muang Phitsanulok (table 4.2).

Table 4.1 The 12th factors of potentiality analyzed of appropriate area in residential, commercial and industrial area.

Factors	Residential area	Commercial area	Industrial Area
stream	*	*	*
Environment	*	*	*
Suitable of soil	*	*	*
Flood Area	*	*	*
Conservation area	*	*	*
Built up Area	*	*	*
Accessibility	*	*	*
Market Place	*	*	-
Elementary School	*	-	-
Land value	*	*	*
Recreation area	*	-	-
Slop	*	*	*

4.2.1 The 12th factors of potentiality analyzed of appropriate area in resident, commercial and industrial area.

4.2.1.1 Natural Factors

4.2.1.1.1 Slop

Slope of land is an importance natural factor to decide to develop settlement area. In the study area, there are five slope ranking that is sorted according to the physical condition.(28) Figure 4.4

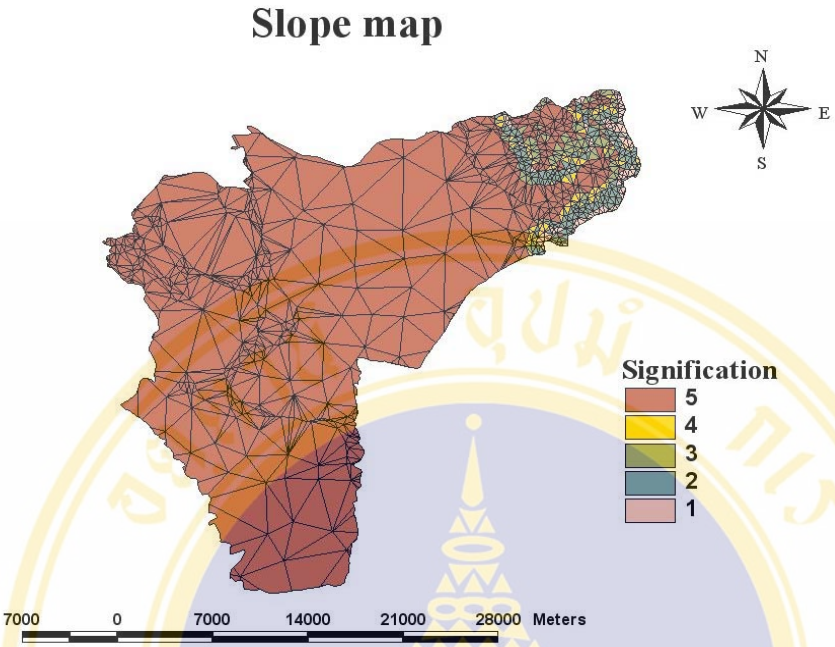


Figure 4.4 Slop map

Source: Department of Lands Development, 2002

4.2.1.1.2 Stream

The Buffer of stream was accordance to ability of discharge wasted water and garbage from resident area or some working area as factories, offices, etc. into the stream. (27) Figure 4.5

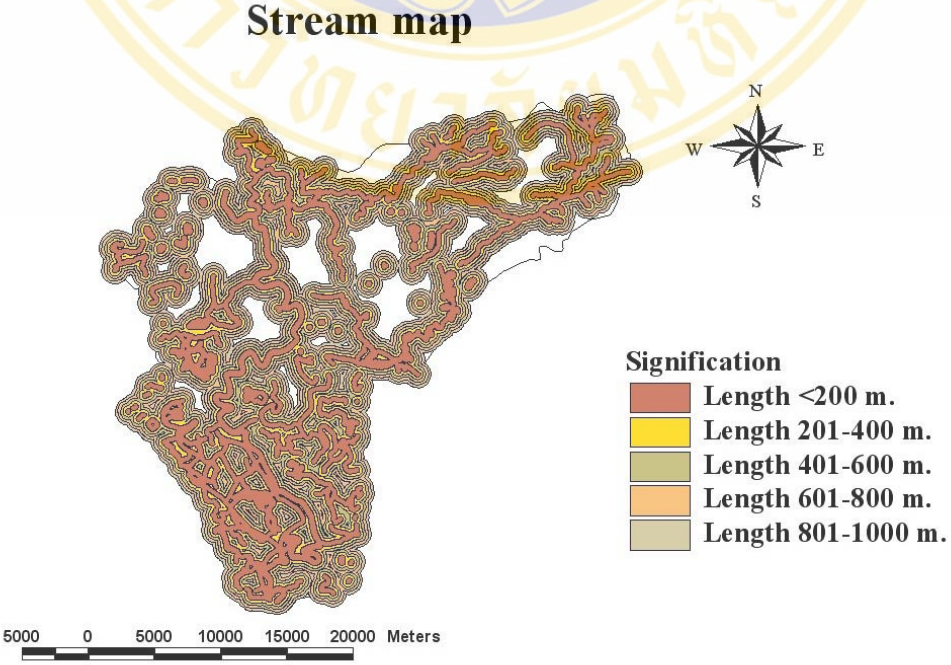


Figure 4.5 Stream buffer map

Source: Department of Lands Development, 2002

4.2.1.1.3 Built up area

Built up area is determine from Built area in the study area by used land use map year 2004. Figure 4.6

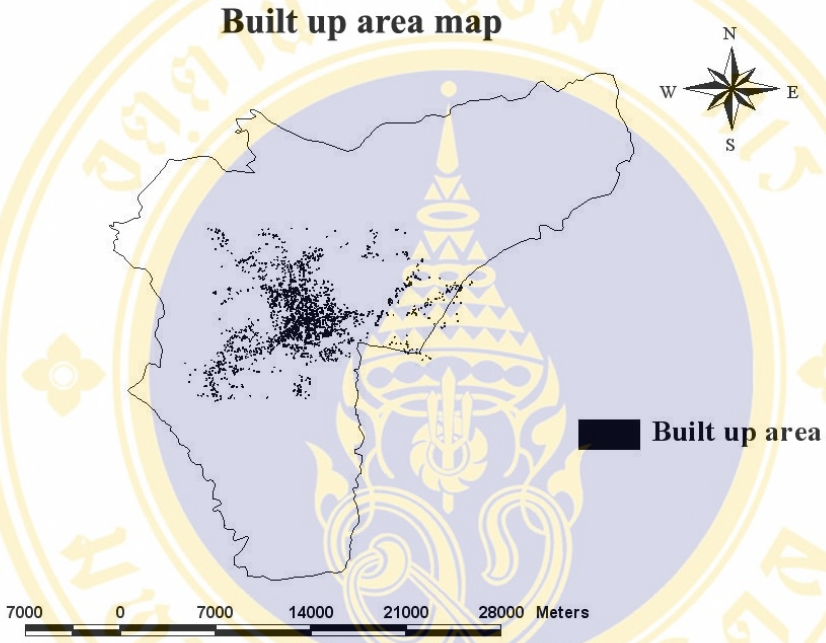


Figure 4.6 Built up area map

Source: Bangkok City Planning Department, 2002

4.2.1.1.4 Suitable of soil map

Suitable of soil is the important factors for people to determine activity of land. Figure 4.7

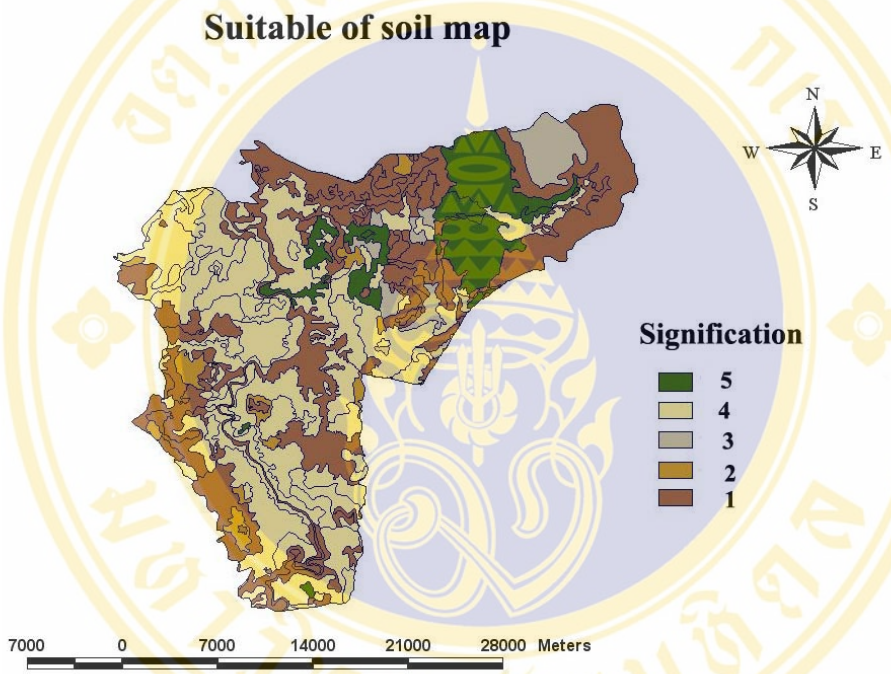


Figure 4.7 Suitable of soil map

Source: Department of Lands Development, 2002

4.2.1.1.5 Conservation area

Conservation area is the important area for conservation which does not suitable for develop land for other land use that is forest area, Cultural Heritage and region area. Figure 4.8

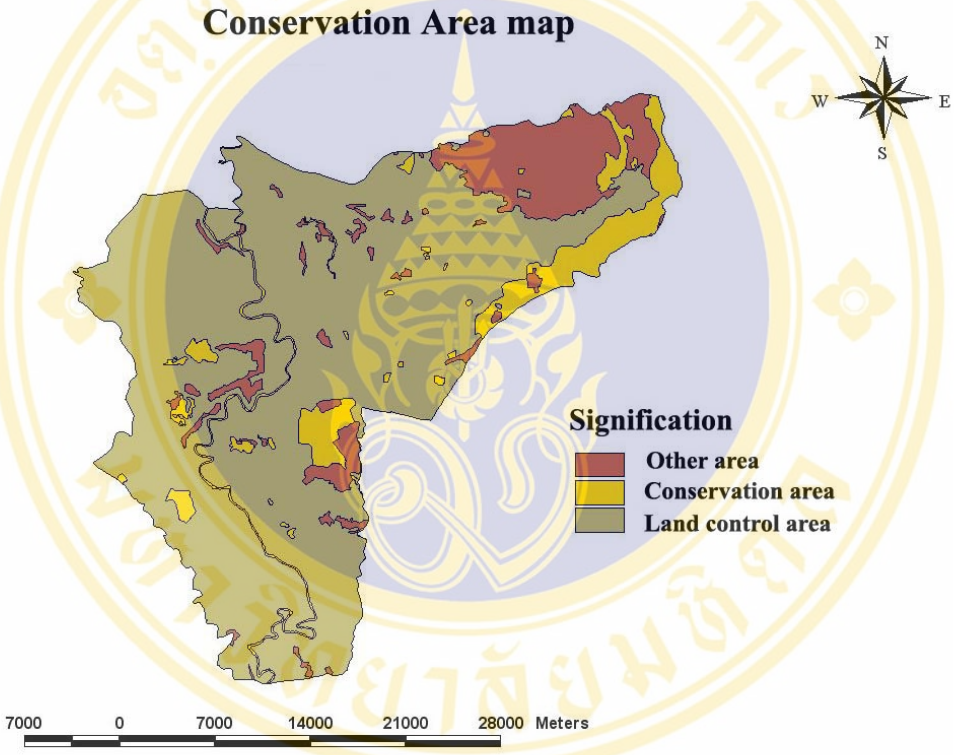


Figure 4.8 Conservation area map

Source: Department of Lands Development, 2002

4.2.1.1.6 Flood Area

Benefit of production and safety of human living is impacted by the flooding condition. During rainy season, flood is hazard for both human living in the inner city and human living offshore Nan River. The minus value was given for whole land use accompanying with consideration of impact. Figure 4.9

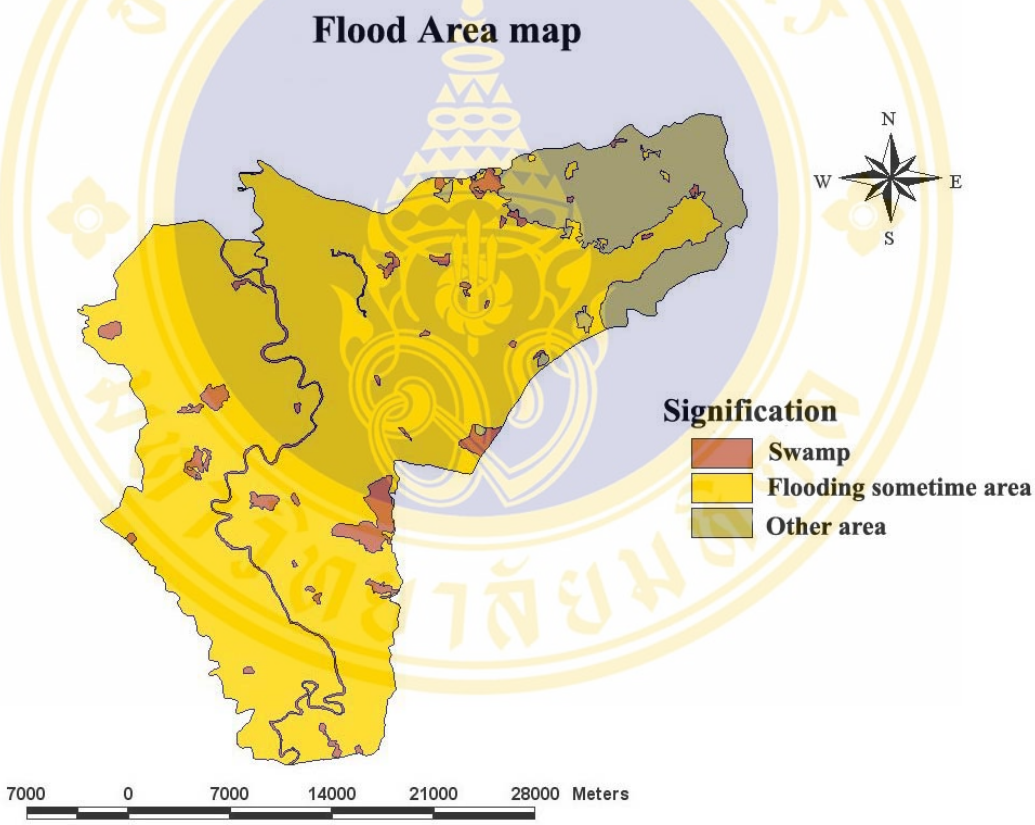


Figure 4.9 Flood Area map

Source: Department of Lands Development, 2002

4.2.1.1.7 Environment factor

Urban land is need a good environmental and don't have pollution from industry. Figure 4.10

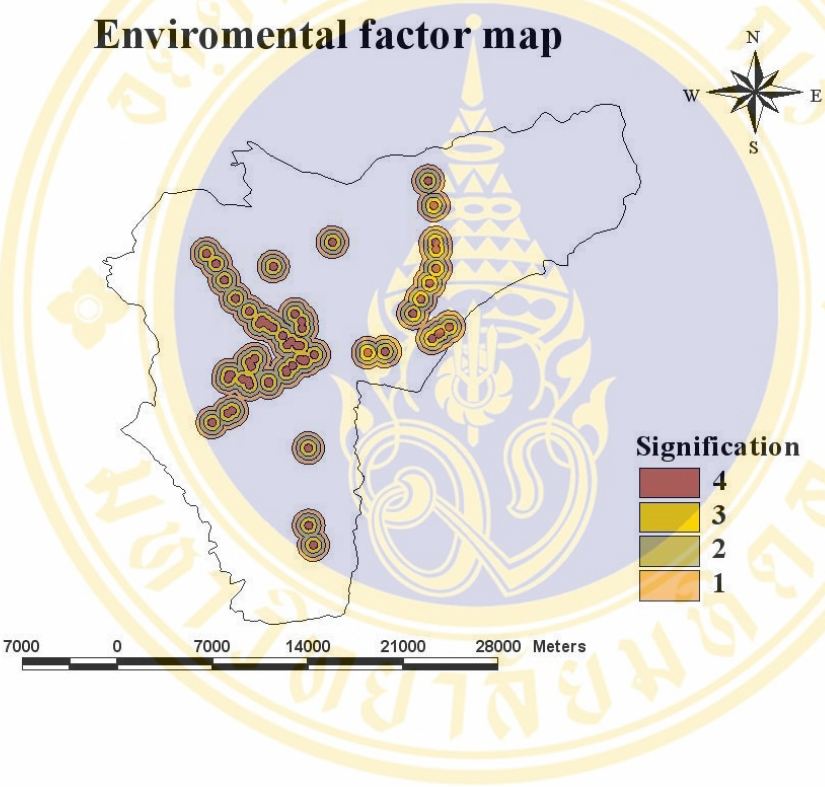


Figure 4.10 Environment factor map

Source: Department of Lands Development, 2002

4.2.1.1.8 Accessibility

Accessibility to the main road was sorted in accordance of simulation of distance from the main road. Distance of 100 m., 200 m., 300 m., 400 m., 500 m., and over have been used for determining the area by making buffer. Figure 4.11

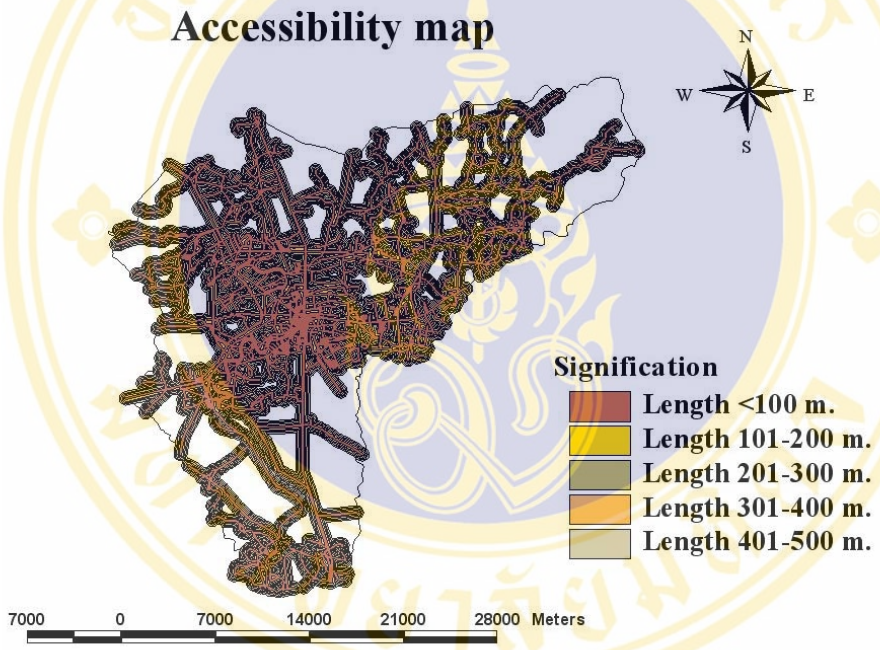


Figure 4.11 Accessibility map

Source: Bangkok City Planning Department, 2002

4.2.1.1.9 Land price

Land price is economy factor for determine settlement because residential area don't want high price of land. Figure 4.12

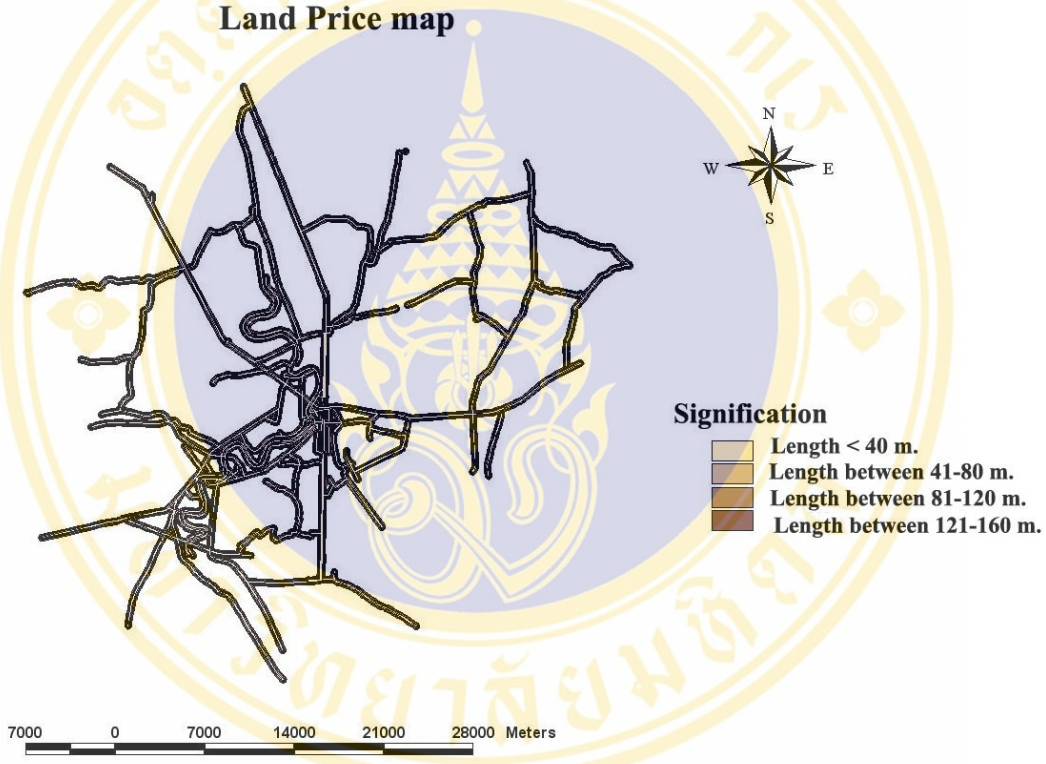


Figure 4.12 Land price map

Source: Department of Lands Development, 2002

4.2.1.1.10 Recreational area

Recreation area is a factor for support people to determine residential area. This study is determining the length of resident to public garden: 2.8 km far from small recreation area. Figure 4.13

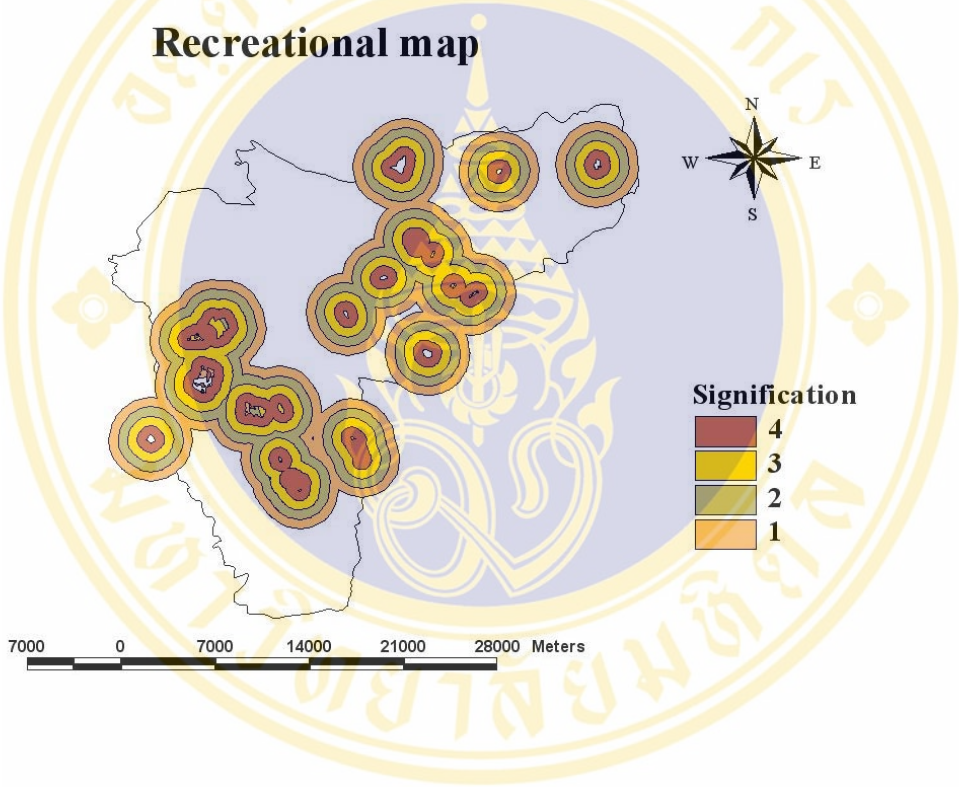


Figure 4.13 Recreational area map

Source: Bangkok City Planning Department, 2002

4.2.1.1.11 Elementary school

School is a social factor for education of people and factor for shoot a settlement especially elementary school because it is an education standard of Thailand. Figure 4.14

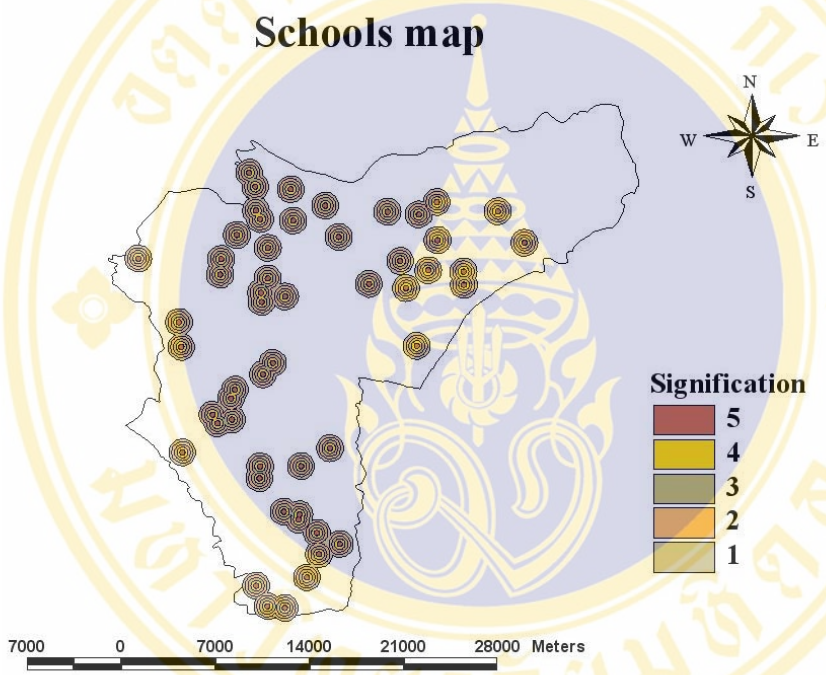


Figure 4.14 Elementary school map

Source : Bangkok City Planning Department, 2002

4.2.1.1.12 Commercial district

Commercial district is an important factor for determines land settlement of people because people are wants accessibility to buy goods. Figure 4.15

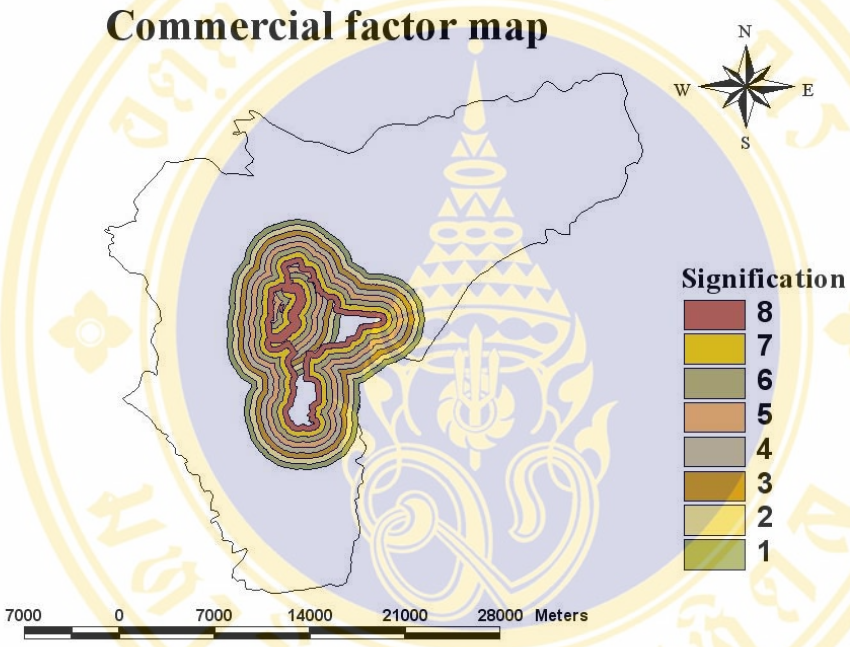


Figure 4.15 Commercial district map

Source: Bangkok City Planning Department, 2002

4.2.2 The result of potentiality analyzed of appropriate area in residential, commercial and industrial area by using environmental factor

4.2.2.1 The result of potentiality analyzed of appropriate area for residential area by using environmental factors.

From selecting the appropriate area for land using in commercial, residential and industrial by using Geographic information system analyzed all 12 environmental factors, Stream, Built up area, Conservation area, Environment, Accessibility, Land price, Recreation area, Elementary School, Slop, Suitable of soil, Commercial area, Flood area and Overly Analysis with Regression analysis. The study is show potentiality of appropriate area for resident area as follow Figure 4.16 and Table 4.3.

Table 4.2 Table of the suitable land use potential level and area of resident area

The suitable land use potential level and area of resident area		
The suitable land use potential level	Area(km^2)	Percentage(%)
The most suitable land use	76.36	10.06
The moderate suitable land use	420.64	55.43
Less suitable land use	261.84	34.51
Total	758.84	100

Figure 4.16 and Table 4.3 show the suitable land use potential of residential area.

The less suitable land use potential of resident area is sign by yellow color that there are 26.184 km^2 (34.51 %) in Tumbol Tha Pho, Tumbol Bung Pra, Tumbol Ban Pa, Tumbol Don Thong and some part of Tumbol Pak Thok and Tumbol Makham Sung.

The moderate suitable land use potential of residential area is sign by grey yellow color that there are 420.64 km^2 (55.43 %) in Tumbol Aranyig, Tumbol Wat Phik, Tumbol Ban Krang, Tumbol Don Thong, Tumbol Pak Thok, Tumbol Bung Pra, Tumbol Phai Kho Don and Tumbol Makham Sung.

The most suitable land use potential of residential area is sign by strong yellow color that there are 76.36 km^2 (10.06 %) along the 12^{th} route in some part of Tumbol Tha Pho, Tumbol Tha Thong, Tumbol Phai chum Phol, Tumbol Don Thong, Tumbol Ban Klong, Tumbol Wat Phik, Tumbol Bung Pra, Tumbol Wang Num Khu, Tumbol Samo-khae, Tumbol Ban Krang and Hua Raw.

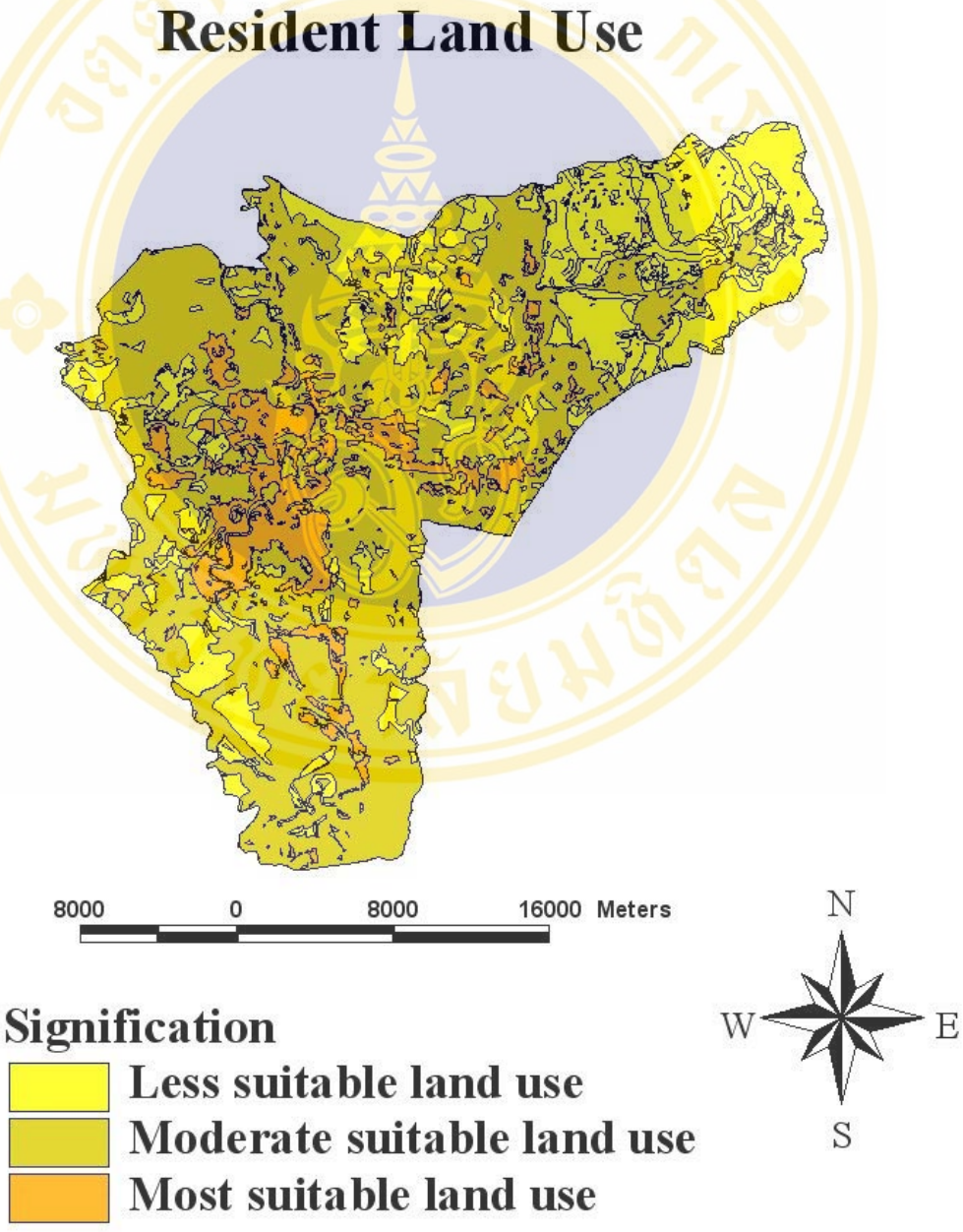


Figure 4.16 The suitable land use potential of residential area.

4.2.2.2 The result of potentiality analyzed of appropriate area for commercial area by using environmental factors.

From selecting the appropriate area for land using in commercial, residential and industrial by using Geographic information system analyzed all 12 environmental factors, Stream, Built up area, Conservation area, Environment, Accessibility, Land price, Recreation area, Elementary School, Slop, Suitable of soil, Commercial area, Flood area and Overly Analysis with Regression analysis. The study is show potentiality of appropriate area for resident area as follow figure 4.17 and table 4.4.

Table 4.3 Table of the suitable land use potential level and area of commercial area

The suitable land use potential level and area of commercial area		
The suitable land use potential level	Area(km^2)	Percentage (%)
The most suitable land use	65.46	8.6
The moderate suitable land use	315.31	41.6
Less suitable land use	378.07	49.8
Total	758.84	100

Figure 4.17 and Table 4.4 show the suitable land use potential of commercial area.

The less suitable land use potential of commercial area is sign by yellow color that there are 378.07 km^2 (49.8 %) in some part of Tumbol Tha Thong, Tumbol Tha Pho, Tumbol Bung Pra, Tumbol Wang Num Khu, Tumbol Don Thong, Tumbol Pak Thok and Tumbol Makham Sung, Tumbol Phai Kho Don, Tumbol Ban Pa.

The moderate suitable land use potential of commercial area is sign by grey yellow color that there are 315.31 km^2 (41.6 %) in some part of Tumbol Aranyig, Tumbol Wat Phik, Tumbol Ban Krang, Tumbol Don Thong, Tumbol Pak Thok, Tumbol Wang Num Khu, Tumbol Phai Kho Don and Tumbol Makham Sung, Tumbol Ban Pa, Tumbol Ban Khlong, Tumbol Tha Pho, Tumbol Tha Thong and Tumbol Hua Raw.

The most suitable land use potential of commercial area is sign by strong yellow color that there are 65.46 km^2 (8.6 %) along the 12^{th} route in some part of

Tumbol Nai Muang, Tumbol Tha Pho, Tumbol Tha Thong, Tumbol Phai chum Phol, Tumbol Ban Klong, Tumbol Bung Pra, Tumbol Aranyig, Tumbol Samo-khae and Tumbol Hua Raw.

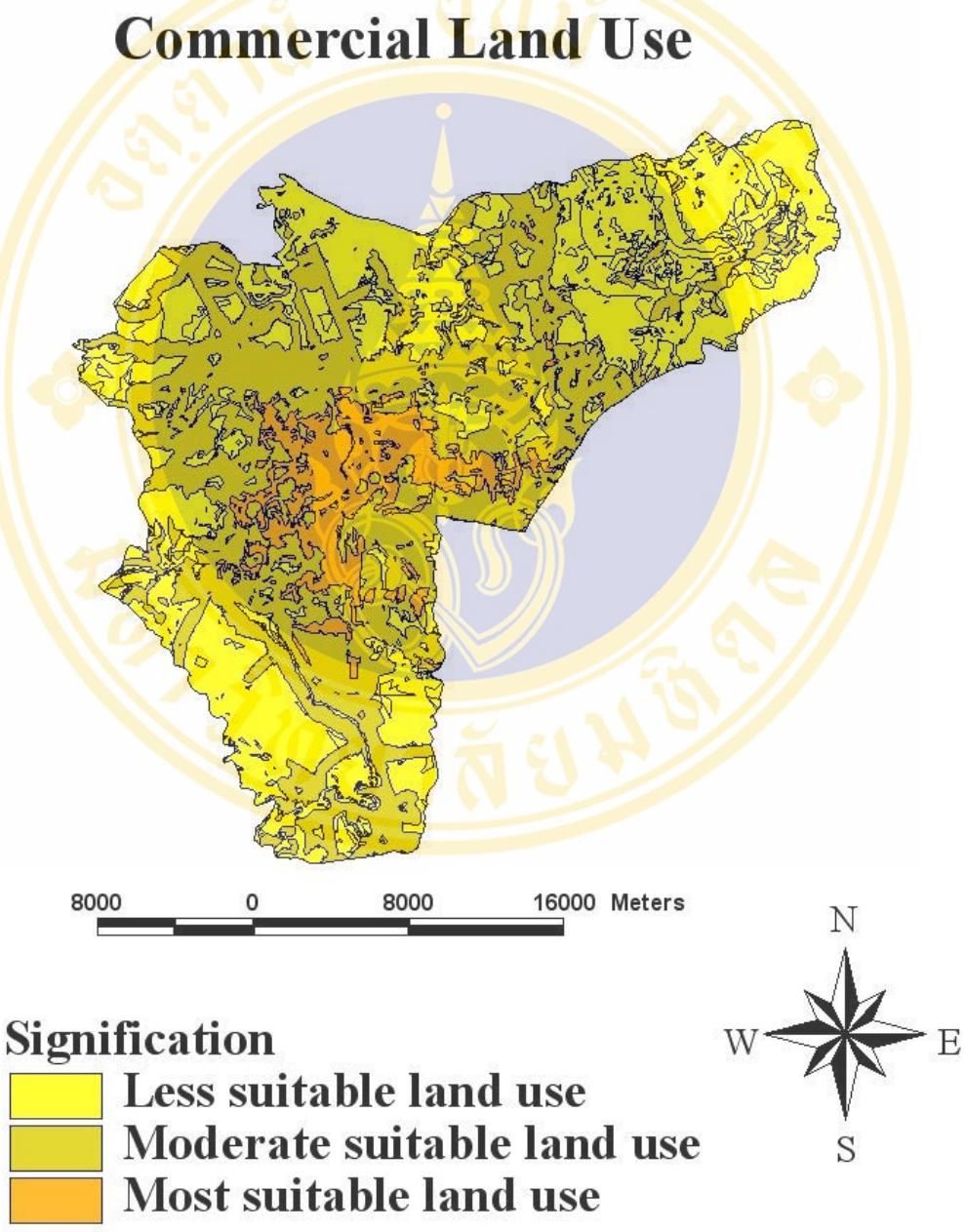


Figure 4.17 the suitable land use potential of commercial area.

4.2.2.3 The result of potentiality analyzed of appropriate area for industrial area by using environmental factors.

From selecting the appropriate area for land using in commercial, residential and industrial by using Geographic information system analyzed all 10 environmental factors, Stream, Built up area, Conservation area, Environment, Accessibility, Land price, Recreation area, Slop, Suitable of soil, Flood area and Overly Analysis with Regression analysis. The study is show potentiality of appropriate area for resident area as follow Figure 4.18 and table 4.5.

Table 4.5 Table of the suitable land use potential level and area of industrial area

The suitable land use potential level and area of industrial area		
The suitable land use potential level	Area(km^2)	Percentage(%)
The most suitable land use	75.72	10
The moderate suitable land use	261.50	34.5
Less suitable land use	421.62	55.5
Total	758.84	100

Figure 4.18 and Table 4.5 show the suitable land use potential of industrial area.

The less suitable land use potential of industrial area is sign by yellow color that there are 421.62 km^2 (55.5 %) in some part of Tumbol Tha Thong, Tumbol Tha Pho, Tumbol Bung Pra, Tumbol Wang Num Khu, Tumbol Don Thong, Tumbol Pak Thok, Tumbol Makham Sung, Tumbol Phai Kho Don, Tumbol Ban Pa, Tumbol Hua Raw and Tumbol Wat Phik.

The moderate suitable land use potential of industrial area is sign by grey yellow color that there are 261.50 km^2 (34.5 %) in some part of Tumbol Aranyig, Tumbol Wat Phik, Tumbol Ban Krang, Tumbol Don Thong, Tumbol Pak Thok, Tumbol Phai Chum Phol, Tumbol Ban Khlong, Tumbol Tha Thong, Tumbol Samoe-khae, Tumbol Ban Pa, Tumbol Bung Pra, Tumbol Chom Thong and Tumbol Hua Raw.

The most suitable land use potential of industrial area is sign by strong yellow color that there are 75.72 km^2 (10 %) along the 12^{th} route in some part of Tumbol Don Thong, Tumbol Tha Thong, Tumbol Samoe-Khae, Tumbol Ban Klong, Tumbol Bung Pra, Tumbol Aranyig, and Tumbol Ban pa.

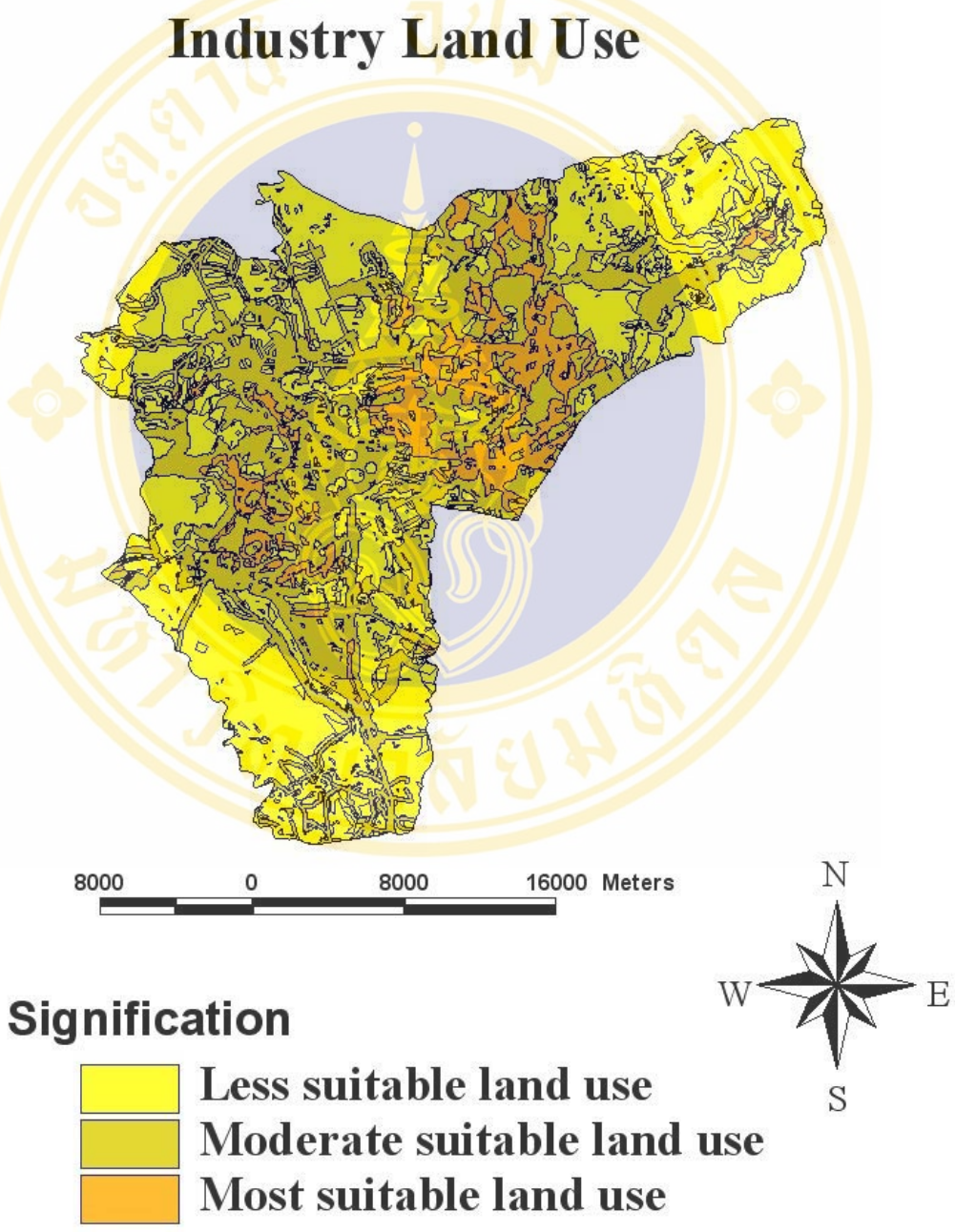


Figure 4.18 the suitable land use potential of Industrial area.

CHAPTER 5
DISCUSSION

The study of the environmental land used planning for urban expansion a case study Amphoe Muang Phitsanulok was analyzed and summarized as follow.

5.1 Urban expansion and land used changed between years 1994 to 2002.

5.2 Land selected using potentiality analysis discussion in residential, commercial and industrial by environmental factors.

5.3 Recommendation for urban planning in study area.

5.1 Urban expansion and land used changed discussion between year 1994 to 2002 was classified as follow

5.1.1 Urban expansion and land used changed analyzing

5.1.2 Communication network analyzing

5.1.3 Institution developmental analyzing

5.1.4 Developmental project and policy analyzing

5.1.5 Currently area issues analyzing

5.1.6 Law limited analyzing

5.1.1 Land used changed analyzing and urban expansion

The study found Amphoe Muang Phitsanulok community rapidly increased because of the increasing of Phitsanulok province economic by the developmental distribution to local region. Phitsanulok province was set to a center of the northern region focus in the southern part and economic hexagon gateway to Indochina. There were many projects support Phitsanulok province to be major city. Those projects would affect to increase the economic and education opportunity to community. However, the old area could not receive all projects. Therefore, education project have to set in the local area of the old community. This affect would change agricultural community to education community. The 758.84 square kilometers land used changing between year 1994 and 2002 could be explained as follow.

5.1.1.1 Land used changed analyzing

5.1.1.1.1 Residential, commercial and industrial area

Because of the centre of the northern region in southern part got project supports from government to increase Phitsanulok province economic. Residential, commercial and industrial areas would increase from communications to be economic and education centre, there would be a moving of labor force, student force and people who were looking for jobs. Therefore, the land used planning would have to be set for community expansion and environmental affect in the future.

5.1.1.1.2 Forest and grassland area

These area were increased because of the new replace forest policy and economic forest farm, farmers would take unused and dead forest to joint the policy.

5.1.1.1.3 Build up area

The most decreased build up area was paddy field, because almost of the old areas in Amphoe Muang Phitsanulok was paddy field. When the city was expansion, some of the paddy field would be changed to other areas such as

accommodation areas. Moreover, paddy field investment did not worth in present day, some farmers changed to do farm crops and plants.

5.1.1.1.4 Institution and airport area

Institution areas included government and education institution. Many students from other areas would come to study in this area. The old institution could not accept all student, thus, education institution area would have to expand to local area.

5.1.1.2 Urban expansion analyzing

5.1.1.2.1 Trend and direction of the Amphoe Muang Phitsanulok community expansion.

The expansion of Amphoe Muang Phitsanulok was the affect of many factors such as economics, communication, government project and education institution expansion. From ten years of the land used expansion, many areas would be needed to support to the community, while the downtown was too crowed and land was too expensive. Therefore the community would have to expand to local areas because of Centrifugal Force.

The study found the continuously expansion of previous downtown in Amphoe Muang Phitsanulok related to communication route both main inner city route and main connection road to closed provinces. These solutions could be considered that the expansion of land using in Amphoe Muang Phitsanulok related to many theory center. The increasing areas in year 1994 consider to years 2002

5.1.1.2.1.1 Northern area expansion was from Tumbol Nai mueng to Tumbol Hue Raw along Dhammabucha Road and Ekhadhossarot Road, and from Tumbol Nai mueng to Tumbol Play Chum Pol along Chong Faa Road and Wad Taal Road.

5.1.1.2.1.2 Eastern area expansion was from Tombol Nai Mueng to Tumbol Samor Khae along Mitraphap road. The establishing of industries, Big C and Lotus supercentre might be main affect for community expansion.

5.1.1.2.1.3 South western expansion was from Tumbol Nai Mueng to Tumbol Aranjik along Chon Ko road and Buransiwong road. Tumbol Aranjik was the second most population follow the Nakon Phitsanulok province council and was the area in specific area of accommodation medium crowed using in year 2000 Phitsanulok province city regulation planed to set square road network to attract continuously community expansion from commercial location and crowed accommodation along 12th main road.

5.1.1.2.1.4 Western expansion was from Tumbol Nai Mueng to Tumbol Ban Khlong, but this is the less expansion area. Because of the connection road in this area was not the main communication road, the economic expansion would be less than other area.

5.1.1.2.1.5 South western expansion was from Tumbol Nai Mueng to Tumbol Wat Chan, Tumbol Tha Thong and Tumbol Tha Pho along 17th main road, Wang Chan road and Buddhabucha road. One area expansion was of Naresuan University and Macro super centre were here.

5.1.1.2.1.6 Southern expansion was from Tumbol Nai Mueng to Tumbol Bung Pra along 1064th main road and Sridhammatripidhok because of this area was the air communication centre of Northern lower region and Soldier area.

5.1.2 Communications network Analyzing

Communications network development would affect to community settle and expansion in Amphoe Muang Phitsanulok because of the communication between closed areas was more comfortable. People would start to move from Naan river coast to settle along Tumbol main road. The roads network development that affect to potential land changing and community settled was as follow

5.1.2.1 Communications network development

5.1.2.1.1 117th main road construction (Phitsanulok province – Nakonsawan – Uttradit)

117th main road construction (Phitsanulok province – Nakonsawan connected to Uttradit to joint to Myanmar) and increased traffic to 4 lanes road would created Phitsanulok province look like gateway connect between Pichit, Nakonsawan and other province in central region included Bangkok and be communication route to Uttradit, Chiang Rai to connected to Myanmar to respond Indochina square project. Because of the 117th main road was shorter than 11th main and 117th main road area in front of Naresuan university was increased to 10 lanes that would help traffic user to connect to community along Naresuan university and Amphoe Mueng Phitsanulok for car increasing.

5.1.2.1.2 The 12th main road construction (Round about route)

The 12th main road (Round about route) has 2 lanes link 117th main road part through northern part of Tumbol Tha Pho 1 kilometer away in the northern part of Naresuan University through Tumbol Tha Thong, Tumbol Raw Clong, Tumbol Plaay Choom Pol, Tumbol Raw Graang, Tumbol Jom Thong, Tumbol Parg Tok, Tumbol Huo Raw and Tumbol Don Thong connected to Mitraphap road of old 12th main road. These constructions help people to travel more comfortable through Phitsanulok province city and next to provinces, because of the traffic expansion. For the Mitraphap road (Old 12th main road) Phitsanulok province-Petchaboon-Kon Khan-Kalasin-Mookdahan was increased to 4 traffic lanes.

5.1.2.1.3 The 1063rd main road expansion (Phitsanulok province-Banggratoom)

The 1063rd main road expansion (Phitsanulok province-Banggratoom) connected to Baromtrilokanad that was the important communication route for Phitsanulok province community expansion was through Tumbol Taa to Amphoe Banggratoom. At the moment, the 1063rd main road in the area of Phitsanulok province city to corner of southern round about route was

increased to 4 lanes to travel more comfortable. The community expansion along this road was accommodation and commercial area which continuously expand from Baromtrilokanart.

5.1.3.2.4 Phitsanulok -Sukhothai-Taak province route expansion

This project would respond to traffic developmental to next to country for communication comfortable.

5.1.3 Institution lands developmental

Phitsanulok province suburb was a trend to move government centre to suburb areas. The study showed almost of the education institution has a plan to move to suburb area such Phitsanulok province Pittayacom school, Piboonsongkram Rajabhat University: Tung talaykaew campus, Phitsanulok province technical collage and Naresuan university. The community expansion trendy from those institutions should be occur in 3 areas, Wat Sa-kud, southern round about intersection across Phitsanulok province-Kratoomban road, where accommodation and shops were increased to service Naresuan university population and Phitsanulok province technical collage students which was 6 kilometers away.

Naresuan University developmental was one main reason to attract accommodation and commercial projects in this suburb area from the number of the increasing student every year because of Naresuan University was the major institution in the Northern lower region. Therefore, the developmental projects would for responding to university population and would affect to the relation of land using, commercial relying and population supported of community and land around the university. Where as the Phitsanulok province land management committee submitted projects to central land evolution committee to ask permission of using 2,745 Rai in this area to be developmental area. Last area was western round about route around Phitsanulok province Pittayacom School and Piboonsongkram Rajabhat University: Tung talaykaew campus, while new community settled to service to education institution as same as around Naresuan University.

The study showed education institution was main major affect to Amphoe Muang Phitsanulok community expansion; especially Naresuan University was the large project that affect to region part, city and suburb community commercial.

The expansion of the institution would affect to the area around the institution. The land change was clear, especially the increasing number of the shops and accommodations which would change from agriculture area to retail shop. Food shop, dormitory, commercial building, and house commercial village, were the affects of the settled of people around the institution. But the institution could not service accommodation and shop to all population. Therefore, community around this area would have to expand to respond physical and commercial need. Those reasons would change agriculture social in Amphoe Muang Phitsanulok suburb area to city community that would push Phitsanulok province government to reform all infrastructure to respond all community need.

5.1.4 Policy and developmental project

The developmental direction of the northern lower provinces group is set to support and relate to the closed province of Phitsanulok province. It is the major city in the Northern Southern developmental group which creates policy and developmental projects to support the major city role. The projects affects the increases of the commercial community role therefore those projects would affect to the increasing of the commercial community role and expansion of around suburb community area because of the city was to crowed and could not received more development.

The study showed Major developmental policy was main affect to Amphoe Muang Phitsanulok community expansion such as Tertiary education expansion in region part, National developmental project such as Indochina square project, that Phitsanulok province would be the centre to develop along main communication route such as 117^{th} , 11^{th}, 12^{th} main road and Northern lower developmental project included other community project such as expansion and improving infrastructure, expansion and moving government institution and education institution to suburb area.

5.1.5 Currently problem in study area analyzing

5.1.5.1 Land used problem

The Amphoe Muang Phitsanulok expansion would rapidly affect the land use increase from agricultural area to a housing commercial village, commercial building, dormitory, food shop, retail shop, golf court, industrial factory etc, and the approval of land management for agriculture use highly increased for the approval of land management for non agriculture use. Those affected will make conflict to land management between building area and agricultural area. The land management regulation does not set the control of the community expansion and the approval of land management. It also did not set the appropriation of land demanding quantity, for the agriculture community expansion that would be rapidly increased the community expansion characteristic is freely, the building expansion would not in order.

5.1.5.2 Basic infrastructure problem

The study showed some communities would have basic infrastructure problem such as area around education institution could not service to community, the dispersion of infrastructure was not constant and adequate to respond the future of community expansion, especially communication sector. Some areas got some communication problem because of some roads were too small and soft, did not improve. Some areas did not have telecommunication systems because did not have telephone line and currently telephone service could not respond all demand.

For electrical service, Phitsanulok province in year 2002 was contain of 1011 village, could use electricity 1,005 village(99.4 percent) the electrical usage number was 189,856, electrical consumption was 557.464 millions units.

For water supply, in year 2002 Phitsanulok province could supply water 3,260 cubic meters, however, for 18,220,908 cubic meters, would supply to water usage 12,884,633 cubic meters, while other 5,336,275 cubic meters would be for publics usage and leaked. The water usage number was 42,724 (31)

For electrical and water supply, the study found almost of the areas could use electricity, but some village could not use water on tab. Those populations

would mostly use water from an artesian well and other reasons were lack of irrigation system and waste water canal maintenance. Because of some areas were controlled by agriculture land management, some infrastructure could not be affectively developed to respond to population.

In the future, when expansion areas was promoted to development area by the order of central evolution committee of regulator and permission of land management for non agriculture. The expansion of community areas would be increase higher than currently expansion, which would affect to the increasing of infrastructure demand. If management committee did not set appropriate plan for community expansion, would take affect to community expansion in the future.

5.1.5.3 Environmental problem

5.1.5.3.1 Waste water

The environmental study in Phitsanulok province found Amphoe Muang Phitsanulok waste water was from 3 places Firstly was community waste water such as from accommodations, shops, dormitories which occurred from washing and cleaning. Secondly was from agriculture such as chemical, anty-weed chemical, inorganic chemical from manure and drug and organic from animal dropping. Thirdly was low quantity water from sediment in water source. The study showed Amphoe Muang Phitsanulok had waste water 57,894 cubic meters per day (28) where in the future when more people were here, the waste water problem would be increased.

5.1.5.3.2 Rubbish problem

The community expansion would make more rubbish from accommodations, shops and other commercial activities. The average rubbish per day per person was 0.89 kilogram, currently Amphoe Mueng Phitsanulok made rubbish 241,068.96 kilograms per day(32), excluding rubbish from shadow population who did not live in area, while Tumbol management organization and council could not manage all rubbish, therefore some community left rubbish near home or some space areas, although Phitsanulok province province set some place rubbish areas, there

were not adequate officer. In the future, Phitsanulok province management organization should set some plan to solve this problem.

5.1.6 Law limitation

In agriculture management area as seen in Figure 5.1, there were some regulations set for agriculture land using which would effect to Tumbol management organization that could not set developmental planning for land management and community expansion because got conflict to law. However, at this moment they were many areas got permission for land management without basic infrastructure planning to response the expansion, which were serious problems for community management and infrastructure service to people who were born in these area, therefore community could not manage the development be efficiency as Figure 5.1. (33)

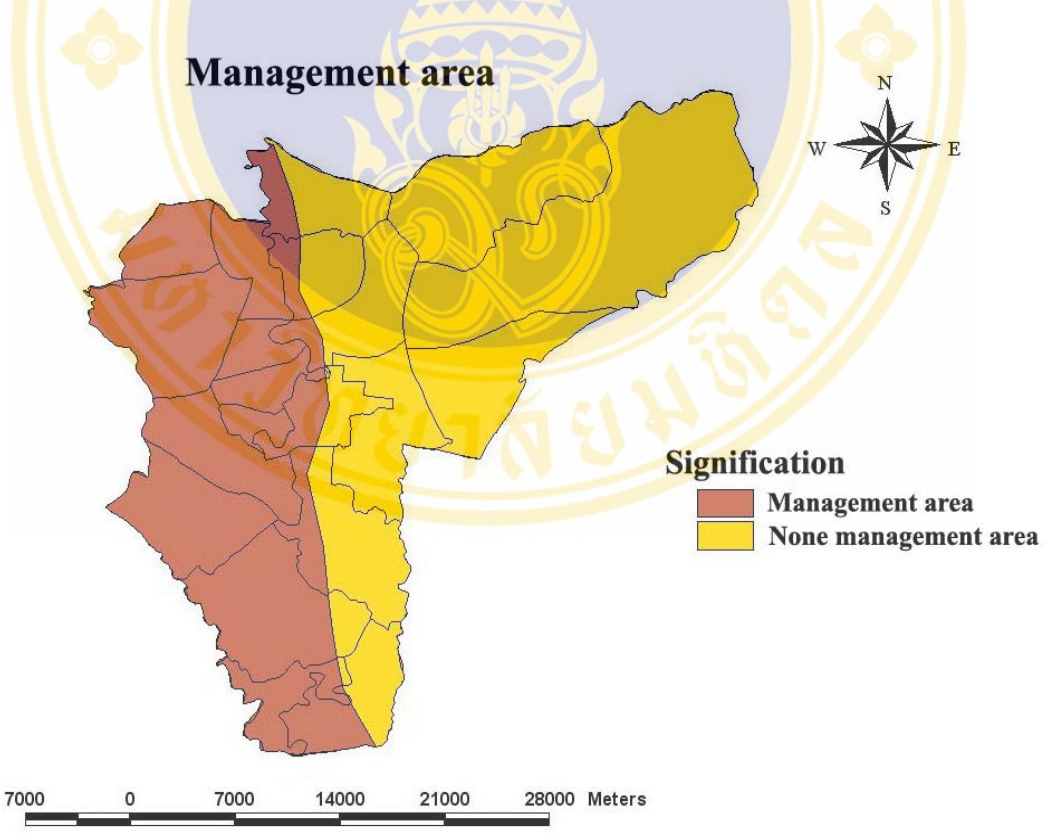


Figure 5.1 Picture of areas in management area

Source : Land Management Division, Department of Lands Development, 2004

Figure 5.2 Picture of Phitsanulok province land management areas (33)

5.2 The result of potentiality analyzed of appropriate area in residential, commercial and industrial by environmental factor.

From selecting the appropriate area for land using in commercial, residential and industrial by using Geographic information system analyzed all 12 environmental factors, Stream, Built up area, Conservation area, Environment, Accessibility, Land price, Recreation are, Elementary School, Slop, Suitable of soil, Commercial area, Flood area and Overly Analysis with Regression analysis. The study shown potentiality of appropriate area for residential, commercial and industrial areas. The appropriate areas were set to 3 level, very appropriate, moderate appropriate and low appropriate. The most appropriate areas analysis was as follow.

These areas were the most appropriate in residential, they were 76.36 square kilometers (10.06 percent) along 12th road in Tumbol Nai Muang, Tumbol Tha Pho, Tumbol Tha Thong, Tumbol Play Choom Pol, Tumbol Ban Klong, Tumbol Wat Prik,

Tumbol Bung Pra, Tumbol Wang Num Khu, Tumbol Hua Raw, Tumbol Smor Khae, Tumbol Raw Krang, Tumbol Don Thong where these area would connect to old community and communication route, especially new communication route and was inexpensive area. The second most area was 420.64 square kilometers(55.43 percent) along roads in Tumbol Aranyig, Tumbol Wang Pikul, Tumbol Wat Prik, Tumbol Raw Krang, Tumbol Hua Raw, Tumbol Wang Num Coo, Tumbol Tha Pho, Tumbol Ban Klong, Tumbol Don Thong, Tumbol Pak Thok, Tumbol Bung Pra, Tumbol Wat Prik, Tumbol Makham Sung, Tumbol Phai Kho Don.

Figure 5.3 Picture of some appropriate accommodation areas in Tumbol Play Choom Pol and Bung Pra

The most appropriate area for commercial using was 65.46 square kilometers (8.6) along 12th road in Tumbol Nai Muang, Tha Thong, Play Choom Pol, Ban Klong,

Bung Pra, Aranyig, Smor Khae, Hua Raw, some parts in Tumbol Tha Pho still connected to old business centre and main road that connected to closed areas.

Figure 5.4 Picture of appropriate commercial areas in Tumbol Ban Khlong and Hua Raw

The most appropriate area for industrial developmental was 75.72 square kilometers (10 percent) along 12th road in Tumbol Aranyig, DonThong, Smor Khae, Raw Paa and some part in Tumbol Ban Klong Tha Thong, Bung Pra Which were far away from commercial and community centre. Moreover, those areas were inexpensive and not to far from communication centre.

Figure 5.5 Picture shown industrial appropriate areas in Tumbol Don Thong and Smor Khae

5.3 Recommendations for study areas development

5.3.1 Study areas development

The study of community expansion and land used, and land management, direction and trend of Phitsanulok province city community shown Phitsanulok province city located in the centre that connecting to regions and had many communication routes connected which made more comfortable to communicate to closed areas.

By considering to Urban Form and city developmental policy from urban policy making concept found Phitsanulok province urban organization set Phitsanulok province development to be Monocentric by set old community centre to be commercial and crowed area for living which were surround by moderate living area and low living area where set outside area of cooperation urban to be local and agriculture areas to protect and secure local environment area.

Because of currently study areas were increased and many areas were not in urban plan and were more expansion trend in the future such as areas around education institutions which did not have developmental planning for community expansion, and some areas were in land evolution regulations. These effects caused developmental infrastructure problems and could not set system in some areas which expansion to fast and caused in order community expansion problem, where if publish those areas to be developmental area, areas expansion would be increased and would have more building in agricultural areas. Developmental controlling for area expansion would support community role be efficiency and could control in order community expansion.

In sum up, developmental proposing areas around Phitsanulok province city should set areas which expanded too fast to be community centre in local areas ready to expand, and could serviced all physical and commercial need to population be efficiency by losing some agriculture areas to respond commercial role and kept appropriate agricultural environmental areas to avoid agriculture invading out of control.

5.3.2 Regulation problems solving

Because of community were not expanded in order, cause infrastructure problems, community got permission to manage land from land management organization in agriculture rules to manage land for other profits which were not agriculture, where were not clear in community expansion control, including land management rules in land management areas for agriculture did not set to prohibit to divide land area and permit to use for accommodation in 1 Rai or less. Moreover, there were not definition of accommodation land used, therefore some people

managed land to sell for accommodation, build accommodation for sell, created dormitory, made industrial factory which required different infrastructure service from agriculture accommodation.

The proposing to cancel land management area in some areas would decreased some conflict problems in area development and made clearly to set community expansion areas and could set infrastructure developmental areas to community requirement, which would effect to help population service. However, some areas in land management areas did not offer to cancel land management areas, they were still controlled by Phitsanulok province land management organization, where these areas should not be permitted to use land for commercial propose, and should set some rules for accommodation land management considering to be single accommodation of agriculture propose to prevent of accommodation land management for commercial propose.

5.3.3 Infrastructure service expansion policy

The study shown expansion areas would have some infrastructure problem, such as roads, water supply, telephone which could not service to all users especially the areas which were not in council area should be improved as follow

5.3.3.1 Road network improvement

Moderate crowded and higher in community areas should propose to set local road network system and improved minor roads surface in Tumbol to make road network lead community expansion to relate for land used planning and major road network including roads which connected to each community by proposing appropriate road projects.

5.3.3.2 Water supply improvement

Water supply system in outside council area service currently was Village water system which could not service all currently and future requirement. The study propose to improve water service by let Tumbol management organization cooperated to region water supply organization to increase water service for cover future community expansion.

5.3.3.3 Telephone service improvement

Community expansion would effect to telephone service requirement which currently was control by telecommunication organization that Tumbol management organization should cooperate for telephone service by rapidly increasing telephone line and service in crowded areas

5.3.3.4 Rubbish management improvement

Rubbish management improvement could be done by let Tombol management organization hired more staffs and trucks including increased rubbish management areas and rubbish bins in crowed areas for avoiding rubbish left over problem. Furthermore, should promote to population to decreased rubbish and separated rubbish types to safe environment.

5.3.3.5 Public transportation expansion

Public transportation expansion could be improved by increasing public transportation lines to cover more areas to make more comfortable for people who lived out side council area.

5.3.4 Environmental problem solving and preventing

5.3.4.1 Environmental pollution maintaining and preventing concept

The most important pollution was waste water from community and dust from road using where in the future when community will increased and there's effects to irrigation and agriculture areas. Therefore, Tumbol management organization and council should promote regulation to prevent left waste water to water resources and cooperate to other organizations to maintain water resources and should set irrigation project in community areas and maintained all old irrigation and promoted regulation to all building areas installed waste irrigation before let that water to water resources.

Dust problem from road used could be solved by promoting local transportation system to decrease road user.

Because of rapidly increasing in community areas would cause to lack of green areas, therefore, entertainment community area should be planed to secure environment and be rest area for all people. The appropriate area for community entertainment could be irrigation boundaries supply, Naan river coast, Rachanok and swamp coast which could be used for protect areas to avoid community areas. Moreover, green area near Naan river coast could be managed in the same time of dam making to prevent the problem of the river bank from Naan river that set in development plan.

CHAPTER 6
CONCLUSION

6.1 The study result

The study of the environmental land use planning for urban expansion: a case study Amphoe Muang Phitsanulok focused in land management of Amphoe Muang Phitsanulok from year 1994 to 2002, and land using potential in residential commercial and industrial. The study set basic factors value and diagrams to show 12 potential factors. They were Stream area, Built up area, Conservation area, Environment area, Accessibility, Land price , Recreation area, Elementary School area , Slop, Suitable of soil, Commercial area, Flood Area. Then use Potential Surface Analysis (PSA) method and analyzed them by Geographic information system (GIS) to find the land management and land used potential. Next, the study used all land used information to create map to show the land used potential in commercial residential and industrial by Arcview program. The result of the study showed as follows.

6.1.1 The study results of the land management and urban expansion from year 1994 to 2002.

The study showed, in year 1994 the residential areas was 74.70 square kilometers (9.84 % of study area). In year 2002, the area was 113.46 square kilometers (14.95 % of study area) 38.76 square kilometers increased (5.11 % of study area). The commercial area in year 1994 was 5.25 square kilometers (0.69 % of study area) and in year 2002 was 29.84 square kilometers (3.93 % of study area) 24.59 square kilometers increased (3.24 % of study area). For the industrial areas, in year 1994 large industrial area was not found, only small industrial area. In year 2547, the industrial area found to be 0.49 square kilometers (0.65 % of study area)

6.1.2 The study result of land used potential for residential areas, commercial areas, and industrial analyzed in environmental factor.

6.1.2.1 By using the Geographic information system to analyze the land used potential from all 12 planning factors found 3 appropriated land levels, highly appropriated level, moderated appropriated level, less appropriated level. The study showed the Geographic information system contained area analyzing ability for decision making and can apply to use in area development planning. These analyzing abilities were more appropriated to the study assumptions than using Manual approach because of it was faster and more comfortable. However, the Geographic information system required properly information, analyzed method and selected factor to response the assumptions.

6.1.2.2 The selected areas from Geographic information system showed the potentiality considering order area for developing. The most potentiality area would be ready for developing. Therefore, the most potentiality area should get priority decision and soon.

6.1.2.2.1 The most residential potentiality area was 76.36 square kilometers (10.06 % of study area) located along the 12th road in Tumbol Nai Muang, Tumbol Tha Pho, Tumbol Tha Thong, Tumbol Phai Chum Pol, Tumbol Ban Khlong, Tumbol, Wad Prik, Tumbol Bung Pra, Tumbol, Wang Num Khu, Tumbol Hua Row, Tumbol Samo-khae, Tumbol Ban Krang and Tumbol Con Tong through the previous community and communication routes, especially new communication routes which were not expensive and connected to the old community, market, schools and other facilities. The second potentiality area was 420.64 square kilometers (55.43 % of study area) located, along roads in Tumbol Arun Yig, Tumbol, Tumbol Wat Prik, Tumbol Ban Grang, Tumbol Hua Row, Wang Num Khu, Tumbol Tha Pho, Tumbol Ban Klong, Tumbol Dong Thong, Tumbol Pak Thok, Tumbol Bung Pra, Tumbol Makham Sung, Tumbol Phai Kho Don, Tumbol Tha Thong

6.1.2.2.2 The most potentiality commercial area was 65.46 square kilometers (8.6 % of study area) located along the 12th road in Tumbol Nai Muang , Tumbol Tha Thong, Tumbol Phai Chum Pol, , Tumbol Ban Klong, Tumbol

Bung Pra, Tumbol Arun Yig, Tumbol Samo-khae, Tumbol Huo row, some part in Tumbol Tha Pho still connect to the previous business center while main road connected to closed area.

6.1.2.2.3 The most potentiality industrial area was 75.72 square kilometers (10 % of study area) located along the 12th road in Tumbol Arun Yig, Tumbol Don Thong, Tumbol Samo-khae, Tumbol Baan Pa, some part in Tumbol Ban Klong, Tumbol Tha Thong, Tumbol Bung Pra which were away from commercial and community area, low cost but not to far away from communication center.

6.2 Recommendation in technical research

6.2.1 The study only focused on influence physical factors of the development areas in residential areas, commercial areas and industrial areas to use as an information and line for development areas in residential areas, commercial areas and industrial areas in Amphoe Muang Phitsanulok. Indeed, other factors such as cooperation of population and the government developmental policy in the selected area should be considered.

6.2.2 Collection data by computer should be reminded the efficiency and correctly of the Geographic information system would depend on the detail, correctly and updating of the data entry. From the study, almost of the potentiality analysis data was not up to date; the result might be different to currently situation. Therefore, all data must be corrected before analyzing. However, the study area was very large and time was limit. The data of the study might be not finely enough.

6.2.3 For the appropriate analyzing of factor and selecting factor by specialist advised, researchers choose to ask urban planning specialist. Therefore, the selected factor would be influenced to urban planning factor. The study result might be likely to urban planning study. For the next study before going to selecting the specialist, researchers should be defined clearly understanding the objective of study. It is very important influent to the result at the end.

6.2.4 Overlay analysis was happened when using 2 data layers to overlay. The new data would get an effect of sliver polygon from 2 lines did not overlay properly. If the silver polygon was less than 1 meter, the study will skip it.

6.2.5 The study might get some mistake data from using computer for importing and managing data because of time limit and equipment limit, such as land price. The study would consider the area along to main roads by taking information from land trading officer and some existing document. Thus, the result might not be correctly enough.

6.3 Recommendation for further research

6.3.1 The study focus in residential areas, commercial areas and industrial areas in Amphoe Muang Phitsanulok. Furthermore, mapping the land using for environment emphasized in physical factors for basic planning area, to study the currently community detail, to encourage applying information technology for urban planning. Moreover, economic factor, social factor and regulation changed should be considered for the future developmental area.

6.3.2 The Geographic information system was the product of science knowledge's, the user should study the system to prevent some problem from the result.

6.3.3 Government should support to use Geographic information system for urban planning to be friendly to environmental area for satisfaction lifestyle of the population in province, Amphoe and Tumbol.

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APPENDIX

Table of weighting for the expertness in the study of urban growth and assessing land use potential for environmental land use planning: a case study Phitsanulok province.

Table A.1 Table of weighting for the expertness

Factors	Full score	Expertness			mean
		First	second	third	
Stream					
Slop					
collecting area					
Suitable of soil					
Flood Area					
Conservation area					
Built up Area					
Accessibility					
Market Place					
Elementary School					
Land value					
Recreation area					

การวิเคราะห์ปัจจัยการใช้ประโยชน์ที่ดินประเภทที่อยู่อาศัย มีการกำหนดค่าคะแนนดิบ การปรับฐาน การให้ค่าน้ำหนัก ของแต่ละปัจจัย ดังต่อไปนี้

1. ความเหมาะสมของดิน (Suitable of soil)

ลักษณะพื้นที่	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
มีสมถรรถนะทางการเกษตร	0	0	2.43
ไม่มีสมถรรถนะทางการเกษตร	1	10	

2. พื้นที่น้ำท่วม (Flood Area)

ลักษณะพื้นที่	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
พื้นที่หนองน้ำหรือมีน้ำตลอดปี	0	0	6.86
พื้นที่อาจเกิดน้ำท่วมขัง	1	5	
พื้นที่อื่นๆ	2	10	

3. แหล่งน้ำ (Stream)

ระยะห่าง	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
<200	5	10	7
201-400	4	8	
401-600	3	6	
601-800	2	4	
801-1000	1	2	
>1000	0	0	

4. ความลาดชัน (Slope)

ความลาดชัน (%)	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
0-5	4	10	6
5-10	3	7.5	
10-15	2	5	
15-30	1	2.5	
>30	0	0	

5. พื้นที่อนุรักษ์ (Conservation area)

พื้นที่อนุรักษ์	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
พื้นที่ควรค่าแก่การอนุรักษ์	0	0	6.57
พื้นที่ที่ควรควบคุมการใช้ประโยชน์	1	5	
พื้นที่อื่นๆ	2	10	

6. พื้นที่อาคารปกคลุมดิน (Built up Area)

พื้นที่อาคารปกคลุมดิน	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
0-25	3	10	6
26-50	2	6.7	
51-75	1	3.3	
76-100	0	0	

7. สภาพแวดล้อม (Environment)

ระยะห่างจากโรงงาน	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
0-200	0	10	6.29
201-400	1	7.5	
401-600	2	5	
601-800	3	2.5	
> 800	4	0	

8. ความสะดวกในการเข้าถึง (Accessibility)

ระยะห่างจากถนน(เมตร)	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
0-100	5	10	6.57
101-200	4	8	
201-300	3	6	
301-400	2	4	
401-500	1	2	
>500	0	0	

9. ย่านธุรกิจ (Commercial district)

ระยะห่างจากย่านธุรกิจ(เมตร)	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
<400	8	10	6.86
401-800	7	8.8	
801-1200	6	7.5	
1201-1600	5	6.3	
1601-2000	4	5	
2001-2400	3	3.8	
2401-2800	2	2.5	
2801-3200	1	1.3	
>3200	0	0	

10. โรงเรียน (Elementary School)

ระยะห่างจากโรงเรียน	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
0-200	5	10	6.71
201-400	4	8	
401-600	3	6	
601-800	2	4	
801-1000	1	2	
>1000	0	0	

11. ราคาที่ดิน (Land price)

ราคาที่ดิน(บาท/ตรม.)	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
<1000	0	10	5.43
1000-2000	1	3.3	
2000-3000	2	6.7	
>3000	3		

12. สถานที่พักผ่อน (Recreation area)

ระยะห่างจากสถานที่พักผ่อน	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
0-700	4	10	6.29
701-1400	3	7.5	
1401-2100	2	5	
2101-2800	1	2.5	
>2800	0	0	

การวิเคราะห์ปัจจัยการใช้ประโยชน์ที่ดินประเภทพานิชกรรม มีการกำหนดค่าคะแนนดิบ การปรับฐาน การให้ค่าน้ำหนัก ของแต่ละปัจจัย ดังต่อไปนี้

1. ความเหมาะสมของดิน (Suitable of soil)

ลักษณะพื้นที่	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
มีสมถรรถนะทางการเกษตร	0	0	5.86
ไม่มีสมถรรถนะทางการเกษตร	1	10	

2. พื้นที่น้ำท่วม (Flood Area)

ลักษณะพื้นที่	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
พื้นที่หนองน้ำหรือมีน้ำตลอดปี	0	0	6.86
พื้นที่อาจเกิดน้ำท่วมขัง	1	5	
พื้นที่อื่นๆ	2	10	

3. แหล่งน้ำ (Stream)

ระยะห่าง	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
<200	5	10	8.14
201-400	4	8	
401-600	3	6	
601-800	2	4	
801-1000	1	2	
>1000	0	0	

4. ความลาดชัน (Slope)

ความลาดชัน (%)	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
0-5	4	10	6.29
5-10	3	7.5	
10-15	2	5	
15-30	1	2.5	
>30	0	0	

5. พื้นที่อนุรักษ์ (Conservation area)

พื้นที่อนุรักษ์	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
พื้นที่ควรค่าแก่การอนุรักษ์	0	0	6
พื้นที่ที่ควรควบคุมการใช้ประโยชน์	1	5	
พื้นที่อื่นๆ	2	10	

6. พื้นที่อาคารปกคลุมดิน (Built up Area)

พื้นที่อาคารปกคลุมดิน	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
0-25	3	10	6.14
26-50	2	6.7	
51-75	1	3.3	
76-100	0	0	

7. ความสะดวกในการเข้าถึง (Accessibility)

ระยะห่างจากถนน(เมตร)	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
0-100	5	10	8.14
101-200	4	8	
201-300	3	6	
301-400	2	4	
401-500	1	2	
>500	0	0	

8. ย่านธุรกิจ (Commercial district)

ระยะห่างจากย่านธุรกิจ(เมตร)	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
<400	8	10	7.86
401-800	7	8.8	
801-1200	6	7.5	
1201-1600	5	6.3	
1601-2000	4	5	
2001-2400	3	3.8	

8. ย่านธุรกิจ (Commercial district)(ต่อ)

ระยะห่างจากย่านธุรกิจ(เมตร)	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
2401-2800	2	2.5	
2801-3200	1	1.3	
>3200	0	0	

9. ราคาที่ดิน (Land price)

ราคาที่ดิน(บาท/ตรม.)	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
<1000	0	10	5.43
1000-2000	1	3.3	
2000-3000	2	6.7	
>3000	3		

10. สถานที่พักผ่อน (Recreation area)

ระยะห่างจากสถานที่พักผ่อน	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
0-700	4	10	6.71
701-1400	3	7.5	
1401-2100	2	5	
2101-2800	1	2.5	
>2800	0	0	

การวิเคราะห์ปัจจัยการใช้ประโยชน์ที่ดินประเภทอุตสาหกรรม มีการกำหนดค่าคะแนนดิบ การปรับฐาน การให้ค่าน้ำหนัก ของแต่ละปัจจัย ดังต่อไปนี้

1. ความเหมาะสมของดิน (Suitable of soil)

ลักษณะพื้นที่	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
มีสมถรรถนะทางการเกษตร	0	0	6
ไม่มีสมถรรถนะทางการเกษตร	1	10	

2. พื้นที่น้ำท่วม (Flood Area)

ลักษณะพื้นที่	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
พื้นที่หนองน้ำหรือมีน้ำตลอดปี	0	0	6.43
พื้นที่อาจเกิดน้ำท่วมขัง	1	5	
พื้นที่อื่นๆ	2	10	

3. แหล่งน้ำ (Stream)

ระยะห่าง	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
<200	5	10	8.14
201-400	4	8	
401-600	3	6	
601-800	2	4	
801-1000	1	2	
>1000	0	0	

4. ความลาดชัน (Slope)

ความลาดชัน (%)	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
0-5	4	10	5.71
5-10	3	7.5	
10-15	2	5	
15-30	1	2.5	
>30	0	0	

5. พื้นที่อนุรักษ์ (Conservation area)

พื้นที่อนุรักษ์	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
พื้นที่ควรค่าแก่การอนุรักษ์	0	0	5.29
พื้นที่ที่ควรควบคุมการใช้ประโยชน์	1	5	
พื้นที่อื่นๆ	2	10	

6. พื้นที่อาคารปกคลุมดิน (Built up Area)

พื้นที่อาคารปกคลุมดิน	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
0-25	3	10	5.17
26-50	2	6.7	
51-75	1	3.3	
76-100	0	0	

7. ความสะดวกในการเข้าถึง (Accessibility)

ระยะห่างจากถนน(เมตร)	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
0-100	5	10	6.17
101-200	4	8	
201-300	3	6	
301-400	2	4	
401-500	1	2	
>500	0	0	

8. โรงเรียน (Elementary School)

ระยะห่างจากโรงเรียน	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
0-200	5	10	5.29
201-400	4	8	
401-600	3	6	
601-800	2	4	
801-1000	1	2	
>1000	0	0	

9. ราคาที่ดิน (Land price)

ราคาที่ดิน(บาท/ตรม.)	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
<1000	0	10	5.57
1000-2000	1	3.3	
2000-3000	2	6.7	
>3000	3		

10. สถานที่พักผ่อน (Recreation area)

ระยะห่างจากสถานที่พักผ่อน	ค่าคะแนนดิบ	ค่าปรับฐาน	ค่าน้ำหนัก
0-700	4	10	5.57
701-1400	3	7.5	
1401-2100	2	5	
2101-2800	1	2.5	
>2800	0	0	

BIOGRAPHY

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