URBAN SPRAWL MEASUREMENT ON SPATIAL FACTOR USING GIS AND REMOTE SENSING APPROACH: CASE STUDY OF RAWANG, SELANGOR DARUL EHSAN, MALAYSIA

BY

KHIN CHO MYINT @ ZAINAB

A dissertation submitted in fulfilment of the requirement for the degree of Master of Urban and Regional Planning

Kulliyyah of Architecture and Environmental Design
International Islamic University
Malaysia

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ABSTRACT

The measurement of sprawl using GIS and Remote Sensing (RS) techniques is an area of interest that has been attracting increasing attention since urban sprawl is one of the contemporary issues of cities all over the world nowadays. This research is an attempt to analyze measurement of urban sprawl using three spatial factors which is land use segregation, leap frog and highway strip. This development characteristic has been analyzed using the approach of GIS and Remote sensing applied on every dimension of urban sprawl which being based on quantitative and qualitative methods. The techniques of Remote Sensing (RS) and GIS-based tool relies on the assumption that sprawl is a multidimensional phenomenon which can be measured only within a multiple indicator approach. The analysis illustrates that the land use segregation has indicated that urban sprawl has mainly taken place in a residential area in the study area. The finding has shown that the pattern of spatial factor which contributes to the urban sprawl in Rawang Mukim. Finally, it can conclude that measurement of the spatial distribution of urban phenomenon with the integration of Remote Sensing (RS) and GIS are useful for implementing and managing the development plan of the future.

ملخص البحث

يعد الزحف العمراني من أكثر القضايا شيوعاً في كثير من مدن العالم في العصر الحديث، وبناءً على ذلك أصبح قياس هذا الزحف باستخدام نظم المعلومات الجغرافية (GIS) والاستشعار (Remote sensing) من المجالات الهامة للباحثين في التخطيط العمراني. يشكل هذا البحث محاولة لقياس الزحف العمراني المتمثل بثلاثة عناصر: الفصل بين استخدامات الأراضي المختلفة، النمو العمراني المتقطع أو الغير متصل، وتصميم الطرق السريعة. تم تحليل العناصر الثلاثة الآنفة الذكر باستخدام نظم المعلومات الجغرافية (GIS) والاستشعار (Remote sensing)، بناءً على فرضية تقول بأن ظاهرة الزحف العمراني ظاهرة متعددة الأبعاد لا يمكن أن تقاس إلا باستخدام مؤشرات متعددة. أشارت نتائج التحليل في هذا البحث إلى أن ظاهرة الزحف العمراني ذات وجود بشكل أساسي في المناطق السكنية الموجودة في منطقة راوانج، ولاية سيلانجور. من أهم نتائج هذه الدراسة هو إثبات فائدة استخدام نظم المعلومات الجغرافية (GIS) بطريقة تكاملية مع نظم الاستشعار (Remote sensing) في مجال تنفيذ وإدارة الخطط العمرانية التنموية للمستقبل.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Urban and Regional Planning.

.....
Norzailawati Bt. Hj. Mohd. Noor
Supervisor

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Urban and Regional Planning.

…….....
M.Zainora Asamawi
Examiner

This dissertation was submitted to the Department of Urban and Regional Planning and is accepted as a fulfilment of the requirement for the degree of Master of Urban and Regional Planning.

…….....
Mariana Bt.Mohamed Osman
Head, Department of Urban
Regional Planning

This dissertation was submitted to the Kulliyyah of Architecture and Environmental Design and is accepted as a fulfilment of the requirement for the degree of Master of Urban and Regional Planning.

.....
Khairuddin Abdul Rashid
Dean,
Kulliyyah of Architecture and
Environmental Design

DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

Khin Cho Myint @ Zainab

Signature……..... Date…….....

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Affirmed by Khin Cho Myint @ Zainab

…… ……

Signature Date

To My Beloved Parents,

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In the name of Allah the most gracious, most merciful, Thanks to Almighty Allah for His guidance, blessings and protection throughout my granting me the opportunity to accomplish this research.

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LIST OF ABBREVIATIONS

ARSM	:	Malaysia Remote Sensing Agency
CBD	:	Central Business District
EEA	:	European Environment Agency
ENVI	:	Environment for Visualizing Images
GIS	:	Geographic Information System
GPS	:	Global Positioning System
GIUS	:	Geospatial Indicate of Urban Sprawl
MMS	:	Multi -Spectral Scanner System
NPP	:	National Physical Plan

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

Urban sprawl has increasingly become a major issue in the global trend towards urbanization. It is faced not only by developed countries but also by developing countries around the world. Urban sprawl refers to a specific form of urban development characterized by low-density, leapfrog, commercial strip development and discontinuity of development (Ewing, 1997; Downs 1999; Galster et al., 2001 and Malpezzi and Guo, 2001). Furthermore, the important characteristics of sprawl include unlimited outward extension of development, dominance of transportation by private automobiles, fragmentation of land use, and large fiscal disparities among individual communities (Burchell, 1998; Downs, 1999 and Brueckner, 2000). According to Ewing (1997), these features accelerate the spatial expansion of metropolitan areas by creating discontinuous land use patterns It is not immediately apparent how all the series of characteristics or attributes can be measured. Over the last decade, there has been a rapid increase in the amount of literatures on the measurement of urban sprawl. This is because urban sprawl, which encompasses multiple aspects of urban spatial development, has been one of the debatable discussions in the field of urban and regional planning. Attempts have contributed to the current debate over its causes, consequences, and policy implications. Some researchers have identified measurable characteristics of sprawl; others have proposed specific indicators of sprawl to characterize patterns of urban sprawl (Brueckner,

2000; Carruthers and Ulfarsson, 2002; Downs, 1999; Ewing, 1997; Galster et al, 2001; Gordon and Richardson, 1997; Peiser,1989; Pendall, 1999).

Understanding the sprawl processes, its dynamics and modelling provide an insight of future growth trends, which is useful for effective resource utilisation and infrastructure planning. Management of urban sprawl entails quantifying the pattern of sprawl and capturing the processes requires analysis of causal driving factors. This requires understanding and visualisation of the consequences of policies, local planning and administration on sprawl, like lack of effective public transport system with varying work-home distances, giving rise to independent motor vehicles and the consequential congestion and spatial expansion. This necessitates integrated spatial factor for measurement of urban sprawl. Thus, it is essential to undertake a study to understand the dynamics of sprawl and evolve a dynamic spatial factor.

1.2 BACKGROUND OF STUDY

Urban sprawl is one of the contemporary issues of cities all over the world nowadays. Urban Sprawl was a major problem in the course of the urban development of the Western countries in the 20th century, most of the urban sprawl is considered to be the expansion of low density accompanied by a series of environmental and socio-economic issues. Across states and cities of Europe and North America, there is a growing awareness and concern about urban sprawl, which has a different background from the cities of Malaysia. It contributes to the inefficient use of land resources, energy and large scale absorption of open space that can otherwise be used more effectively for activities which can contribute to the development of a city. Most authors agree that sprawl is a multidimensional phenomenon. Urban Sprawl can be defined as a condition of land use and states that general approaches to sprawl can be

by aesthetics, efficiency, equity, and environmental aspects (Galster, 2001). It varies in degrees between the developed and the developing world.

The apparent fact of urban sprawl has received extensive attention in the literature for the past. Some empirical and geographical studies for over a decade have shown that sprawl development has detrimental effects on society and costly. However, the factors influencing the development of sprawl are multifaceted and include rapid urbanization, agriculture, industrialization, migration, economic development, income growth, development policy, market failures and population growth. Thus the issue of sprawl is becoming important nowadays.

Urban sprawl has been equated to the natural expansion of metropolitan areas as population grows (Sinclair, 1967; Brueckner and Fansler, 1983 and Lowry, 1988) and to "haphazard" or uncontrolled, uncoordinated and unplanned growth. Urban sprawl can take different forms. The inability to visualize such growth during planning, policies and decision making process has resulted in sprawl that is both unsustainable and inefficient. More often, though, sprawl can be identified in terms of "undesirable" land-use patterns, whether scattered development, leapfrog, strip or ribbon development or it may involve low-density residential developments or so-called "edge cities" (clusters of population and economic activity at the urban fringe) these land use pattern business activity like office buildings, retail and even manufacturing. As different types of sprawl are caused by different factors, different approaches are required to address them. Based on these facts, it is necessary to survey different an aspect of urban sprawl thus gives opportunity to prevent or control the negative effects of that. The majority of the urban sprawl is caused low-density suburban development is a "natural" consequence of rising incomes, technological changes, and low travel costs and high travel speeds (Boyce, 1963 and Giuliano,

1989). The higher the rate of growth in a metropolitan area, the greater the expectations of land appreciation, and the more land will be with held for future development (Lessinger, 1962 and Ottensmann, 1977).

Moreover, it can be clear that sprawl is associated with urbanization whether it takes place in developer developing countries. Many studies have shown that sprawl is more expensive than alternative patterns of development. The spatial patterns of urban sprawl over different time periods, can be systematically mapped, monitored and accurately assessed from satellite data (remotely sensed data) along with conventional ground data (Lata et al., 2001). Mapping urban sprawl provides a "picture" of where this type of growth is occurring, helps to identify the environmental and natural resources threatened by such sprawls, and to suggest the likely future directions and patterns of sprawling growth. Ultimately the power to manage sprawl resides with local municipal governments that vary considerably in terms of willingness and ability to address sprawl issues.

Therefore, remote sensing and GIS can be used separately or in combination for application in studies of urban sprawl. In the case of a combined application, an efficient, even though more complex approach is the integration of remote sensing data processing, GIS analyses, database manipulation and models into a single analysis system (Michael and Gabriela, 1996). The integration of GIS and remote sensing with the aid of models is the technically most advanced and applicable approach nowadays.

1.3 STATEMENT OF PROBLEM

Urban sprawl has become a common problem, and is being faced by both developed and developing countries nowadays. Malaysia is experiencing rapid urbanization which is a result of natural population growth and rural urban migration due to push and pull factors of physical, social, and economic conditions (Ghani, 2000). In addition, sprawl is also the result of the moving of urban populations from major city centers in urban fringe areas due to the changing lifestyle which emphasized spacious, comfortable and environmentally friendly living environment (Burchfield et al. 2006). It is important to forecast the consequences of urban sprawl for land-use planning with an understanding of the pattern, process and causes. Thus, it would require the model to generate possible scenarios of land-use change along with the implications on various indicators to identify the consequences of urban sprawl. Certainly, many of the problems connected with urban sprawl could be avoided by proper planning, such as a total system planning. The problems of urban development are crucial to the future developers and planning authorities. Sprawl generally refers to some type of development with impacts such as losses of agricultural lands, open spaces, and ecologically sensitive habitats in and around the urban areas. These regions lack basic amenities due to the unplanned growth and lack of prior information and forecasts of such growth during policy, planning and decision-making. Therefore, there is a status for, mapping, analyzing and continuous monitoring of the phenomena of urban growth patterns because it is the responsibility of urban administrators, and planners to apply the whole infrastructure and service facilities in a complex urban area. Hence, it is important for research to identify the appropriate spatial factor and sprawl measurement that would influence the land-use changes. Urban sprawl is a relatively

new phenomenon that is spreading at an alarming rate and causing a multitude of serious problems.

1.4 OBJECTIVES

Urban sprawl is one of the main challenges in spatial planning in the 21st century. This research concerned with the study of the GIS and RS approach to spatial factor analysis for urban sprawls. The objectives of this research are:

1) To analyze the spatial factor in measuring land use sprawl by using Remote Sensing (RS) and Geographic information system (GIS).
2) To assess the characteristic of expansion of land use based on spatial factors.
3) To identify the pattern of urban sprawl for Rawang district.
4) To recommend the advance measurement for spatial factor analysis on urban sprawl.

1.5 RESEARCH QUESTIONS

Based on the objectives of the study, a few research research questions have emerged as stated below:

1) What is the pattern of urban sprawl for Rawang Mukim?
2) What are the factors contributing the urban sprawl in the study area?
3) What are the possible limitations of measurement for spatial factor in urban sprawl?
4) What is the attribute analysis of the spatial factors in urban sprawl?

1.6 SCOPE AND LIMITATIONS

The scope of this research confined to studying the measurement of spatial factor on the physical expressions and pattern of sprawl in Rawang district, Malaysia. Indeed, there is no doubt that urban sprawl exists in most of the cities in presently. The patterns of sprawl are being described using a variety of metrics and through visual interpretation techniques Most of the researches have highlighted the classification of the patterns of sprawl and analyses of spatial and temporal changes would help immensely in the planning for proper infrastructure facilities. Patterns of sprawl and analyses of spatial and temporal changes could be done cost effectively and efficiently with the help of spatial such as Geographic Information System (GIS). Currently, most of the towns of the country have little attention in terms of physical expansion and dynamic population growth which create a burden on basic supply of public services and infrastructural developments. Therefore, the study will also highlight positive assess to the characteristic of expansion of land use based on spatial factors and analyze the spatial factor in measure land use sprawl.

The limitation of study usually constricts the scope and the finding of the research. The patterns of urban spatial development are highly complex and require the theoretical and methodological framework. However, this study has some limitations in data collection and time constraint.

1.7 SIGNIFICANCE OF RESEARCH

One of the major impacts of urban sprawl is a shrinking amount of cultivated land through the development of infrastructures and various development projects. Therefore, residential sprawl and land-use/land-cover change studies are important tools for urban or regional planners to consider the impacts that can occur on sustainable urban development of the study area. The results of this study would provide information relevant to contribute in the urban planning processes. Generally, upon completion of the research, it addresses the following significances. It will help the concerned bodies to understand the sprawl/ development of residential units and the rate of continuous land-use/ land-cover change in the study area. This may provide some idea to find appropriate solutions for scattered or non regulated urban residential sprawl and problems of unwise use of land resources. It will provide local engineers, urban planners and policy makers with the necessary information.

1.8 ORGANIZATION OF REPORT

This research study on urban sprawl with spatial factors using GIS and RS approach in Rawang Mukim in Malaysia. Empirically, it analyse the pattern of urban sprawl its characteristic occurred in the study area. Theoretically, this research tests the urban sprawl conceptual framework developed via GIS and RS approaches. Thus, the organization of study basically involves five chapters (Figure 1.1).

Chapter one is the introduction of the research which states background of study, problem statement and scope of the study. Then, it determines the research objectives which lead to research questions. After that, it addresses the significance and limitations of the research as well. Finally, it describes the organization of the study.

Chapter two is a literature review of research which is divided into two main parts. The first part includes the definitions, theories, measurement concepts of urban sprawl. The second part, introduce an over view of spatial factor and Geographical Information System (GIS) and Remote Sensing (RS). This stage includes a deeper understanding of the software program used to carry out the analysis. The Geographical Information system (GIS) studies in depth to achieve the objectives of the study by using the modern methods in urban sprawl. An intensive literature review of books, articles, newspaper and internet were the main source of materials.

Chapter three describes the research methodology with a detailed description of data collection and data analysis used to achieve the research objectives and answer the research questions. Thus, this stage comprises a study area of the Rawang district and the data gathered from the field survey of the study area to identify the urban sprawl pattern.

Chapter four is the discussion on the analysis and findings of urban sprawl. This stage includes the analysis and presenting the output generated by ENVI software and Geographical Information system (GIS). This entails the documentation of the data analyzed, explanation of the output and the organization of the information. The output was then being represented to show the potentials and limitations of Geographical Information system (GIS) and Remote Sensing (RS) application in spatial pattern of urban sprawl analysis. Finally, the results are represented in the form of maps showing area of urban sprawl based on the finding.

Chapter five provides a summary of the whole research and draws conclusions based on the key findings. It further presents the achievement of the study and recommends areas for future studies. This last chapter is followed by appendices and references used for the research. The recommendations were drawn according to the