ASSESSMENT OF URBAN DEVELOPMENT AND LANDUSE CHANGES' IMPACT ON THE ENVIRONMENT: A CASE STUDY OF URBAN DEVELOPMENT IN KLANG VALLEY REGION, MALAYSIA

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Abstract

The increasing demand for housing, employment opportunities, institutions and other urban facilities and services due to migration of rural and town's dwellers to urban centres leading to drastic changes of urban land covers is believed to be the main factor contributing to the degradation of environmental qualities, namely the increase in temperature, geohazard occurrences, as well as noise, air and water pollution in urban areas. Analyses using various GIS functions were carried out to illustrate the relationship between urban development as well as land use changes and the degradation of environmental qualities in Klang Valley Region. This paper will look into the impact imposed by urban development and land use change upon the trend of environmental quality described earlier.

1.0 INTRODUCTION

The framework for urban development and management can be viewed as a complex system, changes in one area e.g intensification of use or changes in management practice will often lead to change and pressure elsewhere. As such, the need to consider environmental issues in planning and policy-making is of greater concern today considering the impact imposed by development. Environmental impact due to development and urban growth has since act as a check and balance in achieving the so called 'sustainable development'. In generic term, sustainable urban and regional development connotes 'sustainable human settlement' requiring the need to adopt innovative planning strategies and to guide urban and region/rural development along sustainable path, a concept emerged from the Rio Conference, 1992 (The Earth Summit) particular under Agenda 21 which calls for a planned approach to resource conservation and pollution control[1]. Such environmental planning system deal with the environmental implications of sectoral policies which integrate spatial economic planning and environmental protection as well as coordinate policies at different levels of planning. This has set the need for an integrated information system to provide rapid and substantive assessments over the growth of an area, be it at the regional or local level.

This paper provides a brief overview on how GIS has been applied in the assessment of land uses changes and environmental quality status as well as defining the interelatedness and impact one has on the other through development and application of analyses models, with references to urban development in Klang Valley Region, Malaysia.

2.0 GIS APPLICATION IN MONITORING LAND USE CHANGE AND ENVIRONMENTAL QUALITY

New planning theories adopting a continuous, cyclical system approach based on the identification of needs and goals, the evaluation of alternative courses of actions and monitoring of adopted programs requires planning to improve its ability to use information system. Up-to-date reliable information is therefore needed at regional and local level to facilities administrative procedures, policy planning and plan implementation. The advent of Geographical Information System (GIS) has created a large field of opportunity for the development of new approaches to the computer processing of geographically referenced data obviously needed in supporting decision-making processes. Hence, a more effective solution to various spatial-related problems including those associated with planning matters can be achieved.

2.1 GIS DATABASE DESIGN AND DEVELOPMENT OF APPLICATION MODULES FOR KLANG VALLEY REGION

Klang Valley, located in the central part of the west coast of Malaysian Peninsular, covers an area of about 2826 square kilometers. The region comprise the Federal Territory of Kuala Lumpur and four other neighbouring districts namely Gombak, Hulu Langat, Petaling and Klang. It is considered as the most developed and fastest growing region in the country. This has faced the region with the most serious urbanisations and environmental problems, made worse by the tremendous impact on the uncontrolled development caused by the boom in the last two decades. Most of the urban growth were accommodated by outward expansion from the existing inward city centre. However the new urban areas outside the city centre were usually subjected to serious land use problems such as urban sprawl and scattered development, conflicted land use, squatters and slum housing development, inadequate network facilities, land shortage, inevitable high land prices and consequently leading to environmental quality degradation. These problems could just only be realised long after their effects have taken place. The main contributing factor to the existence of the these problems is the lack of information to aid the monitoring of that situation.

Meant as a tool to assist in addressing issues and problems mostly location dependent, as well-integrated and comprehensive database have been designed and developed regionally to support ten main application modules namely built-up area, green and recreational area, traffic and urban transportation, squatter and low cost housing, utilities and community services, industrial and commercial development, population and socioeconomy, environment, as well as two new applications i.e tourism and geohazards. In order to achieve the requirements of these database development, 12 elements of data have been prepared comprising base maps, administrative boundary, physical characteristics, land development, population and socioeconomy, environmental quality, traffic and urban transportation, green and recreational areas, public amenities and utilities, tourism and geohazards. These elements made up a total of more than a hundred cartographic layers. (**Fig. 1**). An easy and friendly user interface was also developed to facilitate the use of the database applications. The whole system was named the GIS Application for Klang Valley Region (AGISwlk).

AGISwlk started with the gathering of information required for the applications development. The data acquired from various sources including digital topographical maps and aerial photographs from the Department of Surveying and Mapping of Malaysia (JUPEM), existing digital files of different mapping packages produced by various agencies, Landsat Thematic Mapper imageries obtained from the Malaysian Centre for Remote Sensing (MACRES), hardcopy maps and plans from various local authorities, reports of land development and statistics mostly from the districts' Town and Regional Planning Units as well as field survey observations[2]. Hardcopy maps had to be digitized, corrected for errors and transformed into the adopted coordinate system and map projection (Rectified Skew Orthomorphic projection). Digital information in formats including MapInfo, AutoCAD, AutoDesk World, ReGIS and many others was transformed to conform to the ARC/INFO NT format earlier decided as the primary GIS package in developing the database and hence for the manipulation and analysis of data. Data entry was carried out using various methods such as table and screen digitizing, scanning, the use of existing digital data and image processing. The ARC/INFO approach (georelational concept) is employed in AGISwlk implementation due to its capabilities in storing, manipulating and analysing spatial data effectively. Attribute data gathered from various sources such as reports, site surveys, digital data in multiple formats as well as raw data is adapted to the standard format and stored in a relational database management system (RDBMS), INFO which has the ability to relate to other database.

2.2 DATA MANIPULATION AND SPATIAL ANALYSES

Working in a GIS environment for the urban development control and monitoring at regional level forces analyst to think more about the nature of the underlying data model, and hence what questions are sensible to ask of any given data set. The analyst can browse the content of the database and selectively view any particular area of interest. Once the area is identified, various types of GIS spatial analysis can be performed which among others include[3]:

i. feature extraction, record selection, record updating and calculation;
ii. information retrieval, classification and measurement;
iii. map overlay;

iv. neighbourhood search;
v. connectivity and network analysis.

A very important requirement, which is common in every application module, is the data-to-analysis matrix. This matrix defines exactly what data layers are required to solve a problem at hand through a certain analysis model. **Table 1** shows an example of this matrix, i.e. for monitoring the trend of land use change while **Figure 2** represents one of the associated model used to get the solution.

Table 1: The data layers that have been used in the various land use analyses

NO.	ANALYSIS \ DATA LAYERS	BUILT UP AREA 1998	BUILT UP AREA 1996	BUILT UP AREA 1994	BUILT UP AREA 1990	BUILT UP AREA 1988	LAND USE 1999	LAND USE 1998	LAND USE 1996	LAND USE 1994	LAND USE 1990	LAND USE 1988	PROPOSED LAND USE IN STRUCTURE PLAN	PROPOSED LAND USE IN PERSPECTIVE PLAN	GREEN AREA	GEOHAZARD	RIVER	SLOPE	DEVELOPMENT SCHEME	ADMINISTRATIVE BOUNDARY	ROAD	PUBLIC FACILITIES & UTILITIES
1	Changes of Land Use 1988 - 1998							X	X	X	X	X								X		
2	Changes of Built Up Area 1988 - 1998	X	X	X	X	X														X		
3	Analysis on Exsiting Land Use Compared to the Proposed Land Use in the Structure Plan						X						X							X		
4	Analysis on Exsiting Land Use Compared to the Proposed Land Use in the Perspective Plan						X							X						X		
5	Analysis of Development Suitability	X	X				X									X	X	X		X	X	X
6	Analysis of Identification to Land Available for Development	X													X	X	X	X		X	X	
7	Analysis of Identification to Development Pressured Area												X		X				X	X	X	

Source: AGISwlk Research, BIP, UTM, 1999

3.0 URBAN DEVELOPMENT AND LAND USE CHANGE IN KLANG VALLEY REGION – ANALYSES FINDINGS

Analyses on trend of land use and built up areas change were done in AGISwlk through comparing the land use pattern for the year 1981, 1988, 1990, 1994, 1998 and 1999 (**Fig. 3**). Klang Valley Region was shown to experience rapid land use growth for all land use types from 1981 to 1998 except for agriculture land and forest which were reduced as much as 70% of the size in 1981. It was observed that built up areas has increased 4 times in the period of 10 years (1988 to 1998), of which the spread was towards new development areas such as Rawang, Wangsa Maju,, Bandar Baru Selayang, Pelabuhan Klang and Pulau Indah[4].

As the eastern part of Klang Valley Region is covered by high terrain, the spread of built up areas has been concentrated on the lowlands mostly in the area of Petaling and Klang, including the coastal and mangrove areas of the offshore islands namely Pulau Ketam and Pulau Indah. Pulau Indah in particular has changed drastically from mangroves swamp forest to industrial development[5]. Nevertheless, development has also started to climb up the hills. This is obvious as in 1999, 14.4 hectares of land in the area exceeding 25^{o} slope defined as high risk areas has already been developed of which 65% was housing, 27% recreational while the rest was industrial areas[6].

Separate analyses done have pointed out that between 1988 and 1998 approximately 20% of green areas was lost and being converted to other land use, mainly for housing and industrial development. This include the 14% of green areas allocated in the Structure Plan being developed mainly for housing to cater for the increase of population in Klang Valley Region. Apart from that, most of the land use conflict as compared to the Structure Plan involves housing (27%), industries (13%), recreation areas (7.8%), institutions (6.8%) and commercial areas (2.3%)[7]. The increase of population from 2.07 million in 1980 to 3.7 million in 1997 was seen to be the main factor influencing the spread of urban growth especially the built up areas.

4.0 IMPACT OF URBAN DEVELOPMENT AND LAND USE CHANGE ON THE ENVIRONMENT

The purpose of environmental database for Klang Valley is to analyse the element associated with environmental quality such as water, noise, air, erosion and flood. Point and line data from sampling stations were interpolated and analysed with other data sets such as land use and population to determine among others the extent and impact of environmental pollution to urban dwellers[8]. The change in the trent of environmental pollution, on the other hand, act as a tool in evaluating the extent of urban development and land use change and its effect and threat to the environment. Cartographic modeling techniques were used in AGISwlk to determine the areas under threat, environmentally sensitive (Fig. 4) and those which need protection such as forest, water catchment zone, reservoir and hill land.

4.1 Water Quality

Analysis based on water quality index set by the Department of Environment has shown a considerable degradation of water quality in the past ten years. Only recently, some improvements were shown by a certain segment of the Klang River. This could be attributed to the success of several programs adopted such as in upgrading the river water quality as well as the relocation of squatters settlement and illegal industries. Analysis on water quality trend within 1995 and 1999 showed 28% of the rivers experienced a decrease in water quality, 46% remain moderately polluted or polluted with a water quality index (WQI) of 75% while the rest 25% were upgraded to a better quality level. Further analysis has also pointed out the main sources of river water pollution to be industry, agricultural activities, construction works, soil erosion and domestic waste particularly in the locality of urban centres with high population density.

4.2 Air Quality

Currently, the air quality in the region is generally under control although it has been subjected to haze in certain period. The slightly high content of suspended particulates (TSP) in few areas in Kuala Lumpur may be due to constructions work being done which could be regard as periodical.

4.3 Noise Generation

The intense land use development has also contributed noise pollution. The latest trend observed between 1998 to 1999 showed a tremendous increase in noise generation with 31% of the region experiencing an increase in noise level (LEQ) while only in 13% of the area the noise level was reduced. However, the noise level in more than 50% of the region have not exceeded the noise pollution limit especially in the rural areas. Most of the areas affected by noise pollution were the town centres like the Federal Territory of Kuala Lumpur, Klang and other new development areas which also happen to be the central business districts and centre for miscellaneous daily activities. The increase in noise level in certain areas could also be associated with the high traffic volume and the lost of greens which play an important role in reducing noise.

4.4 Temperature Increase

Comparison of Landsat-TM images on Klang Valley Region (Band 6 – thermal band) with a 30m x 30m data resolution for the year 1994 and 1998 has shown more areas having an increase in temperature. This phenomenon occurred mainly in built-up areas within urban centres, especially the Federal Territory of Kuala Lumpur which experienced among the highest temperature compared to other parts of the region. This so called ‘urban heat island’ effect is believed to have a significant relationship to the increase in built-up areas and the lost of green. Analyses performed on land use change within 1994 and 1998 showed that these has been an increase of as much as 148.7% of built-up areas as well as 11.7% lost of green.

4.5 Geohazard Occurrences

Geohazard occurrences have been reported in the Klang Valley Region in the past 10 years particularly landslides, ground subsidence, floods and flash-floods, and river bank erosion. Within 1990 and 1996 alone, 22 landslides, 8 ground subsidence, 22 river bank erosions and more than 150 floods and flash-

flood incidents were recorded [9]. With three quarter of the region made up of the river basin, it is not shocking that floods and flash-floods are the most common geohazards especially in the locality along the Klang River and its tributaries, with more than 100 separate incidents over the past five years.

Most of the incidences occur in areas with high development activities where disturbances to and alterations of natural geological features took place. The federal Territory of Kuala Lumpur, being the most built-up area in the region recorded the most geohazard recurrences with 83 incidences within 1971 and 1999 [10].

5.0 CONCLUSION

Continuous rapid growth of the Klang Valley Region for the past two decades has made the area into a large and concentrated conurbation until eventually ecologically not able to sustain future development[11]. The population outburst has increase the need for housing, employment opportunities, institutions as well as other urban facilities and services and thus more land for development. Higher traffic volume along the roads and urban centres as well as lost of green areas contribute to higher level of air and noise pollution as well as the rise in temperatures. River pollution are likely caused by settlement, commerce, squatters and illegal industries located along rivers reserves. Activities such as concentrations of tourism related development and industrial development have often been associated with degraded water quality. Other activities such as land reclamation operations, deforestation and land clearance to allow for conversions into other users has also significantly influenced the environmental quality.

Since development especially large scale ones affects the environment in various ways, planning agencies should take the initiative to assess if the impact of the proposed development will be favourable. The use of computer application such as GIS in the impact assessment can help produce a good decision and proper actions. The generation of environmental sensitive areas and high risk zones maps using GIS base modeling, for example, would very much help in planning decision making process. As such, the areas identified can be avoided from being developed. If development is a must however, these maps could act as guidelines to futher justify the type of development to be implemented together with comprehensive procedures, standards and preventive measures embedded throughout the development activities.

Although GIS is a useful tool to carry out sophisticated works as data can quickly be modeled and the result can be presented efficiently with high quality, it is highly dependable on the availability and quality of the data generated in the model. Data availability would very much depend on the cooperation of various agencies involved either at the regional or local level. In brief, the application of a GIS requires collaboration, often among different professional and disciplines, and often individuals at different locations.

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