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INTEGRATED LAND USE ASSESSMENT (ILA) FOR PLANNING AND MONITORING URBAN DEVELOPMENT

Ahris Yaakup, Siti Zalina Abu Bakar, Susilawati Sulaiman

Abstract

The dynamic nature of planning and monitoring of development in Klang Valley region requires for a 'tool' for continuous evaluation and analysis of the current environment as well as the capacity for future development. As such, Integrated Land use Assessment (ILA) is introduced as a new concept within the "Application of Geographic Information System (GIS) for Klang Valley Region" (AGISwlk). The introduction of ILA as an integrated land use planning approach that exploits the GIS analysis capabilities, supported by the use of planning support systems is seen as a good mechanism for monitoring urban development especially in environment-sensitive areas (ESAs). ILA is also aimed at reducing causes of degradation to environmental quality due to rapid development and expansion of city limits which have either directly or indirectly affected environmental quality in Klang Valley. The ILA model is implemented through incorporation with the use of the What if? PSS which is a scenario base, policy-oriented planning support system that uses increasingly available GIS data to support community-based process of collaborative planning and collective decision making. This paper will discuss the approach, developed model and underlying concept of ILA and emphasize on the case study concerning the use of ILA for defining and mapping of ESAs. To conclude, several issues raised in the study will be discussed.

INTRODUCTION

Rapid urban development in Klang Valley and expansion of city limits have either directly or indirectly affected environmental quality which in turn contribute to the degradation of quality of urban life. The increasing demand for housing, employment opportunities, institution and other urban facilities and services from the city dwellers are the main factors contributing to the deterioration of environmental qualities and increase in environmental problems in urban areas such as air and water pollution, as well as frequent occurrence of flash floods, landslides and other geohazards. As such, planner should plan and monitor the development to minimise the environmental degradation. Fortunately, the emergence of technical capacity in computing and associated technologies brings greater hope to urban planners and decision makers in assessing and monitoring urban development as well as making effective policy decisions as fastest and efficient as possible.

Planning and monitoring of the environmental aspect involve not only the need to understand and review current development scenarios, but also to predict changes that will occur, formulate policies and strategies, as well as control the urban development. The urban and regional planning approach also concern about the environmental issues. In attempt to tackle the environmental issues, the environmental study had been included in the development plan preparation at the regional, state and local level. It is of particular importance to identify the Environmental Sensitive Area (ESA) to be able to recognize the areas that need to be preserved and areas that can be developed. With the ESA map, the consequences of any changes to the environment can be predicted and thus help planner to understand more about the environment sensitive area.

This paper discusses the management approach and strategy of urban and regional development, ILA and adoption of the 'What if?' approach in generating scenario alternatives in assessing development where the environmental sensitive area is concerned. This paper will also discuss a case study concerning the implementation of ILA especially for defining and mapping of ESAs using the GIS spatial analysis technique combined with the [1]What if? Planning Support System for enhanced end product.

THE URBAN AND REGIONAL PLANNING APPROACH

The quest for sustainable development means that local authorities have to maintain comfort, convenience, efficiency, and preserve their built and natural environment (Mohamad Saib, 2002). As much as the issues in planning which are sometimes too complicated and 'wicked', planners are responsible in managing the environmental changes. As managers, planners should adopt effective management approach in the planning process to arrange, control as well as lead changes (Bruton and Nicolson, 1987). Planners should thus adopt incremental and contingency approach to address current issues and pressing changes. In confronting these complex problems, planners have to resolve to consensus and bargaining measures to limit scenario pertaining conflict of interest.

The activity of planning should be seen as a process (McLoughlin, 1969: Chadwick, 1971) and not be carried out just once and for all. The preparation of development plan adopted a continuous, cyclical system approach based on certain stages such as identification of needs and goals, the formulation and evaluation of alternative courses of actions and monitoring of adopted programmes. The planning process we are concerned with here are intended to answer very general "what-if" or hypothetical questions and by changing the hypotheses and sifting the results, to arrive at recommendations for many coordinated aspects of future development (Harris. B, 2001). Thus, the plan making procedures may have to move in a direction that would substantially improve its ability to use information systems. This philosophy is based on the concept of feedback of information to evaluate plans and the plan making process (Geddes, 1949). In the plan making process, Calkins (1972) suggested that, 'better planning will be achieved through better information, and better information will necessarily flow from an information system'.

The data required in planning is always a mix of the spatial, aspatial and nonspatial, a blend of the qualitative and the quantitative, covering a wide range of physical, social and economic attributes, many of which are not comparable with one another (Harris. B, 2001). Due to the scope, process and methods involved in land use planning, a development programme does not only need a broad set of data and information but they should also be easy to be processed and manipulated base on requirement and situation. Data and information that need to be analysed will be coming from various sources either in the primary or secondary forms. This has set the need for planning agency to develop a planning information system appropriate with its urban and regional planning and monitoring functions.

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[1] What if? (Klosterman, 2001a) has been developed by Community Analysis and Planning Systems, Inc.

Information System For Urban Planning And Monitoring

Given the dynamic nature of planning and management, it is particularly important to have a well conceived information system, which can serve as the eyes and ears to a regional development planning and monitoring process. It provides for the monitoring and surveillance of compliance with planning regulations and it serves as an early warning system with regard to sources of friction, imbalances, shortfalls and failures in the process of planning and management (Yaakup, Johar and Dahlan, 1997). Up-to-date, reliable information is therefore needed at the management level to facilitate administrative procedures, policy planning and implementation as well as development strategy. It is a necessity for forecasting, modeling and evaluation of current situation and changes that are in progress.

The major functions of information system in planning should include as follows:

i. The descriptive function – information should help to describe situation;

ii. The cognitive function – information system also contribute to improved understanding of regional problems by providing the key factors and variables that can be analyzed using regional modeling and other statistical techniques;

iii. The normative function – the information system can also contribute to improved action by reducing the cost of actions with known consequences of actions already taken or about to be taken.

The Role of GIS

Much of regional planning activities have to do with the use of land and how the different types of land use relate to one another. As such, spatially referenced data including parcel boundaries, buildings, ownership of land and so forth are a fundamental part of an information-based approach to regional planning. This information combined with socio-economic data such as the population consensus and environmental data, provides more meaningful information for planners and decision makers.

The Geographic Information Systems (GIS) is seen as the most appropriate solution to addressing spatially referenced data. GIS provide the facilities to deal with the data requirement for the functions mentioned above. One important GIS capability is in handling both digital cartographic data and the associated databases of attribute information for map features (Healey, 1988). GIS systems can store the map coordinates of point locations, linear and area features. These features have attributes that must be stored in the database. Once all the data are stored, both the digital map and the database can be manipulated simultaneously. This is particularly important in many land use planning applications, which require data on a wide variety of physical and environmental attributes. Since the geographic information is stored in its primary form, analysis can be more quantitative and rational. The modeling stage which is called for in planning process, requires planner to make explicit their criteria for the selection of alternative programmes. This encourages the selection of objective criteria, based on real data about the area under study.

GIS has proved to be invaluable tool for evaluating alternative solutions to urban planning problems especially in environmental issues. The database developed can be extensively interrogated to generate several alternative solutions to urban strategic planning problems. Various scenarios, which take into, account the socio-economic characteristic of urban dwellers, the constraints of physical development, availability of land and land suitability for particular type of development can be generated.

Requirements For Planning Support System

The evolution of sciences and technology has effected the change of planning decision method. Planning support system (PSS) and spatial decision support system (SDSS) is one of tools for achieving planning quality in optimum development. PSS are (or at least can be) useful tools for the planner, public officials, and the community (Brail and Klosterman, 2001). PSS is a combination's of GIS data, urban model and presentation technique using computer for planning support base on community. PSS is also a tool for planner, public officer or community in development plan using computer base software (Brail and Klosterman, 2001). PSS structure and information access should visualize the world reality and support the capabilities for analyzing, prediction and planning decision. Generally, PSS involved urban database and usage of simulation database model in urban planning that can interact with planner through dialog module (Figure 1).

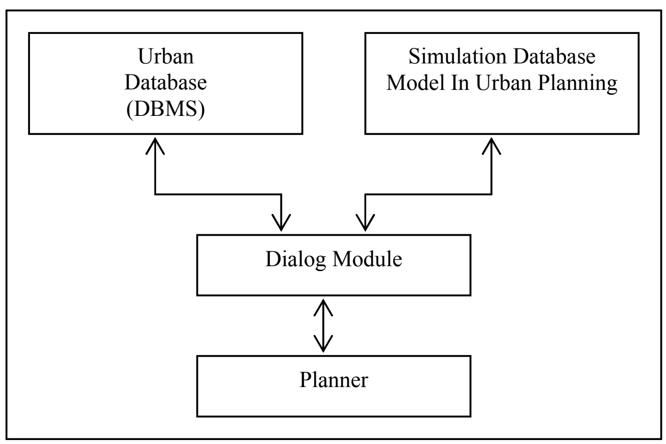

Figure 1: General Concept of Planning Support System (Yaakup *et al.*, 2000)

According to Klosterman (2001a), the perfect PSS would be a fully integrated, flexible, and "user-friendly' system that allows user to:

(1) Select the appropriate analysis or forecasting tool from an "intelligent digital toolbox" that helps the user identify the most appropriate methodologies and tools for dealing with a particular task

(2) Link the appropriate analytic or projection model to the required local, regional, or national information stored or accessed through the PSS.

(3) Run the appropriate models to determine the implication of alternative policy choices and different assumptions about the present and the future; and

(4) Instantaneously view the results graphically in the form of charts, maps and interactive video/sound displays.

INTEGRATED LAND USE ASSESSMENT (ILA)

The dynamic nature of planning and monitoring of development calls for a continuous evaluation and analysis of the current environment as well as the carrying capacity for future development. In the planning evaluation process, it is important to have several alternatives, in which various factors such as the cost-benefit and the socio-economic characteristics have to be taken into account (Yaakup, 1991). In the past, the number of alternative planning scenarios was rather limited due to the difficulties in producing them. This is mainly due to the time consuming procedures of creating scenarios as well as the evaluation that follows. Policy-makers, like most decision-makers, face the difficult task of evaluating and examining the impact of various resource allocations. In the past, the evaluation process appeared to be quite static and limited. Having prepared the evaluation model, the operation can be accomplished within a much shorter time frame by computer processing of the data and computer mapping of the results (Yaakup and Johar, 1996a; 1996b).

With rational planning approach, the quality of planning and decision making process can be substantially improved with valid data appropriately and efficiently handled. Information from a well-conceived database can be used to generate various scenarios taking into account the socio-economic aspect, physical development constraint and location suitability by applying criteria that can be easily adapted to suit the situation. The development scenario alternatives can be generated using the GIS spatial modelling method. The development scenarios can then be evaluated through employment of various evaluation techniques such as the cost-benefit analysis, the development goal achievement matrix analysis, the policy achievement and development strategy analysis, and some others. These techniques will enable comparison of proposed development base on the scenario alternatives to be made and thus produce a more practical and reliable development plan.

GIS Application For Klang Valley Region

The Klang Valley region is considered as the most developed and fastest growing region in the country. This has faced the region with the most serious urbanization and environmental 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 that consequently lead to environmental quality degradation. One of the main factors contributing to the existence of these problems is the lack of information in supporting the monitoring processes. This has set the need for an integrated and efficient information system particularly to assist in environmental control.

In response to the current need for application of information technology, a comprehensive database and GIS-based planning application had been developed under the project named “Application of Geographical Information System for Klang Valley Region (AGISwlk)” to be used as a planning support tool for formulating and evaluating development policies and strategies as well as coordinating and monitoring the development of Klang Valley. The project was first initiated in 1995 with a mission to develop a database and 10 planning applications. This project is considered successful and significantly contributes to the understanding of the development characteristic of the Klang Valley region and in turn helps in the planning, coordinating and monitoring of the database for optimum utilisation of every potential of the system mainly as a decision support tool in planning and monitoring the development programmes of the area.

The GIS capabilities as a regional planning and management tool is further enhanced through integration with a Planning Support System especially in generating development scenario alternatives that can serve as a basis for the formulation of more rational and effective development policies and strategies. An integrated land use approach called Integrated Land use Assessment (ILA) was employed in order to integrate AGISwlk's sectoral-based analyses previously undertaken and simultaneously translate them into a model that enable the generation of scenario alternatives using a PSS. Based on the importance and need for ILA in regional planning, a pilot study was undertaken through implementation of the ILA model for generating scenario alternatives to be used as guidelines and reference in formulating a more effective policies and strategies.

The Underlying Concepts of ILA

ILA is a new concept introduced within AGISwlk, aimed at developing an integrated spatial analysis model with the ability to generate alternative development scenarios by integrating physical and socio-economic information. The introduction of ILA as an integrated land use planning approach that exploits the GIS analysis capabilities, supported by the use of planning support system is seen as a good alternative for achieving better and more rational decisions. The concept of integrated approach in ILA is focused on the aspect of integration of the applications previously developed in AGISwlk, which are more sector-based (Figure 1). ILA emphasizes on the concept of integration whereby relationship exists between the database developed in AGISwlk and implementation of application-based analyses, with the use of planning support systems.

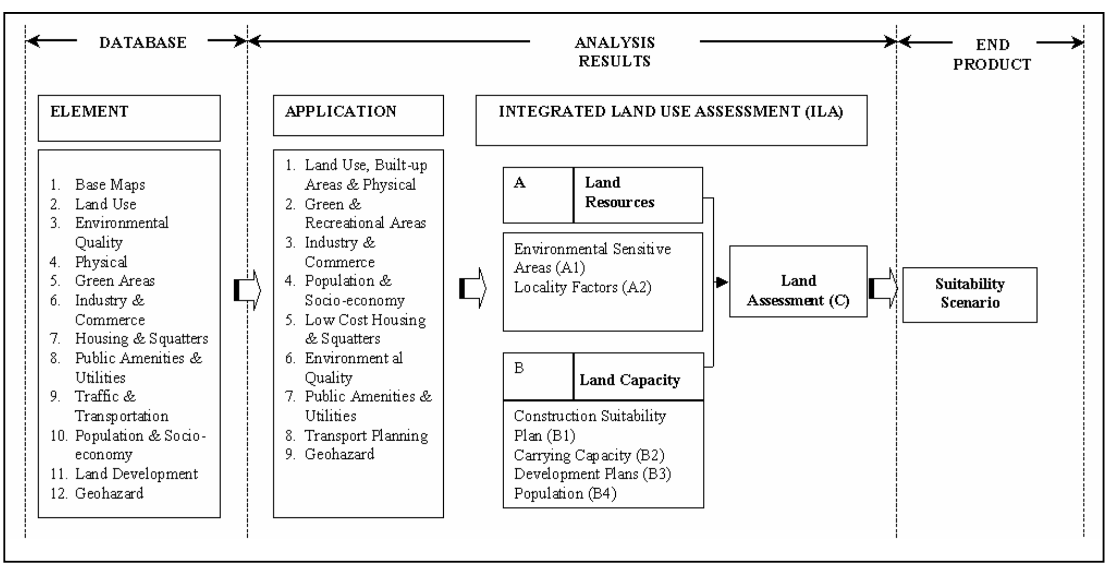

Figure 1 : The Integrated Land Use Assessment (ILA) *Concept*

Purpose of ILA

The main purpose of ILA is to create a relationship and subsequently integration between the sector-based applications in AGISwlk for generating the development scenario alternatives. The need for ILA is basically as follows:

- To act as a development planning mechanism at the regional level and be used as a guideline and reference for defining the suitable type of development in the future.

- To support land development control and provide a direction for development in Klang Valley through analysing the forecasted development scenarios.

Model Development

The ILA Model is dynamic in approach, providing flexibility for users in manipulating the criteria used and organising them on priority basis based on the development scenario to be generated (Figure 2). The assessment technique in ILA adopts the GIS spatial analysis technique combined with the weighting and sequential techniques. ILA involves two types of assessment namely Land Resources Assessment and Land Capacity Assessment. Land Resource Assessment aims at evaluating potential land resources for development in terms of suitability by considering two deriving factors, which are Environmental Sensitive Areas and Highly Accessible Area base on locality factors. While Land Capacity Assessment evaluates the extent of acceptable development in terms of land supply and carrying capacity toward environmental sustainability. The Land Capacity Assessment involves four deriving factors including Construction Suitability (Terrain Map), Carrying Capacity for River Basin, Transportation as well as Public Facilities, Development Plan and Population Carrying Capacity.

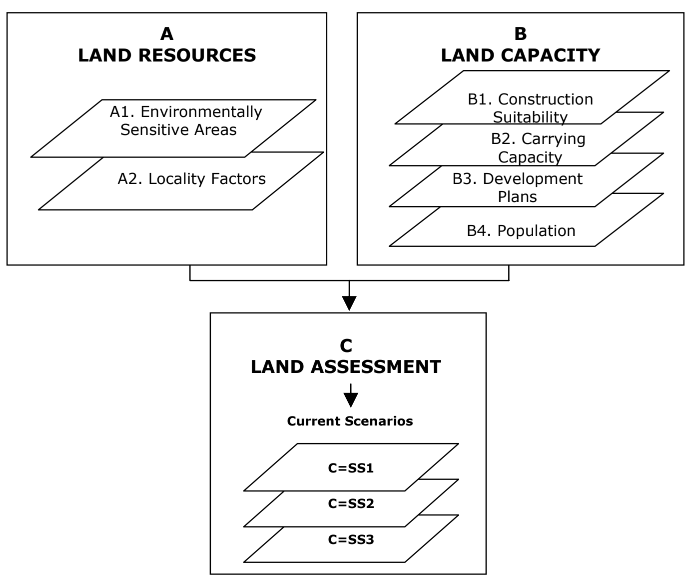

Figure 2: ILA Model

The ILA model is implemented through incorporation with the use of the What if? PSS which is a scenario base, policy-oriented planning support system that uses increasingly available GIS data to support community-based process of collaborative planning and collective decision making.

Using Spatial Multi criteria Evaluation (SMCE)

Evaluation is an essential in the planning process especially in selecting the appropriate development scenario alternative to be implemented. As such, it is necessary for decision-makers to define the suitable planning evaluation model so that the development scenario chosen could cater for future planning and its implementation is beneficial to the public. In defining the planning evaluation model, the development scenario alternatives should satisfy various criteria such as taking into consideration the planning objectives proposed and measuring all the costs and benefits for every sector.

In the case of ILA, a table of deriving and selection factors based on the developed model was prepared while at the same time allowing users the choice and flexibility of redefining the factors to generate the scenario alternatives subject to particular policies, weights and ratings concerned (Appendix 1).

MODEL IMPLEMENTATION – CASE STUDY OF GOMBAK AND BATU SUB RIVER BASINS

ESAs are areas identified as sensitive towards development and further aggravation could lead to the overall degradation of the environment which led to the increase risk of natural disaster and threatening ecosystem. The definition of ESA applies the concept under the Sustainable Development Strategy and Agenda 21 outlined by the Department of Town and Country Planning of State of Selangor. In the study, the integrated concept of ESA is adopted whereby ESAs are grouped into three classes based on functions concerning heritage value, hazard risk and life support (Kerajaan Negeri Selangor, 1999).

ILA study was implemented for the sub river basins of Batu and Gombak, covering an area of approximately 7,508.2 hectare in the District of Gombak in Klang Valley (Figure 3). In this study, the ESA sub model was applied to generate development scenario alternatives concerning environmental sensitive area. However, due to certain constraints, not all the selection factors are used. This is considered a preliminary study to design a model based on an integrated approach in generating development scenario alternatives with emphasis on the environmental aspect.

The objective of this study is to identify ESAs that need to be preserved and therefore indicate areas suitable for development. The model for the identification of environmentally sensitive areas involved various criteria including natural habitat which has not been interfered by human activities, natural habitat that has to be managed for human and environmental needs, natural or modified steep slopes as well as water catchment areas.

Figure 3: The study area

Methodology of Study

The study involved four main stages. The methodology was developed and organised based on the GIS spatial analysis process and planning support system framework. The stages can be simplified as follows:

Stage 1: Identify Policy and Strategy

This stage involves identification of policy and strategy to be used as guideline and direction in achieving the desired output.

Stage 2: Collecting Data for analysis

The second stage involves identifying data in AGISwlk database to be used for creating Uniform Analysis Zone (UAZ) based on predetermined selection factors. UAZ are GIS generated polygons, which are homogeneous in all respects considered in the model (Figure 4). For instance, all points within a UAZ have the same slope, are located in the same municipality, are within the same distance of an existing or proposed highway, and so on (Klosterman, 2001b).

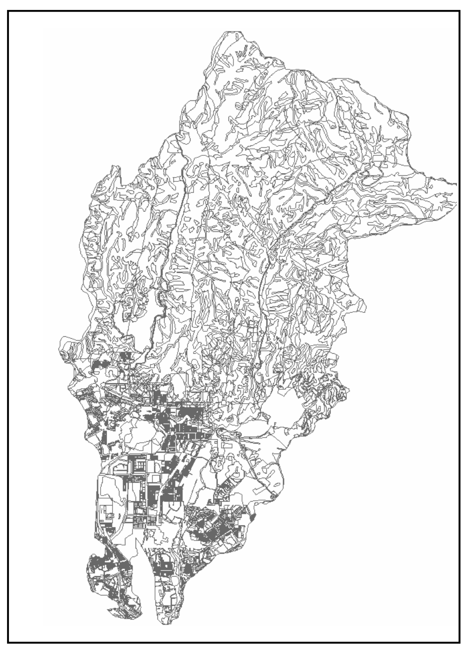

Figure 4: Example of Uniform Analysis Zone (UAZ)

Stage3 : Analysis and Modelling

The analysis and modelling stage involves the process of creating *Uniform Analysis Zone* (UAZ), designing project file and conducting suitability analysis. The process of creating UAZ layer includes combining of GIS data layers. The GIS functions involved in the process are overlay, classification and measurement. Designing the project file is most important because it influence the suitability analysis and affects the resulting output.

The suitability analysis involves three steps which are selecting the suitability factors, specifying factor weights and specifying factor ratings. In this study, a mathematical formula was applied for all factors considered in generating the development scenarios.

$$y = \sum_{i}^{n} w_i r_i$$

where:

y : Score
w_i : Weight of suitability factor
r_i : Rating of factor category

Stage 4 : End product

The end product is in the form of a map, graph and table. Basically, the map showed the ESAs based on level of sensitivity such as critical, high, medium and low. The generated report provides a formal documentation on the assumption used for each alternative scenario and summary of the result in the form of graph and table. The table listed the ESAs based on level of sensitivity and the calculated areas in the unit of hectare while the graph provides comparison in term of areas (hectare) between the different generated scenarios. This end product would help in the decision making process by providing support for a more rational and reliable judgement.

Generated Scenarios for ESAs

In this study, the implementation of ESA sub model has taken into consideration seven factors including historical area, erosion, flood, stream, recreation area, water body and forests. Two scenario alternatives were generated by using the same factors but by applying different weights and ratings appropriate to two different policies.

Scenario 1

In Scenario 1, six factors were considered as highly important in preserving the environment while excluding the forest. Forest area is assumed a less important factor to be considered for preservation and thus development shall be allowed within the forest area with certain limitations and control measures. The scenario generated showed 13.47% of land as less sensitive, 69.71% moderately sensitive and 16.83 % highly sensitive (Figure 5). As the forest falls under the 'moderately sensitive' category, this means that more land can be developed. With proper control and development based on the environmental functions concerned i.e heritage value, life support and hazard risk, the area can bring numerous benefits while at the same time still maintain its integrity.

Scenario 2

In Scenario 2, the policy outlined that no development shall be carried out in the forest area and all the factors listed is considered as of high importance in identifying the ESA. The generated scenario showed 13.47% of land as less sensitive, 25.69% moderately sensitive while 60.84% highly sensitive. As no development is allowed in all the highly sensitive ESAs which covers more than 50% of land, the land available for development is reduced. This scenario emphasized that ESA have to be preserved as changes to the existing status could generate negative impact and affect the function of the area (Figure 6).

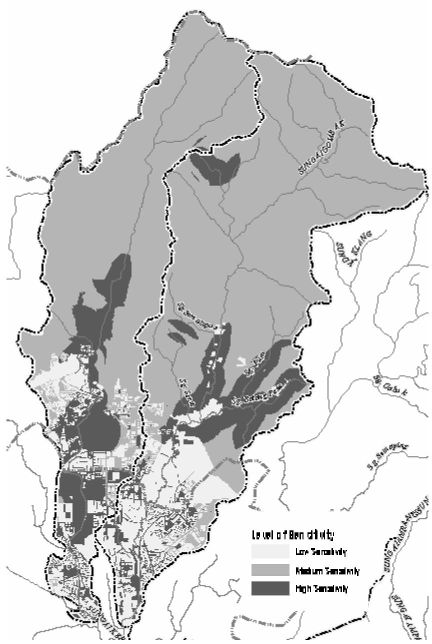

Figure 5: Scenario 1 of ESA

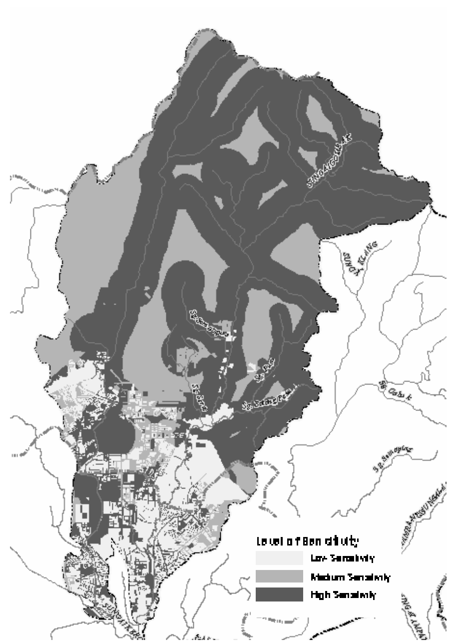

Figure 6: Scenario 2 of ESA

The generation of environmental sensitive areas maps using GIS based modelling would very much help in planning decision making process, especially that relating to the environment issues. The requirement for an ESA map is to serve as a guideline for identifying areas that should be avoided from being developed and if development is "a must", these maps could act as guidelines to further justify the type of development that is to be implemented together with comprehensive procedures, policies, standards and preventive measures embedded throughout the development activities. ESA map also can act as a tool for supporting control, monitoring and managing of development through implementation of the five main strategy i.e delineation of boundaries, limitation of use, defining standards, use of buffer spaces and design manipulation through technology optimisation (Kerajaan Negeri Selangor, 1999).

DISSCUSSION

From the study conducted, it is clear that the usage of GIS and PSS can enhance planning and monitoring. In this case, the environmental aspect can be well incorporated into development planning through good modeling for producing a better ESA map. The study also raises several issues that need to be given particular attention:

a) Defining data requirements

Data and information is an important component in ensuring the success of GIS implementation. In defining ESAs, the detailed information required needs to be defined. User should list out the factors and criteria to be used in the GIS analysis process such as current land use, forest area, flood area, recreation and etc. Clarifying the use of data for analysis purpose with concern on limitation and availability of data would much help in minimizing the time, cost and effort consumed in implementing the GIS analysis.

b) Number of criteria used in the study

There are a lot of criteria involved in identifying the ESAs. The criteria used in the study were based on the availability of data. The number of criteria used in identifying the ESAs could reflect the end products. So it is important to choose and design the criteria based on discussions with the stakeholders. As a guide to choose the number of criteria to be used in the study, several questions were raised to check criteria uncertainty including i) are all the relevant criteria considered in the study?; ii) do all the criteria's definition fulfils the objective of the study?; and iii) are all the sub criteria equally distributed among all the categories?.

c) Using 'What if?' PSS

There are several strengths and weaknesses identified in using the 'What if?' PSS for the purpose of ILA. The advantages are that the model is simple and easy to be used by non-technical people; flexible for manipulating the selection criteria, dynamic in approach and it represents a policy oriented simulation model. However, a disadvantage of the software is that not more than ten criteria can be processed within the model. As in the case of the study, the identification of ESAs needs to consider more than ten criteria. As such, the criteria had to be pre-processed based on the three classes involved which are heritage value, life support and hazard risk.

CONCLUSION

Today, the ever-accelerating growth of the computer technology especially that involving the GIS and PSS have further simplified the method of environmental assessment. Although PSS 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 PSS requires collaboration, often among different professional and disciplines, and often individuals at different locations, without which the PSS application cannot be effectively performed.

In realising an integrated and sustainable development, planner needs to play an active role in grabbing the opportunities provided through the advancement in information technology towards a better regional planning and monitoring quality. Formerly, the policies and strategies are formulated only in the form of statements and thus made it difficult for decision makers to assess the impact in spatial form. However, the adoption of ILA will enable the spatial assessment of the policies applied and amendment be made based on the generated set of predicted scenarios. Adoption of ILA as an integrated land use planning approach through the use of GIS analysis capabilities supported by a Planning Support System resulted in a more integrated planning and serves as a good alternative in producing more rational decisions. The use of ILA at different stage of planning and monitoring of Klang Valley Region is hoped to facilitate planning agencies in deriving at more effective decisions.

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Jabatan Perancangan Bandar dan Wilayah
Fakulti Alam Bina
Universiti Teknologi Malaysia
81310 UTM Skudai, Johor

e-mail: b-haris@utm.my

Appendix 1: Selection Factors For ILA Model

<table>
<tr><th>FACTOR</th><th>DERIVING FACTOR</th><th>SELECTION FACTOR</th><th colspan="3">SPECIFIC SELECTION FACTOR</th><th>OUTPUT</th></tr>
<tr><td rowspan="18">A. Land Resources</td><td rowspan="18">A1. Environmental Sensitive Area</td><td rowspan="14">A11 Heritage</td><td rowspan="5">A111. Historical, monument and archaeology</td><td colspan="2">Buildings</td><td rowspan="14">1. Very Critical
2. Critical
3. High Sensitivity
4. Medium Sensitivity
5. Low sensitivity</td></tr>
<tr><td colspan="2">Hills</td></tr>
<tr><td colspan="2">Caves</td></tr>
<tr><td colspan="2">Villages</td></tr>
<tr><td colspan="2">Archaeology Sites</td></tr>
<tr><td rowspan="2">A112. Biodiversity</td><td colspan="2">Reserved Forest</td></tr>
<tr><td colspan="2">Wild Life reserves</td></tr>
<tr><td rowspan="6">A113. Geology</td><td rowspan="2">Unique Rock</td><td>Limestone Hill</td></tr>
<tr><td>Sedimentary rock</td></tr>
<tr><td rowspan="3">Ex-mining area</td><td>Major Coal Mine (Batu Arang)</td></tr>
<tr><td>Biggest & deepest mine (Sungai Besi)</td></tr>
<tr><td>Major Tin mine (Perigi Tujuh Serendah)</td></tr>
<tr><td colspan="2">Hot Spring Area</td></tr>
<tr><td>A114. Landscape</td><td colspan="2">Public recreation Park</td></tr>
<tr><td rowspan="4">A12 Geohazard Risk</td><td>A121. Landslide</td><td colspan="2">Hill Area</td><td rowspan="4">1. Very Critical
2. Critical
3. High Sensitivity
4. Medium Sensitivity</td></tr>
<tr><td>A122. Flood</td><td colspan="2">Natural retention area</td></tr>
<tr><td>A123. Land Subsidence</td><td colspan="2">Limestone, ex-mining land</td></tr>
<tr><td>A124. Erosion</td><td colspan="2">Beach</td></tr>
</table>

<table>
<tr><td rowspan="26"></td><td rowspan="15"></td><td rowspan="3"></td><td rowspan="3"></td><td colspan="2">River</td><td rowspan="3">5. Low sensitivity</td></tr>
<tr><td colspan="2">Pond</td></tr>
<tr><td colspan="2">Island</td></tr>
<tr><td rowspan="12">A13. Life Support</td><td rowspan="3">A131. Fresh Water Supply</td><td colspan="2">Groundwater</td><td rowspan="12">1. Very Critical
2. Critical
3. High Sensitivity
4. Medium Sensitivity
5. Low sensitivity</td></tr>
<tr><td colspan="2">Dam</td></tr>
<tr><td colspan="2">Drainage System - River</td></tr>
<tr><td rowspan="5">A132. Food</td><td colspan="2">Aquaculture area - Resources</td></tr>
<tr><td colspan="2">Crops area - Resources</td></tr>
<tr><td colspan="2">Poultry area - Resources</td></tr>
<tr><td colspan="2">Agriculture Industry Center</td></tr>
<tr><td colspan="2">Research Station - institution</td></tr>
<tr><td rowspan="4">A133. Energy and Building Materials Resources</td><td>Mineral Metallic</td><td>Tin</td></tr>
<tr><td rowspan="3">Industrial mineral resources area</td><td>Sand</td></tr>
<tr><td>Aggregate rock</td></tr>
<tr><td>Clay</td></tr>
<tr><td rowspan="11">A2. Locality Factors</td><td rowspan="4">A21. Accessibility</td><td colspan="3">A211. Main road</td><td rowspan="4">1. High
2. Medium
3. Low</td></tr>
<tr><td colspan="3">A222. Main Railways</td></tr>
<tr><td colspan="3">A223. Main Junction</td></tr>
<tr><td colspan="3">A224. Transit Station</td></tr>
<tr><td rowspan="5">A22. Proximity</td><td colspan="3">A221. Built up area</td><td rowspan="7">1. High
2. Medium
3. Low</td></tr>
<tr><td colspan="3">A222. Committed Development</td></tr>
<tr><td colspan="3">A223. Public Amenities</td></tr>
<tr><td colspan="3">A224. Town Centre</td></tr>
<tr><td colspan="3">A225. Main River</td></tr>
<tr><td rowspan="2">A23. Land Status</td><td colspan="3">A231. Land Reserve</td></tr>
<tr><td colspan="3">A232. Land Ownership</td></tr>
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2. Class II
3. Class III
4. Class IV</td></tr>
<tr><td colspan="3">B12. Elevation</td></tr>
<tr><td colspan="3">B13. Activity</td></tr>
<tr><td colspan="3">B14. Erosion & Stability</td></tr>
<tr><td rowspan="16">B2. Carrying Capacity</td><td rowspan="8">B21. Transportation</td><td rowspan="4">B211. Road</td><td>Main road</td><td rowspan="4">Level of Services (LoS)
1. Class A
2. Class B
3. Class C
4. Class D
5. Class E
6. Class F</td></tr>
<tr><td>Traffic Volume (Traffic demand)</td></tr>
<tr><td>Capacity (Road capabilities to support number of vehicles)</td></tr>
<tr><td>Volume/ capacity ratio</td></tr>
<tr><td rowspan="3">B212. Junction</td><td>Geometry & Configuration</td><td rowspan="3">Service level</td></tr>
<tr><td>Types of control</td></tr>
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<tr><td>B213. Public transportation</td><td>Types of public transportation
Usage choices</td><td></td></tr>
<tr><td rowspan="6">B22. Public Amenity Carrying Capacity</td><td colspan="2">B221. Educational Centre</td><td rowspan="6">Carrying Capacity base on population</td></tr>
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<tr><td colspan="2">B232. Drainage Capacity – River, Retention pond</td></tr>
</table>

	B3. Development plan	B31. National Physical Plan	Land use zone
		B32. Klang Valley Perspective Plan	
		B33. Selangor State Structure Plan	
		B34. DBKL Structure Plan	
		B35. District Local Plan	
	B4. Population	B41. Enumeration Block	Population density, distribution, etc
		B42. Census District	
		B43. Local Authority	
		B44. District/area	
		B45. County	
		B46. Planning Zone	
		B47. Town	