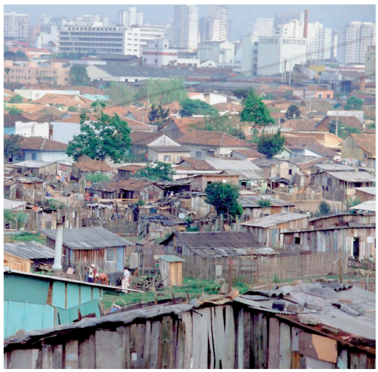
UN-HABITAT Lecture Award Series 3

GIS as a Planning Support System for the Planning of Harmonious Cities



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UN-HABITAT

The UN-HABITAT Lecture Award

The UN-HABITAT Lecture Award is an annual award organized by the Global Research Network on Human Settlements (HS-Net) to recognize outstanding and sustained contribution to research and thinking in the human settlements field. Upon selection, the Award winner will be invited to deliver a thought-provoking lecture during a session of the World Urban Forum or another major international event. The Award winner will also be presented with a commemorative plaque engraved with his/her name and a prize of $10,000.

The Award seeks to stimulate global dialogue on human settlements issues and capture and disseminate new thinking and trends in addressing the multi-faceted challenges of sustainable human settlements. Furthermore, the Award is designed to enhance the visibility of the Habitat Agenda and of human settlements issues in general. It also keeps UN-HABITAT up to date with current research and thinking on human settlements thereby enriching the content of the Global Report on Human Settlements.

The Lecture Award is open to any individual with an outstanding and sustained track record of research in the human settlements field, both urban and rural. The ideal candidate will:

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b) Have a sustained record of research and publication in reputable refereed journals, or in the form of books and book chapters;
c) Have a substantive reputation, evidenced by widespread peer recognition, either globally or regionally;
d) Be engaged in innovative research on current human settlements issues; and
e) Be a citizen or permanent resident of a country in the region designated for the Lecture Award for the relevant calendar year.

Institutions or individuals can nominate candidates for the award. Individuals may also nominate themselves. The HS-Net Advisory Board, composed of experienced researchers in the human settlements field, serves as the selection committee for the award.

The theme for the lecture may be related to the theme of an upcoming Global Report on Human Settlements, or it may be a topical issue, as determined by the Award winner in consultation with the HS-Net Advisory Board. The lecture is widely disseminated through various media, and a written copy of the lecture is posted at the HS-Net website.

For further information, and to nominate candidates, visit the HS-Net website at http://www.unhabitat.org/hs-net

UN-HABITAT Lecture Award Series, No. 3

GIS as a Planning Support System for the Planning of Harmonious Cities

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Centre of Urban Studies and Urban Planning
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GIS as a Planning Support System for the Planning of Harmonious Cities

It has long been the desire of human beings to be harmonious with the physical environment, society and inner self. In China, the earliest harmonious concept is *yin-yang* which originates from the *Book of Change* (*I-ching*), a Chinese book often associated with fortune-telling and Taosim. It can be dated back 3,000 years to the transition period between the Yin (1600-1100 B.C.) and Chou dynasties (1122-256 B.C.). Y*in* represents softness (weak, submissive) and *yang* represents strength (strong, dominant). While being opposite, they work in harmony. The balance of *yin* and *yang* is needed to create a harmonious system. *Yin-yang* is often applied to Chinese medicine in which the balance of the *yin* and *yang* will lead to good health. When applied to cities, *yin* can represent the natural environment and *yang* the urban development. The balance between urban development and the natural environment will lead to sustainable cities.

The desire to strike a balance between human living and the nature of *yin-yang* has led to the development of *feng-shui* (wind and water), geomancy in China. It can be considered as the earliest form of landscape architecture and site planning, although with a lot of superstitious elements in it. *Feng-shui* comes from multiple origins, such as Taoism, *yin-yang*, and the five elements (gold, wood, water, fire, and earth). It has been developed over many centuries by trial and error, through observation and mysticism. It reflects the ancient Chinese view of the environment and ecology and a mystical combination of Chinese philosophical, religious, astrological, cosmological, mathematical and geographical concepts (Yan, 1963). Although many people argue that *feng-shui* is superstitious, some of its theories and principles are also rational, explainable and scientific (Tam, Tso, and Lam, 1999). *Feng-shui* is used to find the right location for building a house or village that is in harmony with its environment. *Feng-shui* can also be computerized for site selection (Chiou and Krishnamurti, 1997). Information about the site is important in locating a house, building or village with good *feng-shui* that will bring prosperity and good health to the people living in it.

The desire to find harmony in society is well embedded in Confucianism, which like *yin-yang* and *feng-shui*, has strong influence over China, Korea and Japan for more than 2,000 years. The concept, *zhong yong* or the middle road, first appeared in *Lun Yu (The Analects of Confucius*) and was explained in detail in *Zhong Yong (The Doctrine of the Mean)* which is one of the four classics of Confucianism. The purpose of the *Doctrine of the Mean* is to demonstrate the usefulness of the Confucius way (*dao*) to gain harmony in society and with the inner self. It gave much emphasis to the proper behaviour of a gentleman in society and the relationship among different groups of people in society as exemplified by the *Three Mainstays of Social Order* (social order between master and worker, parent and child, husband and wife) and *Five Bonds of Human Relationship*s (relationships of master and worker, parent and child, husband and wife, brothers and sisters, and between friends). By having good courtesy and manners in accordance with the principles of the five basic relationships, there will be less conflict and society will be harmonious. The concept of the middle road has been used by the rulers of China as a way of informal social control to maintain social order and harmony in China for a long time. Although it has often been criticized for being too compliance, nevertheless it has helped to maintain social order and harmony in Chinese society for a long time.

In urban planning, the need to have a balance with nature is well embedded in the work of Ian McHarg's influential book, *Design with Nature* (1969). It is through better site design that we can achieve harmony with nature. The recent emphasis on sustainable development with concern for environmental, economic and social development to a certain extent is a manifestation and a more elaborated and extended version of the search for harmony with the environment, taking a middle approach of balancing economic development with the needs of society without destruction of the environment for future generations (World Commission on Environment and Development, 1987).

In the West, the urban planning paradigm has moved away from the technological approach of the 1960s and 1970s to a more participatory approach and greater role of civil society (Douglass and Friedmann, 1998). Planning decisions are no longer mainly based on the results of urban planning models generated by computers but more on consultations and negotiations with different stake holders in the planning process. The dominant role of urban planning models has diminished. They have become one of the tools for supporting the planning process. Despite the diminishing importance and role of planning models and computers in urban planning, geographic information system (GIS) is increasingly being used in urban planning (Yeh, 1999). This is mainly because even in the paradigm of participatory planning, spatial information and analysis is important for facilitating informed discussion and decision making. As a computerized system for the storage, retrieval, visualization, analysis and modeling of spatial information, GIS can provide the textual and visual spatial information as well as the results of spatial analysis to aid public discussions and deliberations in the planning process and the making of plans that are in harmony with development, the environment and society.

Use of GIS as a Planning Support System in Urban Planning

The development of GIS has a very close relationship with urban planning. In *Design with Nature*, McHarg (1969) used blacked-out transparent overlays to identify sites that are in harmony with nature. Hand drawn map overlay analysis and land suitability mapping is a basic skill in urban planning (Steinitz et al., 1976; Hopkins, 1977). The concept of map overlay analysis was computerized by Carl Steinitz of the Department of Landscape Architecture of Harvard University into GRIDS in 1967 and later further developed by David Sinton (1977) into IMGID in the 1970's. These grid-based packages played a key role in the development of GIS in its inception stage in the 1970s (Chrisman, 2006). They laid the foundations of many spatial processing, statistical and analytical functions of modern GIS. Apart from these packages, Jack Dangermond, a graduate of landscape architecture in Harvard University developed MAGIS (Maryland Automatic Geographic Information System) in the 1970s and founded the Environmental Systems Research Institute (ESRI) in the late 1970s for its vector-based Arc/INFO (now called ArcGIS), with very strong map overlay and spatial analysis functions, which is now the leader in GIS.

In the early days of the development of GIS in the 1960s and 1970s, there were very few planning departments that installed GIS because of their expensive hardware and limited software and data. The decrease in the price of hardware, computer storage and devices, and accompanying improvement in the performance of hardware and software (particularly the speed of computer processors) and advancement in the data structure and related algorithms of vector-based GIS, has made the once expensive and time consuming GIS to be more affordable and workable. Since the early 1980s, there has been a marked increase in the installation of GIS in different levels and departments of urban and regional governments in the developed countries in Australia (Newton and Crawford, 1988), Europe (Bardon et al., 1984; Campbell, 1994), and North America (French and Wiggins, 1990). With the further decrease in price and increase in performance of computer hardware and software, the use of GIS in urban planning in the developing countries has been increasing in the 1990s (Yeh, 1991). GIS is now more accessible to planners and is an important tool and database for urban planning both in the developed and developing countries (Yeh, 1999).

GIS is one of the formalized computer-based information systems capable of integrating data from various sources to provide information necessary for effective decision making in urban planning (Han and Kim, 1989). Other information systems for urban planning include database management systems (DBMS), decision support systems (DSS) and expert systems (ES). GIS serves both as a database and tool-box for urban planning (Figure 1). In database-oriented GIS, spatial and textual data can be stored and linked using the geo-relational model. This supports efficient data retrieval, query and mapping. Planners can also extract data from the databases and input them to other modelling and spatial analysis programs. When combined with data from other tabular databases or specially conducted surveys they can be used to make effective planning decisions. As a tool-box, GIS allows planners to perform spatial analysis using geoprocessing functions such as map overlay, connectivity, and buffer (Berry, 1987; Tomlin, 1990). Of all the geoprocessing functions, map overlay is probably the most useful tool. This is because planners have a long tradition of using map overlay in land suitability analysis which is an important component in urban planning (McHarg, 1969; Steinitz et al., 1976; Hopkins, 1977). The integration of multi-media data and the use of web-GIS in the internet/intranet environment has increased the

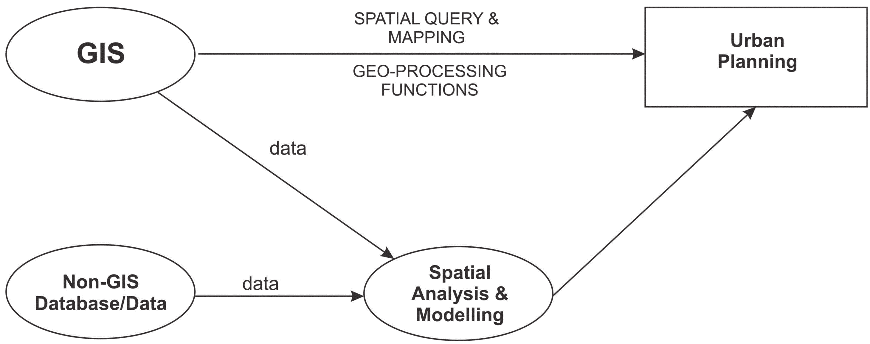


Figure 1 – GIS and Urban Planning

utility of GIS in urban planning. The incorporation of images, videos, aerial photos and sound within GIS can increase planners' and decision makers' comprehension of the planning problem that they are analyzing (Fonseca et al., 1995). The integration of GIS with virtual reality can enable planners to examine the space that they are planning more realistically (Faust, 1995). The Internet/Intranet is very useful in communicating design ideas (Coyne et al., 1996). The use of GIS through the internet can also facilitate the dissemination of planning information and enhance citizen participation in the planning process (Yeh and Webster, 2004). Unlike the past when citizens had to physically go to the town hall to examine the plans, they can now see them in their offices and homes via the internet at any time. The internet can thus help in the development of a multimedia-based collaborative planning system (CPS) (Shiffer, 1995).

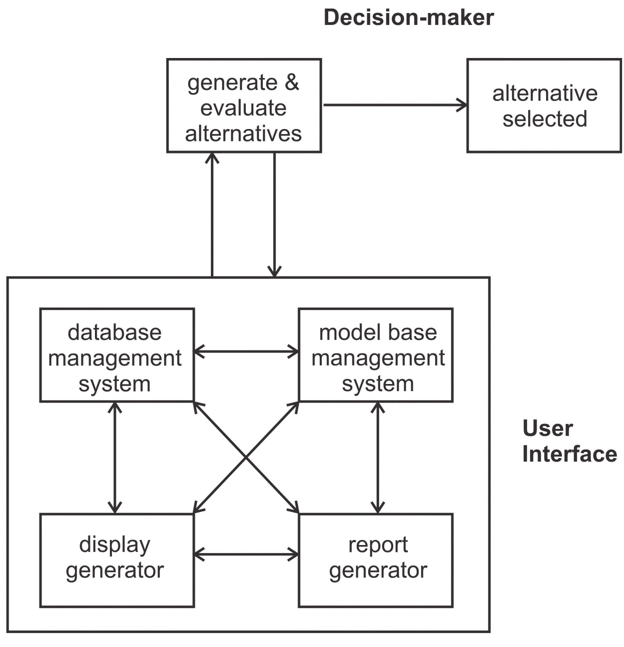
Database management, visualization, spatial analysis, and spatial modelling are the main uses of GIS in urban planning (Marble and Amundson, 1988; Levine and Landis, 1989; Webster, 1993, 1994). GIS is used for the storage of land use maps and plans, socio-economic data, environmental data, and planning applications. Planners can extract useful information from the database through spatial query. Mapping and 3D views and virtual realities are the most powerful visualization tools in GIS. Maps can be used to explore the distribution of socio-economic and environmental data, and display the results of spatial analysis and modelling exercises. 3D views and virtual realities can give a community a more realistic view of the problems that it is facing and the likely development that will result from the plans. Spatial analysis and modelling are used for spatial statistical analysis, site selection, identification of planning action areas, land suitability analysis, land use-transport modelling and impact assessment. Interpolation, map overlay, buffer and connectivity are the most frequently used GIS functions in spatial analysis and modelling. The use of the above functions varies according to different functions and stages of urban planning.

There are many benefits in using GIS in urban planning that include (Royal Town Planning Institute, 1992):

- improved mapping - better access to maps, improved map currency, more effective thematic mapping and reduced storage cost
- greater efficiency in retrieving information
- faster and more extensive access to the types of geographic information

important to planning and ability to explore a wider range of "what-if" alternatives
- improved analysis
- better communication to the public and staff
- improved quality of services, for example speedier access to information for planning application processing

Decision support systems were developed as a response to the shortcomings of the management information systems (MIS) of the late 1960s and early 1970s. At this time MIS did not adequately support analytical modelling capabilities and facilitate the decision maker's interaction with the solution process. DSS provides a framework for integrating database management systems, analytical models and graphics, to improve decision-making processes. They are designed to deal with ill- or semi-structured problems which are poorly defined, partially qualitative in nature. The decision support system concept was extended to the spatial context in the development of spatial decision support system (SDSS) (Armstrong and Densham, 1990; Armstrong et al.,

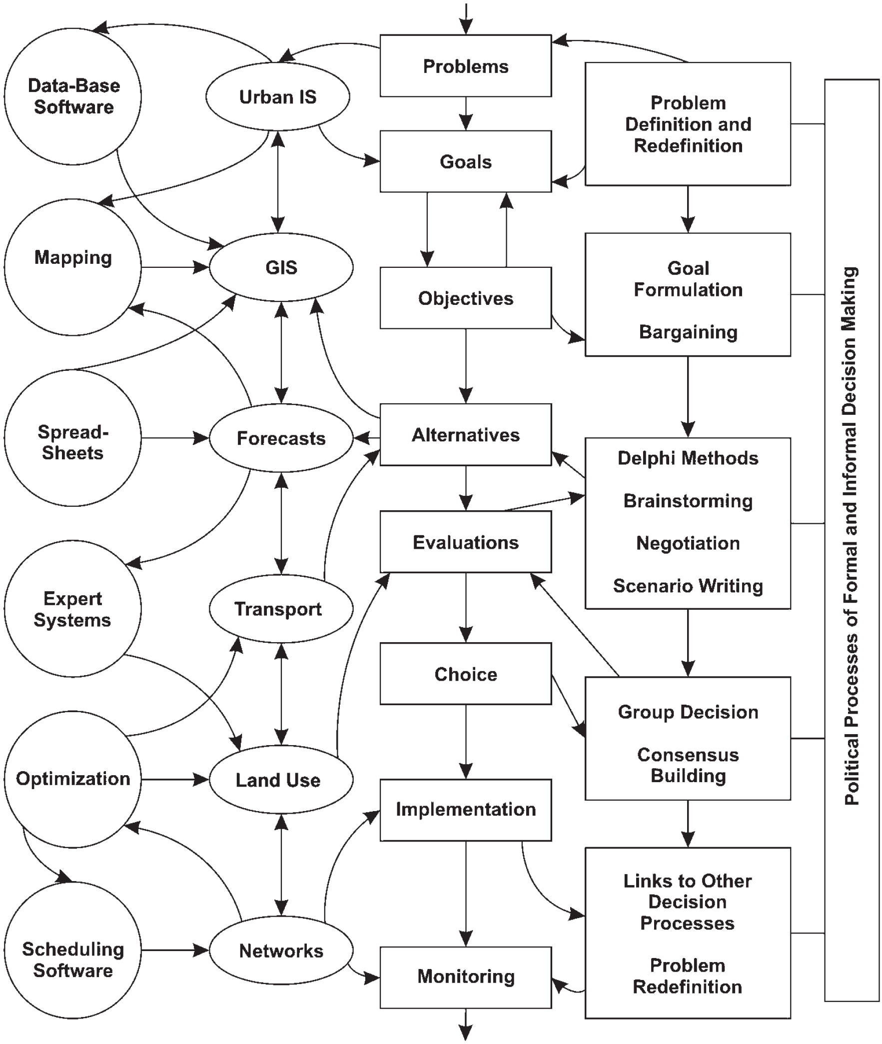


Source: Armstrong, Densham and Rushton, 1986

Figure 2 – Architecture of a Spatial Decision Support System (SDSS)

1986; Densham, 1991; Densham and Rushton, 1988) (Figure 2). SDSS helps decision makers to make decisions on different locational alternatives (for example, optimal location of service centres). Because of the lack of analysis functions in the past, GIS has not been considered as part of SDSS. Instead GIS was used to generate and store spatial data which were then used as inputs for the analytical models. Results of the analytical models were then displayed using GIS. Much research has been done on the use of GIS in the visualization of the results of the analytical models. Advancements have been made in incorporating analytical models into GIS (Maguire et al., 2005). For example, location-allocation and spatial interaction models have been incorporated as a standard function in ArcGIS. It is to be expected that in the future the distinction between a GIS and spatial decision support system will become less and less.

A parallel development in the planning field is the concept of planning support systems (PSS). A PSS, as first advocated by Harris (1989), is a combination of computer-based methods and models that support the planning functions. PSS not only serve as a decision support system to decision makers, they also provide the tools, models and information used for planning (that is, the information technologies that planners use to carry out their unique professional responsibilities) (Harris and Batty, 1993). PSS comprise a whole suite of related information technologies (e.g. GIS, spreadsheets, models, and databases) that have different applications in different stages of planning (Batty, 1995; Klosterman, 1995) (Figure 3). GIS will form an important component of a PSS because of its geoprocessing, graphic display, database and modelling capabilities. However, a PSS cannot consist of a GIS alone. It must also include the full range of planners' traditional tools for economic and demographic analysis and forecasting, environmental modelling, transportation planning, and land use modelling. It should also include other technologies such as expert systems, decision support aids (e.g. multi-criteria decision analysis), hypermedia systems and group decision support systems. With the advancement of GIS, it is becoming an increasingly important component of planning support system (Brail and Klosterman, 2001; Geertman and Stillwell, 2003, Yeh et al., 2006).



Source: Batty, 1995

Figure 3 – Planning Support Systems (PSS)

Use of GIS in Different Functions and Stages of Urban Planning

Urban planning involves many functions, scales, sectors and stages. In general, the functions of urban planning can be classified into general administration, development control, and plan making. General administration and development control are relatively routine planning activities, whereas plan making and non-routine strategic planning are not frequently carried out. The scale of the planning area covered can range from a whole city, to a sub-region of a city, a district, or a street block. The most frequently involved sectors of urban planning are land use, transport, housing, land development and environment. Within the different scales of planning, there are different stages - the determination of planning objectives, the analysis of the existing situation, modelling and projection, development of planning options, selection of planning options, plan implementation, and plan evaluation, monitoring, and feedback. With the increasing importance of participatory planning, public participation occurs in many stages of urban planning. Different functions, scales, sectors and stages of urban planning have different uses of GIS.

The use of the data management, visualization, spatial analysis and modelling components of GIS varies according to different functions of urban planning. Data management, visualization and spatial analysis are used more in routine work of urban planning. Spatial modelling is more frequently applied in strategic planning. General administration mainly employs data management and visualization. Finally, development control mostly uses the visualization and spatial analysis functions of GIS. The more routine general administration and development control work of urban planning includes (Newton and Taylor, 1986; Newton et al., 1988): management of land use records; thematic mapping; planning application processing; building control application processing; land use management; land availability and development monitoring; industrial, commercial and retail floor space recording; recreational and countryside facility planning; environmental impact assessment; contaminated and derelict land registers; land use-transport strategic planning; public facilities and shops catchment area and accessibility analysis; social area and deprivation analysis. Visualization, spatial analysis and spatial modelling are the most frequently used GIS functions in plan making. Webster (1993, 1994) discusses the advantages of using the data management, visualization, and spatial analysis and modelling functions of GIS as scientific inputs to urban planning description, prediction and prescription. There are significant differences in the degree of use of GIS in the description, prediction, and prescription aspects of the planning process. Description is used more often in general administration, whereas prediction and prescription are used more often in the plan making. 3D GIS and associated virtual reality are now increasingly used in public participation in order to give the participant a more real world feel of the issues and plans being discussed which can not be achieved through abstract maps and plans.

Different scales of planning require different data and techniques. Raster (grid) data and GIS are more useful for city-wide strategic planning, because of the large area involved and high resolution is not required. The processing of raster data is much faster than that of vector data, especially in map overlay and buffer analysis. On the other hand, vector data is generally used for district and local action area planning because of the need for very high resolution analysis.

There are many applications of GIS in the land use, transport, housing, land development and environmental sectors. Key examples include site selection and land suitability analysis. In contrast, network analysis and route selection are most frequently used in transport planning, and environmental planning and management use buffer and overlay processing. There is an increasing trend in the integration of modelling in different sectors of urban planning (Goodchild et al., 1993).

The role of GIS also varies in different stages of the urban planning process (Figure 4). For example, GIS is more useful in modelling and development of planning options, than in the determination of objectives, resource inventory, analysis of existing situations, modelling and projection, development of planning options, selection of planning options, plan implementation, and plan evaluation, monitoring, and feedback. GIS can only satisfy some of the data and techniques that are needed in different stage of the urban planning process. It also has to work with other databases, techniques and models at different stages of the planning process.

Data collection

GIS, when integrated with remote sensing, can save time in collecting land use and environmental information. Remote sensing images are becoming an important source of spatial information for urban areas (Paulsson, 1992). They can help to detect land use and land use changes for the whole urban area (Barnsley et al., 1993). In particular, stereoscopic pair of digital aerial

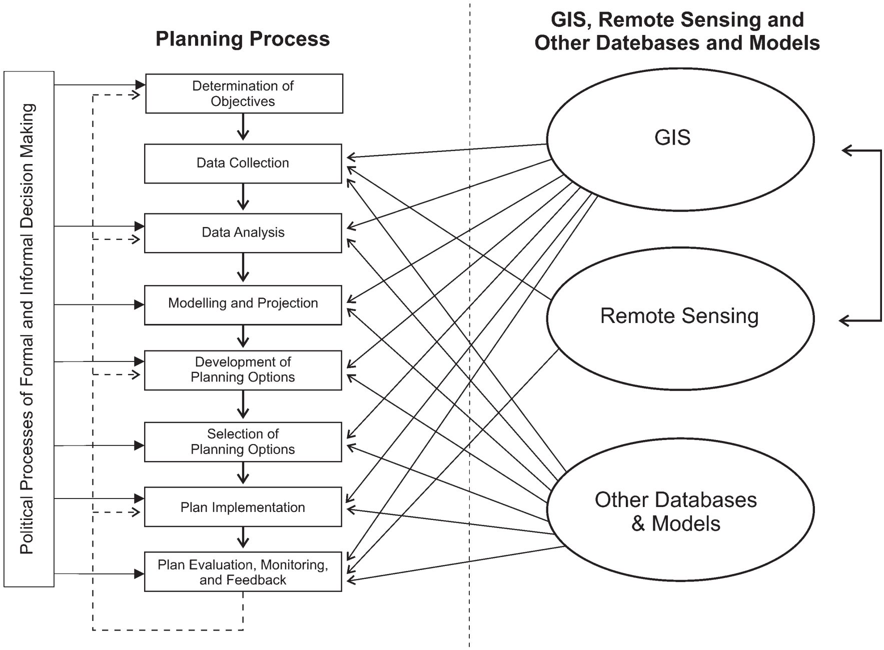


Figure 4 – Integration of GIS, Remote Sensing and Other Databases and Models in the Planning Process

photographs can be used to derive three dimensional CAD models of buildings for dynamic visualization of a city, or for direct import into a GIS database.

Data analysis

GIS can help to store, manipulate, and analyze physical, social and economic data of a city. Planners can then use the spatial query and mapping functions of GIS to analyze the existing situation of the city. Through map overlay analysis, GIS can help to identify areas of conflict of land development with the environment by overlaying existing land development on land suitability maps. Environmentally sensitive areas can be identified using remote sensing and other environmental information (Yeh and Li, 1997).

Modelling and projection

A key function of planning is the projection of future population and economic growth. GIS can be used for prediction and projection (Longley et al., 1994). Spatial modelling of their spatial distributions in space needs to be undertaken, analysed and evaluated to estimate the impact of existing trends of population and economic growth. GIS can additionally be used to forecast the future impact of development on the environment if the current trends continue. This can be carried out by the projection of future demand of land resources from population and economic activities, modelling of the spatial distribution of such demand, and then using GIS map overlay analysis to identify areas of conflict. With the socio-economic and environmental data stored in the GIS, environmental planning models have been developed to identify areas of environmental concern and development conflict (Schuller, 1992). GIS can also model different development scenarios. It can show the modelling results in graphic form, making them easy to communicate with decision makers (Armstrong et al., 1992). Planners can use such information to formulate different planning options and help guide future development so that they avoid such conflicts.

Development of planning options

Land suitability maps are very useful in the development of planning options. They can be used to identify spaces for future development. The association of spatial optimization models with GIS can help to develop planning options which tries to maximize or minimize some objective functions (Chuvieco, 1993). The simulation of different scenarios of development with GIS can help in developing planning options (Landis, 1995). The integration of cellular automata with GIS can help to generate different planning scenarios for sustainable development by taking environmental constraints, development density, and urban form into consideration (Li and Yeh, 2000; Yeh and Li, 2001). The integration of location-allocation models with GIS can help to find the optimal location of public facilities (Yeh and Cbow, 1996). The use of multicriteria decision analysis in GIS can help to consider multiple criteria in deriving different planning options (Malczewski, 1999)

Selection of planning options

The final selection of planning options is increasingly a political process, but planners can provide technical inputs to this process by providing spatial information and analysis and 3-D maps and virtual reality to help communities in making their collective choice. The integration of spatial and non-spatial models with GIS can help to evaluate different planning scenarios (Despotakis et al., 1993). The use of GIS with multi-criteria decision analysis can provide the technical inputs in the selection of planning options (Carver

1991; Eastman et al., 1993). The comparison of base-line growth with planned growth can help communities to appreciate the advantages of compact development versus dispersed development (Yeh and Li, 2000)

Plan implementation

GIS can be used in plan implementation by supporting environmental impact assessment of proposed projects to evaluate and minimize the impact of development on the environment (Schuller, 1992). It can be used effectively for the programming and monitoring of land development (Yeh, 1990). The integration of case-based reasoning and GIS can help to automate the planning office and enable more consistent decision making in development control (Shi and Yeh, 1999).

Plan evaluation, monitoring, and feedback

When used together with remote sensing, GIS can help to monitor the environment. For example, it can be used to monitor land use changes (Yeh and Li, 1997). By overlaying a land development map produced from the analysis of remote sensing images on the land use plan, it can examine whether land development is following the land use plan, In addition, GIS can be used to evaluate the impact of development on the environment to see whether adjustments of the plan are needed.

Public participation

Public participation is increasingly important in the planning system. Public Participatory GIS (PPGIS) has been developed to broaden public involvement in policy making (Jankowski and Nyerges, 2001; Sieber, 2006; Tang and Waters, 2005). The increasing accessibility of internet service has provided a platform for the use of PPGIS to enhance public participation in plan discussion, local community information collection, and decision making support. GIS can be used to help the community to visualize and understand their community better (Greene and Pick, 2006). The use of 3-D visualization can help planners, the public, and decision makers to compare different urban designs more effectively (Batty et al., 2001).

Constraints in the Use of GIS in Urban Planning

The use of the GIS in urban planning does not depend solely on the advancement in GIS software and hardware. This may be the least important factor in determining whether GIS is used in urban planning in a city. The status and character of the organization, data, state-of-the-art of planning, and staff are more important factors, especially in developing countries (Yeh, 1991 and 1999).

Organization

No matter how sophisticated and advanced it is, a decision support system is useless if it is not being used by decision makers. Studies on the applications of GIS repeatedly show that staff and organizational factors are more important than technology in successful applications of GIS (Campbell, 1994; Campbell and Masse, 1995). There are three sets of conditions that are important for the effective implementation of GIS: a) an information management strategy which identifies the needs of users and takes account of the resources at the disposal of the organization; b) commitment to, and participation in, the implementation of any form of information technology by individuals at all levels of the organization; and c) a high degree of organizational and environmental stability (Masser and Campbell, 1991; Campbell, 1994). GIS applications that are most likely to be used are those that can deal with identifiable problems. More complex applications are less likely to be used than simple ones.

Data

The lack of available data is one of the major hindrances in the use of GIS (Yeh, 1991). This is further complicated by the pricing and general availability of spatial data to the public because of national security (Yeh, 1998). As a type of information system, GIS needs graphic and textual data in order to function. There is no life in GIS if there is no application and there can be no application if there is no data. In short, data are vital to GIS. In the developed countries, a reasonable amount of data that is needed for setting up a GIS is collected and readily available thus making the establishment of a GIS relatively easy, but, data are not so readily available in developing countries. The most readily available data are those from remote sensing, but they are mainly limited to land cover information from which a very limited amount of information can be extracted. Because remote sensing is the predominant method of data collection for GIS, it is not surprising to find that data contained in the developing countries GIS are dominated by those on the physical environment and land cover. Socio-economic data, which are vital to urban and regional planning, are generally lacking and often limited mainly to census data.

Socio-economic data require field surveys which are expensive and time consuming. In a study of information systems for planning in Ghana, Akom (1982) found that there was a lack of up-to-date and reliable data for planning because some departments were slow in the acquisition of data, and coordination among various departments and institutions in the flow and exchange of information was weak. The lack of financial resources and trained personnel to collect data, and the unavailability of modern and efficient data processing equipments were also cited as inhibiting factors. The relatively low price of computers today can help to alleviate some of the hardware constraints. However, the main obstacle still lies with inadequate government recognition of the need for statistical information for planning and the willingness and ability to mobilize resources for its collection.

In many developing countries, base maps which are more essential than textual data to GIS are often lacking or outdated. There are usually many types of base maps, each compiled by different agencies with different accuracy and map scales. This makes them difficult to integrate into GIS. Furthermore, there is generally a lack of a standardized geocoding system which makes it difficult to link the textual data with the graphic data. It is, of course, difficult to start GIS without the necessary maps, geocoding systems and textual information.

It is not only the availability of data which is a problem but the quality too. The currency of data is very important in planning because data will be of limited use if they are outdated. There is, unfortunately, a general lack of institutional arrangement to determine, coordinate, and monitor the frequency of data updating by different departments. A fairly large amount of data used for planning in developing countries is collected by agencies over which the planning agency has little control (Batty, 1990). There is a general lack of procedure for verifying the quality of the data collected.

There has been a misconception that hardware, software and human resources are major constraints on the use of GIS in urban planning in the developing countries. However, the availability of up-to-date data is the most important bottleneck in preventing GIS from being used effectively in the developing countries. There is an urgent need to establish an institutional framework to ensure that the required data are regularly collected and updated.

State-of-the-art of planning

The state-of-the-art in planning in the developing countries has not advanced much in comparison to GIS. The skills of planners and the planning system may not be ready to utilize the data and functions provided by GIS. Planners could employ GIS in conjunction with new planning techniques so that they are better able to diagnose potential problems and assess the desirability of alternative plans. In spite of this, most planners in the developing countries are not yet aware of the benefits and potential applications of GIS. Furthermore, even though much effort has been spent on data collection, comparatively little has been spent on transforming data into information for making planning decisions.

Staffing

With the rapid growth of GIS, there is a general shortage of urban planners with skills in GIS even in the developed countries. Although this situation has improved a lot in the last two decades with increasing integration of GIS education in universities, and sometimes in high schools, in the developed countries, this shortage is still quite prevalent in the developing countries both in absolute numbers and relative terms, considering their foreseeable rapid increase in urbanization.

In the developed countries, GIS training is often led by teaching and research in the universities. The reverse is the case in many developing countries where, very often, it is government agencies which buy and use GIS first through funding from international agencies. It can be several years later before GIS equipment is installed and courses are offered in universities and other tertiary institutes. Training of GIS personnel is often carried out by software companies by either sending their staff to run short courses on site or sending the operators and users to be trained in their headquarters. GIS courses and training programmes if available in developing countries are normally carried out in the departments of surveying, remote sensing and geography. There is a general lack of GIS courses in planning schools. To use GIS more effectively in planning, planners must be trained not so much in the operation of the system but how to make use of the data and functions of GIS in different processes of planning and plan evaluation (Drummond, 1995). There may be many books on the technical aspects on GIS, but there is a general lack of text books to teach planners how to use GIS beyond simple mapping and visualization.

Conclusion

GIS is quite prevalent in the planning agencies in the developed and developing countries (Worrall, 1990; Yeh, 1991). Many planning departments that had acquired mapping systems in the past have shifted to GIS in lieu of mapping software (French and Wiggins 1990). With the increase in user friendliness and functions of GIS software, and the marked decrease in the prices and increase in performance of GIS hardware, GIS is now an affordable, operational, and effective spatial planning support system. Recent development in the integration of GIS with planning models, 3-D visualization, virtual reality and the internet will make GIS more useful to urban planning. It can be used in different stages of the urban planning process. The advancement of PPGIS, 3-D visualization and web-GIS has made GIS to be increasingly useful in the public participation process of urban planning. Today, the main constraints in the use of GIS in urban planning are no longer technical issues, but the availability of data, organizational change, and training. If these constraints can be removed, GIS will be a more effective planning support system for the planning of harmonious cities no matter how they are defined and what planning paradigm they are in.

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Professor Anthony Gar-On Yeh, one of the foremost urban planners in Asia, won the 2008 UN-HABITAT Lecture Award which recognizes outstanding and sustained contribution in the field of human settlements.

Professor Yeh is currently Dean of the Graduate School, Head and Chair Professor of the Department of Urban Planning and Design, Director of both the Centre of Urban Studies and Urban Planning and Geographic Information Systems (GIS) Research Centre at the University of Hong Kong. Apart from serving as honorary professor in key universities and research institutes in China, he has served in numerous academic institutions across Asia in various capacities. He has been the Chairman of the Hong Kong Geographical Association, President of the Hong Kong GIS Association and Vice-President of the Hong Kong Institute of Planners. Professor Yeh also holds key positions in international associations including as Vice-President of the Commonwealth Association of Planners (1988-91); as Founding Secretary-General of the Asian Planning Schools Association (1993-present) and Founding Secretary-General of the Asia GIS Association (2003-present); and as Chairman of the Geographic Information Science Commission of the International Geographic Union (1996-04).

Having authored 40 books and monographs and over 200 journal papers and book chapters, Professor Yeh has had, and continues to have, a profound influence on thinking and practice in the field of urban planning. In particular, he has pioneered the application of information technologies to the field of urban and regional studies and continues to make outstanding contributions in this regard in addition to his work on new towns in Asia and urban development and planning in Hong Kong and China. His work has had widespread influence on human settlements research and policy formulation within Hong Kong, China and across the Asia-Pacific region.

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