GIS SUPPORT FOR URBAN PLANNING IN WUHAN, P.R.CHINA

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ABSTRACT

The shift from a planned economy to a market economy has been a great challenge for the urban planning bureau of Wuhan. This challenge lies partially in finding new land for the rapid urban expansion as well as reconstructing existing urban areas especially inner city areas. The urban planning bureau initiated two projects: the revision of the master plan and the development of an urban renewal plan. In both plans the university assisted in spatial data analysis and the development of a spatial data model to support the inner city redevelopment process.

1 LAND SUITABILITY ANALYSIS FOR URBAN EXPANSION

Within the context of the economic reform policy in China, Wuhan is facing many opportunities. The open-door policy has especially in coastal areas (e.g. development of the Pudong area in Shanghai) in fast economic growth, which has also affected the hinterland of Shanghai along the Yangtze river. The city is located in the central part along the Yangtze river, as well as the center of the north-south railway line, thus considered to be a regional transportation hub. These locational advantages have resulted in a steady growth and currently the city has over 3 million inhabitants, while the Wuhan municipal region has a total population of 7 million and is over 8000 square km in size. The increased growth rate together with the need for relocating certain activities (inner city industries for example) makes that new areas have to be developed for living and industrial activities. The city however has a number of natural constraints like the Yangtze river and the many lakes around the city.

To respond to these changes the municipality initiated the revision of the master plan in which the physical land use plan is an important aspect, a prerequisite for this plan is the land suitability analysis. The first step of this analysis is to investigate factors which are constraints for urban development like land use, land form, engineering geology, water supply and disaster prevention. Data of these factors are collected and mapped on a scale of 1:100,000 for the total municipal area of 8600 sq. km. Each factor is classified into three or four levels according to their suitability for urban
development and the factors are combined by using weighting factors according to their relative importance.

The following factors and their classifications are used:

* Bearing capacity of the soil:
  - below 10 tons per sqm, 10-15 tons; and > 15 tons

* Topography and flooding hazard
  - Elevation below 50 meters above sea level and areas below the flooding line (approximately below 20 meter contour level) but with concrete dams; elevation 50 - 100 meter, low lying areas with moderate quality dams; areas above 100m and areas below the flooding line and unprotected.

* Land use:
  - Areas unsuitable for agriculture; areas with high agriculture productivity; environmental (scenery, forest, lakes) protected areas.

* Earthquake hazard:
  - Areas free from earthquake; limited earthquake vulnerability; earthquake prone areas.

* Transportation:
  - Areas around different hierarchies of roads and road intersections.

Besides these restrain factors several other factors were used which can be considered as impetus to development. These aspects include availability of electricity, drinking water, location of harbor facilities, location of railway stations and the airport. These factors however have only be used for qualitative analyses.

Based on the output of the individual reclassified maps and the weighting factors a final land suitability map was made indicating the areas which will be investigated in more detail for the selection of urban expansion areas.

2 A GEOGRAPHICAL INFORMATION SYSTEM FOR INNER-CITY REDEVELOPMENT

The changes from a planned economy towards a socialist market economy have resulted in the possibility to obtain land through long term leases. These changes have had a major impact on the redevelopment of mainly central located areas through large scale (foreign) investments in commercial real estate development. New hotels, shopping centers, high income housing and corresponding investments by the municipality in roads, flyovers, bridges makes Wuhan, like other Chinese cities, looks like one big building site. The original activities and inhabitants are facing pressure of relocation, however many newcomers (migrants and the so-called floating population) are settling in the area, resulting in extremely high densities with all corresponding
problems (infrastructure and traffic problems).

The planning department can hardly cope with these problems due to lack of experience with this new situation. The past situation of blue print planning in which the government was the only actor in urban development suddenly changed with private developers and uncontrolled population movements (migration, informal economic development). There is a pressure to handle land lease and building applications quickly and regulations what to do with current inhabitants (rehousing in the city centre or at peripheral locations) are not yet fully developed. Physical and social-economic analysis of a city was not the major function of master and structure plans, designers and engineers were the most important professionals in urban planning.

The current situation requires adaptations in the urban planning bureaus to be able to use for example process planning ideas and develop entrepreneurial behaviour even in governmental offices to respond effectively to the changes within an overall strategy. One of the drawbacks is that data needed for planning exist but is not accessible (isolated in the different (statistical) bureaus) and incompatible with each other.

The spatial units for the urban area are: districts, subdistricts, neighbourhoods and buildings.

Municipality: contains all general time series data about the population, landuse and physical change.

District: contains all data by district, such as population, landuse, building and economical data. For the 7 urban districts only a limited amount of data have been used in this study.

These two spatial units are mainly used to provide the comparative context to the study area so as to understand the difference of physical and functional change.

Subdistricts: contains mainly spatial and attribute data about landuse, landrent, buildings, population, economic and household characteristics for all 13 subdistricts of the study area while only partial (census data only) for the other subdistricts.

Neighbourhood: contains detailed demographic data and household interview data for one neighbourhood only to deepen the spatial and statistical analysis.

Block: is not an official administrative spatial unit, but is a spatial unit used in this study to store detailed data on landuses and corresponding building regulations.

Building: is the lowest level of the spatial units to store all variables of each building.

The above four units are the key spatial units, which are employed to get necessary information by aggregating or disaggregating between them, based on spatial and statistical analysis. Generally, landuse should be regarded as a separate entity. In this study, landuse was linked to block and neighbourhood levels by overlaying. Therefore, it is treated as an attribute, which will be linked to different spatial units.

In the existing situation of China, the importance of socio-economic data in the
analysis especially in urban planning was highly recognized by planning departments and statistical departments. In 1993, a new National Standard Classification of Economic Activities was designed with more tertiary information added. Therefore, at macro level, the collection of socio-economic data is being provided with more chances. Due to the long period of the centralized planned economic system and close door policy of China, people are still sensitive to the security of economic data, and the supply of economic data is often thought of as illegal. The competition and conflict between different levels of organization are proving to be resistant to gaining necessary socio-economic data. Access to data even for planning departments themselves is difficult due to hierarchical restrictions, unclear organizational structures and due to incompatibility of data.

For this study, databases are designed to explore and test the application for urban analysis at different spatial levels. Different data sources and components (physical, demographic and economic) and time series were used to fill the model with the data needed to function. The necessary aggregation and disaggregation were carried out to be able to construct an integrated information system.

Redevelopment of inner cities in Wuhan aims to change the land use pattern according to market principles of land allocation. These changes are motivated from environmental (inadequate infrastructure and industries in city centre) and social point of view (improvement of living conditions by relocating people to newly built apartments).

This is seen as a complicated process involving physical, social, economic and environmental aspects, which are all very much in a process of transformation; it should be thought of as an organic whole and given comprehensive and comparative consideration from social, economic, cultural and psychological angles. Process planning should be related to the coordination between these factors. The possibilities for the formulation of an effective policy will be determined by availability of relevant data. Relevant information should include the following aspects:

- Physical (buildings and infrastructure)
- Functional (landuse, socio-demographic, economic and socio-facility)
- Environmental.

Building data

Before decisions can be made of demolition and redevelopment in built-up areas the existing situation of buildings should be analyzed including building functions, quantity, quality, value, density, number of floors, plot ratio and changes in time etc. Based on this information, it is possible to discuss and decide which buildings will be preserved, improved or demolished, how to control plot ratio etc.

The base map to identify individual buildings is the topographical map of 1988 (scale 1:2000). With intensive fieldwork this map has been updated to the 1994 situation. As large scale redevelopment started in this period with demolition of buildings a substantial amount of residential buildings had to be deleted from the 1988
building file. Based on the comparison of aerial photographs and maps of the 1988 situation with the 1977 situation little changes could be found so the 1977 building map was not created.

**Infrastructure data**

Redevelopment of cities involves as well the improvement of the inadequate infrastructures in most Chinese cities. Insufficient supply of water, sewerage systems, roads and parking spaces affect the normal development of a city. The overloaded infrastructure system will cause unnecessary loss; meanwhile, improvement of infrastructure is a basic condition of economic and environmental recoveries. The main information requirement includes: the existing networks and capacity of water supply, sewerage and drainage channels, electricity, gas and telephone systems.

**Land use data**

Owing to the complexity of land use in Chinese cities, it is necessary to analyze and evaluate the use and function of urban areas. Redevelopment possibilities should be evaluated for the necessary adjustment of the structure of the urban land use.

**Economic data**

Stimulating economic development and creation of employment opportunities are important factors for urban redevelopment. Information as the economic structure, employment, economic efficiency, restriction to development, development potential and trend could be analyzed in order to properly organize and adjust the location of economic entities.

**Socio-demographic data**

Improvement of living condition is an important concern in urban redevelopment. Relevant data regarding socio-demographic characteristics of the inhabitants in urban redevelopment areas are: number of population, number of households, age structure, employment structure, educational background, income of household, types of household, population density, living floor area per capita, floating population and its trend etc. This information comprises the basis of following decision-making:

- What percent of households could be moved out?
- How many new apartments and what types should be provided for them?
- How many types of employment-opportunities would be required?

**Social-facilities data**

Improvement of inhabitant's life consist not only of the housing condition but also that of socio-facilities such as school, health care, cultural/recreation and welfare. The quality, service level, spatial distribution of facilities are to be considered in the course of urban redevelopment.

**Environmental data**

Recovery or improvement of the environment is a basic need for the inhabitants. Strict regulations on water, air and noise pollution will however effect private investments and (small) business. In the long term however protection of the
environment is also an economical interest. Information such as air, water pollution and
noise pollution are needed but also on solid waste collection etc.

Data collection consisted of the collection of graphic data (maps and aerial
photographs) and attribute data. Although the emphasis was on the use of existing data,
some primary graphic and attribute data have been used like the making of small format
aerial photographs and the collection of data through interviews. Checking and
updating of data in the field concentrated on land use and building data.

The graphical data of the study area consist of different sources. One source are
aerial photographs either conventional ones or self-made (Small Format Aerial
Photographs) from different years. The other source are topographic maps from
different years and with different scales. The graphic data have been converted into
digital files by manual digitizing. The land use information of 1994 derived from the
interpretation of the aerial photographs have been checked and updated with fieldwork.
The detailed building map has also been checked in the field. The land use classifications
used are based on the Chinese national standard landuse classification.

Existing attribute data is related to the published population census data of 1982
and 1990 while economic data have been acquired from the statistical bureau of Wuhan.

3 CONCLUSION

GIS technology is crucial to urban analysis. The results of land suitability analysis
assisted the planners in finding new places around Wuhan for future urban development.
It shows that PC ARC/INFO is suitable for land suitability analysis.

The study in the inner city indicates that there exists big problems concerning
land use, residential areas, infrastructure, and environment. The combination of
ARCVIEW and EXCEL facilitated greatly to information analysis.

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Plan for Satellite Towns of Wuhan

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