Land Information Systems for muncipal planning

A. P. Subudhi, B. S. Sokhi & P.S. Roy
Indian Institute of Remote Sensing,
4, Kalidas Road, Dehradun
Emil: apsubudhi@hotmail.com

Introduction :
Land information is required for the majority of the activities of the municipal authorities. The need for this information is so extensive that municipalities can be considered to be very large producers and consumers of land information. In this paper, a survey result is being presented of the most important activities for which this information is required. The problems in the field of land information systems for urban areas is being described with reference to an investigation carried out in the city of Ropar (Ward No. 5) of Punjab. It also includes an indication of the subjects, which have to be covered by efficient land information for urban activities.

Land information :
An important part of the surrounding reality consists of land, which includes all geographic units having a fixed location on, in and under the surface of the earth. They vary from large administrative areas to small objects. For example, an area of an industry, for instance, is a geographic unit, as well as a house, a parcel of ground, a cable or a pipeline. Since the activities of the government, industry and private persons, with regard to land are increasing, we see in our society a growing demand for information in connection with land. Collecting, processing and supplying of land information is effected in so-called land information systems. Every city has a lot of such systems, and each covering a part of information. These systems do not cover the complete and there are gaps and overlaps.

Land information may be classified in two groups. The information referring to the geographic units themselves is called topographical information. The other group is the thematic information. We hereby mean the information that can be added to the geographic units (refer Fig. 1). Another type of land information is in the registrative and statistical information groups. Registrative information refers to geographic units such as the cadastre, cadastral parcels and houses. Statistical information refers to larger units, such as street segments, etc. Statistical information is usually expressed in numerical terms and generally collected using questionnaires. In principle any information can be linked to a geographic unit.

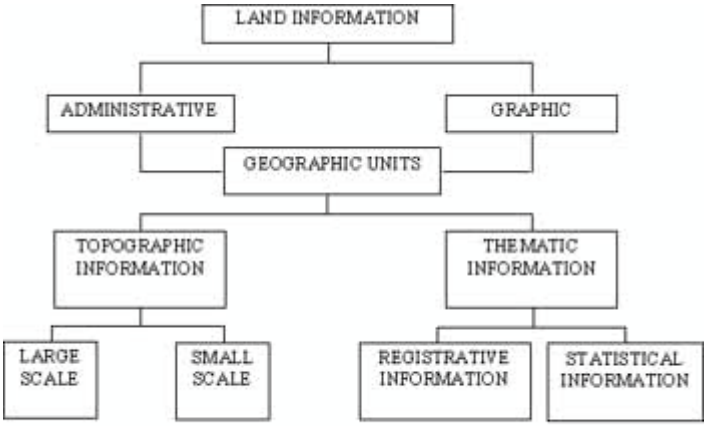

Fig.1 Land Information System

For instance, the legal situation, the value or the use that is make of a unit. It can be further explained as land information is an information about the geographic units themselves (topographic information) and the thematic information, which is very closely connected with them. Very important is the location of the geographic units with respect to the surface of the earth. This, in fact, is the only common information of all geographic units. Therefore, the location is pre-eminently the information that serves for the exchange of data between land information systems.

LIS in Municipal Organisations:
Within municipal organisation, at least three clusters of activities can be distinguished in which locationally referenced information plays an important role (Fig. 2). In number of technical and administrative departments, land based information is predominantly used for executive tasks, while in planning departments this information processed in order to support decision making. In each of these three "realms" one finds different professional backgrounds and working cultures; and information processing has specific characteristics.

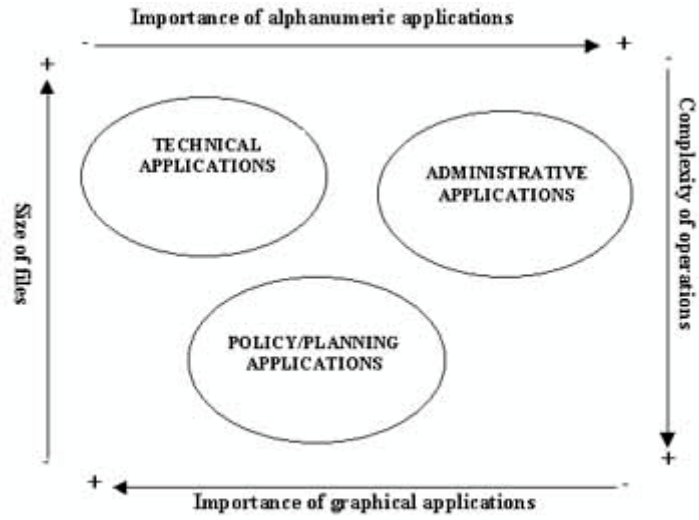

Fig 2 Working Environments in Municipal organization

The technical departments deal with the physical aspects of the built development. They fulfill design, building and installation tasks and are also responsible for control and maintenance. In this type of environment, land information systems have to be able to produce detailed and high precision technical maps. Moreover, the systems have to support the daily operations of the department; for example through the production of maintenance schemes and work orders. A central role is played by the large scale base maps including base topography and objects such as buildings, roads, facilities, and distribution networks. In general, relatively few attributes are linked with these maps.

Administrative departments manage large databases that necessary for the legal and fiscal management tasks of a municipality. These type of base systems typically deal with the registration of population, land ownership, real estate, businesses, public institutions, etc. Primarily, these systems are applications of regular relational database management packages and for the most part are routinely utilized. It is often useful to link this information to location.

The policy departments within municipal organisations are dealing with preparatory activities for strategic decision making. Tangible products of these departments are zoning plans, master plans, urban renewal

plans, housing plans, facility/utility plans, traffic plans and environment protection plans. Policy activities require information at a higher level of generalization and aggregation compared to management and maintenance activities. In order to produce this type of information, large municipalities have separate statistical or policy/management information departments. This information has to be derived from research based complex data analysis.

With respect to the automation of tasks of departments discussed above, various information systems is chosen. Technical departments, usually opt for design oriented systems (CAD: computer aided design), administrative departments select systems specially for alphanumeric data management (DBMS : data base management systems); and planning departments prefer land information systems.

Where the introduction of information systems begins is partly due to coincidence. Individual department can play an important role in this respect. In some instances, small scale dedicated solutions on personal computers are the first step. However, the automation of large administrations and registrations can lead to direct and easily demonstrable savings. For this reason, computers have often been installed in these departments first. The automated production of technical maps is highly cost-effective, which explains the wide spread installation of CAD systems. These systems are often combined with database packages to form fully operational automated mapping/facility management systems (AM/FM).

The acquisition and implementation of analytical systems is much more problematic. Cost benefit calculations with respect to the use of land information systems for production purposes are difficult

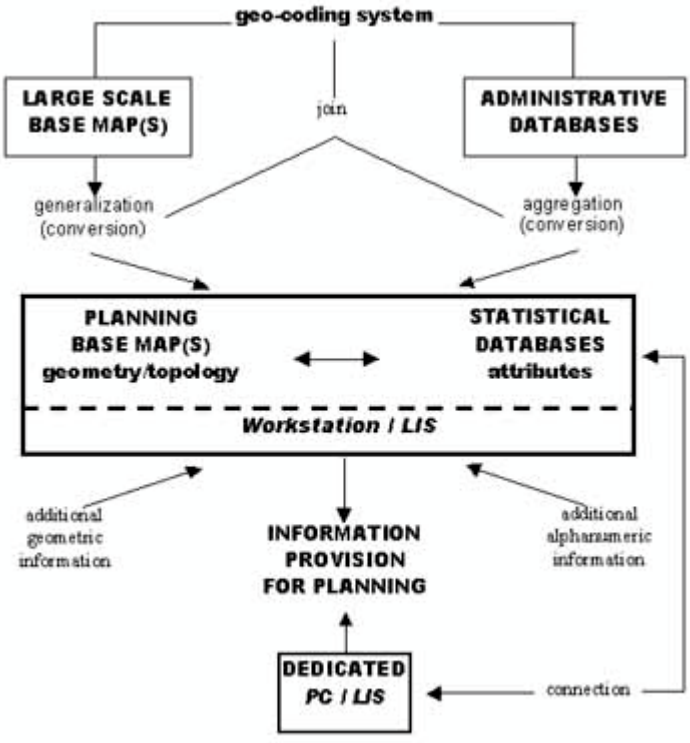

Fig3 A Top-Down Approach for LIS

to compile, although recently a number of feasibility studies with positive outcomes have been completed. The introduction of LIS has to be justified with a demonstrable qualitative improvement of decision making, which is a complicated task. Moreover, individuals working in planning departments are usually more reluctant and skeptical than in other departments of municipal organization, causing delay in the startup of computer support for planning activities.

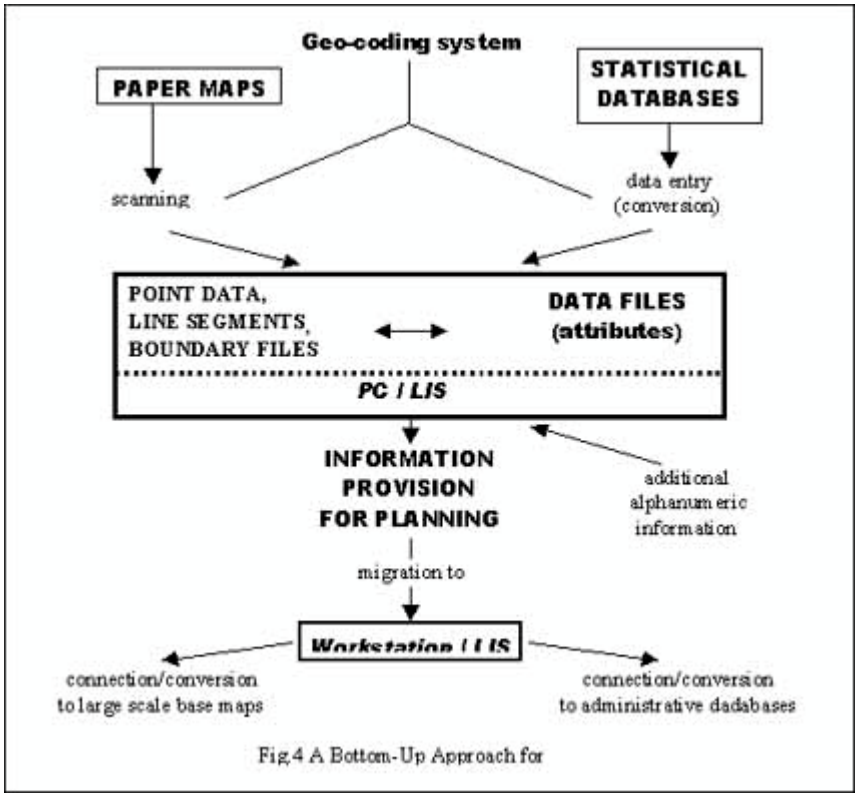

Fig.4 A Bottom-Up Approach for

The installation of different systems (CAD, DBMS and LIS) is characteristic for the first round of automation. The systems have the functionality for design, management and analysis tasks. Various modules have been added to CAD-packages as well as analytical systems have been upgraded for more design functionality. Most large LIS software packages are now interfaced with the major commercial DBMS-packages and are adopted to operate in a client server network environment based on UNIX workstations or windows. This development gives much more flexibilities and opportunities for distributed information processing solutions with central databases, local databases and also dedicated for specific applications.

Approaches to the introduction of lis in municipal planning:
Which strategies can be utilized in the introduction of land information systems in planning departments ? It is a well known fact that a transition from traditional to computer based operations involves major financial, organizational and personal consequences. Moreover, it may well take up to few years before information planning becomes a fully operational aspects: the flow of information and the employment of systems. Theoretically, an organization has to make two initial choices :

a. Follow a bottom-up or a top-down approach : starting within the planning department itself or from a broad computerization for the organization as a whole,
b. Begin with a simple LIS or install a large multi-purpose LIS package.

Both can be lead to the some ultimate goal i.e. well integrated, effective and efficient computer support systems for all activities involved in the entire municipal organization. The two choices are inter-related. The choice for a bottom-up approach will most likely lead to start with personal computers and a small easy to use software package. While, A top down approach involves the implementation of a network of servers & workstations, and the installation of a large complex LIS.

Let us examine the two models discussed above (Fig. 3 & Fig. 4). The creation of databases for planning departments can be based on the central graphical and alphanumerical databases maintained by the technical and administrative departments. Extensive data processing is

required to transform the information to the necessary format. Additionally, information must be gathered and entered into the system.

A first step is joining the graphical and alphanumerical data forming a common geo-coding and identification system. The existence of uniform classification and geocoding procedures is essential to be able to link the databases. This means that the records in administrative databases have to be linked to objects in the graphical databases. Street sections, parcel numbers, blocks, wards, transportation networks, etc. are often the geographical units that are used in planning base maps. Further the graphical data have to be generalized to the preferred map scale and, when necessary, converted to the required LIS data structure. The alphanumeric data have to be aggregated to the geographical units used in planning. The joining of two databases can be done either before or after the generalization and aggregation procedures. When all data manipulation procedures have been successfully completed, advanced information processing and mapping become feasible.

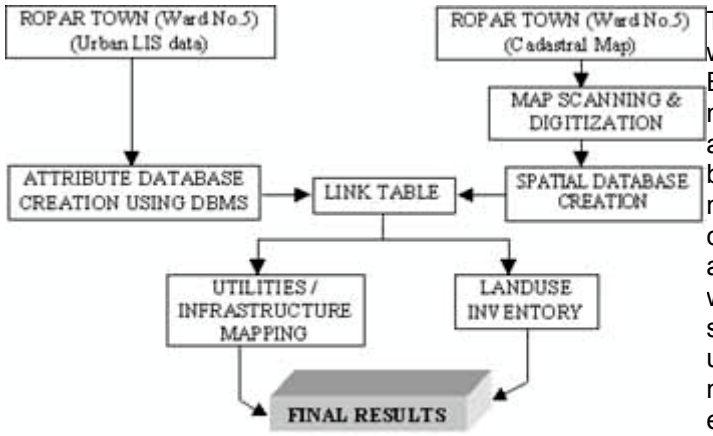

Fig.5 Methodology Flowchart

The second approach is initiated within the planning department itself. Based on a small PC, existing paper maps can be digitized / scanned and available statistical databases can be connected to these map files. The map files will most likely be a combination of point, line segment and boundary files. This approach will result in a planning information system for a municipality that is useful for many queries and thematic mapping applications. It can be expected, however, that after some time a need for a larger scale system and advanced applications might arise. The possibilities for advanced LIS applications on PC's will grow considerably in the next few years, although a decision to migrate to a LIS based system on a workstation may be unavoidable. In order to preserve the information in existing databases, data conversion would be necessary. The number of graphical and alphanumerical exchange standards, conversion programmes and data restructuring tools have increased considerably. So, the fear of complete loss of data is no longer justified.

In both cases, a LIS will be constructed consisting of one or more digital planning maps and statistical data as attributes of map objects. This database has to be supplemented with data from other information sources. Ideally, information in policy documents should be stored in the planning information system as well.

A LIS based planning information system has to be employed for the support of the main activities of a planning department. Four types of applications seem particularly well suited for computer support.

- Area Monitoring: analysis of major spatial developments in the city by means of indicators and geo-statistical methods;
- Planning Analysis: projections and simulations of alternative future development lines, often supported by spatial modeling;
- Decision Making: evaluation of alternatives and impact analysis;
- Plan Implementation & Monitoring: the production of planing maps, the provision of information about plans, the issuing of development and building permits and regular monitoring of planned and real developments.

Ropar Case Study :
One of the primary goals of LIS research is to explore the application possibilities of LIS on

different city levels. The local level is very important because in municipalities numerous managerial, research and planning tasks containing spatial dimensions can be supported by LIS. The predominantly large municipalities have been initiated into automation similar to LIS. However, restrictions with particular tasks, such as land and facility management and map making continue. The automation is often more on application of CAD instead of LIS.

In this background, present study of Ropar town (Ward No. 5) of Punjab in a step towards demonstrating feasibility of using urban land information system for parcel based inventory of land use, infrastructure and utility services for creation of a municipal information system. In this case study, problems in the field of land information systems for small towns is being described and mapped. Attempts also have been made to demonstrate whether it is technically possible to tie the existing cadastral map with the existing non-graphical databases in a LIS environment. Ropar town falls in Rupnagar district of Punjab State. It is about 50 kms. away from Chandigarh. The study is limited to the urban boundary of Ropar Town (Ward No. 5) and in primarily based on parcel based data collected by Town & Country Planning Organisation, New Delhi using a house-hold questionnaire.

The present study was restricted to one ward (Ward No. 5) of Ropar town and two databases:

- cadastral map showing details of parcel based information (with many characteristics and used as a basis for municipal information);
- statistical information (with characteristics as type of landuse, built-up area, age of building, type of structure, water supply, sewage, drainage, street light, electricity etc. used as management information for statistical purpose referring to each parcel).

Both graphical and attribute databases contain parcel identification numbers that offers a potential key to attach and join the databases to each other and to the map.

The methodology adopted for digital database creation of parcel based map, inventory of landuse, infrastructures and services/utilities for creation of municipal information system is discussed in Fig.5.

Initially the 1:4000 scale cadastral map showing parcel boundaries and other information was scanned and on screen digitization was carried out using ARCVIEW GIS software. Topological relationship were established using PC ARC/INFO GIS software. However, the digital map had non-closed polygons, crossing and interrupted lines, under and overshoots, etc. complicating the transformation to a topological digital map. These errors were removed and topology was again established in the PC ARC/INFO environment. This corrected and edited digital cadastral map was later used as basic background map for linking attribute information. The statistical information collected using questionnaire was converted into digital format using database management program of ARCVIEW GIS software. We tried to provide parcel number in both the databases in order to ensure proper link. The creation of tables and link numbers was done by a specially developed software component of ARCVIEW GIS software and statistical information is automatically linked to graphical database.

Upon completion of the link operation, we succeeded in creating a whole set of maps and tables to fulfill the objective of municipal information systems. The results of manipulations (selections, combination, etc.) in the database are being presented in the following maps, which can serve as a basis for information system in Ropar town.

1. Landuse map (Fig.7)
2. Built-up area map (Fig.8)
3. Parcel Location Map (Fig.9)
4. Water Supply Map (Fig.10)
5. Hand Pump Availability Map (Fig.11)
6. Street Light Map (Fig.12)
7. Sewage Map (Fig.13)
8. Flush system (Fig.14)

9. Electricity Availability Map (Fig.15)
10. Drainage Map (Fig.16)
11. Status of Road (Fig.17)

Conclusion & Recommedations:
The two models of the introduction of LIS in planning discussed above should be considered as theoretical extremes. Generally in the present circumstances, it will lead to an intermediate path i.e. hybrid of the both models. The organisational structure of the municipal organization, the state-of-the-art computer technology and databases are all important factors to be considered before taking any decision about the system to follow. Additionally, the future of computer hardware and software is always uncertain. Developments are continuously occurring and difficult to predict. This would suggest a careful, gradual and flexible approach. On the other hand, a stable environment is necessary for production purposes, which means that hard and software changes should not take place at short intervals.

Planners should try to become involved with the introduction of LIS in municipal organisations. This will result in broadening the scope of the profession. Planning can make contributions to forms of computerization that are important for society and environment, which will further give planners new professional opportunities.

The investigations carried out in the town of Ropar show that there are many land information systems in the municipality being handled manually or with less automation. The information supply is rather inefficient, there are many overlappings and gaps in the activities. The chaotic situation is made more chaotic because even large departments are not in a position to acquire inexpensive micro-computers of their own purposes. The advises to municipalities in general are:

- make an automated municipal information system (information on land & water) for urban area management and maintenance ;
- standardize the land related data (classification, quality, designations, spatial structures, etc.)
- install a basic system with land & building data that can be used for various applications of municipality functioning ;
- investigate the possibility for the application of a digital topographic basic file for the production of large scale maps.