Land Information System (LIS) – A Case Study in Orissa

N. Dhal
B-21 (HIG), Housing Board Colony,
Baramunda, Bhubaneswar Orissa - 751003 (India)
Ph: 0674 556184, *E mail :brig_dhal@hotmail.com*

Keywords: land information system, stereo digitization, cartographic editing, topology building

Overview

1. Introduction

Land has been the basic resource on which man has depended upon for his livelihood since time immemorial. It is permanent in nature, finite in extent, but its usage may change with time. Every activity in general, and developmental project activity in particular, is in some form or the other associated with land. Therefore, for planning purpose all land-associated information should be available in the form of a computer database, which can be easily accessed, manipulated by decision makers while formulating and executing a project. Such a database system is called Land Information System (LIS).

A parcel is an extent of land and, in today's context of an urban area, the volume of space over an area of land, is shown in the government records associated with a set of ownership rights officially recognized as property. The property also includes all items attached to the parcel of land. The physical boundary of the parcel is contiguous and is defined uniquely in the database. The said boundary is approximated to a graphical entity generally in the form of a polygon while all other associated information of the parcel are separately linked to the polygon as its attributes. These include name of owner/s, nature of tenure (free or leasehold), land-use, soil information, information about previous ownership transfers, if any, etc. The extent of inclusion of such attribute information differs from government to government and also depends on the nature of LIS application. Generally for land record purpose the parcel boundary is shown as a 2-dimentional plan or component measurements that can be used for calculation of its area and to re-lay it on the ground, when its demarcation is legally needed. Should we associate its elevation data, or in other words, define the parcel boundary in 3-dimention, such land parcel information can be better utilized for planning of a wide variety of developmental projects. A well designed parcel based LIS can guaranty ownership and tenure, resolve land disputes, improve conveyance, facilitate better land consolidation scheme, improve land revenue collection, and above all, provide the government necessary support for proper land management and monitoring of the project activities at micro level.

2. Background of Orissa Settlement Procedure

It is worthwhile to briefly look into the existing settlement procedure of Orissa to properly understand the significance of the project being discussed in subsequent paragraphs. In Orissa resettlement operation is carried out once every 25 to 30years interval to update the land records. The basic material used is a large-scale (approximately 1/4000 scale) village map prepared by methods of plane-tabling and chain & tape measurements. The village map shows individual parcels of all free hold, public and government land, encroachments and adverse possessions, if any. Area of a parcel is measured from the map graphically or with help of simple instruments. The re-settlement operation starts with a blue print of the old map, taken to field and changes/alterations graphically carried out using chain and tape measurements, during a field operation called *Kistwar*. There after the village blue map is inked up and a new corrected map is printed out. With the help of this new map and other associated records the settlement staff visit each parcel in order to examine records / transactions as claimed by each land holder or his authorized representatives. Any discrepancy found is checked through further verification on the ground during next stage of operation called *Khanapuri & Bujharat*. A final village map is then prepared along with other records, which are notified for next stage of operation called *Objection Hearing,* when any further claims by landowners can still be heard and examined. There after the map and records are handed over to the District Collector, who once again provides an opportunity to the owners to raise complaints, if any, after which the final map and records are kept as the new land records superseding the previous ones. Any land transaction there after is registered in Land Registration office and changes in form of corrections are kept by the Tehshildar

through a process of field visit by his staff called *Mutation.* All such changes are again properly reflected in a new village map during the next phase of re-settlement operation.

The process gets inordinately delayed during every stage of settlement operation for delay in preparation of maps. Also, inaccuracies of graphical measurement progressively affect the land records. The process is manual and does not support computerization. With time the quality of village map is diluted causing more complicity at next stages of settlement operation. Mutation work in the Tehshil offices remain pending with the hope of being properly incorporated during next stages of resettlement operation. Even the re-settlement operation continues at places much beyond the stipulated time frame, in a way helping the field staff to continue their camps almost indefinitely resulting in heavy cost of field work. The bureaucracy in over all charge of land records find the survey process to be difficult to understand and leave all aspects of area measurement and re-laying of parcel boundaries to the grass-root level staff to finalize, thereby, breeding corruption and scope for manipulation. This gives rise to land litigation and to be redressed only through Court cases, which are time consuming. Even courts confirm ground situation through the same set of field staff forcing people to depend upon them (patwaries/amins).

3. The Case Study

The case study of a LIS project being discussed here is a parcel based LIS created for Angul district of Orissa, more popularly called Angul-Nalco project. The project was jointly funded by the ministry of rural development, government of India and land records & survey department of government of Orissa. The project from formulation of proposal to its completion stage was executed under the direct supervision of the author while he was in R&D directorate of Survey of India. The project was sanctioned in 1992 and took over 6 years to complete. The project area covered 369 villages of Angul subdivision and over 1,00,000 hectare of revenue land where re-settlement operation was overdue. The project was called a pilot project. Yet much of the activities were in developing an indigenous technology - to generate 3-dimenational spatial data for all the parcels village-wise using the analogue photogrammetric plotters available then in SOI, to develop PC and DOS based software for processing of the parcel data to create a suitable graphic data base village-wise, and to digitally produce various intermediate cadastral documents for the state government staff so that the re-settlement operation may be carried out through modified procedure and the parcel database is created, corrected and updated *pari-pasu* with various phases of the settlement operation. In a way, the project aimed at developing digital technology for each stage of settlement operation with a view to expedite the field process and to end with a cadastral database. The database can be subsequently used through a modified *Mutation* procedure to continuously update village cadastral maps and records without going through the expensive and time consuming periodic re-settlement operations. As an offshoot, such a database should provide much needed parcel data for LIS work, which is legally validated and meets quality requirement of various micro-level developmental project activities.

4. Project Activities Step-by-Step

The activities involving the LIS work in Angul-Nalco project may be described under the following seven heads:

1. Photogrammetric 3-D digital data acquisition (stereo digitization)
2. Cartographic editing of raw parcel data in PC environment
3. Plotting of 'blue map' for *Kistwar* and *Khanpuri* operations
4. Field data acquisition, validation and updating of parcel database
5. Topology creation, editing and manipulation
6. Plotting of 'not-final' map for Objection Hearing
7. Data archival, continuous updating and LIS use

We shall go over each stage briefly to get a fair idea about why and how the LIS was developed.

5. Photogrammetric 3-D data acquisition (stereo digitization)

In *Angul-Nalco* project parcel geo-data were acquired in the form of 3-D coordinates of each village using the latest large scale (1:10,000) aerial photographs and analogue stereo plotters of SOI. The plotters were indigenously upgraded to enable digital data capture. The upgradation made use of an in-house developed attachment, patented as PCEK22 system, to interface the stereo plotters to the PC. The steps followed before actual stereo-digitization work were the same as laid down in the standard operating procedure (SOP) for photogrammetry of SOI. The stereo- digitization procedure was developed for the photogrammetric operators of SOI which has been explained in detail in a know-how documentation titled PCEK22 - PC based digital data capturing system, a joint publication of R&D, SOI and CEERI, Pilani.

Raw parcel data was digitized in the machine coordinate system by identifying on the stereo image the bends and corner points of parcels/sub-parcels, which formed the first stage of the parcel database. These were sequentially stored on-line in PCEK22 binary format during each session of digitization. The binary data were then converted to ASCII text and transformed into ground coordinates using a DGN.PRG software creating village data files of the type <file name>. EK2.

6. Cartographic editing of stereo digitized parcel data

The next stage of processing of .EK2 files used a software package called CADA (Cartographic Data edit module). Parcel coordinates generated through stereo digitization and kept in .EK2 files were having redundant values of points and nodes. When displayed graphically and zoomed out on the monitor, these additional points show more than one set of lines between two adjacent parcels. Conventionally parcels are digitized in a clock-wise fashion. But due to oversight the operators sometimes digitize in reverse direction. Some times the operators also miss out digitizing a parcel, when other parcels surround it. All such defects are reconciled in an interactive session using the CADA package. After this stage the .EK2 files could be merged to form parcel boundaries of a village as collected from photo models. By no means these are a complete set of parcel data of the village and need further ground validation and corrections.

7. Plotting of 'blue map' for *Kistwar* and *Khanapuri* operations

For preparing a 'blue map' meeting the exact technical specifications of the Settlement manual the .EK2 files of the village were brought to 'dgn' format and then used to get A0 size village 'blue maps' by plotting with help of commercially available Microstation software. Grid tics were provided 100 m apart on 1:2,000 scale for congested villages and on 1:4,000 scale for non-congested ones. Thereafter the settlement staff used the 'blue map' to correct the incomplete parcels, and provided such corrections in the form of Field Measurement Book(FMB). A software package called Field Correction Module (FCM) was developed to transform the FMB measurements into digital data and displayed on the monitor in graphic form. After validation by the field staff the digital data was then merged with the parcel database. Once the parcel boundary data was field verified, individual parcel maps were printed out using a Print Map software on scales of 1:1,000 or 1:500, the scales automatically chosen by the software depending on the extent of a parcel. The Plot Map of the parcel boundary indicated parts of adjacent parcels, provided separate space for ROR details to be recorded and indicating a host of other information like computed area in hectare, various node coordinates forming the boundary line of the referenced parcel, distances between adjacent node points for field checking, land use, soil and crop data, if available earlier. All such information could be checked and necessary corrections/ entries made on the Plot Map during *Khanpuri* stage, which subsequently helps to complete the LIS database.

8. Topology building, manipulation and updating of parcel database

Corrected and completed individual parcel plot maps as brought from *Khanapuri* work were used along with another software package called Parcel Edit Module (PEM) to show changes in parcel topology due to various land transactions, illegal encroachments or adverse possessions as field verified during combined *Kistware* and *Khanapuri* operations. Once these are completed another round of backup with PEM software ensures a properly updated parcel topology of all parcels available in the village. Additional information in form of ROR, land –use, soil, crop etc are updated in an attribute database created using DBase IV . The common linkage between the parcel boundary database and the attribute database is the parcel code number uniquely created by the software package PEM. Since the parcel database is created through various stages of field based settlement operations, such a database also meets the basic legal requirements. The attribute data is also fully ground verified.

9. Plotting of 'not-final' map for Objection Hearing

The next stage of the settlement operation is *Objection Hearing* for which a 'not-final' map was plotted using the Microstation32 software and parcel boundary data taken from PEM processed updated village database. Changes at this stage are often limited to some of the ROR. Such changes are brought into the village data base editing with the DBaseIV software. After this step the database is complete as far as the settlement department is concerned. The department prepared draft copy of the final village map and along with relevant records handed over to the District Collector for notification to the public.

10. Data archival, continuous updating and LIS use

Traditionally directorate of land records & survey holds a set of village map and supporting records for archival purpose after completion of the settlement operation and a new set of map and records are handed over to the district officials for their maintenance until the next cycle of re-settlement operation. In light of the modernization attempted in Angul-Nalco project, village-wise parcel databases are maintained at the Directorate, while a copy is maintained at Tehshil office. The Tehshil office staff use a *Mutation* software package to bring about changes in the village database as and when land transactions take place. A copy of such changes is also sent to the Directorate to update the main database maintained there. A confirmation from the Directorate completes the *Mutation* activity initiated by the Tehshil office. This way any person / organization can get a current copy of the village map either in soft or hard copy option only from the Settlement Directorate and from no other source.

Potentially Angul-Nalco technology provides for terrain elevation data to be available in the parcel database. This is in contrary to the traditional practice to maintain cadastral data / map in 2-D format. Also, the topographic information can be associated with the parcel polygon.

This way not only the requirement of property cadastre is met but also the database can be made available to the District authorities for multi-purpose project activities. It may be stated here that LIS activities of the pilot project were forming the second phase, which was actually not executed. Whatever development discussed here was based on R&D work undertaken in SOI and were not implemented in practice.

11. Conclusion

LIS is an expensive and time taking proposition. Often governments have tried to find easy solution through computerization of existing Land Records – because, creating authentic land data confirming to the ground realities is very difficult to attempt. Had the present set of records been meeting the need of the day, perhaps mere computerization of the records is the obvious solution. But, alas, almost all the existing cadastral systems are out-dated, the reason being the existing system was introduced in the distant past when land was in abundance and cheap. Therefore, loosely made specifications were laid down to prepare the land records. As the land prices sore up and fragmentations of private land and encroachment of public land grew rapidly taking full advantage of the existing weaknesses of the system, the records were badly corrupted by the unscrupulous ones year after year.

No computer database will behave better than quality of its data sets. In the context of LIS, the primary data- set are the land parcels, whether belonging to private, public or the government, and all other information are associated to this primary set of data. Hence looking to the future needs, one cannot avoid once for all to pick up these parcels true to their present shape and size using improved technical specifications.

Coming to the technology aspects – a wide choice is available today, from high resolution satellite imagery, soft copy photogrammetry to field oriented GPS and Total Station. No modern technology is cheap except for information technology. Therefore innovative way of blending of indigenous software can only reduce the overall technology cost as has been tried in the subject case study. Also one needs to take into consideration the available infrastructure and the capacity of human resource available to create and maintain the LIS.

Computerised land records are not acceptable in the Court of Law unless the existing legal system is suitably modified, which in itself is a major task. This needs strong public opinion and support. Any system, which is transparent, conforming to the ground reality is needed by all of us to harness the technology properly for success of various developmental projects.