

Cadastral Map Specification, Methodology And Infrastructure For Adoption By The States

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ABSTRACT

The Cadastral map which was so far being considered only as a revenue map and a sort of personal possession of Patwari of the village, has all of a sudden attained an importance of becoming a base for all types of maps needed for development in any field or management in natural or unnatural disasters/ calamities. With the introduction of Panchayati Raj System, the Cadastral maps have attained a new dimension for there is no map available on large scale which Panchayats may use for planning or execution of their schemes. Though all powers of planning and execution have been invested in Panchayats with full financial support but no attention has been paid to see as to how they will function without maps of the scale needed for the purpose.

To plan any project, how so ever big or small, one needs a map. For general planning a small scale map can serve the purpose but for detailed planning a large scale maps are generally prepared on demand as per the requirements of the project but the only large-scale map available otherwise is a 'Cadastral Map' or usually called a 'Revenue Map'. But the trouble is that it is a line map of the cultivated fields of a village and does not depict details except for odd survey points. Yes, keeping the latest technology in mind it can become a base on which other details can be superimposed to get any variety of map. These details are now easily available from large scale imagery for super imposition on the frame works whose coordinates are known. The cadastral map can provide such a base when surveyed with GPS and other techniques as it would become a digital map to hold and mosaic any type of data which one may like to superimpose.

There is no country in the World, which has made progress without first preparing large scale maps of the areas they wanted to develop. In our country we only say that the tremendous progress made in various fields is not percolating to grass root level but make no efforts to get large-scale maps made of the areas without which progress is not possible. Projects after projects are being sanctioned without providing the basic requirements of large-scale maps and as a result the projects either get delayed or do not see the light.

Effort has been made to identify structure, specifications and methodology etc. which can be adopted by various states, especially by the new and up coming state of Uttaranchal, to tide over the initial problems and put development on firm footing at grass root level.

INTRODUCTION

The cadastral map which was so far being considered only as a revenue map, and a sort of personal possession of Patwari of a village, has all of a sudden attained an importance of becoming a base for all types of maps needed for development in any field or management in natural or unnatural disasters/ calamities. With the introduction of Panchayati Raj System the Cadastral maps have attained a new dimension for there is no map available on large scale which Panchayats may use for planning or execution of their schemes. Though all powers of planning and execution have been invested in Panchayat with full financial support but no attention has been paid to see as to how they will function without maps of the scale needed for the purpose. Maps on 1:10,000 scale are considered ideal for the purpose.

To plan any project, how so ever big or small, one needs a map. For general planning a small scale map can serve the purpose but for detailed planning a map on large scale

commensurate with the scale of the project envisaged is required. Large scale maps are generally prepared on demand as per the requirements of the project but the only large scale map available otherwise is a 'Cadastral Map' or usually called a 'Revenue Map' which is normally on 1:4000 scale and in congested areas on 1:2000. But with the latest techniques it is being prepared on 1:5000 scale. But the trouble is that it is a line map of the cultivated fields of a village and does not depict details except for odd survey points. Yes, keeping the latest technology in mind it can become a base on which other details can be superimposed to get any variety of map. These details are now easily available from high resolution imagery for super imposition on a framework whose coordinates are known. The cadastral map can provide such a base when surveyed with GPS and other techniques as it would become a digital map to hold and mosaic any type of data which one may like to superimpose.

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wanted to develop. In our country we only say that the tremendous progress made in various fields is not percolating to grass root level but make no efforts to get large scale maps made of the areas without which progress is not possible. Projects after projects are being sanctioned without providing the basic requirements of large scale maps and as a result the projects either get delayed or do not see the light.

Effort has been made to identify structure, specifications, and methodology etc. which can be adopted by various states, especially by the new and up coming state of Uttaranchal, to tide over the initial problems and put development on firm footing at grass root level.

GPS (Global Positioning System)

GPS Technology has been adopted by all advanced countries of the world in large scale mapping. But the experiments conducted by them in various fields are not being introduced in our country to the advantage of our people. We still think of again experimenting them here before adopting the proven system. GPS Technology which has been utilized by many countries for producing large scale maps and especially cadastral maps is yet to be utilized in our country for the purpose.

GPS TECHNOLOGY

Global Positioning System (GPS) it is an all weather space based navigation system. The launching of artificial satellite into space heralded the beginning of the space age. Artificial satellites were launched into the space for the purpose. The artificial satellite can be classified into three different technological destination: (1) Remote Sensing Satellite (150-1000 km); (2) Navigation Satellite (1000-20,000 km); (3) Communication Satellite (36,000 km). A satellite is put in a geo-stationary orbit at rest with respect to the rotating earth. The system consist of three major segments (a) Space segment - satellite that transmit radio signals (b) Control Segment - ground based equipment to monitor the satellite and update their signals (c) User Segment - equipment which passively receives and converts satellite signals into positioning and navigation information. The complete system operates on two L band frequencies - L1 (1575.4 MHz) and L2 (1227.6 MHz). The full constellation consist of 24 satellites in different orbital planes, 60 degree apart and each plane having three satellites in 2,200 km circular orbits, inclination of 55 degree with 12 hrs periods. Spacing is planned to ensure that at least 4 satellites remain in view to the user at any time. The positioning of the earth is obtained through the use of GPS instrument placed at the point where coordinate are required. Each GPS satellite transmits a unique signal on two

band frequencies L1 and L2 with wave length 19 and 24 cm approximately. The present day GPS receiver are fitted with the following gazettes:-

Pseudo ranges using thus C/A code

Sudo ranges using the P-code

Doppler measurements

Phase measurements of carriers

P-code is not frequently available to civil users' and the system suffers from multi-path affects.

The satellite are in circular orbits, 20183 kms above the earths surface. At this height the satellite revolves around the earth once every twelve hours.

The Navtar Global Positioning System (GPS), is now considered to be one of the most powerful geodetic advantages over classical geodetic techniques like triangulation and trilateration. GPS is rapid, more economic, less weather dependent, needs no intervisibility between stations and can be used continuously for gathering data.

ERA OF SATELLITE

Exploration of space brought satellites and earth satellite. Moon became the first target to explore and know what it exactly looks like from the other side which cannot be seen from the earth and secondly to find the possibility of human life there. Soon the interest turned towards exploring our own earth from space which led to Earth Observation (EO) satellites.

The data transmitted by the satellite being enormous problem arose about its compiling, handling, storage and retrieve. It was solved through computers which are now in common use. A variety of EO satellites were put in orbit exploring information in different fields. It started with monitoring global environmental changes specially affecting weather, telecommunications etc. and soon covered practically all aspects of human life. Its main aim was to provide high resolution imagery of land to decipher details of happenings in every part of the world. An integrated system to know changes taking place anywhere in the world was introduced by putting in orbit a number of satellites. Recently, IKONOS space imaging system has given imagery of one meter resolution by which even motor cars parked on street can be seen. The same satellite imagery has been used by Reliance to prepare Geodatabase which comprised of datasets of city level data of 1:1000 scale of 194 cities. It also has the landbase data for the long distance backbone route and network data collected by performing a physical land survey and is geo-

referenced by a differential GPS survey in navigational mode through out the country.

In this regard, India since March 1988 had regularly been placing satellites in space with remote sensing data services. The thrust had been on various key sectors affecting the human life. Here too we started with weather, communications and other aspects of land and water resources and management. In the field of cartography IRS-1C was put in orbit in December 1995 giving satellite imagery of resolution of about 6 mts. with which a map of scale 1:50,000 could be prepared with the base framework of Survey of India map or control work. Such a base was needed to prepare map with the details got from the imagery on the same scale.

The Indian department of space was to put in orbit IRS-P5 (CARTOSAT-I) quite sometime back, as per their space programme to provide state-of-art capabilities in the cartographic field but due to financial constraints had to postpone it to the year 2002, though it's launching was included in the 10th five year plan. We understand that even that is being modified to put in some other plan. IRS-P5 was fitted with two panchromatic camera's such that one looking fore at + 26 degrees with respect to NADIR and the other looking aft at - 10 degrees with respect to NADIR along the track direction thereby giving a stereo pair of imagery to work on, providing 102.5 mt. Resolution with 12 to 30 km swath. It will provide cadastral level information up to 1:5,000 scale for thematic application. The launching of this satellite has been postponed as the planners have not properly understood the implications it has on the grass root level. It will be appreciated that there are no large scale maps for Panchayats to work on and our cadastral maps are very old and need quick revision. The only maps available are on 1:50,000 or in some cases maps on 1:25,000 scale and those too are not available to the public due to restriction policy. The district maps produced recently are also on the scale of 1:50,000 whereas the need of the hour is a map on 1:10,000 scale for Panchayats and 1:5,000 scale for cadastral work.

WGS-84 and EVEREST SPHERIOD

In Global Positioning System the coordinates are based on World Geodetic System (WGS) 1984 which is Geo-centric i.e. where the centre of its ellipsoid coincides with the true centre of the earth and its surface provides an average fit of the joint. The coordinates on which we work in India are based on Everest Spheroid, which was devised by Sir George Everest, the then Surveyor General of India in 1830. In this minor axis is assumed to be parallel to or coincident with the mean polar axis of rotation of the earth. Kalyanpur in central India was taken as its origin which is at the intersection of two primary

series - the Greater Arc Meridional series connecting Cape-Comorin (Kanya Kumari) and Mussoorie and the longitudinal series connecting Calcutta and Karachi. A reference Ellipsoid is defined by Semi major axis, flattening at ends, latitude, longitude and deflection from vertical, prime vertical, Geodetic undulations etc. when worked out. Normally the sea level is taken as datum as zero level which again varies in different parts of the world depending upon the sea depth, temperature, ocean currents etc. Similarly, for World Geodetic System a surface has been developed by revolution of a suitable Ellipse along the minor axis and Ellipsoidal surface generated is a convenient Mathematical model which has been sub divided into latitude, longitude etc. This ellipsoid is geocentric whereas the Ellipsoid used in various parts including India are non-geocentric ellipsoids. In India all the mapping activities are based on Everest Spheroid and in GPS it is WGS-84. As such, some conversion parameters have to be worked out for bringing data from one system to another. For this transformation, three translation, three rotation and scale factor are needed for the mathematical model to convert coordinates at a known station. Survey of India has done it and have used these parameters in revising their control work. They have found the GPS system more accurate and quick than their normal control work.

Restriction Policy

The greatest advantage of GPS is the transformation of coordinates in three dimensions into plain surface in two dimensions which can be used in cadastral surveys as x-y coordinates. It may be added here that taking smaller areas into consideration the curved surfaces of the ellipsoid get transformed into plane surfaces. The rectangular grid can be used conveniently. This does not mean that the coordinates of the point are not available in three dimensions. These remain stored and can be used if required with National grid. In some of the GPS instruments the facility of software to give x-y coordinates is in built and they provide x-y coordinates without any additional software.

As we all know, Survey of India maps are based on Everest Spheroid as datum and control other data on maps of border sheets up to three sheets depth from all borders or even more at places is classified as restricted for use of Defence Forces only or for official use to be obtained with special permission from authorized officials. To obviate this problem Survey of India has released on 20th November 2002 the first Map in digital format on WGS-84 Datum on Gujarat state on 1:25,000 scale for public use with less details. Map was released both in analogue and digital format and is available for sale at Surveyor General's Office. Very soon they will release these

digital maps on WGS series for the entire country. But the trouble is that even these do not serve the purpose of large scale maps needed for the development and cadastral maps for land revenue.

ADVANTAGE OF GPS

The advantages of GPS system are that it can work in any weather, needs no clearance as required for other instruments and above all the three dimensional coordinates can be converted into two dimensional coordinates which allow easy plotting and reading. Since the plotting is in x-y coordinates, it jumps the preview of Restriction Policy which essentially applies to coordinates in latitude, longitude. Well, the coordinates in three dimensions too remain in the system for use for other purposes as and when required. Laser Technology has also come with GPS to get coordinates of the remote places which are hidden from the satellites or where one cannot reach or doesn't want to go due to one or the other reason say soft ground, insects, reptiles, ferocious dogs, wild animals or areas covered by foliage or thick trees or forest or areas under bridge etc.

Once we talk of GPS, the terminology used in its application is brought forward in a mind boggling manner. A variety of terms in carriers of frequencies, the type of observations, movement of instruments appear like static, pseudo - kinematic, realtime-kinematic (RTK) etc. which sound very complicated. Normally, short observation time is achieved by dual frequency observations but with longer observations, if static, even single frequency is preferred. Actually static and dynamic are the two modes which cover all operations. Longer observation time gives more accuracy and reliability especially where high multi path environments with more than four satellites are visible for best fitting as it helps least square adjustment of vectors in static mode.

The greatest advantage with GPS is that a person who has some knowledge about surveying can be trained to work with GPS within a week and can handle the Rower part of the instrument effectively to carry out the Traverse with it to make a line map-cadastral survey. With more number of rowers which are allowed with one GPS instrument, a village can easily be covered in one day. If this activity is carried out simultaneously in all the states and districts you can imagine how fast the country can be covered. Well, this becomes the base not only for Cadastral Surveys but for large scale surveys needed for Panchayats.

INFRASTRUCTURE

It may be mentioned here that cadastral surveying is a state subject but the Ministry of Rural Development, Govt. of India

keeps on providing funds under various schemes to state Govts. or sometimes shares the cost of projects undertaken by the State Govts. For their uplift. Survey of India is the technical advisor to the centre and states on Technical matters and provide technical advice and know how as and when asked for. But unless the three work together or join hands it is not possible to take up projects of National interest. In such schemes the Ministry of Rural Development should provide necessary funds to purchase the instruments & equipments and the State Govts. Should provide necessary staff and infrastructure to run the project and Survey of India should provide technical know-how by deputing their officers to those projects. Unless all the three join their hands its not possible to implement such schemes of National importance.

I think Govt. of India should constitute a committee to remove restrictions which do not allow them to work together by suitably amending their duties and responsibilities to meet this National requirement. Apparently there appears to be no hitch but when it comes to working together the duties and responsibilities create water tight compartments and things fizzle out under one or the other excuse. Had it not been there, the cadastral survey revision work would have started in a big way as back as in 1995 when Appu Committee, where I was a member, recommended it's use.

As suggested by the High Power National Committee on Land Revenue Administration a separate Institute for Cadastral and Large Scale Maps be set up to prepare large maps for which infra structure be provided by the state Govt. with working staff of state survey Department, the Ministry of Rural Development and Employment should provide sufficient funds and equipments required for the institute and Survey of India to provide Technical know how and control other technical department by sending officers on deputation. This institute should function for two or three adjoining states to produce cadastral and other large scale maps needed for various purposes. Since this new institute will have sufficient potential to work for various states, the adjoining states must join hands to take full advantage of the institute by providing equivalent assistance needed as by the other states.

Map Projection

No set pattern of projection was being followed by the state Govt. for preparing Cadastral maps but in majority of cases Cassini Projection was being followed. On Cassini Projection the North-South stretching of scale is not balanced by any East - West change of scale except for very small areas. In any projection the meridians and parallels must necessarily cut at right angles. The projection having this feature will be orthomorphic and at any point the scale along the Meridian is

equal to the scale along the Parallel. Precisely it is the same projection with which we use in guide maps. It is equal area rectangular projection. This is most suitable as it has many advantages besides being easy to operate and beyond the preview of restriction policy as no values of Latitude and Longitude are shown and Grid could be reflected in alphabetical and numerical values. Of course it can be correlated with control points but nothing is given on a platter. As I said earlier the GPS provides coordinates in x-y, besides three dimensional coordinates, which can be put on rectangular grid to avoid restriction policy parameters.

GIS (Geographic Information System)

GIS is a very versatile Technology and there is no field where this technology has not been used. It is a computer system that can hold and use data describing places on the earth's surface. The data stored for each layer of features contain two major components: Spatial information (i.e. feature coordinates and topology) and descriptive, tabular information. It serves as a repository of data at various levels available in different layers for mosaicing with other data as and when required. The real power of GIS is not only to produce maps of existing information but to combine and analyse multiple layers to produce new layers of information. Another capability of GIS is the Terrain Modeling to get 3D view and it is possible to rotate and tilt the model, to exaggerate the vertical scale, to find the height of any point, to determine whether by standing at one point you can see another. When fitted with GPS, GIS can produce wonders as data stored in different layers can provide a variety of information which can be used as convenient on maps or otherwise. Classified data can be put on Restricted Maps and not classified on unrestricted. It is a big advantage and helps in quickly segregating data as per use and Restriction policy and one can get from workstation a map in any form -soft-copy or hardcopy.

COMPUTERIZATION OF RECORDS

Many State Governments have undertaken computerization of land records not only to save records from the vagaries of weather, insects and pesticides but to save space and have permanent records, copies of which could be retrieved and updated and supplied quickly. The Department of Revenue in Karnataka has computerized 20 million records of land ownership of 6.7 million farmers in the state. A copy of the Record of Rights, Tenancy and Crops (RTC) - a revenue document needed for many tasks such as taking bank loans etc. can be had for Rs. 15/-. They call it Bhoomi Project and Bhoomi Centres have been set up in 177 taluks of the state to supply such copies. It permits on line updating of land records for which NIC (National Informatics Centre) has developed the software.

LASER TECHNOLOGY WITH GPS

The introduction of laser offset information has added a new dimension to GPS. It is a combination of distance and direction and can be used with GPS instrument to get offset without visiting the place. Sometimes the place required to be visited may be covered or does not have opening to go or may be a place where one does not want to go due to various reasons may be the angry dogs or other insects to bite. The laser instruments are either hand held or can be fitted along with the GPS and display the range, azimuth and inclination to any target without use of any prisms or reflectors. It can be directed on any junction which can be plotted without visiting that. It can expedite survey where the fields are very small and more in number. Thus from one central place one can plot various junctions around without visiting them. A variety of laser equipment viz. Geolaser, Laser gun, Laser Range finder etc. are available for the purpose.

High resolution airborne laser scanners have been used to detect and measure individual trees and their crown diameter as airborne laser scanning systems offer the possibility to retrieve three-dimensional information about individual trees and other details.

AIRBORNE DIRECT DIGITAL IMAGING SYSTEM

Solid State Digital Cameras are now replacing the normal film mapping Cameras which are being fitted in aircraft to pictorise ground for ground survey providing ortho-rectified frames or mosaics on CD-ROM, photo paper or transparencies as we get from satellite imageries and can be processed in the same manner. It presents high image quality in color or color-infrared imager. Each frame is geo-positioned by use of kinematic GPS and a precision Litton inertial measuring unit (IMU). The integration of the GPS, the IMU and camera data along with the digital elevation model (DEM) permits to ortho-rectify and geo-position their image product without the need for ground surveyed ground points. This process is called direct geo-referencing and it obviates the need for aerial triangulation and ground control points - a major cost saving. This system will be useful for quick revision to examine changes which occur due to sudden natural calamities.

The cameras used are Kodak DCS 460 frame Cameras with a CCD array of 3072 by 2048 pixels. In each frame CCD is charged couple device which is sensitive to wavelengths (0.4 to 1um) in the visible and near infra-red parts of the spectrum. The camera can be used in a variety of focal length lenses. The digital image is reconstructed at the ground station where hardcopy can be printed and can be brought up on computer workstations for image processing such as geometric and

radiometric corrections. This is especially true for those who use GIS - a powerful tool in today's imagery driven mapping. Even the film in normal cameras is being scanned into pixels for use in softcopy workstations.

CONCLUSION

If the above technology is adopted, it will not only meet the requirements of cadastral maps where a quick and fool proof system is required to demarcate lands which is the main source of quarrels, fights and litigations in villages and on which some of them spend the whole lives earnings. Besides, it will provide a base for getting a variety of large scale maps needed practically in every field of activity especially the Panchayati Raj, Wasteland management, Disaster management, Watershed Development etc. It will fasten the process of development at grass root level as completion of NGO and other Government projects will become easy. Newly formed states like Uttaranchal can take maximum benefit out of it for their quick development. The system will be able to sustain and adopt the latest advances in technology which are fast

developing and are needed for the progress of the country.

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