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Stručni članak

# Digital Cadastral Surveying for Land Encroachment Identification using Spatial Technologies

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*ABSTRACT. Digital Cadastral Surveying is the need of present and future generations. The invention of Computer has revamped the face of the world dynamically. Every day in our life is digitalised and with out computers the world could not perform efficiently. The Computers, Satellite images, Aerial digital images could be efficaciously used in the creation of new experimental methodologies for Cadastral Surveying. Land records are obtained by Cadastral Surveying, which in turn provides the cornerstone for Land Use Planning. Land Use planning is influenced by many factors directly and indirectly. Land encroachment is found to be one of the direct factors affecting Land Use Planning. The Land Encroachments are identified by digitisation and overlaying analysis using standard GIS software, GPS Equipments for obtaining Ground Control Points, with Satellite images and Aerial images combined with conventional land records available with the Government Authority. Disquisition of Land encroachment is undertaken in this paper, to find the encroachment and its types. The problems involved in the encroachments, their detrimental effects on country's growth are considered while formation of methodology to the serve the purpose of its creation. Pros and Cons of the technology is known from the work and explained. This is a Research application requiring hybridization of technologies to obtain high quality spatial surveying products.*

*Keywords: digital cadastral survey, land encroachment, identification, GIS, GPS.*

## 1. Introduction

The concept of Digital Cadastral Survey evolved from the concept of digital photogrammetry (Agrawal and Kumar 2008). The Digital Photogrammetry deals with three dimensional mapping of terrain features, the digital cadastral surveying deals with two dimensional mapping of terrain features. Today's trend is 2 Dimen-

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sional Cadastral Surveying to 3 Dimensional Cadastral Surveying, but the 2 Dimensional Cadastral Survey's efficiency in finding the Land Encroachment is experimented in this paper. Image for digital cadastral surveying could be obtained from high resolution satellite image and by aerial image for the study area. Land is the important aspect of human life by which human wealth and riches are measured. The need for land escalated desperately for all kinds of human activities like settlement, cultivation, farming, rearing, and of infrastructural needs like roads, buildings, airports, ports, water storage structures in the past decades. The encroachment in land is not a recent issue for developing country like India. The land survey and land records were prepared by the British in India during their rule to collect taxes from people through Zamindars, and Thagirdhars. All the lands classified as government, forest, private lands, temple lands, grazing lands, water bodies and lands lacked proper ownerships are encroached by peoples living around the places. The Indian constituency permits them to claim ownership if they habituated the land for certain period and paid taxes for the land, they could be declared as owners if the land lacks ownership records of the past.

India is an enormous country with geographical area of 3,287,240 square kilometres approximately and 1,210,193,422 persons approximately by 2011 population survey, 28 states and 7 union territories form this enormous country which is the worlds second populous. Managing and surveying the land is a consequential task (URL 1). Poor management of land already led to the court cases and mafia interferences in the land transactions. The fluent possible surveying and management of land are by spatial technology, which conceals larger area in shorter span of time.

The encroachment in land is a perpetual problem which is found its existence even now in many places of the country. Encroachment seems to be a powerful instrument for some real estate owners and mafia to abduct land from government and even from private land owners some times. Due to encroachment in the land, which is needed for the public infrastructural projects, the delay is observed in completion of the project till the encroachments are removed completely. This situation in turn increases the project cost indirectly due to floating market rates of raw materials needed to complete the project (Blagonić and Prosen 2007).

Satellite image and aerial image are two benevolent sources of data from different platforms, which provide spatial data for analysing digital cadastral surveying to experiment its suitability in land surveying digitally. This will be a fruitful method in finding the government land and also in monitoring the land related activities. The activities of illegal manner, like non-permit constructions, encroachments in private and government lands, and violation of master plan of the city could also be monitored.

Any non-permit mining, deforestation, construction along coastal line could be managed and monitored. The satellite image of high resolution renders its part in finding the features easily in the satellite image as it would be carried out in the field. For fields which are very large it is difficult to identify the boundaries in site, even those issues could be easily solved by use of the satellite images. The aerial image comprises the same properties of satellite images in feature identification in the images. The availability of satellite images cannot be ensured, due to the climatic conditions like rain, fog, snow, cyclones. The aerial images are costly

when compared to satellite images in terms of image area coverage, can be availed on requirement by flying the aircraft on pre-planned image acquiring techniques.

## 2. Existing Land Surveying Method

The method of surveying adapted in India varies from state to state, because of the difference in the terrain of the country. India is bordered by Himalayan Mountains in the north-east, Eastern Ghats and Western Ghats along the east and west side of the country and Deccan platue in the south. Similar method of survey could not be followed throughout the country. Chain and tape method is followed in the state of Tamil Nadu located south of India. Plane table method is followed in the hilly and mountainous regions to prepare the cadastral maps of the other parts of the country region.

The error allowance for chain and tape method is one link (+ or – 20 cm) for one chain measurement of 20 meters. Error allowance for area is + or – 5% for the total area calculated per field. The method followed, while using chain and tape is Diagonal and Offset method. Village is the smallest unit for maintaining land records. Each parcel of land will be in village administration boundary. The value of dimensions and area which are obtained by chain and tape may have additive or subtractive errors as per the error allowances.

## 3. Spatial Technologies

The Spatial Technologies such as GPS, GIS, Satellite Image, and Aerial Digital Image are employed in the research methodologies to find out the economical and suitable land encroachment identification method. The satellite image of Quick Bird having spatial resolution of 0.61 meters is used and the Aerial Digital Image of 0.15 meters of Ground Sample Distance is used in the research application methodologies. The Global Positioning System equipment used in this methodology is Trimble 4000SSE, and 5700 models. The GIS software used in this research is ARC GIS 9.1 product from ESRI Company.

## 4. Method of Digital Cadastral Surveying

The spatial data used for carrying out the digital cadastral surveying are satellite imagery of quick bird with image resolution of 0.61 meters and aerial image of the study area with 0.15 meters Ground Sample Distance (GSD). The software required is ARC GIS or any other GIS (Geographical Information System) software suitable for digital cadastral survey could be used. The equipments used are Global Positioning System in static mode and respective software provided from the brand of purchase for processing the data obtained. The study area chosen is Ambattur taluk, Thiruvallur district which is under administrative boundary of Chennai. The Chennai metropolitan city is the capital of the state of Tamil Nadu, which is located in the south India. The study area and its administrative boundaries are shown clearly in Fig. 1. The study area consists of 46 villages, out of

which 8 villages are under the administrative boundary of corporation of Chennai metropolitan city. The study area is in fast developing pace with variety of terrain features in the relatively flat surface having water bodies, residential settlements, industries and area of commercial and economical importance. The availability of various features in the study area enhances the testing ability of digital cadastral survey in a relatively flat terrain.

Fig. 1. *Ambattur Taluk Map Showing 46 Village Administrative Boundaries.*

The satellite image is obtained from the digital globe company by placing order for purchase to the specific study area by row and path numbers. Suitable locations for making GPS (Global Positioning System) observations are selected with satellite images and by field visits. The locations where GPS observations are carried out, it will be used as GCPs (Ground Control Points). Building edges with out canopy cover, road junctions, farming field edges with out vegetation cover, bridges are more suitable locations for Ground Control Points. The GPS observations are carried out in the suitable selected areas where vegetation and high rise buildings are less (Seeber 1993). The GPS unit is made to observe latitude and longitude in static mode as precise values are required for carrying out Digital Cadastral Survey. The observation made in static mode lasts for minimum of 20 to 30 minutes in static differential global positioning system mode of operation. Accuracy and precision achieved by this mode will be + or – 10 mm. This is the recommended level of accuracy for Ground Control Points in the cadastral surveying.

The images are uploaded in the arc catalogue and the projection is set to UTM zone for India, State Tamil Nadu, which is 44N in the projected coordinate system

option in ARC GIS 9.1. The spatial data are registered using the ground control points obtained by GPS surveying. The Land Survey Record maps collected from the Land Survey and Land Records Department of Tamil Nadu State Government are scanned and uploaded in the Arc catalogue of Arc GIS and registered with the coordinates of latitude and longitude obtained from GPS in static mode of survey (Boc 2009). The spatial data of aerial and satellite image is uploaded in layers of Arc Map and the map layers of Land records are overlaid. The land records identical to the field boundaries in satellite image and aerial image are distinguished. The government lands are identified by land record register, which states the details of land by parcel numbers, subdivision of the parcels in the land record and in the image at the same time.

The parcels belonging to government are identified and digitised in a separate layer. The encroachments in the land will be visible in the spatial data of the aerial and satellite image. The encroachments in the land parcels could be easily identified by this method. Then the encroachments are digitised separately in the same layer with different coloured hatchings. The Fig. 2 show

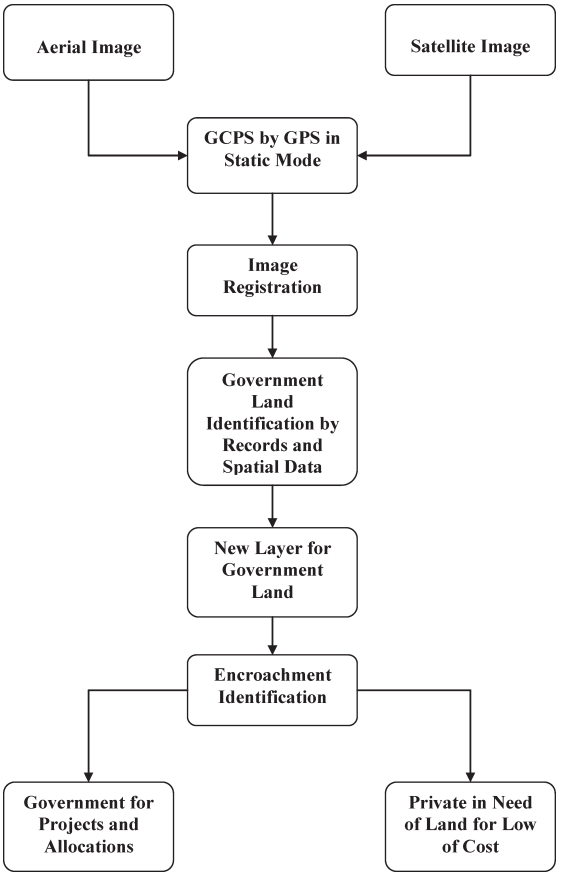


Fig. 2. *Work Flow Diagram for Identification of Encroachments using Spatial Data.*

the simplified flow diagram of the complete methodology to obtain result through this research application. The encroachment in any country is not a simple issue to be considered with ease. Spatial Technological development incites in managing and maintaining land and land records precise and updated (Enemark 2008).

## 5. Encroachments Specified

The encroachments such as roads, pipelines, buildings in government and non-governmental lands are identified and digitised in a separate layer colour. Then the encroachments are verified with the data provided from the government for allocations and permissions for new constructions. The encroachments recorded in the separate layer are created as a separate record for land management. These encroachments will not be recorded as encroachments but will be recorded as allocated land for specific projects by Government and in the case of non-governmental lands it will be considered as permitted construction activities. If the activities on the lands are found to be non-authorised by government, then it will be considered as encroachments. In the case of private non-permit construction or infrastructural activities it will be considered as encroachments in need of immediate action from government. Then hatching will be applied to the delineated polygons of the parcel boundaries of encroached land.

Confining the encroachment to two classes such as Private and Government, incites us in reducing the work. As the Government encroachments will be termed as allocated land after verification with the government allocation land records, only the private encroachments needs to be identified. Private encroachments are encroachments in private property. These private encroachments are identified by Survey Land Records and from permit for construction and infrastructural activities from the town or village land management authorities. The lands which were allotted ownership by Government have to be identified and separately digitised, which once were termed as encroachments. The details of ownership allotted lands could be obtained from the Survey and Land Records department of Tamil Nadu Government and Slum clearance board of Tamil Nadu Government. These land details are recorded in a separate layer and verified with the land records maintained by the Tamil Nadu Survey and Land Records Department, Town development and planning authority.

## 6. Encroachments Identified

Certainly encroachments are defined as advancing beyond the limits or unauthorised gradual taking of another's possession. The types of encroachments are important to be discussed. There are various forms of encroachments that could be found while surveying. There are Road encroachment, public land encroachment, private land encroachment, forest land encroachment, water body encroachment, river bed encroachment, boundary encroachment, memorial and sacred places encroachments and non-permit activities on land like construction, industries, wa-

rehousing. These are encroachments which cause great loss to the nation and its revenue.

These encroachments are not just losses to the land value and owning authority but will lead to court cases and settlement problems. There are many encroachment issues left unsolved which causes infrastructure problems, due to that future needs cannot be met by the society. Any kind of infrastructure requires land, when the common land for infrastructure is scarce, providing basic needs like water, sanitation, fire safety, and electricity would be difficult and creates infrastructure management problem, which eventually results in accidents and trauma. Fig. 3 clearly shows the institutional encroachments. Fig. 4, 5 urban sprawl encroachments in shallow water bodies. Fig. 6, 7 shows the industrial encroachments in remote village water bodies. From the identification it's certain that, land lacking proper protection like fencing, and compound wall are vulnerable to land encroachment. The effect of urbanization plays an important in land encroachment. The land lacking proper protection measures like fencing, compound wall and nearer to infrastructure, urban developments are susceptible to land encroachment problems. The locations like village and areas where no infrastructure facilities like roads, drinking water, and power are far, those locations showed less encroachment when compared to the previous case, some places showed zero encroachments. From this method the encroachments are able to be identified easily, the high resolution satellite and aerial imagery incites in finding the encroachments effectively.

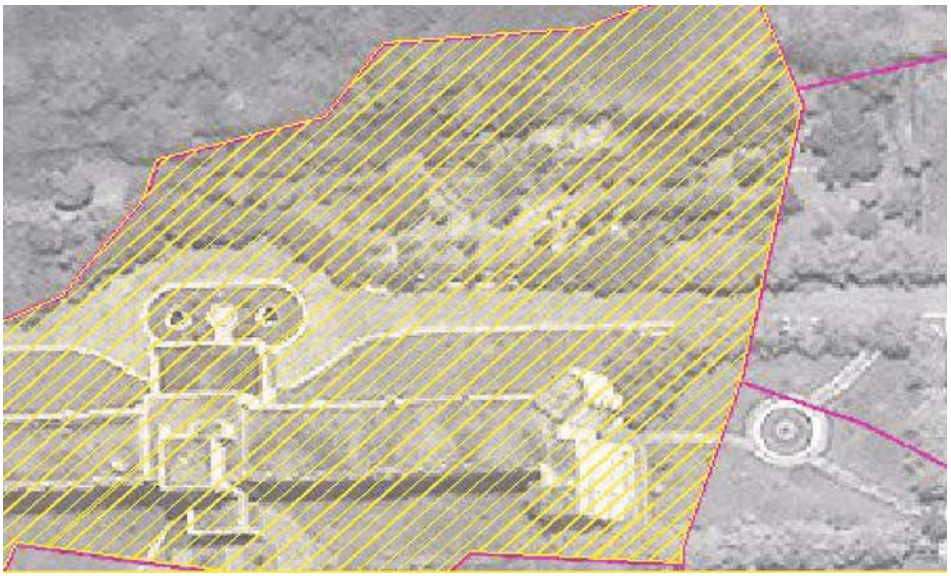

Fig. 3. *Institutional Encroachment in Government Land Shown in Hatching.*

Fig. 4. *Village Parcel Showing Shallow Water body Encroachment in Hatching.*

Fig. 5. *Urban Sprawl Showing Encroachment in Water Body and Government Land.*

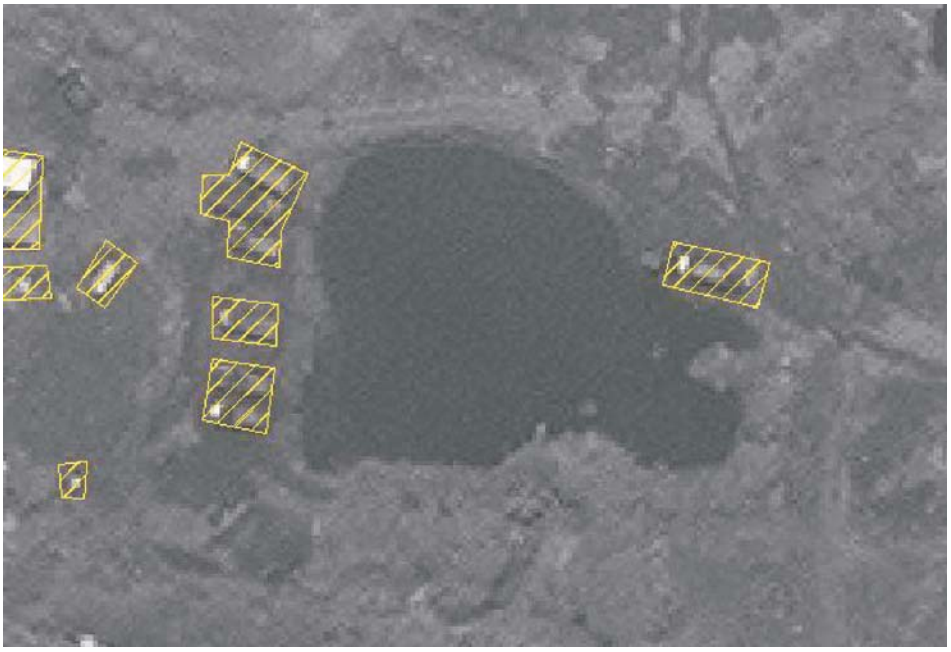

Fig. 6. *Village showing Industrial Encroachment near Water Bodies.*

Fig. 7. *Parcels Shared by Water Bodies Showing Encroachments in Hatchings.*

## 7. Causes of Land Encroachments

The peoples those who reside in the encroached land are not real encroachers. The persons who are responsible for encroachments are mafia and illegal abductors of land. These peoples sell land lacking proper records for cheap costs to the peoples who are poor and needy, promising them about the land law for claiming ownership in the future.

This is how the land are encroached by the people, which belong to the government and some times even private land. A main cause for land encroachments are not alone illegal land abductors and mafia, but also by poor management and maintenance of land incites the local discriminates to take advantage of the existing condition. Need for land has escalated by the past decade, for various land related activities. Global rise in real estate value resulted in the demand for land in low cost. The poor peoples have to go for low cost land which will be termed as encroached land technically.

## 8. Result and Discussion

The land encroachment in the private and government is being identified effectively utilising modern technology such as aerial and satellite image aided digital spatial technology. Concept of Digital Cadastral Survey is being developed and applied in the identification of encroachment of land by using two dimensional Aerial and Satellite images. GPS is used in obtaining Ground Control Points through Static Mode. The land records matched apparently with many locations of satellite and aerial images. The purpose of encroachment identification, overlaying analysis of chain and tape created records over aerial and satellite images are attained. But the conventional records created by chain and tape surveying remain unmatched in some parts of the study area over the satellite image. Further research contributions are required in the unmatched areas.

## 9. Pros

Man power, costs involved, times required are saved through this method. Larger area is covered in short span of time. Instant results are possible for study area if software and computer facilities are available on site. Present condition of the study area is easily verified with very few field visits for vegetation covered areas, which are poorly or non-visible in Satellite and Aerial images. This method proved to be economical when compared to the conventional method of land management for enormous country like India.

## 10. Cons

Image availability by satellite acquisition cannot be ensured due to cloud cover and other natural factors like fog, snow. Aerial images have restrictions like climate and defence permissions for image acquisition and use. Satellite image

acquisition depends on optical remote sensing so climate and atmosphere has greater effects on image and its quality.

## 11. Conclusion

The demonstrated technology is found suitable for land surveying in digital mode. Launch of high resolution satellites and high resolution aerial images contribute to research of land surveying in optically remote sensed image. This field requires research contributions and hybridising the existing technology with the help of other methods of remote sensing like Microwave, and ALTM with high resolution and reaching to earth surface with vegetation cover and poor visible areas are possible.

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# Digitalna katastarska izmjera za identifikaciju prisvajanja zemljišta primjenom prostornih tehnologija

*SAŽETAK. Digitalna katastarska izmjera potreba je sadašnjih i budućih generacija. Pojava računala promijenila je u dinamičkom smislu cijeli svijet. Bez digitalnih uređaja i bez računala svijet ne može učinkovito funkcionirati. Računala, satelitske i zračne digitalne snimke mogu se učinkovito upotrebljavati u kreiranju novih eksperimentalnih metoda katastarske izmjere. Podaci u zemljišnim knjigama dobiveni su katastarskom izmjerom, što nam osigurava temeljne podatke za planiranje i upotrebu zemljišta. Planiranje upotrebe zemljišta pod utjecajem je brojnih čimbenika, izravno i neizravno. Prisvajanje zemljišta moguće je identificirati digitalizacijom i razlikovnom analizom pomoću standardnih GIS softvera, uz upotrebu GPS uređaja, satelitskih i aerofotogrametrijskih snimki u kombinaciji s uobičajenim podacima iz zemljišnih knjiga. Rasprava u ovom radu provodi se u svrhu otkrivanja vrsta i tipova prisvajanja zemljišta. Razmatraju se problemi koji nastaju zbog prisvajanja te njihovi štetni utjecaji na državu koja ima tendenciju rasta i širenja, kao i definiranje metodologije koja služi njezinom stvaranju. Prednosti i nedostaci takve tehnologije objašnjeni su u radu. Primjena istraživanja zahtijeva hibridnu tehnologiju za dobivanje visoko kvalitetnih rezultata.*

*Ključne riječi: digitalna katastarska izmjera, prisvajanje zemljišta, identifikacija, GIS, GPS.*

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