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Institutional Layout Plan using Digital Elevation Model (DEM)

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Abstract - Digital Elevation Model (DEM) of high quality is required for many applications like urban modeling, readiness for catastrophes or disaster assessment like floods. In order to derive DEMs of any place in the world very high resolution (VHR) satellite stereo images like Ikonos, Quick Bird or Word View are required. In this paper digital elevation model of the area is prepared which is later compared with slope map and cadastral map of the same area to have a 3D appreciation of the land surface for foundation construction, drainage system development, landscaping, development of water tanks, and identification of landfills etc. The generated DEM is compared to ground truth data where ever available to increase the quality and efficiency of the work.

Key words - Cadastral Map, DEM, Mussavies, Streamline, Sinkpoint

1. INTRODUCTION

A digital elevation model (DEM) is a regular spaced grid which contains the elevation of a point on a surface that is coincident with the location of the grid cell. Often DEMs are also referred to as a DTM (Digital terrain Model), or a DSM (digital surface Model) (Poon et al. 2005). High quality DEM provide essential basic information for many tasks. Especially in urban areas such DEMs provide basic data for the generation of urban models. DEM integration in image classification helped to increase the classification accuracy of digital data (Bonner et al., 1982; Jones et al., 1988; Frank, 1988; Janssen et al., 1990; Gastellu-Etchegorry et al., 1993; Palacio-Prieto and Luna-Gonzalez, 1996). In this Paper automatic terrain extraction (ATE) methods as implemented in many software packages like ERDAS [Xu et. al., 2008] is used for the generation of DSMs from aerial or satellite imagery.

Sophistication in satellite technology in capturing geometrically accurate images of earth's surface coupled with GIS technology holds the capability of large scale mapping of land resources at cadastral level. Cadastral boundary vectors obtained from ortho-images are used as base maps and obscured different areas (not delineated/mapped from ortho-images) are surveyed using Differential GPS (DGPS) and electronic total stations (ETS). The vector data sets thus derived through these geo-spatial techniques are integrated in GIS environment to generate the base cadastral vector datasets for further settlement or title confirmation activities.

Cadastral maps are large scale maps on 1:4000 Scale giving information of land ownership and property. Haryana has a fairly evolved land record system. Land has been divided into uniform grids of 1 acre each called Kilas and 25 Kila was known as a Murraba. This system of dividing land into uniform grids helped in eliminating any major error in measurement of Kilas.

1.1 The Study Area:

The Indian Institute of Management (IIM), Rohtak, abbreviated IIM-R, is a public business school located in Rohtak, Haryana, India. It is the eight Indian Institute of Management to be established in June 2010. IIM Rohatak is amongst the seven new IIMs that were approved by the Union Cabinet on August 27, 2009. It is also India's first IIM north of Delhi. The study area falls under the longitude 76°32'10"E to 76°32'50"E and latitude 28°5'40"N to 28°50'40"N shown in figure 1.

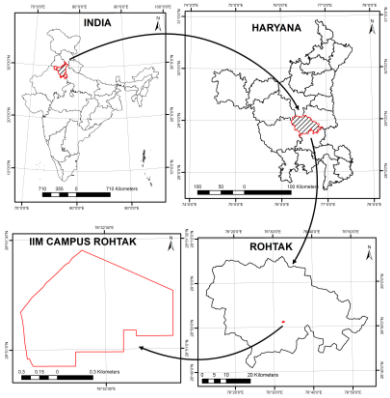

Figure 1: Location Map

1.2 Rainfall and climate:

The climate of the area can be classified as subtropical monsoon, mild and dry winter, hot summer and sub-humid which is mainly dry with very hot summer and cold winter except during monsoon season when moist air of oceanic origin penetrates into the district. The hot weather season starts from mid March to last week of the June followed by the south west monsoon which lasts up to September. The transition period is from September to November which forms the post monsoon season. The winters start from November and ends in March.

1.3 Geomorphology and soil types:

The area is occupied by Indo-Gangetic alluvium called older alluvial plain. Physiographically the area is a flat terrain. The area slopes towards southeast to northwest.

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The general elevation in the district varies between 164m to 182m above MSL. The soil is Fine to medium textured. It comprises of sandy loam. The soils of the area are classified as arid brown (Solemnized) and sierozem. The older alluvial plain is further divided into sand dunes, plain and depressions. Sand dunes are present on the eastern part of the region where sand mining activity is noticed.

2. Materials And Methodology

2.1 Satellite and other data:

WV - II 4 band
WV - II Stereo data
Cadastral Data Vector

2.2 Software Used:

Arc GIS 9.3 – For preparation of Cadastral layout Plan, Geo – referencing and Rectification of available satellite data and lastly for preparation of current land use map.
Erdas Imagine 9.2 – For preparation of DEM.

2.3 Methodology:

Various steps followed in the present study were as under:

- Area of interest (AOI), IIM campus digitized from satellite image.
- Preparation of cadastral layer by digitization on the mussavies.
- WV – II satellite imagery for the AOI was extracted from the database and georeferenced using the control points.
- Cadastral vector data was overlaid on satellite imagery and rectified to generate Cadastral Map.
- Preparation of DEM of AOI – First .blk file was generated on LPS – 2011 software. Interior/Exterior orientation of the satellite data is done. Triangulation method was calculated to know RMS error. The required DEM was generated. Classification of DEM value in meters is done which gives us the estimates of heights. The 3D View is generated in ArcScene.
- Preparation of Sinkpoints – With the help of Arc GIS 9.3 software the contours of the area, slope map, sinkpoints, streamlines are generated from the raster data of DEM
- Preparation of Land Use Map – Four band satellite data of WV-II was extracted for the area of interest. Layer stack is done and the images were mosaic. Using on screen digitization technique in Arc- GIS land use classification for the AOI was done.
- Cadastral vector was overlaid on the land use map so prepared. Digitized land use was classified as structures, trees, cart-track, open land with scrub, open land without scrub, fellow land, sand mining etc. Thus map of land use was generated.

3. Results And Discussion

3.1 Land use map

The land use map of the IIM campus is shown in the figure-2 below. Most of the area in the proposed IIM Campus is under sandy fellow land and scrub land. There is no construction area visible at present. Land use map of the given area provides us with the information that the north-western side of the campus is a low land consisting of fellow land where as the eastern part is at a higher elevation consisting of sand dunes where from local mining of sand has taken place which can be easily identified from satellite images as white patches.
Open land could be easily separated from the fellow land using the tonal difference seen on the satellite images. The total land use statistics of the given area is provided below in table 1.

Sr. No.	Land use classes	Area in Acre
1	Car track	4
2	Fellow land	83
3	Grasses	16
4	Open land	0.6
5	Sand mining	3
6	Scrub land	25
7	Tree	68
8	Structure	0.1
	Total Area	199.7

Table 1: Landuse data

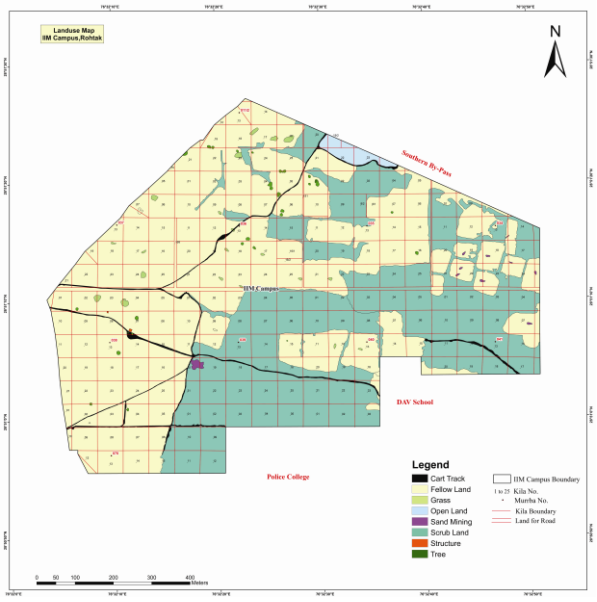

Figure 2: Landuse land cover map of IIM rohatak

3.2 Cadastral map IIM Rohtak

Cadastral Map (Sajara) obtained from the Revenue Department has been digitized and the IIM Campus boundary overlaid on this map. The cadastral map is then overlaid on the high resolution satellite data (figure 3) so as to indicate the acre wise land use and other information. Cadastral map overlaid on the satellite image indicates the current land use parcel wise. Most of the south-eastern parts are covered by scrub lands where as most of the north-western part is fellow or open land.

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Figure 3: Cadastral Map of IIM Rohtak.

3.3 Digital Elevation Model (DEM) of IIM Campus

DEM of the area has been generated using the stereoscopic high resolution World View – II satellite data in Lieca Photogrammetric suite (LPS) software. DEM and slope maps of AOI have been shown in figures 5 and 6 respectively. Most of the area of the campus lies between 210-235 meters mean sea level (msl) height. As can be seen in DEM map (figure 4) as well as the slope (figure.6) maps, the area in the northern part has lower elevation while in south-eastern part elevations are high. Middle part of the IIM Campus has elevation from 225 meters to 230 meters. On the basis of this Statement it can be said that the elevation is decreasing from east to west. In eastern part it has higher elevated land while in western part there is low elevation. The 3D DEM view has an azimuth of 315 degree; its altitude is 30 degree and a contrast of 50.

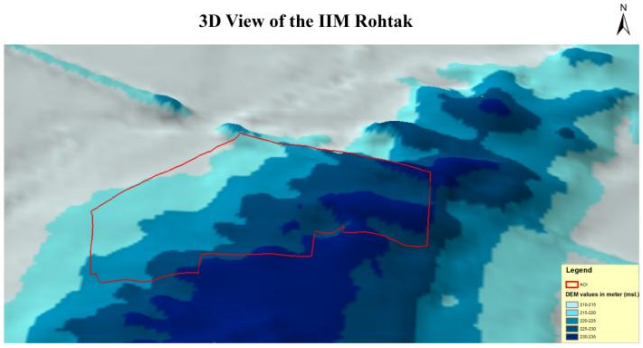

Figure 4: 3D view of IIM Rohtak

3.4 Slope Map, Sinkpoints and Stream lines

From the slope Map it is easily visible that the slope is smoothly decreasing form east to west. Three contours are present of 240, 230 and 220 which are being digitized from toposheet confirms that the slope generated from the DEM is quite accurate. From this Slope map further streamlines and sink points are generated by 3D Analysis Tool. This sink points are those points where there is possibility of water accumulation. In the concern AOI there are no such sink points present as the area has a gentle but steady slope, thus perfect for construction. There are stream lines present which extends from elevated part in the east to the western part thus the drainage of the institute should have a gradient towards west for a free flow of sewage water . As illustrated in figure 6.

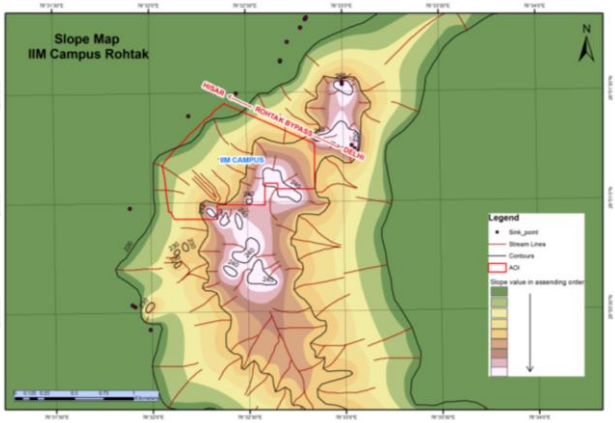

Figure 5: Slope Map showing streamlines and sink points

3.5 Comparative Analysis

Comparative analysis from the three maps of the IIM Campus, namely the landuse map, DEM map and the slope map along with contours sinkpoints and streamlines shows that north – west part of the campus have low elevation, gentle slope and fellow land where as the eastern part have high elevation, moderate slope of and largely scrub lands. The high elevation region consists of sand dunes where from sand mining activities are discernible. Slope gently decreases from east to western region. North part of the area has gentle slope and lower elevation than the surrounding area. Middle part of the area has moderate slope 220 meters. Current land use of acquired land of the campus consists of scrub land, cart track, fellow land, structure and trees. Comparative thematic maps can be visualized in fig.8. According to the comparative view, north-west part of the campus may require land fill before construction as it currently has lower elevation than the surrounding area of the IIM Campus and may become stagnated with water draining in from the south-eastern region during heavy rainfall as we see that the sink points lye mostly in the western part just outside the AOI. As the slope in the campus is from east to west, the water flow will be in the same direction. This will also help in easy linking to the main drain which runs nearby in north-west part of the campus.

4. CONCLUSION

Geo-referencing and rectification of the satellite data provide the accuracy in result which was obtained from satellite imagery and cadastral vector (Sajra).

High resolution worldview-8 band data suitable for Cadastral mapping and land use classification for small area at large scale.

World view – RPC data was suitable for DEM generation. It is cost effective for small area such as IIM Campus, Rohtak.

GIS mapping will be utilized in planning for drainage, infrastructure and environmental activities in a systematic way.

Software such as LPS, Arc-GIS, and Erdas- Imagine and MS – office was effective tool during entire project.

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