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Comparison studies in Land-cover Mapping Analysis

Rajesh Gopinath¹, Vijayalakshmi Akella² and P. R. Bhanumurthy³

¹ Research Scholar, Department of Civil Engineering, JNTUA, Anantapur, India

² Professor & Head, Dept. of Civil Engineering, K.S. School of Engineering and Management, Bangalore, India

³ Professor and Director Admissions, Jawaharlal Nehru Technological University Anantapur, Anantapur, India

Abstract: The land-cover pattern of Vaderahalli Village, a station within Bangalore Jurisdiction was quantified for a Radius of Influence 250m. This was achieved in 3 ways. Firstly by analysing Remote Sensing cloud free enabled satellite imageries using G.I.S. tool 'MapInfo Professional'. Secondly and thirdly from analysis of Google Images by using 'Google Pro' Software and MatLab software respectively. The details from each methodology were confirmed on-site with the aid of hand-held G.P.S. The present study hence compares the procedure, merits/demerits and efficiency of the methods. The study was based on pre-defined land cover features such as green cover, water body, open spaces, paved and unpaved surfaces and built-up spaces.

Keywords: G.I.S.; G.P.S.; Land Cover; Google;

Introduction

Land cover can be referred as to "the physical materials on the surface of a given parcel of land such as grass, concrete, tarmac, water [1]. It hence corresponds to the physical condition of the ground surface [2]. As land is a finite resource and satisfies a multitude of needs, consequently availability of accurate land cover information becomes essential for several applications like natural resource management, planning and monitoring programs [3]. Land cover mapping thereby forms a part of major environmental projects.

Several techniques are available to achieve land cover mapping, ranging from traditional approaches such as terrestrial survey and basic aerial photo-interpretation to land cover mapping using remote sensing satellite imagery [4]. Land cover studies up to late 60's and early 70's were based on conventional surveys, which were very expensive and time consuming [5]. Of all the available techniques, remote sensing and G.I.S. are the most effective tools in detecting urban land-cover change [6]. In recent years, remote sensing has lent itself well in the study of land cover mapping. The technology collects multi-spectral, multi-resolution and multi-temporal data spatial distribution of temperature, and allows for feasible acquisition and analysis of spatial data across large areas due to the wide scan collection process and temporal repetition with relative ease. It has the advantages of low cost, large area coverage, repetitively, and computability [7]. The increasing availability of satellite imagery with significantly improved spectral and spatial resolution offers greater potential for more detailed land-cover mapping [8]. At the same time, rapid advances in the computer science as well as other information technology fields have offered more powerful tools for satellite image processing and analysis. Access to faster and more capable computer platforms has aided our ability to store and process larger and more detailed image and attributes datasets.

Digital image processing involves interpretation of digital images with the aid of computer technology [9]. The enhanced information content of high-resolution satellite imagery invariably highlights the need for more powerful tools by land cover planners to obtain detailed land cover maps. As a result, in recent years several approaches to satellite image classification have been developed and research continues to strive on the utility of per-pixel classification of spectral reflectance for identifying areas of land cover, as a result of uncertainty that are present in areas of significant landscape heterogeneity [10].

II. Study Area and Research Design

In the scope of present research, the land-cover pattern namely; green cover, water body, open spaces, paved and unpaved surfaces and built-up spaces of "Vaderahalli Village" was quantified for a Radius of Influence (R.O.I.) 250m from the classification of remotely sensed geo-spatial data. The area under study was largely a non-urbanised area, North of Bangalore city. The area was out-marked by scattered buildings and growing territories (Figure 1).

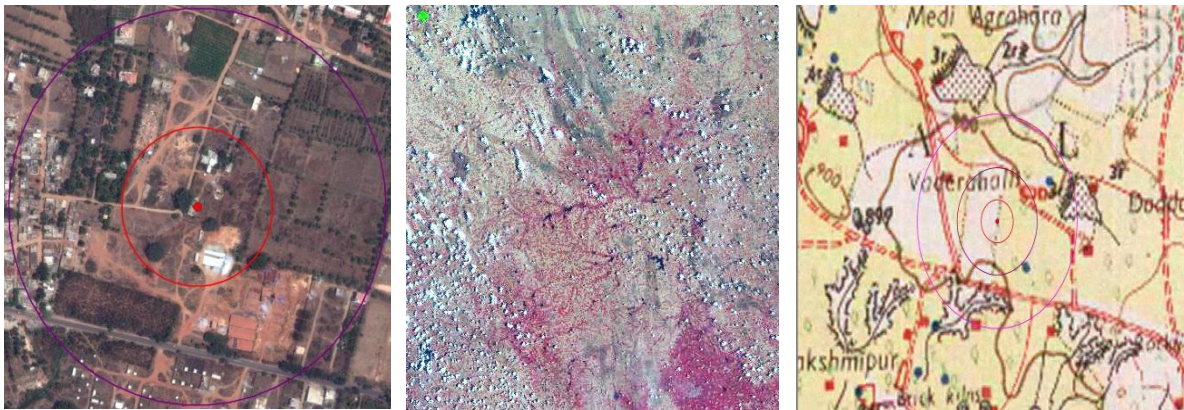


Figure 1. Google Image of Station.

Figure 2. Cloud-free Satellite Image.

Figure 3. Topo Sheet of Vaderahalli Village.

III. Research Methodology: Urban Fabric Analysis

The land cover pattern achieved in 3 ways. Firstly by analysing the Remote Sensing satellite imageries. Secondly and thirdly from analysis of Google Images via Google Pro Software and image processing tool ‘MatLab’ software respectively. For the purpose of fixing the boundaries, a fixed point on the station was considered as a focal point, and the boundary was limited to a buffer of 250m in all directions. The details for each methodology was verified for best fit by confirming the areas, enclosed by each feature for each land-cover pattern on-site with the aid of hand-held G.P.S. (i.e., supervised classification). The present study hence presents a comparison of the procedure, merits/demerits and efficiency of the methods. The detailed procedure has been dealt with further in corresponding sub-sections.

IV. From Remote Sensing Images (Satellite Imageries)

Primarily the latest cloud free enabled Landsat image (Figure 2) was procured from N.R.S.A. (Hyderabad). This was obtained from the sensor LIS3 mounted on satellite IRS-P6. The Radius of Influence was distinguished from the coordinates 13.0139N/77.3654E and 12.7065N/77.7462E. The procurement was based on the availability of cloud-free data of pre-monsoon season of 2011, for February-March. This was derived by satellite data browsing and obtaining Geo-coded product of I.R.S. I.D. L.I.S.S.3, combination of Band 2, 3, 4, with False Colour Composite (F.C.C.). Then registration of satellite data using WGS84 and creation of the digital layers like road network, surface water bodies if any, built-up area, green belt was carried out. Figure 3 depict the extracted plot from the Topo sheet for Vaderahalli Village. The Topo sheet was then registered and projected using ‘WGS84’ and ‘UTM’ projections. The required information like road network, drainage network with surface water bodies, built-up and green belt layers were then extracted using digitization software, AutoCAD ver. 2007. Google Images of 2011 were then used to update the base maps created. For this purpose, digitised Topo sheets were added as image overlays after conforming geospatially onto the satellite image, to generate land-cover thematic map of station environment. These layers were then superimposed onto earlier generated base map to modify and generate the actual land-cover map of each site. Proper attributes were given to each polygon of different land-cover categories and the area statistics was unraveled for buffers of 250m. For this purpose, MapInfo Professional software ver. 9 was used and various ‘tab’ files and ‘work sheets’ were generated, to create the required thematic maps of the study area. Figure 4 shows the screenshot of analysis by using the MapInfo software.

V. Using ‘Google Pro’ Software

Primarily, Aerial photographs (Google Images) were downloaded using ‘Google Pro Software’ ver. 6.1.0.5001, of “Vaderahalli Village” within the requisite R.O.I. of 250m for the current period of study. The image was then subjected to ‘area’ computation, by utilising the inbuilt ‘polygon’ function to identify the distinct land cover patterns available in the aerial photographs. Hence, polygon representation is vital in the current study for characterising land-cover. Figure 6 depict the application of the functionality for the station. Manually, the parameters of interest were selected as polygons, using zoom in/out feature. Based on the total area occupied within the 250m R.O.I., the area of each polygon was calculated and analysed, to obtain the percentage distribution. Even though the station presented a unique challenge, useful and repeatable observations could still be obtained, despite the complexity and inhomogeneity of their urban environments.

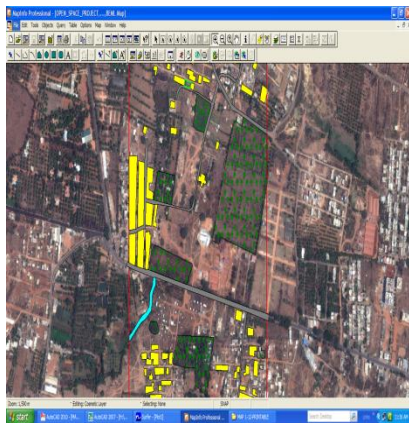


Figure 4. Screenshot of MapInfo.

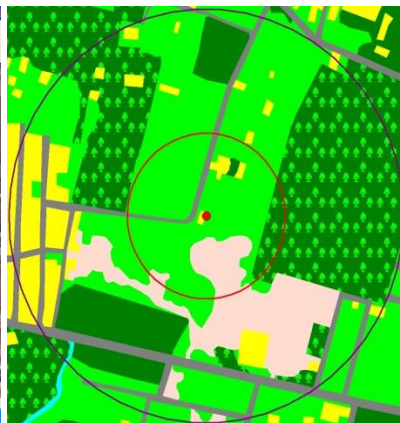


Figure 5. Outlook of MapInfo Analysis.

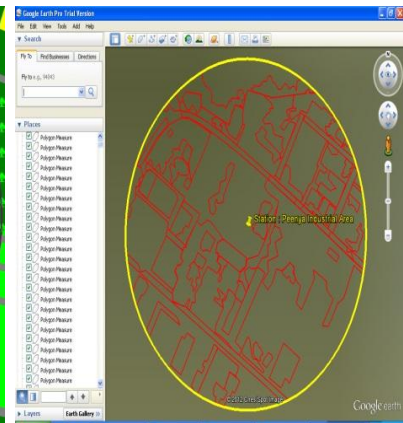


Figure 6. Computation with Google Pro.

VI. Using Matlab Software

Google images are essentially digital images plotted as 2 dimensional representations basically composed of pixels. The digital data for Bangalore, for each station approximately included 708608 pixels. Due to this large volume of data, reviewing all of them visually, in detail was very difficult and time-consuming. Hence to overcome the pitfalls of Google polygon method, the application of MatLab as a colour detection application was warranted as an advanced solution/tool. The Image classification procedure first involved reading the image using *imread()* function. This was followed by obtaining the matrix representation of the image, which is simple representation as a set of pixels, plotted as 2-dimensional representation. The matrix basically so derived was composed of values which range from 0-255 for gray scale, 0-1024 for jpg and so on, wherein each value signified the color of the image. Further visual inspection and assigning of surface classification was achieved before finally extrapolating the results. Further on, image classification technique was used to classify the image based on the value of the pixel. The division of total number of target pixels by total pixel count enabled ascertaining the colour density. Further on the percentage of each classified area of the image was calculated by primarily obtaining the size of the image using *imshow* function, wherein, if 'm' by 'n' is the resolution of the image, 'm'×'n' gives the total number of pixels in an image. Finally the percentage of the area covered is calculated by dividing the total number of pixels with the number of pixels of the same color [11]. The application of MatLab as an image processing tool comfortably served in classification process and validation of the Google Earth data. The objective was realized with much satisfaction by assessing the area occupied by the colour composition with author designed program (figure 6).

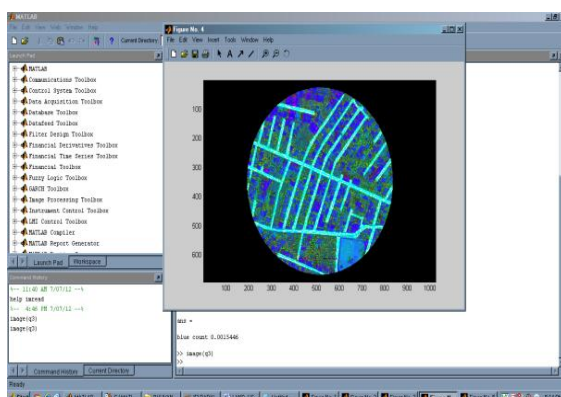


Figure 7. Area Analysis using Mat Lab Software.

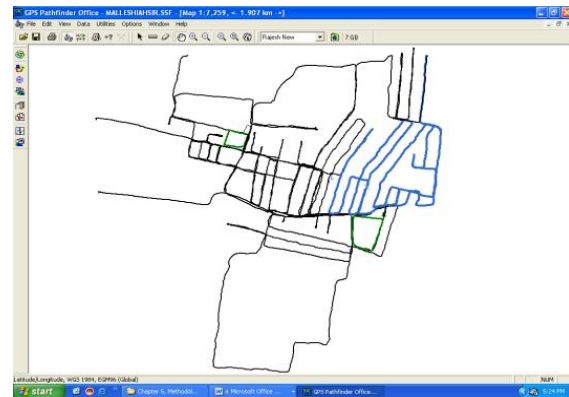


Figure 8. Work screen of G.P.S. Pathfinder Office

In all the previous methods, due to the complex nature of the ground cover colouring, at times no consistent pattern between the various surfaces could be directly detected. Therefore it was most imperative to visually and manually confirm the land cover at each station first. From the previous techniques, it is most imperative to visually and manually confirm the land cover, to ascertain the best technique. Hence, mapping by G.P.S. as semi-automated method, was implemented to classify the data.

VII. Using Handheld G.P.S.

This method involved, visually inspecting the aerial ortho-photos and preparing a list of various surface-types identifiable in the photos, grouping the surface types, and categories into the major components. This ‘supervised classification’ was accomplished on-site with survey using Handheld G.P.S. This aid in identifying which among the previous techniques are supreme in land-cover classification. The surveys were conducted at the station within a radius of a 250m in all directions from focal point. An hand held G.P.S. having High-yield receiver with 2 to 5 meter positioning, Accuracy in real time or 1 to 3 meter post processing, Integrated SBAS receiver to achieve 2-5m positional accuracy, Post-processing technology for 1-3 m accuracy and 533 MHz processor, was utilised. G.P.S. coordinates were collected for location along with ancillary data. Upon returning from the field, coordinates were differentially corrected using reference position from base provider and imported to update the location with the aid of base station located within Indian Institute of Science. Finally, the outlook map of station achieved by G.P.S. pathfinder was then superimposed on the final processed images. The best fit of overlays enables the field/on-site exercise confirms the boundaries and areas enclosed by each feature. This detailed exercise was also envisioned to identify and reduce any errors. Therefore by this conjoint methodology, the characteristics of the surface morphology of Bangalore were accessed and confirmed (Figure 8).

VIII. Results and Discussion

As can be observed from the Table 1, it can be realised that the results of field survey was closest to the results obtained from the satellite image analysis with MapInfo. This amounted from the extent of precision and set of overlays fed to the analysis. But at the same time, this process needed skilled personnel and was expensive. Also, the frequency and availability of the images for the requisite time period was a matter of concern. Comparatively, analysis by Google Pro software provided lesser efficiency. However, the process consumed lesser time and was more economical. Hence, this application was most handy based on the tasks demands. The feature of zoom-in / zoom-out were an added advantage in feature identification, but the lack of clarity and effect of shadows could also not be ruled out. Thereby the results were subjective to human error. Compared to these 2 image processing methods, MatLab gave the least efficiency. This may be substantiated because the processing is purely based on the colour composition of each pixel. The process is also extremely time consuming process, and subjective to human eye judgment. As at times no consistent pattern between the various surfaces can be directly detected due to the complex nature of ground cover, and hence the application of Hand held G.P.S. was warranted as a check. But it needs to be mentioned that this handy tool also is subjective to error based on precision the model offers. The greater the precision warranted, invariably the cost of the model is higher. Also the instrument cannot probe inaccessible points and hence may not be the perfect check for remotely sensed data.

Table I. Comparison of the Area % Results

Technique	Green Cover	Open Spaces	Water Bodies	Built-up Density	Paved Surfaces
Google polygon	66.10	24.30	0.00	8.20	1.40
MapInfo	63.77	21.22	0.00	7.41	7.60
MatLab	80.19	9.60	0.55	4.41	5.25
Hand Held GPS	62.19	22.60	0.00	7.30	7.91

IX. Summary

The efficiency of extracting land cover information was found to be highest with the application of MapInfo during the analysis of satellite images. However it also needs to be realized that this process is extremely expensive and also needs skilled personnel. On the other hand, the application of Google Earth Pro could be deemed necessary based on the cost and precision necessitated from the task. MatLab however falters in land cover extraction, as it is time consuming and also needs specialist programming skills. Compared to all the methods, it needs to be noted that the remotely sensed data obtained from space-borne sensors are more acquiescent to computer analysis using G.I.S. and most accurate in terms of analysis.

X. Acknowledgments

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