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INTEGRATED USE OF LANDSAT ETM+ AND SRTM DEM TO DECIPHER LATERITES IN AREA AROUND LANJA, DISTRICT RATNAGIRI, MAHARASHTRA, INDIA.

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Abstract:-Geological studies are requiring standard methods and procedures to acquire precisely information. However, traditional methods might be difficult to use due to complex topography, thick vegetation and soil cover and mountainous region in the area under study. In this paper, we consider the application of Landsat 7 ETM+ imagery and Shuttle Radar Topographic Mission (SRTM) digital elevation model (DEM) for laterite mapping of the study area. The accuracy assessment was based on ground control points acquired by GPS and reference points digitized from Landsat imagery along segments of selected rivers.The area of investigation is Konkan Coastal Belt (KCB) characterized by the common geological features as basaltic flows and laterite cappings.The laterites were discriminated using feature extraction workflow in ENVI EX platform. Different threshold values were used to find the most probable areas of lateritic zones in the image. Field investigation was carried out and GPS points are mapped to use as Ground Control Points (GCPs). The threshold values were determined from a published geological map and known GCPs of lateritic areas with good exposure in the image. SRTM DEM (30m resolution) was used to understand the levels of laterites and their tectonic significance.

Keywords: Laterites, Landsat ETM+, SRTM DEM, Threshold values, KCB.

INTRODUCTION

Evolution of Western Ghat has played significant role in the genesis of Konkan Coastal Belt (KCB). The tectonic uplift initiated by the collision of Indian and Eurasian Plate during Early Tertiary has resulted in the formation of Western Ghat escarpment. The western extension of the uplifted Cenozoic plateau that was submerged under waters of the Arabian Sea has evolved as Konkan. This narrow coastal belt is arranged in step like terraces, pointing to the recent oscillations in the sea level and of submergence as evident from the drowned valleys, lagoons and sand bars. Wave cut cliffs and platforms are also common along the coastline indicating changes in the sea level. The basaltic flows and intrusive, Intertrapean and laterite capping are common geological features of Maharashtra coast. The basement of basalt flows was formed by extruded Deccan Volcanic activity during Late Cretaceous – Early Tertiary period. The coast displays a variety of landforms developed due to fluvial and marine activity, both erosional and depositional during the Tertiary and Quaternary periods.

1.1 STUDY AREA:

The area selected for the present study is Southwestern part of the Deccan Volcanic Province (DVP) between Ratnagiri and Vijaydurg in the State of Maharashtra. The study area is bounded between Lat. $16^0$35'N and Lat. $17^0$00' N and Long. $73^0$17' E and $73^0$48' E (Fig. 1) and cover an area about 2000 sq.km. The study area exposes Poladpur and Ambenali formations (68+0.6, 65+0.7 Ma respectively) represented by massive and amygdaloidal basaltic flows. At some places these basaltic flows are overlain by laterite capping (duricrust). Physiographically the Deccan Volcanic Province (DVP) can be divided into three regions viz. (1) the Konkan Coastal Belt, (2) the Western Ghats and (3) the Maharashtra plateau. The Konkan Coastal Belt (KCB) is coastal low-land forming narrow and elongated strip of land whose average width is about 40 km. The footslope of the Western Ghat indicates retreat of the escarpment during Cenozoic time. The laterites present as capping at KCB and upland indicate preservation of palaeo-surfaces. (Widdowson and Cox, 1996 and Widdowson, 1997) The laterites in the KCB are present as capping to the isolated basaltic plateaus raised in Konkan lowland. The younger lateritic surface, occur in the KCB at elevation between 10 and 200m asl on the older basaltic flows. A laterite free corridor of 10 to 15km width, between Sahyadri escarpment and laterite covered coastal plain could be the result of scarp retreat, subsequent to the formation of this surface in the Miocene (Widdowson and Cox, 1996). Kale and Subbarao, 2004 also estimated similar age from calculation of the former extent of valleys in the upland area.

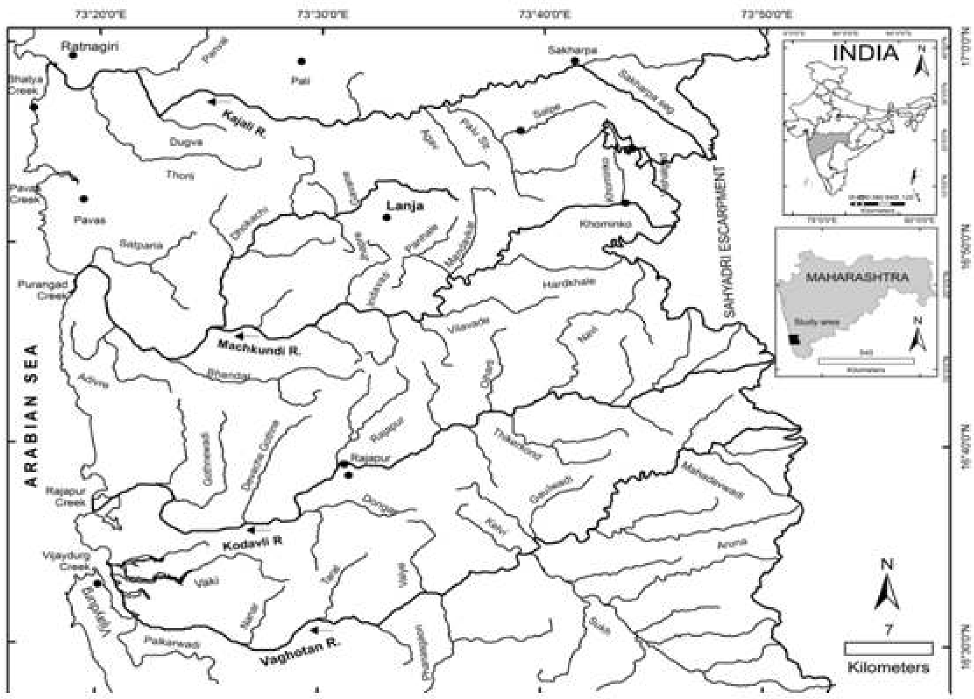

Fig.1: Location map of the study area

2. METHODOLOGY:

2.1.:Data used:

Landsat -7 Enhanced Thematic Mapper + (path 147 and row 048) is used to for visual interpretation and manual digitizing of lineaments in the Konkan Coastal Belt province. Source of this data set was the Global Land Cover Facility (GLCF), www.landcover.org. Landsat-7 ETM+ is a multispectral scanner supplies high resolution visible and infrared imagery with thermal and panchromatic image of spectral range between 0.450 and 2.35? m. The data has pixel resolution of 30m (for bands 1 to 5 and 7). The panchromatic band has resolution 15m and the thermal infrared band is 60m.The Shuttle Radar Topographic Mission (SRTM) is elevation data and most complete high-resolution digital topographic data base of earth. The capture resolution is 3 arc second with pixel resolution 90m in World Reference System (WRS-2) and dated Feb. 2000 is used to overlay extracted laterite outcrops. Using the Synthetic Aperture Radar (SAR) interferometry to produce the first near-global high resolution digital elevation model (DEM) of the Earth, Application of this resource had the advantage of furnishing digital elevation information with a minimum influence of vegetation and perennial clouds. The Survey Of India (SOI) topographic map of the study region at scale 1:50,000 is used for getting geoinformation. The ground survey was carried out to collect 113 reference points at random using hand held Global Positioning System (GPS) receiver. This data is used for accuracy assessment, resampling of images, georeferencing and ground truthing and mapping of laterites and basalts outcrops.

2.2: Pre-processing Landsat 7 ETM+ images:

The scene is georeferenced in the UTM projection and the WGS-84 ellipsoid, Zone 43N. The data was radiometrically converted to sensor reflectance using an image-based correction method. Processing of the image included radiometric correction to remove atmospheric effects. Reflectance is an intrinsic property of materials and is independent of illumination conditions, slope, sensor, and atmospheric effects. For the purpose of geological feature extraction Landsat TM band 7 (spectral range: 2.08 to 2.35 mm) has already proved to be most suitable for lithological discrimination. TM band 4 (spectral range: 0.76 to 0.90 mm) is the only band representing near infrared region and gives good information about the vegetation cover. But band 3 (spectral range: 0.63 to 0.69 mm) is proved to be useful for soil-boundary and geological- boundary delineations. Band 3 also exhibits more contrast than bands 1 and 2 because of the reduced effect of atmospheric attenuation. Therefore a colour composite of bands 7(red), 4(green), 3(blue)

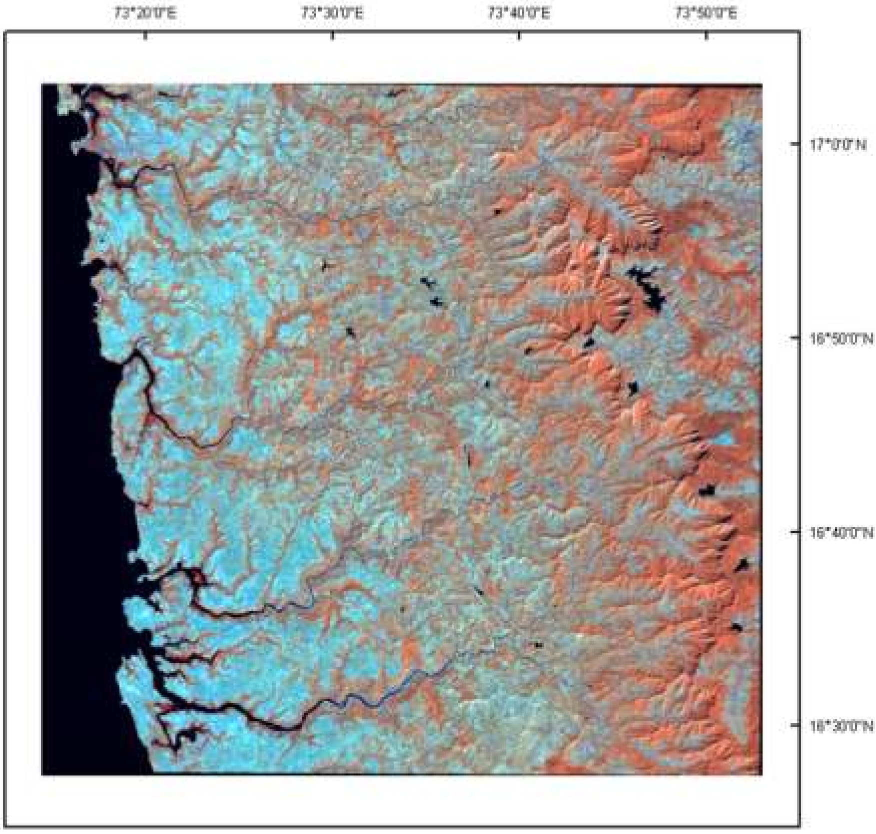

Fig. 2A: False Colour Composite (FCC) of bands 7(red), 4(green), 3(blue

(Fig. 2A) was prepared to delineate the laterite and bauxite cappings as well as the extent of vegetation and soil cover in this region. (Das I.C.) The enhancement techniques like contrast stretching, histogram equalization, directional filtering have been used. The GCPs are mapped on the imagery for resampling and orthocorrecting the iimage. The GCPs recorded with the help of GPS instrument also help to locate the laterites.

The methods of vegetation suppression and feature extraction workflow were used to discriminate laterites in ENVI EX environment.

Vegetation Suppression removes the vegetation spectral signature from multispectral and hyperspectral imagery, using information from red and near-infrared bands. This method helps better to interpret geologic and urban features and works best with open-canopy vegetation in medium spatial resolution (30 m) imagery. The model calculates the relationship of each input band with vegetation, then it de-correlates the vegetative component of the total signal on a pixel-by-pixel basis for each band. (Fig. 2B)

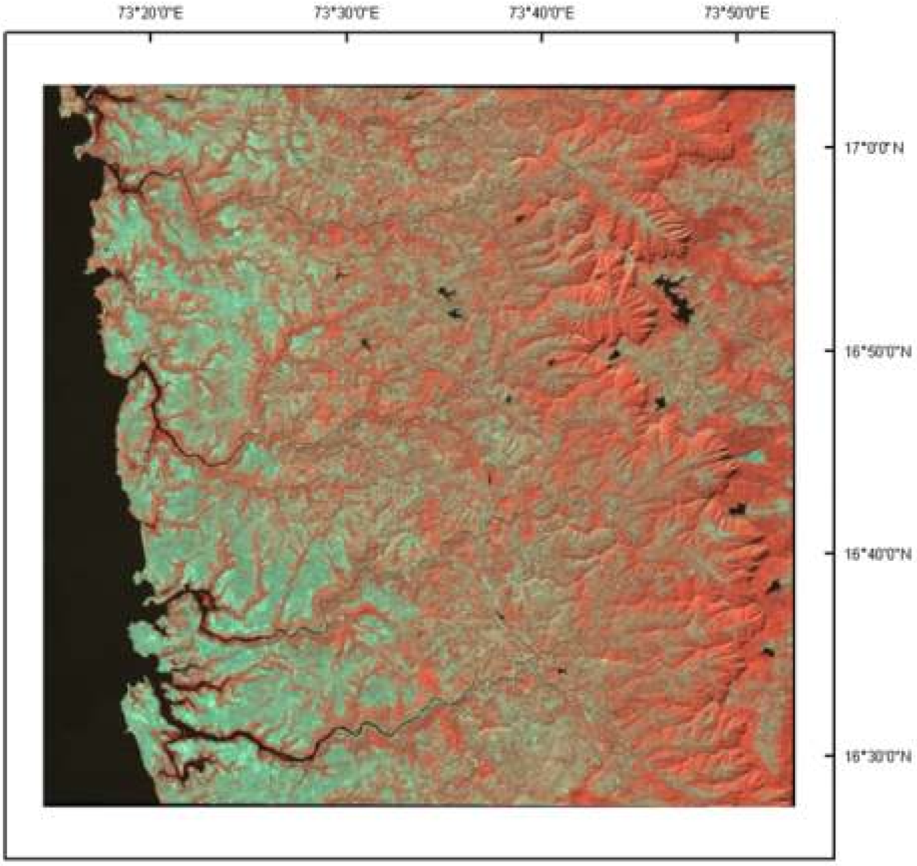

Fig. 2B: Vegetation Suppression image of the study area.

Feature Extraction is a tool for extracting information from high-resolution panchromatic or multispectral imagery based on spatial, spectral, and texture characteristics. Feature Extraction uses an object-based approach to classify imagery. An object is a region of interest with spatial, spectral (brightness and color), and/or texture characteristics that define the region. Feature Extraction lets you extract multiple features at a time. Traditional remote sensing classification techniques are pixel-based, meaning that spectral information in each pixel is used to classify imagery. This technique works well with hyperspectral data, but it is not ideal for panchromatic or multispectral imagery. With high-resolution panchromatic or multispectral imagery, an object-based method offers more flexibility in the types of features to be extracted. The image is then segmented by the process of partitioning an image into segments by grouping neighboring pixels with similar feature values (brightness, texture, color, etc.). These generated segments are then refines using threshold values. The threshold values of pixels are between 0 and 255. When threshold is defined the lower and upper limits of the threshold, are essentially defining new boundaries for features of interest.Feature Extraction uses an object-based approach to classification, as opposed to pixel-based classification. The feature extraction workflow then adopt an object-based approach in which the extracted objects can be depicted with a variety of spatial, spectral, and texture attributes.

3. RESULTS AND DISCUSSION:

Iron oxide and hydroxyl minerals have spectral features in the visible and infrared parts(400–2,500 nm)(Kennedy PJ, 1989). In general, lateritic spectra present lows at 400–500 nm and 920 nm, a 650 nm shoulder, and a higher broad reflectance at longer wavelengths (Fig. 3). These spectral characteristics are indicative of the predominance of goethite as the source of ferric oxide as confirmed by X-ray diffraction analysis (Townsend TE, 1987). According to the laterite spectral signature, a notable reflection occurred in the band 3 of ETM+.

Thresholding, the simplest method of image segmentation, is an image processing technique for converting colour composite bands 7(red), 4(green), 3(blue) image into segments based upon a threshold value (Sezgin M, Sankur B, 2004). The threshold values were determined according to known lateritic areas in the image. For each image a sub-layer image was created. If a pixel in the original image has an intensity value less than the threshold value, the corresponding pixel in the sub-layer image is set to black (value 0), otherwise, it was set to white (value

1)(Myint Soea, et al, 2008). Thus

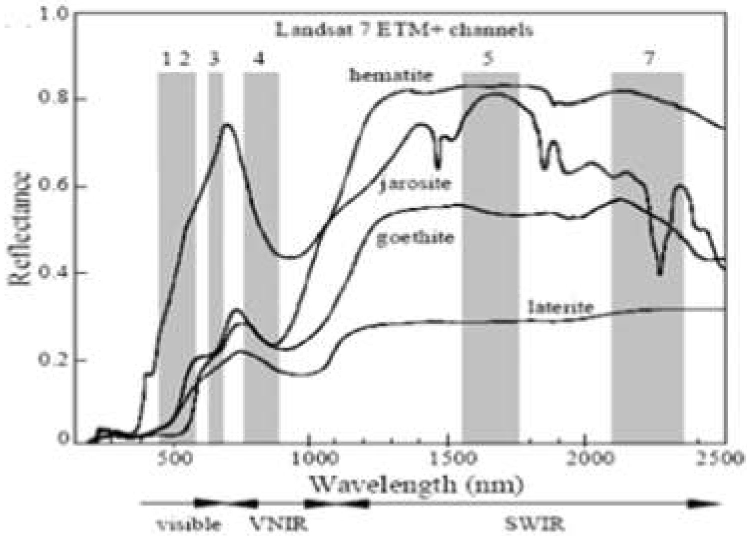

Fig. 3. Spectral reflectance of laterites (After. Hunt GR, Ashley RP (1979))

$$g(i,j) = \begin{cases} 1; \text{ if } f(i,j) \geq T \\ 0; \text{ if } f(i,j) < T \end{cases}$$

Where f(i, j) is the pixel value in each layer of colour composite bands 7(red), 4(green), 3(blue) image. The results of these three indices were overlaid on top of each other using to define the preliminary laterites image. The three extracted lateritic layers in binary format were then added together in order to form the final lateritic threshold layer (Fig. 4). When using the thresholding method, we could adjust the result from the field GPS data of lateritic for the known outcrops. The threshold values for laterite mapping derived is between 119.145 and 162.240 while Deccan basalts can be mapped using threshold valued between

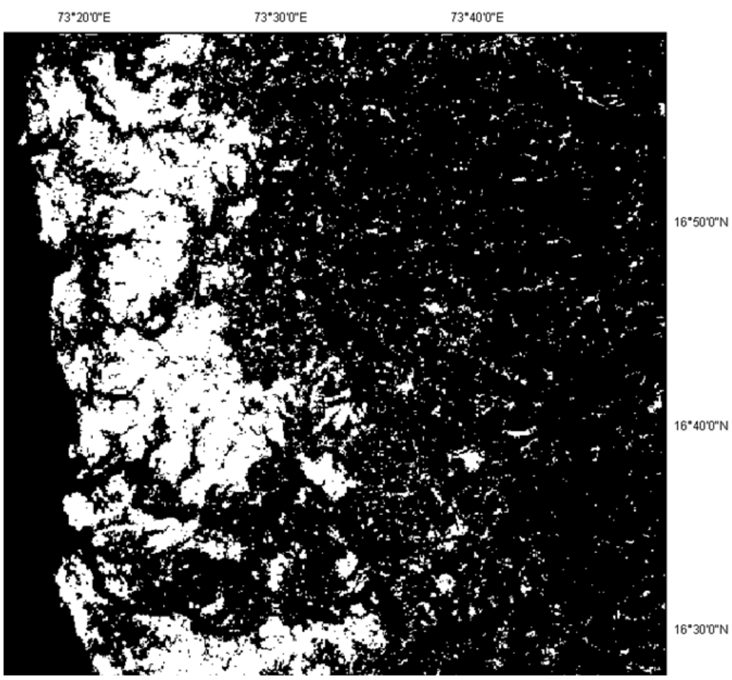

Fig. 4: The discriminated laterite exposure segments (White in color) from the FCC.

168.578 and 211.672, water bodies can be discriminated by threshold between 0.00 and 94.350. Thus, the map of laterite outcrops was prepared from the segmented image. (Fig. 5)

The discriminated laterite segments are then overlaid on pre-processed and resampled (conversion of resolution from 90m to 30m) DEM to understand the tectonic setting and palaeo-surfaces of the study area. The laterite outcrop map was overlayed on DEM to understand their elevation difference and tectonic setting in the study area. (Fig. 6).

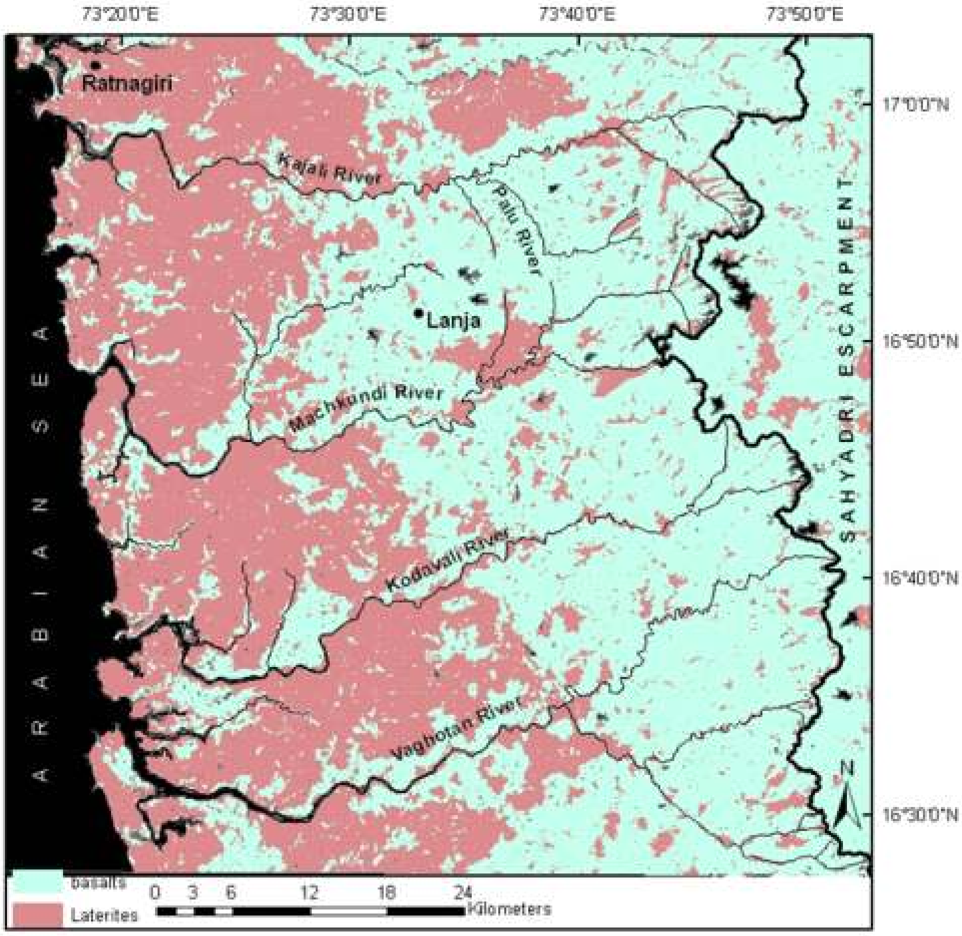

Fig.5 Geological map of the study area

The result shows the younger lateritic surface, occur in the KCB at elevation between 10 and 200m asl on the older basaltic flows. A laterite free corridor of 10 to 15km width, between Sahyadri escarpment and laterite covered coastal plain could be the result of scarp retreat, subsequent to the formation of this surface in the Miocene (Widdowson and Cox (1996)). The total area covered by the laterite is 1437 sq.km.

4. CONCLUSION:

In this paper we define the method to discriminate laterites using landsat ETM+ images. The threshold values are derived for segmention of laterites, basalts and water bodies. Two level laterites are mapped, one at upland and other at Konkan lowland. Their elevations difference determined to understand tectonic setting. The lateriteless strip is mapped.

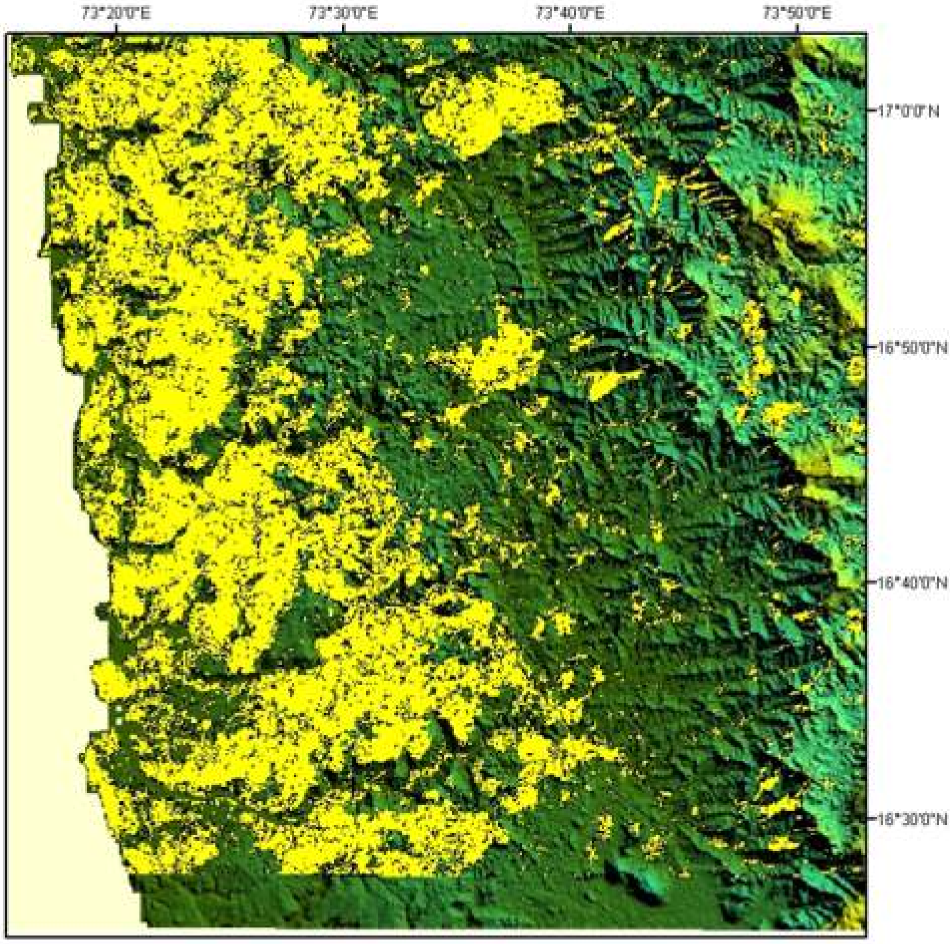

Fig. 6: Laterite outcrops draped over digital elevation model.

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