Cloud Publications
International Journal of Advanced Remote Sensing and GIS
2015, Volume 4, Issue 1, pp. 1026-1032, Article ID Tech-393
ISSN 2320 - 0243

Research Article | Open Access

Forest Canopy Density and ASTER DEM based Study for Dense Forest Investigation using Remote Sensing and GIS Techniques around East Singhbhum in Jharkhand, India

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Publication Date: 1 June 2015

Article Link: http://technical.cloud-journals.com/index.php/IJARSG/article/view/Tech-393

Abstract In this research paper Forest Canopy Density (FCD) and Aster DEM monitoring of dense forest is carried out in East Singhbhum district is situated at the southeast corner of Jharkhand. This model calculates forest canopy density using the three indices of bare soil index (BSI), shadow index (SI) and vegetation index. For this, the LANDSAT 8 images are used. At first, the dense forest map was prepared by using forest canopy density modeling whose overall accuracy is 86 to 90%. Aster DEM is used to calculate Aspect, Elevation, Hillshade maps. Aspect, Elevation and Hillshade map point out the dense forest from our region. At last, the change in area of dense forest is distinguished by using the FCD model map and map formed by interpretation Aspect, Elevation, Hillshade map.
Keywords *Landsat 8; FCD; SI; BSI; Remote Sensing; Aster DEM; GIS*

1. Introduction

Now a day's Urbanization, Mining and Industrialization and so on are general direction for social, money and economical development. The great space is used for these activities and for this reason, forest areas are increased and deforestation is common hard question. Forest area act as a parameter to measures of forest density and varieties of plants which are major issues of biodiversity and so on which are kept protected. So forest management is the important part of our sustainable development.

In a move to our current issue, International Tropical Timber Organization (ITTO) developed a new methodology [4]. In this new methodology, forest position (in society) is the value put on the base of its cover relation between mass and size. The methodologies called the Forest cover relation between mass and size mapping design or in short the FCD design.

The Forest cover density model trading group's facts from the three indices which give a reaction differently to all the plant types such as the forest. Advanced vegetation index (AVI) has reactions sensitively for the planet's amount made a comparison with NDVI [5].

The shadow Canopy index increases as the forest relation between mass and size increases (Forest Density). Bare Soil Index increases as the uncovered soil exposure degrees of get onto land increase. The values of above said-about indices are calculated out for every pixel [1].

A Digital Elevation Model (DEM) is a raster image which is used to get elevation values. Raster's represent the earth as regular arrangements of pixels. Raster's give themselves to ordered observations of the relationships between places and their properties [3]. For example, a Raster GIS can work out many useful derivatives of getting height, such as: Slope or Aspect -- the direction of slopes or seen at a distance -- what is able to be seen from the location? Hillshade worked out from a DEM is a great way to make come into existence visualizations of land with other semi-transparent themes. DEM can also be used to make come into existence 3-d places or to make contours which may be sent to another organization to be used in CAD programs.

2. Study Area

East Singhbhum district is situated at the southeast corner of Jharkhand [2]. The study area extended between 22°41'N: 86°14'E and 22°28'N: 86°27'E. It receives heavy rain during July to September and average temperature is 40-45 degree.

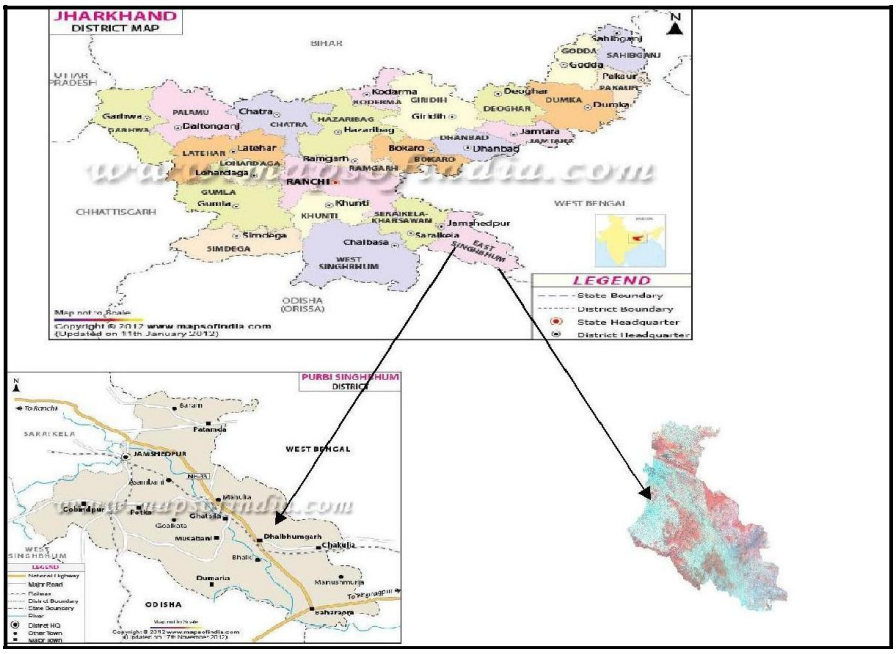

Figure 1: *Location of the Map of the Study Area*

3. Objective

The main objective of our paper is to determine change of the dense forest through comparative study of ASTER DEM and FCD model in East Singhbhum.

4. Data Used

The data used for the project is the Satellite Imagery – Landsat 8 (OLI) November, 2013, USGS, Aster DEM. Landsat 8(OLI) - Operational land image and thermal Infrared sensor. Image consists of nine spectral bands with a spatial resolution of 30 meters for 1 to 7 and 9. It consists of 16 bit data. Approximate scene size is 170km north–south by 183km east-west.

Aster DEM-Aster DEM consists of a satellite – borne sensor "ASTER" to cover all the land with a resolution of 30 meter.

5. Methodology

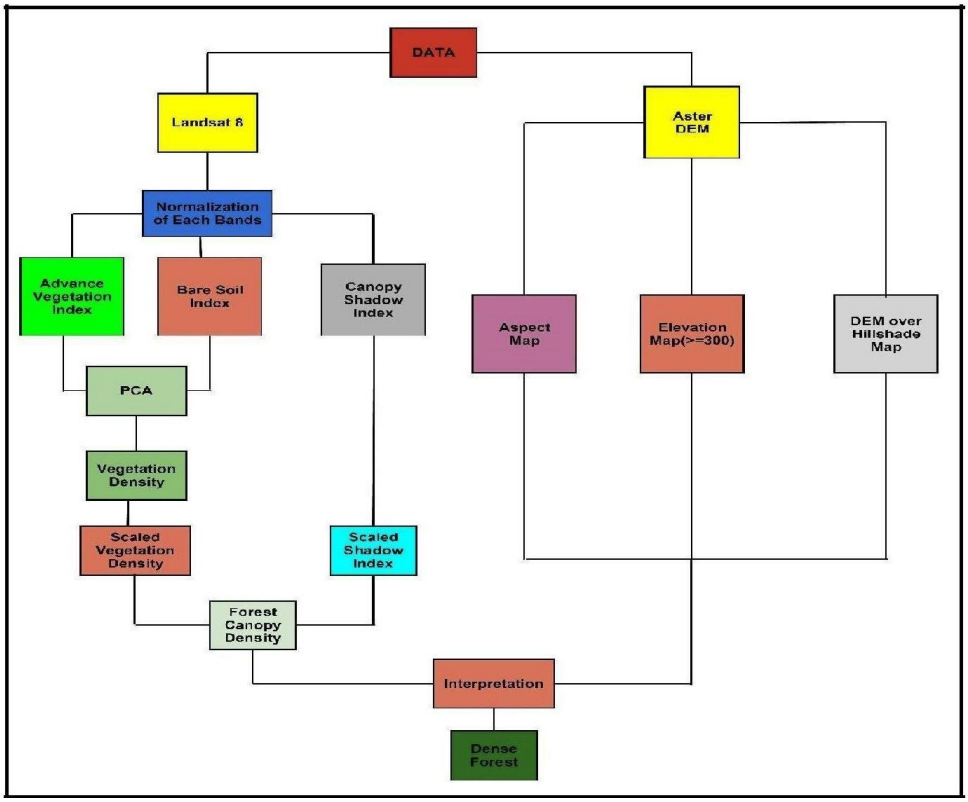

Figure 2: *Methodological Flow Chart of the Study*

To extract the dense forest from our interested area we have to take following steps:

5.1. Case 1: Using Forest Canopy Density Model

- We have to take the TIFF file (Landsat 8) where each band are present that is downloaded from USGS site
- Apply Normalization on each band i.e. 2,3,4,5,6,7 Bands
- Now we are interested to determine the following Indices i.e. use for calculating Forest Canopy Density

Advance Vegetation Index (AVI)

NDVI is unable to high-light delicately balanced amount in cover relation between mass and size [3]. For this reason, it has been getting better by using power degree of the infrared response [6]. The calculated index has been termed as an advanced vegetation index (AVI). AVI has been worked out using an equation [1].

$$AVI = \{(B5 +1) (65536-B4) (B5-B4)\}^{1/3}$$

AVI = 0 If B5<B4 after normalization

Bare Soil Index (BSI)

This index helps us to give clear idea of vegetation from the surrounding. Its equation

$$BIO = ((B6+ B4) - (B5+ B2)) / ((B6+B4) + (B5+B2))$$

$$BI=BIO*100+100$$

Canopy Shadow Index (SI)

This index works out with a shadow pattern affecting the spectral response when the crown arrangement in any forest. It shows a low canopy shadow index in the case of young even aged as compared to mature natural forest.

$$SI= ((65536 –B2)*(65536-B3)*(65536-B4))^{1/3}$$

Vegetation Density (VD)

This is determined by yield through principal component analysis (PCA 1) between AVI and BI as these two parameters have a high correlation of negative. Then it is scaled from 0 to 100 to form Scaled Vegetation Density (SVD).

Scaled Shadow Index (SSI)

Before going to scale 0 to 100 to form SSI first we have to normalize the SI so that we utilize the other parameters. SSI 100% represents the highest possible shadow whereas 0% represents the opposite. It is calculated by using a linear transformation of SI.

Forest Canopy Density (FCD)

It is synthesis by using SSI and SVD and also both indices are scaled and unit of each produces Forest Canopy Density by using

$$FCD= ((SVD*SSI) +1)^{1/2}-1$$

5.2. Case 2: Using DEM Data

First we have to take ASTER data and extract it out our study area from it.

Now to determine the location of dense forest we have to form Aspect Map and Hillshade Map. By composing DEM data over the Hillshade Map (Azimuth: 315, Sun angle: 45) we clearly visualized the dense forest [2].

Another way to visualize the dense forest by adjusting the elevation 300 or above in DEM data so that we point it out clearly.

6. Results and Discussion

By analyzing the above map we observe that there is a maximum dense forest given by the FCD model, whereas other two techniques which applied on Aster DEM i.e. Aspect Map And Elevation Map give approx. extend of Dense forest by interpretation, it which is not as good as FCD model. The Landsat Imagery of the 2013 have been represented by Band combination of 4 3 2 (True Color Composite). These images were subjected to the pca1 scaled and scaled SSI following forest canopy density Maps were generated, with the overall accuracy of 86% to 90%, tested using the Kappa-statistical methods generated from Erdas Imagine 9.2 tools. However the lowest accuracy was observed at the scene of the year 2013, with an accuracy of 82% and k-statistics were 0.8380.

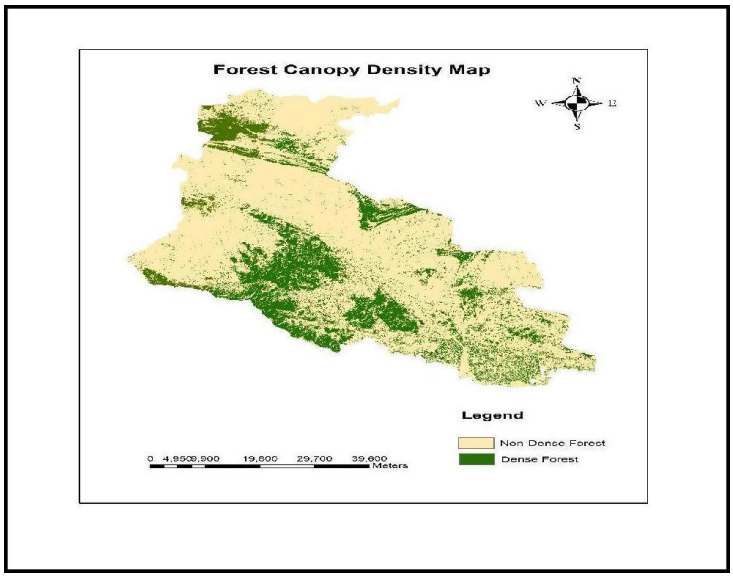

Figure 3: *Forest Canopy Density Map of East Singhbhum*

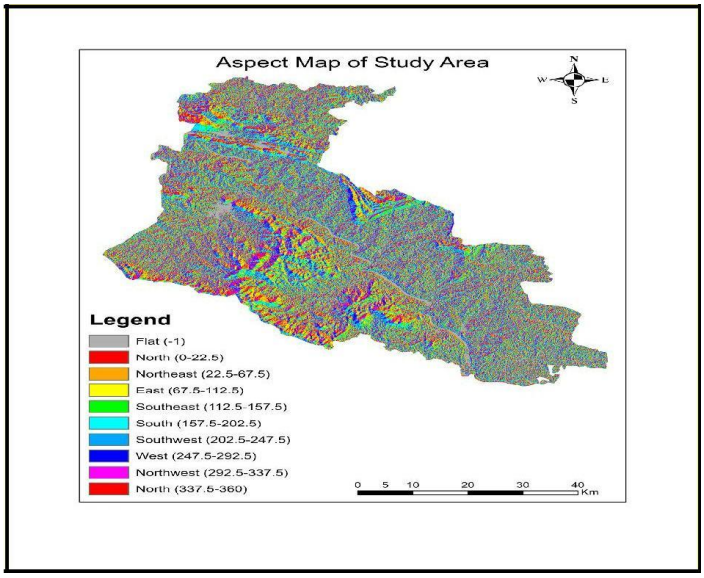

Figure 4: *Aspect Map of East Singhbhum*
(Source: Aster DEM)

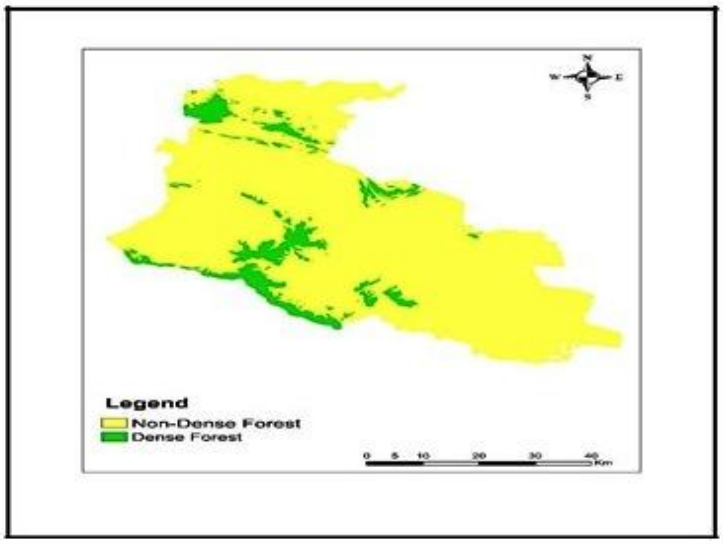

Figure 5: *Elevation Map (Equal and Greater than 300 m)*
(Source: Aster DEM)

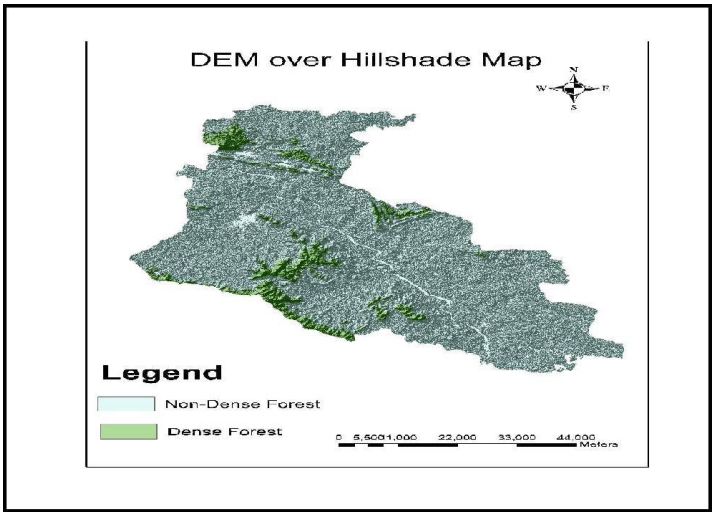

Figure 6: *Overlapped of DEM and Hillshade Map (Azimuth 300, Sun angle 45)*
(Source: Aster DEM)

7. Conclusion

In the present research work the Dense Forest cover affects measured as a comparable change in the area with its surroundings which provides a measurement and can be implemented by policy makers in the planning of the protecting of Forest cover. Landsat 8 satellite data is used to study the Dense Forest variations in larger scale and then same-resolution of the ASTER DEM data can be used. Although higher Dense Forest regions can be located easily from FCD Model using satellite data further analysis could be carried out only when these data merged into Land use/land cover data and also more detailed analysis could be achieved using Quick Bird satellite data.

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