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Assessment of Forest Cover Conditions and Canopy Density using Remote Sensing and GIS Techniques in Parts of Jharkhand State

Jai Kumar[1], Paras Talwar[2], A. P. Krishna[3]

[1]*Department of Remote Sensing, Birla Institute of Technology Ranchi, Bihar, India*
[2]*Department of Remote Sensing, Birla Institute of Technology Ranchi, Delhi, India*
[3]*Department of Remote Sensing, Birla Institute of Technology Ranchi, Ranchi, India*

***Corresponding Author:** Jai Kumar, Department of Remote Sensing, Birla Institute of Technology Ranchi, Bihar, India*

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ABSTRACT

A Landsat 8 satellite image was used for preparing forest cover mapping and derived the Normalized Difference Vegetation Index (NDVI) in Arc GIS 10. The Supervised Classification on Landsat 8 image was done whose Kappa statistics are carried out in ERDAS Image 9.2.The correlation has been enumerate between Forest cover Density and mean NDVI (using R statistical software),which comes out to be good and also between average Elevation (which comes out through ASTER DEM data) and Forest cover Density comes out to be not to good. This model calculates forest canopy density using the three indices of bare soil index (BSI), shadow index (SI) and vegetation index. the forest map was prepared by using forest canopy density modeling whose overall accuracy is 86 to 90%. The correlation is calculated between forest cover density and forest canopy density which comes out to be not to good also between average elevation and forest canopy density comes out to be good.

Keywords: *Landsat 8, Remote sensing, Deforestation, forest, NDVI, ASTER DEM, Correlation, FCD*

INTRODUCTION

Forest stands or cover types consisting of a plant community made up of trees and other woody vegetation, growing more or less closely together. Therefore, there scope for intensity of forest cover. It becomes compulsory to monitor current status of forest .Understanding of altitudinal variation of forest cover density in Jharkhand state area. Thus plays a major role in this context. The forest cover condition defines land cover classification and various altitudinal ranges with forest cover density. Forest density expressing the stocking status buildup single major stand physiognomic character of forest .So for the scientific forest management, the knowledge of forest density classes is necessary at the local, regional, state and national levels purposes.

Forest canopy cover, also known as canopy coverage or crown cover, is defined as the proportion of forest floor covered by the vertical projection of the tree crowns. The anthropogenic intervention in the natural for reduces the number of tree per unit area and canopy closure. Forest canopy density is one of the most useful parameter to consider in planning and implementation of rehabilitation program.

Remote sensing is a very powerful tool in the provision of such information .it involves the acquisition of information about object, area or phenomenon through the analysis of data acquired by a device that is not in contact with the object, phenomenon or area under investigation Remote sensing technique to know the forest condition areas of Jharkhand India. Forest plays an important role in global carbon cycles. Forest conversion is the second largest global source of anthropogenic carbon dioxide emissions. Satellite remote sensing has played Pivotal role in generating information about forest cover, vegetation type and land use change.

Objectives of study

To assess the forest cover condition and forest canopy density of the study area.

To establish relationship between topographic variables and forest cover condition in the study area.

To assess the relationship between vegetation indices and forest cover density.

Study Area

The study area is Jharkhand state which lies between 22°00'& 24°37' North latitude and 83°15'& 87°01' East longitude.

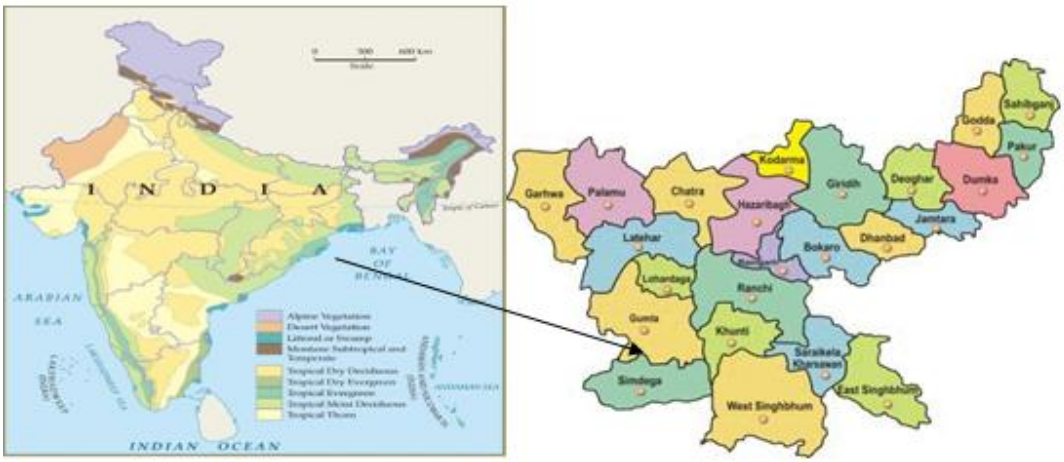


Figure1. *Study Area*

Data Used

Satellite Imagery – Landsat 8 (OLI) November, 2013, USGS, Aster DEM

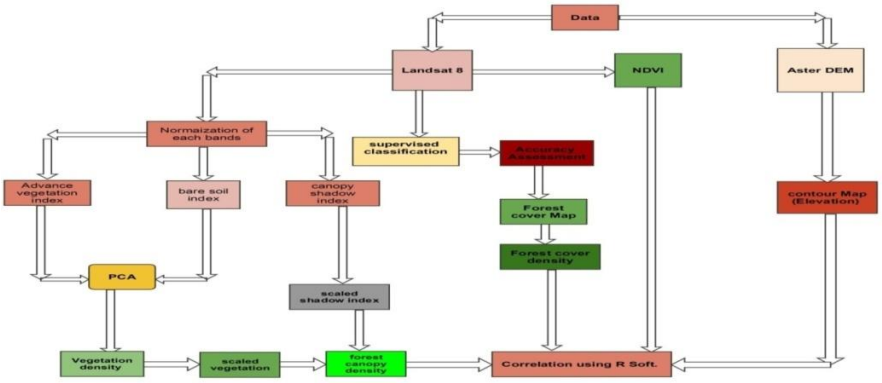


Figure2.*Flow chart of methodology*

METHODOLGY STEPS

Forest Cover Density

Forest classification(Supervised Classification) is carried out by digital image processing techniques in Erdas Imagine 9.2 .The classified image have four classes i.e. Forest, Fallow Land, Agriculture Land ,Water Body, BuiltUp/Mining.

The classified image is now going through Kappa statistical test i.e Accuracy assessment using Erdas Imagine 9.2.

After that we have calculated the Forest Area in Sq Km. The classified image is then used in Arc-GIS 10 to represent the forest cover through Map. At the end we have calculated Forest Cover Density. Forest Cover Density (%) = (Forest Cover Area/Total Land Area)*100

Altitudinal Calculation

Now I have to take ASTER DEM data and clipped out our study area.

Contour map is generated in Arc-GIS to determine the altitude of each districts in Jharkhand.

Normalized Difference Vegetation Index (NDVI)

The NDVI ratio is calculated by dividing the difference in the near-infrared (NIR) and red color bands by the sum of the NIR and red colors bands for each pixel in the image as follows.

NDVI= (NIR-RED)/(NIR + RED)

Correlation in R Statistical Software

Forest Density with Mean NDVI

The following steps are followed in R software window i.e.

```
> cor(Jh$Forest.Density,Jh$ndvimean,method="pearson")
[1] 0.682079
> cor(Jh$Forest.Density,Jh$Elevation.m.,method="pearson")
[1] 0.0533213
```

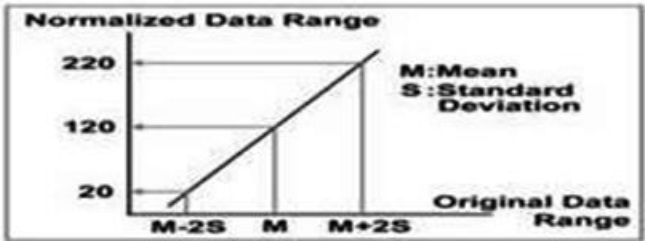
The LANDSAT 8 bands were normalized using linear transformation (equations 1 and 2)

A = (Y1-Y2)/ (X1-X2) = 20-65520/ (M-2S) - (M+2S) (1)

B= -AX1+Y1

Y=AX+B (2)

Where: X1=M-2S X2=M+2S Y1=20



Y2=65520 M=Mean S= Standard deviation

X= Original data Y= normalization data

Apply Normalization on each band i.e. 2, 3, 4,5,6,7 Bands

Advance vegetation Index

NDVI is unable to high-light delicately balanced amount in cover relation between Mass and size. For this reason, it has been getting better by using power degree of the infrared response.

The calculated index has been termed as an advanced vegetation index (AVI). AVI has been worked out Using an equation.

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 = ((B5+ B3) − (B4+ B1)) / ((B5+B3) + (B4+B1))

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

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

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.

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

Correlation in R Statistical Software

1) Forest canopy Density with Mean NDVI / Forest cover density and elevation:

The following steps are followed in R software Window i.e.

```
> cor(JH$Forest.Canopy.Density,JH$Forest.Cover.Density)
[1] 0.3330436
> cor(JH$Forest.Canopy.Density,JH$Elevation.m.)
[1] 0.5500228
> cor(JH$Forest.Canopy.Density,JH$NdviMean)
[1] 0.1866475
```

RESULTS & DISCUSSION

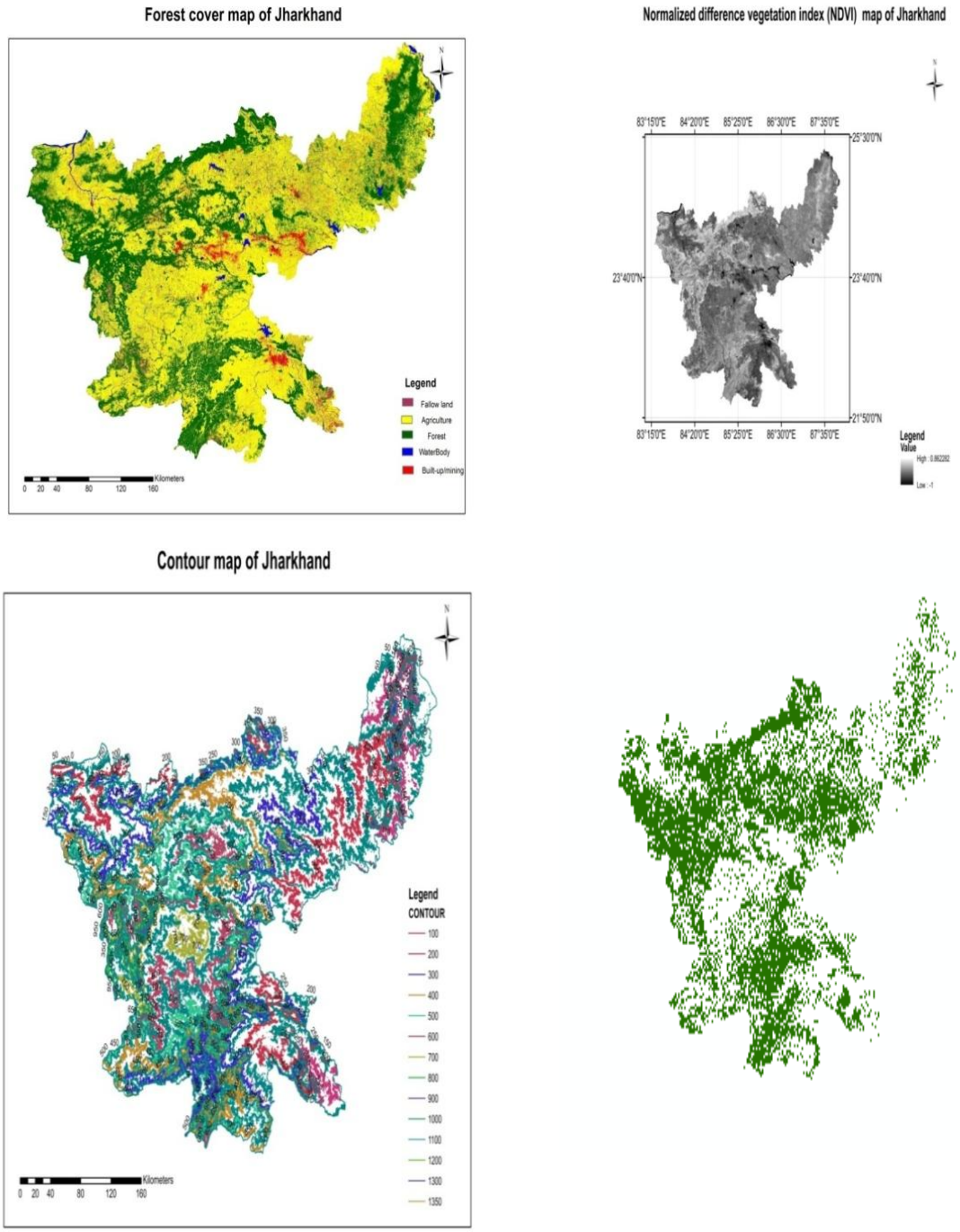


Figure3. *Forest map, NDVI map, contour map and forest canopy map of Jharkhand*

Correlation of Average Elevation, Mean Ndvi & Forest Cover Density of Different Districts of Jharkhand

	District	Total.Area	Total.Forest	Forest.Density	Elevation.m.	ndvimean
1	Ranchi	3841.62	774.7224	20.16655	525	0.2817736
2	Lohardaga	1496	518.98	34.69118	550	0.2906081
3	Gumla	5340.6	1590.54	29.78205	550	0.2893403
4	Simdega	3769	1360.834	36.10597	550	0.2896208
5	Palamu	4429.96	1591	35.91455	325	0.2899677
6	Latehar	4254	2319.22	54.51857	575	0.3139274
7	Garhwa	4050	2022.343	49.93441	575	0.3005241
8	West singhbhum	7193	3008.435	41.82448	437	0.3078573
9	Saraikla kharasawan	2642.06	422.0106	15.97279	450	0.2524294
10	East singhbhum	3562.98	714.95	20.06607	450	0.2786901
11	Dumka	3738	1437.97	38.46897	225	0.3044571
12	Jamtara	1772.46	277.75	15.67031	175	0.2877612
13	Sahebganj	2175.94	960.16	44.12622	225	0.2997219
14	Pakur	1794	833.34	46.45151	275	0.2940202
15	Godda	2218.8	658.8701	29.69488	275	0.303972
16	Hazribagh/ramgarh	6142.98	1954	31.80867	500	0.2865929
17	Chatra	3741	1798	48.06202	400	0.3141051
18	Koderma	1315.8	686.28	52.15686	325	0.3200411
19	Giridih	4976.82	1051	21.1179	675	0.2860518
20	Dhanbad	2071.74	454.63	21.94436	325	0.2982494
21	Bokaro	2830	497.26	17.57102	325	0.2765598
22	Deoghar	3980	363.8032	9.140784	350	0.3006745
23	Khunti	3792	959.76	25.31013	425	0.2919872

Figure4. *Result in R (STATISTICAL SOFTWARE)*

Land use /land cover & forest cover has been done using pattern recognition, viz. supervised classification. The forest cover density was calculated using following equation.DEM was classified in different altitudinal rang. The forest cover density was compare with mean normalization difference vegetation index (NDVI).The above result clarifies that they are positive (0.68) relation between Forest cover density and NDVI where as the relation between Elevation and Forest Cover density is not up to our expected value (0.036).

Correlation of Average Elevation, Mean Ndvi & Forest Cover Density, Forest Canopy Density of Different Districts of Jharkhand

	District	Total.Area	Total.Forest	Forest.Cover.Density	Elevation.m.	NdviMean	Forest.Canopy.Density
1	Ranchi	3841.62	774.7224	20.15	525	0.2817736	50.6694
2	Lohardaga	1496	518.98	34.63	550	0.2906081	45.0357
3	Gumla	5340.6	1590.54	29.76	550	0.2893403	48.95
4	Simdega	3769	1360.834	36.07	550	0.2896208	50.09344
5	Palamu	4429.96	1591	35.93	325	0.2899677	58.716
6	Latehar	4254	2319.22	54.5133	575	0.3139274	75.65
7	Garhwa	4050	2022.343	49.9	575	0.3005241	70.32
8	West singhbhum	7193	3008.435	41.8	437	0.3078573	62.08634
9	Saraikla kharasawan	2642.06	422.0106	15.9	450	0.2524294	40.68
10	East singhbhum	3562.98	714.95	20.81	450	0.2786901	58.19
11	Dumka	3738	1437.97	38.45	225	0.3044571	34.175
12	Jamtara	1772.46	277.75	15.65	175	0.2877612	33.822
13	Sahebganj	2175.94	960.16	44.12	225	0.2997219	20.502
14	Pakur	1794	833.34	46.47	275	0.2940202	15.56
15	Godda	2218.8	658.8701	29.67	275	0.303972	24.98
16	Hazribagh/ramgarh	6142.98	1954	31.81	500	0.2865929	60.7954
17	Chatra	3741	1798	48.1	400	0.3141051	69.987
18	Koderma	1315.8	686.28	52.2	325	0.3200411	72.89
19	Giridih	4976.82	1051	21.1	675	0.2860518	58.75
20	Dhanbad	2071.74	454.63	21	325	0.2982494	51.288
21	Bokaro	2830	497.26	17.563	325	0.2765598	56.00706
22	Deoghar	3980	363.8032	9.13	350	0.3006745	17.558
23	Khunti	3792	959.76	25.3	425	0.2919872	63.85

Figure5. *Result in R (STATISTICAL SOFTWARE)*

By analyzing the above map, we observe that there is a maximum forest given by the FCD model, whereas other two techniques which applied on ASTER DEM and LANDSAT 8: Forest cover Map Elevation Map gives approx. extent of forest by interpretation, which is not as good as FCD model. Forest cover loss is going on in large rate in the test area mainly due to deforestation and expansion of agricultural land, which can easily be monitored using the biophysical modelling in conjunction with the satellite image.

CONCLUSION

Forest cover density variation was found to be in tune with NDVI variation showing increase in forest density. Hence, indicating healthy forest conditions in the study area. It was also observed that the elevation is not compatible with the forest cover density due to fluctuation in elevation range.

For the Jharkhand state as a whole, the correlation coefficient value between Forest Canopy Density model and forest cover check shows a value of 0.33. For the forest variations in larger scale, similar resolution of the ASTER DEM data can be used. FCD Model shall be helpful in locating regions with higher Forest regions density with ease.

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AUTHOR'S BIOGRAPHY

Jai Kumar, was born in Bokaro, India, in 1990. He received the Bachelor of geography (Hons)from the ST. Xavier College, Ranchi, India, in 2010, and the Master of geography from V.B.U hazaribag,india in,2013 and M.Tech. degrees in Remote Sensing from the Birla Institute of Technology (BIT) Ranchi, Jharkhand, India, in 2013 and 2015 respectively. He has a keen interest in Remote Sensing and GIS.

Paras Talwar, was born in Delhi, India, in 1990. He received the B.Sc (Hons) degree in Electronics from the University of Delhi, India, in 2011, and Master degrees in Electronics and Communication from Devi Ahilya Vishwavidyalaya, Indore,M.P india ,in 2013. M.Tech in Remote Sensing from the Birla Institute of Technology (BIT) Ranchi, Jharkhand, India, in 2015 respectively. He has a keen interest in Open Source Geographical Information System softwares .

A.P Krishna, have 13 and 30 years of experience in teaching and research respectively. He has received many awards and attends many national and international conferences. He is also the Life member of nine professional bodies. Currently, he is the HOD of Remote Sensing Department in Birla Institute of Technology, Ranchi, Jharkhand.

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