*Biological Forum – An International Journal* **9**(1): 183-188(2017)

**ISSN No. (Print): 0975-1130**
**ISSN No. (Online): 2249-3239**

# Long Term Deforestation Assessment in Jharkhand state, India: A grid based Geospatial Approach

***Firoz Ahmad* and Laxmi Goparaju****
**Vindhyan Ecology and Natural History Foundation, Mirzapur, Uttar Pradesh, India.*

*(Corresponding author: Laxmi Goparaju)*
*(Received 15 March 2017, Accepted 18 June, 2017)*
*(Published by Research Trend, Website: www.researchtrend.net)*

**ABSTRACT: Forest is a fundamental component of the environment. Deforestation is caused by various anthropogenic factors, forest fire and fragmentation of large contiguous forests. Deforestation represents a global issue mostly caused by human influence and the forest of Jharkhand, India is not an exception as they have also been witnessing large scale deforestation. The aim of the present study is to identify deforestation using historical data for the year 1935 (Survey of India topographical maps of 1924–1935) and for the year of 2015 with Landsat -8 datasets in Jharkhand, India. To achieve this objective, the analysis focuses on grid (5 km*5 km) based assessment to detect long term change. The grid based analysis reveals forest percent in Jharkhand for the year 1935 and 2015 were roughly 49% and 23% respectively. The result shows 2596 forest grid for the year 1935 out of which 1372 forest grids were found present in the year 2015. 1224 forest grid (equivalent to 26% forest area) was lost during the span of 80 years. The analysis of remote sensing data in GIS domain and its derived product must be incorporated in forest conservation; management and planning which will certainly fetch better result in decision making support system.**

**Keywords:** Jharkhand, forest assessment, deforestation, geospatial technology, GRID Analysis.

## INTRODUCTION

Deforestation is a conventional environmental challenge considerably affecting the resilience and distribution of forests across the different boundaries. It is defined as the loss of trees' cover usually as a result of forests being cleared for other land uses purpose (Gorte and Sheikh, 2010). Over the years, the world has experienced unprecedented forest loss at a global scale. The rate of deforestation is still alarming because in the year 2010 it was observed that the world had just over 4 billion hectares of forest, which corresponds to an average of 0.6 forest per capita (FAO, 2010). As a recognized global challenge, deforestation has gained greater boost in policy and research which has also indicated that there is increasing research on various dimensions of deforestation by many scientists. Though deforestation is well identified problem, it has important to highlight the changes that affect the manifest the rate and extent of it has however varied across the world *viz.* continental, national, regional and local level (FAO, 2005).

Monitoring of forests has gained momentum due to the advancement of remote sensing and GIS technology and it is possible to monitor and analyse the gross and net changes in forest ecosystems (Reddy *et al*. 2013a). Forest Survey of India has been carrying out mapping of forest cover at national level at an interval of 2 years. Though, there are protected areas, still protection of forests is not fully achieved as the anthropogenic pressure has increased over the times. Deforestation studies by Reddy *et al*. 2013a reveals that at regional scale, it has been observed that the overall net rate of deforestation was relatively high in the North East region (–0.90 to –5.29) and Deccan Peninsula (–0.19 to –3.2) followed by the Western Ghats. Jharkhand is a state of India retains beautiful sal (*Shorea robusta*) forest and is a home for several tribes. The state had 23,478 sq. km of land under forest which was about 29.48 percent of the total area of the state (FSI 2015). The major cause of deforestation in Jharkhand is due encroachment of forest land for agriculture purpose, forest land diversion for industries, large Dams, Roads, Mining, Power Plants. With the increase in population here in Jharkhand state they demands for food and space has increased.

To meet these needs man has destroyed the forests and converted them into food growing fields or space for building houses etc. Due to the progress and growth of modern civilization, industrial expansion along with increasing human population, there has been a widespread destruction of the forest cover further leading to soil erosion, floods, drought and increasing wasteland. The natural cause of deforestation here is forest fire, which is frequent during the summer.

Several researchers has evaluated the deforestation in forest of various part of India (Menon and Bawa, 1997; Jha *et al.* 2000, Reddy *et. al.* 2007; Reddy and Roy, 2008; Giriraj *et al* 2008; Josheph *et al*, 2009; Reddy *et al.* 2009; Reddy *et al.* 2010; Reddy *et al.* 2013b; Reddy *et al.* 2014; Reddy *et al.* 2015) using remote sensing and GIS.

Few researchers have evaluated the deforestation using GRID based analysis using long term deforestation. Reddy *et al.*, 2013b and Reddy *et al.* 2014 have evaluated long term deforestation based on GRID (5km × 5 km) for the Orissa state of India whereas Reddy *et al.*, 2015 has evaluated the grid based deforestation analysis for the state of Telangana, India.

The objective here is to study the forest percent based on grid of 5km × 5km over the state of Jharkhand utilizing the 1935 and 2015 data. Assessment of deforestation between these two periods.

## MATERIALS AND METHODS

### *A. The Study area*

Jharkhand (Fig. 1) become state in the year 2000 having geographical coordinates with latitude 21º 58' 02" N to 25 º 08' 32"N and longitude 83º 19' 05" E to 87º 55' 03" E. The total geographical area of the state is 79,714 km² accounted for nearly 2.4 % of total geographical area of the country whereas total forest area 23,478 km² and is surrounded in east by West Bengal, on the west by Chhattisgarh, on the north by Bihar and on the south by Orissa. The state have some major rivers which are Sone, Koel, Damodar and Subarnarekha whereas the average elevation varies from 6 m to 1366 m from the mean sea level with average rainfall varies from 945 mm to 1297 mm and temperatures varies from 6ºC in winter to 47ºC in summer. The word 'Jharkhand' means 'land mass covered with forests' and is the home for various ethnic tribes such as Munda, Oraon, Ho, Santhal, Paharia and traditionally, these indigenous people have friendly relations with nature and forests.

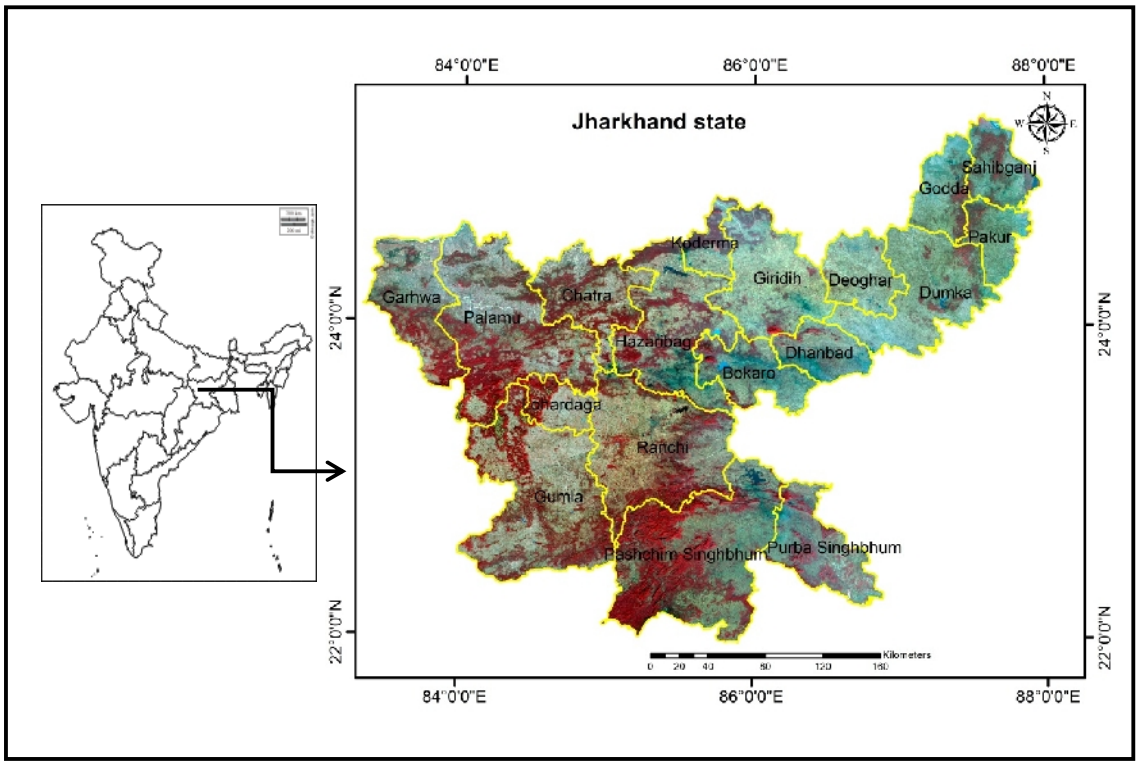


**Fig. 1**. The location of the study area.

**Data Preprocessing and analysis**

In the present study for long term forest deforestation assessment we defined forest as land with more than 1% of grid area dominated with indigenous tree species with over story canopy greater than 10%. A grid of 5 km × 5 km (each 25 $km^2$) size has been prepared to understand the status of threat. Historical/long term changes of forest cover have been expressed in quantitative terms. The spatial distribution of forest cover during the last 80 years (2015-1935) has been mapped during the present study. The software used for long-term deforestation analysis was ERDAS IMAGINE 11 for digital image processing and ArcGIS for GRID analysis and presenting the results in geospatial domain (in form of map). Survey of India topographical maps of 1924–1935 (say 1935) were downloaded (http://www.lib.utexas.edu/maps/ams/india/) and interpreted visually to generate spatial data sets on 1:250,000 scale for the year 1935. Remote Sensing data pertaining to Landsat 8 (2015) was utilized to obtain forest cover of 2015. The nine Landsat images (path /row: 142/43, 141/43, 141/44, 140/43, 140/44, 140/45, 139/43, 139/44 and 139/45) of the time December 2015 were downloaded from USGS website. All the images were mosaicked with providing cutline and resampled using Nearest Neighbor resampling methods in order to preserve the radiometry of pixel and spectral information in the imagery. For classification we have used hybrid classification techniques/approach (combination of visual, supervised and Normalized Difference Vegetation Index) to map forest cover with two class *viz.* forest and non-forest class. The accuracy of classified forest cover map was analyzed/ evaluated by generating 250 random sampling points, and each point was then assigned to the respective class based on ground truth knowledge and literature. The error matrix was used to compute overall accuracy and kappa statistic. The GRID analysis was performed in the vector grid (5 km × 5 km) the percent forest column were created in vector grid for the year 2015 and 1935. If the grid percent is full of forest means 100 values or if there is no forest in that grid means 0 values. These values for the year 1935 and 2015 were finally utilized to create grid based maps that includes forest cover % (<20%, 20-30%, 30-40%, 40-50%, 50-60%, 60-70%, 70-80%, 80-90% and >90%). The long term deforestation was evaluated by counting the spatial grid data of forests in the time series 1935–2015 has been considered for assessment of historical decline.

**RESULTS**

The overall classification accuracy of the final classified forest cover map of 2015 was 94.1% and the kappa value was 0.91. The forest was quantitatively evaluated based on grid analysis which is given in Table 1, Fig. 2 and Fig. 3.

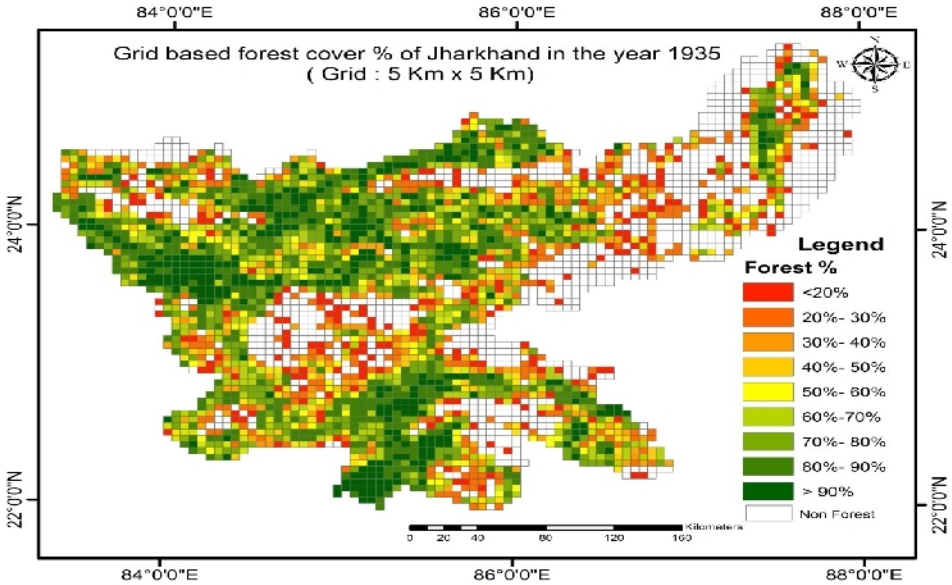


**Fig. 2.** Grid based forest cover percent for the year 1935.

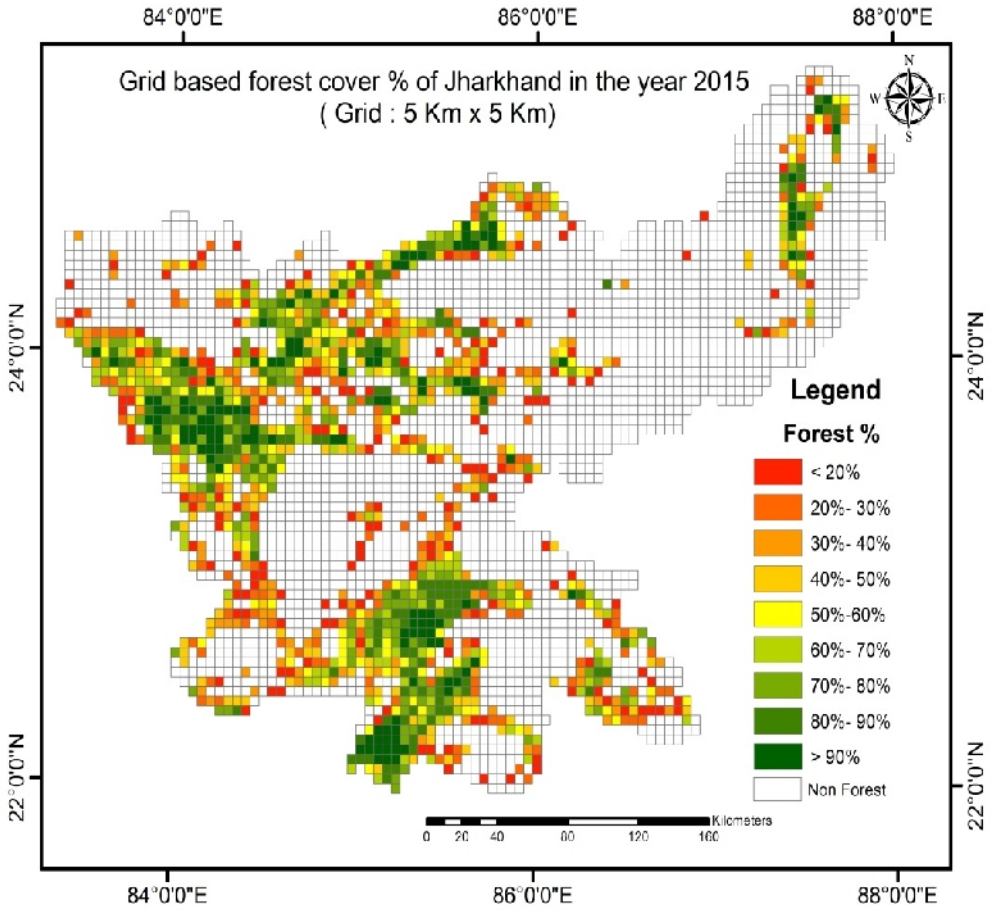


**Fig. 3.** Grid based forest cover percent for the year 2015.

Total number of grids of forest in the year 1935 was 2596 out of which 1685 grids shows more than 50% of forest cover. Similarly for the year 2015 total number of grid of forest were 1372 out of which 751 grids shows more than 50% of forest cover. The approximate forest percent calculated based on grid analysis for the year 1935 was 49% where as for the year 2015 it was 23 % when compared with the total geographical area of Jharkhand. So we can say 934 grids of more than 50 % forest cover has been lost during this 80 years of span. The driving factors of deforestation (loss of 1224 grid) between the period 1935 and 2015 were industrialization, urbanization, mining activity and conversion of forest land to other land use purpose *viz.* dam construction, agriculture purpose etc. Within the state, the losses of forest ecosystems are more pronounced in those areas where population was high which resulted into forest loss by various anthropogenic activity. We have also compared our result with Forest Survey of India report 2015 (FSI, 2015) of Jharkhand. FSI has reported 29 % of forest in Jharkhand for the year 2015 whereas our evaluation for the same base year exhibits 23 % of forest. The difference (6%) in percent is due to because our evaluation procedures, we only consider the forest greater than 25 ha as forest whereas FSI has considered greater than 1 ha as forest. Several small forest patches from less than 25 ha are excluded in the present study whereas FSI has included greater than 1ha forest patches for their evaluation.

**Table 1: Grid based statistics (forest cover %) for the year 1935, 2015 and deforestation.**

| Forest cover % | 1935 | | 2015 | | Deforestation | |
|---|---|---|---|---|---|---|
| | No. of Grid | % | No. of Grid | % | Loss of Grid | % |
| <20% | 214 | 8.24 | 163 | 11.88 | 51 | 23.83 |
| 20%-30% | 305 | 11.75 | 159 | 11.59 | 146 | 47.87 |
| 30%-40% | 228 | 8.78 | 157 | 11.44 | 71 | 31.14 |
| 40%-50% | 164 | 6.32 | 142 | 10.35 | 22 | 13.41 |
| 50%-60% | 224 | 8.63 | 145 | 10.57 | 79 | 35.27 |
| 60%-70% | 224 | 8.63 | 134 | 9.77 | 90 | 40.18 |
| 70%-80% | 420 | 16.18 | 170 | 12.39 | 250 | 59.52 |
| 80%-90% | 512 | 19.72 | 165 | 12.03 | 347 | 67.77 |
| >90% | 305 | 11.75 | 137 | 9.99 | 168 | 55.08 |
| Total Grid | 2596 | 100.00 | 1372 | 100.00 | 1224 | 47.15 |

## CONCLUSION

The present study has attempted to develop grid (5 km × 5 km) based forest cover percent of Jharkhand for the year 1935 and 2015. Deforestation has been evaluated based on the grid loss between the 80 years period. Roughly 53 percent of the forest area has been lost between these periods. The deforestation within the state of Jharkhand which is at such alarming rate is concern for forest policy/decision maker. There is an urgent need to strictly implement the Indian forest conservation act 1988 and formulate appropriate conservation measures and strategies in deforested and degraded forest areas. There is urgent need to provide environmental education to the people and involve/encourage them for tree planting/ protecting forest which would involve local bodies for conservation measures plans. The driving factor for deforestation in Jharkhand must be closely monitored and restricted. Finally we recommend that the forests for the Jharkhand state should be temporally monitored using remote sensing and GIS for identifying forest health (quantitative and qualitative) and disturbance (driving factor for deforestation) so that appropriate conservation related policy/decision should be taken on time.

## AUTHOR'S CONTRIBUTIONS

FA proposed the idea, analyzed the satellite and ancillary data in GIS domain and drafted the manuscript, LG supervised the analysis and improved the manuscript. All authors read and approved the final manuscript.

## COMPETING INTERESTS

The authors declare that they have no competing interests.

## FUNDING

No funding in any form has been received by any of the author for current work.

## ACKNOWLEDGEMENT

The authors are grateful to the USGS for free download of Landsat data which was used in the analysis. Required GIS layers were downloaded from DIVA GIS".

## REFERENCE

Gorte, R.W. and Sheikh, P. A. (2010). Deforestation and Climate Change, Congressional Research Service, March 24, 2010. Retrieved on 23rd May, 2017, from http://www.fas.org/sgp/crs/misc/R41144.pdf

Food and Agriculture Organization (2005). State of the World's Forests 2005, Food and Agriculture Organization of the United Nations, Rome, available at http://ftp.fao.org/docrep/fao/007/y5574e/y5574e00.pdf

Food and Agriculture Organization (2010). "Criteria and Indicators for Sustainable wood fuels", in FAO Forestry, Paper 160, Electronic Publishing Policy and Support Branch, Viale Delle Terme di Caracalla, I-00100 Rome, Italy, pp. 5, 10 and 11.

Reddy, C.S., Dutta, K., and Jha, C. S. (2013a). Analysing the gross and net deforestation rates in India. *Current Science*, **105**(11): 1492-1500.

FSI (2015). http://fsi.nic.in/isfr-2015/isfr-2015-forest-cover.pdf (accessed on 15th May 2017).

Reddy, C,S., Jha, C. S. and Dadhwal, V. K. (2013b). Assessment of large-scale deforestation of Nawarangpur district, Orissa, India: a remote sensing based study. Environ Monit Assess 185: 4399. doi:10.1007/s10661-012-2877-5.

Reddy, C.S., Pasha, S.V., Jha, C.S. & Dadhwal, V.K. (2015). Geospatial characterization of deforestation, fragmentation and forest fires in Telangana state, India: conservation perspective. *Environ Monit Assess*. **187**(7): 455.

Reddy, C. S., Khuroo, A. A., Harikrishna, P., Saranya, K. R. L., Jha, C. S., and Dadhwal, V. K. (2014). Threat evaluation for biodiversity conservation of forest ecosystems using geospatial techniques: a case study of Odisha, India. *Ecological Engineering*, **69**: 287-303.

Giriraj, A., Shilpa, B. & Reddy, C.S. (2008). Monitoring of Forest cover change in Pranahita Wildlife Sanctuary, Andhra Pradesh, India using remote sensing and GIS. *Journal of Environmental Science and Technology* **1**(2): 73-79.

Jha, C.S., Dutt, C.B.S. & Bawa, K.S. (2000). Deforestation and land use changes in Western Ghats, India. *Current Science*, **79**: 231–238.

Menon, S. & Bawa, K.S. (1997). Applications of geographic information systems, remote sensing and a landscape ecology approach to biodiversity conservation in the Western Ghats. *Current Science*, **73**: 134-145.

Reddy, C.S., Rao, P.R.M., Pattanaik, C. & Joshi, P.K. (2009). Assessment of large scale deforestation in Nawarangpur district, Orissa, India using remote sensing and GIS. *Environmental Monitoring and Assessment*, **154**: 325-335.

Reddy, C.S., Pattanaik, C. & Murthy, M.S.R. (2007). Assessment and Monitoring of Mangroves of Bhitarkanika Wildlife Sanctuary, Orissa, India using Remote Sensing & GIS. *Current Science*, **92**: 1409-1415.

Reddy, C.S. & Roy, A. (2008). Assessment of three decade vegetation dynamics in Mangroves of Godavari delta, India using multi-temporal satellite data and GIS. *Research Journal of Environmental Sciences*, **2**, 108-115.

Reddy, C.S., Prachi, U., Shilpa, B., Giriraj, A. & Sudhakar, S. (2010). Assessment of Fragmentation and Disturbance patterns in Eastern Ghats: A case study in R.V. Nagar Range, Visakhapatnam district, Andhra Pradesh, India. *Journal of Indian Society of Remote Sensing*, **38**(4): 632-639.

Joseph, S., Blackburn, G.A., Gharai, B., Sudhakar, S., Thomas, A.P. and Murthy, M.S.R. (2009). Monitoring conservation effectiveness in a global biodiversity hotspot: the contribution of land cover change assessment. *Environmental Monitoring and Assessment*, **158**, 169-179.