BURNT AREA ASSESMENT

A Report submitted in partial fulfilment

For the award of the Degree of

MASTER OF SCIENCE IN APPLIED GEOGRAPHY AND GEOINFORMATICS

By

MADHURI

Pursued in

NORTH EASTERN SPACE APPLICATIONS CENTRE

TO

CENTRAL UNIVERSITY OF KARNATAKA

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Bonafide Certificate

This is to certify that the project report entitled **"BURNT AREA ASSESSMENT**" submitted by **MADHURI D/O SHANTKUMAR** to the North Eastern Space Applications Centre, Umiam, Shillong and Central University of Karnataka, Kalaburagi, in partial fulfilment for the award of the degree M.Sc in Applied Geography and Geoinformatics, is a bonafide record of the project work carried out by her under my supervision from 01-12-208 to 31-03-2019.

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Place: Umiam, Shillong

March, 2019

Declaration by Author

This is to declare that this report entitled "BURNT AREA ASSESSMENT" has been written by me. No part of the report is plagiarized from other sources. All information included from other sources has been duly acknowledged. I aver that if any part of the report is found to be plagiarized, I shall take full responsibility for it.

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Central University of Karnataka

Place: Umiam, Shillong

Date: 31/03/2019

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Last but not the least I would like to thank all my friends who helped me directly or indirectly in my project work.

Abstract

Forest fire is any fire that has occurred by natural or anthropogenic which has the diverse effects on the forest. According to the Down to Earth in the period of 16 years since 2001 to 2017 it has been recorded that there was 46% of increase in the forest fires and it has occurred more in the North Eastern regions which led to the forest vegetation loss. Thus this burnt area assessment was carried out. To complete the research the standard methodology was built from basic processing and corrections to the final extraction of the areas which includes both the raster and vector processing. By following this methodology it was found that there is pattern in the burning process, the burning pattern can be seen as the cyclic process like there is a consistence in burning for two to three years and there is sudden rise again the same low burning for two – three years and again rise in this. This pattern of study is useful to correlate the burning pattern and the shifting cultivation as well as it can used for the study of vegetation recovery too.

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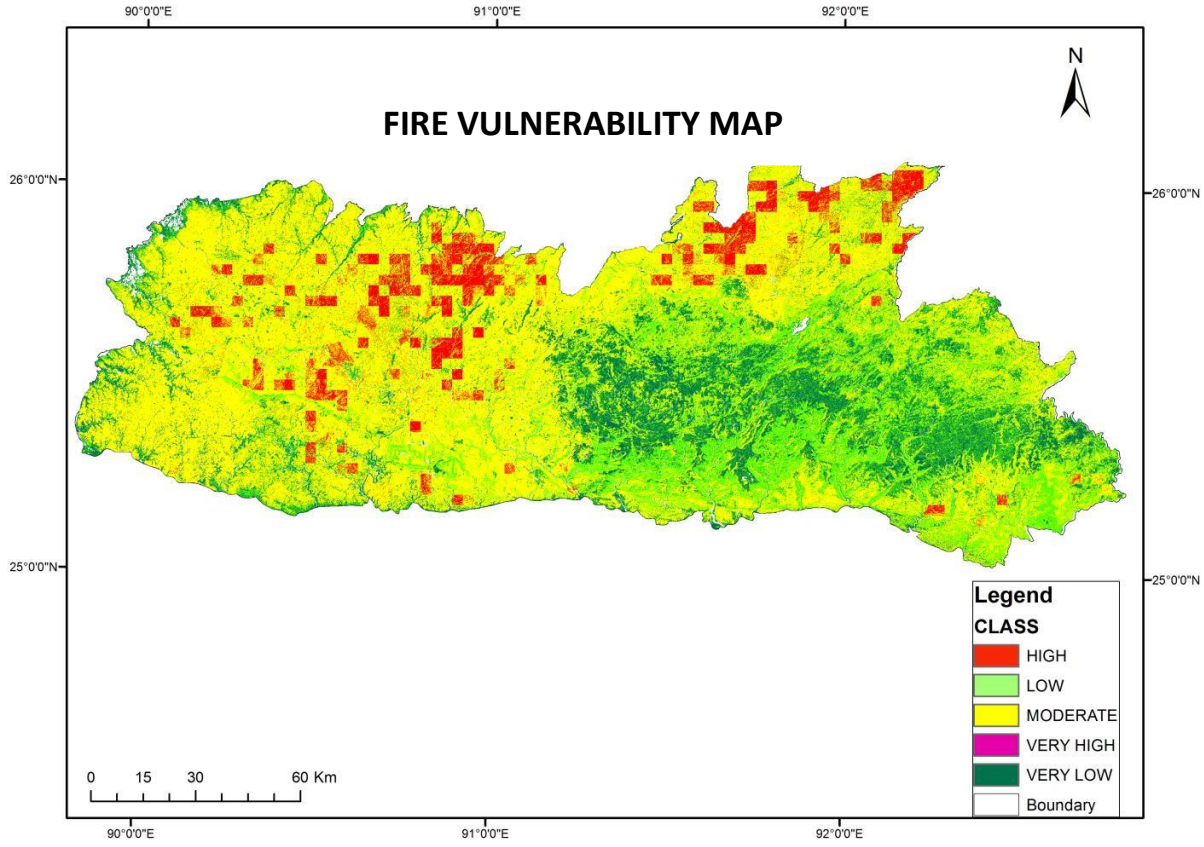
1. Introduction:

"The forest is a peculiar organism of unlimited kindness and the benevolence that makes the no demands for its sustenance and extends generously the products of its life activity; it affords protection to all beings, offering shade even to the axe-man who destroys it". Gautama Buddha.

The forests which provides the life for the huge number of species and supports the life system of the flora and fauna, is also exposed to the hazards it may be the natural or the man made hazards. Forest fire is one of the most imperilment in forest areas; these forest fires exist since the forest exists. Any fire on the forest which may be occurred naturally or Anthropogenic and is not for the forest protection and management in harmony with the authority is termed as the Forest fire or Wild fire (ES & A, 1986). This forest fire is intimidation to the forest recourses and also affects the entire ecosystem critically disturbing the biodiversity and also affects the socio-economic condition of the people living around that area. During the Spring and Summer season, when there is no rain for months the forests turns to littered dry senescent leaves and twinges as spring season is meant to shading of the leaves and growing of new leaves. Slightest spark can turn these dry leaves and twinges to burst into flames. This is common phenomenon in the Lower Himalayan ranges during the late winters and summers since more than one decade leading to the loss of vegetation cover in that region.

Need of the study: In the period 16 years since from 2001 to 2017 it has been recorded that India has witnessed 46% amplify in the forest fires it has witnessed the spike of 125% (from 15,937 to 35,888 fires locations) within these fire in two years (2015 to 207). This shows that there is huge destruction in the environment due to these fires. It has led to the loss of forest resources. The Fig: 1 represents the fire vulnerability map which has been generated based on the elevation factors and historical basis, according which the most of the part of Meghalaya, comes under the High and Moderate zones. Thus the aim of the study is to study the burned area from 2005 to 2018 and mapping the areas.

Fig: 1



Source: NESAC, 2014

STUDY AREA:

Study is carried out for the two District of Meghalaya. Meghalaya is one among the most beautiful states of India. It's literal meaning is, Megha means "Clouds "and Alaya means "Abode" in the Sanskrit. Thus Meghalaya is termed as "abode of clouds", and it is geographically known as the "Meghalaya plateau" or the "Shillong plateau". It is one of the most beautiful state in India comprising of 22,429 Sq.Km. Nature has blessed the Meghalaya

with the Abundant rainfall, sunshine, virgin forests, high plateau , , crystal clear rivers, meandering streamlets and above all with sturdy , intelligent and hospitable people. The landscape of Meghalaya is mostly rolling plateau with south facing slopes being extremely steep and the area is made up of oldest rock formations. The plateau is highly dissected and has the irregular terrain in the Western and Northern side. Its elevation varies between 150 meters to 1961 meters above sea level.

PHYSIOGRAPHIC INFORMATION:

Location:

Meghalaya is located in the north-eastern part of the India between the latitude 25°1′ to 26°5′N and Longitude 89°49′ to 92°52′E. It is bounded by the Nagaon, Kamrup and Goalpara districts of Assam on the north, Mikir and North Cachar Hill districts of Assam on the East, and Mymensingh and sylhet district of Bangladesh on the South and west i.e. Meghalaya has bounded both with national as well as the International border.

Location of the East Garo Hills: East Garo hills district is located between the 90°E and 91.3°E longitude and between the 25.24°N and 26.10°N latitudes covering 2603 Sq.Km. The District is bounded with the Northern side by North Garo hills; on the southern side by the South Garo hills, on the western side by the West Garo hills and Eastern side by the West Khasi hills.

Climate:

Depending upon the altitude the climate of Meghalaya varies. There is a difference between the climate of the Jaintia hills, Khasi hills and Garo hills. To some extent the Jaintia and the Khasi hills comparably similar climate i.e. pleasing and refreshing whereas the Garo hills has warm and humid climate other than the winter season.

East Garo hill district enjoys the comfortable climate throughout the year i.e. it has the moderate climate all over the area where summer and winter temperature are moderate.

Temperature varies between 5°C to 36°C. The climate of district is influenced by the monsoons due to which it has tropical type of climate and healthy climatic throughout the year.

Topography and Drainage: as the name indicates, the east Garo hills is has the hilly terrain. The hills in this region are highly dissected and Arbella Range is one of the major formations. The range is composed of the peaks of an average height of 700mts above sea level. The topography of the other part of the district is undulating with low hills with the altitudes varying between the 150 metres to 600 meters above sea level. Another significant physiographic feature in this district is the Simsang Valley, which derived the name by the Simsang River which is the longest river in Garo hills.

DEMOGRAPHIC INFORMATION:

According to the census of India 2011, the district had total population of 317,917 lakh among which 161,223 male and 156,694 female respectively. The data released by the by census India shows that the density of the East Garo Hills was 122 person per.sq.km. Among the total population of the district 13.90% population lives in the urban area and 86.10 % population lives in the rural areas. The average literacy rate of the in 2011 was 73.95%. When it was looked according to the gender the literacy rate were found 77.72% and 70.05% respectively.

Working Population: in East Garo hill district out of total population 46% was working population among which 45% male and 34% female population was working. Among these working people most of them were engaged in the Agricultural related activities.

DATA AND METHODOLOGY

To carry out any research the first and foremost thing is that, acquisition of input data in order to support the proposed study. Therefore, to carry out this research study Landsat-5 and Landsat-8 satellite data with different band combinations have been used. . Landsat satellite series was first civilian Earth Observation satellite which was launched in the 1972.These Landsat satellite series are proven their efficiency in the research study by providing the quality input data as well as it provides the output up to the mark when processed. The information provided by these satellites is valuable source for global change study.

Landsat-5: This satellite was launched on the march 1, 1984. Its sensor specification was same as the Landsat 4 which carried MultiSpectral Scanner (MSS) and Thematic Mapper instruments. This was the longest Operating Earth Observation Satellite which delivered the data almost 29 years. Satellite was orbited the earth in Sun-synchronous, near polar orbit, at an altitude of 705 km, at an angle 98.2 degrees and circled the earth every 99 minutes. The satellite has the 30m spatial resolution and the temporal resolution of 16 days with an equatorial crossing at 9:45 am +/- 15 minutes. The Landsat 5 provided the data in the Worldwide Reference System-2(WRS-2) path/ row system, with the swath overlap. The swath overlap varies from the Equator to towards poles i.e. Swath overlap is 7% at the Equator and approximately 85% at higher latitudes.

Table: 1

SENSOR	Band number	Band name	Wavelength (μm)	Resolution (m)	Band Applications

TM	1	Visible Blue	0.45 - 0.52	30	Bathymetric mapping, distinguishing soil from vegetation, and deciduous from coniferous vegetation
TM	2	Visible Green	0.52 - 0.60	30	Emphasizes peak vegetation, which is useful for assessing plant vigour
TM	3	Visible Red	0.63 - 0.69	30	Discriminates vegetation slopes
TM	4	NIR	0.76 - 0.90	30	Emphasizes biomass content and shorelines
TM	5	SWIR 1	1.55 - 1.75	30	Discriminates moisture content of soil and vegetation; penetrates thin clouds
TM	6	Thermal	10.40 - 12.50	120	Thermal mapping and estimated soil moisture
TM	7	SWIR 2	2.08 - 2.35	30	Hydrothermally altered rocks associated with mineral deposits

Landsat-8: This satellite was launched on 11 February, 2011. Landsat-8 payloads are consisting of two push-broom science instruments i.e. the OLI (Operational Land Imager) and TIRS (Thermal Infrared Sensor). This satellites spectral band of the OLI sensor provides the improvement from prior Landsat satellite with the addition of the two bands one is coastal zone investigation, and other one for the detection of the cirrus clouds. These sensors are capable of collecting the valuable data and images of global landmass and providing the seasonal coverage of the global landmass which is used in Agriculture, Education, Business, and Science etc.

Table: 2

Sensor	Band number	Band name	Wavelength (μm)	Resolution (m)	Band Applications
OLI	1	Coastal	0.43 - 0.45	30	Coastal and aerosol studies
OLI	2	Blue	0.45 - 0.51	30	Bathymetric mapping, distinguishing soil from vegetation, and deciduous from coniferous vegetation
OLI	3	Green	0.53 - 0.59	30	Emphasizes peak vegetation, which is useful for assessing plant vigour
OLI	4	Red	0.63 - 0.67	30	Discriminates vegetation slopes
OLI	5	NIR	0.85 - 0.88	30	Emphasizes biomass content and shorelines

OLI	6	SWIR 1	1.57 - 1.65	30	Discriminates moisture content of soil and vegetation; penetrates thin clouds
OLI	7	SWIR 2	2.11 - 2.29	30	Improved moisture content of soil and vegetation and thin cloud penetration
OLI	8	Pan	0.50 - 0.68	15	15 meter resolution, sharper image definition
OLI	9	Cirrus	1.36 - 1.38	30	Improved detection of cirrus cloud contamination
TIRS	10	TIRS 1	10.60 - 11.19	30 (100)	100 meter resolution, thermal mapping and estimated soil moisture
TIRS	11	TIRS 2	11.50 - 12.51	30 (100)	100 meter resolution, thermal mapping and estimated soil moisture

Table: 3

Year	Image Date
2006	16-Nov-05

	08-Mar-06
2007	05-Dec-06
	11-Mar-07
2009	24-Nov-08
	28-Feb-09
2010	11-Nov-09
	15-Feb-10
2011	14-Nov-10
	06-Mar-11
2014	22-Nov-13
	26-Feb-14
2015	25-Nov-14

	17-Mar-15
2016	28-Nov-15
	16-Feb-16
2017	30-Nov-16
	18-Feb-17
2018	03-Dec-17
	09-Mar-18

Methodology:

To accomplish the aim of the study, the following methodology was used which is represented in the flow chart which includes the stepwise representation and the description of each step is also provided below. The steps involved to get the results are

1: Selection of study area: This step is where the study area is selected depending upon the topic of the study .the area where the intensity of the forest fire is high and it has the impact on the surrounding people.

2: Acquisition of the satellite data: As this study is the trend analysis hence the data Acquisition plays a major role where each and every data is checked properly and downloaded according to the study.

3:Necessary pre-processing: This step includes the basic process to carry out i.e. the layer stack , this layer stacking process is very important as it has to be done by the selected bands according to the resolution and the requirement. As it will be used to carry out the further processes so this step should be performed carefully. The negligence in this step may lead to the wrong results. For the Landsat-5 image the band 1, band2, band3, band4, band5 and band 7 are used for the layer stack; band 6 is not used as it is the thermal band and does not has the reflectance value. In same way for the landsat-8 image the band2, band3, band4, band5,band6 and band 7 were used for layer stack where the band1 is Coastal hence it is not included along with the other bands. Not only the first band but also the bands from 8 to 11 are not used in layer stacking. As these bands are not required for the study because of the characteristics of the bands.

4: Conversion to the Surface Reflectance: surface reflectance is the fraction of the incoming solar radiation which is obtained after the atmospheric corrections. The surface reflectance provides the approximate what would be measured by the sensor which was held just above the earth's surface without any noise. The conversion is basically done in two steps in the first is the DN values are converted into the radiance value then from the radiance to reflectance.

4.1 Conversion from DN value to Radiance:

$$L_\lambda = \left(\frac{LMAX_\lambda - LMIN_\lambda}{QCALMAX - QCALMIN}\right) \cdot (QCAL - QCALMIN) + LMIN_\lambda$$

Where:

L_λ = Spectral Radiance at the sensor's aperture in (Watts/(m² * sr * µm))

QCAL = Quantized calibrated pixel value in DN

$LMIN_\lambda$ = Spectral radiance scaled to QCALMIN in (Watts/(m² * sr * µm))

$LMAX_\lambda$ = Spectral radiance scaled to QCALMAX in (Watts/(m² * sr * µm))

QCALMIN = Minimum quantized calibrated pixel value (corresponding to $LMIN_\lambda$) in DN (1 for LPGS products; 1 for NLAPS** products processed after 4/4/2004; 0 for NLAPS** products processed before 4/5/2004)

QCALMAX = Maximum quantized calibrated pixel value (corresponding to $LMAX_\lambda$) in DN = 255

4.2 Conversion from Radiance to Reflectance:

$$\rho_p = \frac{\pi \cdot L_\lambda \cdot d^2}{ESUN_\lambda \cdot cos\theta_s}$$

Where:

ρ_p =Unit less planetary reflectance

π =Mathematical constant approximately equal to 3.14159

L_λ = Spectral radiance at the sensor's aperture

d = Earth-Sun distance in astronomical units interpolated from value.

$ESUN_\lambda$ = Mean solar exo-atmospheric irradiances

θ_s = Solar zenith angle in degrees

Source: https://yceo.yale.edu.

5: Normalized Burn Ratio (NBR): NBR is the indice which is used to identify and index the burned areas in large fire zones. The formula of the NBR is similar to the NDVI (Normalized Difference Vegetation Index) where red band is replaced by the SWIR (Shortwave Infrared Radiation). This formula is combination of both Near Infrared Radiation (NIR) and

Shortwave Infrared Radiation (SWIR).burned areas have relatively low reflectance in the NIR and high reflectance in the SWIR band.

$$NBR = \frac{NIR-SWIR}{NIR+SWIR}$$

Source : https://www.earthdatascience.org

6: Differenced Normalized Burn Ratio (DNBR): This is the most suitable tool to understand the extent and severity of the conditions after calculating the difference between the pre and post fire conditions.

$$dNBR \text{ or } \Delta NBR = PrefireNBR - PostfireNBR$$

Difference NBR (dNBR) equation. Source Humboldt.edu

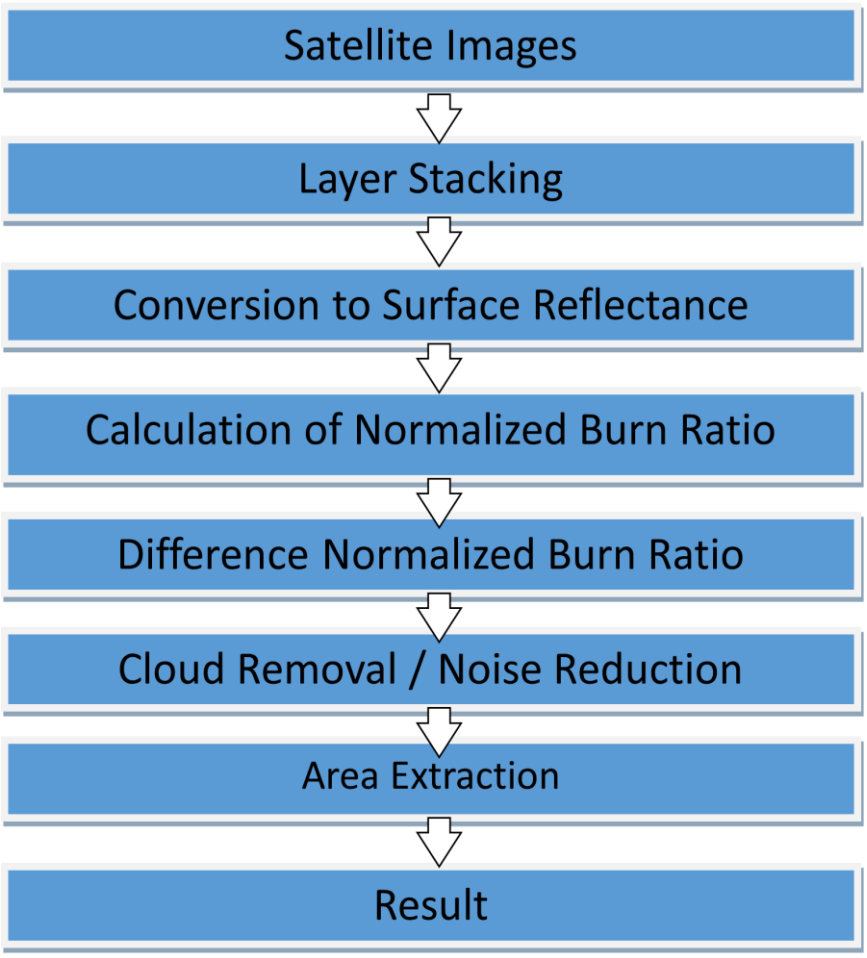
7: Extraction of Burned Areas: The burned areas are extracted depending upon thresholds. Threshold of the burned area is dependent on the value of the pixel and burned severity.

8: Cloud Removal: Meghalaya, the name suggests the abode of clouds thus cloud removal is the important process. Most of the post fire images will have the cloud covering and this is the biggest challenge. Cloud removal for the images is done using the BQL values and greater then value equation in the Erdas.

9: Noise Removal: When the extraction is done using the thresholds along with the burned areas other features also gets selected which have the same value due to the reflectance value hence the noise removal process is carried out. This is done by applying the 3*3 majority filtrations and using the land cover data.

10: Area Extraction: To get the exact area of the extracted area from the raster image, the pixels are converted to the vector. By converting the raster pixel into the vector form using the Conversion tool "From Raster to Polygon". This is to calculate the burned area.

11: Conversion from Raster to Vector: After the final extraction of the burned areas the raster file is converted to the vector in Arc-GIS using the conversion to "From raster to Polygon". This is done to calculate the



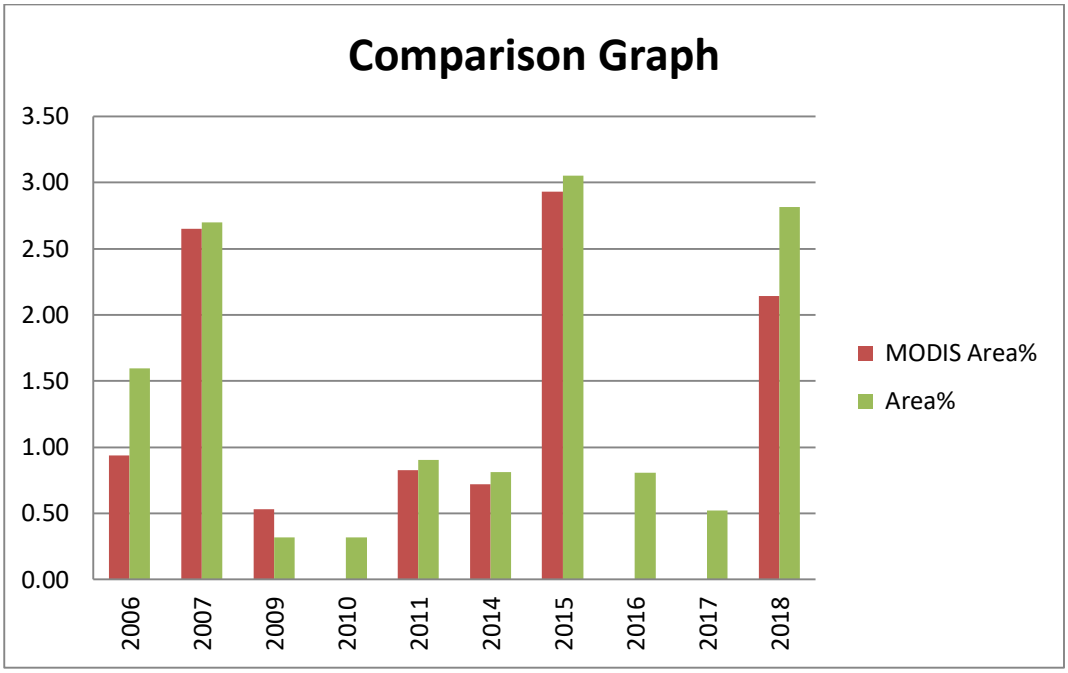
SOFTWARES USED:

Software's used to achieve the aim of the study were

Arc-GIS desktop 10.4.4: This software is used to calculation of DNBR and area extraction using the raster calculator.
Erdas 2014: This software is used for pre processing of the images, model building for the conversion of DN value image to surface reflectance, cloud removal and the Noise Reduction.
Google Earth: For the cross verification of the burned area patches as reference.
Microsoft Excel: This software is used for analysis of the results and generating the figures.

RESULTS AND ANALYSIS

The burned area is calculated for each from 2005 to 2018 excluding the years 2008, 2012 and 2013 due to lack of data availability. By the study it has been found that there is continuous change in the intensity of the forest fire. The intensity of the fire is high in the month of March. It is observed by the MODIS fire location data that the fire starts from the month of the January and ends by the month of April. By the study it is found that the Landsat Burnt area in 2006 till 8th March 2006 was 4588.02 hectares and MODIS was 2697.35 hectares and 1.60 and 0.94 in percentage respectively. In 2007 till 11 March it was 7755.03 hectares in Landsat image and the 7616.75 hectares area is burnt according to MODIS data. Till the28 February 2009, 1015.66 hectares of land is burnt i.e. 0.35% according to the Landsat Data ad till same date according to the MODIS data it was 1520 hectares i.e. 0.53%. In 2010 till 15 February there are no big burnt patches thus there was no burnt patch in the MODIS data due to its Low resolution but according to the Landsat Generated there was 916 hectares of Land was burnt. In 2011, 2602.59 hectares of land was burnt. In 2014 till the 26 February the total burnt area according to the Landsat was 2339.82 and MODIS was 2054.87 i.e. 0.81 and 0.72 percent respectively. It has recorded the highest burnt area in 2015 till 17 March total 8768.79 hectares of area was burnt i.e. 3.05% of area was burnt. In 2016 and 207 same as like 2014 there was no burnt area according to the MODIS data till 16 February 2016 and 18 February 2017 but there was a burnt Area according to the Landsat data i.e. 2325.96 and 1498.59 respectively. Again in 2018 there was a spike in the burnt area , there was total 8086.32 hectares of vegetation was burnt according to the Landsat data and 6161.46 percent of area was burnt according to the MODIS data. These all results represents that there is a cyclic change in the burning pattern. It increases to some extent after every 2 – 3 years.


Comparison Graph
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2006
2007
2009
2010
2011
2014
2015
2016
2017
2018
MODIS Area%
Area%

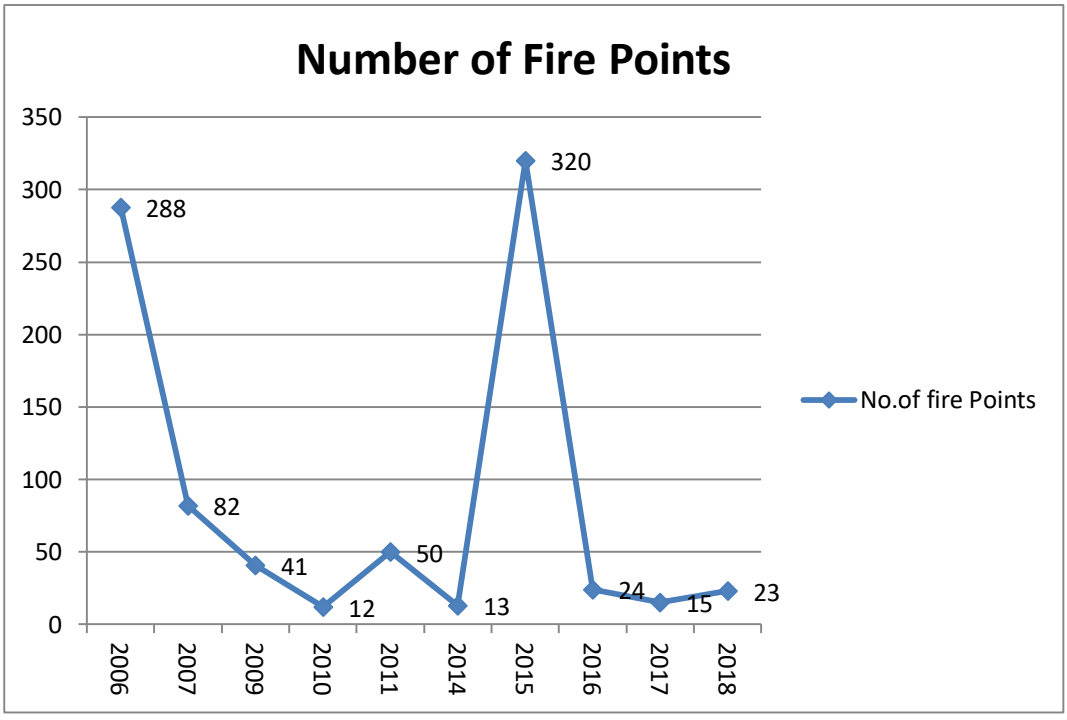

Number of Fire Points
350
300
250
200
150
100
50
0
288
82
41
12
50
13
320
24
15
23
2006
2007
2009
2010
2011
2014
2015
2016
2017
2018
No.of fire Points

Figure 2

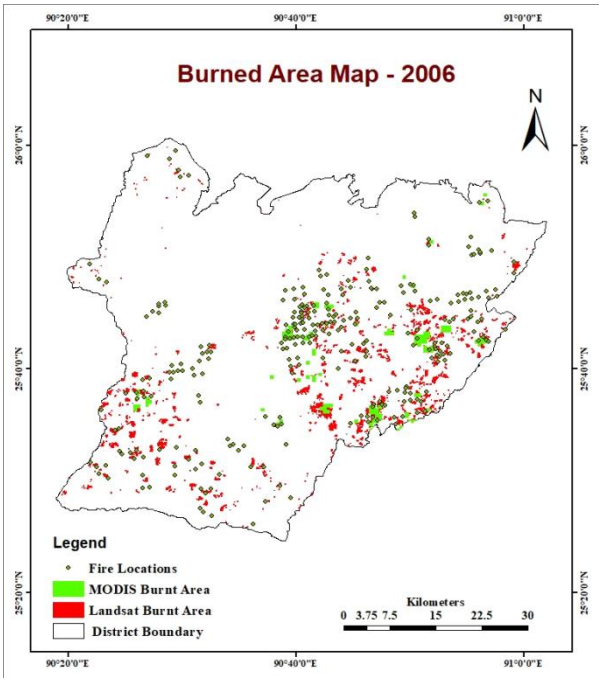


Figure 3

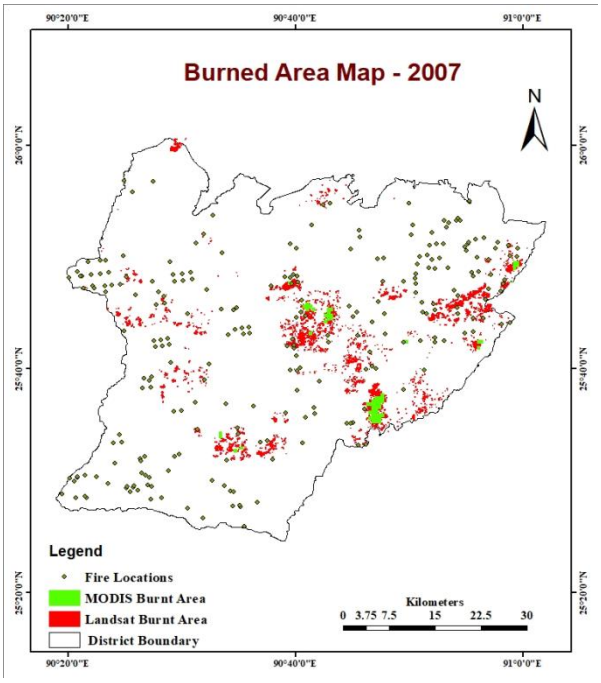


Figure 4

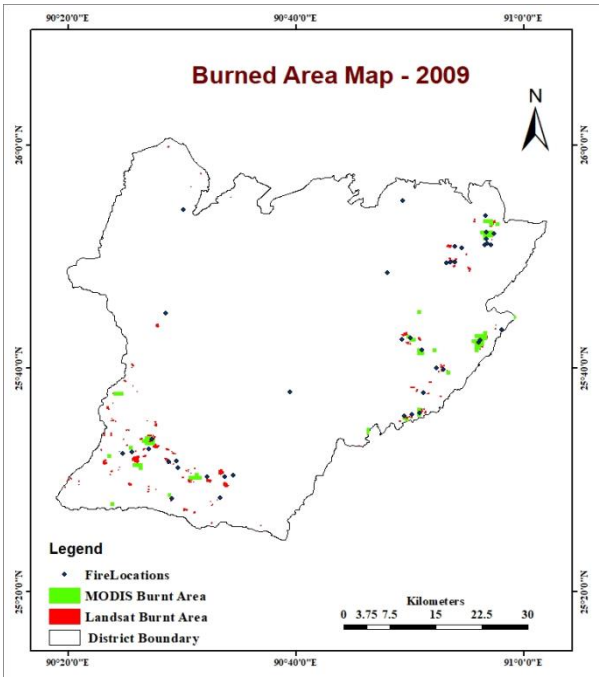


Figure 5

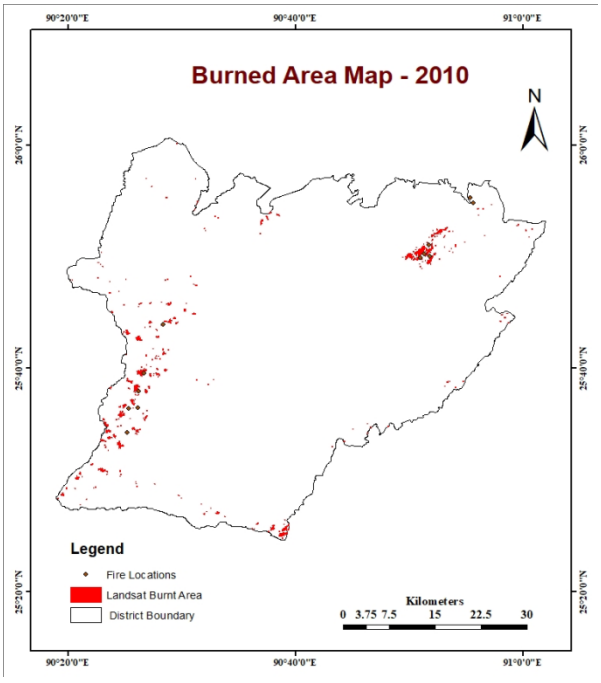
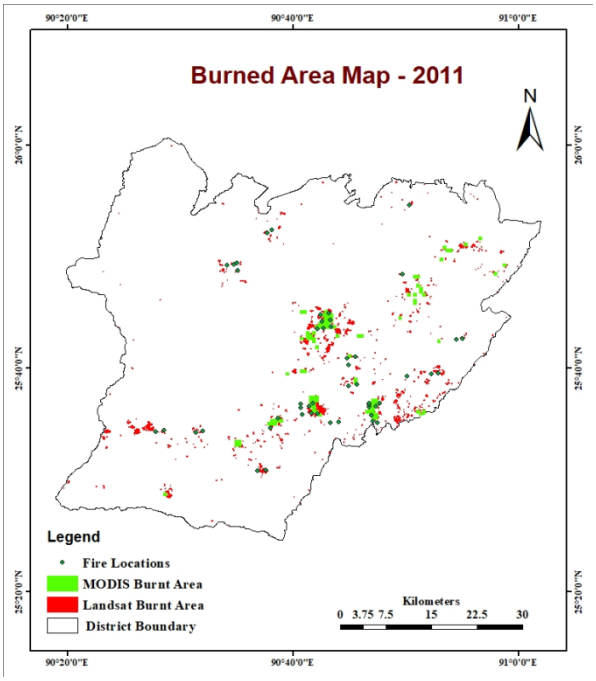


Figure 6 **Figure 7**



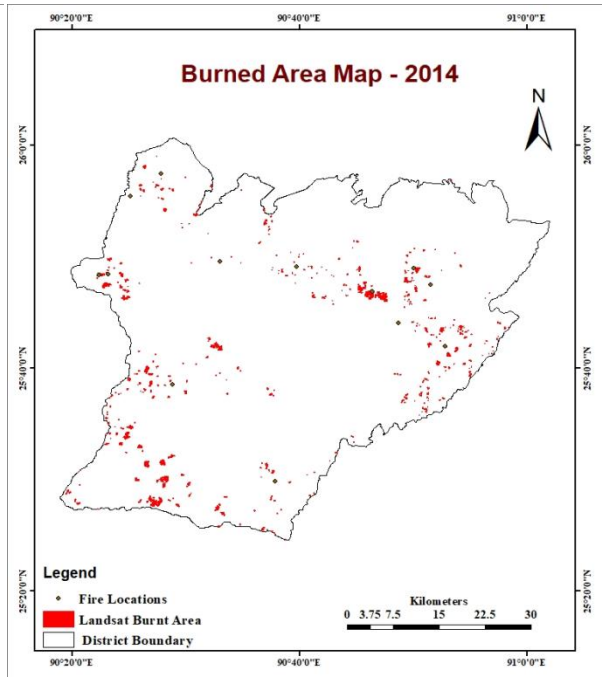
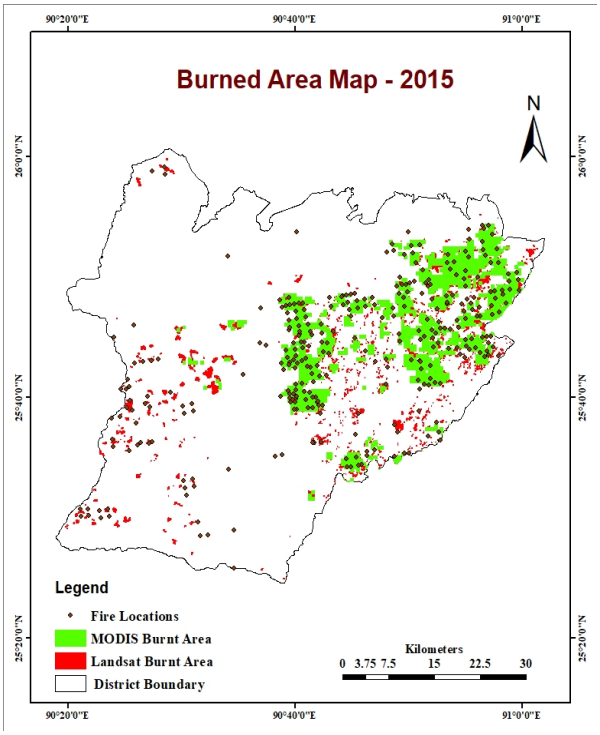


Figure 8 **Figure 9**



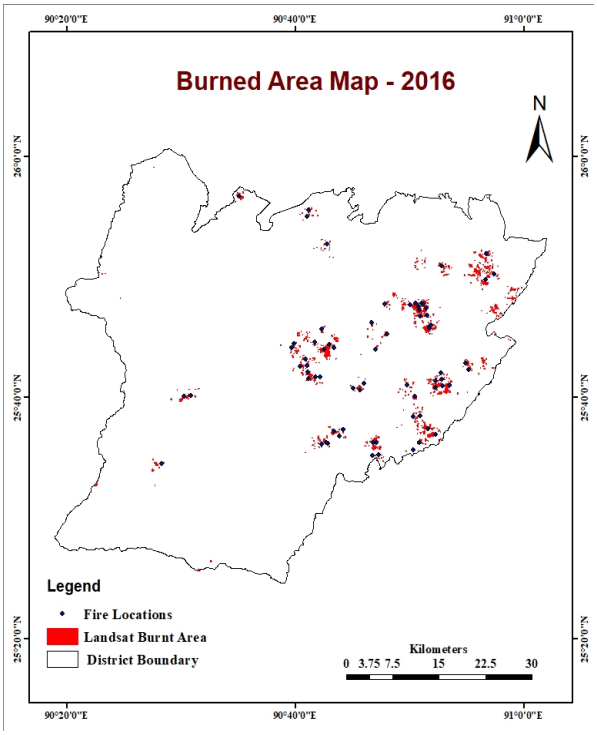
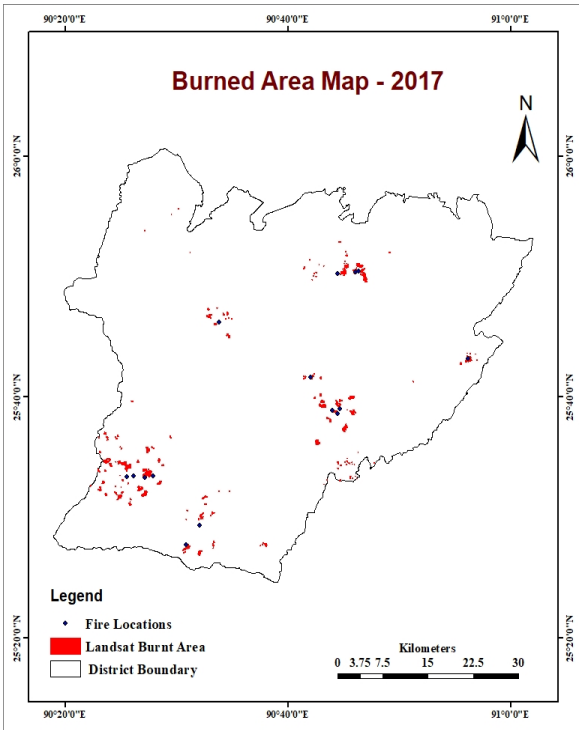
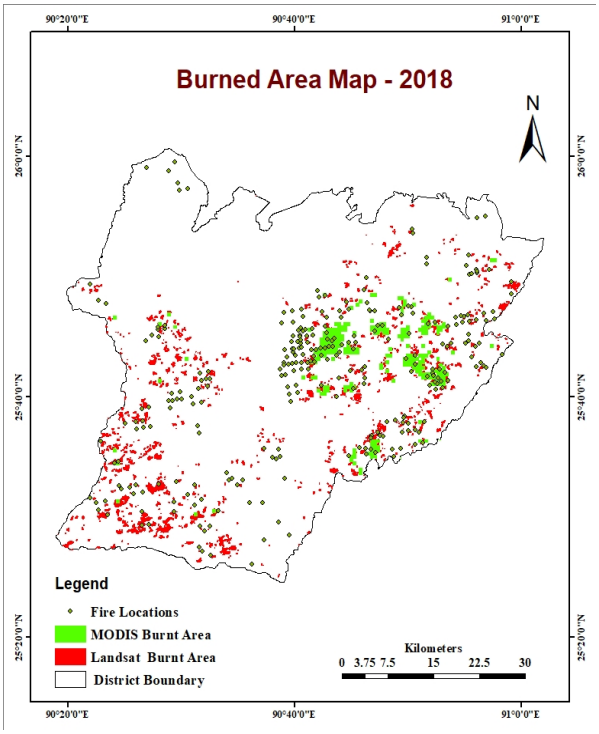


Figure 10 **Figure 11**





Conclusion:

Forest fire has both advantage and disadvantage; it can be seen as the cyclic process. in this area after every few years there was a spike in the fire intensity this shows that the most prominent factor for the this anthropogenic burning was the shifting cultivation. There is to develop the study on the recovery of the vegetation i.e. the study can be done on the time period of the recovery of the area.

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