

Recovery Analysis of Vegetation in Gorewada Forest After Fire Using GIS And Remote Sensing

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ABSTRACT

Maharashtra registered 60,851 alerts out of the over 3.86 lakh fire alerts issued countrywide by the Forest Survey of India (FSI) based on satellite data, accounting for 16% of the nation's total forest fire events in 2021. These studies draw attention to the growing problem of declining forest cover due to forest fires over the past five years. Wildland fires significantly impact the sustainability and loss of biodiversity in forest ecosystems. This study is about the detailed analysis of the Gorewada forest fire. In May 2022, a forest fire broke out in Gorewada. As the wind blew, the forest fire spread to a larger area toward Lava-Dabha village. After a massive effort for five hours, the fire was doused. The fire destroyed a total of 541.75 hectares of forest area which included 161.604 hectares of zoo area. This research provides a detailed evaluation of vegetation cover and growth dynamics by the Normalized Difference Vegetation Index (NDVI) with the help of various sentinel bands using GIS and remote sensing. The spectral characteristic of vegetation was analyzed prior to the fire incident, post-fire incident, and one year after for the purpose of observing the recovery of the burned vegetation. It was found that, while the remaining 44% of the land is still in the recovery phase, the burned area has shown nearly 56% regrowth.

Date of Submission: 12-07-2023

Date of Acceptance: 25-07-2023

I. INTRODUCTION

Wildland fires significantly impact the sustainability and loss of biodiversity in forest ecosystems. Additionally, they have a major impact on the global carbon balance and future climate change. Destroying the present vegetation cover influences the composition of the post-fire vegetation regeneration and hence the study and monitoring of vegetation cover is necessary. This can be achieved with the help of the Normalized Difference Vegetation Index (NDVI). It is an index that measures the density of vegetation on the land with the help of satellite images. For vegetation with varied densities and scattered vegetation from a multispectral remote sensing image, the NDVI approach produces better results. The various densities of vegetation coverage can be detected by adjusting the threshold index value[1]. Due to the fact that NDVI data only provides information on vegetation cover, it is impossible to distinguish between built-up and desolate areas[2]. It indicated whether there was vegetation there or not. The USGS Global Visualization Viewer was used to download Sentinel-2 pictures that had been radiometrically and geometrically rectified (Level 2A product)[3]. The photos were extracted to show the surface damaged by fire after performing atmospheric adjustments and calculating spectral indices. Red or infrared bands, which describe the greenness conditions of above-ground biomass and vegetation cover, were used in NDVI[4]. In order for VIs to function, specific combination bands must be chosen that exhibit surface reflectance at two or more spectral wavelengths. The properties of a certain type of vegetation will be revealed by introducing a mathematical formula for that type of vegetation. to learn about flora The visible and near-infrared portions of the spectrum are utilized[5].

V. DATA SOURCES FOR REMOTE SENSING

This research involves satellite data with a 10m resolution to understand changes in land cover from 2022-2023.

1. NDVI CALCULATION AND ANALYSIS

NDVI have a wide range of practical applications, including assessing forest supply and forecasting fire zones. A false-color composite is used to make burn scars more visible. It is a multispectral picture interpretation that uses the standard visual RGB (red, green, and blue) band range. Each color (band) combination can be tailored to enhance some specific object or feature type. A false-color picture composed of the NIR (near-infrared), Red, and Green bands, for example, will give all vegetation a unique red color, allowing it to be differentiated from its surroundings by the human eye. This is owing to plants' strong reflectivity in the near-infrared range. Furthermore, in a false color picture, the NIR, Red, and Green scheme helps in distinguishing clean water (darker shade of blue) from turbid water (cyan). The false color composite is made up of the colors red, green, and blue. This means that the red channel belongs to Band 4, the green channel belongs to Band 8 (near-infrared), and the blue channel belongs to Band 3 (blue band). QGIS allows to visualization of the data with maps, charts, and diagrams, as well as customizing the presentation with a range of symbology options. QGIS's geographical analytical features, such as buffer generation, spatial querying, and geoprocessing. After that the geospatial data was saved in a number of file formats, such as shapefiles, GeoTIFFs, and KML files, as maps, web services, and print maps. Classification of the Dead plants/Water, Barren land, and Vegetation was done as shown in Table 1.

Table 1: NDVI Classification Ranges

NDVI Range	Features
-1 to 0	Dead plants/Water
0 to 0.2	Barren land
0.2 to 1	Vegetation

The methodology could be summarized as shown in Figure 2.

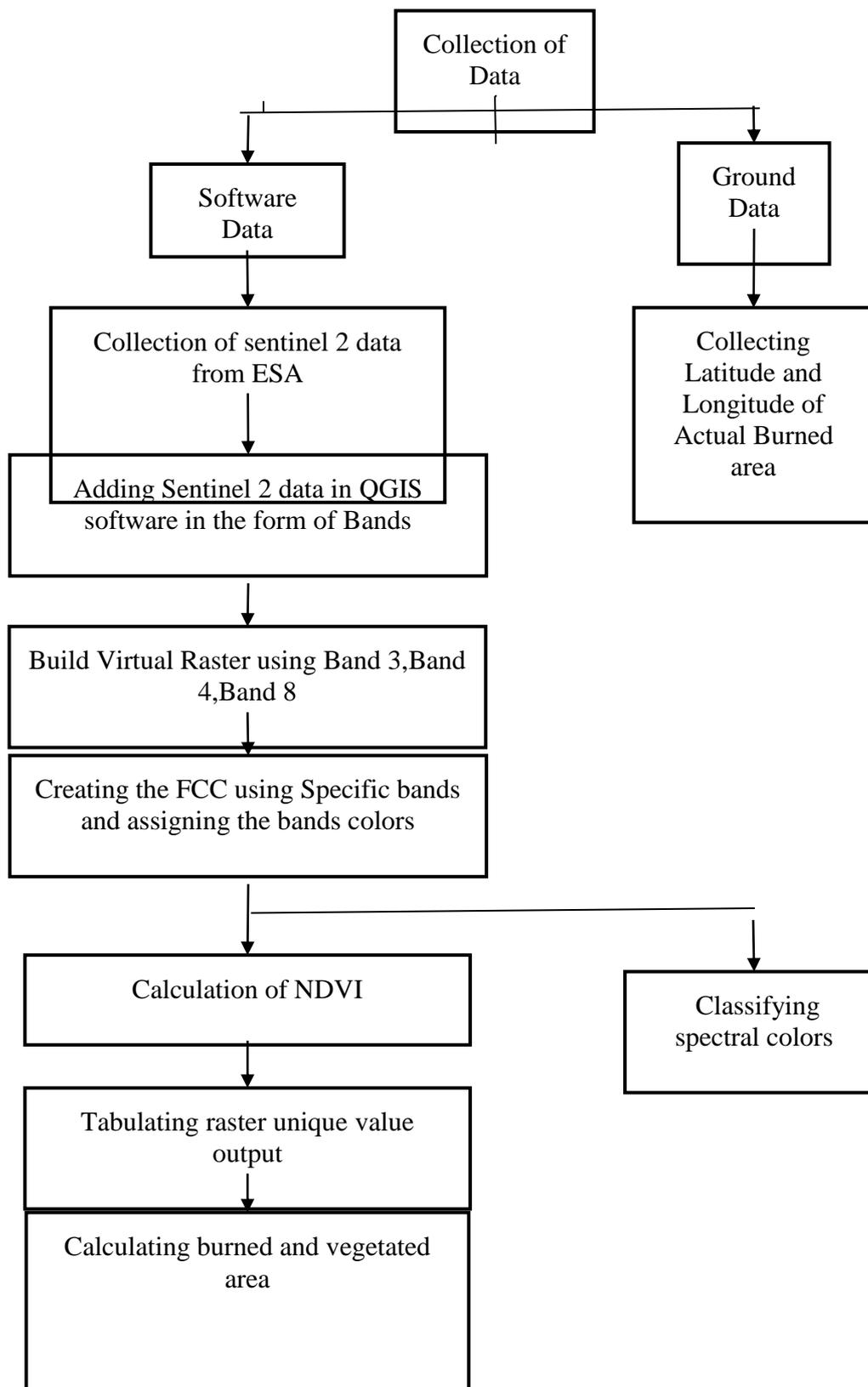


Fig.2: Flow Chart For Calculation of Vegetation Index

ANALYSIS

The analysis of the burned area in Gorewada is divided into three parts i.e., prefire analysis, postfire analysis, and present data analysis.

Pre-Fire Analysis

A FCC of prefire data from February 22, 2022, was created which could be seen in Figure 3.

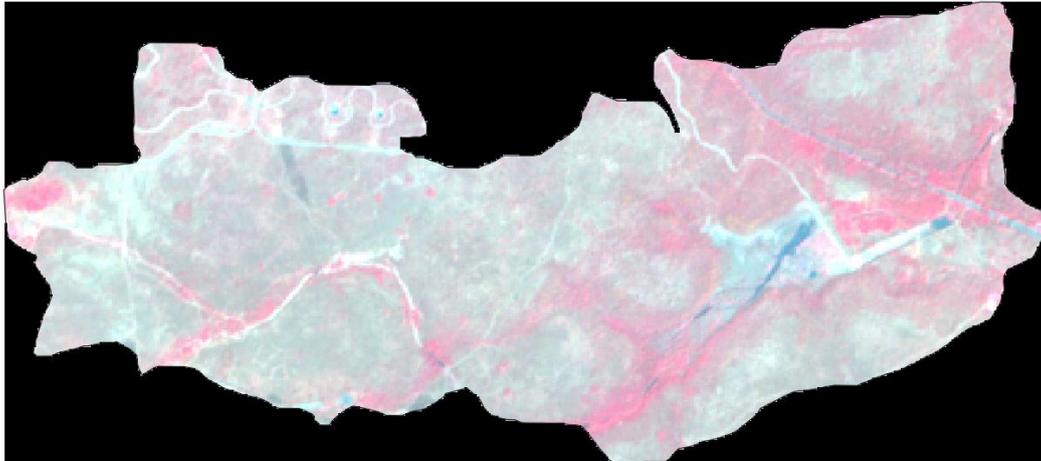


Fig. 3: Prefire False Color Composite of Study Area

In this figure the red portion indicates the vegetated area whereas the dark greenish blue area indicates barren land and as the color shade gets lighter it will indicate roads and water. After calculating NDVI the following image was obtained as shown in Figure 4.

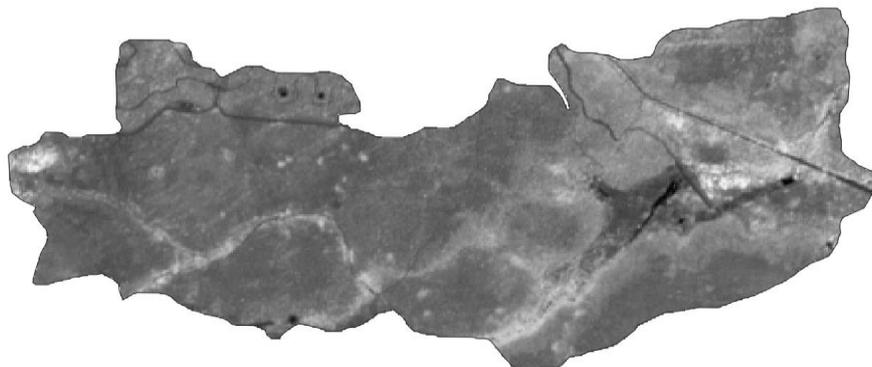


Fig. 4: Actual NDVI

After assigning the properties the following image was obtained as shown in Figure 5.

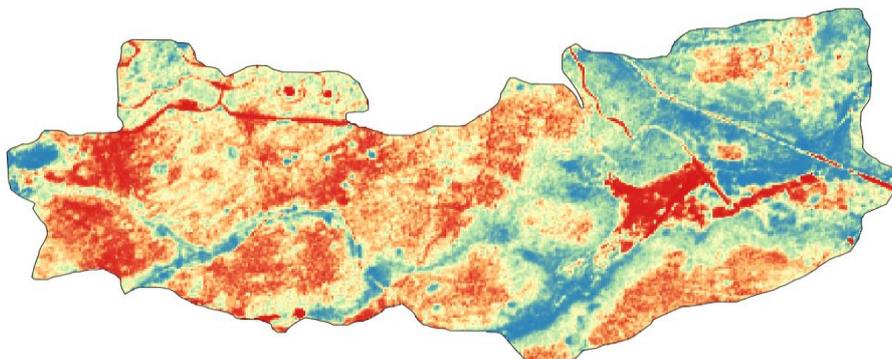


Fig.5: NDVI in Spectral Bands

The NDVI Index value ranges from -0.0914306 to 0.532497.

Post-Fire Analysis

A FCC of postfire data from May 28, 2022, was created which could be seen in Figure 6.

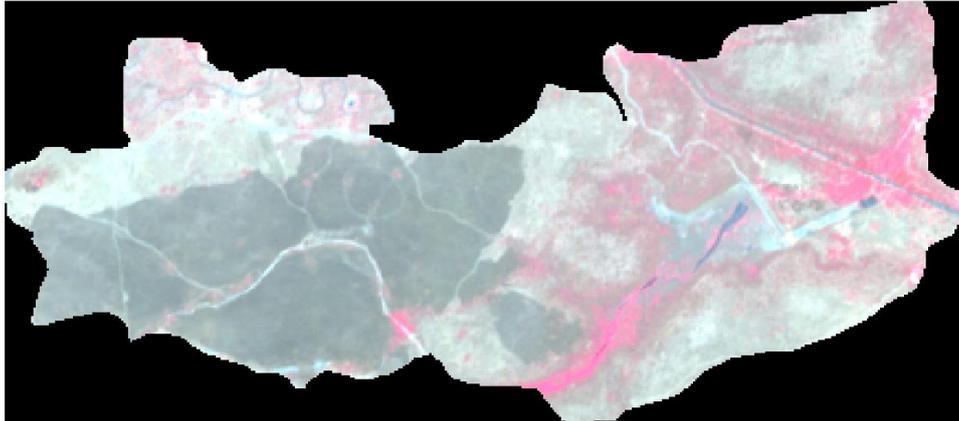


Fig.6: Postfire False Color Composite of Study Area

In this figure the red portion indicates the vegetated area whereas the dark greenish blue area indicates barren land and as the color shade gets lighter it will indicate roads and water. After calculating NDVI the following image was obtained as shown in Figure 7.

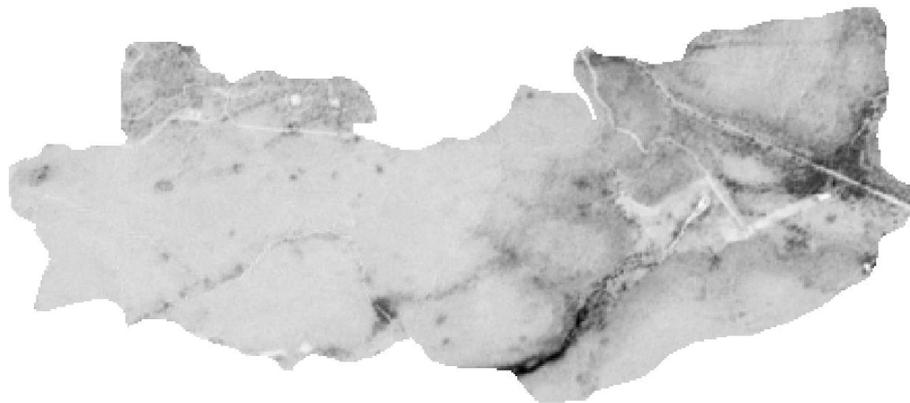


Fig. 7: Actual NDVI

After assigning the properties the following image was obtained as shown in Figure 8.

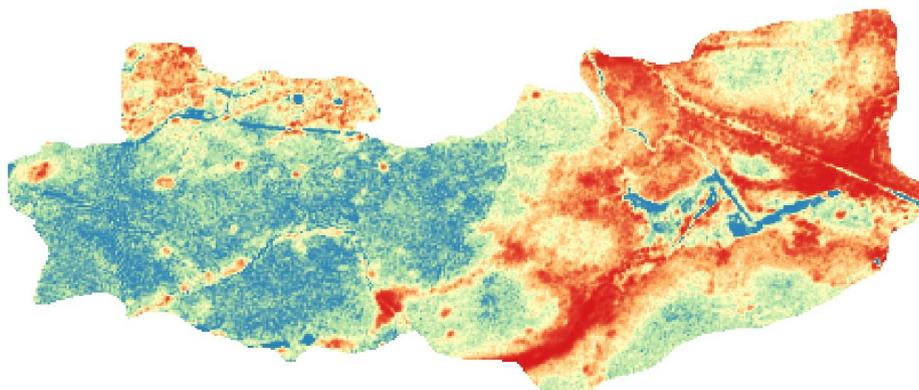


Fig.8: NDVI in Spectral bands

NDVI Index value ranges from -0.612623 to 0.00220751.

Present Analysis

A FCC of postfire data from February 27, 2023, was created which could be seen in Figure 9.

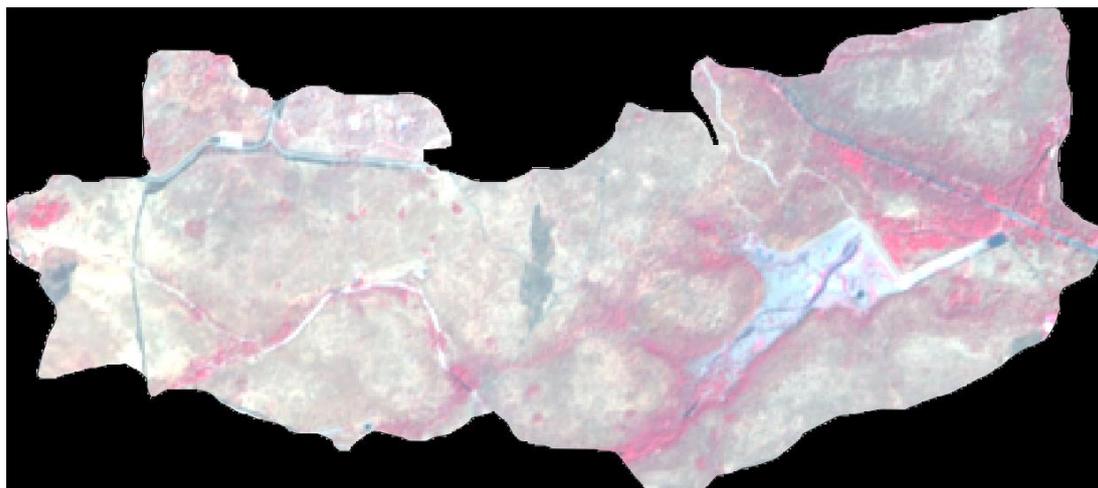


Fig.9: Present False Color Composite of Study Area

In this figure the red portion indicates the vegetated area whereas the dark greenish blue area indicates barren land and as the color shade gets lighter it will indicate roads and water. After calculating NDVI the following image was obtained as shown in Figure 10.

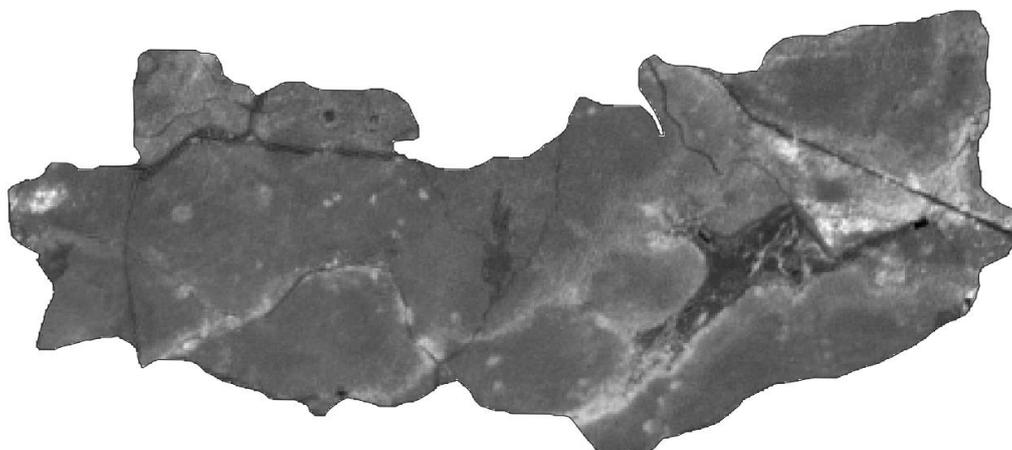


Fig.10: Actual NDVI

After assigning the properties the following image was obtained as shown in Figure 11.

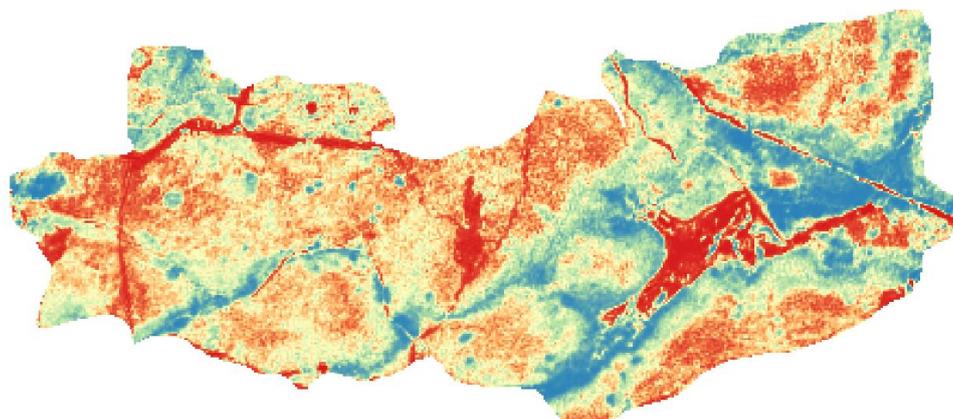


Fig.11: NDVI in Spectral Bands

Index value ranges from -0.0422339 to 0.49275.

IV. RESULT

Investigation of prefire data from February 27, 2022, revealed that 2221900 square meters as in 41.01% of the region had decent vegetation, 58.86% of the land was barren, and the remaining 0.13% was either dead plants or water as shown in Figure 12.

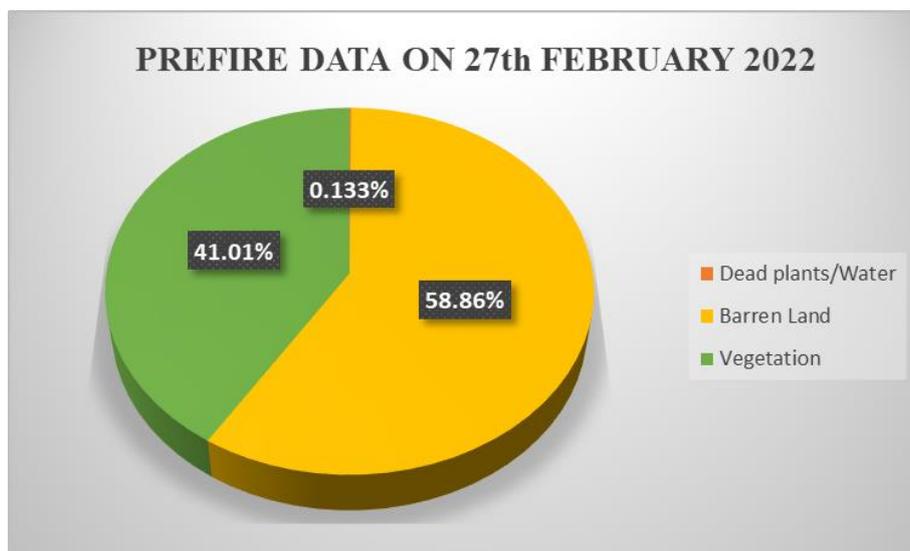


Fig.12: Prefire Data Analysis

A review of post-fire data on May 28, 2022, showed that all vegetation having an area of 5417500 square meters had completely vanished and there was barely any vegetation left as shown in Figure 13.

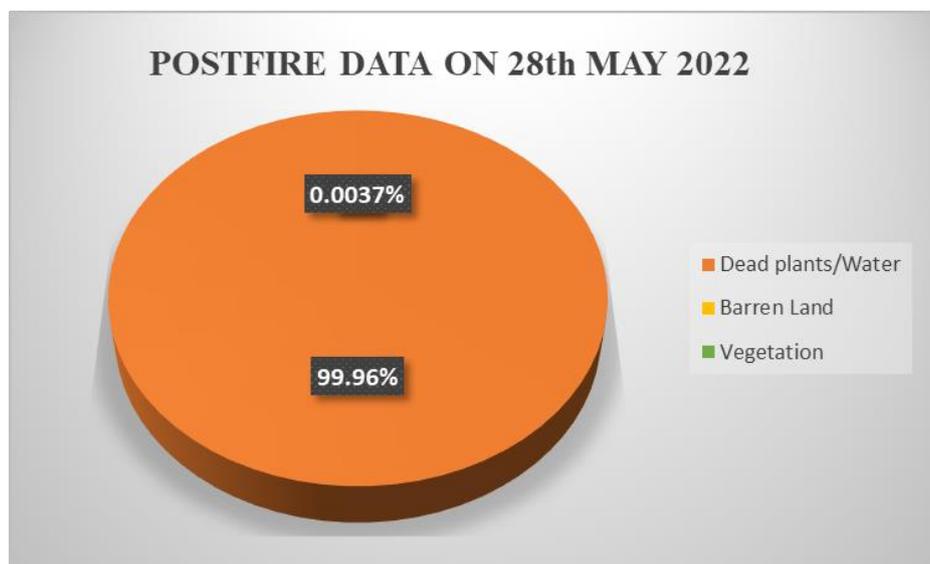


Fig.13: Post-fire Data Analysis

As of February 22, 2023, 23.% of the land is covered in vegetation, but 76.98% of it is still uninhabited and contains only 0.0185% of either water or dead plants as shown in Figure14.

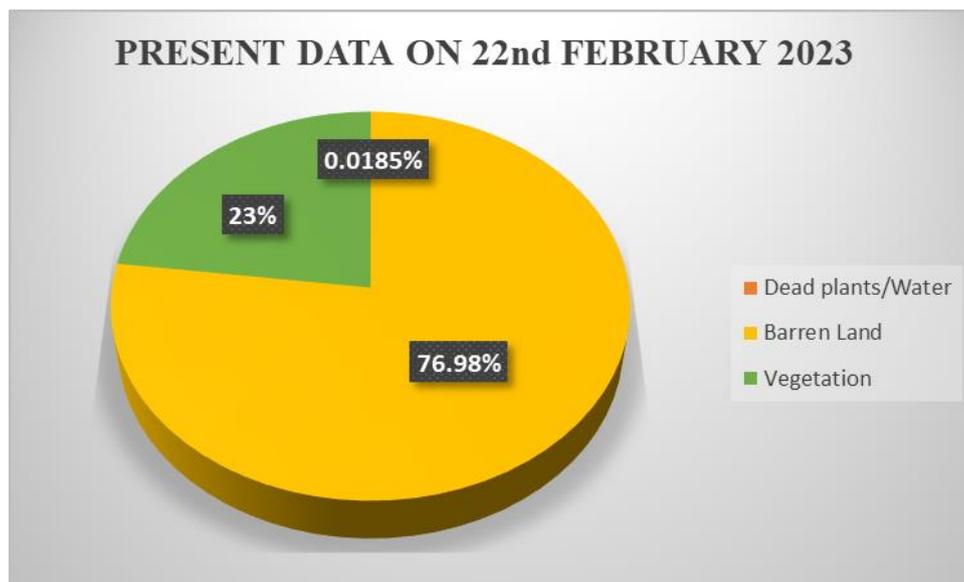


Fig.14: Present Data Analysis

So according to Table 6.4, the 1255500 square meter area is recovered but the 966400 square meter area is yet not been recovered

Table 2: Area Data of Prefire, Postfire, and Present

RANGE	CLASS	AREA IN SQUARE METER		
		Prefire	Postfire	Present
-1 to 0	Dead plants/water	7200	5417500	1000
0 to 0.2	Barren land	3188600	202.0024656	4161200
0.2 to 1	Vegetation	2221900	0	1255500

V. CONCLUSIONS

From the study, it can be concluded that

- The study's findings indicate that the forested area is susceptible to fire incidents, with a high likelihood of such incidents occurring every couple of days, either naturally or due to human activity. The summer season and dry vegetation significantly contribute to the high incidence of fire outbreaks. Meteorological data from Nagpur city recorded a temperature of 43.4 degrees Celsius on the day of the study.
- The commonly used remote sensing index, NDVI, measures the near-infrared to visible light reflectance difference. NDVI values that are more negative suggest a decrease in live green vegetation, while live green vegetation has a higher NDVI rating since it absorbs more visible light and reflects more NIR. The NDVI value is lower on non-vegetated surfaces, such as bare soil or water, because these materials absorb both NIR and VIS light. Therefore, higher percentages of negative NDVI values suggest lower levels of live green vegetation in the measured area.
- At present, 56.51% of the vegetation shows signs of regrowth, and it took 269 days to recover from the loss. However, 43.49% of the land remains unvegetated.

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