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FOREST CONSERVATION AND PLANNING FOR SAGRESHWAR WILDLIFE SANCTUARY USING GEOSPATIAL TECHNIQUES

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Abstract: Forests are vital natural resources, and they play a very crucial role for life existence of human on earth. However, forest conservation must be our first priority in order to maintain and sustain life on the earth. The present study aims to assess the vegetation condition for forest conservation and planning for sagreshwar wildlife sanctuary by using geospatial techniques. The study area is about 10.87 sq.km and lies between 17° 6’ 56.36’’ to 17° 09’ 41.19’’ north latitude and 74° 20’ 05.73’’ to 74° 24’ 19.59’’ East longitude. Sagreshwar wildlife sanctuary is located at the trijunction of three tahsils and those are Kadegaon, Walwa and Palus tahsils of Sangli District. NDVI, TNDVI, and Vegetation Index are developed to assess vegetation conditions and to carry out comparative analysis. The thematic layers generated through GIS like slope, soil, vegetation index; land use/ land cover are being used for overlay analysis to identify degraded areas of forest. Vegetation Indices and LULC analysis show that most of the forest of this part is open forest, and dense forest areas of Sagareshwar accounts for only 8.86 percent (247.8 acres). Degraded forest areas have been identified with the weighted overlay technique of GIS. It shows that 11.12 percent of the area which is highly degraded and it requires immediate action for forest conservation.

Keywords: Forest conservation, NDVI, TNDVI, Geospatial Techniques

I. INTRODUCTION

Forest conservation is an active protection, improvement or creation of different forests and specific forest functions and services. The term ‘‘forest’’ refers broadly to all kinds of forests, ranging from ‘‘natural’’ ones to those with high levels of intervention and management (Archard. H. D., 2002). ‘‘Natural’’ forests are the focus of most conservation concern though highly managed forests can also be an important source of biodiversity. Strategy of forest conservation is very essential to control biodiversity losses, extenuating climate change, and maintaing livelihood of more than 1.5 billion people who depend on forests directly or indirectly for their needs (FAO, 2014). Now a days the whole world is suffering because of global warming. The area under forest is decreasing very rapidly. It affects the flora and fauna of the entire world. Therefore, it is very necessary to conserve our forest resources.

The forest is the natural resource. It provides us various direct-indirect benefits. Forest conservation is required to maintain the livelihood of human beings and to support all life forms of this planet. We have to conserve the forest resources for future generation. Geospatial technology can play an immense role in forest conservation and development. Remote sensing technique helps us in forest characterization, assessment, and monitoring.

The evaluations of the NDVI at biweekly intervals were found to be adequate for monitoring seasonal growth patterns in types of rangeland, forests, or agriculture areas. The Canadian Centre for Remote Sensing (CCRS) has published NDVI map for North America (Eidenshink and Haas, 1992). Gomarasca et al. (1993) used NDVI transformations in conjunction with a maximum-likelihood classification to analyze land-use changes in Milan, Italy. Ray et al. (1993) studied the land degradation after abandonment using NDVI computed from both Airborne Synthetic Aperture Radar

(AIRSAR) and Airborne Visible/ Infrared Imaging Spectrometer (AVIRIS) images and found that abandoned fields supported less vegetation than the undisturbed desert after six or more years. Panhalkar et al. (2014) have also assessed soil erosion of Panchganga basin and suggested the conservation of vulnerable resources which are much more susceptible to soil erosion using Geoinformatics techniques. Ajai et al. (1983) studied the potential usefulness of spectral measurements to estimate leaf area index, chlorophyll content and biomass of canopy. Bachulka, M., and Awale, V., (2009) have also assessed flora of Sagreshwar wildlife Sanctuary. Tappan et al. (1992) studied a series of three NDVI images from AVHRR data. They concluded that the NDVI image series could be useful for monitoring the seasonal vegetation conditions of Sahel and Sudan rangeland, and were particularly valuable for differentiating seasonal, weather-driven fluctuations from long-term production characteristics.

Sagareshwar sanctuary is man-made sanctuary which falls in rain shadow region of South-western part of Maharashtra. Serious problems of this sanctuary are degradation of forest and availability of water for flora and fauna during late winter and summer season. Some measures are being taken by constructing check dams and percolation tank but even though the percent of the barren land and the open forest is increasing. This sanctuary depends on water tanks for water during the summer season. The problem of degradation of forest and water availability should be tackled through geospatial and proper watershed management techniques. This sanctuary can set an example for other forest areas through proper watershed management. The primary objective of the present study is to assess the vegetation condition and to suggest a comprehensive plan of action for forest conservation by using remote sensing and GIS techniques.

II. STUDY AREA

Sagreshwar wildlife sanctuary is located at the trijunction of three tahsils those are Kadegaon, Walwa and Palus tahsils of Sangli District. It is a manmade sanctuary. It (fig.1) extends between 17° 6’ 56.36’’ to 17°09’ 41.19’’ north latitude and 74°20’ 05.73’’ to 74°24’ 19.59’’ East longitude. It is one of a unique experiment and a significance endeavor in conservation in the sense that it is almost entirely a man-made sanctuary created through a planned a forestation programme with the help of the local population. This sanctuary covers a total area of 10.87 sq. km. It occupies areas of 10 villages, mainly, Mohote Vadgoan, Asad, Kumhargaon, Devarastra Dudhari, Takari, Dahyari, Tupari, Ghogaon and Kundal. It mostly covers forest areas with grassy hill slopes. It comprises a total of 52 species of fauna. This sanctuary is also famous for many insects, reptiles, and birds.

Fig.1: Location Map of Study Area

III. DATABASE AND METHODOLOGY:

Data is the one of the most important components of the GIS. The data or materials used for the study include topographic data, satellite data, GPS point and field data are collected from the ground. SOI toposheet is scanned and georeferenced with UTM projection in ArcGIS software. CartoDEM and FCC image were rectified with the same toposheet by applying the image to image transformation. CartoDEM and toposheet are used to study physiography of Sagareshwar sanctuary. By using the above data, slope, contour, morphometry, hillshade and aspect maps are prepared for further analysis.

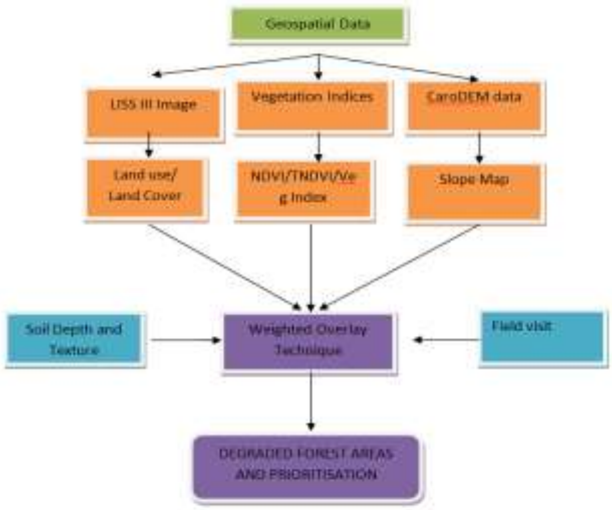

Fig. 2: Flow Chart to identify degraded forest Areas

LISS III data of IRS ID satellite image is used to generate various vegetation indices. NDVI, TNDVI, and Vegetation Index are developed to assess vegetation conditions and to carry out comparative analysis. A Vegetation Index (VI) is a "synthetic image layer" created from the existing bands of a multispectral image. VIs have been shown to quantify or predict vegetation biomass, productivity, leaf area, and/or vegetative ground cover. Land should be used properly by considering its capability and limitations otherwise it would cause severe soil erosion (Panhalkar S. S. & Pawar C. T., 2011). As per the flow chart (fig.2) thematic layers like slope, soil, vegetation index, land use/ land cover are being used with the help of weighted overlay technique to identify degraded areas of forest and suggest conservation measures.

IV. RESULT AND DISCUSSION

Planning and conservation of resources require accurate quantification and monitoring of available resources to identify the problem and prospects of the area. Remote sensing helps us to assess the resources spatially and temporally. GIS techniques can be successfully used to bring the different dataset in a single domain to identify the problem and to suggest a solution for it.

Terrain plays a crucial role in creating forest diversity. Hence, it is better to study forest conditions with respect to terrain. It also helps us in preparing a plan for forest conservation. Digital Elevation model is developed with the help of CartoDEM data of Bhuvan website. It was downloaded and reprojected in UTM, WGS 84 projection. With the aid of the scanned toposheet, CartoDEM data (fig.3) is clipped with respect to study area.

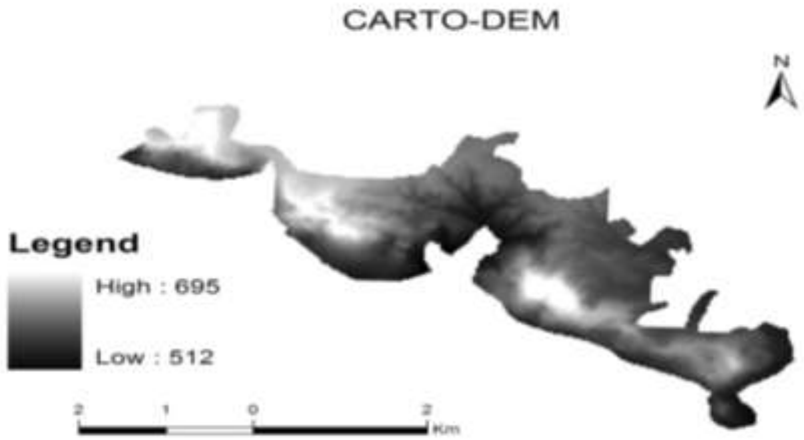

Fig. 3. Carto-DEM

With the help of ArcGIS software, slope map (fig.4) of the Sagareshwar sanctuary has been prepared. This sanctuary is nurtured on the undulating hilly area which is elongated in shape. The hilly area is extended in the Northwestern to southwestern direction. The height of the Sagareshwar forest ranges from 512 m to 995 m. The analysis reveals that slope is higher towards the southern side and gentle towards northern side. Northern and northwestern parts are encircled by plateau area. Along the riverine tract, slope is highest as compared to other areas

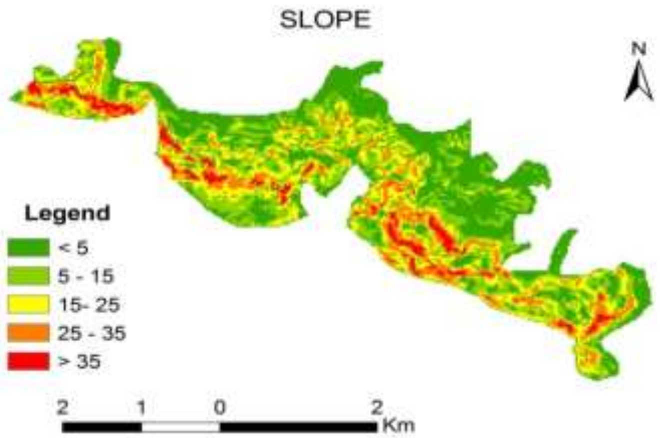

Fig.4. Slope Map

This forest area is having few streams of first and second order and only single stream of third order. No major river passes through this forest. These streams have generated the radial pattern. Most of the streams have their origin in a hilly area and drain their water towards outer margin of this forest.

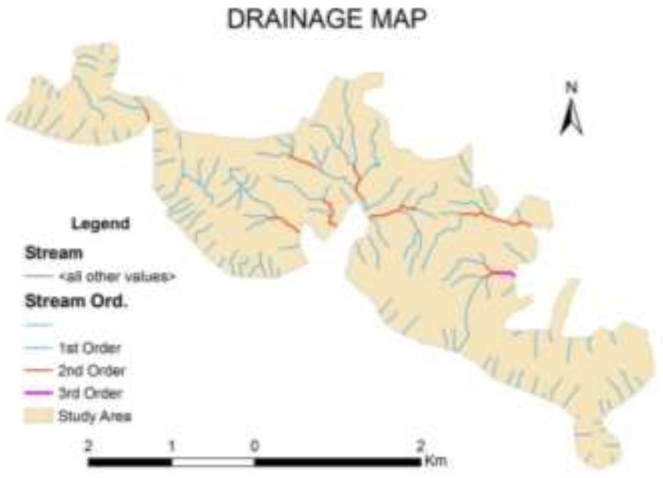

Fig. 5. Drainage Map

4.1. Land cover analysis:

Various natural resource management, planning, and monitoring programs depend on accurate information about the LU/LC in a Region. Land use/land cover plays a very crucial role in soil vulnerability analysis (Panhalkar S. and Pawar C. T. 2011). Proper planning of forest resources requires spatial and temporal information of land cover. Remote sensing plays a very crucial role in assessing forest conditions. Supervised classification technique is used to classify FCC image of Sagareashwar forest, and the forest is classified as the Dense forest, Open forest (Grassland) and Barren land. The analysis reveals that dense forest cover is very less in the study region. It is only limited towards few pockets of Sagareshwar forest. Forest cover is thick, along the riverine tract.
Land use / Land cover map (fig.6) shows the distribution of land use and land cover for various purposes like vegetation cover, water bodies, open forest, grassland and barren land, etc. Remote sensing technology plays important roles for land use mapping and studying the trend of their change over the period of time.

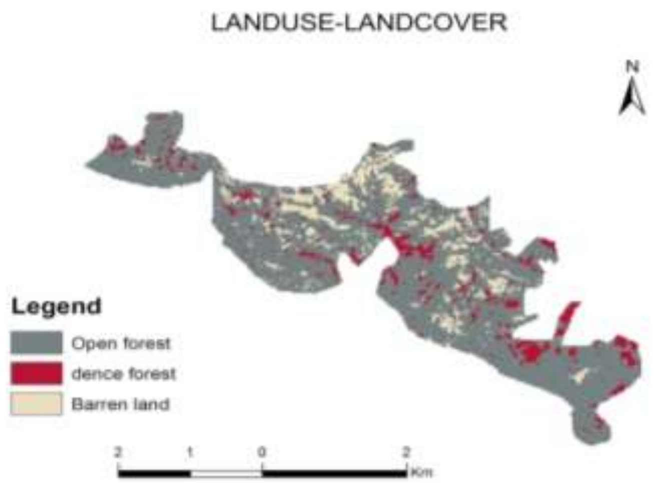

Fig. 6. Land use-Land cover Map

This study area is having a dominance of open forest and grassland. The total area covered by a dense forest of is only 8.86 percent. It shows that the proportion of the dense forest is less as compared to open forest. In open forest area, the vegetation cover is very sparse. The percentage of barren land is also notable as it accounts for 12 percent. Barren land is found in the northern plateau areas of the study region. The proportion of barren land is less as compared to the open forest but more than dense forest. Efforts are required to control the barren areas, and proper management practices should be adopted to convert these areas into dense forest cover.

4.2. Vegetation Indices:

A Vegetation Index (VI) is an artificial image layer created from the existing bands of an FCC image. This new layer often provides unique and valuable information and which is not found in any of the other individual bands. Vegetation indices have been shown to quantify or predict vegetation biomass, productivity, leaf area, and/or vegetative ground cover. (Pearson and Miller (1972), Wiegand et al. (1974)).

4.2.1. NDVI:

The normalized difference vegetation index (NDVI) has been in use for many years to measures and monitor plant growth (vigor) vegetation cover and biomass production from multispectral satellite data. The NDVI image (fig.7) is prepared from LISS III dataset. Spectral data in the visible region and near-infrared regions of the electromagnetic spectrum is used to calculate NDVI is as follows:

$$NDVI = (NIR - Red)/(NIR + Red) \text{ ------------------- } 1$$

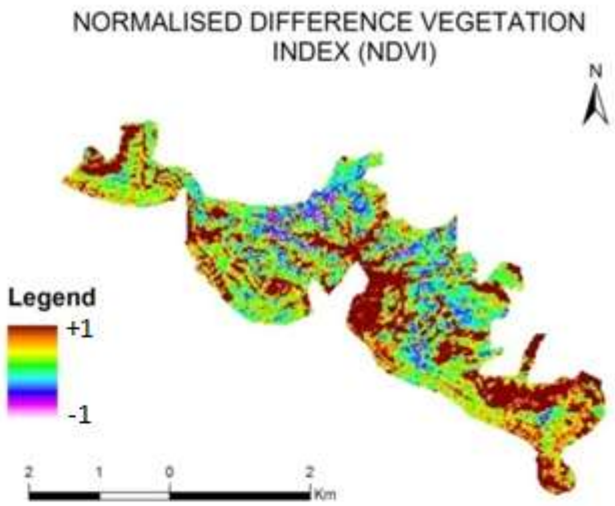

Fig. 7. NDVI Map

This index ranges between -1 to 1. The highest value of +1 shows very dense vegetation cover and lowest value indicates very sparse or negligible vegetation cover. This map of NDVI index also shows a strong correlation with land use / land cover map. The southeastern part of Sagareshwar forest is having good vegetation cover. The northwestern part and middle part of the riverine tract have dense vegetation cover as per NDVI index. Plateau areas have very less vegetation cover as the indices value is near to -1.

4.2.2. TNDVI:

Transformed Normalized Difference Vegetation Index is the square root of the NDVI. It has higher coefficient determination for the same variable, and this is the difference between TNDVI and NDVI. The formula of TNDVI always has positive values, and the variances of the ratio are proportional to mean values. TNDVI indicates a relation between the amounts of green biomass that is found in a pixel (Senseman et al. 1996).

TNDVI values (fig. 8) represent relative changes of seasonal vegetation rather an amount of the vegetation. The TNDVI is based on the Normalized Difference Vegetation Index (NDVI), which is the difference of near-infrared (NIR) and visible (red) reflectance values divided by total reflectance (Leo et al., 2000). The equation for the TNDVI is as follows:

TNDVI= sqrt (NDVI + 0.5) ----------------------------------2

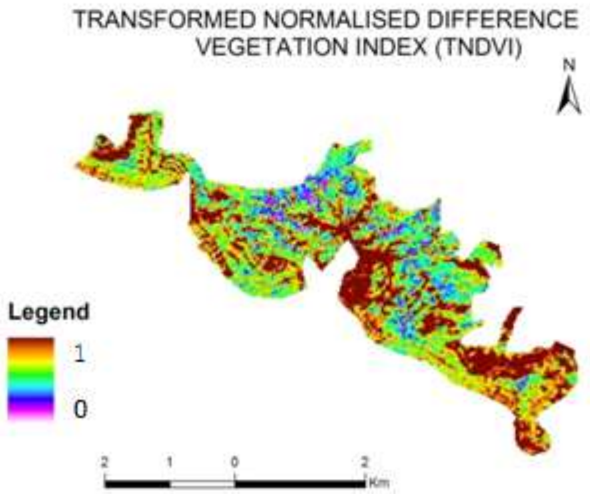

Fig. 8. TNDVI Map

4.2.3. Vegetation Index:

Vegetation index (fig.9) demarcates high and sparse vegetation areas. The southeast and a middle part which shows the high vegetation cover as compared to another part To carry out the comparative analysis of assessment of vegetation indices, these indices are being considered. The analysis reveals that NDVI, TNDVI, and vegetation index have given almost the same result.

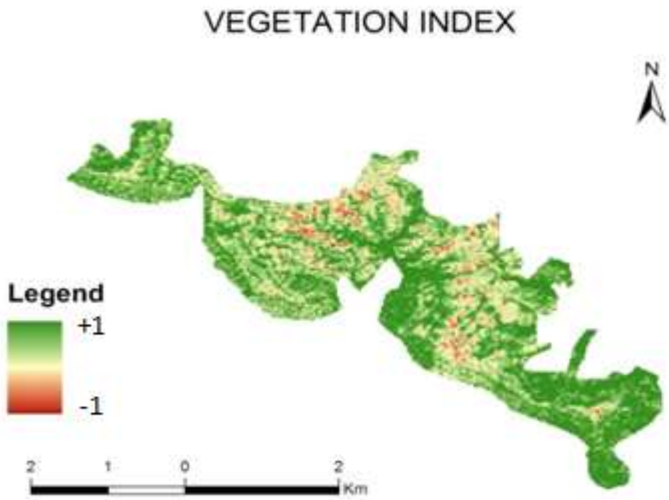

Fig. 9. Vegetation Index Map

V. IDENTIFICATION OF DEGRADED FOREST AREAS:

Proper planning of resources requires proper initial assessment of problems and prospects of the study area. Remote sensing techniques are very crucial in the evaluation of resources. To identify the degraded areas of the forest these techniques play a significant role. Spatial and temporal analyses of forest resources are very crucial with respect to sustainable forest development.

Within the forest, prioritization for conservation should be given to susceptible area of forest degradation. To recognize these areas, geospatial techniques and field survey are being used. Various thematic maps are prepared with the help of geospatial techniques. Slope, LU/LC, vegetation indices and soil layers are used for weighted overlay technique. Weights are applied to each layer per its role in degradation, and final weightage is calculated in ArcGIS software.
ArcGIS software is used to bring all geospatial and field work data on a single platform, and weighted overlay technique is used to identify and prioritise degraded areas for the forest (fig. 10).

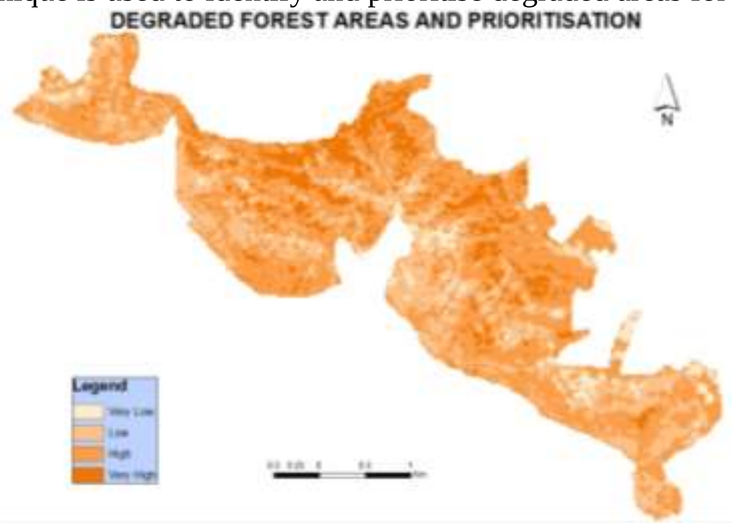

Fig. 10. Degraded Forest Areas & Prioritization

The analysis reveals that the plateau and hilly areas are facing the severe problem of forest degradation. The vegetation of this part is very sparse, and most of these areas are barren land. Gully and sheet erosion are much more prominent in these areas. These areas are much more susceptible to forest degradation. Hence, immediate conservation efforts should be taken to control these areas from degradation.

VI. CONCLUSION

Present work highlights the importance of forest assessment and its need for framing conservation program for Sagreshwar sanctuary. It also emphasizes the role of geospatial technology in forest study and preservation.

LULC analysis shows that most of the forests of this part are open forest, and dense forest areas of Sagareshwar accounts for only 8.86 percent (247.8 acres). This forest is facing the problem of degradation of land. The plateau areas are much more degraded which needs to be conserved properly. Gully and sheet erosion can be observed in the hilly areas of this forest. This forest is facing a severe problem of availability of water for wild animals and vegetation. Even though measures are being taken to conserve the water by constructing nala bunds and percolation tanks, but it seems that the efforts are not sufficient as the forest department has to arrange water tanks to fulfill the need of water during late winter and summer season. Vegetation indices are very useful to assess forest cover. NDVI, TNDVI and Veg. Index have been calculated to study forest conditions. All the indices have confirmed the same result as the dense forest cover is very less with respect to the total geographical area of the forest. Degraded forest areas have been identified with the weighted overlay technique of GIS. It shows that 11.12 percent of the area which is highly degraded requires immediate action for forest conservation.

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