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Fire Risk Zone Assessment in Chitrakoot Area, Satna MP, India

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Abstract

Chitrakoot is pilgrimage place of India and situated on boarder of MP and UP. It is known for its natural environment and scenic beauty at present natural environment of this area is degrading due to conversion of forested land in to agricultural land. This is a tropical forest and characterized by mature dry deciduous species. Factors responsible for Forest fire is fuel type, elevation, slope and aspect. Fire risk zonation map generated shows, very high risk zone is scattered on high altitude of area, highly risk zone is scattered in forest, and moderate risk zone is found in small patches in forest and in entire agricultural land. Low risk zone is found in north and north east part of area.

Keywords: Chitrakoot, fire risk zone, weight analysis and fuel type.

Introduction

Land and forest degradation process is one of the major environmental problems, which has lead to a variety of environmental disasters. The incidence of fire if effected by land use pattern, anthropogenic activities and change in the weather condition. During summer due to high level of water stress, especially in tropical deciduous forest, fire is a natural. It is a main cause of forest degradation and decrease in the growth of grass and shrub. Leading to increased soil erosion and decrease in natural habitat of floral and faunal species[1].

For understanding the behavior of forest fires, the factors that contribute to making an environment fire prone and the factors that influence fire behavior is essential for forest fire risk zone mapping[2]. Majority of induced fires in the Indian forests are mainly caused people who are harvesting the timber, cattle grazing, and crossing the forest. Fires set on farmlands to clear agricultural residues, sometimes spread into the forests[3]. As such this paper deals with forest fire risk zone mapping of Chitrakoot to minimize the frequency of fire by taking appropriate fire prevention measures, avert damage etc.

Study area (2346.78 sq km) falls on the boarder of Madhya Pradesh and Uttar Pradesh, in northern part of MP in Satna District and lies in between latitude 24°30'40"N to 25°11'6"N and longitude 80°28'40"E to 81°7'57"E. in the study area rocks exposed are mainly Sandstone, shale and Dolomitic limestone of Vindhyan group. Southern and eastern part of study area is hilly undulating topography with ravenous land all along the drainage streams. During summer forest fire is noted almost every year.

In study area most of the forest falls under protected and reserved forest. Floral species of this area is characterized by dry deciduous with Bamboo and Teak. Mandakini (Paisuni) is important river, flowing from south to north in the study area and has markedly periodic climate, characterized by dry and increasingly hot season from March to June, a warm humid monsoon season from July to September and dry and cold weather from October to December. Maximum temperature of this area goes up to 47^0C and minimum 3^0C.

Material and Methods

To obtain fire risk zone mapping, fuel type, elevation, slope and aspect are used and LISS III imageries[3]. The 12 yr data between 2000 to 2012 was obtained from National Remote Sensing Agency (NRSA), Hyderabad for study of fire affected area. Besides the satellite data topographic maps on 1:50,000 scale are used. Contours are prepared by toposheets for Digital Elevation Model. Slope and aspect map prepared from DEM of study area. Weight to each factor is assigning in decreasing order of its influence.

Results and Discussion

By the interpretation of satellite images of different years, forest fire is noted every year on the about to same region (figure 1) and influencing factors are as given.

Forest / Fuel type: Forest type of the study area is categorized in 7 categories depending upon fire sensitivity[4,5]. Forest characterized by dry deciduous with bamboo and teak. Dry bamboo is very sensitive for fire[6]. Ravenous and scrub forest is scanty and dry with grass. Dry deciduous forest covers about to 781.7 sq km area. Detail forest type is given in table-1 and figure-2.

Elevation: Elevation influences vegetation structure, fuel moisture and air humidity. It is mentioned that humidity and temperature have higher influence on fire at upper altitude areas

than lower ones[7]. According to fire risk zone, study area is divided in to four categories and highly prone area is found in central, west and east of study area (table-2, figure-3).

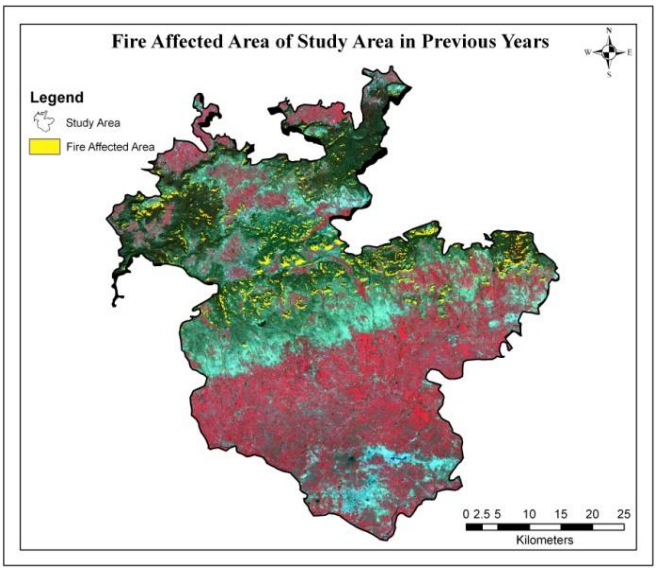

Figure-1
Fire Spots in previous year

Table-1
Forest/Fuel type of study area with their distribution

Forest/Fuel Types	Area sq km	Weight	Distribution Area
Dry Deciduous	781.69	4	Scattered in upper Half Part
Dry Deciduous with Bamboo	176.71	4	Scattered in entire Forest
Teak Dry Deciduous	0.42	3	Very small patches in North
Mixed Deciduous	0.17	3	Very small patches in North
Mixed Scrub	159.63	2	Big patches in East, North, West and South
Riverine forest	0.48	2	Very small patches in East
Agriculture	985.13	1	North and Lower Half Part

Table-2
Elevation classes of study area with their distribution

Elevation	Area sq km	Weight	Distribution Area
401 – 483	247.51	4	In Centre West to East Patch
301 - 400	1683.28	3	In North, North-West and South
201 – 300	256.11	2	In North-North-East, North-North-West and Southern
130 – 200	159.35	1	North and North-west Part

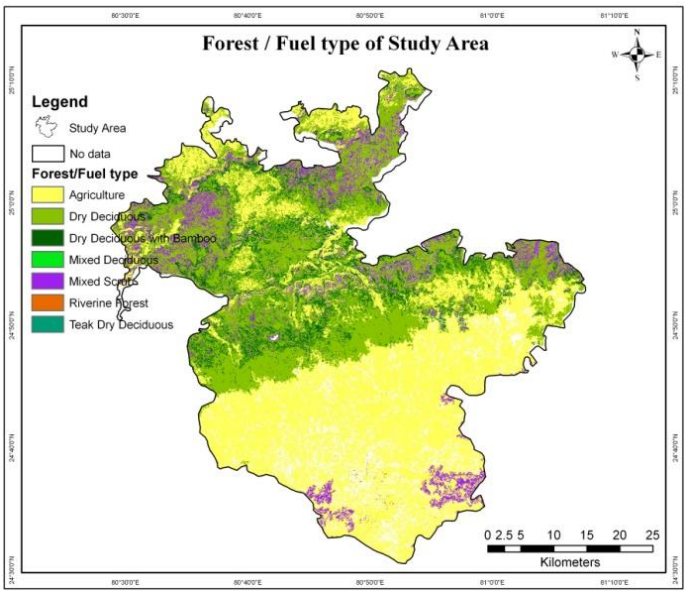

Figure- 2
Forest/Fuel type of study area

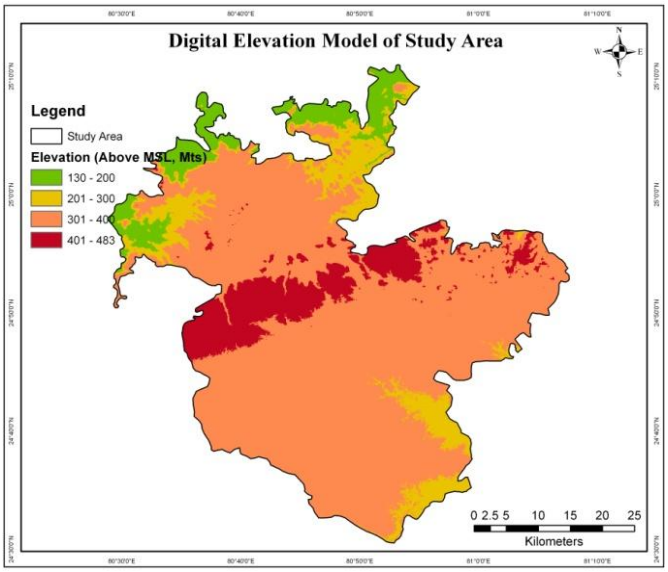

Figure-3
Elevation Map of study Area

Slop: Slope is one of the parameters that influence fire behavior. Fire moves most quickly up slope and least quickly down slope[8]. Also, in steeper slopes, rate of fire spread might rise, since flames are angled closer to the surface of ground and wind effects can supply the process of heat convection for the fire produced[9]. Depending upon the fire risk mapping, highly risky area is found in central and northern part (table-3, figure-4).

Aspect: South aspect slopes are higher temperatures, robust winds, minor humidity and lower fuel moistures because Southern aspects receive more direct heat from the sun[10]. In the earlier day East aspects get more ultraviolet and direct sunlight

than west aspect, as a consequence east aspect dries faster. To achieve the fire risk zone, highly prone area is found in central from west to east (table-4, figure-5).

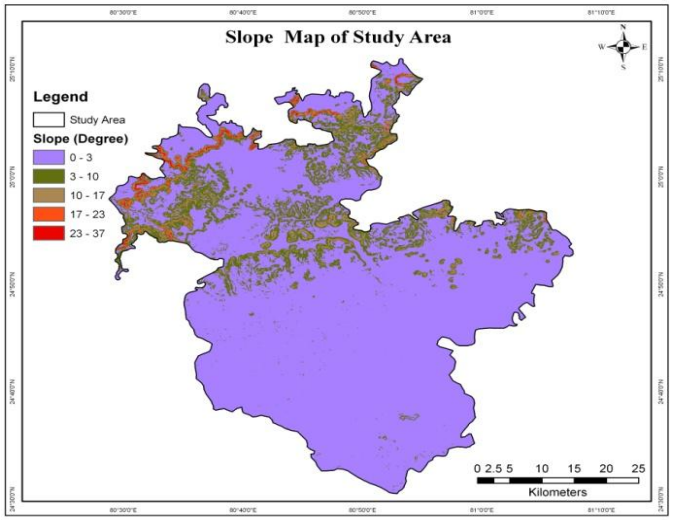

Figure-4
Slope Map of study area

Table-3
Slope classes of study area with their distribution

Slope	Area sq km	Weight	Distribution Area
10 – 17	58.54	4	Scattered in Upper Half
17 – 23	14.66	4	Very Small Patches in Upper Half
3 – 10	317.97	3	Small Patches in Upper Half
23 – 37	8.43	2	Very Small Patches in North
0 – 3	1946.65	1	Extreme North and Southern

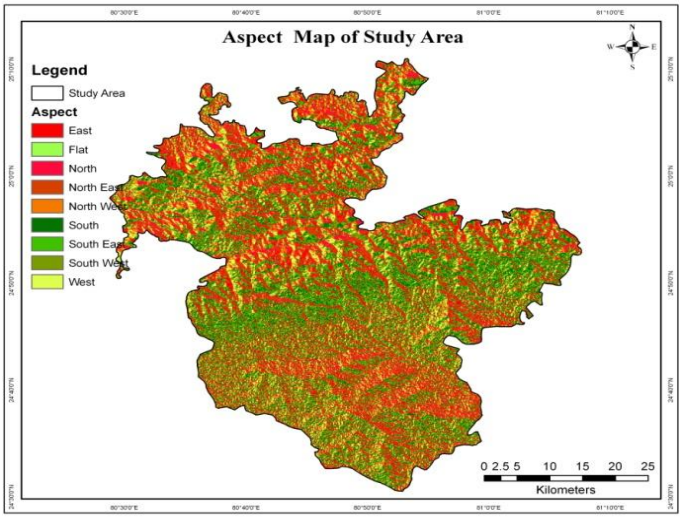

Figure-5
Aspect Map of study area

Table-4
Aspect of study area

Aspect	Area sq km	Weight
South East	349.37	4
South	349.44	4
South West	302.62	3
West	257.85	3
North	251.17	2
North East	279.56	2
East	318.39	2
North West	229.95	1
Flat	7.89	1

Fire Risk Model: Based on above studies of elevation, slope, aspect and forest/ fuel type, obtained from different sources are classified based on subjective weights. Each class has an own rate that shows the degree of fire sensitivity. All the thematic maps (layers) were then integrated using the weight analysis of GIS. Fire risk zonation map showing that Very highly prone area is found in to small patches and cover 65.24 sq km area. Highly prone area is scattered in to entire forest and cover 890.00 sq km area. Moderate prone area cover a small area in forest but mostly found in agricultural land and cover 1093.92 sq km area. Low fire prone area is found in North and North West part of study area. It covers a 47.3 sq km area (table-5, figure-6).

Table-5
Fire risk zones of study area with their distribution

Fire Risk	Area sq km	% Area	Distribution Area
Very High	65.24	3.11	Very Small Patches in Central Region
High	890.01	42.45	In Upper Half Part of area
Moderate	1093.93	52.18	Small Patches in Forest and Lower Half Part
Low	47.31	2.26	Small Patches in North

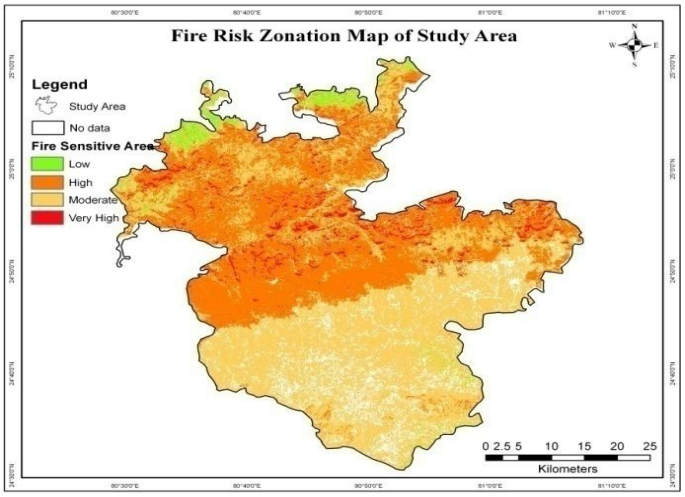

Figure-6
Fire Risk Zone Map of study area

Conclusion

Factors responsible for forest fire are elevation; slope, forest and aspect are mapped. Their spatial analysis and area is calculated. Depending upon the risk factor, each factor is divided in to very high risk zone, high risk zone, moderate risk zone and low risk zone and weight- 4, 3, 2 and 1 is assigned. According to risk factor in decreasing order and spatial distribution of all factors are overlaid. Categorized risk zone is presented in Fig no. 6. Very high risk zone is found on higher altitude, high risk zone is found on less steep slope, moderate risk zone is found on gentle slope and low risk zone on low altitude with gentle slope.

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