FOREST FIRE RISK ZONATION MAPPING USING GIS AND REMOTE SENSING: A CASE STUDY IN BADULLA DISTRICT, SRI LANKA

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Introduction

Forest fires are the main reason for changes in the structure of the forest coverage. According to the records of the Forest Department, Sri Lanka, as a percentage, more than half of forest fires were recorded in Badulla District. Badulla district is vulnerable to forest fires every year. It is one of the major natural disasters in Badulla district. It is not possible to control nature and natural disasters but possible to map forest fires and reduce their vulnerability. The identified problem of the study is, not having a proper forest fire risk zonation map for Badulla district, Sri Lanka. The main objective of the study is to analyse forest fire vulnerability and prepare a forest fire risk zonation map for the Badulla district. The study is based on Remote Sensing and GIS data. Those are the best methods for forest fire mapping beyond traditional methods.

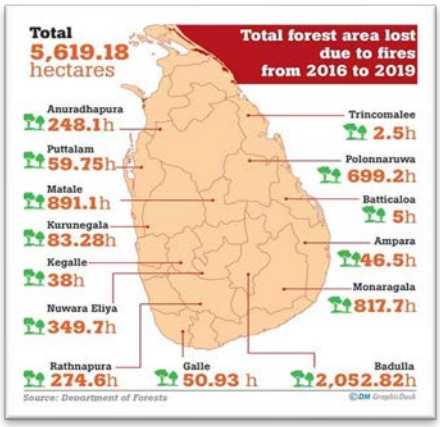

Figure 1: Total forest cover lost due to forest fire from 2016 to 2019
Source: Forest department, Sri Lanka

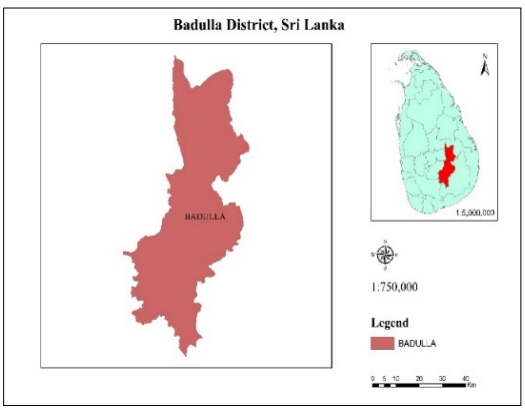

Figure 2: Study area

Traditional approaches make it challenging to map the intensity of fires. Topography, Land cover classes, and anthropological activities were taken as the variables of the study. Accordingly, the forest fire index was developed and given the ranks to variables variated from high to low. Further, a Forest fire risk zonation map was prepared and finally, a model was validated by calculating the RMSE value.

The study's findings may help policymakers take precautionary measures by reducing the danger and consequences of forest fires. Hence, a proper risk mapping of forest fires in the Badulla district is a timely requirement of the country.

Methodology

Badulla district of Sri Lanka is the case study of the research as shown in Figure 2. In the current situation, Badulla district shows the highest forest fire vulnerability (Heenatigala, 2021). According to the past recordings of the Forest Department, a significant fire destroyed about 20 acres of land in Ravana Ella, Badulla, in 2016. In 2018, at least 156 forest fires were recorded in Sri Lanka, with 80 of them occurring in Badulla district. In 2017, there were more fire occurrences in Sri Lanka, according to the Disaster Management Center, with half of them being reported in the Badulla area as shown in Figure 1. The input data on elements that influence forest fires are presented descriptively and identify the factors that increase the risk of a fire. For the GIS analysis that followed, the descriptive data was turned into a forest fire risk index and a grading system, so that appropriate conclusions could be reached by computing and other mathematical procedures. Vegetation, topography, road network, and proximity to the settlement were examined in order of importance, as elements that affect a location's fire risk (Parajuli et al., 2020). Each factor's impact on the likelihood of a forest fire was evaluated, and the various classes of each factor were given the appropriate weights along with the forest fire index and classified by given scaled values from very low to very high. The percentage of each factor was calculated and then weighted along with the influence of forest fires and then all the factors were overlaid in ArcGIS (Parajuli et al., 2020).

FRI = 45%LC +15%S + 15%DR + 15%PS + 5%A + 5%DEM (1)

Where,

FRI - Fire Risk Index
A-Aspect
LC - Land cover
LST- Land surface temperature
S- Slope
DR - Distance from the road
PS - Proximity to settlement

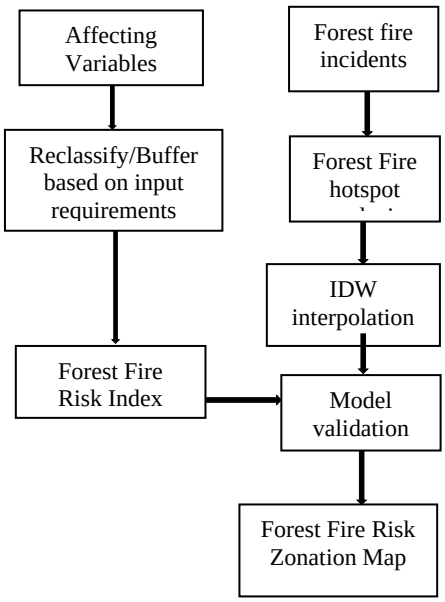

Figure 3 : Methodology implemented over the study

As a result, the risk model was created using equation 1 shown below following previous studies. Since the model was developed using six different independent variables, separate data on the frequency of forest fire incidents were used to validate the map. Beginning with the concept that high-up fire counts equate to a higher risk rating in the assigned category, recorded fire counts were overlaid in each fire risk zone. Using the forest fire incident data, forest fire hotspot analysis was carried out, followed by the creation of an IDW interpolation surface and the calculation of the RMSE value to verify the model. Following Figure 4 implemented the comparison of three maps. In order to three maps can be identified the same area of the three maps was vulnerable to occurring forest fires.

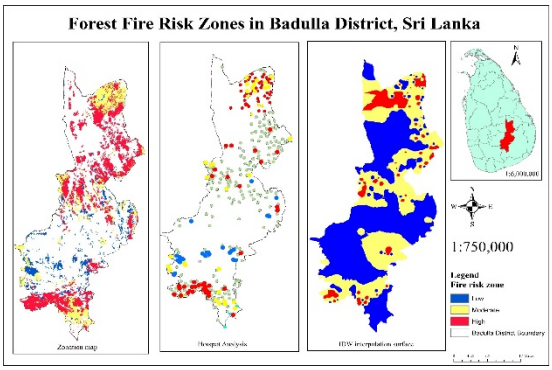

Figure 4: Comparison of three maps

Results and Discussion

Nature cannot be controlled, but it is feasible to map the areas where most likely to have forest fires and so reduce the frequency of fires, avoid damage, etc. The places known as "forest fire risk zones" are where fires are most possible to start and easily spread to neighboring areas. Critical components of fire control include anticipating the variables that cause fires to occur and comprehending the dynamic behavior of fire. A fire risk zone map must be provided to accurately assess forest fire issues and decide on appropriate remediation strategies. Results were analyzed according to the objectives of the study. Hotspot analysis is a spatial examination and planning procedure inspired by the recognizable proof of grouping of spatial peculiarities. These spatial peculiarities are portrayed as focuses in a guide and allude to areas of occasions. According to the forest fire risk zonation map (Figure 5) in Badulla district, Mahiyanganaya, Ridimaliadda, and Haldummilla, DSD divisions are mostly influenced by the forest fires in Badulla district. Figure 6 illustrates how the vegetation types are affected by the forest fires from the year 2009 to 2019. Shrub land areas are mostly influenced by forest fires. The overall study area was 2861 square kilometers, and 49% of it was forested, along with the land cover class map. 27% area was shrubland from the total forest area of Badulla district. Due to its high sensitivity to fire damage, shrubland has nearly disappeared from much of the study region yearly.

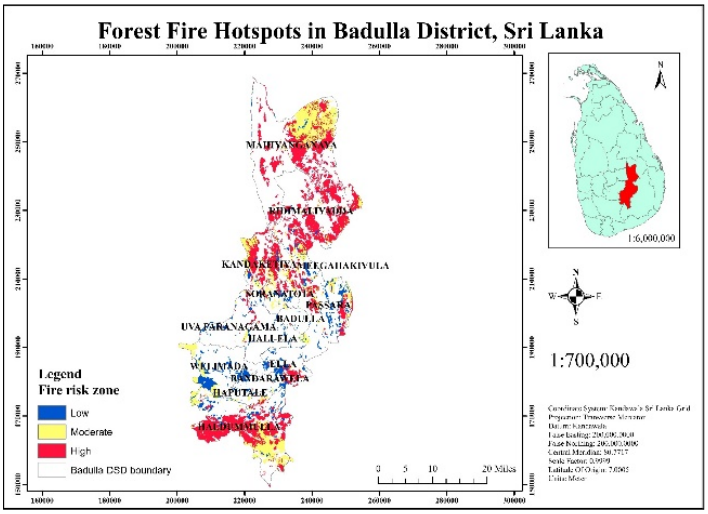

Figure 5: Forest fire risk zonation map

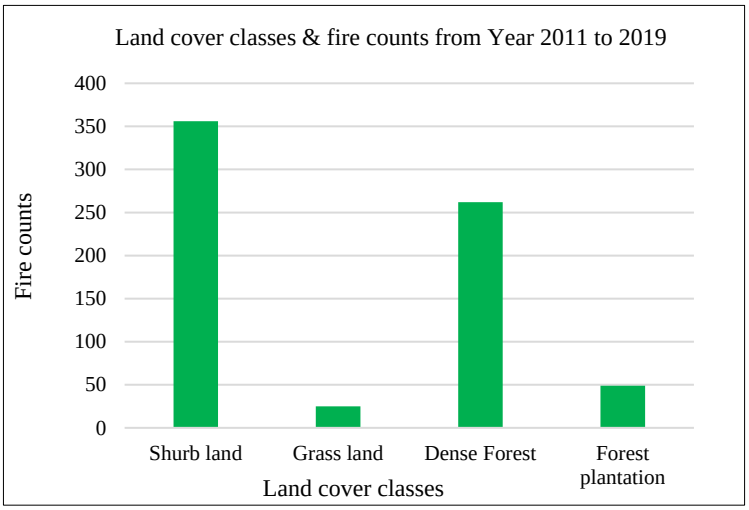

Figure 6: Land cover classes and fire counts

Conclusion

Traditional methods of forest fire analysing require more ground data collection and are time-consuming. Consequently, RS and GIS technology is beneficial for preparing forest fire prediction models. If there may not be any records of the area's previous vegetation, it also is the main problem when using conventional methods. Therefore, RS and GIS may help to develop forest fire mapping also, are useful for monitoring healthy vegetation cover, burned vegetation, and fire risk zoning. One of the main limitations of the study that identified is, there was no database management for the forest fires in Sri Lanka.

Hence faced so many difficulties while taking the data regarding the forest fires. Therefore, it is preferable to switch from manual book-keeping to a database management system for organizing and retrieving the data connected to forests to continuously measure forest fires and maintain an appropriate web-based fire management database- a timely requirement of the country. This study can be developed with many independent parameters. Such as climate patterns (Wind direction and wind speed). Forest fire management is also very important. Therefore, develop forest fire management for Badulla district, Sri Lanka by introducing vegetation implementation, Fire belts, Firefighting reservoirs, and establishing sufficient fire brigades, etc as further studies. Not only for the Badulla district but The case study can also be developed into the forest fire analysis for the areas where on the forest fire belt which is introduced by the forest department in Sri Lanka (Sandamali and Chathuranga, 2021).

References

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