ASSESSMENT OF FOREST FIRE RISK SCORE: AN MCDM APPLICATION

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ABSTRACT

Forest fires are one of the disasters that nature adapts to. However, due to increased industry and urbanization, the number of fires is rising. Forest fires not only have a severe impact on the environment, but they also threaten the lives of humans and animals. The danger of forest fires and their spread hazards are analyzed in various studies, and the fire risks of the regions are identified. Furthermore, several studies appeared to aim to optimize fire protection strategies based on risk output. In this study, to assess the fire risk, an MCDM approach based on AHP is utilized. The evaluation criteria are determined in accordance with previous research and experts' recommendations. The decision hierarchy has 6 main criteria and 18 criteria. A pairwise comparison questionnaire survey is conducted. Tree species and composition is found as the highest forest fire risk factor.

Keywords: Forest Fires, Risk Assessment, AHP

1. Introduction

Forests are critical natural resources that serve a key role in the conservation of biological diversity, as well as a variety of many important functions such as water regime regulation, soil protection, and fighting against climate change. Forest fires are a major environmental hazard that threatens forests, not only cause economic and ecological harm but also cause human suffering. Forest fire's occurrence and the damage caused by it have increased in recent years in the world due to climate change and growing human impact. Forest fire is a major issue in the Mediterranean climate zone. There is a significant increase in the average annual burned area and the amount of burned area per fire. While the amount of burnt area per fire in Turkey was 2.8 ha. in 2010-2012 period, 2.2 ha. in 2013-2015 period, and 3.5 ha. in 2016-2018 period; this value increased to 19.3 ha. in 2019-2021 period. The annual average amount of burnt area was 5794 ha., 5931 ha., 8931 ha., and 57.269 ha. for the same periods, respectively (Atmiş et al., 2022). Forest fire risk assessment is a critical step in preventing high-intensity fires, which seriously affect the natural and cultural environment. The fundamental purpose of this research is to calculate the fire ignition risk score to have an insight into preventing forest fires. Because of the various aspect of forest fire, researchers have used multi-criteria analysis integrating ANN or GIS techniques to deal with these complex issues and estimate the potential forest fire risk.

2. Literature Review

Sakellariou et al. (2019) stated that forest fires are one of the most serious hazards to forest viability, endangering the socioeconomic health of any people, which shows a need for an effective prevention plan for dealing with repeated and devastating forest fires. Previous studies' conclusion is that the combination of the most important factors, such as natural (slope, aspect, fuel kinds) and anthropogenic components (proximity and interaction with

road networks and inhabited regions), influences the fire outbreak, subsequent igniting, and spread. Furthermore, different weights were assigned to each factor at the end of the model based on the degree of impact on fire ignition, intensity, and spread. The forest fire risk map was created using seven criteria linked with fire ignition and propagation to guide forest rangers in designing effective patrolling and managers in adopting fire prevention measures (Nuthammachot & Stratoulias, 2021).

3. Hypothesis/Objectives

The aim of the model is to calculate the fire ignition risk score for forestry areas. As a case study, the risk scores of selected forestry enterprises will be calculated for validation.

4. Research Design/Methodology

The evaluation criteria are determined according to the literature review and judgments of experts (scientists affiliated with the Faculty of Forest, Istanbul University – Cerrahpasa). The revealed hierarchy representing the decision model has 18 criteria grouped under six main criteria (Appendix 1). Then, a pairwise comparison questionnaire survey is conducted to reveal the judgments of the experts (forest-fire experts who worked for national forestry service and scientists affiliated with the faculties of forestry in Turkish universities who has worked on forest fires) which will be used to determine the priorities of the main criteria and the criteria. The geometric mean method is used to aggregate the judgments.

5. Data/Model Analysis

The priorities of the main criteria and criteria are given in Appendix 2 and 3. The inconsistency ratios are computed and none of them is greater than 10%.

6. Limitations

This is an ongoing study; the evaluation of alternatives is in progress.

7. Conclusions

The aim of this study is to construct an MCDM model to compute the fire risk score of a forest area. First, the most relevant criteria are determined based on the previous studies and experts' opinions in the problem structuring stage. We come up with 6 main criteria and 18 criteria. Due to the hierarchic structure of the decision model, in the second stage, we use the AHP method to assess the relative importance of these criteria. We contact scientists at the faculties of forestry in Turkish universities, and practitioner forest fire experts for conducting a pairwise comparison questionnaire survey to reveal their judgments. According to this survey, the most important main criterion is forest structure and vegetation. Tree species and composition, followed by Litter and Population density are found as the highest risk factors for forest fire risk. In the next step of this study, we will evaluate alternatives and calculate their forest fire ignition risk scores.

8. Key References

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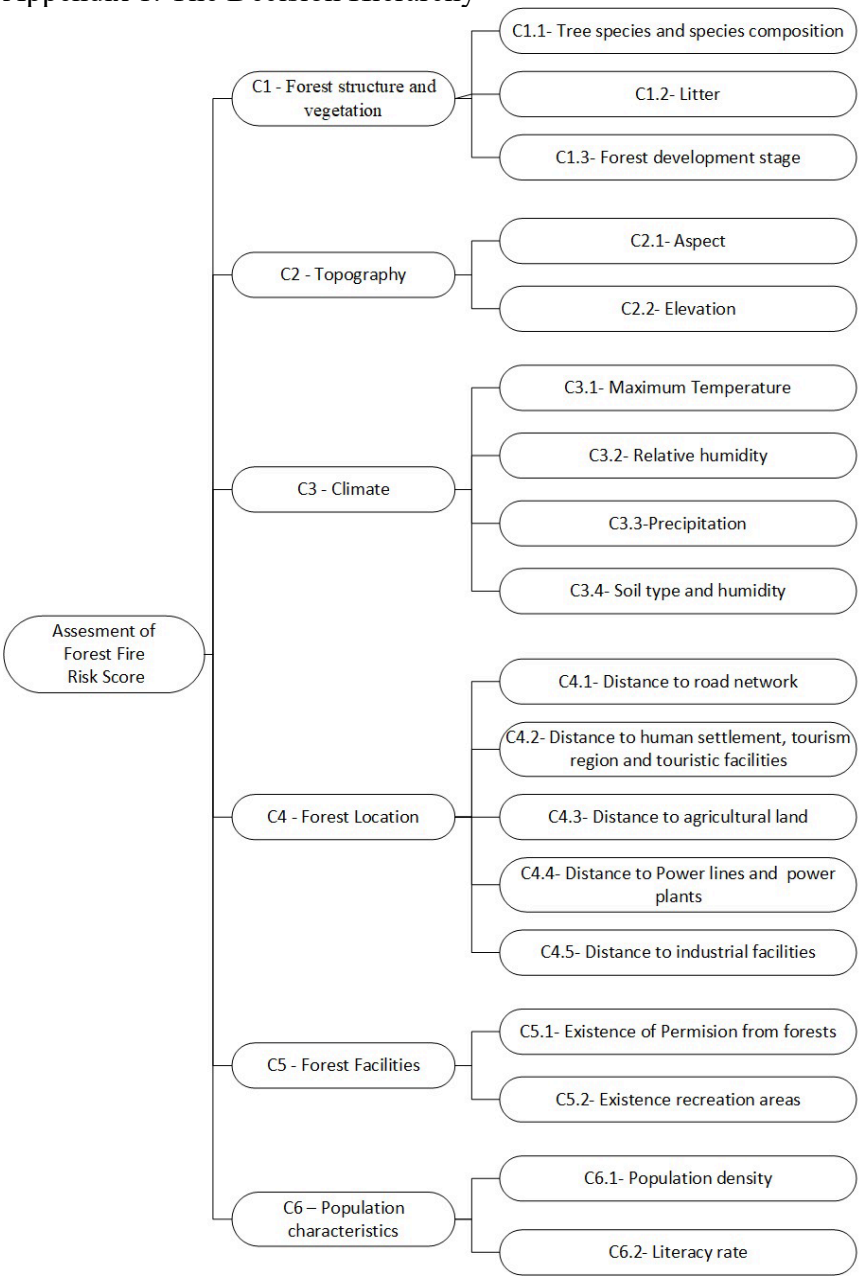
9. Appendices

Appendix 1. The Decision Hierarchy



Appendix 2. Importance of Main Criteria and Criteria

Main Criteria	Priorities	Criteria	Priorities
Forest structure and vegetation	28.6%	Tree species and composition	46.65%
		Litter	36.58%
		Stand development stage	16.77%
Forest Location	21.36%	Distance to facilities	31.31%
		Distance to power lines & plants	22.88%
		Distance to agricultural land	18.05%
		Distance to road network	17.49%
		Distance to industrial facilities	10.28%
Climate	17.54%	Relative humidity	41.51%
		Maximum temperature	23.92%
		Precipitation	20.62%
		Soil type and humidity	13.95%
Population characteristics	16.25%	Population density	62.08%
		Literacy rate	37.92%
Forest facilities	9.33%	Existence of permission	56.64%
		Existence of recreation areas	43.36%
Topography	6.91%	Elevation	51.85%
		Aspect	48.15%

Appendix 3. Global Priorities of the Criteria