

Predicting Forest Fire Spots Using Nonparametric Predictive Inference with Parametric Copula: Malaysia Case Study

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Abstract. Forest fire causes major and expensive damage to a country, including ecological, economic and anthropological aspects. Still, there were a lot of uncertainties and knowledge regarding forest fire management, especially in small fire detection. Many past studies throughout the decades, in machine learning approaches, were non-generalizable and needed more accuracy. Therefore, this study aims to introduce nonparametric predictive inference (NPI) with a parametric copula, which considers the dependence structure to predict the forest fire hotspots using the coordinate – longitude and latitude. The proposed method was theorized to perform better than the current models and be able to generalize in other regions with the same parameters. A case study of Malaysia was chosen as there was a lack of mathematical and statistical solutions in forest fire management in this country. The four copulae integrated with the proposed method generated imprecise probabilities with a minimal gap showing the forecasting accuracy. Amongst, Gumbel and Normal copula parameters displayed the best imprecise probabilities of forest fire occurrences for the Malaysia location due to the lowest differences. In conclusion, the NPI can be an alternative method to predict forest fire hotspots.

INTRODUCTION

Natural disasters are bound to happen when triggered by underground, topographical, weather or biological-related factors. Among the concerned ones is forest fire or wildfire. It is a recurrent natural phenomenon in climate and dry regions such as Malaysia, close to the earth's equator. Annually, millions of hectares (ha) of forests, occupied by both humans and animals, are lost to forest fires worldwide. Furthermore, forest fire events have spiked in recent years due to the increased human advancement in industrial activities, leading to a rise in temperature [3][9]. According to the [2], Malaysia had accumulated 162kha of tree cover loss from 2001 to 2021 due to wildfires. It had the highest tree cover loss in 2016 with 20.4kha, a continuation of the prior year's critical haze. Concurrently, Sarawak is the most prone to wildfire incidents in Malaysia, with an average yearly tree cover loss of 4.72kha [2].

Forest fire causes grave damage, including ecological, economic and anthropological aspects, which require expensive re-development costs. For example, property destruction, vegetation loss, severe injuries and deaths, cost