

Project Title: TEMPORAL ANALYSIS OF CLIMATIC INFLUENCES ON FOREST FIRE PATTERNS IN PENINSULAR MALAYSIA USING STATISTICAL METHOD

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Chapter 1 Introduction

1.1 Introduction

Climate change is one of the most exigent natural events which is identified by persistent shifts in temperature and weather patterns. Human activities such as fuel combustion and deforestation have significantly increased greenhouse gas (GHG) concentrations since Industrial Revolution, resulting in increased global temperatures, changed patterns of precipitation, and more frequent severe weather events. Wildfire is an unplanned, interface fire, independency fire or vegetative fire spread rapidly through the plant biomass involving its layers. For instance, climatic change aggravates these fires by such conditions as high temperatures, low humidities, long periods of drought and changing winds that progress the development of fires.

Nonetheless, the considerations have been historically significant to ecosystem maintenance even though wildfires are generally known as destructive phenomena. However, today's fires are more negative and large-scaled owing to climatic change and human influence. The instances of the USA Great Fire of 1910 or Australian Bushfire Season (2019- 2020) assert that fire in forest is rather frequent and might be extremely severe; hence, there is a paramount need to adopt proper fire management strategies. In Peninsular Malaysia with tropical climate, it becomes relatively more dangerous for the forests to burn during the dry season periods. It was formerly relevant to slash and burn of agricultural practices but today it has been made more frequent and severe by urbanization through deforesting and climate variations. This has been occasioned by the occurrence of El Nino event 1997-1998 and drought episodes of 1983-1984 creating concern in effective way these unfavourable natural events can be managed. Understanding of the climate's relationship with fires has become more important after the improvement of data and information gathering and processing.

Therefore, this research aim is to determine the effects that climatic factors such as temperature, rainfall, humidity and wind strength have on forest fires in Peninsular Malaysia

for at least five years' data on fire occurrences in the forests and the climatic data of those years. In addition, the goals of the study are to analyse trends, compare the data and find the correlation between the climate and forest fire occurrences; to combine data on the weather conditions of the analysed regions and develop methods and models for the evaluation of the fire risks, and then offer the improvements for the management of such scenarios. Therefore, prior literature in other regions is still available, but the literature on Peninsular Malaysia is limited, and the data sources and methods used are often insufficient and not highly developed. This research intends to fill those gaps employing statistical techniques which include time series analysis, adding a significant contribution to the topic of environmental management and climate influences on forest fires.

1.2 Background of the Problem

Climate change has worsened the situation whereby forest fires have become an environmental and socio-economic problem in areas such as Peninsular Malaysia. Wildfires has great impact to biodiversity, human well-being, and economic stability. More extensive intense bush fires, associated with climate change and longer dry seasons require more studies for the causes and patterns of the disastrous events for better strategies in firefighting to mitigate ecological damage and safeguard public health and financial assets.

There are plenty previous studies that analysed the relationship between forest fires and climate factors in different areas. For example, Turco et al.'s study in 2014 explains how increased temperature and decreased in precipitation contributes to fire. While Flannigan et al. in 2005 analysed historical data which highlighted the changes in the temperature and amount of precipitation affects the frequency and severity of fire. The study by Balshi et al. (2009) on the Alaskan boreal habitat used dynamic vegetation modelling in predicting the increasing trend in size and frequency of burning under various climates' conditions. These results imply that to stop the increase of this trend, management strategies that are tailored for the region should be developed. Ensuring the sustainability of used natural resources in operational strategies designed for management of climatic change across affected regions, special critical climatic aspects must be put into consideration. Thus, studies on specific fire management strategies are crucial for the mitigation of environmental shifts and other climate change realities to protect the requisites of society as well as its welfare.

1.3 Statement of the Problem

Even though climatic factors have been identified as a major cause of forest fires all over the world, knowledge on temporal patterns and climate on forest fire in Peninsular Malaysia is limited. This resulted from inadequate data and analysis not yet been undertaken in particular area of interest (Chew et al., 2022). This gap has excluded the possibility of proper management of the forest fires in the country and therefore risk the countries biological diversity future health of the people and the circulatory economy. It is therefore important to fill this knowledge gap to explain the factors leading to such fires; and to improve on the management decisions of forest fires. Undoubtedly, there is a desire to raise research efforts to develop a better early warning system that would be instrumental in the mitigation of the risks of forest fires in the region of Peninsular Malaysia.

1.4 Research Questions

1. What trends can be deduced in relation to the forest fire incidences in Peninsular Malaysia in the last five years?
2. Which month and seasons of the year are responsive to the highest number of times that forest fire occurred in Peninsular Malaysia?
3. Where is the hotspot area that defines an area most likely to be affected by outbreak of forest fires?
4. What is the relationship between geographical characteristic in the Peninsular Malaysia and the climatic factors that determine forest fire?

1.5 Objectives of the Research

To answer this research question, the following specific objectives are set:

1. To collect an extensive list of forest fire records and climatic features that coincide with the period of the analysis in Peninsular Malaysia.
2. To analyse the temporal characteristics of the forest fire occurrences and determine the relationship between climatic variables and forest fire occurrences.
3. To create models that will allow to predict the factors of forest fire potential depending on climate.

1.6 Scope of the Study

The scope of this project includes:

1. The study will utilize the dataset provided by the collaborator where the dataset is obtained from Global Remote Sensing Data from Google Earth Engine (GEE).
2. The analysis will cover at least 5 years to capture long-term trends and patterns.
3. Key climatic variables such as temperature, humidity and windspeed will be examined for their influence on forest fire patterns.
4. The study will focus exclusively on Peninsular Malaysia, excluding East Malaysia due to different climatic and ecological conditions.
5. The research will use historical data that is currently obtainable, although it may have some constraints regarding precision and comprehensiveness.
6. Statistical and machine learning tools will be used for data analysis and model development.

1.7 Significance of the Research

The significance of this research is that it will be able to explain how climate affects the probability of forest fires in Peninsular Malaysia. The advantages could possibly assist in the prediction of fire hazards; thereby enhancing the firefighting strategies. Last but not the least, the total benefit that can be gained from the project will be in the field of forest management particularly the sustainable one and protection of the forest and habitation in peninsular Malaysia.

1.8 Structure of the Thesis

The outline of this thesis comprises of seven chapters and every chapter entails a systematic and exhaustive way of solving the research questions posed depending on the thesis title “Temporal Analysis of Climatic Influences on Forest Fire Patterns in Peninsular Malaysia using Statistical Method”. Here are the outlines of how those different chapters will be formatted.

Chapter 1: Introduction

The opening of the article commences with introducing the focal research inquiry and elucidating its importance in comprehending how climatic factors affect forest fires. It imparts imperative contextual details on climate change and forest fires, underscoring their worldwide and local repercussions, especially within Peninsular Malaysia. The section delineates the study's intentions, extent, presumptions, and significance to lay down a foundation for further exploration. A summary is provided at the end of this chapter.

Chapter 2: Literature Review/Problem Background

In this chapter, the literature and research pertinent to the field are reviewed. The aim is to create a framework for the current project by discussing the historical context as well as how understanding climate change and forest fires have evolved both globally and specifically in Peninsular Malaysia. Various key studies are analysed with emphasis on their methodologies, findings, and limitations. Additionally, gaps in existing research are identified which emphasizes that there exists an urgent need for in-depth study focused solely on investigating region-specific ecological conditions given its unique climatic characteristics within that area.

Chapter 3: Research Methodology

In the study, the methodology chapter delineates a framework for the data science project life cycle and how it was employed. It expounds on where climatic and forest fire data were sourced from, as well as illustrates the approaches used to collect such information. Also explored are measures taken in the pre-processing of collected data - cleaning up errors; and conducting transformations - so that they can be analysed efficiently through feature engineering methods. Aiming at maintaining accountability, this all-encompassing account securities replicability of research procedures utilized herein.

Chapter 4: Exploratory Data Analysis (EDA)

In this chapter, the primary emphasis is on Exploratory Data Analysis (EDA), which commences with visualizations and descriptive statistics to comprehend and investigate data. Diagnostic analytics also known as initial observations from EDA are addressed along with executing feature engineering for building influential features meant for modelling purposes. Additionally, various predictive modelling methodologies utilized in assessing forest fire jeopardy grounded upon weather-related factors are explained while further examining

probable prescriptive analytic alternatives tailored towards recommending effective management tactics against fires.

Chapter 5: Model Development

In the chapter on model development, readers will explore the various steps and experiments undertaken to create predictive models. The accuracy and reliability of these models are thoroughly assessed using appropriate metrics. Furthermore, this section delves into creating a results dashboard that aids decision-making through effective visual communication emphasizing storytelling techniques as essential for sharing findings effectively.

Chapter 6: Results and Discussion/Interpretation

In this chapter, the study's outcomes are showcased. The data processing and analysis pipeline used in case applicable is described with visualizations and tables that simplify the discoveries made by providing a precise interpretation of results relative to the problem background and research objectives identified in Chapter 1. Additionally, implications for forest fire management policies have also been highlighted along with comparing it with existing studies emphasizing its contributions as well as differences discovered from other works conducted before.

Chapter 7: Conclusion

The final chapter aims to summarize the pivotal discoveries of the study while highlighting its contributions to the area of focus. It also reflects on both achievements and constraints faced during project implementation, providing conclusive remarks along with suggesting avenues for future research or improvements. Notably, it emphasizes that there is a continual need for effective management and understanding regarding forest fires within climate change contexts by offering actionable recommendations accordingly.

The sequential arrangement of the chapters ensures a coherent progression of concepts, resulting in an extensive grasp of the research issue and its remedies. Such architecture is purposed to furnish lucid guidance for undertaking the study proficiently; ultimately leading towards valuable findings and feasible suggestions.

1.9 Summary

This thesis primarily focuses on analysing the effects of climatic variables on forest fires' temporal patterns in Peninsular Malaysia, a critical issue that has been exacerbated by climate change with substantial environmental and socio-economic consequences. The problem statement emphasizes the inadequacy of specific research on this subject within the region, characterized often by incomplete data and insufficient analytical techniques. The develop of predictive models for fire risk assessment while creating dashboard tools capable of visualizing outcomes- all geared towards supporting crucial decision-making processes. By compiling an exhaustive collection dataset leveraging advanced analytical methods intended explicitly for backing up ecological nuances unique to Malaysia; this study aim to bridge contemporary research gaps in comprehending how forest fires operate concerning natural warming trends affecting tropical rainforest eco-spaces around our planet today. Ultimately, this exploration's essence pertains additional importance given its potential illumination impacts exacerbating wildfire risks from global heating are significant not just environmentally but also socio-politically influential. Relevant stakeholders can yield valuable insights via such studies enhancing strategies aimed at managing wildfires effectively under unfavourable contexts related chiefly due damaging human activities as well as having negative overshadowing detriments operative through climate shifts occurring unbowed. In conclusion, the gains from this study could aid better conservation approaches across affected areas dictated here ultimately benefiting both society-at-large guidelines govern management practices over time framed decisions necessary going forward safeguard continuity amidst known fallouts emanating bad policies or ineffective strategies employed previously.

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