

# Assessing the Impact of the 2021 Evia Wildfires through Social Media Analysis

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**Abstract.** The 2021 Evia wildfires had profound economic, environmental and social impacts, necessitating an in-depth investigation. This study proposes the utilization of large language models and machine learning techniques to extract meaningful insights from Tweets, facilitating a comprehensive analysis of the consequences resulting from this devastating event. Through the application of computational tools, this research aims to illuminate the multiple dimensions of the disaster impacts, encompassing affected population, property loss, environmental impact, community resilience, as well as the efficacy of disaster response and recovery measures. The aim of this research includes an evaluation of the validity of data produced by the developed system via comparison with other sources such as EM-DAT public disaster loss database and Wikipedia. The findings from this research endeavor will contribute to a more nuanced method of identifying and analyzing disaster impacts, while offering valuable insights to enhance future disaster management strategies.

**Keywords:** Disaster management; Large language model, deep learning, social media, Twitter, wildfires.

## 1 Introduction

The 2021 Evia wildfires had a devastating impact on the island of Evia, Greece, necessitating a comprehensive investigation to assess the consequences on various aspects of society. Recent advancements in Artificial Intelligence (AI) methods including machine learning and deep learning have enabled the development and application of AI-based methodologies and tools for disaster management (Linardos et al., 2023, Linardos et al., 2022). ML has been used to extract valuable information from social media platforms, mainly Twitter, for disaster management applications (Christidou et al., 2022).

This study proposes a novel approach utilizing large language models and newly developed tools for disaster analysis through social media specifically for the Evia wildfire. To achieve this, we collected a dataset of English disaster-related tweets of 2021, as well as data from EM-DAT, an international database for disasters. EM-DAT provides comprehensive information on the occurrence and impacts of over 26,000 mass disasters worldwide, compiled from various reliable sources. The EM-DAT and Wikipedia data will serve as the "ground truth" for the evaluation of our system's output specifically for the Evia wildfire.

We aim to create a robust system composed of three main components: a large language model (specifically, gpt-3.5-turbo), a vector database containing 240,000 disaster related vectorized tweets from August and September of 2021, and a tool called Semantic Kernel. The large language model serves as the analytical engine, capable of processing and analyzing the collected tweets to extract valuable insights. The vector database acts as an information retrieval engine, enabling programmatically searching for relevant tweets to feed into the model for analysis and report generation. The Semantic Kernel tool is the building block for this system, enabling the AI model to interact with the database as well as the development of "skills" that enable the model to utilize libraries and functions. To validate the accuracy and reliability of the system-generated report for the Evia wildfire, we will compare its findings with the confirmed data from EM-DAT and Wikipedia. This comparative analysis will enable us to evaluate the usefulness and truthfulness of the system and its potential to assist authorities in understanding and responding to similar events in real-time through social media analysis.

The goals of this research are threefold: first, to evaluate the ability of a large language model to generate reports about the Evia wildfire based solely on social media data; second, to evaluate the truthfulness of the data obtained from social media analysis with the authoritative sources of EM-DAT (EM-DAT, 2023) and Wikipedia; and finally, to provide practical implications for disaster managers, highlighting the potential of similar systems to enhance situational awareness and aid decision-making in managing future disasters. By leveraging the power of social media analysis and advanced AI techniques, this research aims to contribute to a novel approach of identifying the impacts of disasters.

## 2 Relevant Literature

Palaiologou et al. (2021) examines the perceptions of stakeholders in Greece regarding wildfire management and its impacts. The researchers utilized an online survey with a sample size of over 100 participants, including civil protection agencies and research entities. The survey aimed to gain insights into the stakeholders' perspectives on the negative, indifferent, and positive effects of wildfires, as well as their opinions on fire prevention strategies and causes of ignition. The findings of the study emphasize the necessity of reforming wildfire management policies to address societal and agency functioning, as well as the influence of climate change on wildfire frequency and behavior. The respondents expressed a negative viewpoint towards allowing wildfires for resource objectives and attributed most ignitions to arsonists. Additionally, they identified the absence of a national cadaster system as a significant source of wildfire-related issues. While there was limited support for fuel treatments, there was a growing acceptance for the legalization of fire use during firefighting efforts. Overall, this study provides valuable insights into the current perceptions of wildfires in Greece and identifies opportunities and challenges for enhancing wildfire governance and risk management programs.

Karyotakis (2022) investigated the media coverage of the Mati wildfire in Greece in 2018. He examines a total of 1,573 news articles from nine prominent Greek news websites using a method called ideological discourse analysis. The main objective of the study is to determine whether there is a consistent tendency to downplay the human impact on the environment in the news discourse. The results of the analysis indicate that the news outlets primarily framed the wildfire as a political matter rather than an environmental event. The coverage exhibited a populist discourse that favored a specific political group and portrayed the government in a negative light. The study highlights the importance of journalists providing critical explanations about the role of human activity in environmental issues, rather than solely focusing on political debates.

Katzilieris et al. (2022) investigated the behavior of individuals and households during the 2018 Attica wildfires in Greece, specifically focusing on their evacuation decisions. To gather empirical data, a questionnaire survey was administered to residents who were affected by the wildfires. The survey questionnaire was designed based on the Protective Action Decision Model (PADM). Statistical analysis techniques, including logistic regression models and machine learning algorithms, were employed to identify the key factors that influenced the decision to evacuate and the chosen mode of evacuation. The study findings highlight the significance of various factors such as risk perception, age, duration of residence, information-seeking behavior, gender, prior warning, presence of minors, education level, and income in shaping the decision to evacuate. Additionally, factors such as availability of transportation, age, information-seeking behavior, and risk perception were found to be influential in determining the mode of evacuation.

Based on the existing literature we emphasize on two crucial aspects. Firstly, there is a pressing need for a more comprehensive understanding of disasters in Greece, coupled with an improvement in the administration system. Secondly, it is essential to have access to alternative sources of information, distinct from mainstream media, which often prioritize political implications over the actual impact of disasters. By utilizing a public data source, such as a social media platform, valuable "hidden" information from individuals can be surfaced, providing valuable insights.

## 3 Methodology

Our methodology consisted of several key components designed to extract meaningful insights from Twitter data and generate comprehensive reports. The approach we followed is known as RAG which in the context of large language models stands for Retrieval Augmented Generation.

First, a vector database was created to store and organize a dataset of 240,000 English disaster-related tweets

from August and September 2021. To represent each tweet, HuggingFace's sentence transformer all-MiniLM-L6-v2 was used to generate embeddings, which served as the basis for subsequent analysis. It is a clear limitation that we only tweets in english. A much better analysis could potentially happen by incorporating also greek tweets in the system. This would require different development techniques and a change in the approach and in the configuration of the system.

The retrieval process was tested to ensure the accuracy and relevance of the retrieved tweets from the vector database. Table 1 includes some results of the retrieval for the query “big wild fire greece”.

**Table 1.** Some results of the retrieval for the query “big wild fire greece”.

Retrieved Text	Relevance
Greece is facing a “natural disaster of unprecedented proportions,” as 586 wildfires burn in “all corners” of the country. The nation is broiling under one of its worst heat waves in decades. @EleniGiokos has the details. <a href="https://t.co/nNUMZXWgXt">https://t.co/nNUMZXWgXt</a> #TheLatest #7NEWS <a href="https://t.co/jd8lnARPJq">https://t.co/jd8lnARPJq</a>	0.6561340411976498
Greece was always a place close to my heart since childhood. Today I've wept at the images of the damage done to people, animals, property and the environment by the fires.  #firesinmediterranean	0.5654183534375476
#Israel will dispatch two firefighting aircraft to #Greece to help combat wildfires that Greek PM Kyriakos Mitsotakis described as “a natural disaster of unprecedented proportions.”  #greeceisburning #GreeceFires	0.5192656244156442

Next, a semantic kernel was developed and connected to the OpenAI API, specifically utilizing the gpt-3.5-turbo language model. The vector database was registered as memory to the semantic kernel, enabling efficient retrieval of relevant tweets for analysis and report generation.

The methodology also involved the development of a custom plugin called TextServices, which contained three key skills: KeywordsGenerator, Summarization, and Composer. The KeywordsGenerator skill created search keywords based on user queries, facilitating the retrieval of relevant tweets from the vector database. The Summarization skill condensed the retrieved information into concise summaries, while the Composer skill combined the summaries from different sources to create a comprehensive report with a focus on the identified keywords.

The functionality of the plugin is presented in Table 2.

**Table 2.** TextServices Plugin Skills

Skill	Description	Parameters
KeywordsGenerator	Creates search keywords based on a user query	query (user query), maxkeywords (maximum number of keywords to generate)

Summarization	Summarizes the retrieved information into concise summaries	context (retrieved information), format
Composer	Combines the summaries from different sources to create a comprehensive report in bullet points with emphasis on keywords	source1, source2, keywords (identified keywords), maxbulletpoints (maximum number of bullet points in the report)

We developed an approach that leveraged the semantic kernel in an iterative manner. The process involved inputting the following query: "What was the environmental, social, and economic impact of the Evia wildfire in Greece? How many people died? How many houses were destroyed? How many hectares of forest were burned?"

The KeywordGenerator created the search terms and queried the database, resulting in the extraction of tweet chunks. These chunks were then passed through a summarization module, which produced concise summaries. Subsequently, the summaries were fed into a composer module, which iteratively combined them to generate a comprehensive final report.

#### 4 System's Report

The following section presents the report generated by our system, which utilizes large language models and social media analysis to assess the impact of the 2021 Evia wildfires. The report presented below is generated by our system, which utilizes large language models and social media analysis to assess the impact of the 2021 Evia wildfires. We would like to emphasize that we are using the report from the system and in no way take responsibility nor support any offensive content of any kind the model may produce. The purpose of this report is to provide insights and analysis based on the data collected from social media, and it should be interpreted with caution and further validated.

##### *REPORT ON EVIA WILDFIRE IN GREECE*

###### *Affected Population:*

- *Hundreds of people displaced due to the Evia wildfire.*
- *Greek government must prioritize safety and well-being of citizens in future disaster response and recovery measures.*
- *Angry Greeks criticize government response to recent wildfires, blaming deliberate political decisions and prioritizing profit over life and human welfare.*
- *Experts developing and applying methods to measure inequities in natural hazard impacts and resources allocated for risk reduction and disaster recovery.*
- *Need to enhance emergency and disaster response measures in local urban constituencies and build local community resilience.*

###### *Property Loss:*

- *Evia wildfire razed homes, and caused significant property loss, including homes and farmland.*
- *Severe post-fire floods impacted local communities, causing damage to private property, public buildings, infrastructure, and roadways.*
- *Protecting homes against natural disasters becoming more important as extreme weather such as hurricanes and wildfires becomes more common due to climate change.*

*Environmental Impact:*

- *More than 100,000 hectares of land ravaged by wildfires.*
- *Climate change exacerbating frequency and severity of wildfires in Greece and across Southern Europe.*
- *Environmental experts describe situation as a major environmental disaster, and international community has sent support to aid in disaster response and recovery efforts.*
- *Extreme weather, climate change, and rapid urban development in disaster-prone areas have driven ever higher natural catastrophe losses.*
- *Wildfire resilience not just a land management issue, but a matter of public health, equity, safety, and a climate-res.*

*Disaster Response and Recovery Measures:*

- *Prime Minister Kyriakos Mitsotakis declared blazes “a natural disaster of unprecedented dimensions.”*
- *Israel sent team of firefighters to help Greece battle wildfires.*
- *EU Commission will support Greece through Technical Support Instrument to help tackle natural disaster of recent wildfires and recover biodiversity loss in Greek island of Evia.*
- *Government's firefighting and disaster relief policies in need of overhaul, and Greece created Climate Crisis ministry to respond to wildfires.*
- *Measures that reduce exposure to natural and man-made hazards lead to good governance.*
- *Assistance available for those impacted by wildfires and other natural disasters.*

## **5 Evaluation**

In order to assess the accuracy and reliability of our model, we need to evaluate its output in comparison to the actual data we have collected. Our data sources include the Emergency Events Database (EM-DAT) and Wikipedia.

According to EM-DAT, the summer wildfires in Greece in 2021 resulted in the loss of two lives. Additionally, over 7,000 individuals were affected by these wildfires, and the total damages amounted to more than 580 million units of currency.

Further information obtained from Wikipedia specifically highlights the Evia wildfire, which encompassed an area of 50,000 hectares. In total, the wildfires in Greece in 2021 covered an area of 125,000 hectares. The Evia wildfire resulted in the deaths of three individuals, with approximately 2,000 people being evacuated from the affected area. Moreover, at least 20 individuals sustained injuries during this incident.

Unfortunately there is not much information specifically for the Evia wildfire, but rather a grouped view of 2021 Greece wildfires in both sources. Nevertheless we will assess the model's output based on the facts we were able to gather.

In order to evaluate what the system reported we will review its answers per section.

The system did not provide any information regarding the number of fatalities resulting from the wildfire. However, it reported that hundreds of people were displaced due to the fire which is a fact. It also reported on the sentiment expressed by individuals, highlighting that "Angry Greeks criticize government response to recent wildfires, blaming deliberate political decisions and prioritizing profit over life and human welfare." It is important to note that this sentiment is based on social media data and cannot be independently verified for accuracy. Additionally, the system retrieved information on experts who are employing various methods to assess disparities

in the impact of natural hazards and the allocation of resources.

The system's report acknowledged the destruction caused by the Evia wildfire, including the loss of homes and farmland, as well as property damage. However, it did not provide any specific figures or estimates regarding the extent of the damage or the financial implications. While the system correctly identified the presence of infrastructure damage, it was unable to provide detailed information on the specifics of the damage. Additionally, the system generated a rather generic statement highlighting the importance of protecting homes against natural disasters, attributing the increase in extreme weather events such as hurricanes and wildfires to climate change. It is worth noting that this statement could potentially be a result of the system's exposure to climate change discussions on social media or a manifestation of model hallucination.

The system reported that over 100,000 hectares of land were devastated by the wildfires. However, this information is not accurate for the Evia wildfires, which actually burned 50,000 hectares, but it is accurate for the accumulated 2021 Greece wildfire status. It is important for the system to improve its ability to distinguish specific information related to targeted events, rather than gathering general information mentioned alongside the event. Additionally, the system consistently emphasizes the significance of climate change and the need for environmental resilience in planning.

The system provides an analysis of the disaster response and recovery efforts undertaken in relation to the Evia wildfires. It includes a statement of the Greek Prime Minister and emphasizes the support extended by other countries and the EU Commission to Greece in addressing this natural disaster and restoring biodiversity. Additionally, the report highlights the government's plans to aid individuals indirectly affected by the wildfires. Notably, it acknowledges the establishment of a climate crisis ministry under the civil protection ministry, a valuable piece of information that is tied with the disaster and that we have verified for accuracy.

The assessment of the system's ability to measure the impact of the Evia wildfire reveals certain limitations. These limitations primarily stem from the system's inability to accurately distinguish between information specifically related to the wildfire under study and information that is unrelated to the event. However, despite these limitations, the system still provides valuable insights and information regarding the impact and aftermath of the wildfire. It is important to note that further enhancements to the system are necessary in order to improve all three main components. Firstly, the database should be enriched with Greek language tweets. Secondly, the retrieval engine can be improved. Lastly, the semantic kernel functions should be improved to better assess information and generate more targeted reports.

## 6 Conclusion

In conclusion, this research paper has explored the use of social media analysis and advanced AI techniques to enhance situational awareness and aid decision-making in managing future disasters. By leveraging the power of social media data, valuable insights can be gained regarding the impacts of disasters, as well as the perceptions and behaviors of stakeholders. The evaluation of the system's output revealed certain limitations, particularly in accurately distinguishing specific information related to the targeted event. However, despite these limitations, the system still provided valuable insights and information that can contribute to enhancing situational awareness and decision-making in managing future disasters. This research contributes to a novel approach of utilizing social media analysis and advanced AI techniques to identify the impacts of disasters. Further research in this domain is needed to improve the accuracy and specificity of social media analysis in assessing the impacts of disasters. This includes developing techniques to better distinguish between information related to the targeted event and unrelated information, as well as new approaches in the usage of these systems through the cycle of disaster management.

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