The Effects of Heat Waves and Rising Temperatures on Health and Safety: Insights from Riyadh and California

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Abstract

Heat waves and rising temperatures represent a growing threat to public health and safety from a personal level to a country level. This study explores the impacts of extreme heat and rising temperatures on two typical regions prone to climate change: Riyadh, Saudi Arabia, and California, USA. The research highlights the influence of long-lasting heat wave areas on individual health by examining Riyadh hospital admissions. It also demonstrates the rising threats of wildfires in California associated with the rising temperatures over past decades. At last, the article investigates topics that news usually covers related to heatwaves and rising temperatures.

1 Introduction

At the beginning of this year, a series of 14 destructive wildfires affected the Los Angeles metropolitan area and San Diego County in California, United States, lasting from January 7 to 31, 2025. These fire accidents cause destruction in a lot of homes, resulting in significant financial damage. Eventually, these wildfires kill 29 people, including people that try to execute their home during fires. After an investigation, the official department identified several factors that caused this natural disaster, including drought weather conditions, low humidity, a buildup of vegetation from the previous winter, and hurricane-force Santa Ana winds (California Department of Forestry and Fire Protection, 2025).

Wildfires are one of the most destructive natural disasters that cost economic losses and increase human dangers. In addition, when a fire happens, it is hard for people to control and save people or homes or wealth during the fire. Therefore, it is necessary to understand some clues for fire happening, and knowing what results it might make, so that it could improve people's attention to such a natural disaster.

Wildfire risk is influenced by numerous factors, including temperature, soil moisture, and the presence of trees, shrubs, and other potential fuel. All these factors have strong direct or indirect connections to climate change. In addition, climate change would create a warmer and drier condition, which would help fires spread so that it would make it more difficult for firefighters to put out. Other factors, such as the presence of trees, shrubs, and other potential fuel, show no connection with climate change, however, it would improve the risk of wildfires due to a warmer and drier environment, when it has trees, shrubs, and other potential fuel. From this aspect, we

could find that climate change has a great effect on wildfires happening. Therefore, we want to explore whether there exist other natural disasters due to climate change.

By analyzing historical climate trends, it is evident that the global climate is becoming warmer. Global warming is the fact that humans could not ignore it, which might have great effects on human life, such as human health, increased occurrences of natural disasters. Understanding these trends and connections could increase human awareness of risks of global warming. Additionally, it could also provide some insights for the officials to develop some strategies to protect communities from disasters or health-problems caused by climate change.

2 Background

In this report, we will discuss the influence of rising temperature from micro perspectives to macro perspectives. To this end, we chose Riyadh and California as the sample of field study as they are prone to climate change. Riyadh, located in the Arabian Peninsula, is a typical arid desert region. The limited water resources and low vegetation make this area even more vulnerable to heat waves. The urbanization worsens the weather conditions, where overall temperature rises more significantly and heat waves last longer. In another part of the earth, California is also prone to natural disasters, including wildfires and droughts, due to reasons including dry weather. Global warming intensifies the situation as a pattern of more frequent droughts and more powerful wildfires.
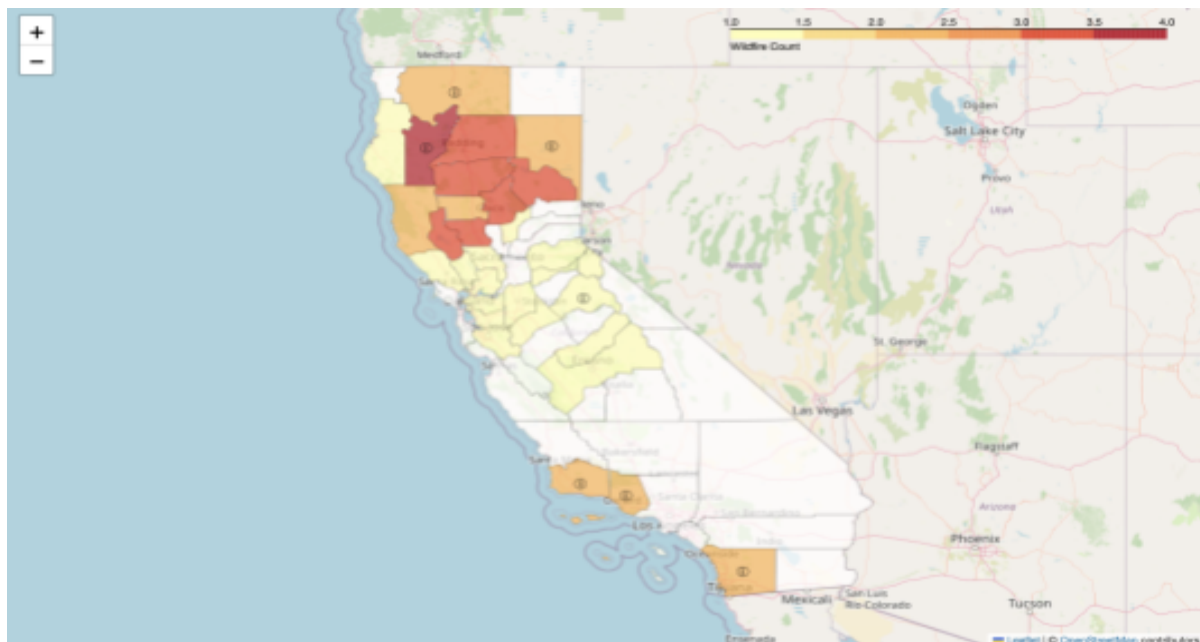
Play with interactive plot

This graph shows 20 major wildfires in California. Most of the cases happened recently and located around Northern California, concentrated in regions with dense vegetation, dry climates,

and mountain terrains, representing the vulnerability of California to wildfires. Many wildfires are caused by lightning, while small proportions are caused by human activities.

3 How Rising Temperature Influence Hospital Admissions in Riyadh

From a micro level, our investigation focused on the influence of rising temperature on individuals' health. In this part, we are aiming to find if the rising temperature would lead to rising hospital admissions by introducing a field study in Riyadh. Our data acquisition process includes requesting hospital admissions by using the Kaggle API and retrieving daily weather information from the Open-Meteo API.

3.1 Data Retrieving

In the first step, we used the Kaggle API to retrieve hourly hospital admissions and emergency visits data from eight main hospitals, respectively, in Riyadh. Then we processed the data, grouping by the date to count the total daily admissions and emergency visits across those eight hospitals. After the processing, we obtained a dataset containing 1730 rows representing daily hospital admissions and emergency visits at Riyadh from Jan 1st, 2020, to Sep 26th, 2024.

In the second step, we aimed to retrieve the weather information, including maximum temperature, minimum temperature, maximum apparent temperature, and minimum apparent temperature, in Fahrenheit, from Open-meteo by using its API. However, the challenge was that the weather website limits the request to 1,000 per day. Therefore, for code reproducibility, we only consider the temperature data from Jan 1st, 2022, to Sep 26th, 2024. By merging those two data frames, we now have a dataset with 1,000 rows containing daily hospital admissions, emergency visits, maximum and minimum temperature, and maximum and minimum apparent temperature.

3.2 Result Analysis

We want to test if the rising temperature would cause rising hospital admissions, and our model is as follows:

$$HA = constant + T\_max*b1 + a\_T\_max*b2$$

where HA is the daily hospital admissions, T_max is the daily maximum temperature, and a_T_max is the daily apparent maximum temperature.

Our result shows that there is a positive correlation between daily maximum temperature and the hospital admissions. When other variables remain constant, for every one-degree increase in maximum temperature in Fahrenheit, there would be a 0.1749 in daily total hospital admissions. The p-value of 0.043 shows the result is relatively significant, and we can conclude that there is a

potential effect of rising temperature on individuals' health. Therefore, coordinating hospital resources is important during heat waves.

4 How Rising Temperature Influence Wildfire Frequencies in California

From a macro perspective, rising temperatures and heat waves can cause more catastrophic natural disasters as more water vapor is evaporated into the atmosphere. In California, a combination of weather conditions, vegetation, and human activities makes this area prone to wildfires. While wildfire cases can be reduced by limiting human activities, the rising temperature is potentially increasing the risks of wildfires. In this section, we will explore the relationship between rising temperatures and affected areas over time.

4.1 Data Retrieving

Firstly, we aim to figure out the temperature rising pattern over the past several decades. However, we could not find integrated temperature data specifically in California. Therefore, we decided to retrieve available temperature records from each valid weather station in California from the NCEI (National Centers for Environmental Information) API. After filtering out all invalid station ids, we obtained a dataset containing 7651 rows representing annual average temperature from each weather station starting at 1900 to 2024. Since 1164 of 7651 rows are missing, we conducted a missing values deletion as 15% of data deletion would not influence our temperature pattern in the long term. Then we calculate the average temperature all over California, grouping by the year. By the data processing, we have a final dataset containing 123 rows.

In the second step, we firstly tried to scrape annual wildfire information from 2013 to 2024 with Cal Fire (California Department of Forestry and Fire Protection). However, the first challenge was that the website loaded content dynamically by JavaScript, which we could not capture key information by simply using libraries like BeautifulSoup. Therefore, we introduced Selenium to extract the information from the Cal Fire website by finding out factoid elements, which are contained in <li> elements with the <class> factoid__item-wrapper. In this case, we can locate the labels, like "Wildfires" and "Acres Burned," to extract the number associated with the labels. The second challenge that follows is the different web structures, which increase the workload as we have to scrutinize each web page to observe the structure and locate elements, respectively. The third challenge was that we found it hard to observe the trend between rising temperatures and wildfires by working with only past decade data. Therefore, we involved scraping information from Wikipedia from each year's wildfire information page.

The challenge continues due to the occurrence of the mismatch between the expected certificate and the host name. For convenience, we decided to use Selenium to scrape all data from the information box in wikipedia as a dictionary by locating the element table.infobox.vevent.
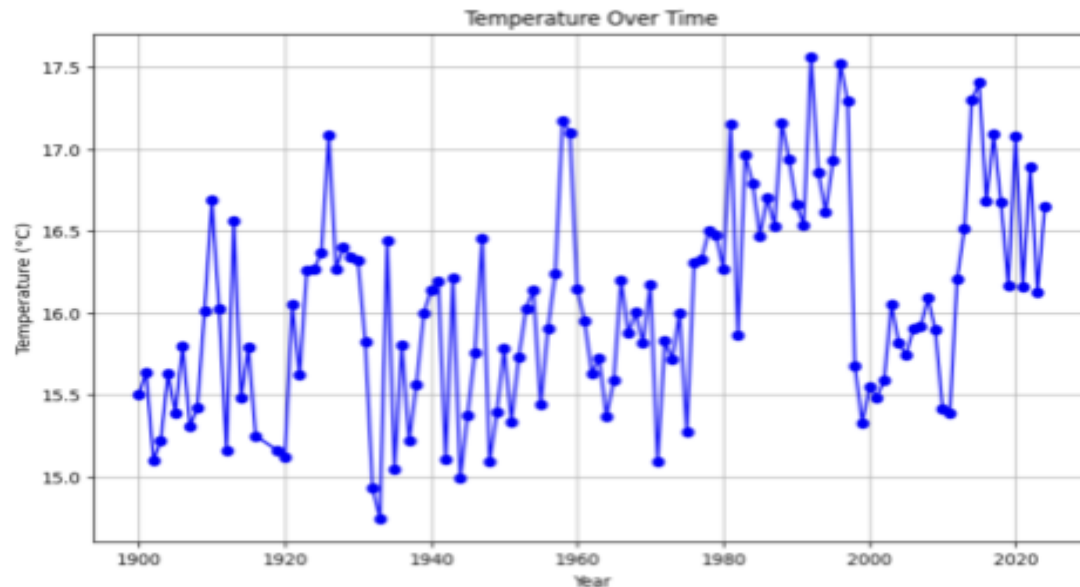
4.2 Rising Temperature Patterns

Figure 1. Rising Temperature Over Year

This graph shows how annual temperature changes from 1900 to 2024. Over the past 120 years, we have seen a consistent increase in global temperature, especially since the mid-20th century. While we do observe the periodical cycles of temperature increases and decreases, the frequency of heat wave events has risen dramatically.
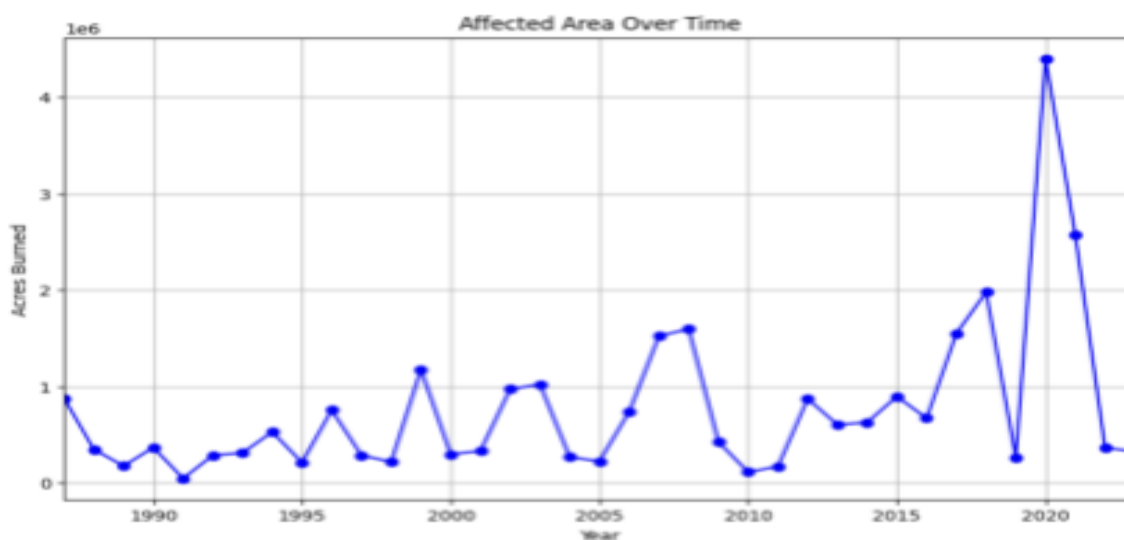
4.3 Result Analysis

Figure 2. Affected Area Over Time

This graph shows a rising trend in acres affected by wildfires over the time period from 1987 to 2024. Though experience periodically influences, the overall trend of acres burned increases, especially at the start of the 21st century.

Then we will use the merged dataset with annual temperature obtained from NCEI and annual acres burned by wildfires obtained from Wikipedia to test if the increase in annual temperature is associated with the increase in affected areas by wildfires. Our model is as follows:

$$A = constant + T*b$$

where A is the area affected by wildfires each year measured in acres and T is the annual temperature.

Our result shows that every one-degree rise in the annual average temperature is associated with a 999.6-acres increase in the affected area. With a p-value of 0.014, we can conclude that the rising annual temperature does have an effect on the increase in the affected areas.

5 Analyzing Topic Prevalence and Term Frequency in Heatwave News Coverage

In this section, we want to explore what topics that news usually cover in their normal news content related to heatwaves. We decided to retrieve news from the news api and BBC website by searching the key words, including heatwave, extreme heat, and global warming.

5.1 Data Retrieving

Firstly, we used the News API provided by a Python package. However, when retrieving data, we found that each query could only return a maximum of 100 entries. To solve this issue, we ordered the news articles by time and retrieved data across different time intervals. This approach allowed us to obtain more information than a single request would provide. Finally, by retrieving news from the past month, we were able to gather nearly 400 articles using the News API.

Secondly, we extracted news from the BBC website. Since the BBC displays only 10 articles per page, we retrieved all search results by first extracting the total number of pages using XPath tools. Then, we generated page URLs based on their standard format to make additional requests and obtain full news articles from each page. Ultimately, we collected 870 news articles from the BBC website.

Considering the use of LDA to extract prevalent topics and term frequency, we realized that extracting only a short description of each news article might not provide enough information. Therefore, we decided to extract comprehensive news details, including the publication date, title, full content, source, and related URLs. In the end, we combined these two datasets (containing over 1,000 news articles) and ordered them in descending order by date.

5.2 Text Processing

Before analyzing the prevalence of topics and term frequency using LDA, we must preprocess the news content using natural language processing (NLP) methods. We follow these steps:

1. We use the en_core_web _sm model from spaCy to perform tokenization and part-of-speech tagging.
2. We remove special characters and numbers to eliminate unnecessary terms that might distract our analysis while retaining temperature-related terms (e.g., *"40°C"*), years, and time expressions. This ensures that climate-related values remain while irrelevant terms are removed.
3. We convert the text to lowercase and tokenize it. We extract only nouns and adjectives to ensure that the selected words are more likely related to news topics. Additionally, due to our limited dataset, we aim to retain as many relevant words as possible. Therefore, words related to "heat" and "temperature" are also preserved to maintain relevance in our analysis.

Before applying LDA, we want to determine whether n-gram frequency analysis is necessary. To do so, we first examine whether the structure of climate-related news text provides additional information.
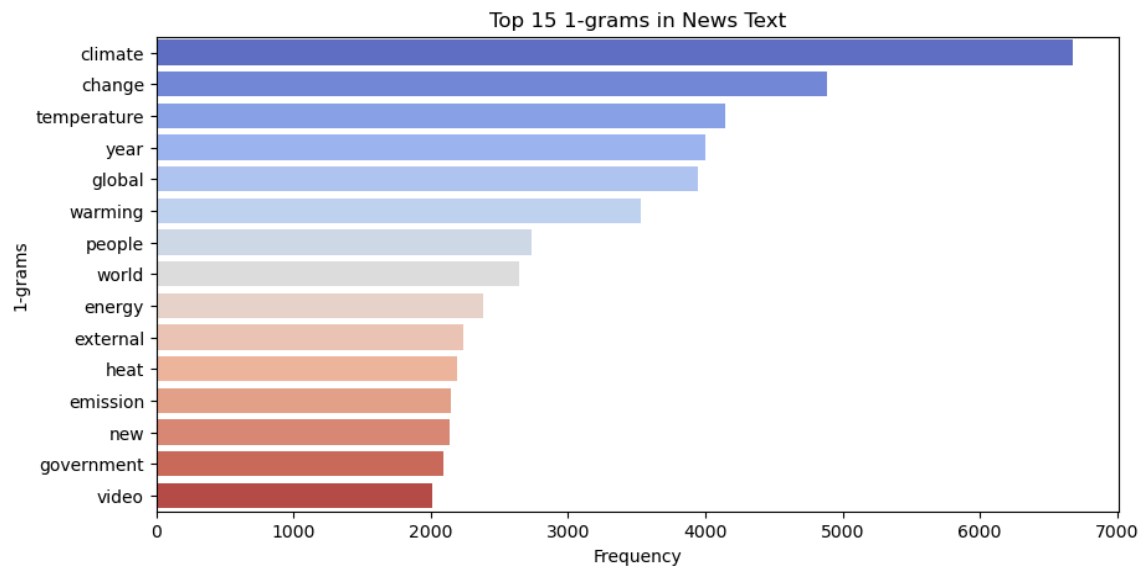
Comparing the top 15 1-grams and 2-grams in news articles, we find that 2-grams would provide us more description about news topics, rather than a single word in 1-grams. For example, the 1-grams word "climate" only tells us the topic related to climate, while 2-grams could tell us the topic related to "climate change", which becomes more specifically about news topics that we want to explore what topics coverage in news articles.

Top 15 2-grams in News Text
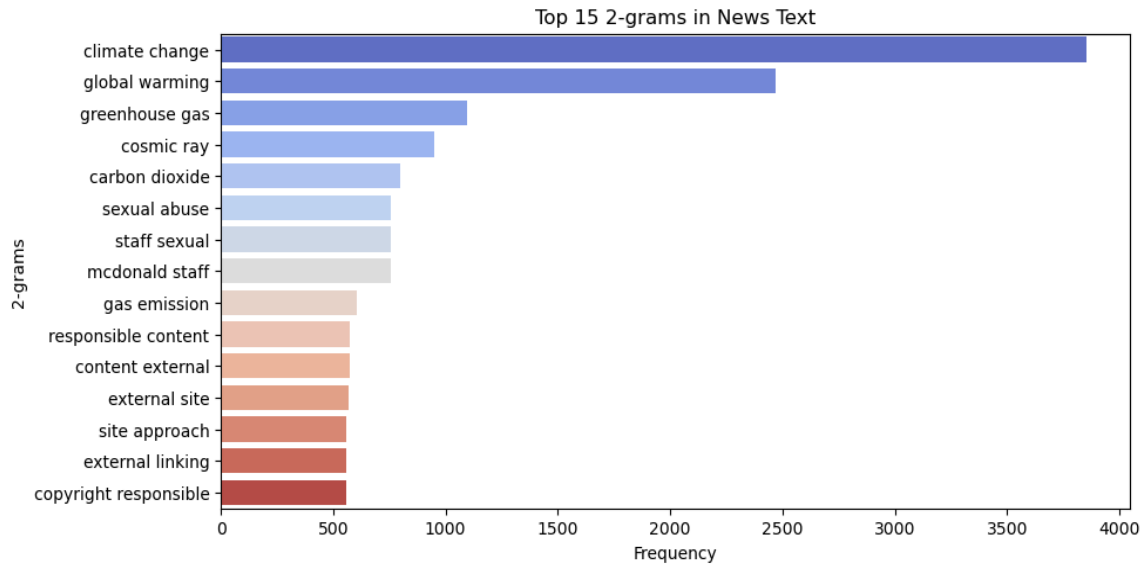
5.3 Topic Modeling of Heatwave News Coverage Using LDA

As mentioned in Section 5.2, n-grams provide more information and details about article topics. After obtaining clean text, we employ the Latent Dirichlet Allocation (LDA) model to extract and analyze topics of interest.

First, we use the CountVectorizer from scikit-learn to convert the preprocessed text into a bag-of-words representation. However, some general climate-related terms appear frequently across many news articles. To prevent these terms from interfering with topic extraction, we add commonly used words such as climate, change, global, and weather to scikit-learn's built-in list of English stopwords.

Next, we apply feature selection by filtering out overly frequent words (max_df=0.85) and infrequent terms (min_df=2). We limit the vocabulary to the top 2,000 most relevant terms and allow n-grams of 1 to 3 words to capture key phrases more effectively.

Finally, we fit an LDA model with 10 topics to identify recurring themes in heatwave news coverage. The model is trained using 100 iterations for optimization. We set the Dirichlet priors to encourage document sparsity (doc_topic_prior=0.1), promoting a more distinct topic structure, and topic sparsity (topic_word_prior=0.01) to ensure each topic focuses on a small set of significant words. Additionally, we set a random seed to ensure reproducibility and save both our LDA model and dataset for future analysis.

By applying this method, we extract key topics from news articles retrieved using the search terms "heatwave," "extreme heat," and "global warming." The results provide deeper insights into dominant topics and concerns surrounding extreme heat events.

5.4 Result Analysis

In the LDA model, each news article was transformed into a topic probability distribution using variational Bayes inference, and the most dominant topic was determined based on the highest probability score. We then calculated the frequency of each dominant topic to assess the relative prevalence of various topics.

To enhance the interpretation of each topic, we extracted only the top 15 most relevant terms per topic based on the topic-word distribution matrix. The following plot illustrates the distribution of topics in news articles, where we observe that Topic 1 is the most prevalent. Additionally, we aim to determine whether this topic remains dominant over time. To investigate this, we conducted a time-based analysis to identify trends in topic prevalence.
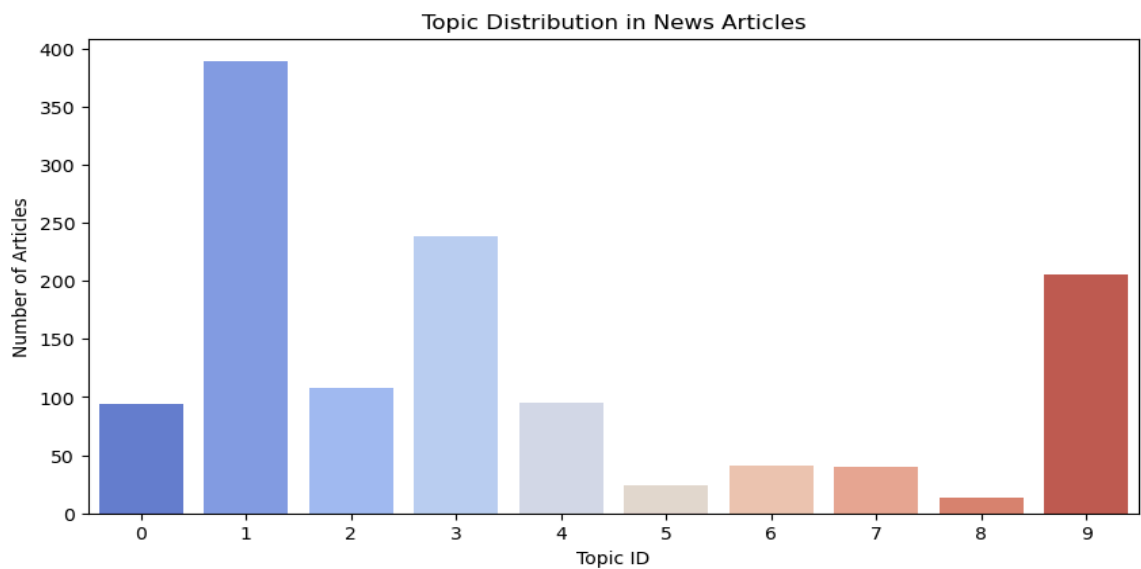
To analyze the evolution of topics over time, we conducted a monthly trend analysis of dominant topics. First, we converted the publication dates into a structured datetime format to facilitate time-based aggregation. Then, for each month, we calculated the frequency of articles assigned to each dominant topic, generating a topic-month distribution.

Monthly Topic Trends
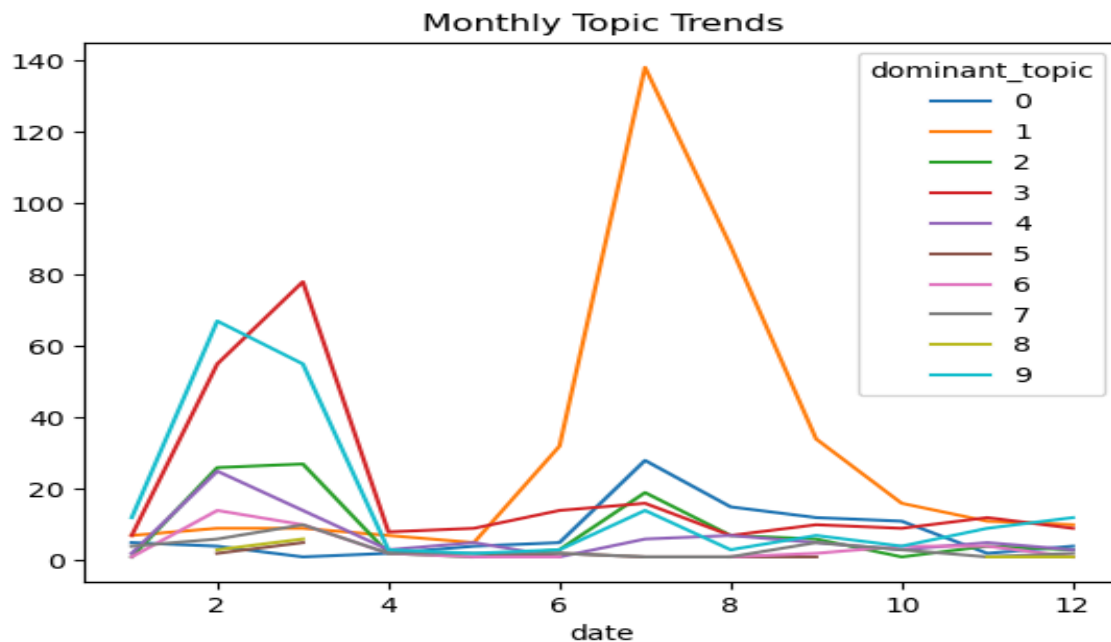
The lines in the plot represent the monthly distribution of dominant topics within the dataset. Each line corresponds to a specific topic, and the y-axis indicates the number of articles associated with that topic per month. The observed trends provide insights into seasonal variations in news coverage, potentially revealing correlations with climate changes across different seasons. For example, Topic 1 peaks in the middle of the year, suggesting increased discussion, possibly linked to extreme summer weather events. Additionally, we can analyze topic compositions by observing long-term trends over multiple years.

Yearly Topic Trends
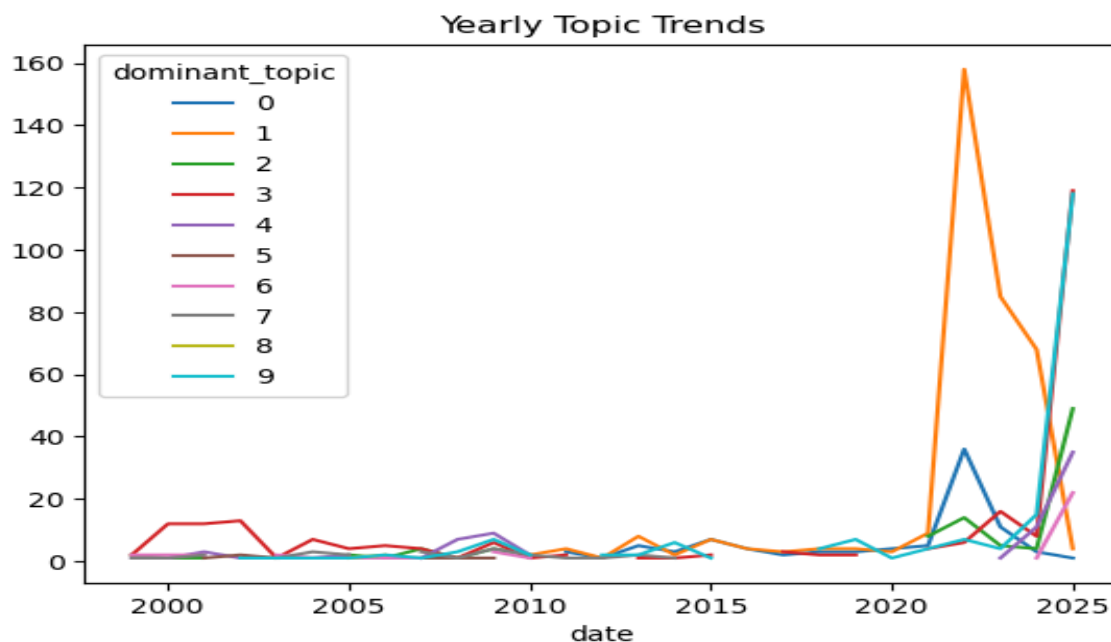
From the plot, we observe that certain topics, such as Topics 1, 3, and 9, are consistently discussed over the years, aligning with the most prevalent topics identified earlier. In contrast, other topics, like Topic 6, exhibit a fragmented pattern, indicating irregular or intermittent coverage over time.

Table 1: Top 10 Topics Obtained from News by LDA

Topic ID	Article Count	Top Terms
1	389	external, people, life, heat, temperature, staff, sexual, abuse, ceasefire, starmer, sexual abuse, mcdonald staff sexual, mcdonald, staff sexual abuse, mcdonald staff'
3	238	world, emission, energy, year, new, country, report, gas, action, level, people, summit, environmental, big, government
9	205	water, char, external, man, pump, team, post, day, new, good, club, time, penalty, site, heat
2	108	temperature, weather, heat, year, high, extreme, water, health, country, heatwave, hot, snow, lake, record, glacier
4	95	ice, sea, carbon, danger, engineering, year, specie, planet, option, food, emission, peak, atmosphere, world, time
0	94	video, oil, gas, ice, australian, ship, tanker, watch, future, external, oil gas, storm, bad, important
6	41	temperature, cloud, cosmic, ray, cosmic ray, sun, greenhouse, year, solar, model, earth, atmosphere, effect, gas, rise
7	40	carbon, emission, comment, year, number, kyoto, country, comment comment, comment comment number, comment number, hurricane, gas, protocol, dioxide, carbon dioxide
5	24	year, world, university, way, probe, issue, wine, methane, student, right, grape, high, family, scientific, field
8	14	nuclear, energy, way, power, government, king, renewable, car, city, nuclear power, comment, people, minister, carbon, efficiency

Therefore, we can observe that, from the past to the present, news has always reported more about the cause of rising temperatures and heatwaves, such as emission, energy, and gas, rather than the effect or danger from rising temperatures. They primarily discuss fire, which shows a more obvious relationship with heatwave and rising temperatures. However, as discussed in this paper, the impacts of extreme heat and rising temperatures not only cause danger of natural disasters, but also improve risks to human health. Therefore, including more relative news reports about dangers of global warming could improve people's awareness of why we need to understand the causes of global warming, rather than only focusing on the causes.

6 Discussion and Conclusion

In this paper, we explore the relationship between global warming, specifically heatwave, and the increasing risks to human health, as well as the rising occurrence of natural disasters,

especially wildfires. Additionally, we use LDA to analyze topics commonly mentioned from news. Finally, we find that news focuses more on the cause of global warming, rather than its effects. Therefore, news articles should emphasize more on the effects of global warming, to raise public awareness of its risks, and help people to prevent themselves from being hurt by disaster or illness due to increasing heat.

However, because many news websites are either not legally accessible or not free for data scraping, the news dataset used in this paper is not large enough for LDA analysis, which may reduce topic accuracy or lower model performance. In the future, we can explore more accessible news sources for scraping to expand our dataset and improve the analysis.

Finally, the rising temperature is evident to post threats on humans' health and safety, which urges policy-makers to take immediate action to stop further development of catastrophic natural disasters.

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