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Earthquake conspiracy discussion on Twitter

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Natural disasters like earthquakes, and global crises like pandemics have historically captured the public's imagination and prompted people to seek explanations. However, in times of limited information, these explanations can take the form of conspiracy theories, particularly regarding the origins or causes of such events. With the advent of social media conspiracy theories can spread quickly and easily, leaving little room for critical thinking. The focus of this study is the analysis of the so-called High-Frequency Active Auroral Research Program (HAARP) conspiracy, which explains earthquakes through the employment of secret weather control weapons. This study aims to answer the research question of how the discourse on the HAARP conspiracy theory changes over time, and what are the potential catalysts for heightened attention to this conspiracy theory. This study uses the Twitter API to collect tweet frequencies about this conspiracy from January 2022 through March 2023. The empirical data include over one million tweets on HAARP. The sentiment analysis of the HAARP conspiracy theory is applied to the tweets before, during, and after the 6th of February 2023 earthquake in Syria and Turkey. In addition, this study investigates possible triggers of the development of the HAARP tweet frequency. This study finds that the frequency of HAARP discussion increases following a high-impact earthquake. There is also a positive correlation between average tweet sentiment and the number of tweets, which could indicate that the discussion of HAARP reinforces people's beliefs. This study makes a significant contribution to the field of social psychology and communication by providing insights into the dynamics of belief reinforcement within online communities amidst heightened attention to conspiracy theories triggered by significant events. This knowledge has broader implications for understanding the impact of social media on public perception during crises.

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Introduction

In recent years, there have been several high-impact events that have left people searching for answers. From the COVID-19 pandemic to the United States Capitol attack, people have been grasping for explanations for what is happening in the world around them (Armaly et al., 2022; Freeman et al., 2022). In some cases, these events have led to the spread of conspiracy theories as people try to make sense of what they are seeing. A conspiracy theory is a belief or explanation that suggests that a group of people or organizations are secretly plotting or working together to carry out a harmful or illegal act, often with the aim of gaining power or control over others (Douglas et al., 2019). They can range from relatively harmless or amusing (e.g., the belief that the world is controlled by a secret organization of cats) to highly controversial and dangerous (e.g., vaccines are harmful and can cause a wide range of health problems), and can have significant social, political, and economic consequences.

Conspiracy theories often arise after unexpected and high-impact events that have long-lasting negative consequences. Some examples of such events include the 9/11 attacks, the assassination of John F. Kennedy, and the COVID-19 pandemic (Freeman et al., 2022; Stempel et al., 2007; Knight, 2000). When unexpected events occur, people naturally try to make sense of them (Van Prooijen and Douglas, 2017). They want to understand why they happened and who is responsible. In some cases, the explanation is clear, and the responsible parties are held accountable. However, sometimes the event is particularly shocking or tragic, and the explanation is not immediately apparent. People may begin to look for alternative explanations. This is where conspiracy theories come in. They offer an alternative explanation for the event. These theories often involve complex and convoluted narratives that are difficult to verify, and they may involve multiple actors working together to carry out the conspiracy (Lazić and Žeželj, 2021).

An earthquake is an example of such an unexpected and high-impact event, in particular, such a massive one as the earthquake in Syria, and Turkey on the 6th of February 2023 with a magnitude of 7.8. This earthquake was so powerful that it left thousands of people dead and many more injured. After this natural disaster, there were a lot of conspiracy theories about what caused it. Some people believe that the earthquake was caused by a secret government experiment gone wrong. Others believe that it was an act of God or punishment for something bad that happened in the world (Kanhai et al., 2016). Regardless of what people believe, it is important to understand why conspiracy theories exist in the wake of disasters like the 2023 earthquake. One reason why conspiracy theories abound after events like this is because people are looking for someone to blame (Biddlestone et al., 2021). When something bad happens, it is human nature to want to find someone to blame. This can be especially true when the event is as devastating as an earthquake. People want to know why this happened and who is responsible. Another reason for all the conspiracy theories is that people need answers and explanations when faced with tragedy (Van Der Wal et al., 2018). They want to make sense of what happened and often turn to stories or theories that provide these explanations, even if they are not based on facts.

Another reason for the popularity of conspiracy theories is the ease of access to information through social media and the internet. With the active penetration of social media into everyday life, social media have become a major source of information, including an important source for discussions of conspiracy theories. This was especially evident during the COVID-19 pandemic when social media discussions with huge amounts of uncontrolled conspiracy and other misinformation[1] led to the emergence of the so-called infodemic with negative consequences on people's behavior and crisis response (Erokhin et al., 2022).

Against the backdrop of the pervasive High-Frequency Active Auroral Research Program (HAARP) conspiracy theory discourse on Twitter—without differentiating between proponents, opponents, or those neutral to the theory—this study seeks to scrutinize the evolutionary trajectory of this discussion. This study aims to answer the research question of how the discourse on the HAARP conspiracy theory changes over time, and what are the potential catalysts for heightened attention to this conspiracy theory.

Understanding the catalysts of changing conspiracy theory attention can provide invaluable insight into how narratives around such theories mutate, gain traction, or fade in the digital sphere. This study attempts to take a look at the drivers contributing to the longevity and proliferation of conspiracy theories in online platforms despite the different perspectives or positions held by different Twitter users. By exploring the changing discourse and identifying key factors provoking increased interest in the HAARP conspiracy theory, this study seeks to provide a deeper understanding of the changing landscape of online conspiracy narratives and thereby expand understanding of the relationship between digital communication, public discourse, and belief formation. Examining the HAARP conspiracy theory in the context of seismic events such as earthquakes is of particular importance due to the ubiquity of conspiracy narratives attributing natural disasters to human intervention. HAARP, known for its scientific studies of the ionosphere, is often misinterpreted and associated with speculative views claiming its involvement in triggering earthquakes. Understanding the evolution and spread of the HAARP conspiracy theory provides a unique opportunity to see how misinformation is intertwined with natural disasters, potentially influencing public perception, political reaction, and scientific understanding of these events.

This study employs the Twitter API to gather data on tweet frequencies related to the HAARP conspiracy from January 2022 through March 2023, totaling over one million collected tweets. In doing so, almost all available tweets about HAARP in the specified period are collected, as Twitter's Academic API is capable of generating comprehensive datasets by capturing nearly complete samples of Twitter data across a diverse range of search terms (Pfeffer et al., 2023). The research explores potential factors influencing the variation in HAARP tweet frequency. Additionally, sentiment analysis is conducted on tweets before, during, and after the February 6, 2023 earthquake in Syria and Turkey. The findings reveal an increase in HAARP discussions following significant disasters and a positive correlation between average tweet sentiment and tweet quantity, suggesting that HAARP discussions may strengthen people's beliefs.

Section "Background" delves into the background of conspiracy theories in relation to social media and earthquakes. Section "Methodology" outlines the data and methodology utilized in the study. In section "Results", the results of the study are presented. Section "Discussion" discusses the results. Lastly, section "Conclusion" provides a concluding summary of the findings.

Background

Social media and conspiracy theories. Social media has played a significant role in the spread of conspiracy theories in recent years (Cinelli et al., 2022). Platforms, including Facebook, Twitter, and YouTube, have provided a means for individuals to share their beliefs and ideas with potentially large audiences.

Conspiracy theories often thrive on social media due to the ease of sharing and the ability to connect with like-minded individuals (Theocharis et al., 2021). Social media algorithms that promote engagement and prioritize sensational content can also contribute to the spread of false information and conspiracy theories (Landi et al., 2021; Bradshaw, 2020).

Some conspiracy theories that have gained significant traction on social media include claims that the COVID-19 pandemic is a hoax (Erokhin et al., 2022; Jennings et al., 2021). Others assert that vaccines are part of a government-led effort to control the population. These false claims have caused misbehaviors of the public, including vaccine hesitancy and the spread of misinformation that has fueled the pandemic (Pertwee et al., 2022). People who believe in conspiracy theories may become increasingly isolated from mainstream society, leading to feelings of persecution and a greater distrust of authority (Uscinski et al., 2020; Pound and Campbell, 2015).

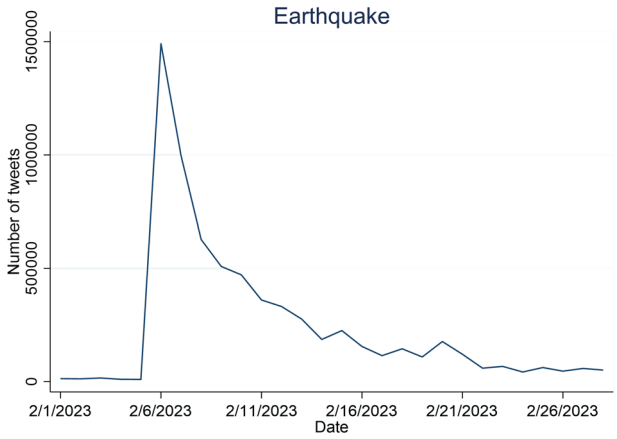

Fig. 1 Tweet frequency. Daily tweet frequency on earthquake (01 February 2023—28 February 2023).

Earthquakes and conspiracies, the case of Turkey-Syria earthquake. Earthquakes are natural disasters that can cause immense damage and loss of life. They are a result of the movement of tectonic plates, and they can occur anywhere in the world, although some areas are more prone to seismic activity than others (Kelleher, 1972). Despite the scientific explanations behind earthquakes, there are some who believe that they are the result of conspiracies rather than natural causes (Erokhin and Komendantova, 2023; Gkinopoulos and Mari, 2023).

One popular conspiracy theory is that earthquakes are caused by secret government organizations or other groups with advanced technology (Radford, 2014). Proponents of this theory claim that these groups use energy weapons or other devices to create seismic activity in order to achieve their own objectives (Sheshpari, 2018). Some believe that these objectives may include the destruction of certain cities or the destabilization of political regimes (De Mucci, 2015). Another conspiracy theory is that earthquakes are caused by extraterrestrial forces (Shlien, 1972). Some claim that aliens use their advanced technology to create earthquakes on Earth as a means of experimentation or even as a way to punish humans for their actions. This theory is often supported by anecdotal evidence, such as sightings of UFOs near areas that have experienced earthquakes (Persinger, 1980).

On the 6th of February 2023, a powerful earthquake with a magnitude of 7.8 hit the southern and central regions of Turkey as well as the northern and western parts of Syria. The death toll has continued to rise with confirmed fatalities exceeding 57,300 as of the 20th of March 2023. Given that the earthquake was one of the most serious in power and impact, it generated a great deal of discussion, including the spread of conspiracy narratives. On the 6th of February 2023, the number of tweets containing the word earthquake rose to 1.5 million (see Fig. 1). One popular theory was that the earthquake was the result of a secret weapon developed by a foreign government or other group. According to this theory, the weapon used advanced technology to create seismic activity in the region as a means of achieving its own objectives. Some proponents of the theory claimed that it was a deliberate attack on the region, possibly as part of a large geopolitical strategy.

Many people have also referred to the so-called HAARP as being the potential cause of the earthquake. HAARP is a research program funded by the US government that investigates the ionosphere (Weinberger, 2014). Despite its scientific purposes, the HAARP program has been the subject of various conspiracy theories. One of the most popular HAARP conspiracy theories is that the program is used for weather control, mind control, or even causing natural disasters like earthquakes and hurricanes (Deruelle, 2020; Miller and Miller, 2003; Naiditch, 2003). According to this theory, the HAARP program uses a network of high-frequency radio waves to manipulate the ionosphere, which in turn affects the Earth's climate and weather patterns and even causes natural disasters.

Table 1 contains a conspiracy tweet example and a graphical illustration created by Midjourney artificial intelligence.

Methodology

Methods

The methodology of this research includes several methods and several steps. First, this study applies the case study method. A case study method is a research approach that involves in-depth investigation and analysis of a single individual, group, or phenomenon (Feagin et al., 2016; Fidel, 1984). The goal of a case study is to gain a deep understanding of the specific case being studied and to generate new knowledge or insights that can be applied to similar situations in the future. Case study approach has been widely applied in the study of conspiracy theories. E.g., there are studies analyzing separate conspiracy theories related to COVID-19 (Erokhin et al., 2022), monkeypox (Elroy et al., 2023), or earthquakes (Erokhin and Komendantova, 2023). The approach of this study is analyzing one conspiracy theory related to earthquakes, which is the most easily identifiable and differentiable from non-conspiracy[2]. The HAARP case study as well as the case study of the recent Turkey-Syria earthquake are selected.

The data is collected with the help of the Twitter API. Twitter API V2 for academic research is used to extract daily tweet frequencies by the keyword "HAARP" to analyze the discussion development of HAARP (01 January 2022–4 March 2023) and to extract tweets on HAARP to analyze the sentiment of the discussion (01 January 2023–28 February 2023). The selected timeline allows for a comprehensive analysis of HAARP discussions, capturing a significant period to observe the evolution of discourse from January 2022 to March 2023. The broader timeframe offers insights into the long-term trends and shifts in public opinion, while the specific January to February 2023 period enables a more focused examination of sentiment during a critical phase of the discussion related to the earthquakes in Syria and Turkey. Tweets on the peak days of the discussions are also extracted and analyzed to understand why the peaks occurred.

During the data analysis, this study looks for what drives the discussions. Over the study period, HAARP peaks are mostly related to natural disasters such as earthquakes. That is why this study investigates the connection between earthquakes and the

Table 1 HAARP conspiracy illustration and tweet example.

Conspiracy theory	Illustration (created by Midjourney AI)	Example of a tweet
HAARP		"Climate change and tsunamis are generally NOT connected...this is caused by the USA's HAARP machine in the south pacific steering a hurricane to Malaysia, when they stop, the ionosphere slams back into the earth causing earthquakes."

HAARP discussion further and estimates a positive and significant correlation between the number of HAARP-related tweets per day as well as the magnitude of the strongest earthquake on a particular day.

This study uses Azure Sentiment Analysis to estimate the sentiment of the discussion on HAARP. Azure Sentiment Analysis is a natural language processing service offered by Microsoft Azure that analyzes text data and determines the sentiment (positive, negative, or neutral) expressed in it. It first preprocesses the text by removing stop words (commonly used words that do not carry much meaning), stemming (reducing words to their root form), and tokenizing (breaking the text into individual words or phrases). It then uses a machine learning model to analyze the sentiment expressed in it. The model is trained on a large corpus of text data and uses statistical algorithms to classify the sentiment of the text. Azure's sentiment analysis service assigns a score between 0 and 1 to indicate the degree of positive sentiment in a given text. A score closer to 1 indicates a highly positive sentiment, while a score closer to 0 indicates a highly negative sentiment. A score between 0.45 and 0.60 indicates a neutral sentiment. Microsoft Azure Machine Learning has already been successfully applied in various literature (e.g., Qorib et al., 2023; Harfoushi et al., 2018; Qasem et al., 2015). This study uses Midjourney to create an illustration of the HAARP conspiracy. Midjourney is an artificial intelligence capable of creating AI art. An illustration of the HAARP conspiracy could enrich the article by offering a visually engaging and informative supplement to the textual content, potentially enhancing reader engagement, comprehension, and interest in the topic.

Data. Whereas in the analysis of tweet frequencies, the study focuses on all languages, in data collection the study is limited to English tweets when analyzing the sentiment of the HAARP discussion.

This study uses Twitter API and collects tweet frequencies between the 1st of January 2022 and the 4th of March 2023. In total, there are 1 041 633 tweets on HAARP.

In addition, this study tests for the correlation between HAARP and the maximum magnitude of an earthquake on a given date. The expectation is that the prevalence of conspiracy beliefs tends to intensify in correlation with the magnitude of earthquakes, where more severe earthquakes in the analyzed time period often garner heightened public attention (Bossu et al., 2023; Ruan et al., 2022). This increased visibility and impact of larger earthquakes on communities may inadvertently elevate the susceptibility to conspiratorial interpretations, thereby emphasizing the need to explore how such catastrophic occurrences intertwine with the proliferation of conspiracy beliefs (Erokhin and Komendantova, 2023). This study uses the Significant Earthquakes Archive operated by the United States Geological Survey (2023) to extract data on earthquakes. It is a scientific agency of the United States government that studies the natural resources and hazards of the earth. The database provides comprehensive information on earthquakes that have occurred all

over the world. The earthquake database is constantly updated with the latest earthquake data, and it includes a wealth of information on each earthquake, including magnitude, location, depth, time, shaking intensity, and tsunami information.

Results

Table 2 summarizes the number of tweets per month. In total, in the observed period, there were 1 041 633 tweets on HAARP.

Table 3 presents summary statistics on a monthly basis, and Table 4—on a daily basis.

The frequency analysis shows that peaks in the discussion on HAARP were mostly attributed to severe earthquakes. Figures 2 and 3 reveal that the discussion on HAARP had its all-time high on the 6th of February 2023 with more than 150 000 tweets. It was the day when a 7.8 earthquake struck southern and central Turkey and northern and western Syria. The next highest point is the 23rd of November 2022 with 11,700 tweets when a 6.1 earthquake struck near Düzce, Turkey[3]. It is followed by the 19th of September 2022 with more than 6100 tweets when a 7.7 earthquake struck between the Mexican states of Michoacán and Colima. The 5 700 tweets on the 30th of November 2022 were connected to a very heavy rainfall[4], which hit several states in south-eastern Brazil in late November 2022[5]. On the 19th of July 2022 a video with more than 160 000 views "China: world's largest weather-modification system (HAARP)"[6] was published, which explains the peak with more than 3600 tweets the day after. The peak of about 2500 tweets on the 27th of December 2022 was connected with a discussion of a research campaign, which was launched by HAARP in cooperation with NASA. On the 16th of March 2022, a 7.4 earthquake struck off the coast of Fukushima, Japan, which led to a peak in the HAARP discussion on the 18th of March with about 2400 tweets.

Given that most of the HAARP-related highs were related to earthquakes this study analyzes the correlation between the number of tweets on HAARP on a date and the highest magnitude of an earthquake on this date for all the earthquakes between January 2022 and March 2023. The correlation is positive and significant (0.1438***). The frequency of the HAARP discussion increases with the earthquake magnitude.

Table 5 summarizes the results on the sentiment of the HAARP discussion and the tweet frequency. The average sentiment and the sentiment standard deviation have a negative and significant correlation. It implies that differences in sentiment decline with higher sentiment. There is a positive and significant correlation between the number of tweets and the mean sentiment. Figure 4 shows that the mean sentiment of tweets was below the January – February 2023 average before the February 2023 earthquake and increased thereafter.

In addition, this study analyzes and compares the discussions before and after the February 2023 earthquake. When looking into the discussions from January 2023 until the earthquake, the discussion on HAARP is quite diverse and covers a wide range of topics, from weather manipulation and climate control to conspiracy theories and government involvement (see Fig. 5 for the 50 most frequently used words). The sentiment in the discussion seems to be mixed, with some expressing genuine concern about

Table 2 Monthly frequency of conspiracy discussion.

Month-year	HAARP
January-2022	16,510
February-2022	21,046
March-2022	26,028
April-2022	16,712
May-2022	17,410
June-2022	23,241
July-2022	26,992
August-2022	26,283
September-2022	43,683
October-2022	20,493
November-2022	45,510
December-2022	27,380
January-2023	30,070
February-2023	678,641
March-2023 (until March, 4)	21,634
Total	1,041,633

Table 3 Monthly summary statistics (January 2022–February 2023).

Number of tweets	Obs	Mean	Std. dev.	Min	Max
HAARP	14	72,857.07	174,582.5	16,510	678,641

Table 4 Daily summary statistics (01 January 2022–04 March 2023).

Number of tweets	Obs	Mean	Std. dev.	Min	Max
HAARP	428	2433.722	9337.009	275	150,530

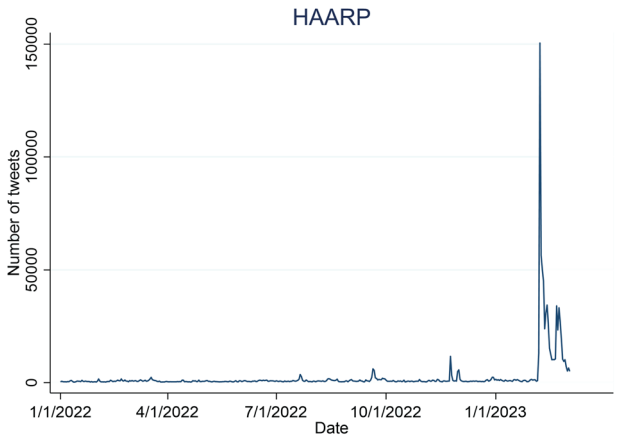

Fig. 2 Tweet frequency. Daily tweet frequency on HAARP (01 January 2022–4 March 2023).

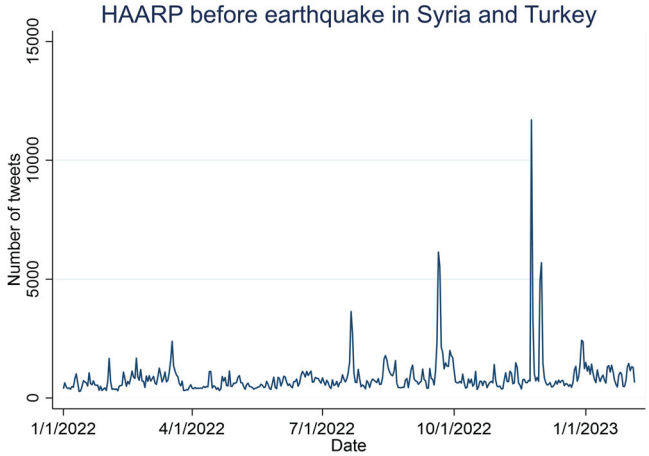

Fig. 3 Tweet frequency. Daily tweet frequency on HAARP (01 January 2022–4 February 2023).

Table 5 Correlation matrix (01 January 2023–28 February 2023).

	Number of HAARP tweets	Maximum earthquake magnitude	Mean sentiment
Maximum earthquake magnitude	−0.0028		
Mean sentiment	0.2247*	−0.1463	
Standard deviation sentiment	−0.1126	0.0720	−0.2975**

**p-value < 0.05, *p-value < 0.1.

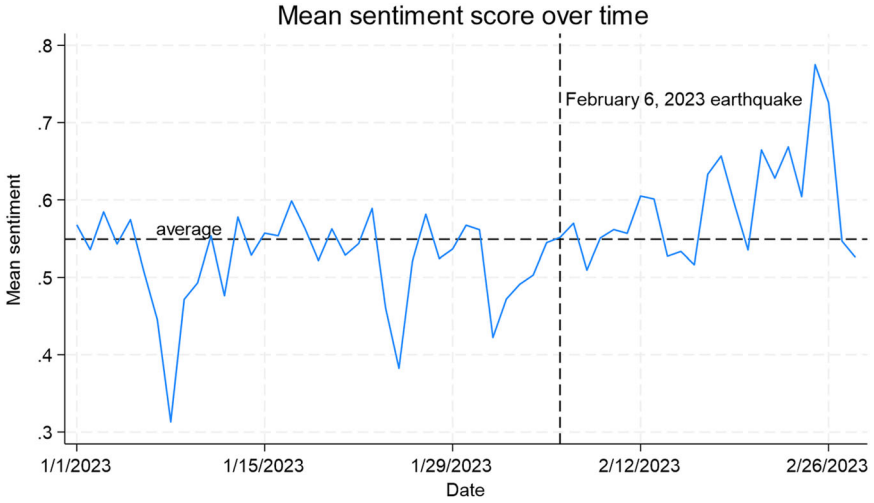

Fig. 4 Sentiment. Mean sentiment score over time (01 January 2023–28 February 2023).

Fig. 5 Word cloud. Word cloud of the 50 most frequently used words (01 January 2023–05 February 2023)[7].

the potential impact of HAARP on the environment and weather patterns, while others are more skeptical and view it as a tool for conspiracy theories. One of the most discussed topics is the potential use of HAARP for weather manipulation and geoengineering. Many individuals in the discussion express concerns about the impact of HAARP on natural weather patterns and climate change. Some believe that HAARP is being used to control the weather, while others are skeptical and view it as a conspiracy theory. Another prominent topic is the connection between HAARP and chemtrails. Some individuals in the discussion link these two phenomena, suggesting that they are part of a large conspiracy related to weather control and manipulation. This has sparked debates about the validity of such claims and the potential implications for the environment and public health. Additionally, there are references to government involvement and secrecy surrounding HAARP. Some individuals express skepticism about the official narrative and question the true intentions behind HAARP's operations. This has led to discussions about the need for transparency and accountability in scientific research and government initiatives related to weather and environmental control.

Quite a varied discussion on HAARP also followed the February 2023 earthquake that covered a wide range of sentiments and topics (see Fig. 6 for the 50 most frequently used words). Some people express skepticism and concern about the potential use of HAARP for weather manipulation and geophysical warfare. There are mentions of HAARP being a powerful geophysical weapon and its alleged capability to initiate earthquakes and other natural disasters. Some individuals also suggest that recent earthquakes, such as the one in Turkey, may have been caused by HAARP. The sentiment in the discussion is mixed, with some expressing genuine concern and seeking to understand the potential implications of HAARP, while others dismiss it as a conspiracy theory. The main topics of discussion include the alleged use of HAARP for weather modification, its potential role in seismic events, and its connection to geopolitical tensions. Additionally, there are references to climate change, geoengineering, chemtrails, and the impact of HAARP on the environment.

In summary, before the earthquake, the keywords and phrases primarily revolved around conspiracy theories related to weather control and manipulation, such as "weather modification", "chemtrails", "geoengineering", "climate hoax", and "global warming". There were also mentions of specific individuals and

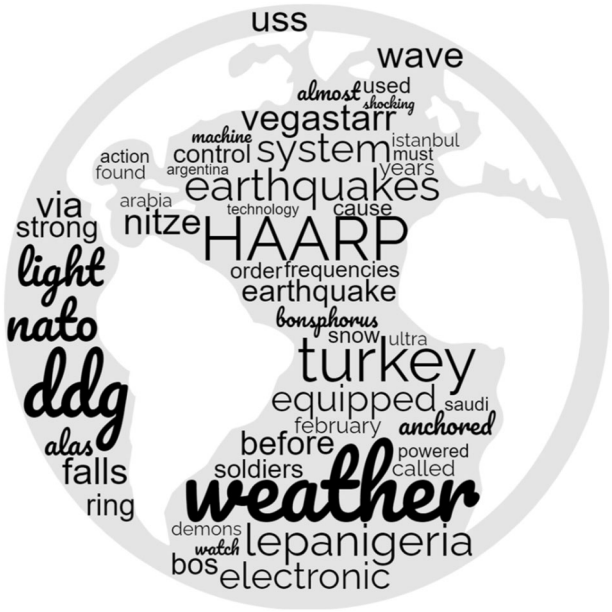

Fig. 6 Word cloud. Word cloud of the 50 most frequently used words (06 February 2023–28 February 2023).

organizations, such as "Mike Hudema", "Pentagon", "DARPA", and "WEF", suggesting a focus on alleged secretive activities and agendas. After the earthquake, the keywords shifted to focus on the earthquake itself and related topics. There were mentions of specific locations and events, such as "Turkey", "earthquake", "Istanbul", "Bosphorus", and "Sanliurfa". Additionally, there were references to military equipment and operations, including "DDG", "soldiers", "NATO", and "anchored", indicating a shift in focus from conspiracy theories to the earthquake and its potential causes and effects.

Discussion

This study finds that the frequency of HAARP discussion is positively correlated with the magnitude of an earthquake. However, though the Pearson correlation coefficient serves as a valuable metric in analyzing relationships between variables, it harbors limitations. While its application can highlight strong statistical significance, acknowledging its potential weaknesses is crucial, especially in scenarios where multivariate analysis could offer a more comprehensive understanding. Indeed, a simple correlation analysis often falls short of elucidating causation or determining the cause-and-effect dynamics between variables. This is particularly evident in cases where the correlation coefficient is low. Despite these constraints, when confronted with a situation like the earthquake triggering discussions about HAARP, rather than the converse, the correlation enables us to observe the likelihood of such events. While one should be cautious not to conflate correlation with causation, such observations do offer valuable insights, especially when substantiated by strong statistical significance.

This study also finds a positive correlation between average tweet sentiment and the number of tweets, which could indicate that the discussion of HAARP reinforces people's beliefs. Users discussing conspiracy theories may feel more positive when they find other people who share their beliefs because it reinforces their worldview and provides a sense of validation and community. When they encounter others who believe in the same conspiracy theories, it can confirm their suspicions and give them a sense of belonging to a group that shares similar ideas and beliefs (Douglas et al., 2017). In addition, group discussions and social media can create an "echo chamber" effect, where individuals are exposed to information and opinions that confirm their existing beliefs while dismissing any opposing viewpoints (Cinelli et al., 2022). This can further reinforce the conspiracy theory and make it harder for individuals to question or doubt their beliefs. Furthermore, the feeling of being part of a "secret club" or possessing special knowledge that is hidden from the general public can give individuals a sense of empowerment and importance. This can lead to a psychological phenomenon known as "grandiosity", where individuals feel a sense of superiority over those who do not share their beliefs (Ük and Bahcekapili, 2022).

One of the limitations is the use of a single platform—Twitter—and a single language—English— when analyzing tweet sentiment. Uncertainties from the sole data source and missing geotag information can be reduced using other social monitoring data, such as Google Trends (Gizzi et al., 2020; Kam et al., 2021). Geoparsing is another possibility to identify the location of users (Baranowski et al., 2020). Geoparsing is possible through alternative metadata channels, including the user's nationality, hometown, and direct references to specific locations within the message itself (e.g., province or city names). Although this approach entails estimations and may occasionally assign messages to inaccurate locations, leveraging a substantial volume of data, rather than individual tweets, helps mitigate the impact of potential inaccuracies in geoparsing, thus reducing random noise in the analysis.

Figure 7 shows that the search for HAARP on Google peaked following the major earthquake in Syria and Turkey similar to the number of tweets. This study also found that other earthquakes, which triggered peaks both in the Twitter discussion and Google searches (see Fig. 8). There was a peak following the 19th of September 2022 earthquake, the 23rd of November 2022 earthquake, the 30th of November 2022 rainfall. However, there was no difference in activity following the video publication in July 2022 suggesting that the video was mainly spread on Twitter and its discussion did not have a spillover effect on Google searches. The March 2022 earthquake in Japan also did not have any effect on the change in Google searches. There was only a slight increase in Google searches following the December 2022 launch of a campaign by HAARP and NASA. Google Trends also allows figuring out where the search queries come from. Table 6 shows the top 10 regions searched for HAARP.

Another limitation of the study may lie in the application of the Azure Sentiment analysis (Microsoft, 2023). The sentiment prediction model, primarily trained on product and service reviews, might not exhibit optimal performance in scenarios beyond this domain. Challenges may arise with dialects and less-represented languages in the training dataset, potentially impacting accuracy. Additionally, the system lacks an intricate understanding of the relative importance of sentences in a document and may not grasp elements like sarcasm or contextual factors such as tone of voice or prior conversation. Despite efforts to minimize bias, there remains a possibility of encountering inaccurate and unreliable output. However, given that this study analyzes tweets in English without referring to any prior conversations the potential bias should be low.

This study contributes to several strands of literature, including the study of conspiracy theories, social media dynamics, and natural disasters. In the realm of conspiracy theories, the study sheds light on the evolving landscape of online conspiracy narratives, providing insights into the catalysts that drive the proliferation and longevity of such theories. It also contributes to the understanding of how social media platforms facilitate the spread of conspiracy theories. Furthermore, the study adds to the literature on natural disasters by examining the intertwining of conspiracy beliefs with earthquakes.

Fig. 7 Google Trends. Google Trends HAARP worldwide interest over time (01 January 2022–4 March 2023).

Fig. 8 Google Trends. Google Trends HAARP worldwide interest over time (01 January 2022–4 February 2023).

Table 6 Top 10 regions search for HAARP on Google (1 January 2022–4 March 2023).

Region	Score[a]
Turkey	100
Albania	53
Kosovo	49
Lebanon	42
Cyprus	40
Bangladesh	40
Romania	36
North Macedonia	34
Pakistan	30
Azerbaijan	23

[a]A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular.

The implications of this study are far-reaching and have significant relevance for the audience as well, particularly in the context of media psychology. The study sheds light on the dynamics of belief reinforcement within online communities amidst heightened attention to conspiracy theories triggered by significant events, such as natural disasters. For the audience, this study underscores the importance of critical thinking and analysis, especially during times of crisis. It highlights the potential impact of social media on public perception and the spread of misinformation, emphasizing the need for accurate and reliable information to be disseminated to the public. In terms of media psychology, the study provides insights into what drives narratives around conspiracy theories in the digital sphere offering a valuable understanding of the relationship between digital communication, public discourse, and belief formation. This can help media psychologists and researchers better comprehend the mechanisms through which conspiracy theories spread and gain influence and develop strategies to counteract the negative effects of misinformation and conspiracy narratives.

Future research could focus on the validation of the study findings using surveys or interviews to find the received risk of the public (Liu et al., 2023) and to analyze reasons behind conspiracy beliefs, which could include character traits, social norms, mental health conditions, and others (Ahadzadeh et al., 2023; Gong and Ren, 2023; Green et al., 2023).

Conclusion

The findings of this study reveal that conspiracy theories remain a popular topic of discussion on social media, with the frequency of discussion increasing after a high-impact earthquake. This study finds that major earthquakes like the severe February 2023 earthquake in Syria and Turkey do trigger the HAARP discussion on Twitter.

Furthermore, the analysis of sentiment suggests that the discussion of conspiracy theories reinforces people's beliefs, leading to a more positive discussion with a higher number of tweets. This suggests that once people believe in a particular conspiracy theory, they are less likely to question it or engage in critical thinking and may even seek out information that confirms their beliefs.

In conclusion, the prevalence of conspiracy theories on social media is a growing concern, and this study has provided important insights into the dynamics of these theories and their impact on public discourse. The findings suggest that more needs to be done to promote critical thinking and analysis and to provide accurate and reliable information to the public, particularly during times of crisis. By doing so, it is possible to help prevent the spread of misinformation and conspiracy theories and ensure that the public is better equipped to navigate complex issues in an informed and rational way.

Data availability

Twitter data and publicly available data were used for the analysis as described in the study.

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Note

1 Misinformation encompass false or inaccurate information, whether created intentionally or not, that is disseminated (Komendantova et al., 2023). On the other hand, disinformation is specifically crafted with the conscious aim to deceive, cause harm, or influence different social groups.

2 To give an example of why it is important one could think of the conspiracy on Bill Gates' role in the COVID-19 pandemic. Whereas some tweets could be related to the conspiracy, there could be non-conspiracy tweets as well as talking about Bill Gates donating money for the development of vaccines. In this case, one would need to train a machine learning algorithm, which would be able to distinguish between conspiracy and non-conspiracy tweets. On the other hand, it is quite sure that HAARP is most likely related to conspiracies when discussing earthquakes.

3 The fact that two major peaks coincide with major earthquakes that occurred in Turkey could also lie in the fact that some populations may be more subject to conspiracy beliefs. E.g., Gürpınar (2019) refers to Turkey as a "conspiracy nation".

4 Though other types of natural disasters such as rainfalls could trigger the HAARP discussion, the study focuses on earthquakes because as the findings and literature reveal the HAARP conspiracy is most frequently connected to earthquakes.

5 Though significant rainfall events occurred worldwide in 2022, only the rainfall in Brazil led to a high number of tweets discussing HAARP in connection to the rainfall. One explanation could be a general widespread conspiracies in Brazil where "false information … has penetrated … society" claiming a plot of developed nations against Brazil (Silva, 2022).

6 It is an interesting observation that in this case HAARP is used as a nominative name. Although the program is not related to China, China's climate change program is also referred to as HAARP. It can be assumed that this is an attempt to link the program to conspiracy theories. Many of the tweets are accompanied by comments that climate change is a hoax or a plot.

7 The word clouds were constructed using https://www.wortwolken.com/.

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Author contributions

The authors have equally contributed to the study.

Competing interests

The authors declare no competing interests.

Ethical approval

Ethical approval was not required as the study did not involve human participants.

Informed consent

Informed consent was not required as the study did not involve human participants.

Additional information

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