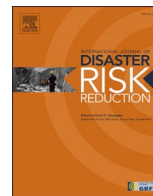


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# The role of bots in spreading conspiracies: Case study of discourse about earthquakes on Twitter

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## ABSTRACT

In this paper, we identified seven most widely spread conspiracy discourses about earthquakes. These conspiracy discourses link earthquakes to military activities like secret nuclear bomb testing, God's Providence like the punishment of humans for their sins, space activities like aliens visiting our planet, the US secret weather control program HAARP, tests of the Large Hadron Collider, fracking projects, and freemasonic plots. Following the major earthquake in Indonesia at the end of November 2022, we extracted data from Twitter by keywords using the Hoaxy tool for tracking the spread of information on Twitter. Applying the Bot Sentinel tool, we also got data on the sentiment of the users. The divine and military discourses dominated the conspiracy discussion, followed by the discussions about extraction and HAARP. Though there were more human-like accounts than bot-like accounts, we found a positive correlation between the frequency of tweets on the conspiracy discourses and the bot scores of the accounts, which suggests that bot-like accounts were tweeting more than human-like accounts. It was also found that normal accounts tweeted more than toxic accounts, and there was a positive relationship between the bot score and the toxicity level of an account. It suggests that bot-like accounts were involved more in disruptive activities than human-like accounts.

## 1. Introduction

Conspiracies are allegedly malicious secret actions by a small group of powerful people for personal gain against the common good [1]. They are not a new phenomenon but today technologies such as social media make their spread much faster and almost universal. Bots are playing a special role. Bots are software applications that use scripts to run automated tasks [2]. In 2020, they made up 40.8% of internet traffic, with almost two thirds being bad bots of malicious intent [3]. Bad bots, among other things, were observed in the spread of the Covid-19 infodemic. This large participation of bots on the Internet requires a careful analysis of their role in spreading conspiracy theories. There are different tools that help to determine bot accounts like Botometer, Bot Sentinel, and Hoaxy [4].

Someone might think that the earthquakes are well known natural events and a lot of scientific knowledge exist in this area. It is also a part of school education and a well-known fact that the earthquakes are being caused by the collision of tectonic plates, the fact which is known already from the 17th century [5]. However, people still have doubts about it and there are a lot of conspiracies about the earthquake's origin, about the possibility to predict it or about possible causality between climate, weather patterns, and the frequency of earthquakes [6]. It is important to acknowledge that in certain topics within seismology, the existence of misinformation can be understandable, given the ongoing scientific debates and lack of consensus. However, efforts must be made to combat this

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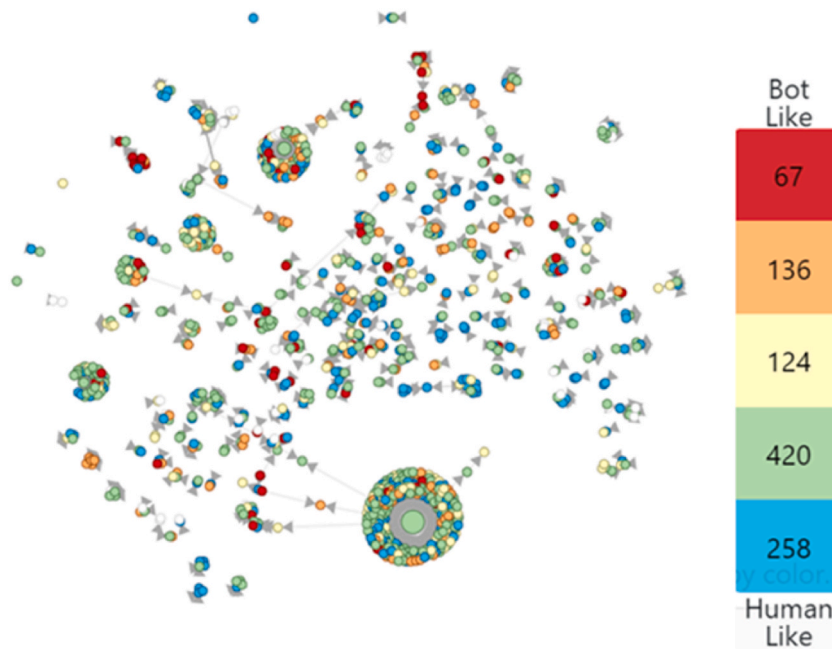


Fig. 1. Diffusion network of accounts discussing HAARP (November 13, 2022 16–30 CET).

misinformation to prevent damage to public understanding of science and evidence-based decision making [7].

Some of the wildest conspiracies were spreading after the Marmara (1999) and the Van (2011) earthquakes in Turkey or the Haiti earthquake (2010). People blamed military actions or ionospheric research projects for these earthquakes. Some of them also considered these earthquakes as acts of God [8]. Another conspiracy is the existence of a global tectonic super-weapon masked under the US High Frequency Active Auroral Research Program (HAARP), which allegedly caused a Haiti earthquake in 2010 [9,10]. There are also conspiracies about the role of Large Hadron Collider (LHC) and the European Organization for Nuclear Research (CERN) in Geneva, drilling companies, water extracting farmers, and freemasons causing earthquakes [11]. There are even conspiracies about the connection of Jerusalem and Mecca by averaged earthquake locations as a proof of God's origin of earthquakes or a claim of a significant increase in earthquakes following the launch of the HAARP [12].

Conspiracies lead to false estimations of risk, they influence behavior prior, during and after earthquakes and even cause blames on scientists. Conspiracies about the possibility to predict earthquakes resulted in a situation when seismologists were sentenced to imprisonment for being not able to predict an earthquake with a large number of victims [13,14].

One of the reasons why all well known facts earthquakes are still connected with conspiracies is that earthquakes represent a typical example of a dread risk – a sudden uncertain event with large social and economic consequences [15,16]. Other reasons for conspiracies on earthquakes can include uncertain side effects, loss of control, intervention in nature, lack of immediately available information after the event, activities of self-proclaimed experts, knowledge gap, not commonly used terms, technical misconceptions, multi-hazard context, personal experience, retrospective evidence, complex dynamics, and emotions [13]. Conspiracies may also be an attempt to replace religious beliefs in a secular society [17]. At the same time, conspiracy theories can also be discussed in anniversaries of earthquakes, indicating their persistence [18].

With the active penetration of social media in the everyday life and the voluminous array of information together with misinformation and disinformation they spread the topic of conspiracies and social media is becoming an important research question [19].

Currently a number of studies was published on the COVID-19 pandemic and the role social media played in the discussion of COVID-19 related conspiracies [20]. Some studies analyzed the role of social media in terms of earthquake management, communication, resilience as well as detection (e.g., Refs. [21–25]). Several papers also looked at the spread of misinformation, rumors, and fake news on earthquakes in social media (e.g., Refs. [26–29]).

Conspiracies are being spread through various social media. A study by Ref. [30] analyzed public responses to the 2019 Ridgecrest earthquake in California and identified that a conspiracy subreddit on Reddit was one of the most popular channels. Moreover, different types of misinformation prevailed on Twitter and Reddit. Whereas Twitter users tweeted that the “Big One”, i.e., an extremely large earthquake, was coming, Reddit users discussed a nuclear test as a potential reason for the earthquake. One of the special tools to analyze earthquake-related discourse is the smartphone app for global earthquake eyewitnesses LastQuake. For example, this app was used to collect data for sentiment and topical analysis of the earthquake that occurred in Albania on the November 26, 2019 [31].

This paper contributes to the strand of literature on earthquake-related conspiracies discussion on social media. In particular, the focus of our study is conspiracies about earthquakes and the source of spread of these conspiracies. Through a thorough literature and news review, we determine seven dominating conspiracies and related keywords. Using the Hoaxy tool for tracking the spread of

**Table 1**  
Conspiracy-related keywords.

Conspiracy	Keywords	Tweet examples	Hashtags
Military	Bomb, nuclear, warfare, weapon, terrorism, war, terror, terrorist	“Nepal conducted an underground Nuclear test codenamed Momo-1. Tremors were felt as far as Delhi.”	#realosint #earthquake
Divine	God, sin, Christ, Allah, devil, apocalypse	“One world government, rise of the beast and the anti christ. Famine, war, and earthquakes.”	
Alien	Planet X, Nibiru, UFO, meteorite, alien	“All the signs are here! CATASTROPHIC FLOODS, FIRES, EARTHQUAKES, STORMS! Prepare now y’all!!! It’s happening ... more and more each day”	#PoleShift #Planetx #nibiru
HAARP	HAARP	“Australia bought a HAARP system just before the Melbourne earthquake and just before all these floods”	
CERN	CERN, LHC	“Okay, please hear me out ... Climate change ... Weather wars ... Chemtrails, direct energy weaponry and CERN and HAARP .... Causes earthquakes ... Silent weapons for silent wars ... Frequencies ...”	
Extraction	Drilling, extraction, fracturing, fracking	“Texas is averaging 2 earthquakes a day, they’re starting to register over 2.8. There are places which will cease to exist due to drilling and fracking. Explain that to the folks who live there, have contaminated well water and are getting cancers.”	
Masonic	Mason, masonic, freemason, freemasonic	“Maybe it’s about the cern project in switzerland the Masonic scholars there are digging the ground hard these days to bring out their god, the Great Satan, which is what causes these huge earthquakes these days.”	

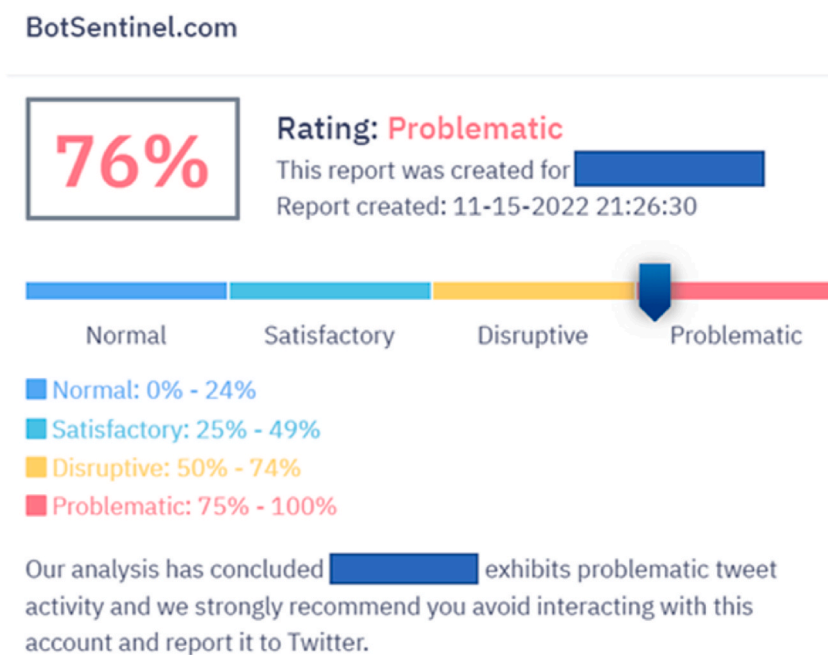


Fig. 2. Bot Sentinel analysis for a bot account tweeting on HAARP. The name of the account was hidden for the privacy reasons.

information on Twitter, we analyze whether the discourses on these conspiracies are led by bot-like or human-like accounts. An importance of analyzing the role of bots lies in the fact that automated accounts are not only used out of good purposes to answer questions or provide updates but can be misused to intentionally spread fake news, conspiracy theories or propaganda on social media [32–37], which can have behavioral consequences [38]. To account for different kinds of behavior, we use Bot Sentinel, which allows distinguishing between normal, satisfactory, disruptive, and problematic accounts.

The paper is structured as follows. The second section introduces methods and data. The third section presents the results. The fourth section discusses the results. Finally, section five concludes.

**2. Methods and data**

The Hoaxy tool [39,40] for tracking the spread of information on Twitter is used to analyze the role of bots in the earthquake conspiracy discourses on Twitter [41–43]. We use the Twitter Search API to retrieve tweets matching our search query and analyze these accounts in terms of their bot score. To estimate the bot score, we use the Botometer machine learning algorithm [44] trained to classify the level of account automation. Graphically, accounts are ranked on a scale of five from being a bot-like to being a human-like account. Hoaxy also provides an exact bot score for each of the accounts between zero and one. The higher the score, the more likely

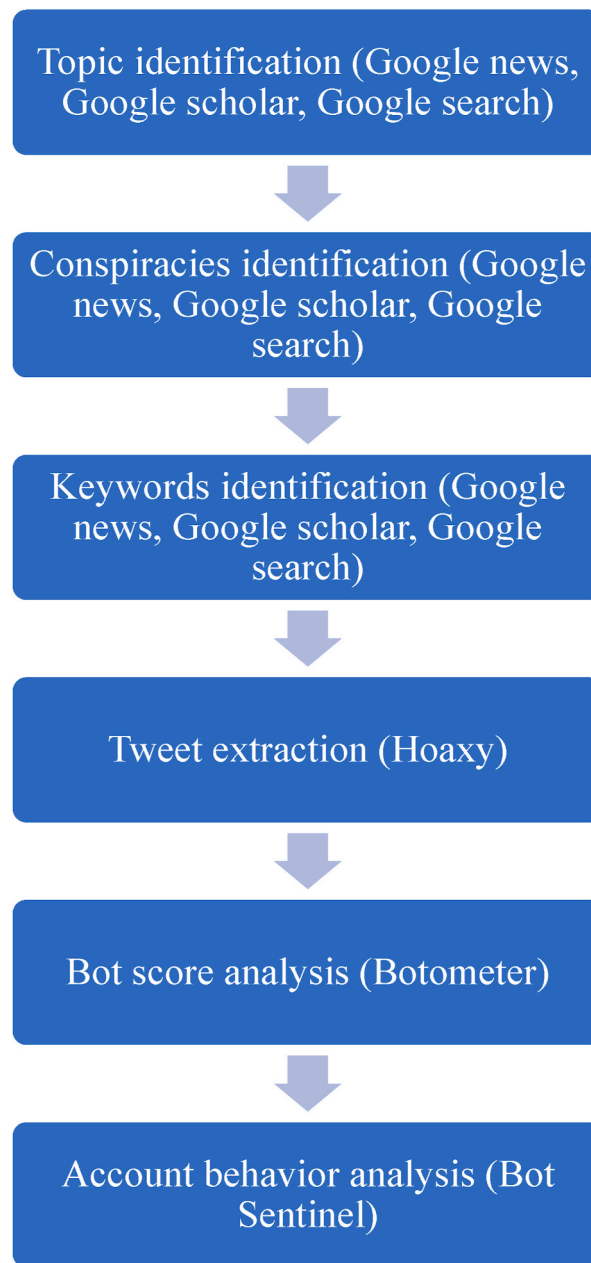


Fig. 3. Stepwise methodology.

Table 2

Number of tweets, number of accounts, tweets per account, and average bot score identified for each of the conspiracy discourses.

Conspiracy	Number of tweets	Number of accounts	Number of tweets per account (Std. dev.)	Average bot score of tweets (Std. dev.)	Average bot score of accounts (Std. dev.)
Divine	1957	246	7.96 (36.15)	0.48 (0.21)	0.43 (0.26)
Military	1316	226	5.82 (36.31)	0.49 (0.23)	0.38 (0.26)
Extraction	637	140	4.55 (8.22)	0.44 (0.30)	0.37 (0.28)
HAARP	408	50	8.16 (14.02)	0.53 (0.19)	0.46 (0.25)
Alien	91	12	7.58 (15.52)	0.47 (0.20)	0.33 (0.25)
CERN	19	3	6.33 (8.39)	0.71 (0.19)	0.53 (0.31)
Masonic	0	/	/	/	/

**Table 3**  
Ordinary least squared (OLS) regression results of the number of tweets per account on the bot score of the account.

Number of tweets per account	Divine	Military	Extraction	HAARP	Alien
Botscore of the account	5.95 (5.31)	9.13 (9.06)	3.57 (3.08)	9.17 (6.52)	18.64 (20.41)
Constant	5.39 (3.46)	2.37* (1.33)	3.22*** (0.99)	3.96 (2.62)	1.53 (4.27)
R-squared	0.00	0.00	0.02	0.03	0.09
Number of observations	246	226	140	50	12

The CERN discourse was excluded because under such a low number of accounts an economic regression would not make any sense. The HAARP and alien discourses also have a low number of observations, but they were kept for completeness. Robust standard errors. \*p < .05. \*\*p < .01. \*\*\*p < .001.

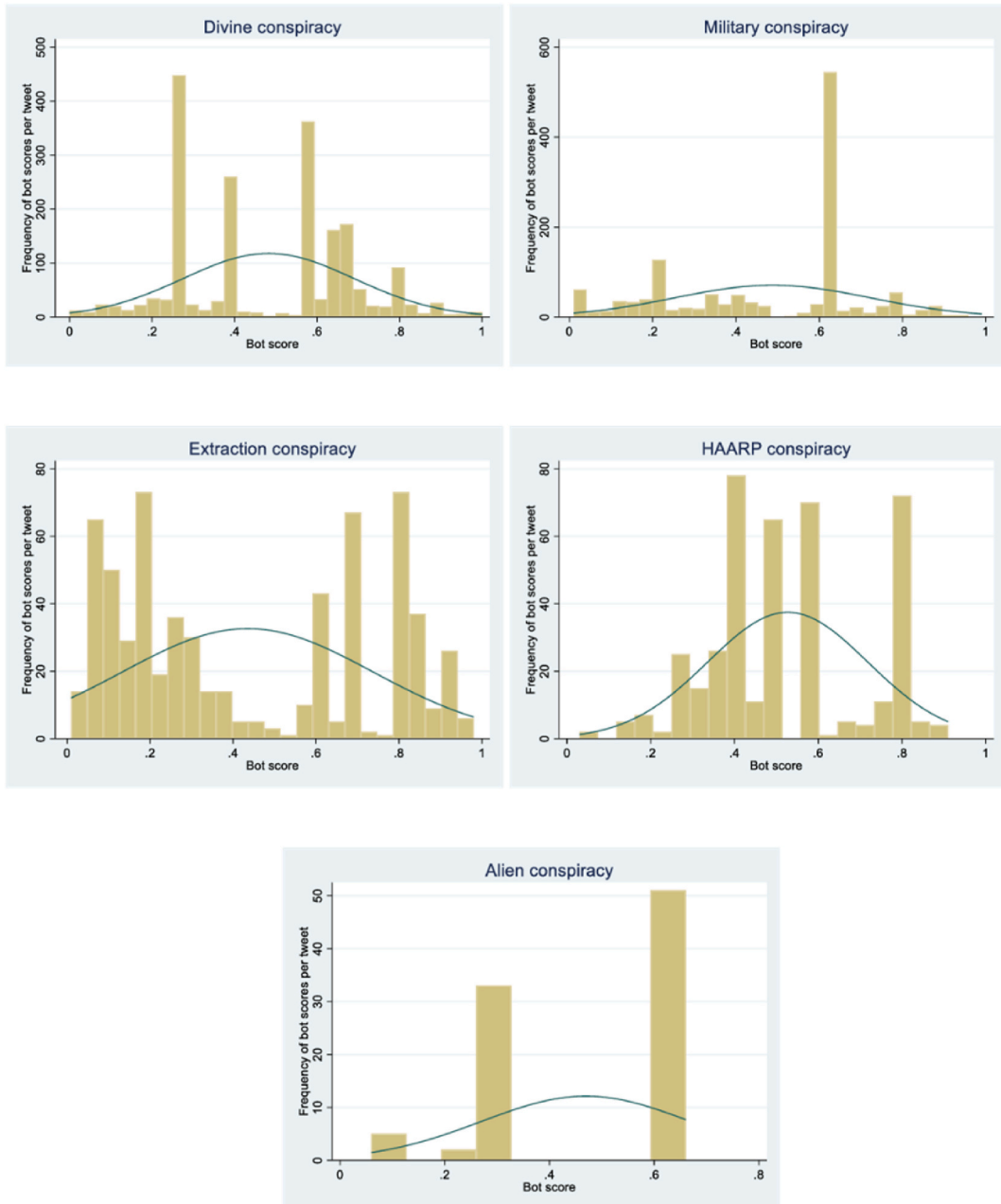


Fig. 4. Distribution of bot scores of tweets.

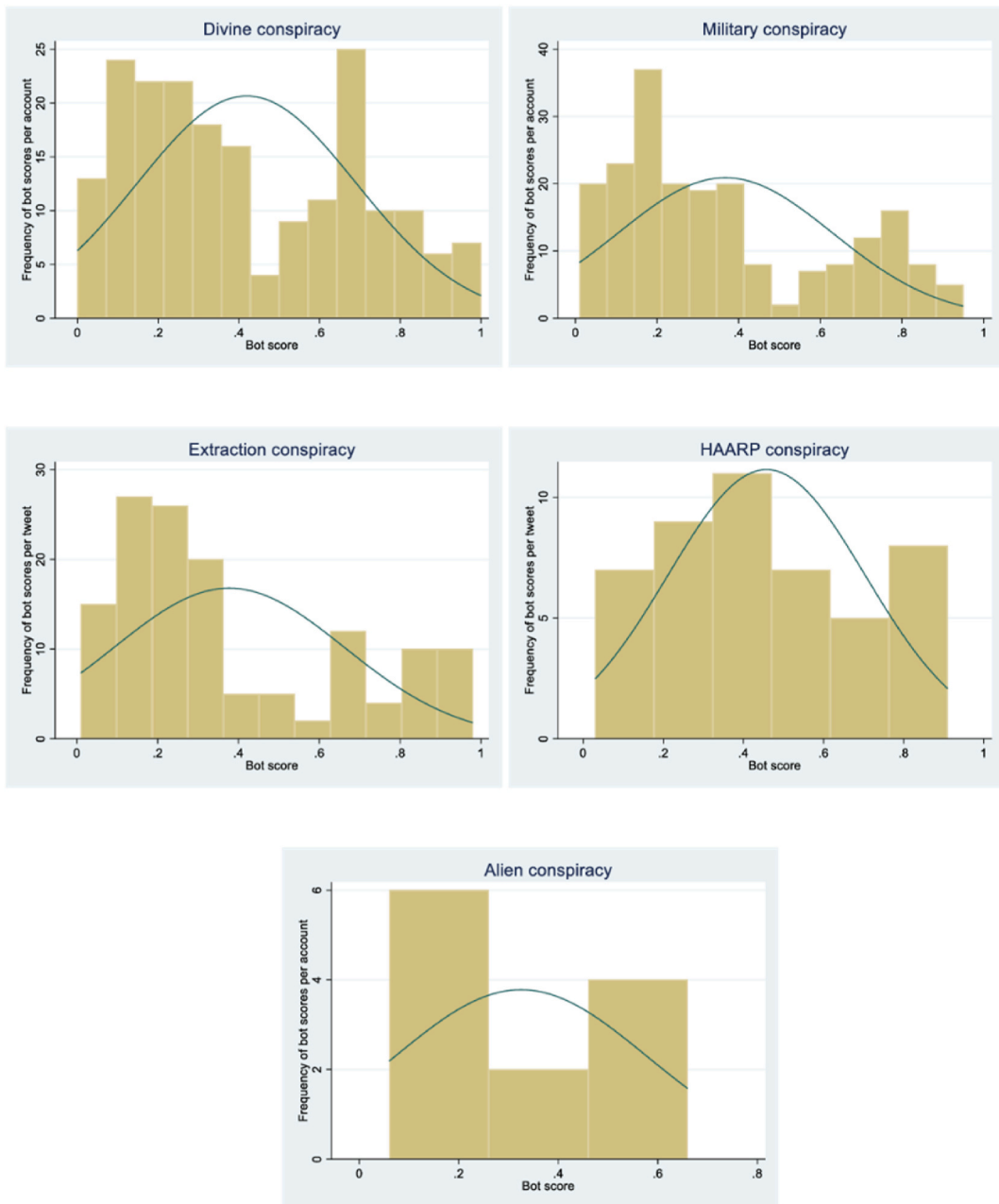


Fig. 5. Distribution of bot scores of accounts.

Table 4

Average Bot Sentinel score identified for each of the conspiracy discourses.

Conspiracy	Average Bot Sentinel score of tweets (Std. dev.)	Average Bot Sentinel score of accounts (Std. dev.)
Divine	0.19 (0.18)	0.27 (0.25)
Military	0.11 (0.16)	0.22 (0.24)
Extraction	0.08 (0.13)	0.14 (0.17)
HAARP	0.22 (0.33)	0.16 (0.25)
Alien	0.12 (0.07)	0.15 (0.17)

**Table 5**

Ordinary least squared (OLS) regression results of the number of tweets per account on the Bot Sentinel score of the account.

Number of tweets per account	Divine	Military	Extraction	HAARP	Alien
Bot Sentinel score of the account	-10.65* (5.49)	-11.05 (8.07)	-9.25*** (3.27)	7.38 (8.99)	-6.47 (11.70)
Constant	10.90*** (3.68)	8.29** (4.22)	5.71*** (1.08)	6.65*** (2.45)	8.52 (5.80)
R-squared	0.01	0.01	0.04	0.02	0.01
Number of observations	240	222	139	49	12

The CERN discourse was excluded because under such a low number of accounts an economic regression would not make any sense. The HAARP and alien discourses also have a low number of observations, but they were kept for completeness. Robust standard errors. \* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

**Table 6**

Ordinary least squared (OLS) regression results of the bot score of the account on the Bot Sentinel score of the account.

Bot score	Divine	Military	Extraction	HAARP	Alien
Bot Sentinel score of the account	1.64e+17 (1.69e+17)	1.41e+17 (1.81e+17)	9.46e+17** (3.96e+17)	-2.75e+17 (4.11e+17)	2.12e+18*** (6.19e+17)
Constant	8.51e+17*** (6.40e+16)	6.66e+17*** (5.91e+16)	3.62e+17*** (6.61e+16)	9.36e+17*** (1.11e+17)	2.47e+17 (1.83e+17)
R-squared	0.00	0.00	0.07	0.01	0.28
Number of observations	240	222	139	49	12

The CERN discourse was excluded because under such a low number of accounts an economic regression would not make any sense. The HAARP and alien discourses also have a low number of observations, but they were kept for completeness. Robust standard errors. \* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

the given account is a bot-like account, and vice versa. In addition, Hoaxy allows visualizing a diffusion network, i.e., how accounts discussing a particular topic are connected with one another (see Fig. 1 for an example). Hoaxy has been already applied in the literature, e.g., to study fake news and conspiracy content before and after the 2016 US Presidential Elections [42,45].

We conducted a search using earthquake and conspiracy keywords on the first 10 pages of Google search, Google Scholar, and Google News to identify the most widely discussed and up-to-date earthquake-related conspiracies. Through analyzing over 100 papers and news articles that covered earthquake-related conspiracies, we were able to identify seven different conspiracies and their associated keywords. These were conspiracies on the military origin of earthquakes [30], the divine origin of earthquakes [17], the alien origin of earthquakes [46], the US HAARP weather control program being the origin of earthquakes [10], earthquakes being connected to the CERN collider [47], extraction projects causing earthquakes [48], or even earthquakes being a mason plot [49]. To use the Hoaxy tool, for the identified conspiracies, we used an earthquake keyword, i.e., "earthquake", and conspiracy-related keywords (see Table 1). The identified tweets do not necessarily support the conspiracies, which is a limitation of the study. We assume that the identified tweets are in some way connected to the identified discourses. However, these can be tweets supporting, opposing, neutral or unrelated to the conspiracies.

To analyze the behavior of the accounts, we use the Bot Sentinel tool [50]. It applies machine learning and artificial intelligence to classify Twitter accounts. It rates accounts based on a score from 0% to 100%, the higher the score the more likely the account engages in targeted harassment, toxic trolling, or uses deceptive tactics engineered to cause division and chaos. Fig. 2 illustrates how such a ranking looks like for a randomly selected account tweeting on the HAARP conspiracy.

We summarize our methodology in Fig. 3.

### 3. Result

Tweets were extracted on the November 24, 2022 following the 5.6-magnitude earthquake in Indonesia, which caused severe damage and killed more than 260 people [51]. Table 2 summarizes the number of tweets for each of the identified conspiracy discourses above. Divine and military discourses were the dominant discourses followed by the extraction and HAARP discourses. A low and a very low number of tweets were linked to the alien and CERN discourses respectively, whereas no tweets discussed masons in connection with earthquakes. From Table 2, we also see the number of accounts discussing each conspiracy discourse, the number of tweets per account, and the average bot score with the standard deviation in brackets. The highest number of accounts discussed the military conspiracy discourse, followed by the divine, the extraction, and the HAARP ones. The alien, and the CERN discourses had only several accounts discussing them. The average number of tweets per account ranged between 4.5 and 8.2 depending on the conspiracy. Moreover, we find a positive correlation between the number of tweets per conspiracy discourse and the bot score of the account, though the finding was not significant for all the conspiracies (see Table 3). Another support of this finding gives a comparison of the last two columns of Table 2. We see that the average bot score of tweets was higher than the average bot score of accounts, which suggests that bot-like accounts were tweeting more. The average bot score of tweets ranged between 0.44 for the extraction discourse and 0.71 for CERN, whereas the average bot score of accounts ranged between 0.33 for the alien discourse and 0.46 for the discussion on HAARP.

The distribution of tweet bot scores can be observed in Fig. 4, while Fig. 5 illustrates the distribution of account bot scores. The figures support the above finding that though there are more human-like accounts than bot-like accounts, the bot-like accounts tweet more.

The average Bot Sentinel scores for tweets and accounts are consolidated in Table 3 and 4Table 4. We see that the average Bot



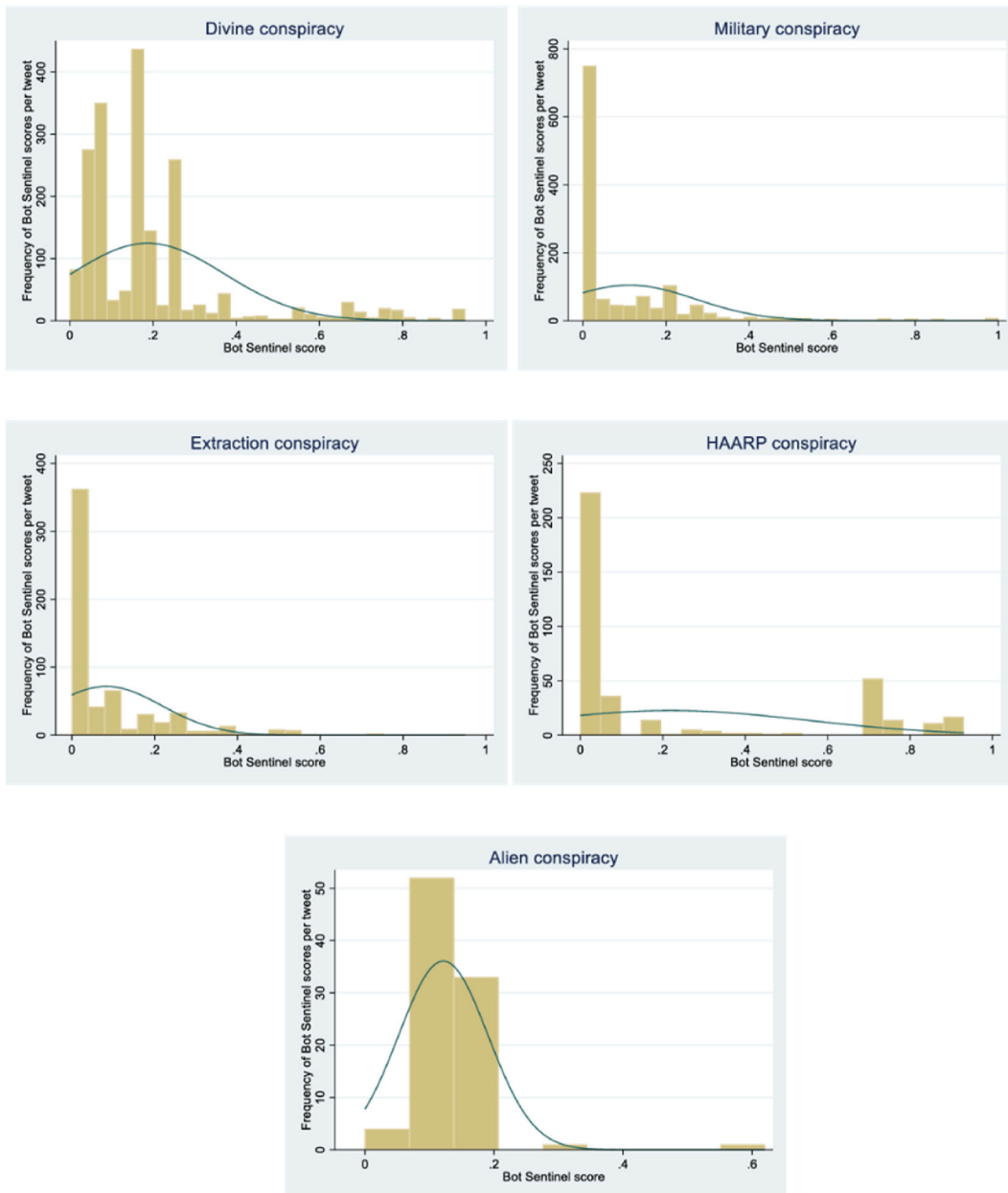


Fig. 6. Distribution of Bot Sentinel scores of tweets.

Sentinel score of tweets is lower than the average Bot Sentinel score of accounts for most of the conspiracies (apart from the HAARP conspiracy), which suggests that toxic accounts were tweeting less than normal ones. In Table 5, we also find a confirmation of the pattern that the number of tweets per account decreased with the Bot Sentinel score. From Table 6, we see that there was a positive correlation between the bot score and the Bot Sentinel score (apart from the HAARP conspiracy).

The distribution of tweet Bot Sentinel scores is presented in Fig. 6, whereas the distribution of account Bot Sentinel scores is depicted in Fig. 7. The figures support the above finding that there are more normal accounts, i.e., accounts which highly likely do not post toxic messages, and these normal accounts also tweet more than toxic accounts.

#### 4. Discussion

Our results allow us to make several findings on the discourse about earthquake conspiracies.

*Dominant discourses.* Through analyzing the tweets, we identified seven discourses: the divine, the military, the extraction, the HAARP, the CERN, the masons, and the alien discourses. Of these, four dominated the discussions. The divine discourse referred to



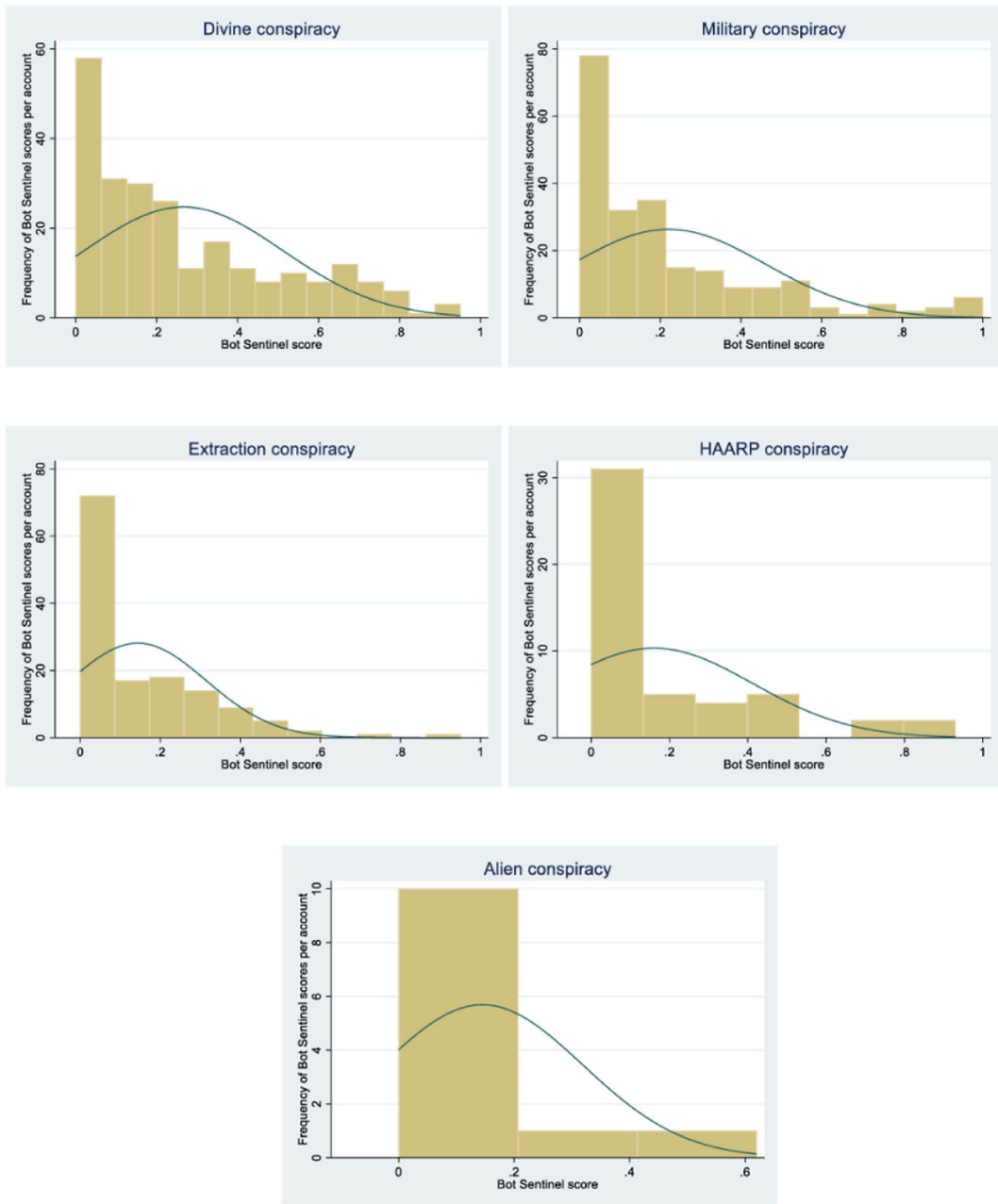


Fig. 7. Distribution of Bot Sentinel scores of accounts.

beliefs in divine intervention or punishment as a cause of earthquakes. The military discourse referred to the idea that the military was responsible for causing earthquakes, either as a weapon or as a side effect of military activity. The extraction discourse centered around the idea that natural resource extraction caused earthquakes, often through fracking. Finally, the HAARP discourse referred to the High Frequency Active Auroral Research Program, a scientific research program that some believe has the capability to control weather and cause earthquakes. These four discourses were far more common than the other three, which were less frequently discussed. The CERN discourse, which referred to the European Organization for Nuclear Research, was only present in a negligible number of tweets, whereas no one was discussing earthquakes in connection with masons. We also discovered that the alien discourse was not as popular as the other four discourses but was still present in the discussions. The alien discourse centered around the idea that extraterrestrial beings were causing earthquakes.

*More humans than bots.* We also looked at the accounts that were discussing these discourses. We found that there were more human-like accounts than bot-like accounts, suggesting that much of the discussion around earthquake conspiracies was coming from real people.

*Bots more active than humans.* We also found that the number of tweets was positively correlated with the bot score of the account, indicating that bot-like accounts tweeted more than human-like accounts. Likewise, we see that the average bot score of tweets was higher than the average bot score of accounts, which supports the pattern. This suggests that while real people may be discussing earthquake conspiracies, bots are amplifying and spreading these discussions to a greater extent.

*More normal accounts than toxic accounts.* We also examined the tone of the discourse around earthquake conspiracies. We found that there were more normal accounts than toxic accounts, suggesting that much of the discourse was not explicitly harmful or malicious. However, it is worth noting that the presence of even a small number of toxic accounts can still have a significant impact on the overall tone and perception of the discourse, particularly for those who are targeted by such behavior.

*Normal accounts more active than toxic accounts.* We found that the number of tweets was negatively correlated with the Bot Sentinel score of the account (apart from the HAARP conspiracy). We see that the average Bot Sentinel score of tweets was lower than the average Bot Sentinel score of accounts, i.e., normal accounts tweeted more than toxic accounts. This suggests that while there may be some toxic discourse around earthquake conspiracies, it is not as prevalent as more neutral or informative discourse.

*More toxic accounts among bots.* Our analysis of the Twitter discourse on earthquake conspiracies also revealed interesting insights into the role of bots and their behavior in promoting or disseminating conspiracy theories. We observed a positive correlation between the bot score of an account and the Bot Sentinel score of the account, indicating that bot-like accounts were more likely to exhibit toxic behaviors compared to human-like accounts. However, it is worth noting that this relationship only held true for all discourses except for the HAARP conspiracy.

## 5. Conclusion

This paper analyzed earthquake-related conspiracy discourses on Twitter. The analysis was conducted following the 5.6 earthquake in Indonesia in November 2022. The paper identified the dominant discourses, which were the divine, the military, the extraction, the HAARP, and the alien ones. Using Hoaxy, Botometer, and Bot Sentinel, the paper then studied the distribution of tweet and account bot scores and also the level of normality or toxicity of accounts and tweets.

The paper found that the distribution of accounts tended towards more human-like accounts, whereas the distribution of tweets was more towards bot-like accounts. The number of tweets was positively correlated with the bot score of the accounts, which posted these tweets, which suggests that bot-like accounts were tweeting more. The paper also found that normal accounts tweeted more than toxic accounts. Moreover, the Bot Sentinel score was positively associated with the bot score, which indicates that bot-like accounts were involved more in disruptive activities than human-like accounts.

The findings of the paper suggest that though most of the earthquake-related conspiracy discourse was normal, toxic accounts still played a role, and a larger share of toxic accounts were bot-like accounts rather than human-like accounts. This implies that bot-like activities should be further observed to avoid potential spread of misinformation, which could have negative behavioral consequences.

## Declaration of competing interest

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All authors declare that they have no conflicts of interest to disclose.

## Data availability

Data will be made available on request.

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