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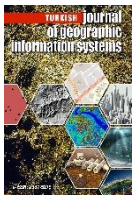

Verifying reports of collapsed buildings from twitter aftermaths of earthquakes: A case study from Turkey

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ABSTRACT

On February 6, 2023, two highly severe earthquakes occurred in a wide region encompassing 11 cities in Turkey, resulting in extensive damage and an official death toll exceeding 50,000. In the aftermath of this catastrophic event that affected multiple cities, identifying the locations of debris with potential survivors became a crucial challenge for search and rescue operations. However, another significant obstacle emerged in obtaining accurate and genuine addresses. Individuals who were either trapped themselves or had relatives under the collapsed buildings attempted to report addresses using conventional communication methods. Communication difficulties on lines prompted disaster victims to resort to internet-based communication methods. Consequently, social media platforms emerged as powerful tools for rapidly disseminating information to millions of people. However, alongside the positive impact of social media, the risk of generating significant panic due to the spread of fake news also surfaced. This study analyzes tweets posted on Twitter within the first 24 hours following the earthquakes. Firstly, tweets containing reports of collapsed structures were identified, and text parsing techniques were employed to extract address information. The veracity of destruction at these addresses was confirmed using imagery captured from Unmanned Aerial Vehicles (UAVs) in the aftermath of the earthquakes. As a result, a 90% accuracy rate was observed in confirming the presence of destruction either at the reported addresses or within a 100-meter proximity, based on the top 100 most widely shared reports on social media. Moreover, the presence of numerous unidentifiable addresses highlights the necessity for continued enhancements to the Address Registration System.

1. Introduction

Earthquakes are natural disasters that result in significant loss of life and property worldwide. In regions with high earthquake risk, such as Turkey, the impacts of earthquakes can be particularly severe (Avdar & Avdar, 2022). On February 6, 2023, two highly severe earthquakes occurred in Turkey, resulting in numerous casualties and extensive damage.

This disaster, which affected 11 cities, led to the collapse of buildings on a large scale, resulting in people being trapped under debris. Immediately following the earthquakes, search and rescue operations were initiated by various institutions and organizations in the affected areas to locate survivors trapped under the debris of collapsed buildings. Identifying the debris sites with potential survivors becomes a critical problem in such large-scale disasters affecting multiple cities. To address this challenge, scans using different technological devices were conducted at the indicated addresses within the debris. However, one of the major challenges encountered during this process is obtaining accurate address information. Address reports provided by individuals trapped under the debris or their relatives are crucial for effectively guiding the efforts of rescue teams. In this context, the address definition is important. It is provided with AKS (Address Registration System) for the standardization of addresses in our country (Türk, 2008). AKS holds immense importance as it guarantees the continuous maintenance of accurate settlement and address information for citizens residing in Turkey. This is achieved through a centralized electronic framework, effectively resolving the prevalent confusion surrounding addresses (Ulutaş, et al., 2021). The Spatial Address Registration System Project (MAKS) was established in order to combine the textual address information on AKS with geographical coordinates and to integrate the created infrastructure with other systems (Öztürkçü & Suri, 2020). Nevertheless, a study has revealed that the addressing system in Turkey has not been thoroughly understood and effectively implemented (Kılıç & Gülgen, 2019).

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The scans conducted with technological devices have made a significant contribution to detecting survivors in the debris (Yılmaz & Demiröz Yıldırım, 2020). However, alongside the available technological capabilities, obtaining accurate address information is also a critical factor. There is an application named as "AFAD ACİL" developed by the Ministry of Internal Affairs, Disaster and Emergency Management Presidency. Thanks to this app users can view the assembly areas and initiate an emergency call in case of disaster. Although this application proves to be very useful, it has been observed that most of our citizens have not downloaded the application (according to number of downloads in stores). Furthermore, there is also the possibility that phones might not be with individuals during an earthquake. Apart from these issues, significant disruptions have also been experienced in local telephone lines during earthquake. Due to these problems, social media platforms have played a significant role in collecting this information. Social media, with its ability to reach millions of people quickly, has significant impacts in various fields (Kankanamge et al., 2020). Particularly in the aftermath of earthquakes, the contribution of social media in rapidly disseminating reports and supporting emergency management is undeniable (Nekoei-Moghadam & Savabi, 2021).

However, the influence and widespread use of social media have also brought some challenges. Fake reports and news can lead to serious panic and waste valuable time. Therefore, evaluating the accuracy of earthquake reports on social media and associating this information with correct addresses is an important research topic.

This study aims to analyze tweets posted on the Twitter platform during the relevant dates to identify address information contained in reports of collapsed buildings. Subsequently, the status of the buildings at these addresses will be verified to analyze the accuracy of the reports.

2. Method

2.1. Dataset

The majority of rescue operations in earthquake disasters occur within the first 24 hours (MacIntyre et al., 2012). In this context, a dataset was created from tweets posted within a 24-hour timeframe starting from the occurrence of the initial earthquake on February 6, 2023, at 04:17.

The Twitter API was used for data retrieval from the Twitter platform. However, due to recent policy changes, the platform has been shut down for free academic use. As a result, alternative options for data retrieval were explored, and it was determined that the APIFY platform (www.apify.com) is most suitable for this task. The platform utilizes code scripts called "actors" to extract data from websites with various parameters. The "tweet flash" tool (Larson, 2023) was used on this platform for retrieving historical and keyword-based tweets. The parameters of scraping are given below Table 1.

Table 1. Scraping parameters

Parameter	Value
Keywords	"hatay" and "enkaz"
Date interval	06 Şub. 2023 04:17 - 07 Şub. 2023 04:17
Number of tweet per user	5000
Language	Turkish
Other infos that scraped (about tweet)	Number of retweets, Number of replies, Number of likes, URL, timestamp, images.
Other infos that scraped (about user)	Username, fullname, number of followers and followings, total tweet count, total like count, profile picture.

To limit the scope of the analysis, we selected Hatay city, which suffered the most damage in the earthquakes. Some of the sample reports are given below Table 2.

Table 1. Samples for collapsed reports tweets

	Username	Tweet	Timestamp	Retweets	Replies
1	**@can********	Hatay belen sarımazı mahallesi tuna sokak no 16 da . . . hâlâ enkaz altında. Ekipler çok yetersiz. Şarjımız çok az ve hava çok soğuk. Lütfen yetkililere haber verin. . . .	2023-02-06 14:01:00	3987	328
2	**@ked********	22 saattir enkaz altındalar. . . . Mehmet Latif Gün Tuğba Pınar Gün 05395558809 Antakya Hatay akademi hastanesi arkası /Odabaşı Mahallesi Akademi Hastanesi sokak Akademi apartmanı	2023-02-07 01:24:00	2231	62
3	**@alp********	. . . enkaz altında bina çökmüş haber alamıyoruz . Güzelburç mahallesi 600 konutlar sitesi 7 blok kat 3 Hatay Antakya Hakan yavuz Ali yavuz	2023-02-06 13:42:00	1466	46

As a result of the process conducted with these parameters, a total of 46,011 tweets were retrieved. These tweets were posted by 27,260 different accounts. The average number of tweets per user was determined to be 1.6. The users who posted the most tweets (more than 20 tweets) are provided in Figure 1. The number of followers for each user is also shown. Further research can be conducted to determine whether the users who posted the tweets are bots or genuine accounts.

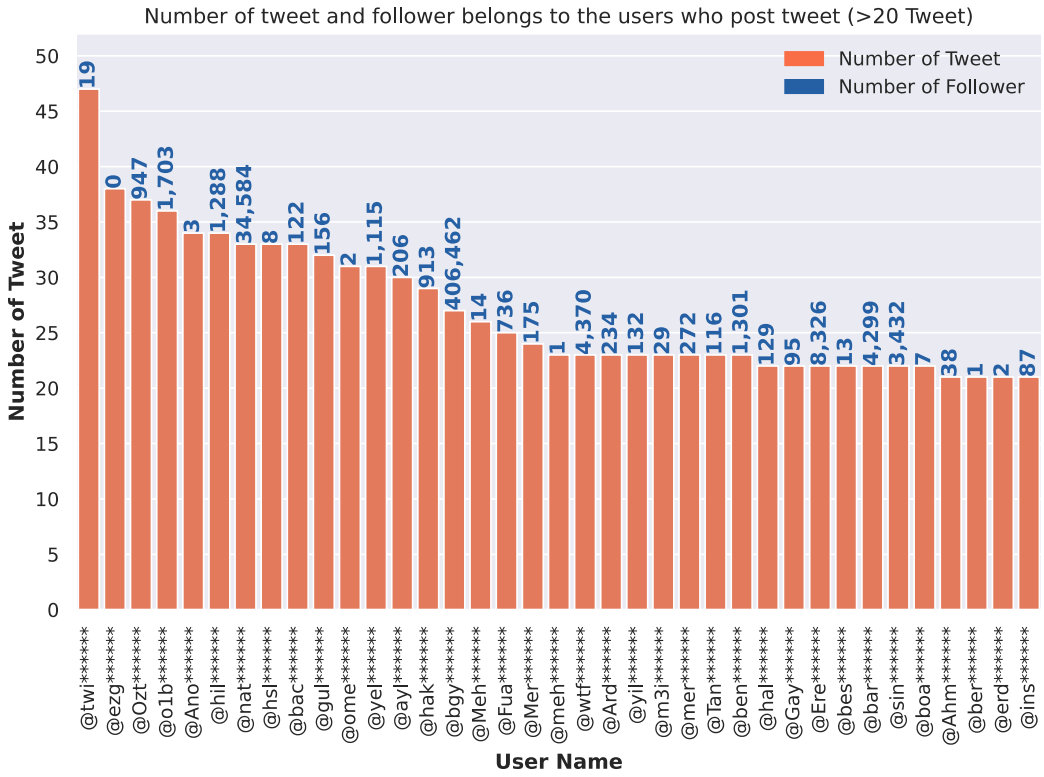

Figure 1. The users who tweeted more than 20

The distribution of tweets over time is depicted in Figure 2, where the tweets are grouped into 2-minute intervals. It is evident that tweeting activity commenced immediately after the onset of the earthquake. On average, 130 tweets were posted, with the highest volume occurring between 17:00 and 23:00. However, certain time intervals exhibited no tweet activity, possibly due to API-related errors. Additionally, the implementation of internet throttling on the specified date in our country could have also contributed to this intermittent tweeting pattern.

2.2. Method

2.2.1. Identification of tweets with reports

Following the acquisition of the dataset, the process of selecting tweets that contain address reports has been initiated. In this regard, the texts of the tweets have undergone standard text preprocessing procedures. Subsequently, the following regular expression (regex) pattern, which represents an address information, has been utilized. The regex statement for address pattern (Equality 1);

```
'\b\d+\s+((?:\w+\.?\s?)+),?\s?((?:\w+\s?)+),?\s?((?:\w+\s?)+)?'          (1)
```

After matching this pattern, a total of 20,249 tweets containing address information were obtained. It was observed that some erroneous data was included at this stage. However, due to the challenging nature of Turkish address detection, these errors were disregarded. Subsequently, an attempt was made to find an automated method for extracting addresses from tweets, but no success was achieved in this regard. Therefore, the decision was made to manually extract the addresses. Instead of performing this process for over 20,000 tweets, the filtered dataset was sorted based on the number of retweets to select the tweets with the widest impact in the region. From this sorted set, the first 100 reports were chosen for visualization purposes.

2.2.2. Analyzing of address text for Turkey

Various issues have emerged in the obtained address information. Examples of these addresses are provided in Table 3.

Table 2. Samples of address text from tweets

Retweet Count	Address Text
4763	Ekinci District İnönü Street B Block 3rd
3224	Floor Hatay/600 Residence Güzelburç
2452	Kurtuluş neighborhood namık kemal street no:18 Hatay/Kırıkhan

As seen in Table 3, the address information is shared in various formats, such as those without building names, those indicating only a region, and those including building numbers. Attempts were made to convert these addresses to latitude-longitude values using different APIs. However, due to the non-standard representations of addresses in Turkey, this process was unsuccessful. For example, with the Nominatim library written in Python, an address in the United States can be easily converted to a geocode value (lat-long).

The sample address from USA and geocode value is given below:

- 175 5th Avenue NYC
- The geocode of this text “40.741059,-73.989641”

No API for Turkish addresses or similar services could be utilized, and the process of obtaining latitude-longitude values from addresses was performed manually.

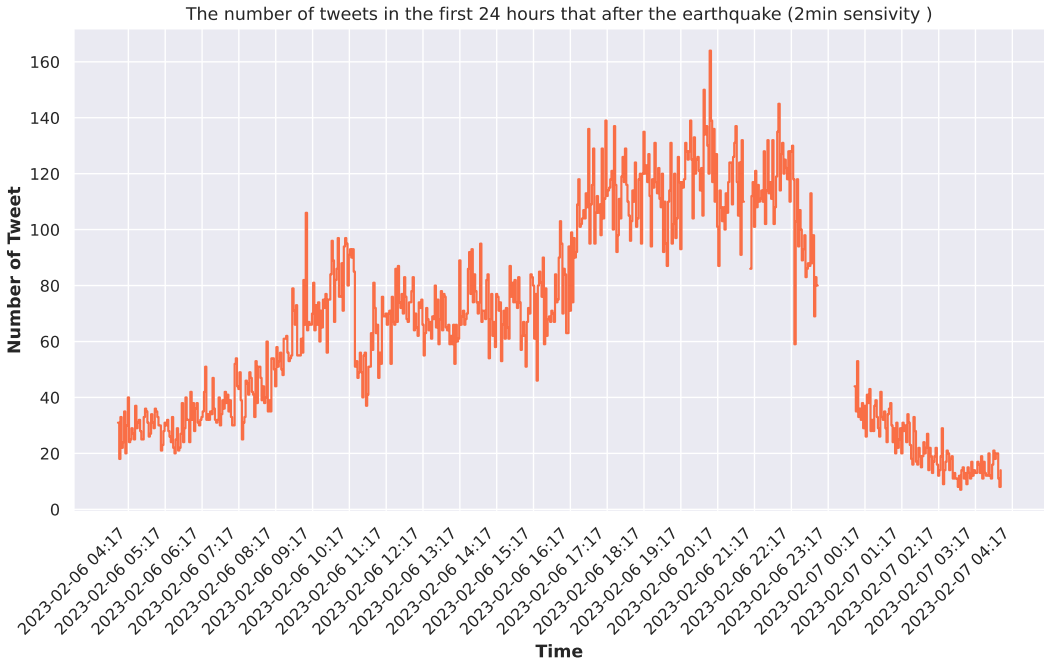

Figure 2. The distribution of tweets over time

2.2.3. Finding the relates addresses

Accordingly, for the first 100 addresses, queries were made directly on Google and Yandex maps using the text within the tweets, and the obtained values were recorded. Considering that search and rescue teams may not be familiar with the specific city/region, it is anticipated that they would rely on the address information obtained directly from these reports. In this context, the information within the tweet text was used without any modifications or additions to the address texts. As a result of these queries, it was observed that some address information was incomplete, and some had no corresponding location on the map.

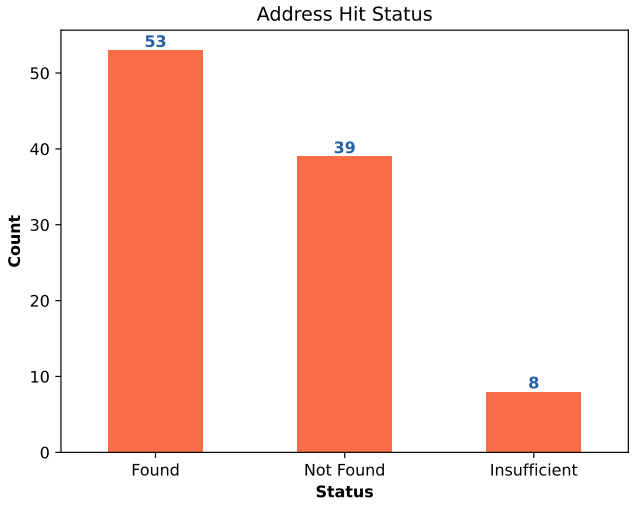

Figure 3. The reported address hit status from related text.

The address statistics for the first 100 reports of collapsed buildings are presented in Figure 3.

The coordinates in the WGS1984 geographic coordinate system for the address information found in the tweets were used to create a point layer in ArcGIS software. The points were categorized into three groups: "Found," "Not Found," and "Insufficient." For the addresses that could not be found or had insufficient information, a circular area with a radius of 100 meters was used to represent their location.

To create a spatial distribution map, aerial images captured by unmanned aerial vehicles (UAVs) shared by the Ministry of Environment and Urbanization and Climate Change were overlaid on a World Map Service (WMS) imagery display service.

The study utilized the WMS (World Map Service) shared by the respective Ministry to determine the spatial distribution. WMS is a service that allows for the visualization and sharing of geospatial data. Post-earthquake imagery captured by Unmanned Aerial Vehicles (UAVs) was integrated into the WMS imagery service. By overlaying the UAV imagery onto the WMS service, a visual representation of the spatial distribution of the earthquake-affected areas was obtained. By incorporating the WMS service into a Geographic Information System (GIS) such as ArcGIS, it was possible to map and analyze various geospatial data. The point data obtained from the tweets was then combined with the WMS imagery to generate a spatial distribution map. This map illustrates the distribution of incidents reported in the earthquake-affected regions.

The general workflow followed in the study is illustrated in Figure 4.

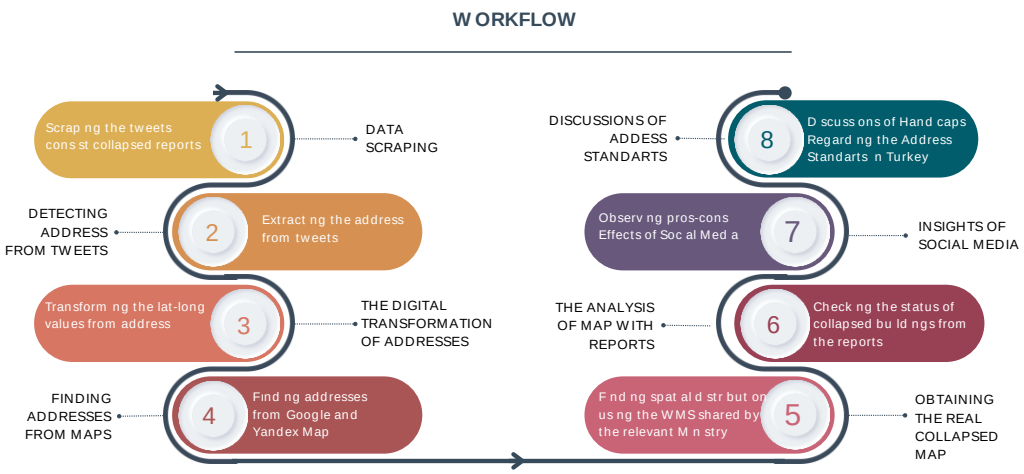

Figure 4. The workflow of the study

3. Results

After the earthquake, the buildings in the addresses accurately identified through maps and the structures surrounding the addresses that could not be found were examined. Based on this, the destruction status is shown in Figure 5 below.

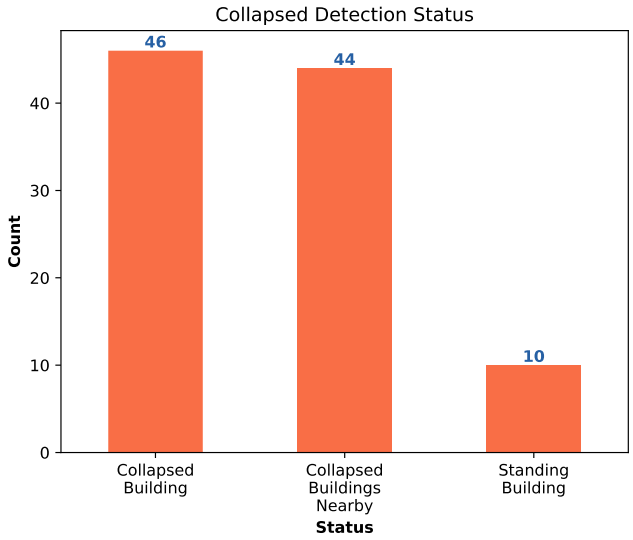

Figure 5. The real status of collapsed buildings that reported via tweets

It was observed that out of the 53 reported addresses with accurately identified locations, 46 buildings were collapsed. According to the examination of post-earthquake maps, it was determined that the structures in 7 addresses remained intact. As for the 54 addresses that could not be precisely located, it was found that 9 of them had debris in their vicinity, while 51 had debris in a 100-meter radius. For 3 of these addresses, no destruction was observed within the scanned area of 100 meters. This indicates that the accuracy rate of the reported addresses is approximately 90%.

The results were obtained by taking zoomed-in visual images for the examined 100 points on the map.

All the images are shared on the GitHub repo named as "kadirseker00/earthquakeTwitter". This study only showcases certain areas of Hatay/Merkez. The whole city center is given in the Appendix part (Appendix 1).

For example, as seen in Figure 7, it was determined that the structure in the 32nd address had collapsed. In the regions marked as "insufficent" (highlighted in red) in the 34th, 46th, 60th, 61st, 66th, and 70th reported addresses, a significant number of debris can be observed.

Moreover in Figure 7, as seen in the 49th and 34th reported addresses, some reports indicate close or overlapping areas. In this context, common marked areas can be observed in the provided images.

In Figure 8, it can be observed that the buildings in the addresses 14, 38, 77, and 89 have collapsed. The 9th reported address, provided as "kışlasaray 1 hatay," was marked as insufficient, and the corresponding area within a 100-meter radius (highlighted in blue) centered around the general region was shown. Again, destruction can be seen in that area.

Figure 6. The debris of the "rönesans residence "

Indeed, one striking example of reports coming from social media is the numerous reports regarding the "Renaissance Residence" site and the surrounding debris where many people lost their lives. These reports serve as a vivid example of the information obtained through social media channels regarding the extent of the devastation and the need for rescue and recovery efforts.

4. Discussion

In this study, it was observed that most of the accurately located building reports were based on numerical addresses. Addresses that directly mentioned building names were found to be untraceable. Although systems such as AKS and MAKS have been developed, studies demonstrate the problems of a standardized address generation system in our country and highlights the significant impact it has. Additionally, repetitive neighborhood, street, and building names in some addresses also contribute to the confusion. it is therefore considered urgent to discuss this issue and complete the standards with ministries between local governments. Another topic of discussion is the impact of social media in such disasters. The results of this study show that the majority of reports made through social media were accurate. However, it is important to address the issue of false information or untraceable addresses disseminated by well-intentioned individuals during the chaotic post-disaster environment. The presence of bot accounts in such platforms is also a concern. In this regard, it is necessary to establish domestic and national systems/platforms where these reports are made by real individuals. Lastly, authorities should actively promote the awareness and adoption of essential applications like AFAD ACIL. Additionally, there is a pressing need to design such applications to cater to various earthquake scenarios, ensuring their effectiveness.

Figure 7. The annotated visual of post-earthquake map reports (from Hatay city center)

Figure 8. The annotated visual of post-earthquake map reports - 2 (from Hatay city center)

5. Conclusion

In natural disasters like earthquakes, social media has both positive and negative effects. It has been observed that during critical times when traditional communication methods are disrupted, internet-based communication plays a crucial role. This study was conducted to demonstrate the impact of social media following the earthquakes that occurred in Turkey on February 6, 2023. Numerous reports were made on Twitter after the earthquake, and an investigation was conducted on the first 100 reports that were believed to have been widely circulated (based on retweet count). The findings revealed that 90% of the reports were accurate. It was concluded that social media does not have a significant negative impact as previously assumed.

Another significant outcome of this study is the observation of the flaws in the addressing system in Turkey. The continuous changes and repetitive addresses in text form can lead to serious misconceptions for search and rescue teams during such disasters. Therefore, transitioning to numerical-based unique and concise addressing algorithms is recommended. Furthermore, this study also considers investigating the origin and impact of false reports as a subject of research.

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Author Contributions

A single author carried out the study.

Statement of Research and Publication Ethics

Research and publication ethics were complied with in the study.

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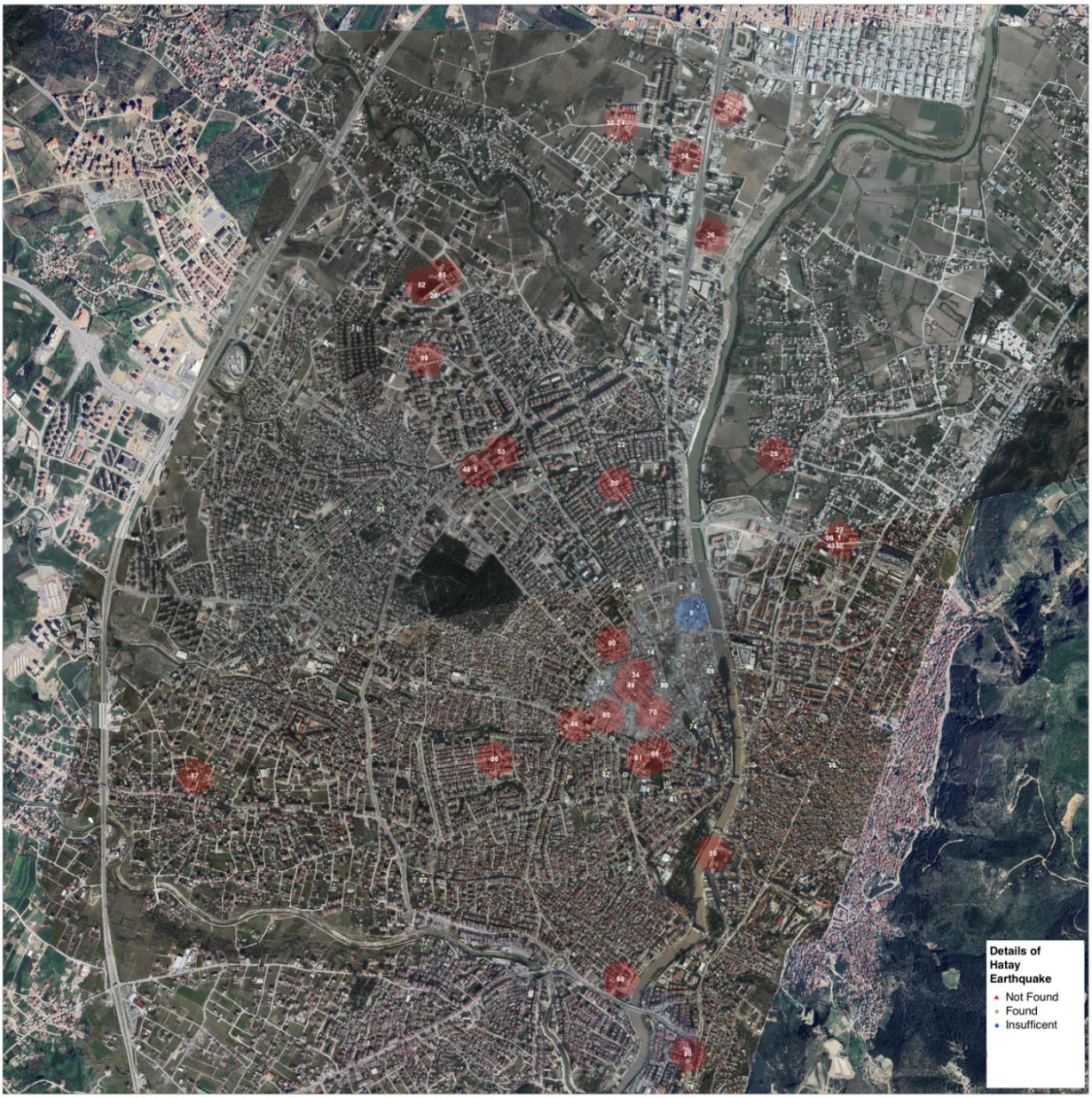
Appendix



Appendix 1. The whole city center