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Visualization of Tweets and Related Images Posted During Disasters

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Abstract. To minimize damage during disasters, rapid collection and delivery of accurate information are essential. From this perspective, the use of social media, especially Twitter, in the case of a disaster has attracted worldwide attention. On the other hand, it is known that the number of tweets explodes at the time of a large-scale disaster. For example, at the time of the 2018 northern Osaka earthquake, more than 270,000 tweets containing the word “earthquake” were posted during the 10 minutes immediately after the quake. Therefore, it is essential to analyze the characteristics of tweets in order to make effective use of Twitter at the time of a disaster. In this study, we develop a system to simultaneously visualize the content of disaster-related tweets as well as the attached images that are related to their textual content. The purpose of constructing the system is to encourage prompt decision-making from local government and rapid evacuation actions by disaster-affected residents in the event of a disaster. From the visualization results using data from tweets posted during Typhoon Hagibis in 2019, it is shown that the proposed system is useful in the event of a disaster. It is also found that good results can be obtained by using datasets consisting of tweets posted during other disasters.

Keywords: Disaster, Disaster Mitigation, Twitter, Visualization, Co-occurrence network

1 Introduction

In recent years, Japan has been hit by several natural disasters. In particular, extensive damage resulted from the 2017 northern Kyushu heavy rain disaster [1], the 2018 northern Osaka earthquake [2], the 2018 western Japan heavy rain disaster (2018 Japan Floods) [3][4][5], and Typhoon Hagibis [6] in 2019. In order to minimize the damage caused by such large-scale disasters, it is crucial to collect and transmit information quickly and accurately. From this perspective, the utilization of social media, especially Twitter, has been attracting worldwide attention [7][8][9][10][11][12]. At the time of the Great East Japan Earthquake in March 2011, many residents in the affected areas

used Twitter to collect information about the tsunami, evacuation centers, and public transportation services [13][14][15][16]. Nishikawa et al. showed that many tweets, including the Japanese hashtag #救助 (meaning “#rescue”), were posted for rescue requests during the 2018 Japan Floods [4]. The following text is an example of a tweet posted after the 2016 Kumamoto earthquake struck (originally written in Japanese): “There is no food or drink at Ubuyama Junior High School. The people there are in real trouble. Please send them food. Please help them. They need disposable diapers because there are many seniors.” Tweets like this can help not only the victims but also government agencies and disaster volunteer groups to get a better understanding of the situation and make the right decisions.

On the other hand, it is known that the number of tweets explodes at the time of a large-scale disaster. For example, on the day of the Great East Japan Earthquake, about 33 million tweets were posted. When Hurricane Sandy hit the U.S. East Coast in 2012, many people used Twitter to share disaster-related information; more than 20 million tweets that included the words “sandy,” “hurricane,” “#sandy,” and “#hurricane” were posted between October 27 and November 1, 2012 (<https://twitter.com/Twitter/status/264408082958934016>). At the time of the 2018 northern Osaka earthquake, more than 270,000 tweets containing the word “earthquake” were posted during the 10 minutes immediately after the earthquake [2]. Therefore, it is essential to analyze the characteristics of tweets in order to make effective use of Twitter at the time of a disaster. From that point of view, in previous work, we have analyzed tweets at the time of a disaster [1][2][3][4][5][6][17]. However, our research so far has focused only on tweet text. It is clear that analysis of the images attached to tweets is also critical in order to further utilize tweets in the event of a disaster [18][19][20].

In this study, we developed a system to simultaneously visualize the content of disaster-related tweets and the attached images, which are related to the textual content of the tweet. The purpose of constructing the system is to encourage prompt decision-making from local governments and the rapid evacuation of residents from disaster-affected areas.

2 Tweet Data for Analysis

This study mainly considers tweets related to Typhoon Hagibis, which caused severe damage in a widespread area of eastern Japan in October 2019. This typhoon killed more than 80 people, more than 3,000 buildings were utterly destroyed, and a further 28,000 were partially destroyed. The typhoon inundated many rivers in areas of eastern Japan. Figure 1 shows an example of a tweet posted during Typhoon Hagibis. We primarily focus on the flooding of the Chikuma River, which runs through Nagano Prefecture, which caused extensive damage to the river basin. Then, we used the Twitter API to collect original tweets (non-retweeted tweets) that were posted between October 12 to 13, 2019 and contained the word “千曲川” (Chikuma River). A total of 64,819 tweets were collected, and of these, 4,755 had images attached. We then deleted tweets that appeared to be quotes from news articles, finally obtaining 4,209 tweets to analyze.

Figure 2 shows the trend in the number of these tweets posted at ten-minute intervals. The number of tweets rose sharply at around 20:50 on October 12. The Chikuma River in Nagano city, the capital of Nagano Prefecture, flooded around this time. The number of tweets soared at around 6:50 on October 13, when the extent of the damage was actively reported in the morning news on TV.

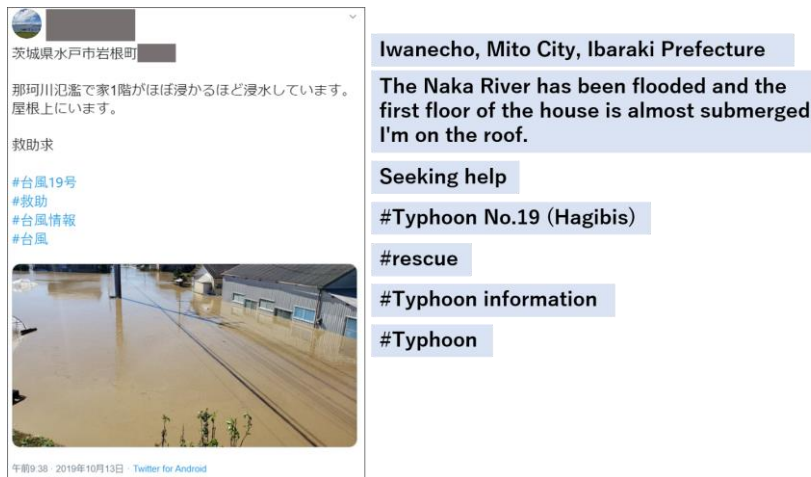


Fig. 1. An example of a tweet posted during Typhoon Hagibis in 2019

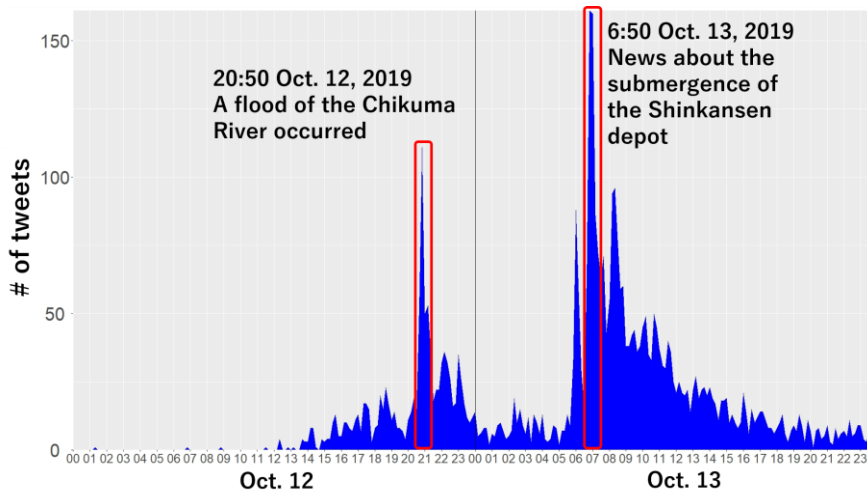


Fig. 2. Number of tweets analyzed at 10 minute intervals (Typhoon Hagibis in 2019)

2019-10-12 14:00:00~2019-10-12 14:59:59
8ツイート 79ルール

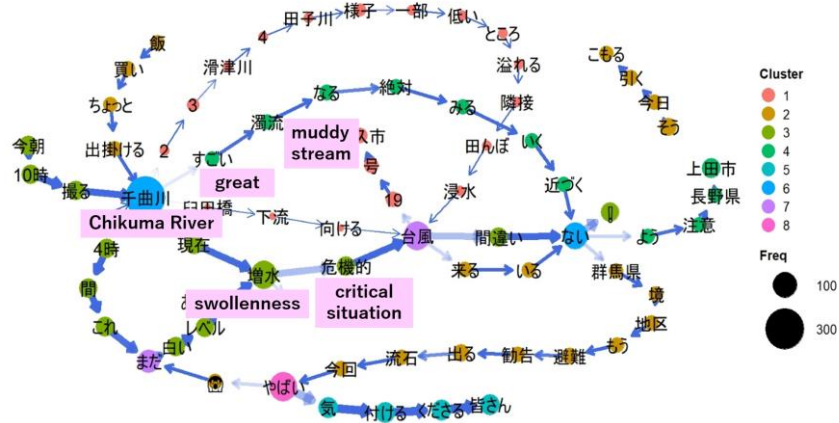


Fig. 3. Example of co-occurrence network of tweets (Typhoon Hagibis in 2019)

3 Visualization of Tweets

3.1 Visualization of Tweets using a Co-occurrence Network for Comprehending Posted Content

In this study, we used a co-occurrence network as a method of comprehending the content of tweets. Figure 3 shows the co-occurrence network created from one hour of tweet data, starting from 14:00 on October 12, 2019. The size of the circle indicates the frequency of occurrence of particular words, the thickness of the arrow indicates the frequency of co-occurrence, and the opacity of the arrow indicates the magnitude of the co-occurrence rate, $CR(A \rightarrow B|B)$, of words A and B , where

$$CR(A \rightarrow B|B) = \frac{Fr(A \rightarrow B)}{Fr(B)}. \quad (1)$$

Here, $Fr(A)$ and $Fr(A \rightarrow B)$ denote the frequency of the occurrence of the word A and the frequency of co-occurrence of two words $A \rightarrow B$, respectively. From Fig. 3, it can be seen that there were posts about the river conditions, containing text such as “千曲川” (Chikuma River) → “すごい” (great) → “濁流” (muddy stream) and “増水” (swollenness) → “危機的” (critical situation). The flooding of the Chikuma River occurred at around 20:50, but it is speculated that it was in a dangerous state even around 14:00.

In the co-occurrence network, it is difficult to comprehend the relationship between the preceding and succeeding words when one word has multiple connections.

Especially in this study, since “千曲川” (Chikuma River) appears in every tweet, it is difficult to comprehend how the words that co-occur before and after “千曲川” (Chikuma River) are connected. Therefore, a cluster analysis was performed using the frequency of the occurrence of the words in each tweet, and the words were then grouped.



Fig. 4. Screenshot of the proposed system (Typhoon Hagibis in 2019, 16:00 on October 12, 2019)

3.2 Simultaneous Visualization System of the Co-occurrence Network and Images Attached to Tweets

We consider a method to visualize the type of images attached to tweets in an easy-to-understand manner. First, in order to make it easier to understand the relationship between the textual tweet content and the attached images, we collected images attached to tweets in which the words in each cluster are included in the text. We also created a system that displays the co-occurrence network and the attached images at the same time.

Figure 4 shows the co-occurrence network created from the tweet data during the one hour period that began at 16:00 on October 12, 2019, as well as the attached images related to the words in the cluster, including “余談” (prediction), “許す” (permit), and “状況” (situation). At the top of the image, the original time that the tweet was posted and the degree of attention (number of retweets and favorites) that the image received are displayed. By looking at the state of the river in the picture, the meaning of “a situation that is difficult to predict (an unpredictable situation)” can be understood more intuitively. We were also able to find two posts from the phrase “an unpredictable situation.” In this way, this system can find similar images from the words in the tweet

and display them all together. Figure 5 shows the analysis results created from the tweet data for the one-hour period that began at 7:00 on October 13, 2019. This was around the time when the number of tweets increased as the typhoon had passed, and the extent of the damage became apparent. In particular, it can be seen that many people were shocked by the submergence of the Hokuriku Shinkansen, with many taking photos of TV news images and posting them. Figure 6 shows the results created from the tweet data for the one-hour period that began at 23:00 on October 12, 2019. Although the number of tweets during this time was not large, information on evacuation shelters had been released, and it can be said that it is a useful visualization to encourage the evacuation of residents.

Our system can display not only the overall result of the co-occurrence network but also only the words that are directly connected to the words within the selected cluster. In addition, the system can choose one post from the attached images and display the tweet text simultaneously. In addition, the target date and time, the lower limit of the co-occurrence rate, the lower limit of the frequency ranking, the maximum number of clusters, and the cluster number for displaying images can be set. With these functions, it is possible to interactively analyze and visualize the object that the user is paying attention to.

3.3 Tweets Visualization Results of Other Disasters

We verified the usefulness of the visualization system constructed in this study by visualizing tweets posted during the 2018 northern Osaka earthquake and the 2018 Japan Floods.

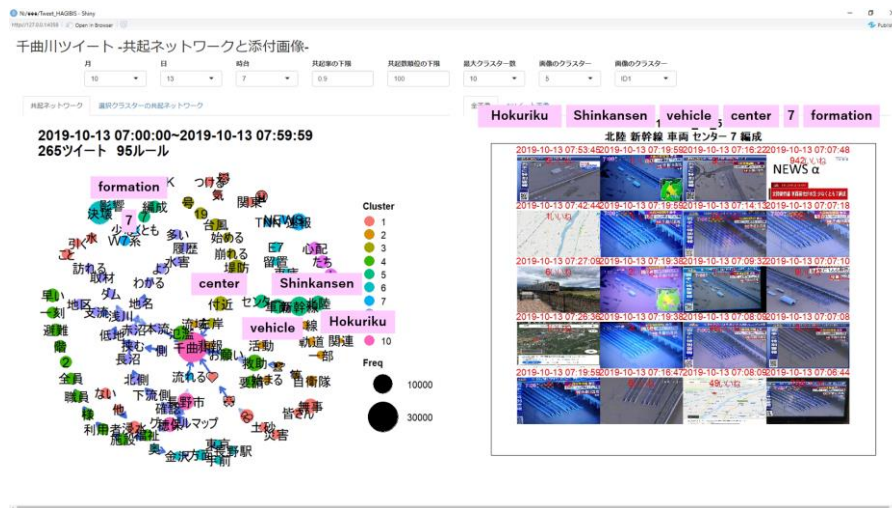


Fig. 5. Screenshot of the proposed system
(Typhoon Hagibis in 2019, 7:00 on October 13, 2019)



Fig. 6. Screenshot of the proposed system
(Typhoon Hagibis in 2019, 23:00 on October 12, 2019)



Fig. 7. Screenshot of the proposed system
(2018 northern Osaka Earthquake, 8:00 on June 18, 2018)

Figure 7 shows the visualization results from tweets posted during the 2018 northern Osaka earthquake (June 18, 2018, 8:00). From the co-occurrence network, there were tweets about the quake, which contained text such as “震度” (seismic intensity) → “6弱” (weak 6) and “深さ” (depth (of the epicenter)) → 10 → km, and tweets about the damage, which contained text such as “水道管” (water pipe) → “破裂” (burst) and

“高槻駅” (Takatsuki Station) → “水” (water) → “漏れ” (leaking). In particular, the situation where passengers flooded the platform attracted attention due to the significant damage that resulted in the suspension of train operations and water leaks at stations across Osaka Prefecture.



Fig. 8. A screenshot of the proposed system (2018 Japan Floods, 19:00 on July 6, 2018)

Figure 8 shows the tweet visualization results from tweets posted during the 2018 Japan Floods (July 6, 2018, 19:00). From the co-occurrence network, it can be seen that tweets about the announcement of the heavy rain special warning were posted in Hiroshima, Okayama, and Tottori prefectures at 19:40, containing text such as “特別” (special) → “警報” (warning) → “発表” (announcement). Besides, it can be seen that there were also posts urging residents to take action to evacuate, e.g., “Take action to save lives.” It can also be seen that images were posted comparing the normal conditions of the Kamo River in Kyoto City with pictures taken following the increase in the water on that day. The original tweets of these images were posted at around 10:00, and they were still being retweeted even 9 hours later and received considerable attention.

4 Discussion

From the analysis results for the three disasters, there was a difference in the shooting locations of the attached images. In tweets posted during Typhoon Hagibis in 2019, many pictures of the river were posted, but in tweets posted during the 2018 Japan Floods, images showing not only the state of the river but also the state of the submerged part of the city were also posted. There were few images of people in typhoons and heavy rain, but in tweets posted during the 2018 northern Osaka earthquake, there

were many posts from places where people were gathering, such as stations and amusement parks.

Since the characteristics of each disaster could be visualized appropriately, the system constructed in this study is considered useful for the analysis and visualization of tweet data.

5 Conclusion

This study developed a system to simultaneously visualize the contents of disaster-related tweets and the attached images that are related to the textual content. From the visualization results using data from tweets posted during Typhoon Hagibis in 2019, it was shown that the proposed system is useful in the event of a disaster. It was also found that good results can be obtained by using datasets consisting of tweets that were posted during other disasters. We are engaged in research pertaining to tweet classification and mapping at the time of disasters [16], efficient disaster information collection [21], and construction of disaster information sharing system using Twitter [22] [23][24]. We plan to expand on the findings obtained in the present study in these subsequent investigations.

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