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A quantitative approach to the 2014 Mt. Ontake volcanic eruption news coverage: understanding the information gap and the public response to the anniversary coverage

Ko Yamada

Abstract

This paper studies the news coverage of the 2014 Mt. Ontake eruption disaster from 2015 to 2019, and the public response to the fifth anniversary coverage. Information on the issues regarding the risk of low-frequency disaster events such as volcanic eruption is brought into the public largely through the media. Unless there is a volcano nearby, there are few opportunities to discuss volcanic disaster prevention, and enhance volcanic risk perception. Therefore, the media agendas on volcanic risk are an indicator of what people know about volcanic disaster preparedness. This study quantitatively analyzed the 2014 Mt. Ontake eruption reports of national, regional, and local newspapers to reveal their topic distributions. In addition, the anniversary gained intense public attention due to the large amount of media coverage. It was a significant opportunity for society to discuss volcanic risk. By observing people's online responses to the anniversary coverage, a trend could be identified. We found a significant difference in media attention among the three newspaper types. The local newspaper covered four topics relating to volcanic risk in a well-balanced way, but the national and regional newspapers paid greater attention to one or two topics. Many online comments presented the view that a mountaineering should be done at individuals' own risk, and volcano shelters would be ineffective for averting volcanic disasters. The anniversary coverage unintentionally contributes to stigmatizing or scapegoating a certain group, rather than promoting risk communication in the public sphere on the Web. With the onset of the information and communication technology era, an online dialogue regarding disaster awareness and prevention is important. A volcano disaster risk communication strategy on the Web should be developed.

Keywords: Volcanic disaster, Content analysis, Text mining, Risk communication, Collective memory

Introduction

Background

On September 27, 2014, Mt. Ontake erupted on the border between Japan's Nagano and Gifu prefectures. This steam-driven, phreatic explosion led to the worst volcanic disaster in post-war Japan, with 63 fatalities (five individuals are still missing) and 69 injured (The volcanic

emergency mitigation plan committee for Sabo of the Ontake volcano 2018). The 2014 eruption of Mt. Ontake occurred when the volcanic alert level of the Japan Meteorological Agency (JMA) was at its lowest. The eruption received extensive media attention, raising public awareness of volcanic risk, and led to the reform of legal frameworks for volcanic disaster risk reduction and management. This calamity is considered a milestone in volcanic risk management in Japan. Table 1 and Fig. 1 portray the timeline of volcanic warnings about Mt. Ontake and a map around Mt. Ontake, respectively.

Correspondence: yamada-k@yasuda-u.ac.jp

Department of Current Business, Yasuda Women's University, Yasuhigashi, Asaminami-ku, 731-0153 Hiroshima, Japan



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Table 1 Timeline of events associated with the 2014 volcanic eruption of Mt. Ontake

Date	Event
1979	A phreatic explosion at Mt. Ontake volcano (VEI 2)
2007	A phreatic explosion at Mt. Ontake volcano
Sep 10-16, 2014	An increase in volcanic earthquakes was observed (the volcanic alert level 1).
Sep 27, 2014	A phreatic eruption occurred at Mt. Ontake, and the JMA raised the volcanic alert level for Mt. Ontake from 1 to 3.
Oct 16, 2014	Relief efforts were completed.
Jan 19, 2015	The JMA set the access-limited area to within 3 km.
Jun 26, 2015	The alert level for Mt. Ontake was lowered to 2.
Jul 1, 2015	The Act on Special Measures Concerning Active Volcanoes was amended.
Jul 29, 2015	The search resumed for those listed as missing.
Jul 31, 2015	One body was recovered from a search, resulting in 58 deaths and five missing persons.
Aug 6, 2015	The search effort for missing persons was called off.
Dec 10, 2015	The revised Act on Special Measures Concerning Active Volcanoes was brought into force.
Jun 28 2016	Some restrictions on mountain trails were lifted.
Sep 24, 2016	The mountain trail up to the ninth station was allowed on the side of the village of Otaki.
Jan 25, 2017	A group of bereaved families filed a lawsuit against the local government and the JMA, claiming that they failed to raise the alert level when there was an increase in volcanic earthquakes at the beginning of September, 2014.
Aug 21, 2017	The alert level for Mt. Ontake was lowered to 1.
Jan 23, 2018	Phreatic explosion at Mt. Kusatsu-Shirane volcano, resulting in one fatality.
Sep 21, 2018	A group of bereaved families searched for missing individuals.
Sep 26, 2018	The town of Kiso lifted restrictions for going to the summit of Mt. Ontake (until Oct. 8th). Some grieving families climbed to the summit.
Jul 1, 2019	The town of Kiso lifted restrictions for going to the summit of Mt. Ontake (until Oct. 16th).

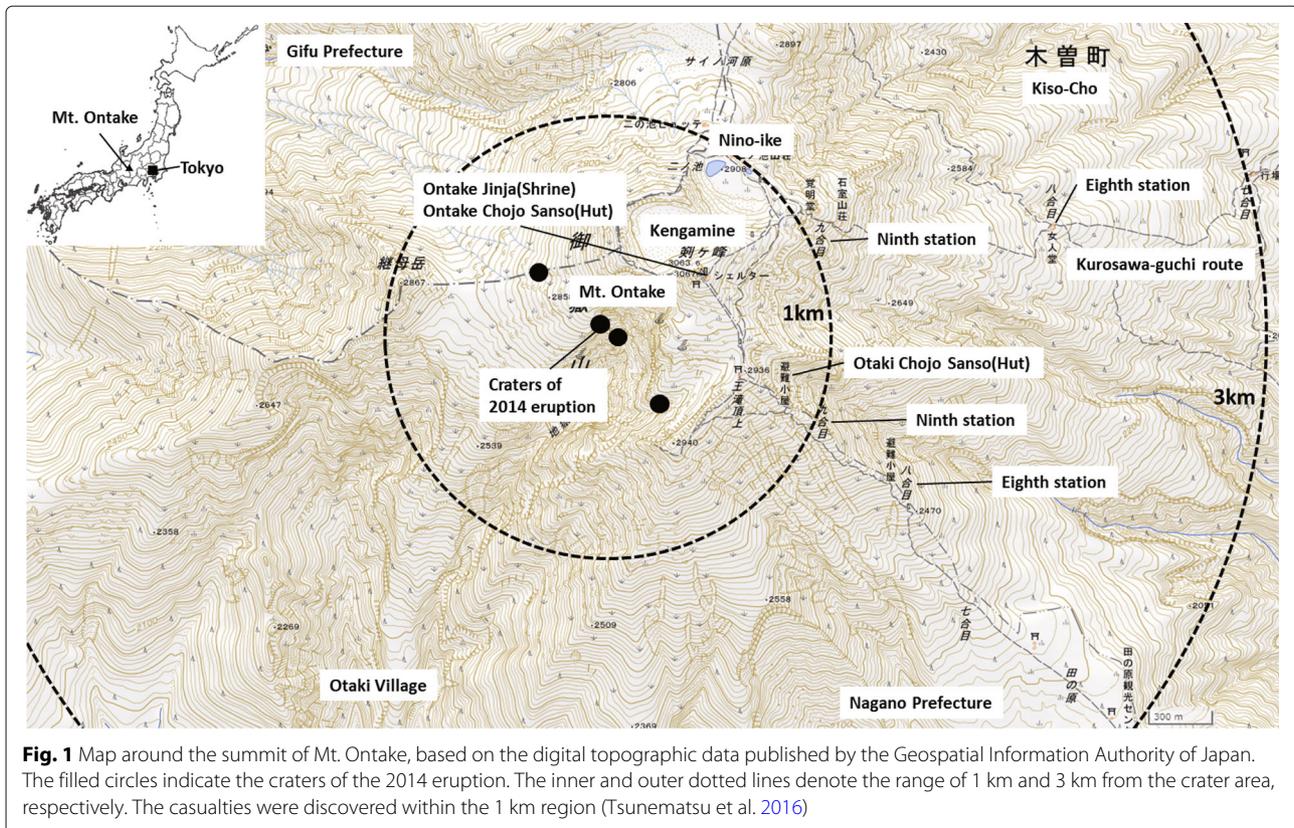
Source: Information taken from articles of the Shinano-Mainichi Shimbun, whose titles are “Events related to the volcanic eruption of Mt. Ontake” (September 26, 2019), and “The volcanic eruption of Mt. Ontake: Five years of recovery” (September 26, 2019) and the JMA (Japan Meteorological Agency 2020). According to the JMA, each volcanic alert level for Mt. Ontake is explained as follows: Level 1: Normal level but keep the active volcano in mind, Level 2: Eruptions that affect an area around a crater could occur, Level 3: Eruptions that cause heavy damage to the vicinity of residential areas could occur

According to the Act on Special Measures Concerning Active Volcanoes, amended after the eruption of Mt. Ontake, hikers and tourists themselves need to take steps to mitigate damage because only tangible factors like shelters are insufficient to save people’s lives from volcanic

disasters, although disaster risk reduction is primarily a government’s task. The Sendai Framework for Disaster Risk Reduction 2015-2030 (United Nations 2015) calls for a preventive approach by various relevant stakeholders in disaster risk reduction and management. Normally, people are not keen to conduct preliminary mitigation and preparedness measures because there is a lack of information about how to cope with natural disaster risks at an individual level. For those who complete formal education, mass media, especially TV and newspapers, are important avenues for acquiring scientific knowledge (National Institute for Environmental Studies 2015; Ministry of Education 2015). While newspaper circulation has steadily declined over the years, newspapers are still among the most credible sources of information (Nakai 2018). It is noted that each generation acquires news through various media channels at a different rate (Institute for Information and Communications Policy 2019). However, media have a tendency to cover similar subjects (Hagiwara 2000), because journalists share similar ideas in terms of news values, which determine the stories to be selected (Wendelin et al. 2017). By examining newspaper content, we can therefore understand which topics regarding volcanic risks are mainly transmitted to society.

Anniversary coverage

Media coverage on disaster and risk issues plays a leading role in increasing awareness of risk before future hazards strike. It also helps people to interpret the meaning of past natural catastrophes and conditioning how they respond to and what are politically prioritized (Pantti et al. 2012). Anniversary journalism focuses on the anniversaries of certain historical events, creating a community’s shared understanding of its past, and handing down lessons learned to future generations. Therefore, anniversary journalism substantially affects the “collective memories” (van Dijck 2007; Edy 2019) of preceding events. Sociological scholars have suggested that “collective memories are shared representations of a group’s past based on a common identity” (Halbwachs 1992; Licata and Mercy 2015). In reconstructing a previous incident, collective memory is crafted through an interaction between public and private forms of memory, and greatly influenced by the media. In sociological frameworks, memory is treated as a social product and a category of cultural knowledge (Schwartz 1990; Edgerton 2000), as recollections are ingenerated from social experiences linked to social systems and identity. In Japan, September 1, the day of the 1923 Great Kanto Earthquake, has been designated as Disaster Preparedness Day (Bosai no Hi in Japanese) to raise disaster awareness since 1960. Mizude (2016) noted that the newspapers utilized memories of the Great Kanto Earthquake to give the meaning of a day, on which the importance of disaster preparedness is realized



again, to the Disaster Preparedness Day, and the fading memory of the Great Kanto Earthquake was refreshed at the national level by the establishment of an official day in 1960 (Mizude 2016). According to Edgerton (2000), news media have the power to reinterpret previous occasions, especially in the digital age. Group memories are constructed via diverse media channels such as newspapers, TV, and online news.

Anniversary coverage reflects current social perspectives. Examining news coverage of the Tiananmen Square crackdown, and the fall of the Berlin Wall from 1990 to 2011 in the *New York Times* and the *Washington Post*, Li and Lee (2013) found that these two elite newspapers harbored a rigid anti-Communist attitude in the era of the post-Cold War. Hence, their anniversary journalism adopted a non-objective stance on the issues involved. In light of the media agenda-setting theory, which posits that audiences receiving a message will consider the topics to be important when mass media stress some topics over others (McCombs and Shaw 1972; Takeshita 2008), Kligler-Vilenchik et al. (2014) compared the “media memory agenda” and the “public memory agenda” to determine the media’s influence in shaping collective perceptions of the past on the 60th anniversary of Israel’s establishment. They found that heavy exposure to televised media

memory enabled people to consider Israel’s 60th anniversary as the most important event in the nation’s history.

As for memories of catastrophic incidents, Su (2012) investigated reporting on the 10th anniversary of the 921 Taiwan Earthquake (1999) through narrative analysis, to understand how news media represented the collective memory of this calamity. The results showed that journalists used memories to produce a discourse assessing the government’s risk management of analogical catastrophic events and that shared memories converged into conventional stories of individual survival experiences and practical lessons learned. Robinson’s study (2009) (Robinson 2009) on the anniversary coverage of Hurricane Katrina delineated the unique agenda-setting role of national and local newspapers. The national media set the political agenda to clean up and rebuild New Orleans, and conveyed lessons learned from the subsequent chaos to the American people. Local media reconnected neighborhood communities by creating stories that evoked feelings of residential satisfaction and a common identity. The press can contribute considerably to strengthening and/or restoring social cohesion by unifying individuals’ experiences into mutual memories, and reaffirming existing social norms (Robinson 2009; Kitch and Hume 2007). Trümper and Broer (2019) indicated that journalists take

advantage of eyewitness accounts to make claims about the present and the future. Shared memory enables journalists to highlight latent problems in the public sphere, prompt preventive or protective actions, and encourage debate on how social problems should be politically addressed.

Risk perception and the media

Risk perception depends on historical and cultural contexts. Paton et al. (2010) identified similarities between Japan and New Zealand regarding how intentions to take earthquake preparedness actions were controlled by variables such as outcome expectancies, community participation, collective efficacy, and trust. Another group of scholars demonstrated that a “sense of collectivity”—a feeling of participation in one’s community—is an important factor in forecasting preparedness behavior (Unagami et al. 2012). For example, the stronger one’s emotional attachment to one’s home, the more likely one is to take protective measures (Evans et al. 2004; Tierney et al. 2001; Kim and Kang 2010). In addition, people who acquire knowledge of natural disasters exhibit intense preparedness-related conduct (Perry and Lindell 1990; Showalter 1993). In general, someone with higher self-efficacy (Bandura 1977) is more likely to take action to prepare for disasters (Paton 2003). Cognitive expectancy theory implies that expectations of personal efficacy depend upon four sources of information: “performance attainment, vicarious experiences, verbal persuasion, [and] physiological and emotional arousal” (Bandura 1977).

Regarding catastrophic wildfires in Colorado, Kroepsch et al. (2018) suggested that while local media conveyed messages about learning and adaptation in early anniversary commemorations of such events, the discourse on these two themes faded in later anniversaries. Generally speaking, local media help to create a sense of collectivity, and of being part of one team (Pollock 2014). The selective memory of preceding events helps journalists guide public attention toward contemporary uncertainties as well as potential future threats, thereby allowing people to cope with these matters (Adam 2004; Nowotny 2008). Public opinion polls on disaster prevention (Cabinet Office 2017) report that the most useful sources of information on natural catastrophes include disaster reporting, hazard maps, TV programs, and past memories. Thus, media are involved in vicarious experiences and verbal persuasion by providing information on memories of previous natural risks.

Objectives

Describing the relationship between the four actors — residents, the government, mass media, and experts— as the tetrahedron of disaster mitigation, previous studies

emphasized that the cooperative relationship between the government, mass media, and experts is significant for retaining the tetrahedron (Okada and Ui 1997; Okada 2015). Our research primarily aimed to discover the kind of information newspaper media provided to Japanese society in terms of the 2014 eruption of Mt. Ontake because the media has the power to shape collective memory, leading to shared perception of volcanic risks. Understanding what information is valued and what is overlooked in the media sphere will help remove the gap between experts and journalists when experts endeavor to collaborate with them.

A disaster management cycle is divided into four phases: mitigation, preparedness, response, and recovery (Federal Emergency Management Agency 2006). It is assumed that media are crucial management tools because of their ability to widely and promptly transmit information about hazards, preparedness, and recovery to a society, resulting in increasing preparedness and facilitating recovery (Wenger and Friedman 1986). The nature of subjects covered by the media across the four phases is distinct (Pérez-Lugo 2004). Through crisis management analysis (e.g., (Okada and Ui 1997; Peterson 1988; Ishimine 2016; Tajima 2017)) and content analysis of news coverage during volcanic crises (e.g., (Harris et al. 2012; Harris 2015a; Harris 2015b; Harris and Villeneuve 2018a; Harris and Villeneuve 2018b; Calabro et al. 2020)), features and challenges about volcanic risk communication have been studied. However, from a long-term perspective (i.e., recovery and mitigation phases), few studies have investigated which issues regarding volcanic risk are covered by the media. In this study, we were interested in coverage of the recovery and mitigation phases. Recovery and mitigation operations restore the community, promote a return to (new) normal functions, and address future disasters. Through their coverage of disasters, media are considered disaster prevention information providers, which supposedly helps the community to raise disaster awareness, prepare for future events, and strengthen community resilience to disasters (Rodríguez 1997; Quarantelli 1996). With regard to seismic risks, Tekeli-Yesil et al. (2019) examined the features of seismic risk information provided by Turkish newspapers, and found that while there was significant coverage immediately after earthquakes, there was little news about earthquake disaster prevention. As a result, the printed media failed to play a central role in communicating appropriate risk information.

Japanese newspapers can be classified as local, regional, or national (Japan Visitor.com 2020). National newspapers circulate throughout the country; their headquarters are located in big cities such as Tokyo and Osaka. Conversely, regional and local newspapers are restricted to limited residential zones, and work significantly on local occurrences (Tekeli-Yesil et al. 2019; Jenkins and Nielsen

2020). The victims of the 2014 Mt. Ontake eruption were tourists, and direct damage (such as from volcanic ash) did not take place in the residential areas around Mt. Ontake. As sudden, small-scale eruptions chiefly impact areas near a crater, tourists from big cities with opportunities to visit a crater are likely to get involved with a volcanic eruption disaster. In other words, although large eruptions which affect a wide area occasionally occur (e.g., the 1707 eruption of Mt. Fuji), most volcanic disasters are restricted to a specific geographical site. Consequently, such an event is less familiar to people living in big cities, compared to earthquakes and typhoons, and its risk may be poorly recognized (Cabinet Office 2017). Under such circumstances, national newspapers widely circulated in big cities tend to consider volcanic risk stories to have relatively lower news value. On the other hand, local newspapers based in communities with volcanoes, give volcanic risk news a higher value, because such calamities directly threaten residents' lives. In fact, Harris (2018) suggested that well-informed journalism was mostly practiced by local tabloids during the April 2007 eruption of Piton de la Fournaise (Harris and Villeneuve 2018a). To make society more resilient to volcanic crises, a social system in which Japanese society as a whole has a common understanding of volcanic risk should be built. However, the media's provision of different types information to different social strata results in an information gap about volcanic risk. Based on this background, the three types of newspapers are likely to frame volcanic disaster prevention and potential volcanic risk in different ways, aiming to make their stories appealing to their readership (Harris 2015a). In this study, we quantitatively explored discrepancies among articles on the 2014 Mt. Ontake eruption. Our first research question is: How have Japanese newspaper media covered volcanic eruption threats in the context of the 2014 Mt. Ontake eruption, especially during its anniversary?

Nick (2012) noted that media rule out alternative ideas, while selected facts are embedded in people's everyday actions and understanding. Hence, an information gap can affect the active process of remembering, through which groups construct their sense of community. Less extensive coverage may engender an apathetic attitude toward volcanic risk in societies that have little to do with volcanoes. Comments posted on news websites serve as public communication tools in the digital age, allowing sociological researchers to analyze public views on disaster risk issues (Valaskivi et al. 2019; Yamada 2020), even though the opinions expressed might not be entirely representative of the population at large. Thus, our second research question is: What rational/emotional reactions are evoked on the Web by the anniversary coverage? Due to the limitations of available data, we analyzed comments posted on the fifth anniversary news articles published on the Yahoo News site. While the news value of

commemoration decreases as time passes, as a social custom, it transiently enhances in units of five or ten years (Forrest 1993). The increased media attention on the fifth anniversary evoked public interest. We observed comments reflecting peoples' opinions and considerations of the 2014 Mt. Ontake eruption.

Methods

Materials collection

Our unit of analysis is an individual newspaper article. The research material comprised five national newspapers (the Asahi Shimbun, the Mainichi, the Nikkei, the Sankei Shimbun, and the Yomiuri Shimbun), one regional newspaper published in the Chubu region in the central part of Japan (the Chunichi Shimbun), and one local newspaper based predominantly in Nagano Prefecture (the Shinano-Mainichi Shimbun). The five national newspapers are mostly distributed in major Japanese cities. According to the Yomiuri Shimbun's media data (2019) (Yomiuri Shimbun 2019), the household penetration rate for these national newspapers exceeds 40% in Tokyo and Osaka. Although the overall circulation of national newspapers has fallen drastically since the rise of social networking sites (SNS), more than approximately 25 million copies are currently distributed nationwide. The percentages of the number of copies for respective newspapers are as follows: 39.6% (Yomiuri), 28.2% (Asahi), 13.4% (Nikkei), 12.1% (Mainichi), and 6.7% (Sankei) (Yomiuri Shimbun 2019). The Chunichi Shimbun is the key regional newspaper of the Chubu area, in which Aichi Prefecture is home to Japan's fourth-largest city, with 7.5 million residents (Aichi Prefecture 2018); its household penetration rate is approximately 42%, and its circulation amounts to approximately 1.4 million copies in Aichi Prefecture (Yomiuri Shimbun 2019). It is more popular than the national newspapers in the Chubu area. The Shinano-Mainichi Shimbun is a local newspaper in Nagano Prefecture (the home of Mt. Ontake); its household penetration rate is more than 50%. Moreover, it has enthusiastically covered various topics related to the 2014 Mt. Ontake eruption through features such as serialized articles.

We obtained news articles on the 2014 Mt. Ontake eruption from an individual database, using the search terms "Mt. Ontake" and "eruption" from July 1, 2015, to October 30, 2019. Immediately after the eruption, the volcanic alert level, designated by the JMA, was raised from 1 to 3, meaning that people should not approach within 4 km of the crater. In January 2015, the restricted area around the crater was reduced from 4 km to 3 km, although the alert level was unchanged. The alert level was subsequently lowered to level 2 on June 26, 2015 (Japan Meteorological Agency 2018), as the JMA judged that the possibility of an eruption had declined (see Table 1). Here, we assumed that the change in the eruption alert level has a larger

impact on the public risk perception than the change in access restrictions for dangerous areas because the alert level itself plays the role of a safety message. This lowered media attention on the 2014 Mt. Ontake eruption. Therefore, we selected a search period of July 1, 2015, to October 30, 2019.

We included articles that contained the search terms in the news item title because they made outstanding references to the 2014 Mt. Ontake eruption. For articles where the search terms did not appear in the title, but only in the news text, we identified eligible articles using the following procedure. We created a list of the top 20 most frequent words from the sample, which contained the search terms in the news item title. Subsequently, we calculated the average percentage of the top 20 words in the texts (frequencies divided by frequencies of all words). When an article without the search terms in its title had a larger number of the top 20 words than the average, it was deemed eligible for analysis, as we expected it to present stories on volcanic eruptions. It must be noted that articles in the local pages of national newspapers, which are circulated only in a limited area, were excluded. We filtered out articles with less than 250 characters because we considered their content to be thin. The sum of characters in articles with 250 characters or less was a tiny fraction of the total number of characters in samples. Therefore, this cutoff rule had little effect on our findings. Finally, we identified 2793 articles (Asahi, $n = 123$; Yomiuri, $n = 130$; Mainichi, $n = 147$; Nikkei, $n = 128$; Sankei, $n = 117$; Chunichi, $n = 683$; Shinano-Mainichi, $n = 1465$) for analysis. Hereafter, the five national newspapers (Asahi, Yomiuri, Mainichi, Nikkei, and Sankei) were handled collectively as national newspapers. In addition, we termed the number of characters in the articles the “information volume.”

To understand public responses to the fifth anniversary coverage of the 2014 Mt. Ontake eruption, we scrutinized comments posted on Yahoo News, which is the most popular online news portal in Japan (Kiyohara et al. 2018), and reaches approximately half (52%) of the country’s online news readers each week (Reuters Institute 2019). Yahoo’s message posting service for news reports is one of the most popular communication platforms. We distinguished arguments shared by online news readers. We found three online news items referring to the 2014 Mt. Ontake eruption during September 2019, which were termed News A, News B, and News C. We collected comments posted on Yahoo News nearly three days after the news reports were published. Consequently, the total number of comments amounted to 627, of which 66, 137, and 424 were posted in response to News A, B, and C, respectively. Since we gathered the comments a considerable time after the articles were published, the number of comments did not change drastically following sample

collection. The average and median numbers of words per comment in the sample were 56 and 40, respectively, on the basis of adjectives, adverbs, verbs, and nouns. Comments with a smaller number of words than the first quartile point (20 words) were regarded as thin content, and were removed from the sample data, culminating in 469 eligible comments. We considered that the discourses on online comments would be sensitive to the articles’ arguments. Although the number of stories was limited, our content analysis of the online comments enhanced our understanding of public responses to the anniversary coverage.

Unsupervised text classification

We subjected the texts of the entire sample to morphological analyses using KH Coder (Higuchi 2016) (a free software package for text mining) which allowed us to generate word frequency lists and co-occurrence network maps (Higuchi 2017), and Mecab (Kudo et al. 2004) (an open source text segmentation library for texts written in Japanese). By applying a bag-of-words model, we can encode a text as a feature vector and obtain the frequency of each word (Yamada 2017). In addition, we calculated word importance weights using Term Frequency-Inverse Document Frequency (TF-IDF) (Büettcher et al. 2010) for individual words, using the Python program (Kawahara 2020). With the development of deep learning approaches, ample progress has been made in automatic text categorization. Computer-assisted content analysis is becoming a popular method for extracting structured data from unstructured text (Aaldering and Vliegthart 2016; Neuman et al. 2014; Damstra et al. 2019). Automatic text categorization, with clear rules and algorithms, helps researchers classify texts into a certain number of pre-defined categories (Le-Khac et al. 2010). We categorized news articles by grouping the vectors that represent texts (Liu and Lu 2018; Yamada 2019). We created the distributed representations of each text using the Paragraph Vector model, an unsupervised method that learns continuous distributed vector representations for pieces of text (Le and Mikolov 2014).

Determining the most appropriate number of clusters in a given dataset is known as the cluster validation problem, and there are plenty of studies (e.g., (Milligan and Cooper 1985; Aggarwal and Reddy 2013; Patil and Baidari 2019)). We used the average silhouette technique (Rousseeuw 1987) and slope method (Fujita et al. 2014) to determine the optimal number of clusters. These correspond to non-parametric approaches. The cluster number examined varied from 4 to 20.

We utilized the Doc2Vec class from the Gensim library (Řehůřek and Sojka 2010), which is one of the implementations of Paragraph Vector. For the average silhouette technique and the slope method, we used the Analysis

of Cluster Variability (ANOCVA) package (Version 0.1.1), implemented in R (Vidal and Fujita 2017). We set the values for other parameters such as the minimum count of words and the window size as 10 and 15, with reference to a previous study (Lau and Baldwin 2016). As for the text vector size, we changed it from 50 to 500 in increments of 50 and calculated the text vector for each parameter. Finally, we applied the text vectors to the Silhouette technique and the slope method to determine the optimal number of clusters. In this study, the size of the text vectors was determined as 150, so that the cluster numbers estimated by the two methods coincided.

Results

Primary themes within the articles

First, in order to look at the trends of media attention for national, regional, and local newspapers, we gauged media attention by the monthly number of characters in articles. Figure 2 illustrates the time series of the percentage of information volume in articles published each month. We labeled September and October as “anniversary months,” since the Mt. Ontake eruption occurred on September 27, 2014, although news stories concerning volcanic eruptions were quite apparent in September. Months other than September or October are “ordinary months.”

The time series of media attention was almost similar, and peak months coincided with anniversary months, resulting in a constant amount of coverage, comprising approximately 8% of the total information volume each year. Figure 2 also shows a small quantity of information volume during each ordinary month. National newspapers had a larger amount of coverage in the first

anniversary year, peaking in January 2018, which corresponds to the volcanic eruption of Mt. Kusatsu-Shirane, where one person was killed and dozens of skiers were injured (see Table 1). The ratios of the information volumes in anniversary months compared to the total were 44.6%, 46.3%, and 41.1% for national, regional, and local newspapers, respectively. These temporal trends of media attention are in line with those of previous studies (Trümper and Broer 2019; Valaskivi et al. 2019).

The automatic text categorization revealed that 2793 news articles from seven newspapers could be grouped into five clusters (categories). Table 2 presents a list of the top 10 most important words for each cluster. Table 3 provides the summary statistics of each cluster. The number of sample months is 52, and that of the anniversary month is 10. If the information volume is equal in all months, N_a/N is approximately 0.2, where N_a is the information volume in anniversary months and N is the total information volume. From Table 3, Additional file 1 depicts the relationship between N_c/N and N_{ca}/N_c for each cluster of national, regional, local, and all newspapers, where N_c and N_{ca} correspond to the information volume of each cluster and that in the anniversary months. As seen in Table 3, the N_{ca}/N_c of clusters 1 and 3 was larger than 0.4; we labeled them as the anniversary clusters. A cluster with $N_{ca}/N_c > 0.4$ means that it had a large amount of coverage in anniversary months.

The national and regional media focused on one or two topics. The topics of clusters 1 and 2 were important for national and regional newspapers, respectively. On the other hand, local media covered four topics evenly. The Spearman’s rank correlation coefficients, which measures

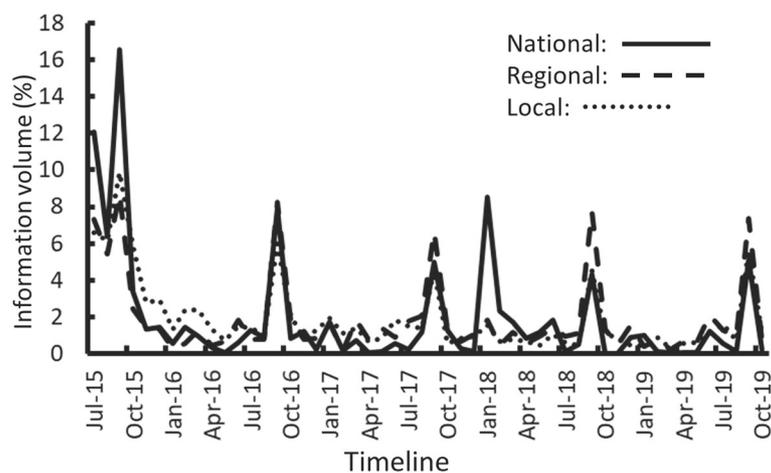


Fig. 2 Monthly temporal profiles of the percentage of information volume for each month. The solid, dashed, and dotted lines respectively represent the time series for the national newspapers (the Asahi Shimbun, the Mainichi, the Nikkei, the Sankei Shimbun, and the Yomiuri Shimbun), the regional newspaper (the Chunichi Shimbun), and the local newspaper (the Shinano-Mainichi Shimbun). We defined the information volume as the sum of characters of news articles published in a month. The total number of characters contained in the samples were 553148, 479479, and 1020193 for the national, regional, and local newspapers, respectively

Table 2 List of the topic labels and the top 10 most important words from the term frequency-inverse document frequency (TF-IDF) for each cluster

Cluster #	Top 10 words	Topic label
1 (anniversary)	regulation, mountaineering, lift a warning, Otaki (place name), village, tourism, a mountain cabin, summit, investigation, town	Mt. Ontake’s volcanic warning status
2	evacuation, plan, research, (warning) level, prefecture, the bereaved, disaster prevention, municipality, earthquake, Kusatsu (place name)	Municipalities’ volcanic emergency plans
3 (anniversary)	search, commemoration, volcano, regulation, Otaki (place name), the bereaved, photo, eulogy, disclosure, Nagano (place name)	Human interest
4	(Mt. Ontake Volcano) Meister, Kiso (place name), climbing, prefecture, (evacuation) shelter, research, disaster prevention, consider, plan, evacuation	Lessons learned from the 2014 Mt. Ontake eruption
5	advance team, shelters, investigation, Gifu (place name), Nagano (place name), establish (a task force), volcano, family, a prefectural governor, send (a rescue team)	Searching for missing persons

The first column shows the cluster number (#). The label “anniversary” indicates that there was a lot of coverage during an anniversary month. “Top 10 most important words” means the ten highest keywords, weighted by their TF-IDF for each cluster

the strength and direction of association between two ranked variables (Laed.com 2020), of the information volume for each cluster between the three newspaper forms in Table 3 were 0.3 (national vs. Chunichi), 0.7 (national vs. Shinano-Mainichi), and 0.7 (Chunichi vs. Shinano-Mainichi), respectively. The low correlation value (Mukaka 2012) between the regional and national newspapers indicates that the attention pattern of each media differed considerably. Further, the correlation coefficients among the five national newspapers were higher than 0.7. We concluded that the five national media had similar trends in their coverage.

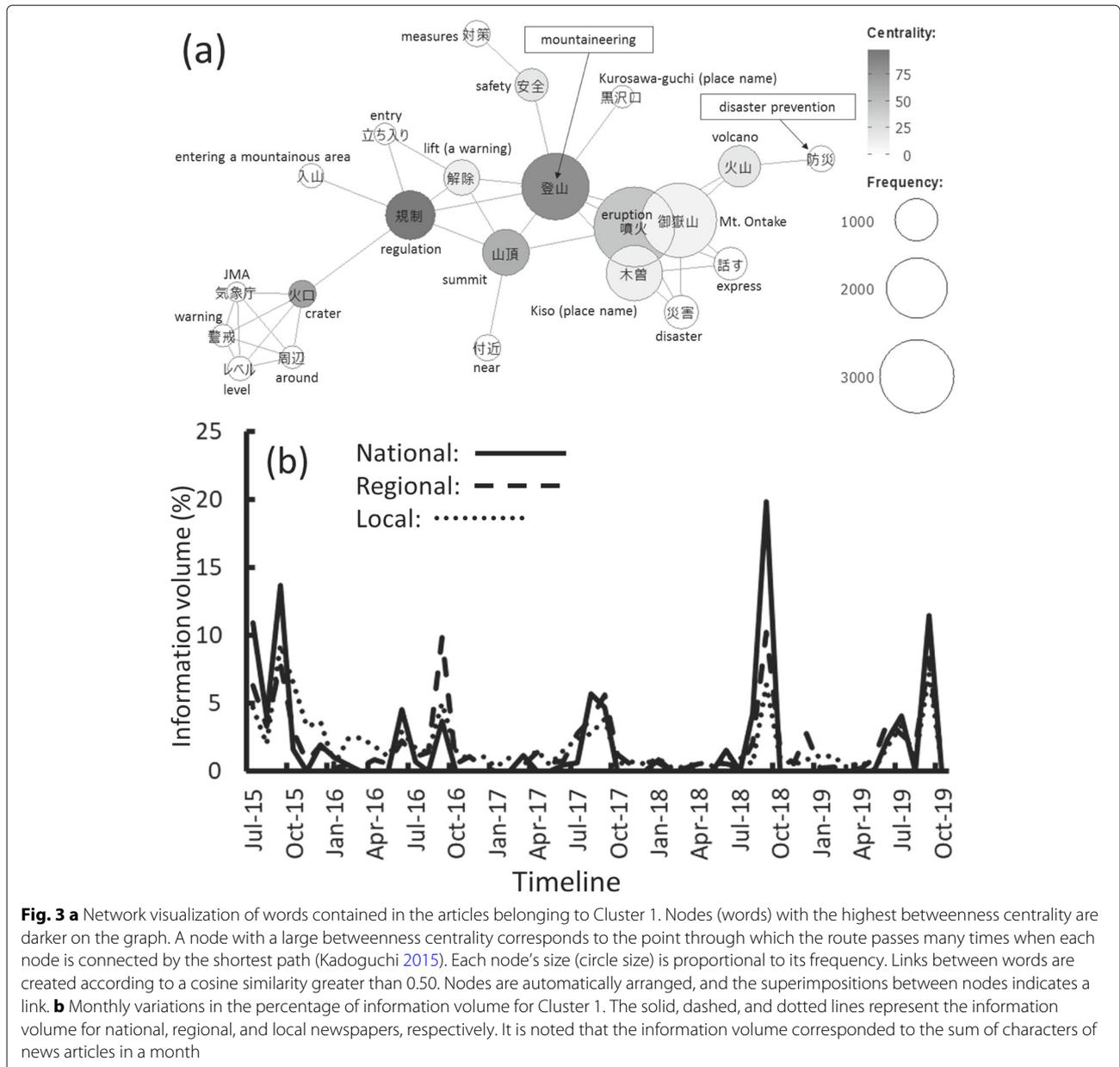
Cluster 1 topic (anniversary cluster): “Mt. Ontake’s volcanic warning status”

Cluster 1, which had the largest information volume, contained terms related to official warnings or regulations issued by the JMA for Mt. Ontake, such as “regulation,” “mountaineering,” and “lift a warning” (see Table 2). We categorized this as an anniversary cluster. The number of articles attributed to this cluster was 94, 284, and 486 for national, regional, and local newspapers, respectively. For the regional and local newspapers, the information volume of Cluster 1 corresponded to 40% and 30% of the total information volumes, whereas it occupied 10% for national newspapers. Regional and local media primarily covered this topic. To probe the relationship between words with high word importance, we utilized a co-occurrence network of high-frequency words in which the interactions between words with similar appearance patterns were connected by links (Drieger 2013; Borgatti 2005). Understanding the patterns of connections between words enabled us to discern the semantic meanings of groups of words. Figure 3 (a) displays the co-occurrence network diagram for Cluster 1. Networks with a small number of nodes are not plotted in Fig. 3a. We

Table 3 Summary statistics

Cluster #	N_c				N_{ca}/N_c			
	All	National	Regional	Local	All	National	Regional	Local
1 (anniversary)	570488 (27.8%)	56198 (10.2%)	196143 (40.9%)	318147 (31.2%)	0.457	0.551	0.491	0.420
2	542768 (26.4%)	261569 (47.3%)	58233 (12.1%)	222966 (21.9%)	0.340	0.364	0.340	0.312
3 (anniversary)	494017 (24.1%)	152135 (27.5%)	123673 (25.8%)	218209 (21.4%)	0.629	0.692	0.637	0.580
4	330112 (16.1%)	52335 (9.5%)	74019 (15.4%)	203758 (20.0%)	0.386	0.293	0.353	0.421
5	115435 (5.6%)	30911 (5.6%)	27411 (5.7%)	57113 (5.6%)	0.038	0.000	0.041	0.057

N_c represents the total number of characters for each cluster, while N_{ca} indicates the number of characters in articles published during anniversary months. The percentages of N_c to N (whereby N corresponds to the total number of characters) for each cluster of each newspaper type are indicated in parentheses. The label “all,” denotes all newspapers. The labels “national,” “regional,” and “local” comprise the national ones (the Asahi Shimbun, the Mainichi, the Nikkei, the Sankei Shimbun, and the Yomiuri Shimbun), the regional one (the Chunichi Shimbun), and the local one (the Shinano-Mainichi Shimbun), respectively



conducted a network analysis of words for all articles belonging to this cluster. A word with higher betweenness centrality is usually called a hub or highly central (Buckner et al. 2009), as other words will be connected through it. That is to say, the word with the highest betweenness centrality will likely appear in the same text as a keyword. This network points to stories that referred to the volcanic alert level. In addition, Fig. 3b shows the time series of the percentage of the information volume in each month for national, regional, and local newspapers. These peaks corresponded to months when volcanic warnings were deregulated (see Table 1). We inferred that the articles in Cluster 1 comprised news stories related to

volcanic warnings about Mt. Ontake. We defined articles that included the highest ratio of the top 10 most important words, as shown in Table 2, compared to the total number of words, as representative samples of Cluster 1. Table 4 provides a list of their titles.

Cluster 2 topic: "Municipalities' volcanic emergency plans"

In Cluster 2, terms such as "evacuation," "plan," and "warning level" had high TF-IDF values (see Table 2). The number of articles attributed to this cluster was 253, 69, and 302 for national, regional, and local newspapers, respectively. Figure 4a shows the largest co-occurrence network diagram for Cluster 2. As displayed in Table 4

Table 4 Example titles of four representative articles for each cluster

Cluster #	Examples of article titles
1 (anniversary)	<p>— Ontake area in the summer, climbing season on the side of the town of Kiso, removal of a warning alert. (Y, July 2, 2019)</p> <p>— To climb Mt. Ontake, regulations will again be established, starting today. (C, October 8, 2018)</p> <p>— A warning alert for part of the Kurosawa-guchi route at Mt. Ontake's ninth station will be removed today. (C, June 28, 2016)</p> <p>— The town of Kiso decided to remove a warning alert for the Mt. Ontake trail from July 1 to October 16. (Sh, March 7, 2019)</p>
2	<p>— Volcanic eruption of Mt. Kusatsu-Shirane. Imperfect volcano evacuation plan in most towns, including Kusatsu-machi, Gunma. (M, January 26, 2018)</p> <p>— There was a phreatic eruption at Mt. Kusatsu-Shirane. Evacuation plans are inadequate in two-thirds of all municipalities in volcanic areas. Kusatsu-machi was also undecided. Obligations have not been firmly followed. (N, January 25, 2018)</p> <p>— Volcanic evacuation plans are created in 51 municipalities, and two-thirds of all plans are being considered. (C, June 24, 2017)</p> <p>— Thirty percent of the municipalities in volcanic zones have produced volcanic evacuation plans. Many municipalities have been unable to keep up with the revised law. (A, January 28, 2018)</p>
3 (anniversary)	<p>— Bereaved families completed a memorial climb on Mt. Ontake and commemorated the victims of the eruption. (N, July 24, 2017)</p> <p>— The second anniversary of the Mt. Ontake eruption. Grieving families requested that a tombstone be built for the victims at a commemorative ceremony site. (Sh, September 28, 2016)</p> <p>— The unveiling of the tombstone for the victims was conducted in the village of Otaki in Nagano Prefecture. (A, September 27, 2017)</p> <p>— The Mt. Ontake executive committee that built the tombstone was dissolved. (Sh, June 27, 2019)</p>
4	<p>— The town of Kiso created an evacuation plan and added it to the Kiso's disaster prevention plan. This is due to the obligation of the revised Act on Special Measures Concerning Active Volcanoes. (C, October 2, 2018)</p> <p>— Nagano Prefecture announced the revised Nagano's disaster prevention plan this year. The Volcanic Disaster Council's role was stipulated. (Sh, December 23, 2015)</p> <p>— The town of Kiso designed an evacuation plan in the case of an eruption. (Sh, October 3, 2018)</p> <p>— The Mt. Ontake Volcanic Disaster Council decided to work out detailed evacuation and guidance procedures for hikers when the action plan was revised in FY2017. (Sh, March 22, 2017)</p>
5	<p>— An advanced team will go to Mt. Ontake tomorrow. (C, July 11, 2015)</p> <p>— The volcanic eruption of Mt. Ontake. An advanced team will be sent tomorrow, Nagano-Gifu. (M, July 11, 2015)</p> <p>— The volcanic eruption of Mt. Ontake. An advanced team will re-investigate tomorrow, and 44 members will be sent. Press release from the prefecture's disaster countermeasures office. (Sh, July 11, 2015)</p> <p>— To resume the search for missing persons, an advanced team will be sent to the summit of Mt. Ontake starting on July 7. (C, July 4, 2015)</p>

In parentheses, we can see the issue dates for articles and newspaper types (A=Asahi Shimbun, C=Chunichi Shimbun, M=Mainichi, N=Nikkei, Sa=Sankei Shimbun, Sh=Shinano-Mainichi Shimbun, Y=Yomiuri Shimbun)

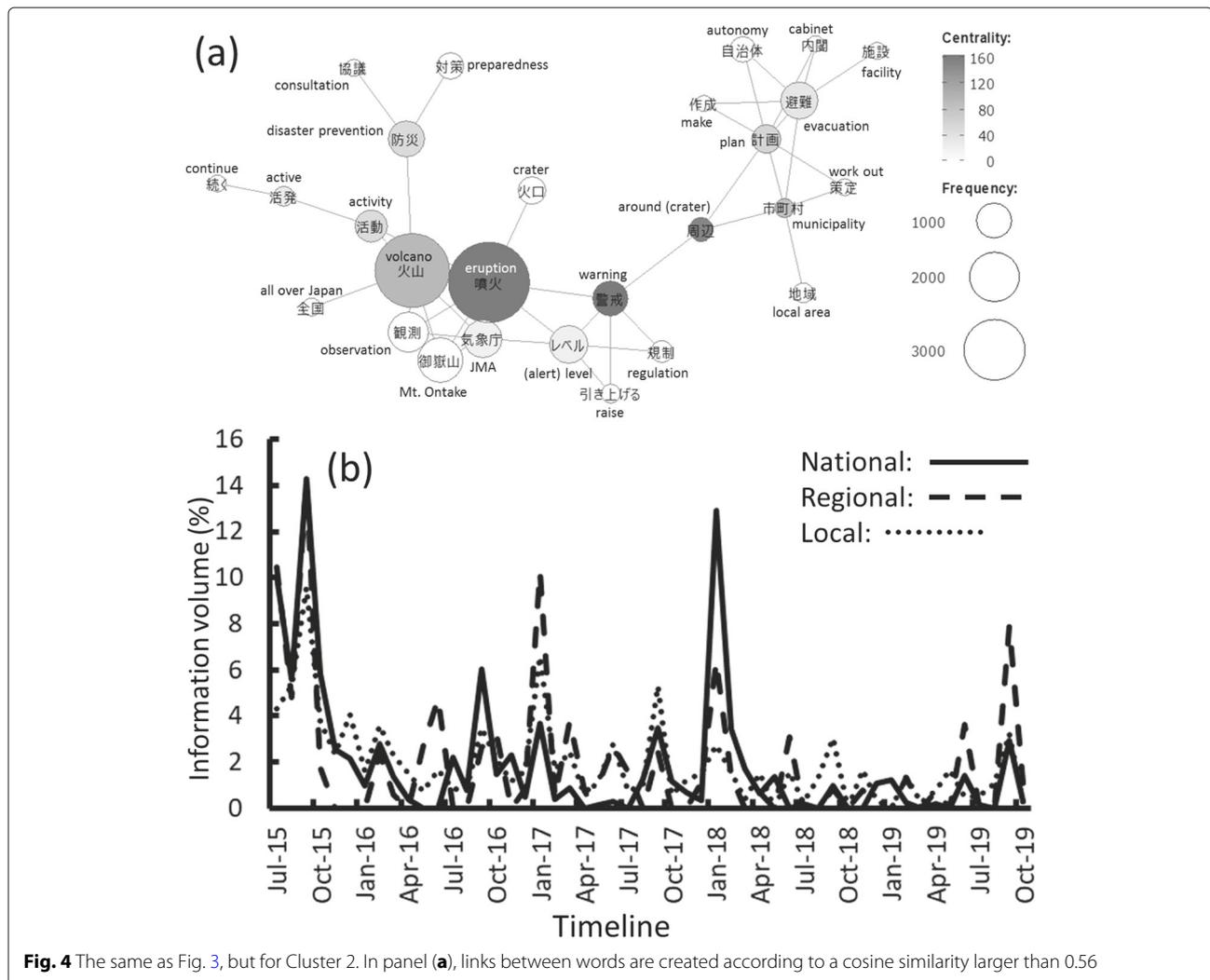


Fig. 4 The same as Fig. 3, but for Cluster 2. In panel (a), links between words are created according to a cosine similarity larger than 0.56

and the network in Fig. 4a, political stories about the development of municipal volcanic emergency plans were mostly centered. The time series of the degree of the information volume in each month are presented in Fig. 4b for national, regional, and local newspapers, respectively. National newspapers focused on this topic in relation to the 2018 Kusatsu-Shirane volcanic eruption. As outlined in Table 3, national newspapers pointed significantly to municipalities' volcanic emergency plans or programs and contained nearly half of the total information volumes, as this political topic was associated with a wide readership. There were many articles pointing out the delay in the development of municipal volcanic emergency plans (see Table 4). Moreover, as mentioned below in detail, the subject regarding the legal action against the local government and the JMA brought by the bereaved was also included. Media framing plays a key role in communicating forecast and uncertainty regarding a volcanic

eruption (Harris 2015a; Harris 2015b). A negative frame may cause people to feel disappointed with the government administrations and experts responsible for volcanic risk management.

Cluster 3 topic (anniversary cluster): "Human interest"

The number of articles attributed to this cluster was 192, 156, and 306 for national, regional, and local newspapers, respectively. The higher TF-IDF words in Cluster 3 were "commemoration," "the bereaved," and "eulogy" (see Table 2), and Cluster 3 had a network in which these terms were linked to each other, as depicted in Fig. 5a. The titles in Table 4 indicate that this cluster included many human interest stories of the bereaved. From Table 3 and the time series of Fig. 5b, all newspapers picked up the topic of Cluster 3 in the anniversary months and had the highest N_{ca}/N_c . The proportion of information volume for national and regional newspapers was higher than 25%.

Table 5 The amount of the information volume of articles published on the front page

Cluster #	National	Regional	Local
1 (anniversary)	1999 (7.9%)	8536 (26.8%)	32750 (25.0%)
2	13683 (54.2%)	5443 (17.1%)	30713 (23.4%)
3 (anniversary)	6409 (25.4%)	12056 (37.9%)	34705 (26.4%)
4	396 (1.6%)	1715 (5.4%)	19974 (15.2%)
5	2750 (10.9%)	4062 (12.8%)	13119 (10.0%)

In parentheses, the percentage of the information volume for each cluster of respective newspaper types is indicated

were 4.6% for national newspapers, 6.6% for the regional newspaper, and 12.9% for the local newspaper. This indicates that, quantitatively, the local newspaper became an important source in terms of the volcanic risk communication, and this result is consistent with the coverage slant of regional reporting agencies during the eruption of Stromboli (Calabró et al. 2020).

Media attention to the lawsuit brought against the local government and the JMA

As shown in Table 1, Mt. Ontake is an active volcano (Japan Meteorological Agency 2020). While volcanic earthquakes occurred frequently in early September 2014, the JMA decided not to raise the eruption alert level at that time. A group of the bereaved filed a lawsuit in January 2017, claiming that this decision was wrong. This issue raises an opportunity to think about what the eruption warning system, linked to eruption predictability, means for the society, and how we should take advantage of it. Here, we examined how substantial attention media paid to this trial. We considered articles containing “trial/suit/lawsuit” in their titles as articles that mainly reported on trial-related topics, and extracted these from the sample data. Table 6 shows the distribution of the information volumes for each cluster. As shown in Table 6, the trial-related articles mainly belonged to Cluster 2. The information volumes for national, regional, and local

newspapers correspond to approximately 4%, 30%, and 15%, respectively. In the case of national newspapers, trial-related articles have not appeared on general pages (e.g., social or political pages) since 2018. On the other hand, the regional and local newspapers had several follow-up articles in 2018 and 2019 (six articles in 2018 and two articles in 2019 were found in the regional newspaper; seven articles in 2018 and three articles in 2019 in the local newspaper). National newspapers regarded this topic as minor news value. Readers of these newspaper could only understand the progress of this trial by obtaining information from other media.

Close reading of the texts showed that all the primary news articles mentioned how the bereaved felt and what claims they made in the court case, with subsequent articles referring to the trial progress. Here, we searched for articles containing the words “forecast/prediction” and “expert/researcher/university/professor” in their texts, and returned 0, 3, and 10 hits for national, regional, and local newspapers, respectively. National newspapers thus had no articles with “expert/researcher/university/professor.” The regional and local newspapers reported on the predictability of the 2014 Mt. Ontake eruption as well as the general eruption predictability, citing comments from experts (see the word co-occurrence network in Additional file 3). Since the focus of the trial was how responsible it was for the JMA not to raise the eruption alert level when volcanic earthquakes increased at the beginning of September 2014, the expert’s comments were quoted in line with this main point. We were not able to confirm any further development of this topic. The eruption predictability was presented in a way that a supplementary explanation of the trial was given.

Public responses to the anniversary coverage

We first examined the relationship between media attention and public interest. We utilized Google Trends to monitor the longitudinal progression of people’s search

Table 6 Summary statistics for articles that contain “trial/suit/lawsuit” in their title

Cluster #	(a) Article number			(b) Information volume		
	National	Regional	Local	National	Regional	Local
1 (anniversary)	0	0	0	0	0	0
2	19 (7.5%)	24 (34.8%)	46 (15.2%)	10337 (4%)	16931 (29.1%)	33690 (15.1%)
3 (anniversary)	1 (0.5%)	0	3 (1%)	700 (0.5%)	0	2771 (1.3%)
4	0	1 (0.8%)	1 (0.4%)	0	949 (1.3%)	334 (0.2%)
5	0	0	0	0	0	0

The columns (a) and (b) denote the number of articles and the information volume for national, regional, and local newspapers, respectively. The percentages of the value to the total for each cluster of each newspaper type are indicated in parentheses. The labels “national,” “regional,” and “local” denote the national newspapers, the regional newspaper, and the local newspaper, respectively

activities (Yeo and Knox 2019). We extracted the time series data from the Google Trends site using the keyword “Mt. Ontake” between 2015 and 2019. The Pearson’s correlation coefficients between the time series data of the search pattern and each newspaper, as seen in Fig. 2, were 0.77 for national newspapers, 0.78 for the regional newspaper, and 0.76 for the local newspaper, meaning that more intense coverage increased search activity. Taking the media agenda setting theory (Takeshita 2008) into account, the heavy media coverage during the anniversary months points to a salient perception of volcanic risk.

Subsequently, we closely explored the public discourse regarding the anniversary coverage of the 2014 Mt. Ontake eruption based on our content analysis of comments posted online. On Yahoo News, we identified three articles that mentioned the fifth anniversary of the 2014 volcanic disaster. Their titles were as follows:

- News A: “Keep Mt. Ontake in a safe place: Measures are being taken to protect a mountain cabin from ash deposits” (September 27, 2019, the Gifu Shimbun, 972 characters).
- News B: “Mt. Ontake, located on the border between Nagano and Gifu prefectures: Fifth anniversary of the volcanic hazard. At the foot of the mountain, bereaved families took part in a commemorative ceremony and offered silent prayers at 11:52 (the time of the eruption) Nagano” (September 27, 2019, Nagano Broadcasting Systems, Inc., 340 characters, transcript text).
- News C: “Fifth anniversary of the volcanic hazard. What is Mt. Ontake ‘now?’ The trails that many victims hiked are still off limits. A man with a missing son said this is regrettable” (September 27, 2019, Tokai Television Broadcasting Co., Ltd., 907 characters, transcript text).

News A was about ash deposit prevention measures for a mountain cabin on Mt. Ontake, and contained an interview with a mountain cabin worker. This article has the characteristics of Clusters 2 and 4. News B and News C were about bereaved families’ feelings. We classified these articles under Cluster 3. The frame of each news report influenced the discourse of the comments. However, as three news articles had a common format of anniversary coverage, we thought that our findings could serve as a reference to understand how anniversary coverage affected readers’ opinions.

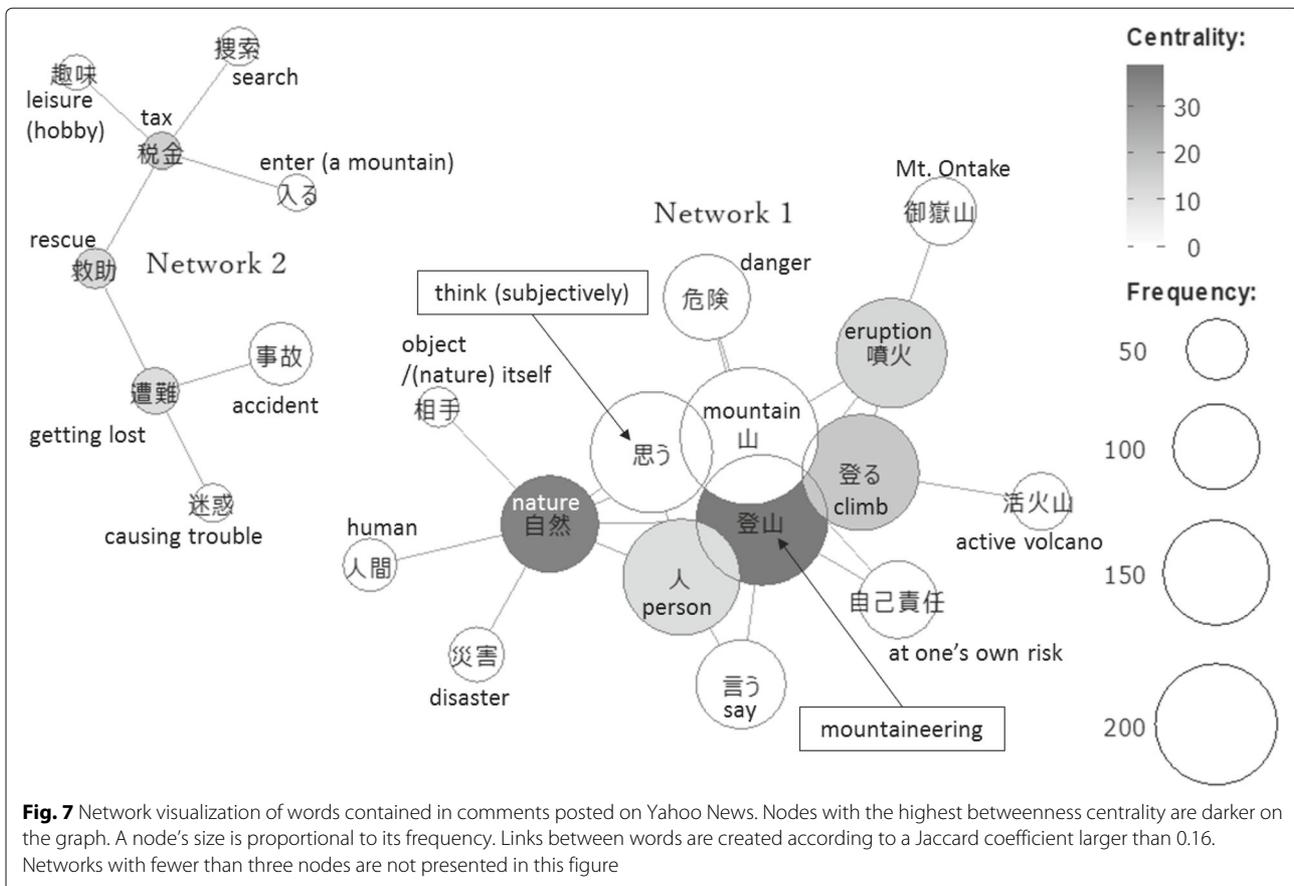
We applied a quantitative approach to our content analysis of the 469 comments. Figure 7 shows a network visualization of the co-occurring terms. In this case, the components of the word vector for each text were basically made of 0 or 1 owing to short sentences. For a binary matrix, the Jaccard coefficient is an effective way

to compute similarities between comments, in contrast to the cosine similarity (Aggarwal 2018). We obtained two networks with 15 and 8 words, respectively. The other networks were small. The largest network (Network 1) encompassed terms such as “mountaineering” and “nature,” which had the highest betweenness. Connecting periphery terms included “at one’s own risk,” “disaster,” “danger,” and “human.” The second largest network (Network 2) had a straight-line structure with “tax,” “rescue,” and “getting lost (in the mountains)” in the center. We determined the typical examples of comments in each network, as follows. We calculated the ratio of frequencies of Network X’s terms in comment No. Y, compared to the product of the total frequencies of terms in comment No. Y and the total number of Network X’s terms, where X is the network ID and Y is the comment ID. We deemed several comments with a larger ratio to be representatives of Network X. These are presented in Table 7.

As seen in Fig. 7 and Table 7, comments belonging to Network 1 insisted that people should climb a mountain at their own risk because a volcano is dangerous, or because human beings are powerless before nature. Comments in Network 2 contended that taxpayers need not fund operations to rescue climbers stranded on a mountain, as mountaineering is a leisure activity. In Network 2, many comments argued about the misallocation of public funds, while a small number advocated for spending tax money to perform rescue efforts. In this case, many comments were posted on human interest reports, especially News C (67.2% of all eligible comments). Hence, people likely looked at the emotional impact of volcanic disasters on survivors, rather than aspects concerning prevention and mitigation. The opinion that volcanic risk should be attributed to a single individual might originate from the idea that volcanic risk does not matter to “we.” This would be associated with the perspective that volcanic risk is closely linked to local territory. However, given the potential for large eruptions that can cause devastating damages to a wider region, this perspective would be a barrier to appropriately understanding the severity of more catastrophic volcanic risks.

Finally, a few comments concerning the News A article had readers evaluating a risk management plan. Although no comments refuted the effectiveness of shelters on ash deposit prevention, some raised questions about volcanic risk management, as follows:

- “...volcanic hazards not only include rocks flying out of the volcano but also pyroclastic flow. How can we protect ourselves against the risk of pyroclastic flow? Mt. Ontake and Mt. Fuji are active volcanoes. An active volcano will erupt someday. Even knowledgeable volcanologists cannot predict when an eruption will occur.”



- “It is impossible to assume that a volcano is safe...a shelter cannot withstand a pyroclastic flow.”

Readers pointed out that a shelter is powerless against pyroclastic flow. Furthermore, one reader used the case of the past volcanic disaster of Mt. Unzen in 1991, which killed 43 people, to underscore the force of a pyroclastic flow: “...A sudden pyroclastic flow killed many people at Unzen-Dake. Unexpected things will happen.” Having learned about various kinds of volcanic phenomena from previous volcanic hazards, readers expressed the concept of the powerless human in their responses.

Discussion: public responses with “we” and “others” in the context of volcanic risk

As noted in existing literature surrounding the communication of volcanic risk through the media during a volcanic crisis (Valaskivi et al. 2019; Calabró et al. 2020), we observed discrepancies in the media’s attention on volcanic risk. Not only does this lead to an information gap among the public, but it could also create a different collective memory. The national newspapers mainly concentrated on political information about volcanoes and human interest stories. Those obtaining information from

the national newspapers could not find updated information on volcanic risk prevention following the 2014 Mt. Ontake eruption. This would prevent tourists from obtaining appropriate information, and also reduce the ability of the disaster prevention measures taken by cities around Mt. Ontake to recover from damage to reputations (Asahi Shimbun 2020). Furthermore, as seen from the time series of Clusters 2 and 3, the reporting pattern of the national newspapers was sporadic. As the contexts of each volcanic risk prevention measure were systematically unconnected, this situation seems to reduce the power to create any broad forums that would allow for a discussion of volcanic risk. Kuri (2019) found that interest in volcanoes is an important factor that enhances awareness of volcanic risk. The national newspapers framed volcanic risk as a political issue. As pointed out by a previous study (Robinson 2009), this framing would put people’s eyes on the competence of the administration to cope with volcanic risk, rather than on volcanic risk itself.

On the other hand, the local newspaper provided considerable coverage of the post-disaster reconstruction, reporting a variety of community activities as the recovery proceeded. There are 327 serialized articles with the title “Live with Volcanoes,” which correspond to 22% of the

Table 7 Examples of comments presented in networks 1 and 2

Network #	Examples of selected discourse
1	<p>— A mountain itself is dangerous, not to mention an active volcano! Genuine mountain lovers prepare substantially in advance of a climb, and will never pass the buck to others [for ending up in a dangerous situation].</p> <p>— If you want to climb a volcano in a highly volcanic country, please climb at your own risk.</p> <p>— No wonder mountaineering is dangerous. Not all mountains can be climbed with ease, like tourist spots. It is common sense that people climb at their own risk. Furthermore, we need to recognize that it is dangerous. Mt. Ontake is a holy mountain. Mountaineering, as a leisure activity, should be prohibited on this holy mountain in the first place.</p> <p>— People who are obsessed with climbing do not take the risks involved seriously. You are going to an active volcano.</p> <p>— Human beings are powerless before nature. During a fun time, mountaineering on a clear autumn day, mountain climbers suddenly lost their lives. It's so sad; I can't bear it when I think about [how the grieving families must feel].</p>
2	<p>— If a volcanic eruption occurs again, the cost of rescuing victims comes out of taxes. I hope that the local government retains the climbing regulations [in this area].</p> <p>— Please take part in mountaineering at your own risk. If climbers call for aid, I hope they themselves will pay to be rescued.</p> <p>— There is always a risk both on mountains and at sea. No wonder that the disaster administrative agency prohibited going to Mt. Ontake because an unexpected eruption occurred. I wonder if it is rational to allocate public funds to build multiple shelters for recreational mountaineering?</p> <p>— In an ideal world, the police and self-defense forces are inactive, but things don't go well like in a [TV] drama. I often read claims that victims should not trouble them, but from another point of view, I feel this claim is incorrect, since one of their jobs is to save lives. We should be grateful for their activities and hard work. It is impolite to think that "we are causing [the police and self-defense forces] a lot of trouble."</p>

total. The title "Live with Volcanoes" is also a metaphor for abandoning the zero-risk view of volcanoes. As shown in Table 3, the local newspaper holistically covered various topics regarding volcanic eruption risk in a well-balanced manner. Political, social, and technological issues should be offered when talking about community resilience, so that they could allow an informed debate on an acceptable level of risk for the community (Reghezza-Zitt et al. 2012). Hence, it was concluded that local newspaper could have some contributions to building resilience, as well as play an effective role in educating the affected population. When tourists come without caring volcanic disaster preparedness, this information gap may cause local people

(including experts) to be confused about tourists' lack of knowledge (Asahi Shimbun 2020).

The news story is basically directed toward either the episodic frame or thematic frame. Episodically framed news stories utilize a particular individual's experience or a specific event, to illustrate social problems, while thematic frames place public issues into broader or abstract contexts and highlight how to improve social conditions that cause particular obstacles (Iyengar 1994). Previous works (Iyengar 1994; Gross 2008) presented that people who receive episodic stories are more likely to assign responsibility for the social issue to individuals rather than society, because episodic frames provide a sense of closer connection to individuals, and are relatively digestible compared to statistical information and generalizations. The media tend to prefer human interest stories because they are considered the content that people can easily empathize with Okuda (2009). In this study, we observed that some articles (i.e., Cluster 3 articles) covered human interest stories. Nakagoshi and Inamasu (2019) conducted a web survey on framing effects, and revealed that people's perceptions of problems depend on how they are portrayed. They found that the effect of episodic frames on receivers was consistent with previous studies. Fifth anniversary coverage on Yahoo News was also framed episodically, rather than thematically. Further, many episodically framed stories circulated in the anniversary month. As mentioned above, it was found that readers argued that mountaineers were personally responsible for their troubles. Readers may endeavor to dispel anxiety by stigmatizing a certain group (in this case, mountaineers), and thinking that "getting rid of these people will bring a social solution" (Flynn et al. 2001). In other words, within the online sphere, a boundary of common in-group identity ("we") was created, and certain prejudice and discrimination was directed toward the out-group ("others").

The sense of fatalism that human beings are helpless in the face of a volcanic disaster was observed in our comment data. As we scrutinized a small number of Yahoo News articles, and it was difficult to obtain reliable demographic data about online readers due to the anonymity of the Internet, it was unclear whether the anniversary coverage would be more likely to elicit negative emotions (such as anger and disgust), rather than compassion and pity, in all cases. However, our finding that online comments had a negative tone is consistent with the outcomes of previous research (Yamada 2020). Furthermore, newspapers, especially national ones, emphasized that local governments were slow to make progress on volcano disaster prevention measures (see Table 5). This would decrease public confidence in the municipal ability to prevent volcanic disasters. Ohtomo and Iwasaki (2011) used an experimental study to gauge the strength

of the relationship between exposure to mass media and preparedness behavior for earthquakes. There is a belief that one's efforts can control the extent of the damage inflicted by a natural catastrophe, and expectations surrounding the impact of preparedness behavior on disaster reduction could promote protective actions. However, the sense of fatalism and the perception of "we" and "others" could hamper concrete steps toward volcanic disaster prevention. We concluded that human interest reporting may not have been an alternative to vicarious experiences (Bandura 1977) in this case.

Some disaster studies have suggested that the usage of the term "natural disaster" offers people a misleading image (Massazza et al. 2019; Chmutina and von Meding 2019). The expression "natural disaster" could be a get-out-of-jail-free card to take zero responsibility for failures of disaster preparedness measures by blaming nature. It affirms the status quo, and deprives our society of opportunities to change. It is thought that "hazards can turn into a disaster due to human acts of omission and commission rather than an act of nature," and that disasters are frequently brought about by socioeconomic factors rather than natural phenomena (Chmutina and von Meding 2019). In this case, the newspaper media frequently utilized the combination of the terms "disaster" and "eruption" instead of the expression "natural disaster" (see the network visualization diagram of words). Only 56 of the total (2797) articles contained the expression "natural disaster" in their text. However, it appears to have the same contribution in terms of producing the image that both expressions are of phenomena distinct from human-made disasters. The important point is that journalists, as watchdogs, monitor whether policy and decision makers attempt to create an advantageous situation for themselves by portraying disasters as unforeseen and unexpected natural forces. It is crucial for journalists to ask elites or politicians hard-hitting questions that the public cannot. Occasional in-depth reporting is insufficient (Marder 1998). The media attention regarding the trial topic of the 2014 Mt. Ontake eruption is dependent on the trial schedule. The bereaved raised a question about the policy-making process with scientific advice. According to the OECD Science (), transparency in the political use of scientific advice is of utmost importance. Therefore, journalists need to endeavor to generate a debate on the sound application of scientific advice through their coverage.

As seen in Fig. 7, the expression "natural disaster" was used more in comments because of the direct link between "disaster" and "nature." This revealed that a sense of fatalism is widespread within Japanese society. When a disaster is conceived as a natural phenomenon, the perceived role of human actors is concealed. This is the case in all disasters, including this one. Opinions about excluding some people and the perceptions

of natural responsibility may hinder the formation of a shared risk awareness of volcanic risk. These factors could have shaped a different collective memory of the 2014 Mt. Ontake eruption, such that it would not be viewed as an opportunity for social progress, but rather as a wound causing distress to society (namely through stigma).

Conclusions

We conducted a quantitative analysis of mass media coverage after the JMA lowered the alert level from 3 to 2 in 2015, investigating which topics were covered by news stories, and to what extent in order to answer the first research question. When the automatic text categorization splits the news articles into five topics, we found that stories about Mt. Ontake's volcanic warning status (Cluster 1) and human interest (Cluster 3) topics were primarily published during the anniversary months. While stories related to municipalities' volcanic emergency plans (Cluster 2) and lessons learned from the 2014 Mt. Ontake eruption (Cluster 4) were covered during ordinary months, stories on missing person searches (Cluster 5) were only reported in July and August 2015. The information volumes of Clusters 1, 2, and 3, which we defined as the number of characters in articles, comprised approximately 25% of the total.

Similar to previous studies, the distributions of clusters for each newspaper form were distinct (see Table 3). For national newspapers, we ranked Clusters 2, 3, 1, 4, and 5 in order from the category with the largest information volume. National newspapers paid substantial attention to Cluster 2. As their readers primarily live in big cities like Tokyo and Osaka, the current status of countermeasures against volcanic disasters (which each municipality should establish) has become an important political issue for journalists working in the national press. The inherent news value resulted in enormous media attention in Cluster 2. Furthermore, human interest stories were covered by national media, constituting the second largest information volume. This would also be associated with the fact that many tourists were victims of the volcanic eruption.

For the regional newspaper that we examined (the *Chunichi Shimbun*), we arranged Clusters 1, 3, 4, 2, and 5 in descending order. In contrast to the national newspapers' lineup of clusters, the regional newspaper devoted less coverage to Cluster 2. In the inventory of this cluster, the information volumes of Clusters 1 and 3 comprised approximately 67% of the total. The stories belonging to these two categories primarily appeared during the anniversary months; we considered them to be topics with higher public attention because readers live around Mt. Ontake, as well as in the Aichi area. The number of articles assigned to Cluster 2 was small. The regional media covers the Chubu region, including Aichi,

and gathers news related to disaster preparedness of the municipalities within the limited area. Since it cannot cover each region with the same resources as a local newspaper, it would be difficult to collect detailed newsworthy topics. This could be confirmed by the relatively high percentage of articles related to the trial held in Matsumoto city (the capital of Nagano Prefecture).

For the local newspaper (Shinano-Mainichi Shimbun), we arranged Clusters 1, 2, 3, 4, and 5 in descending order. The local newspaper had a somewhat higher information volume for Cluster 1 (approximately 30%) than the other categories. On the other hand, the information volumes of Clusters 2, 3, and 4 were nearly the same at 20%. We found that the local newspaper covered various topics in terms of volcanic eruption risk in a well-balanced manner. Since the main business for the region around Mt. Ontake is tourism, abandoning the zero-risk logic is a major disadvantage. However, according to Centemeri's study on the long term recovery process from the Seveso disaster (Italy's industrial disaster in 1976) (Centemeri 2015), "the possibility of transforming a stigmatizing accident that had been inflicted upon the community into an 'opportunity for change' entailed accepting the idea that some of its consequences would not serve in the construction of a collective cause." The local media played a role in coordinating the various opinions of the community and contributed to building resilient communities.

We conducted a content analysis of the online comments (to the articles referring to the fifth anniversary of the Mt. Ontake volcanic disaster) to establish how readers felt in response to the news coverage. This is the second part of our research questions. Only three articles were published on Yahoo News. According to the arguments made by the three articles, one article mainly belonged to Cluster 1, while the others belonged to Cluster 3. The comments claimed that mountaineering should be performed at one's own risk and that administrative agencies need not take countermeasures against volcanic disasters. The readers indicated that any volcanic disaster prevention plan did not match the situation of a pyroclastic flow, and that building shelters might not be worth the cost. At the underlying level, commenters regarded volcanic eruptions as something beyond human wisdom, suggesting a fatalism of throwing their hands up for the prevention of volcanic disasters. Overall it can be said that the commenters felt volcanic risk to be an issue pertaining to mountaineers, or "others," instead of being relevant to themselves, or "we."

Limitations and outlook

Our study had certain limitations. In this study, we focused on news articles regarding the 2014 Mt. Ontake eruption reported by the newspapers. Here, we lumped the five newspaper companies together as the national

newspaper. But each has its own political ideology and therefore the phenomenon of polarization in newspapers' stances toward the government is observed. If we will look at polarization in opinions towards the government's commitment to disaster risk reduction, news articles covered by respective newspaper companies should be investigated separately.

Furthermore, as mentioned above, newspaper subscription rates vary within generations (Institute for Information and Communications Policy 2019). Fundamentally, young people tend to use electronic media such as web news portals and social media, rather than print media, in acquiring news. In addition, people consider televised media as the most reliable source for obtaining information about the world. Newspapers are highly trusted as media, but are not widely read (Institute for Information and Communications Policy 2019). Even though journalists share common news selection criteria, each media applies different types of framing to news. Previous research has suggested that the human interest frame, which is similar to the episodic frame, may be more prevalent in media coverage of crises (Semetko and Valkenburg 2000; An and Gower 2009). According to the frame analysis of health issues (Cho 2006), episodically framed news stories dominate televised media. Our results of the content analysis of online comments show that readers imposed the responsibilities of volcanic disasters on climbers. While this study looked at three online news stories and readers' online reactions to them, there is insufficient data to derive generalizations. Moreover, TV news was not examined. Although it is difficult to gauge the audience's reaction to TV news, comments on social media with quotations or references to TV news allow us to comprehend the effect of TV news frames to some extent. It will be necessary in the future to conduct a content analysis of comments containing the quotations of news organizations on social media.

Our sample size for the content analysis of online comments was too limited to verify whether it is possible to observe a negative feeling toward certain people (e.g., mountaineers) and administrative agencies that try to take countermeasures against volcanic disasters. Future research could involve a content analysis of multiple comments referring to the 2014 Mt. Ontake eruption and other volcanic calamities on online platforms (such as Twitter). Previous studies suggest that media exposure positively influences people's emergency preparedness behavior and risk perception (Hong et al. 2019). Hence, the dominant frame in media anniversary coverage is one of the determining factors affecting emergency preparedness behavior. In our study, we were unable to determine who wrote the comments due to the ubiquitous, often anonymous nature of the Internet. Therefore, we were unable to identify the characteristics of readers

with negative views. Using interviews or questionnaire surveys (Donovan et al. 2018; Kuri and Suppasri 2018), future investigations could extend the current research by ironing out how the different frames of news coverage moderate the relationship between socio-demographic features and public discourse on proper measures to adopt for volcanic disaster prevention.

Despite these limitations, our findings provide direction for future volcano risk communication strategies. In the digital age, civic entities (such as non-profit and non-governmental organizations) that make full use of information technology are important for building a communication strategy for volcanic risk. In the online world, certain groups are secluded due to the filter bubble effect (Pariser 2011). Based on Tocqueville's institutional theory (de Tocqueville 1969), these groups lose social ties to others on the Web. Furthermore, people have no opportunity to acquire ideas from others in terms of handling various volcanic risks in everyday life because the issue of volcanic risk is usually inconspicuous. Thus, the direction of discourse on the Web is vulnerable to the propagation of misinformation (Aswani et al. 2019). A civic body that bridges the gap between isolated groups and government bodies or experts (Putnam 2001) can play a pivotal role in building Web communication strategies, and provide different sides of the opinion spectrum for isolated groups. This kind of civic group would also be meaningful because it enables the spread of copious information beyond administrative districts, in addition to serving as a watchdog for the central/local governments. During volcanic crises, it is very important to deliver one-voice messages from experts to society (Harris 2015a; Harris and Villeneuve 2018b). Such civic groups may be beneficial for monitoring the potential propagation of misinformation or rumors at that time. In the future, it will be necessary to add civic groups as another actor to the tetrahedron proposed by Okada and Ui (1997).

The rise of SNS has weakened the power of newspapers to convey information; in the future, only fragmented information on volcanic risk will be shared. Therefore, it is natural to assume that the information gap will grow increasingly larger. People also seem to presume that volcanic disasters occur in areas with volcanoes. Volcanic disaster prevention at Mt. Fuji has significant news value (Yamada 2017), whereas such efforts made at other sites are unlikely to be widely reported. Thus, people underestimate the potential hazards of volcanic eruptions. How to modify such an inaccurate perception in the age of information and communications technology is a question beyond the scope of this study. However, the key approach to addressing the matter of volcanic risk would involve filling the information gap and not stigmatizing anyone. The design of volcanic risk management will require the active commitment of government agencies

and experts, and a sophisticated communication strategy for volcanic information should be developed. For that, it would be necessary to establish a specialized institution that develops disaster management strategies centrally, for the entire nation.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s13617-021-00113-8>.

Additional file 1: Relationships between N_c/N and N_{ca}/N_c . Scatterplot showing the relationship between N_c/N (the x-axis) and N_{ca}/N_c (the y-axis) for (a) national, (b) regional, (c) local, and (d) all newspapers. The number corresponds to the cluster number. Here, N , N_c , and N_{ca} signal the overall information volume, the total information volume for each cluster, and the information volume during the anniversary months for each cluster, respectively. See Table 3 for a detailed description.

Additional file 2: Network visualization of words and monthly variations in information volume for cluster 5. The same as Fig. 3, but for Cluster 5. In panel (a), links between words are created according to a cosine similarity larger than 0.62.

Additional file 3: Network visualization of words centered on the word "expert". The same as Fig. 3, but we plotted words co-occurring with the word "expert" and used a list of words appearing in the articles that referred to the lawsuit brought against the local government and the JMA by the bereaved. Links between words are created according to a cosine similarity greater than 0.66.

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Author's contributions

The project was conceived of by the author. Data collection, figure production, and manuscript preparation and editing were done by the author. The author read and approved the final manuscript.

Declarations

Competing interests

The author declares that he have no competing interests.

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