

Research Article

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Go social for your own safety! Review of social networks use on natural disasters – case studies from worldwide

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Abstract: Social networking sites (SNS) became an indispensable part of people's everyday life, but also a powerful tool of communication during urgent situations, such as during natural disasters. This is evidenced by a large number of research papers showing the use of SNS in difficult circumstances. Some of the ways of using are the dissemination of information about missing persons, warning on further possible consequences, safety checks during natural disasters, communication about places where the population can find help or a safe refuge. At the same time, SNS could increase awareness among the population about natural hazards. Unfortunately, most parts of the world have at least once been hit by a major natural disaster. People who manage such events have a big task in front of them, as they need to exploit the potential of SNS, but also to reduce the negative side, such as spreading inaccurate information in difficult moments. The paper presents ways of using SNS, and the positive and negative effects of these, before, during and after natural disasters.

Keywords: social networking sites, natural hazards, disaster management

1 Introduction

A large number of natural disasters have been recorded in the last few years and it is predicted that this number will grow [1]. Natural disasters have a negative impact on all aspects of life, from the material and emotional state of the

people to the disturbance of the natural environment, *i.e.* the negative ecological impact [1].

Social networking sites (SNS) are tools for communicating over the Internet, which enable communication between users by creating, sharing, or commenting content [2–5]. In order to use all the ways that can help during natural disasters, it is necessary to present past practices and future steps of using social networking sites (SNS) during natural catastrophes. This implies an organised ways of influencing Internet users and non-Internet users to understand the role of SNS during disastrous moments.

At the moment, there are over 4 billion Internet users and it is believed that this number will be growing by 7% every year, while the number of SNS users is over 3 billion, with the annual increase of 13% [6]. Using SNS is considered to have become a daily routine among the population around the world, while formerly they were only applications on smart devices [7, 8]. It is well-known that SNS provide simple and fast communication and networking. Likewise, SNS is one of the most important communication tools during natural disasters, imposed as a logical step in managing crisis in the modern society [3, 8]. Moreno [9] believes that social networking sites are very accessible, free and can provide a large amount of information. He suggests maximum use of SNS for crisis management, especially for local communities that do not have a high budget, and with the help of Internet users.

Thus, this study will present examples of SNS application in the context of natural disasters worldwide. The main goal is to summarize past practices by identifying the shortcomings that occur in communication during natural disasters through social media. Therefore, it is possible to create strategies for overcoming deficiencies, in order to make the communication better in the future.

For the purpose of this study, authors presented case studies divided into three phases of natural disasters. The first phase is a preparation phase that deals with the creation of plans for activities during a natural disaster. The second phase consist of effectivity implementation the plans from the first phase, while the third phase involves all actions related to the recovery from a natural disaster.

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Since each phase requires different activities, therefore the information that is shared is different by phases [10, 11]. Through these examples it is possible to highlight the advantages that SNS have in relation to traditional media. It should be noted that, at the current spectrum of media consumption, SNS should not be taken as the only means of informing or providing assistance and support during natural disasters, but as one of main pillars in conjunction to traditional media.

2 Social networking sites and natural disasters

Social networking sites allow two-way communication, made up of text, image, audio and video messages. This content can be exchanged between individuals, groups, institutions, or among all users on SNS [12, 13]. Alexander [13] highlights the role of SNS during disasters and crisis moments: *"a listening function, monitoring a situation, integrating social media into emergency planning and crisis management, crowd-sourcing and collaborative development, creating social cohesion and promoting therapeutic initiatives, the furtherance of causes, research"*, p.720.

There is a growing body of literature on the basis of which the potential needs of users or population affected by natural disasters can be identified [14–16]. Communication on SNS related to victim assistance, information on shelters, various types of alerts can be helpful [17–19]. Scientists deal with various aspects of the application of SNS during natural disasters. For instance, Huang *et al.* [20] research disaster forecast, while Acar & Muraki [21] focus on warnings. Ehnis & Bunker [22] have been researching rumours on SNS that could worsen already difficult situation, while Olteanu *et al.* [23] based their research on post-crisis activities. This confirms the fourth place of SNS in importance in the exchange of information in emergencies [16, 24].

It is believed that social networking sites such as Twitter and Facebook play very important role during natural disasters.

Twitter is a social networking site that allows users to communicate openly, regardless of whether they are connected to each other as users [25]. Messages that are exchanged are called tweets. It is possible to publish text messages with less than 280 characters and video content [11, 26, 27]. This can be taken as an advantage and as a disadvantage. Advantage in the sense that the messages are not long, it is easy to see the information in the message, but there may be a defect if the user does not express

accurately in the message. In that case, the message will have no meaning [28]. Communication can be done both publicly and privately. Public means that every user on Twitter can see the conversation, regardless of whether it follows a specific user. Twitter is used mainly for daily communication, commenting on current events [25, 29]. The significance of twitter is highlighted during emergencies, such as natural disasters, as a means of transmitting news and information [25, 30, 31]. The "twitter alert" option was created to allow users to receive notifications from pages like the Red Cross and other emergency management organizations. Thus, users can be informed about a potential natural disaster in time.

The difference between Facebook and Twitter is that users must be connected in some way to communicate. Users are able to share content with friends and the public. If a user marks a post as public then anyone can see it, and in the second case only those users who are connected as "friends". During natural disasters, it is important that all who participate in the spread of information publish public posts. In that case, everyone can see information and provide it to others, communication can be faster and more efficient. In addition, it is possible to create fundraisers on Facebook. It is necessary for the user to have more than 18 years to start collecting money. During natural disasters, Facebook opens the option to "check safe". Thus, users can confirm that they are safe if they are in a vulnerable area. All friends will be notified about this.

Other SNS that can be used as a means of sharing information during natural disasters are Instagram, YouTube, WhatsApp, Skype. Most SNS have an option for hashtag, which is a great help in sorting messages related to a natural disaster or specifically a city that has been hit by a catastrophe. Also, it is possible to link a post or message to a user's location. Some social networking sites, like Instagram, have geo-tags, which means it is possible to see where the user is, while publishing the content.

3 The three phases during natural disasters

The role of the social networking sites is multiple. They are significant in the preparation phase for a natural disaster because it is possible to share warnings before the disaster, then during the disaster, but also after, for example, to find people who were missing [16, 32]. In the further reading, three phases are presented during natural disasters and the application of SNS in given phases with the examples from worldwide. These are: preparatory phase, phase

during natural disaster and recovery phase. In each of the phases, examples of natural disasters and ways in which SNS users have assisted in the dissemination of information are presented.

4 The pre-disaster phase

In the pre-disaster phase or the preparation phase, users on SNS can be alerted by certain organizations about natural disaster probability in the endangered area. Table 1 shows the overview of case studies presented in the pre-disaster phase.

During the Sandy Storm (United States) in 2012, significant use of SNS, such as Facebook, Twitter and YouTube, has been noted. Users on SNS were active before the storm hit the inhabited area, with immense number of evacuation information, the remaining time to the storm, places where food, drink and shelter could be found [33]. The National Hurricane Centre has posted on its Facebook page the direction of the hurricane movement and which regions will be affected in order to evacuate the inhabitants in time (Figure 1b).

In 2010 and 2011, there was a significant use of SNS during natural disasters in various parts of the world. This is illustrated by examples in Belgium, Virginia and Queensland. When a potentially dangerous storm was announced during the festival in Belgium, in 2011, Twitter users posted about 2,000 tweets related to the storm [5, 34]. During the preparatory phase for the Super Tornado Outbreak that hit Virginia in 2011, users shared information on a tornado alert on SNS, how to act during tornadoes, where shelters can be found, etc. [35, 36]. The Queensland Police Service example states that the activity in disseminating information on social networks by organizations dealing with disaster management is important. They created official pages on social networking sites (Facebook, Twitter, YouTube) in May 2010. The goal was to gather as many users as possible to follow their page so that in the event of disasters they could share information. They also educated page administrators on how to act during disasters. Figure 1a shows a flood warning post and how the population should behave, *i.e.* what to avoid during the crisis period and what number they can call in an emergency. When powerful cyclones hit Queensland (Australia) in 2010, the police began to use Facebook, Twitter and YouTube as an information exchange tool. Of course, their activities continued after the cyclone [22, 37].

Chatfield and Brajawidagda [38], Ichiguchi [39], Nugroho [40] find that Twitter can be of great use in the prepa-

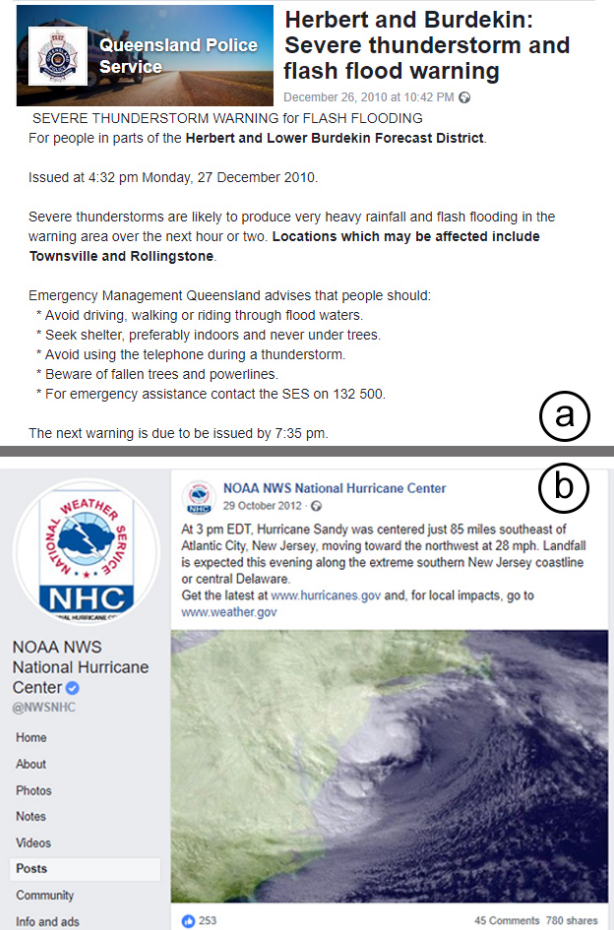


Figure 1: Screenshots of Facebook posts during floods in Queensland, Australia (a) and Sandy Storm (b) in United States *Source: www.facebook.com amended by authors*



Figure 2: Screenshots of Twitter posts presenting earthquake alert and tips on how to protect yourself during earthquake *Source: www.twitter.com amended by authors*

Table 1: Case studies from the pre-disaster phase

PRE-DISASTER PHASE				
Natural disaster	Year	Country/Region	Social media	Reference
Hurricane Sandy	2012	United States	Facebook, Twitter, YouTube	[33]
Storm	2011	Belgium (Hasselt)	Twitter	[5, 34]
Super Outbreak tornado	2011	Virginia	Twitter	[35, 36]
Floods	2010/11	Queensland (Australia)	Facebook, Twitter, YouTube	[22, 37]
Mount Merapi Eruption; Mentawai Earthquake and Tsunami; Singkil earthquake; Simeulue earthquake	2010/11/12	Japan	Twitter	[38–40]

ration phase for a natural disaster, especially for warnings on natural disasters (Figure 2a). During the 2010 Mount Merapi Eruption and the 2011 Earthquake and Tsunami in the east of Japan, Twitter was the main mode of communication in regions where there was no access to the mobile network. They believe that Twitter can play a major role in assisting the population in preparing for a natural disaster as can be seen in Figure 2b, but also for organizations at the local level. Chatfield and Brajawidagda [38] also conducted a survey through the Meteorological, Climatological and Geophysical Agency of Indonesia (BMKG) page that is affiliated with Twitter. This study refers to three earthquakes that occurred in 2010 (Mentawai Earthquake and Tsunami), 2011 (Singkil earthquake) and 2012 (Simeulue earthquake), one of which caused a tsunami. After the earthquake warning, the first tweet was announced for seven minutes after that, which suggests that Twitter can serve as a tool for informing, for the rapid evacuation of the population.

5 Response phase

The second phase or the phase during the natural disaster is often the most important. At that moment, the help is needed to people who are endangered, and in order to succeed in it, it is important to support the spread of information. Dissemination of information, when a natural disaster occurs, is of paramount importance, and other types of information from people who want to help everyone who is at risk. Table 2 shows the overview of case studies presented in the response phase.

There is the evidence that the functional beginning of the implementation of social networking sites during natural disasters began in 2001 [36]. The use of SNS during

natural disasters continued, as evidenced by the images displayed during the tsunami in the Indian Ocean in 2004 and the fire in Southern California in 2007 [36, 41, 42].

Social networking sites were used as a tool for collecting and spreading information during floods in Queensland and Thailand in 2011 [31, 43–46]. They also believe that the information shared on SNS should not always be understood as fully accurate.

Furthermore, during the floods that hit Queensland, Australia, Bird *et al.* [47] noted that: "*While rumours were common at the height of the disaster, respondents reported that the moderators of the Facebook pages were prompted to confirm information and provide official sources when available*" (pp. 30-31). In this case, the administrators of the official pages have acted correctly, because partially accurate information often appears during the crisis situation, which can result in difficult circumstances, in addition to the natural disaster itself. The Queensland Police Service used its official pages on SNS during floods that lasted from December 2010 to January 2011, for various flood warnings (*e.g.* water raising, flooding the region, closed roads) and the dissemination of information [22, 48]. Again, Twitter users exclusively used hashtag #qld-floods in order to be able to sort the flood-related posts as easily as possible [11, 49]. Another example of the use of SNS during the flood was recorded in Tyne and Wear (United Kingdom) in 2012. The presence of users on Twitter was significant. On Twitter, it was possible to find the latest information on the current status of water levels in cities that are endangered and how to help vulnerable population (Figure 3b, 3c, 3d). Just on the day the flood began, there were approximately 1800 tweets that contained hashtags: #toonflood and #newcastleendofday. At this time, local authorities and other organizations at the local level supported the sharing of information via Twitter [46, 50].

Table 2: Case studies from response phase

Natural disaster	Year	<i>RESPONSE PHASE</i>		Reference
		City/Region/Country	Social media	
Earthquake and tsunami	2004	Southeast Asia	Networks that serve	[36, 41, 42]
Fire	2007	Southern California	mainly for posting images	
Flood	2011	Queensland	Twitter	[31, 43–46]
			Facebook	[11, 49]
				[47]
				[22, 48]
Flood	2012	United Kingdom, Tyne and Wear	Twitter	[46, 50]
Tornado	2011	Tuscaloosa, Alabama	Facebook, Twitter	[51]
Fire	2007	California	Not specified	[52]
Fire	2009	Oklahoma	Twitter	[53]
Tornado	2012	Missouri, Branson	Facebook	[54]
Flood	2011	Montana, North and South Dakota, Iowa		
Bushfire	2013	Tasmania	Facebook	[55]
Flood	2016	Louisiana	Facebook, Twitter	[16, 56]
Flood	2015	South India, Chennai	Facebook, Twitter, WhatsApp, Skype	[57]
Flood	2014	Balkan Peninsula	Facebook, Twitter, Instagram	[58, 59]
Flood	2013	Colorado	Twitter	[11]
Hurricanes	2008	Cuba	Twitter	[60]
Earthquakes	2008	China	Not specified	[36, 61, 62]
	2010			
Earthquake	2010	East Japan	Twitter	[63]
Earthquake and tsunami	2011	Tohoku region (Japan)	Twitter	[21, 36]
Earthquake	2010	Haiti	Twitter	[64]
			Instagram, Twitter	[5, 65–67]
			Not specified	[30, 37]
Tornado	2013	Moore, Oklahoma	Twitter	[68]
Hurricane	2012	East Coast, United States	Twitter, Instagram	[5, 69–71]
			Twitter	[72]
			Twitter, Facebook	[68, 73]
Earthquakes	2016	Rieti, Italy	Twitter	[74]
		Vrancea, Romania		
Typhoon	2013	Philippines	Twitter	[75]
				[76]
Snowstorm	2015	North America	Twitter	[77]
Flood	2014	Malaysia	Facebook, Instagram, WhatsApp, Twitter	[78]
Cyclones	2016	Fiji	Not specified	[19]
Flood	2009	North Dakota, Minnesota, Manitoba;	Twitter	[5, 79]
Typhoon	2010	Philippines	Twitter	[5, 80]
Flood	2011	Brazil		
Earthquake	2011	Japan		
Earthquake	2008	China	Twitter	[5, 81]
Earthquake	2011	Japan	Twitter, Facebook, Skype	[5, 82]
Tornado	2011	Joplin, Missouri	Twitter	[14]
Fire	2007	San Diego, California	Twitter	[5, 81]
Ice storm	2008	New England		
Earthquake	2014	Fontana, California	Twitter	[83]
Flood		Jakarta, Indonesia		
Blizzard	2010	Bornholm, Denmark	Facebook	[84]



Figure 3: Screenshots of tweets related to Hurricane Sandy (a) in United States and floods in Queensland, Australia (b, c, d) *Source: www.twitter.com amended by authors*

Butler [51] states in her research that people were aware of the importance of using SNS during natural disasters in the city of Tuscaloosa (Alabama) in 2011. The official page of the city on Facebook had just a few friends and likes before the storm, and after the storm the number of people who followed the page rose rapidly, reaching even the maximum of friends. The city used its official page on Facebook to communicate with the population and help them with information about the storm. Tuscaloosa City Administrators, as well as all other Twitter users, have expanded information about injured people, missing persons, electricity information, parts of closed roads, people who want to help vulnerable people, etc. Tuscaloosa's profile administrators have linked up with a company that has electronic billboards in the region, and every time they used the hashtag "TUS" (Tuscaloosa shortcut), tweets appeared on the billboards in the city (Figure 4). This way, the information came to those who currently do not have electricity, Internet access or the device that is needed for the use of SNS.



Figure 4: Live emergency messaging during storm in Tuscaloosa *Source: www.lamar.com*

There are also examples in which the public had no confidence in the local community and traditional media. During the California fire in 2007, SNS users expanded information on the regions affected by the fire and areas in danger [52]. In contrast, during the 2009 fire in Oklahoma, synergy of local media, public and emergency organizations is shown. Great activities of users who do not live in this region are also noticed, but they nevertheless provided assistance through the public network [53].

When it was announced that the tornado would hit Branson, the page "Branson Tornado Info" was created (Figure 5b). Tornado hit Branson in February 2012. The administrators provided information on volunteering and similar activities, but it also used coordination between government and local institutions, whose regions were affected by the tornado. A similar example is the Facebook page of "Missouri Flood Info", created when floods were predicted (Figure 5a). On this page it was possible to find all official information about water spillage, flood victims, volunteering, river levels, evacuation, and emergency education [54]. Pages on SNS in support of information dissemination were also created during bushfires and Tasmania in 2013. Through "The Tassie fires - We can help", it was possible to share all the information during the fire, as well as donations for all those who are at risk, for refugee centres and all other forms of support and assistance [55].

In emergency situations, users on Facebook and Twitter have provided assistance in disseminating information through the creation of help pages, as well as through hashtags in posts. The flood that struck Louisiana in 2016 has destroyed a large number of households. On social networking sites, in addition to the population, official pages of Louisiana cities that provided updated information were also activated. They used the Facebook and Twitter networks, but there was more activity on Facebook [16, 56]. During the 2011 flood in Thailand, the largest activity on Twitter was recorded by government organizations, organizations that manage the catastrophes, the Red Cross and volunteers [11, 44]. A large number of people were at risk during the Chennai floods in 2015. Facebook, Twitter and WhatsApp were used to request and provide help, find friends and family members. Hashtags (#ChennaiRainsHelp, #ChennaiRescue and #ChennaiMicro) were of great importance on Facebook and Twitter, as it was easier to extract flood-related announcements. Facebook activated the Check Safe option, which also helped in the flood, to determine who is safe. Skype activity has also been reported [57].

Floods in 2014 on the Balkan Peninsula caused great damage. During and after the flood, the population from various countries organized collecting assistance through

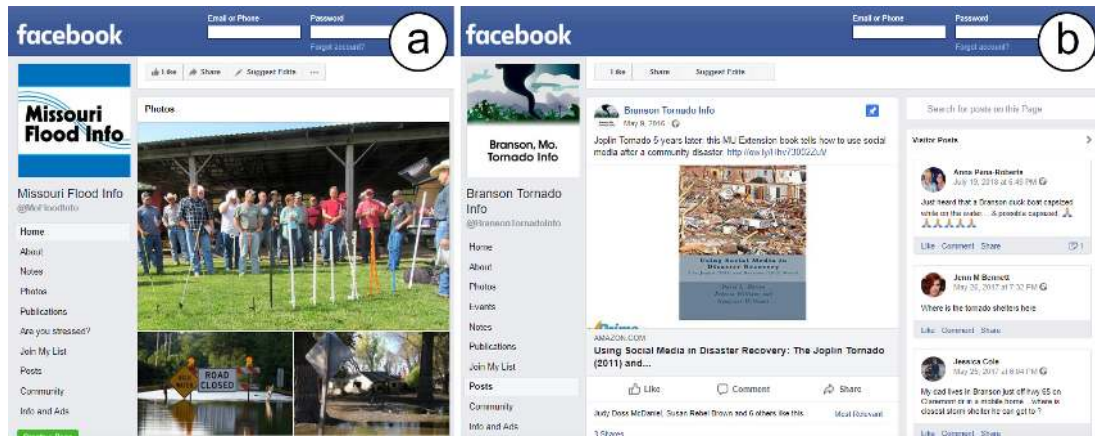


Figure 5: Screenshots of Facebook pages created for purpose of sharing information about Missouri flood (a) and Branson Tornado (b), in Missouri Source: www.facebook.com amended by authors

SNS. Thousands of messages were posted on Facebook and Twitter for help and flood warnings. In a concerted effort, Twitter users launched the *poplave.com* website, with maps of flooded areas and all flood information. Most of the messages contained hashtags such as #floods and #SerbiaFloods, ways to provide help, images, and videos. On Facebook, a page called "Floods in the Region" was created [58]. Activities on SNS during the floods in South-eastern and Central Europe, in 2014, were also recorded from the official page "Balkanalysis" on Twitter. Representatives of governments in the region point out social networking sites as very important tool for communication during floods. It can be said that SNS have provided reliable information, among which Facebook expands. Users have also made great efforts to verify information that is not reliable and mark them as accurate or incorrect. It is believed that during these floods, SNS played a greater role in communication than traditional media [59]. The activity of humanitarian organizations on Instagram has been noted, which immediately triggered the collection of funds for people affected by floods (Figure 6).

During the floods in Colorado in 2013, flood-affected populations, as well as people from other regions, expanded information on Twitter. This was supported by both the Federal Emergency Management Agency (FEMA) and the Meteorological Service. Nearly 10,000 varieties of hashtags were recorded, which were related to the flood [11].

Based on Hughes & Palen [60], during the hurricanes Ike and Gustav from 2008, in Cuba, information was shared on Twitter, as well as the publication of audio and video content. Also, information about people who are at risk, warnings, etc. users shared and published on SNS



Figure 6: Screenshot of Instagram image used for floods in Serbia Source: www.instagram.com amended by authors

during the 2008 Sichuan earthquake in China and during the 2010 Yushu earthquake, also in China [36, 61, 62].

Social networking sites cannot be used only for the publication and sharing of important information during natural disasters. Through them, users can express solidarity during natural disasters that occur anywhere in the world. In this way, users provide a certain type of support to countries that find themselves in crisis situations. An example of such an approach was recorded during the Great East Japan Earthquake in 2010. The survey found nearly 2,000 tweets related to emotional support [63]. Thus, residents of Tohoku Region (Japan) during the earthquake and tsunami in 2011 that hit this region, used Twitter to provide support. Some of the users transmitted information from their surroundings, while some used the opportunity to label themselves as safe. The earthquake struck all possible

telephone lines and then SNS played a crucial role in communication [21, 36].

Most of the tweets during the Haiti earthquake included the hashtags: #HaitiEarthquake, #HaitiQuake or #HaitiHelp. According to the samples and the results of the survey, the majority of activities on Twitter users had the first day of the earthquake, while later the activity of the user decreased. The content of the messages were links to pictures that show the situation in certain places, information from the Red Cross, as well as various types of assistance in the form of foundations and shelters for the people in danger [64]. Volunteer activity on Instagram was also recorded. They created a map with clearly identified areas that were destroyed by the earthquake, and so all types of aid were directed to these regions. Also, about 2.3 million tweets were recorded containing the word “Haiti” or the number created for the donation [5, 65–67]. It is important to note that agencies and emergency organizations in the United States for the first time applied SNS as a means of communication during the Haiti earthquake [30, 37].

Blanford *et al.* [68] conducted an analysis of Twitter activity related to the Moore (Oklahoma) tornado that occurred in 2013. The results of the survey show that the largest number of tweets containing the word tornado is recorded on the day the natural disaster occurred. In the spread of information on Twitter, the National Meteorological Service also took part. Interesting information, the most were tweets that suggest retweet as much as possible.

A very good user response on Twitter was during the Hurricane Sandy 2012 on the East Coast (United States). The word “hurricane” was recorded 1.1 million times in less than 24 hours. The Federal Emergency Management Agency (FEMA) also published updated information on its profile on Twitter (Figure 3a). Instagram played a major role during this natural disaster. It is recorded that 10 images with storm information per second have been published. However, during this period, a large number of misinformation was recorded, such as images of a cloud above New York, processed in Photoshop, or images of soldiers at the Arlington Cemetery, which were recorded in September, not during the storm. Therefore, SNS users must be cautious with information and generally use those from official local community pages [5, 69–71].

Kryvasheyev *et al.* [72] analysed Twitter activity during Hurricane Sandy. They were researching Twitter, compared to the location, because this hurricane hit several regions. They found that activity was greatest in those regions that were most affected. As the hurricane went through, the activity of users in the affected region was reduced. Official pages of government organizations on

Facebook and Twitter received several thousand followers during the storm, who were expected to receive information [68, 73].

During emergency situations, there is a very large response from users on SNS who want to help. This means that they are aware of the certain power of communication possessed by social networking sites. By gathering tweets during earthquakes in Rieti (Italy) and Vrancea (Romania), it was found that the highest tweets were related to earthquake victims. It is believed that the analysis of posts on SNS can improve the ways of communication during natural disasters [74]. An example that confirms users’ awareness of the importance of SNS is Typhoon Haiyan who hit Philippines. Thanks to the Internet and social networks (Facebook, Twitter), users were able to seek help and transfer information from different regions of the Philippines [75].

Takahashi *et al.* [76] and Teodorescu [77] were researching the frequency and content of posts on SNS during natural disasters. During Typhoon Haiyan the highest number of posts on Twitter contained information from other media, for example, from the TV. However, a large number of posts appeared with the expression of emotions or support to all those who are affected by typhoon, as well as the publication of volunteer activities, for the collection of food and other means of assistance [76]. Based on the analysis of tweets containing the words “blizzard” and “snow” during the storm, the results showed about 20,000 messages per day, during a snowstorm in North America in 2015 [77].

Some natural disasters have led to the use of different SNS, not just Facebook and Twitter. Based on the research carried out by Aisha *et al.* [78] results show that users mostly used Facebook, Instagram, WhatsApp and Twitter during floods in Malaysia in 2014. Users were mostly collecting information via Facebook and Twitter, but also by monitoring the release of influential personalities on these social networking sites. However, WhatsApp also played a major role in the exchange of messages during the flood.

Möller *et al.* [19] conducted a research of user activities on the hotel’s pages, during three cyclones in Fiji, 2016. The results show that during the cyclone Winston and the cyclone of Zena the greatest activity was during the cyclone, while during the Amos cyclone the highest activity of the users was recorded in the stage of recovery from the natural disaster. However, during the Winston cyclone, the highest activity was recorded, regardless of the phase. The difference in activity can be related to the fact that cyclone Winston was much stronger than the other two.

Palen *et al.* [79] and Fraustino *et al.* [5] conducted a study of information flow during Red River Valley flood in

March 2009. They followed activities on Twitter related to the flood. They analysed about 20,000 tweets, which were most relevant to pre-set parameters. During the flood, influential users of Twitter reported only flood information and flood relief, without daily updates that had previously been published. Some of them applied for volunteering, and from that moment they issued warnings about the water level in certain places, as well as official information from local authorities. Followers of these profiles shared or read their posts.

Analysing tweets during typhoon in the Philippines in 2010, Brazil's floods and earthquakes in Japan 2011, Nagar, Seth and Joshi [80] and Fraustino *et al.* [5] found that the biggest activity on the Twitter was by users who often use this social network and have large number of followers. The first reports of the 2008 earthquake in China were also on Twitter [5, 81].

Gao, Barbier, & Goolsby [82] and Fraustino *et al.* [5] point out that the public during the 2011 earthquake in Japan used Twitter, Facebook and Skype to get in touch with families and friends, especially because the mobile network was out of service.

Imran *et al.* [14] conducted a tweet analysis that was released during the 2011 Joplin Tornado. The largest number of tweets involved warnings, donations and various types of information via video and audio, while the smallest number of tweets contained information on the number of deaths, wounded and damaged areas.

During the fires in San Diego, in 2007, researchers found information that the most tweets were during a natural disaster by one local radio station and two residents. Thus, information about the electric company was found, which during the ice storm of 2008 in New England had the greatest influence in posting information on Twitter [5, 81].

According to research by Dittrich and Lucas [83], during the earthquake in 2014, nearly 2,000 tweets were recorded in Fontana, California, which included words like "earthquake", "quake", "shaking" and the like. Also, during floods caused by extensive rainfall in 2014 in Jakarta, Indonesia, over 300 tweets were recorded.

Birkbak [84] lists the use of Facebook during Bornholm blizzard (Denmark) in 2010, through two groups created for this purpose. He believes that linking to the group can make a bigger effect, because different opinions and different types of assistance are present in one place.

6 Recovery phase

As it is important to be aware of the importance of using social networking sites before and during natural disasters, their role after the disaster is also important. After a natural disaster, information is shared about who needs help, where there are vulnerable people, which regions are badly damaged, whether someone needs temporary residence. It is also possible to create pages where users can actively participate in the implementation of strategies and activities for the reconstruction of the regions and cities that are most damaged. All this information can be shared and viewed via Twitter, Facebook, Instagram, etc. Table 3 shows the overview of case studies presented in the recovery phase.

Twitter has been shown not only as a tool of communication during a natural disaster, but also afterwards. According to Lobb *et al.* [85], Twitter, after television, was a very good tool for collecting charity funds after an earthquake that struck Haiti in 2010.

For example, volunteers from Tufts University, after the earthquake in Haiti, created a map on which disaster survivors and volunteers were able to send information for help via messages on Twitter. Within 15 days, more than 2,500 messages were received, which is a very good response [5, 82].

It is possible to distinguish several different examples of the use of SNS during natural disasters in 2011. During the Great East Japan earthquake, in Tsukuba city, very important information is shared through the official page of the city on Twitter. Users followed most of the radio stations and other media on their Twitter profiles, in order to have access to the latest information during the earthquake [86]. Some organizations have started raising funds through their Twitter profiles to recover from earthquakes (Figures 7a, 7b). After Japan earthquake and tsunami in 2011 SNS played a major role in disseminating information on public service alerts, helped find missing persons, as well as other important information related to these natural disasters [87]. The official page of Fairfax County (Virginia) received over 10,000 likes and about 100,000 people shared a hurricane-related content that was published on this official page after the hurricane Sandy in 2011 [5, 88]. Certain communities on their Twitter profiles participated in the creation of recovery strategies after the Super Tornado Outbreak (Virginia, US) in 2011 [35, 36].

Creating pages for recovery from natural disasters is often represented. After a tornado hit Tuscaloosa, a page on Facebook named "Joplin, Mo. Tornado Recovery" was created, with information on where to find help, as well

Table 3: Case studies from recovery phase

RECOVERY PHASE				
Natural disaster	Year	City/Region/Country	Social media	Reference
Earthquake	2010	Haiti, Caribbean	Twitter	[85]
Earthquake	2011	East Japan	Twitter	[5, 82]
Hurricane	2011	Fairfax County, Virginia	Not specified	[86]
Tornado	2011	Tuscaloosa, Alabama	Twitter, Facebook, YouTube	[87]
Hurricane	2012	East Coast, United States	Not specified	[5, 88]
Flood	2014	Jammu and Kashmir, India	Facebook	[35, 36]
Flood	2014	Kashmir	Facebook	[5, 54, 89–92]
Landslide	2015	Indonesia	Facebook, Skype	[33]
Cyclone	2015	Vanuatu, Oceania	Not specified	[5, 69–71]
Tornado	2013	Moore, Oklahoma	Not specified	[8, 93]
				[8, 94, 95]
				[8]
				[96, 97]



Figure 7: Screenshots of tweets related to Great East Japan Earthquake (a, b) Source: www.twitter.com amended by authors

as the possibility of finding family members through the page. Also, the “Tuscaloosa Forward” page was created, on which SNS users could put up ideas for restoring areas affected by natural disasters. A lot of people with over 300 ideas responded to this activity. There was also the possibility of applying for all types of volunteering through the page “Joplin Tornado Volunteers List” [5, 54, 89–92]. The “Joplin Tornado Info” page was created on Facebook, after tornadoes, for the purpose of sharing information. It is alleged that there was strict information control in order to avoid the spread of unreliable information. The administrators were active for 24 hours, for three weeks and re-

sponded to each message within a short period of time, but also regularly updated information [33].

Facebook and Skype are listed as SNS used after the Sandy Storm, which was one of the main topics in 2012 on Facebook, and many people made phone calls via Skype after a storm because they did not have a mobile network [5, 69–71].

Scientific American [93] and Chaturvedi *et al.* [8] also mention the use of SNS during Sandy Hurricane. At that moment, when the mobile network was not functional, everyone switched to SNS and thus shared information, from residents to the government.

In 2014, the states of Jammu and Kashmir were hit by floods and caused major damage to the infrastructure, and they took a large number of lives. During the floods, the Indian Armed Forces were engaged in helping, moving, finding missing persons, etc. They used Twitter and Facebook to maintain communication with people in these two countries [8, 94, 95]. Influencers also participated in expanding information for flood recovery (Figure 8a, 8b).

Chaturvedi *et al.* [8] conducted a survey based on predetermined parameters, during floods in Kashmir, Indonesia Landslide and the Pam cyclone. On this basis, they found nearly 4,000 tweets for floods in Kashmir, about 8,000 tweets during the landslide in Indonesia and 6,000 tweets during the Pam cyclone.

News Oklahoma [96], Mukkamala & Beck [97], lists the use of SNS in Oklahoma after tornadoes. The user shared information about the damage caused by a tornado and people affected by a natural disaster.



Figure 8: Screenshots of twitter posts related to activities in recovery phase after floods in Jammu and Kashmir (a, b) *Source:* www.twitter.com amended by authors

7 Instead of conclusion – limitations and recommendations

According to previous reading, it is more than evident that SNS plays crucial role in all phases of natural disasters. When a natural disaster occurs, people actively write messages over SNS and thus get a lot of information. However, some of the information may be irrelevant or not useful at that moment. It is therefore very difficult to extract the information that matters and react to them [98, 99]. Another problem that arises is the speed of reaction on some request for help, *i.e.* how quickly someone on the SNS will react if someone announces the need for help [99, 100]. Similarly, on some social networking sites like Twitter, the length of the message is limited, and this may lead to misunderstanding of the information contained in the message [99, 101]. What is already known in everyday communication via SNS are information that is not accurate or various rumours that spread very quickly. Thus, aid can be directed to the wrong address and therefore lose some time [82, 98–100]. It is also possible to provide assistance in an inadequate way, *i.e.* one person recruits more organizations at the same time and everyone responds, not knowing that help has already been indicated by someone else [82, 99]. Also, there are reasons why people have no trust in social networking sites, thinking about the security and privacy of data on networks [82, 99, 102].

Coombs & Holladay [103] and Fraustino *et al.* [5] considered that researching activities on social networking sites under normal circumstances and during natural disasters can help determine how the public responds to crisis situations, how much they are willing to help, but also how they react to the activities of organizations dealing with natural disasters. An assessment of the success of us-

ing SNS can be made, either positive or negative, in crisis situations.

Daniells [104] and Gelernter & Mushegian [100] emphasize the easy use of SNS as an advantage, because on most SNS it is possible to create an account with an e-mail address. Communication takes place quickly with the general public and messages can be sent from all smart devices or personal computers [82, 99].

There is a division between the young and the older, when it comes to the use of SNS during everyday life. Older people are generally not interested in using social networking sites, and so during natural disasters they do not have access to information that is shared on SNS. The reason for this is mainly the lack of knowledge or experience in using the Internet in general. There are also people who do not have enough money to buy electronic devices that allow access to social networking sites. In addition, there is a problem in accessing the Internet in certain geographic regions. In some places there is no regular access to electricity. In such conditions, it is impossible to use SNS as a communication tool [99, 102, 105]. In relation to the above, it is considered that SNS should be used as a communication tool, but also users should be aware of the shortcomings.

On the basis of examples, it can be concluded that social networking sites in the past few years have been of great importance in communication during natural catastrophes around the world. Regardless of whether it is a catastrophe that causes minor or greater damage, the role of SNS is the same. Some SNS allow issuing a notification of a potential disaster, such as Twitter. Some also provide options like check safe on Facebook, allowing people to verify that they are safe. These two SNS in the presented cases are mostly used. In addition to them, the SNS, like Instagram, WhatsApp, Skype and YouTube are mentioned.

In order to communicate and disseminate information more efficiently it is necessary to pay attention to certain things. SNS users should take care that posts are marked on public. This means that anyone can see the post on the social networking site, not just the user's connection. There is also a problem with inaccurate information, which is very quickly shared. Users need to be cautious, because incorrect information can lead to major problems, such as the departure of emergency help to a location where no help is needed. Thus, the efficiency of providing assistance during a natural disaster is lost.

By analysing the use of SNS during natural disasters, Bernier [33] sets out the most important guidelines for participants in communication through the SNS: the priority should be information that is accurate, all suspicious information needs to be checked before sharing it with others, first we need to be sources for those at risk, then for our

family and ultimately for the whole environment, monitor the frequency of disaster-related messages, always rely on official information, posts should be precise and clear.

The SNS should be exploited in the best possible way and therefore it is necessary to constantly analyse their use as means of communication in emergency situations in order to overcome the shortcomings that the SNS carry with them. The information that is shared during a natural disaster on the SNS can be quickly spread to a large number of users, which is very important at such moments. In this, influencers can play a major role in terms of the number of friends and companions they have on the SNS. Also, official pages of cities, governments, organizations such as the Red Cross, police and other agencies, should actively participate in spreading information through the SNS during natural disasters.

Some agencies and organizations have teams that work on creating plans and strategies for action on SNS during natural disasters. These are mainly organizations for emergency situations in those regions of the world where natural disasters are a common phenomenon. Given the power that the SNS has, not only during emergencies, all emergency organizations and governmental authorities should preventively design strategies for reporting through the SNS during natural disasters.

In a society that quickly adopts new technologies, social networks can be crucial in communicating or transmitting information during natural disasters. In order to ease all the benefits of communication through social networks, it is necessary to work on the speed of spreading and the quality of information, as well as the inclusion of all public institutions.

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