

The role of citizens and geoinformation in providing alerts and crisis information to the public

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Abstract

Mankind has been facing constant threats and challenges from natural and civilisational disasters for centuries. The fundamental responsibility of states is to protect the lives, health, and property of their citizens. However, protection against natural and civilisational disasters is a complex task in which the population also has to take part, and the availability of geoinformation is a prerequisite for effective protection. The aim of this study is to demonstrate the combined power of both citizens and technology in the task of alerting and informing the public of the opportunities offered by virtual crowdsourcing, Web 2.0, the role of geoinformation, crisis maps, and drones through the application of a qualitative method, by analysing case studies and by searching for internal connections between different phenomena. Citizens around the world can collaborate and contribute to the sharing and collection of geoinformation to create real-time, interactive maps. These so-called crisis maps support intervention organisations in obtaining information, and they can also be used as sources of information. The use of Web 2.0, crisis maps and drones, as well as the emergence of digital humanitarian volunteering, have fundamentally changed the role of the public when it comes to responding to disasters, including alerting them using geoinformation.

Keywords:

crowdsourcing, public alert and notification, volunteered geoinformation, digital humanitarian volunteer, crisis mapping

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Introduction

*“All for one, and
one for all.”*

Alexandre Dumas

*“It is possible that the many, no one of whom taken singly is a sound man, may yet,
taken all together, be better than the few,
not individually but collectively...”*

Aristotle

According to a report published by the United Nations (UN), natural disasters claimed 1.23 million lives, affected 4.2 billion people over the last 20 years (between 2000 and 2019) and caused a loss of USD 3 trillion to the global economy, a clear increase compared to the period before 2000 (UNDRR and CRED, 2020). The World Meteorological Organisation (WMO) announced that the number of natural disasters caused by climate change has also increased fivefold in the last 50 years. Most of the natural disasters have occurred in Asia, the USA and Africa, but climate change has also affected less disaster-prone countries to an extreme extent (WMO, 2021). In the Assessment Report of the Intergovernmental Panel on Climate Change published on 9 August 2021, the world's leading climate scientists warned that one should expect an increased number and more severely extreme weather events in the future (IPCC, 2021). In addition to natural disasters, civilisational and societal threats such as armed conflicts, the vulnerability of critical infrastructures, terrorism, migration, epidemics, and in particular the impact of COVID-19, clearly demonstrate that these are no longer threats but have become part of our everyday lives and that the challenges they pose must be faced and addressed. These risks, which occur with extraordinary frequency and intensity, mean that public, governmental, and civil society organisations need to process and satisfy the increased demand for information through appropriate procedures, methods, and tools, in accordance with the latest technical and technological developments.

With the development and popularity of the Internet, the *Web 2.0* phenomenon and related technologies and technical tools, users have entered many areas of government, markets and other professional fields that had been inconceivable in the past. One of these specific areas is the complex system of crises and disasters. People with mass communication devices, especially mobile devices, who are present at the scene of or affected by disasters can use their devices to record or transmit real-time, objective audio and visual information and share their own analysis and assessments with other individuals, governmental and other organisations involved in disaster response.

The communication opportunities provided by advanced technology, mobile phones, and the Internet have not only brought people into the complex system of crises and disasters, but have also turned them into increasingly important players. People on the ground are no longer the only ones who appear in the complex system of crises and disasters, as they are joined by those who access or respond to the content shared by the people physically present. Therefore, in theory, almost everyone who is connected to the web by an ICT device can be 'present' on site. This path of information flow has also developed in the opposite direction, as people in crisis situations can access an almost infinite amount of information or virtual help in the *online* space as well as in their physical reality. In addition to the websites of official bodies, these crises are now being researched, detected, recorded, and made available to all by NGOs and other communities, using a range of excellent applications and making them available *online*.

In the era of global information flows, crises and disasters can no longer be interpreted locally or regionally. Their occurrence, the events of these processes and the details of the events flow freely on the World Wide Web through regions and across national borders. Disasters with a larger spatial and temporal scope, such as earthquakes, tsunamis, volcanic eruptions, nuclear accidents, wars and migration waves, can be transmitted to any part of the world within a fraction of a second, for the purposes of helping governmental and non-governmental systems and individuals in regions far from the point of occurrence but potentially affected, to mobilise and increase their response capacity. This has given rise to the phenomenon of the so-called 'virtual crowd in times of crisis', which has made it possible for practically anyone and everyone to know what is happening in crisis situations and to react to them. The emergence of this practice has radically changed the systems and procedures of crisis- and disaster management, rendering the whole spectrum of response and management faster, more accurate, even more professional, and reliable.

As the virtual crowd is given an increasingly bigger role and its contribution is becoming increasingly more essential in disaster response, it prompts a necessary and complete overhaul as well as adaptation of mass communication, media, and governance systems. Decision-support systems based on real-time, voluntary community participation and geoinformation gathering and sharing have been developed to understand and harness the power and collective wisdom of the masses. Residents around the world can collaborate and contribute to the sharing and collection of crisis information to create interactive and up-to-date *crisis maps (CM)*, through free and open-source software such as Ushahidi *Volunteered geographic information (VGI)* and its analysis on maps provide valuable information for crisis management and response organisations, and also provide real-time, key information and assistance to people affected by a specific disaster.

Thus, alongside the information from organisations involved in the management of crisis situations and disasters, there is also information generated by groups of people present or having specific knowledge, the so-called *Digital Humanitarian Volunteers (DHVs)*. It enables the creation and continuous evolution of a collective dataset of people and organisations connecting people, communities, and governmental organisations, so that the set of actors in a given crisis and disaster situation may merge into a kind of resource pool and then into a *crowdsourcing* solution. The crowdsourcing phenomenon allows for information to be generated in a fundamentally different way from what people are used to or which has been provided by official sources, and this can speed up and clarify the information snapshot on the crisis or disaster at a given moment. It enables faster, more precise, more adequate and more efficient solutions to be created in order to manage and solve a given crisis and to prevent the emergence of further risks.

The civilian population has now been integrated into the disaster response systems, which used to be state-run, and it can now directly support the complex system of public alert and information. This trend increasingly results a situation where *crowdsourcing* will remain outside the competences of the government, creating—from a governmental perspective—a so-called 'outsourced' public alerting and information segment. The fundamental reason is that the exploitation of collective wisdom in crisis situations has proven to be far more effective than the deployment of closed state systems.

This paper therefore seeks to answer the following questions:

- What is the role of citizens and geoinformation in providing alerts and information to the public?

- What process has led to the use of voluntarily generated geoinformation in disasters, paying special regard to the provision of public alerts and information?
- What are the future trends in geoinformation, public alerts and information provision?

The thesis of this paper is that as the Internet and its popularity grew and led to the development of the *Web 2.0* phenomenon and related technologies and technical tools, governmental, non-governmental and civil users have become interconnected, creating a living, mutually supportive community in disaster response. Depending on the particular crisis and disaster, the set of actors that emerges immediately first forms a 'core', then starts to grow and builds up into a kind of resource mass, and later into a so-called 'mass resource'. In this process, voluntarily generated geoinformation is becoming increasingly important as it provides a growing, increasingly diverse and increasingly accurate set of information for disaster response, and thus for the information provision and alerting of the population, the scope of this analysis. This is evidenced by the growing number of websites and applications around the world that use volunteered geoinformation to effectively support the work of governments, humanitarian organisations, civil society organisations and individuals in disaster and crisis prevention, response and recovery, with the involvement of the affected population. Case studies confirm that these platforms worked efficiently when used in the 2008 elections in Kenya, after the 2010 earthquakes in Haiti and Chile and the forest fires in Russia, for the reporting of sexual harassment in Egypt from 2010, for the elections in Nigeria and the earthquakes in New Zealand and Japan in 2011, to trace the Syrian civil war from 2011, in the Obama campaign in 2012, for the monitoring of the cold weather and snow in the Balkans in 2012, for the monitoring of corruption in Macedonia in 2013, in the Nepalese earthquake in 2015, in the Peruvian flood in 2017, for the reporting of violent actions during the peaceful protests in Iran in 2018, and for the monitoring of the Covid-19 situation in certain countries as of 2020, just to mention a few examples ([Ushahidi, n.d.](#)).

In terms of methodology, each chapter of the study is based on different research methods. The research primarily uses a qualitative research method, in which, with a deep content analysis, it looks for internal relations and connections between topics and phenomena. The quantitative method is used to describe statistical data and cause-and-effect relationships, which helps to point out the topicality and necessity of the subject. The first main chapter is based on a literature review, which examines the possibilities inherent in the crowd, especially the power and wisdom of the virtual crowd characteristic of our information society, as well as the connections between the virtual crowd and crowdsourcing in light of Web 2.0. Based on the possibilities inherent in the crowd, the sub-chapter looks for connections in the tasks of crowdsourcing and public alerting and information. In addition to reviewing the literature related to volunteer-based geoinformation, the next main chapter illustrates the role of geoinformation systems such as Ushahidi, OpenStreetMap, drones and the volunteer population in the task of public alerting and information by analysing case studies and processing their experiences.

In order to prove the thesis, this paper first explains the relationship between the public and *crowdsourcing* from the perspective of public alerting and information, and describes the basics and related concepts regarding the use of volunteered geoinformation. It then illustrates the operation and potential of crisis mapping in alerting and informing the public by referring to case studies and drawing conclusions. At the end, it makes suggestions for future procedures by looking at and analysing current trends.

Because of the fast developing technology/governmental structures/international relations/market players, there are specific limitations that the authors had to respect. The aim

of the authors is to illustrate the determining role of the population in the task of alerting and informing the public. There have been many studies on the relationship between social media and volunteered geographic information which examine the importance of social media and volunteered geographic information in disaster situations; however, apart from one or two examples, the focus of this study is open source software solutions. Geoinformation-based solutions are not intended to replace information from official sources; therefore the study primarily deals with the possibilities of the systems, supporting the addition of information from official sources, and not the limitations of the systems.

The relationship between the citizens and *crowdsourcing*

In terms of the relationship between the public and *crowdsourcing*, the public is an effective participant in disaster response through its collective power and wisdom and through its use of *crowdsourcing*. The thesis of this chapter is that through the means of *crowdsourcing*, sharing information makes the masses of citizens active and decisive participants in disaster preparedness, public alert and information, in the right technical and technological environment. The aim of this chapter is to illustrate the potential entailed in the masses of people through the related phenomena of ‘the power of the crowd’ and ‘the wisdom of crowds’, as well as *crowdsourcing* and the *Web 2.0* phenomenon that facilitates its effectiveness on the one hand, and to illustrate the role of *crowdsourcing* in the task of alerting and informing the public, while taking into account the current technical and technological environment on the other. The chapter first analyses the so-called ‘power of the crowd’ and ‘wisdom of the crowd’ phenomena, then interprets the general technological and social context of *crowdsourcing*, and finally goes into detail on the links between *crowdsourcing* and public information.

The ‘power of the crowd’ and the ‘wisdom of crowds’ phenomena

The ‘power of the crowd’ and the ‘wisdom of crowds’ phenomena show what individuals can do when they form a crowd and what they can consequently achieve. The *power of the crowd* phenomenon refers to what can be achieved by a multitude of individuals coming together for a common goal when it comes to problem solving, change, and advocacy. A range of events in history have demonstrated the masses’ capacity for advocacy, such as in revolutions or in the fall of the Berlin Wall, in national and international humanitarian co-operations during natural disasters (e.g. the earthquakes in Haiti and Japan, the Australian forest fires) and industrial disasters (the red sludge disaster in Ajka, Hungary, the chemical explosions in Beirut), but when used for propaganda, such tool can also lead the masses in dangerous directions, such as during National Socialism, and the same negative effect can also be observed in the ongoing armed conflict between Russia and Ukraine. According to [Jeff Howe \(2008\)](#), under the right circumstances, a large diverse group of individuals will almost always outperform a small group of talented professionals. In addition to the phenomenon of crowd power, James Surowiecki popularised the *wisdom of the crowds* theory in his 2004 book, which examined how large groups make the right decisions. The idea behind the theory is that groups of people collectively are likely to be smarter than individual experts when it comes to problem-solving, decision-making, innovation and forecasting ([Surowiecki, 2004](#)). The idea of the wisdom of the crowds appears in Aristotle’s *Politics*, Book III, which he illustrates with a dinner to which everyone contributes and is thus more satisfying than if only one member of the group had

provided it (Aristotle, 1969). The combination of the collective power and wisdom of the crowd has given rise to *crowdsourcing*. The Aristotelian dinner brings together the expertise of a group in much the same way as *crowdsourcing* uses the expertise of the masses to solve a problem.

Crowdsourcing

The term *crowdsourcing* was first described by Jeff How as a contributor to *Wired* magazine in 2006, when he wrote about how companies were using the Internet to outsource jobs en masse (Howe, 2006). Activities such as *crowdsourcing* existed before the advent of the Internet as early as in the 1800s, when the creators of the *Oxford English Dictionary* asked the masses for help. Following a public call, people collected the words they were using, along with their perceived meanings (Ideaconnection, 2019). We also find early examples of *crowdsourcing* in disaster prevention, when, following the Lisbon earthquake of 1755, volunteers from across Europe reported their experiences to help researchers create an early 'quake map' that estimated the scale and intensity of the seismic event (UNDRR, 2017). *Crowdsourcing* can also be interpreted as a business model, activity or function that depends on mass users and the outsourcing of certain tasks. *Crowdsourcing* is also a process whereby companies, public organisations or NGOs 'outsource' parts of their activities to the community, when typically each participant contributes with a small share to the workload. The term *crowd* refers to the large number of participants in a process, who are essentially volunteers. The meaning of the term has evolved and it continues to change, and in the meanwhile it appears and gains legitimacy in newer areas, including the public, business, and civil spheres (Hammon and Hippner, 2012). This chapter argues that crowdsourcing has become a system to create value for a common goal by reaching out to the masses, connecting committed people, and learning about and harnessing opinions to solve a given task. In other words, the information set becomes valuable via the systematisation of the data generated by the masses, which enriches knowledge and collective wisdom as a whole. The masses can thus become a resource mass and a mass resource.

Crowdsourcing and Web 2.0

Crowdsourcing could not have become widespread in different disciplines without the popularity of *Web 2.0*. The World Wide Web initially contained read-only information, but with the advent of *Web 2.0*, the formerly passive, editorial content was shifted towards active user participation. New Internet services have appeared, along with new forms of communication and media platforms. *Web 2.0* introduced blogging, video sharing, *Wiki* sites and social media, which are filled with content by their users. This type of content is usually referred to as user-generated content (Hudson-Smith *et al.*, 2009). *Web 2.0* provides easier access to target audiences and its popular use has made communication and coordination activities cheaper and easier. The uniform technological standards allow for masses of people to be involved in content creation, without any specialised technological skills. Darcy Dinucci first coined the term *Web 2.0* to identify this phenomenon in 1999, and it has become popular and widespread partly thanks to the work of Tim O'Reilly (Prandini and Ramilli, 2012).

The *Web 2.0* functionality allows people to deliver and display their messages on existing platforms, but it also enables their modification and enhancing. *Web 2.0* also brings along *tagging*, whereby an image, video or text can be supplied with metadata. The users may tag content uploaded to the web by adding keywords, and the tags listed for the file lead to files on the same topic (Szűts, 2012). The spread of the Internet and *Web 2.0* has created

a communication platform that makes the notion of the masses even broader. Before the advent of the Internet, the term 'crowd' itself was used to refer to people who were in physical proximity to each other. However, the Internet created the concept of a 'virtual crowd', where people could form communities in online spaces to achieve a specific goal, which also encouraged *crowdsourcing* activities to take place ([Vander Schee, 2009](#)).

The links between crowdsourcing and public information

When considering the connection between *crowdsourcing* and public information, it can be established that similar to the spread of the Internet, *Web 2.0*, smart devices and other related technologies have helped *crowdsourcing* to expand and become more effective; in a similar way, *crowdsourcing*, together with technical and technological developments, helps, supports and complements the task of alerting and informing the public. The popularity of the Internet, social media sites and smart devices created a platform for the public whereby they can take part in disaster response in an interactive way. Based on the research conducted by [Hossain and Kauranen \(2015\)](#), crowdsourcing proves to be particularly successful in disaster situations. Through crowdsourcing, information linked to a geographical location, i.e. geoinformation, can be obtained ([Heipke, 2010](#)), and it is also possible to involve a layer in the phases of disaster management. In other words, a group can also be formed, whose members may be affected themselves, making the population important in the task system of public alerting and information. A resident affected by a disaster or crisis can provide real-time, credible information by sharing their own perceptions and experiences, which can indirectly support the alert and information activities of emergency response organisations. In this sense, citizens operate as sensors and as a special network of sensors, forming a group which is composed of the people themselves ([Goodchild, 2007](#)). They use their five senses to detect and understand local information, and with the help of their communication tools, such as mobile phones—which by their very nature carry sensors in themselves—they also support the task of alerting and informing the public. Professional organisations can obtain real-time information, to supplement their own sources and thus achieve more effective prevention and protection.

According to research, the fastest earthquake alerts—as a positive example for the above—come from social media networks rather than from the seismic underground sensors of the relevant institute, the US Geological Survey. Users of the social media platform *Twitter* use the hashtag earthquake—a method mentioned earlier—to report their experiences in their posts. The US Geological Survey uses software to monitor the appropriate words, which allows it to pinpoint the exact source of the earthquake faster than seismic underground sensors. However, these entries, also known as *tweets*, can only be credible and usable if they are linked to a *Global Positioning System (GPS)* system that determines their exact location. *Twitter* can be used to guess the size and impact of an earthquake, but also to help fill the data gap in regions with sparse seismic networks ([Oskin, 2014](#)). As you can see, the very existence of geoinformation is an essential element in this process. In addition to information sharing, where appropriate, there are also open platforms such as *Ushahidi*, which allow affected residents to be informed, in addition to being able to post comments. The question of authenticity regarding the received information is not addressed in detail in this study, but if the report does not have a geolocation or if the information received is not verifiable, a large number of users report it and it can serve to prove the credibility of the original post. In fact, it is the users themselves who can confirm reliable or uncover fake reports.

In another process the local or geographically distant volunteers are involved in processing information coming in from stakeholders on various platforms, sent in the form of SMS, MMS, through web interfaces, or from the media through the *tags* or *hashtags* mentioned above. The software in question decides its purpose, operation and use. Through the process of *crowdsourcing*, people, who may be affected and local residents or geographically distant persons, use digital technology and voluntarily participate in a disaster and crisis situation. They are the ones reporting or managing such reports with the information they provide, the so-called volunteered geoinformation, and thus emerge as a special group of digital volunteers.

Overall, the potential of the public, combining *crowdsourcing* and the associated state-of-the-art techniques and technologies, is becoming an increasingly important element of the public alert and information task. *Crowdsourcing* gives the public the opportunity to express their opinions and share their experiences. The tools and technologies used by the public support the effective development of *crowdsourcing*, and government systems rely heavily on the crowd-sourced collective wisdom.

Use of voluntary geoinformation

The use of voluntary geoinformation—provided by local or remote individuals and groups which share information—manifests as crisis mapping in times of disaster and crisis situations, and it supports the task of alerting and informing the public. The thesis of the chapter is that as a special group of digital volunteers, these individuals and groups play an important role in supporting decisions by way of the geoinformation-based crisis maps created with their voluntarily provided data. This is how they provide a supporting technical and technological background to the process of public alerting and informing. The aim of this chapter is to present the use of voluntarily provided geoinformation in the task of alerting and informing the public. In light of this, the chapter first highlights the significance, use and connections of volunteer-based geoinformation in the field of public alerting and information, and then analyses the possibilities to map the volunteered data and its related concepts. The chapter illustrates the role of geoinformation systems in disaster response by drawing on the experiences of the *Ushahidi* and OSM platforms, and finally the role of airborne drones in crisis mapping.

Volunteered geoinformation

Volunteered geoinformation is geographic information collected and shared voluntarily by individuals. The term *volunteered geographic information (VGI)* was coined by Michael F. Goodchild. Volunteered geoinformation is a specific form of user-generated content. Most of these users are unskilled, but together they show great potential, which undoubtedly has a profound impact on the role of geographic information systems (Goodchild and Glennon, 2010). The role of volunteer-based geoinformation in disaster management was first observed in the 2007-2009 Southern California wildfires, where volunteer residents shared information about the fires, and it was also noticed that volunteers were able to provide more timely situational information in some circumstances than official sources (Fenga *et al.*, 2022). Today, two approaches to volunteer-based geoinformation are known, one based on direct participation and the other the so-called opportunistic approach (Ostermann and Spinsanti, 2011). A participatory approach requires conscious and active participation, and people usually need to install a specific application, use a website created for it, or register their own account in order to share information.

In contrast, the opportunistic approach is a passive and more unconscious way of providing information, the source of which is, for example, the social media interface.

The concept of information, which is the basis of volunteered geoinformation, is important in disaster and crisis management, as well as in alerting and informing the public, since information at the right time and place can reduce damage and loss, and the information-induced communication can increase cooperative effectiveness. Effective communication and cooperation require real-time information flow. In a crisis, there is increased demand for information in general, from the public and from the intervening organisations and individuals. The number of public reports and requests for help to be handled by the relevant state, governmental and civil organisations as required increases, and the various intervening organisations to some extent also depend on information provided by the public. Processing, sorting, and updating large amounts of information requires adequate information technologies and tools.

Location-based information constitutes a specific group of data. For this group of information, a particular location is of importance, whether it is an everyday life or a disaster situation, because it reveals the location where the events are taking place. Any piece of information on objects or phenomena which is connected to a geographic or spatial location is defined as geoinformation. The means of storing and displaying geoinformation was previously limited to traditional maps but it received a boost with the development of computer technology and the emergence of geoinformation systems. Such information also has an information system which can be used to extract, store, organise, retrieve, manage and analyse data and to perform various operations. These systems, which are used to obtain, manage, analyse and display information in a fixed location, are called spatial information systems or *Geographic Information Systems (GIS)* (Czimer, 2012).

Spatial data was formerly handled only by professionals, but with the advent of *Web 2.0* and the development of mobile devices that provide location data, people are now more involved and share such data not only for their own use, but for the public, and such data and information could be even more detailed and better quality than what official organisations used to provide. This type of voluntary data provision has led to volunteered geoinformation and has become an effective tool for expanding, improving, supplementing, updating and using existing information for humanitarian purposes. This is a specific kind of information, such as familiarity with the location that is not available by means of traditional data collection processes, and it allows for the compilation of highly detailed reports on local conditions during disasters (Haworth and Bruce, 2015).

Digital humanitarian volunteering

Digital humanitarian volunteers (DHVs), as referred to by John Crowley, are a special group of digital volunteers (Crowley, 2013). These *digital humanitarians*, as defined by Patrick Meier, form a new group of disaster response volunteers, sharing volunteer-based geoinformation. Digital humanitarians can include local residents or geographically affected masses alike, who provide raw information directly, and the indirectly involved community, even a geographically distant one that coordinates and manages information to support a humanitarian action. In terms of profession, digital humanitarians could be technologists, geographers, seasoned humanitarian experts, journalists, skilled community translators or academics (Radianti and Gjørseter, 2019). Digital humanitarians can also include those without the above professional skills, as VGI itself refers to a phenomenon where people can report their geographical location and create a map without any

cartographic knowledge (Hung *et al.*, 2016). The use of mapping platforms is the basis for digital humanitarian volunteering. Initially, the term digital humanitarian was often associated with crisis mapping activities during disasters.

The basics of crisis mapping

Crisis mapping refers to the collection of real-time data, the display and analysis of incoming, localised, up-to-date information on a digital map in disaster and crisis situations, such as war, elections, natural disasters and humanitarian crises. Crisis mapping projects usually allow people, including the general public and crisis managers, to provide information either remotely or from the scene of the crisis. The advantage of the crisis mapping method over others is that it can increase situational awareness by allowing the public to make announcements (Stewart, 2011). Crisis mapping can track fires, floods, pollution, crime, political violence, the spread of diseases, as well as provide transparency on fast-moving events and facilitate the identification of longer-term phenomena. It can effectively demonstrate the spread of a geographical phenomenon. Crisis maps are used by intervening organisations to help them identify and respond to situations (Stringer, 2014). The information can usually be sent to the initiators of the map by SMS or by filling out an online form, which will then automatically appear on the online map after approval, or it can be collected by a specific group of volunteers (social media platforms, *mainstream media*, etc.) to be displayed on the map (Aitamurto, 2012). Crisis mappers are usually online groups of volunteers who collect and provide online data to people responding to or affected by disasters. Organisations active in crisis mapping include *Ushahidi* and the *Humanitarian OpenStreetMap Team (HOT)*. The term crisis mapping was made popular in the media by *Ushahidi* after the 2010 Haiti earthquake.

Ushahidi

Ushahidi is an initiative, a platform, a freely editable and usable open-source technology created to collect and analyse crowd-sourced data in disaster and crisis situations. It was created with the aim of exploiting the potential of *crowdsourcing* to facilitate the sharing of information in an uncertain environment. The term *Ushahidi* comes from Swahili; it means witness testimony. The *Ushahidi* platform was set up in early 2008 to map violent incidents and peace efforts in the aftermath of Kenya's general elections. Ory Okkolloh, a Kenyan activist, lawyer and blogger, and later the founder of *Ushahidi*, envisioned a website where people could anonymously report incidents *online* or via SMS and when this information is displayed on a map, people may get a real picture of the course of events. The site was launched with the help of volunteering experts. Information imported by volunteers from social media platforms, blogs, text messages, *mainstream media* and announcements made on the web interface was also displayed on the web-based interactive maps, available to anyone with an Internet connection. All reports had to be manually checked and approved by the *Ushahidi* staff. A growing number of people started to use the new platform to share information, while some radio stations considered the website as a source of information. It turned into an interactive website, which meant that people could not only contribute by providing but could also receive information from the platform. As interest in the website grew, it became clear that the tool could be used outside Kenya, particularly during disasters and crisis situations (Okkolloh, 2009).

Ushahidi can also assist local and international NGOs working in crisis situations in the early monitoring of conflict and danger, in the tracking of emergencies and crisis situations, and to assess damage and losses during recovery. The use of related technology in

emergencies and crisis situations received more attention following the response to the 2010 Haiti earthquake. Patrick Meier helped the crisis mapping process by creating an online map to track what was really happening, using the announcements. Following the earthquake, *Ushahidi* launched a crisis map that enabled volunteers from around the world to start mapping information from various sources, including social and *mainstream* media, as well as from the affected communities submitted via SMS or the Internet, on real-time reports of incidents, damage and calls for help. Residents in need of help or wishing to make a report used their mobile phones to send their messages to a central response team with a designated phone number. For the Haitian population, notifications in SMS were the most predominant, as 80% of the population had a mobile phone while only 10% had Internet access. The incoming messages were translated by online volunteers before they were displayed on the crisis maps (Stewart, 2011). In fact, other search and rescue teams also started to use the information from the map, such as the disaster management agency of the USA, *Federal Emergency Management Agency (FEMA)* as well as the *United States Marine Corps*.

The concept of the *Standby Task Force (SBTF)* was introduced at the 2010 Crisis Mapping Conference to streamline online support from volunteers, building on lessons learnt, and to create a formal platform that forms a network of digital volunteers, so they are ready to be deployed in crisis situations. Some members of the team are specialists in information and communication technology or humanitarian operations, but others come from different backgrounds and the team has helped to develop their skills (Standby Task Force, n.d.). Outside of volunteer groups, however, anyone can create an online map via the website using *Ushahidi*, an open-source software. In 2017 *Ushahidi* released an app for iOS and Android devices, which allows anyone to collect and make reports from anywhere and at any time, in line with *Ushahidi's* mission. The application enables quick notifications to be made with or without an Internet connection. It saves the collected data, the GPS location, images and video and sends them to the map interface as soon as the Internet connection becomes available. It also allows people to collect, analyse, visualise, and respond to data all in one place. *Ushahidi* allows you to create custom surveys and import data from a third-party service (social media platforms, SMS, etc.) and to share such maps and timelines publicly, and there is a group response option, too (Ushahidi, n.d.).

OpenStreetMap (OSM)

The *Ushahidi* platform is not the only mapping technology available that was developed to collect and map crowdsourced data. This can be done by OSM as well, involving volunteer mappers, or through the regular, periodic mapping efforts of local communities to ensure that relevant, up-to-date information is available to support response organisations when a disaster occurs. This type of cooperation has been particularly successful in places without well-mapped or covered areas, e.g. when it was used to map local schools and health services. Experience has repeatedly shown that OSM data is just as accurate, and in some cases more so, than data sets produced by official organisations. The dynamic nature of the OSM allows for the updating of map data, especially in places where active local mapping and map processing communities have developed. OSM is a teamwork-based project that aims to create a freely editable world map. The main reasons for its creation were the restricted access to and use of geoinformation worldwide and the emergence of low-cost navigation tools. The project was launched by Steve Coast in the UK in 2004. The inspiration came from the success of *Wikipedia* and the predominance of proprietary geographical data. Registered users can collect data through manual surveys, GPS tools, aerial photography and other freely available sources, or can utilise their local knowledge (Ramm *et al.*, 2011).

The free and open-source OSM platform is primarily known for its project with community-collected and processed data on roads and streets (road mapping) around the world, but the platform has also been used to map community-sourced data on other types of infrastructure, such as refugee camps in Haiti, health facilities in Libya, damaged buildings in Turkey and disaster preparedness data in Indonesia. Within 48 hours of the earthquake in Haiti, the OSM community began using high-resolution post-event satellite images to map the earthquake-affected area. In the space of a month, more than 600 volunteer contributors signed up to build a base map of Haiti on OSM, which could provide fundamental information for organisations responding to the crisis. OSM mapped the Haiti crisis by synthesising a comprehensive digital map of Haiti's infrastructure including roads, buildings, and camps, gathered from satellite imagery and GPS surveys with the massive input of volunteers ([Internews Center For Innovation & Learning, 2012](#)). The organisation's data was then used by various aid agencies, including the World Bank. In 2010, following the Haiti earthquake, the *Humanitarian OSM Team (HOT)* was established to produce and provide timely maps free of charge during crisis situations around the world, using volunteer cartographers. The OSM Humanitarian Team acts as an interface between OSM communities and humanitarian organisations. To date, however, the *Ushahidi* platform is the technology that is used to map events from community sources ([Humanitarian OpenStreetMap Team, n.d.](#)).

Airborne drones and volunteered geoinformation

In recent years, the use of aerial drones has also emerged in the production of voluntary geoinformation-based crisis maps, with an impact on the emergency alert and information function, as airborne drones are versatile tools that can be used in all phases of disaster response. Volunteered geoinformation is usually available through geoinformation-based collaboration and community mapping sites. *Ushahidi* and OSM are examples of websites that provide informal sources of data and local knowledge about the geography of a place. Technologies enabling volunteered geoinformation such as *Web 2.0*, geo-referencing, tags, GPS, broadband communication are also favourable for the use of multifunctional drones. These can be used to create high-quality maps, images, videos, some of which can be shared on the web, and they can facilitate *First Person View (FPV)*, or live streaming. Volunteered geoinformation is valuable if it can complement the existing spatial data infrastructure. Despite high-resolution images taken from high altitudes, a true understanding of some of the Earth's elements and processes is not possible without the involvement of certain participants. Drones allow these participants to access 3D-space from a different perspective and at a different speed. Drones can also complement what humans are capable of sensing. Sensors connected to drones can be used in conjunction with human observation for appropriate adaptation or processing, either in real time or in retrospect, and these practices can be used for scientific purposes such as early warning, and in disaster and crisis situations ([Choi-Fitzpatrick, 2014](#)).

Since the Haiti earthquake in 2010, Meier's crisis mapping has supported humanitarian action in almost every major disaster. The 2015 earthquake in Nepal also saw the start of the use of robotics for humanitarian purposes, including camera-equipped unmanned aircraft, i.e. drones, which take hundreds of images that can be linked together to create maps or 3D models. Meier envisages that the use of drones will make crisis mapping even more effective in disaster response. Robotics facilitates the collection of information that will be put on the crisis map. This is another way of collecting and mapping geo-referenced data. In the immediate aftermath of the Nepal earthquake that killed over 8 000 people, cloudy weather obscured the view on the few satellite images that were recorded. However, Meier and his team were able to use drones to capture detailed images of the

damage around the capital, Kathmandu. Through *WeRobotics*, the non-profit organisation he started, Meier collaborated with Nepalese experts to create a local “*Flying Lab*” so it could conduct this kind of activity in future emergencies. Meier sees the solution in the power of local communities as the first responders to disasters since they are unmatched in their familiarity with the location. His expertise has been used and recognised by the UN, the World Bank, and the United States Agency for International Development.

However, drones also present some challenges due to air traffic regulations. Each country has different aviation regulations that need to be taken into account when flying drones (NPR, 2016). In 2015, Meier was asked by the World Bank to coordinate a humanitarian drone mission to speed up damage assessment in the South Pacific. At the time there were no local drone pilots available, so two foreign drone companies had to be recruited from Australia and New Zealand. The South Pacific was struck by severe cyclones in 2018. Unlike in 2015, a local drone pilot was assigned to support the affected areas, serving as the *South Pacific Flying Labs* coordinator in Fiji. He became the first local drone pilot to be deployed in the region together with the National Red Cross Society (iRevolutions, 2018). At *WeRobotics*, his mission is to create local opportunities for participation and leading in problem-solving as well as participating in providing a solution. By localising robotics expertise, a new opportunity is created in humanitarian aid and disaster response (Flying Labs, n.d.).

Overall, the rise of the Internet, the popularity of *Web 2.0*, the development of geographic information systems, smart devices, and related developments, and *crowdsourcing* have all improved the collection, sharing and interaction with geoinformation, leading to the emergence of volunteered geoinformation. Voluntarily generated geoinformation provides information as the basis for crisis maps, thus supporting the decision-supporting function of individuals, groups and organisations involved in disasters and crisis management. In recent years, as part of crisis mapping, aerial drones have been used to collect volunteer-based geoinformation, further developing tools for alerting and informing the public.

Conclusions

As a result, it can be stated that the study proved the theses, e.g. the residents are active and decisive participants in disaster prevention, public alerting and information through crowdsourcing, with shared information in the appropriate technical and technological environment, since even posts shared by ‘passive’ individuals on social media can also be collected by active and conscious participants and displayed on crisis maps. Digital volunteers perform a decision-support function and with the development and popularity of the Internet, the Web 2.0 phenomenon, and related technologies and technical devices, governmental, non-governmental, and civil users have become connected and become a living, mutual-helping community during disaster prevention. Voluntarily produced geoinformation has become more and more important, as it has provided an ever-larger, more diverse, and more accurate set of information for protection against disasters, including for the public information and alerts under investigation.

It can be concluded that the development of technology (*Web 2.0*, geoinformation, mobile technology, robotics) and the development of society (the collective power and wisdom of the crowds, crowdsourcing, active participation in humanitarian activities, environmental awareness and being aware of the surrounding dangers), as well as the combined development of technology and society (digital awareness, volunteer-based

geo-information, digital humanitarian volunteering, crisis maps, drone pilots) help and support the task of alerting and informing the public. This manifests itself in the fact that participating volunteers complement the information of professional organisations by sharing volunteer-based geoinformation on the one hand, which can be used as a basis for information, and they can also be informed by geo-information shared and verified by other residents on the other. As a result of digital volunteering, people become more aware of both the technological achievements and the dangers in their environment. Even if someone is involved in a disaster or crisis as a geoinformation sharing volunteer or as a member of a humanitarian team helping to synchronise information to ensure the safety of a community, they are actual participants in the disaster response and they are digital humanitarian volunteers. The public becomes involved as (1) sensors, (2) digital humanitarian volunteers, (3) producers of volunteered geoinformation, (3a) users, (3b) sharers, (3c) synchronisers, map makers, (4) map analysts and (5) drone pilots. The initiatives and examples of *Ushahidi* and *OpenStreetMap* reflect the power and the benefits of using crowd-sourced, user-generated data that enable faster and more direct communication between residents and aid agencies, as opposed to the usual procedures of traditional humanitarian organisations.

Agreeing with Patrick Shirky's idea that technology only becomes socially interesting when it has already become boring at the technological level (de Kretser, 2017), it can be added that in some cases a technology becomes mature in a given field later, when its technical and technological elements have become sufficiently popular, part of our everyday life, and the population accepts it and knows about it on a large-scale. Disaster management in terms of public information and alerting requires continuous monitoring and adaptation to the needs of the population, since technology alone cannot have a positive impact without human factors. Therefore, it is important that the means and methods of public alerting and information are adapted to the constantly changing environment, taking into account and implementing both old and new technologies.

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