# Early Warning Systems and Disaster Management using Mobile Crowdsourcing

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**Abstract:** ***Human populations are constantly under threat from disasters. The nature of the disaster influences the kinds of threats that humans are exposed to by physical phenomena such as extreme weather, seismic, volcanic and human activities like terrorism activities. In this study, an early warning system with capability of a mobile platform is developed to be used by various users to report disasters happening within their neighborhood using their mobile platforms which could either be android, Smartphone, tablet, windows mobile and laptops. The expected belief is that when such information is delivered to the disaster management personnel, other survivors and volunteers who in turn use the information to plan their operations to suit unfolding events on a given disaster. The system is designed to channel information through crow-sourced web based approach of disaster reporting. The resulting information is then made available to public free of charge since it can be hosted on free disaster dedicated websites such as Ushaidi platform. Moreover, a crowd-sourced web platform that allows survivors or other people outside the disaster area to report the kind of disaster that is happening in a given place has been integrated; as well as capability to interact with various aspects of social media such as Facebook, Twitter, email, or even website. Since a number of communication systems overlook the disaster victims, I believe that this application of early warning system will be a valuable tool in promoting the application mobile technologies in disaster management as well as providing feedback from disaster victims.***

**Keywords**: Early warning, mobile technology, disasters, crowdsourcing, volunteered geographic information.

## 1. Introduction

The use of mobile applications in disaster management and unfolding emergencies has greatly improved due to advances in telecommunication and computation revolution [1], which has widened to include multi agent systems [2].The role of mobile technology and mobile phones in improving emergency response has been evidenced in tracking populations in disaster zones and tracking mobile users with their nearest signal boosters. Users can be tracked by their proxies, telephone masts and global positioning systems(GPS) in enabled phones or mobile devices [3]. The field of mobile usage has greatly expanded due to adoption of 3G, social networking, video, voice over internet protocol (VoIP) which has led to massive growth in communication and improved channels of communication.

The expansion of bandwidth especially 3G network and Wifi networks across various parts of the world has provided users of mobile phones and mobile devices with value added services [4]. Use of smartphones has greatly improved due to reduced cost impacted by android technology which has allowed such devices to have improved capability in providing location using GPS, quick internet access and in some mobile devices pre-disaster warning [5]. The users of mobile devices have the ability to receive updates about the disaster in question and are likely to spread the information to their neighbors, relatives and friends through messages on various platforms. Through Wi-Fi and web 2.0 [6], various users can connect in public places which can be useful in getting updates about casualties or survivors. This can be feasible by installing mobile wireless masts at public rescue centers.

Information reporting from disaster zones can be freely gathered by *information volunteers* who can send videos, pictures, messages, and statistical updates on public media about the disaster on the affected areas [7]. The study presented here addresses disaster reporting through use of web and mobile applications provided that there is internet connection. The study mainly focuses on disaster reporting through a well customized website where users can quickly select the nature of disaster at locations and send the same information through an online form. The information received on website can be tracked to establish the frequency and nature of disasters reported.

Although the use of mobile and web technologies are highly embraced in disaster management, there are issues related to data flow especially traffic on data being transmitted can cause network congestion, power consumption on some mobile devices can be extremely high and connection reliability [8]. The initial overhead of restoring destroyed communication system could be high, but necessary [9]. The limitations related to the device in terms of memory and space may apply to some mobile devices [10], but not all, since modern computing has equipped 3$^{rd}$ and 4$^{th}$ generation phones with high capability of RAM and processing power.

Network congestion and data interoperability are inevitable while using mobile and web technologies in disaster management [11]. However, the intention to develop global mobile and web disaster portal is bound to rely on open standards that supports interoperability[12] and utilization of cloud computing and mobile location based services [13] which are becoming ubiquitous practices in VGI[1] and cloud computing era where information volunteers freely avail information to a wider audience.

Getting the right information is useful in all phases of emergency rescue, response, recovery and reconstruction in the disaster management cycle. New genres of information sharing have evolved such as the Google crisis response

team, Google resource finder, Family locator, Usafe tracker and Google person finder. The question here is 'how do disaster management personnel react with mobile media?' The answer to this question will depend on how well he is able to receive the information about disaster in question from various survivors in the disaster zone [14].Use of mobile and web technologies in disaster management should be seen as a new era in micro blogging during disasters to aid in identification of victims and survivors [9]. The development of web 2.0 has made it easy to share both video and still pictures in almost real time [15], otherwise it would take a very long time to get feedback from survivors.

## 2. Related work

### 2.1 Role of mobile technologies in disaster management and emergency communication

Delivering the right information at the right time is very crucial in disaster management. This dates back to the famous "Johnstown flood of 1899" after inspection of Connenmaugh dam River, in which he sent telegraph to report of status of the bridge. Unfortunately, the residents in the valley below never got through and more than 2200 people drowned. Therefore, allowing people to deliver information where they are (real-time) is one crucial step that is necessary in order to avert damage to property and especially loss of lives to ensure successful crisis management. As a result countries like England, Japan, France, USA, Singapore, Australia among others have invested in mobile technology to enhance their capacity of response during disasters [16].

Successful management of crisis and disasters are priority areas in response to natural and manmade calamities. The current advancement in computation technology has led to proliferation of mobile smart phones, tablets, laptops and androids which are used for communication. Such devices are valuable in disseminating information about unfolding events about a given disaster [17]. Mobile devices are suitable for disaster communication because of the following:

1) Small size allows portability and can be used in the field without any weight burden on the user due to their light weight.
2) Mobile devices are chargeable which makes them suitable for use in areas without power supply for several hours.
3) Multifunctional capability of mobile phones allows delivering multiple types of information such as messages, emails, data and calls to other remote users.
4) Customized web applications on mobile platforms make it easier to enter information on mobile devices on various application shortcuts such as Facebook, twitter, without necessary launching various browsers.

The current mobile devices have geo-tagging and geocoding capabilities. Therefore, information gathered from mobile devices is very rich because audio, video, pictorial from mobile devices can be transmitted with geo-location codes [18]. The open access communication in disaster management promotes inflow of information from the general public and other private entities on unfolding important updates. Recent development in technologies has shown that mobile technologies can be used to deliver disaster warning information [19]. When there are no warnings, the consequences of unfolding disaster can very tragic and costly. Warnings are very effective in predictable disasters like flooding, tornadoes and hurricanes. However, unpredictable disasters like earthquakes, wildfires, and man-made disasters, will only benefit from effective disaster reporting through mobile technology to get information from survivors. In this study, we propose an approach in Figure I to enable free flow of information from government authority and associated agencies such as police, Fire unit and rescue command unit to ensure that disaster site is covered through the wider WLAN to allow survivors to submit information and interact seamlessly with responders through the wireless communication architecture.

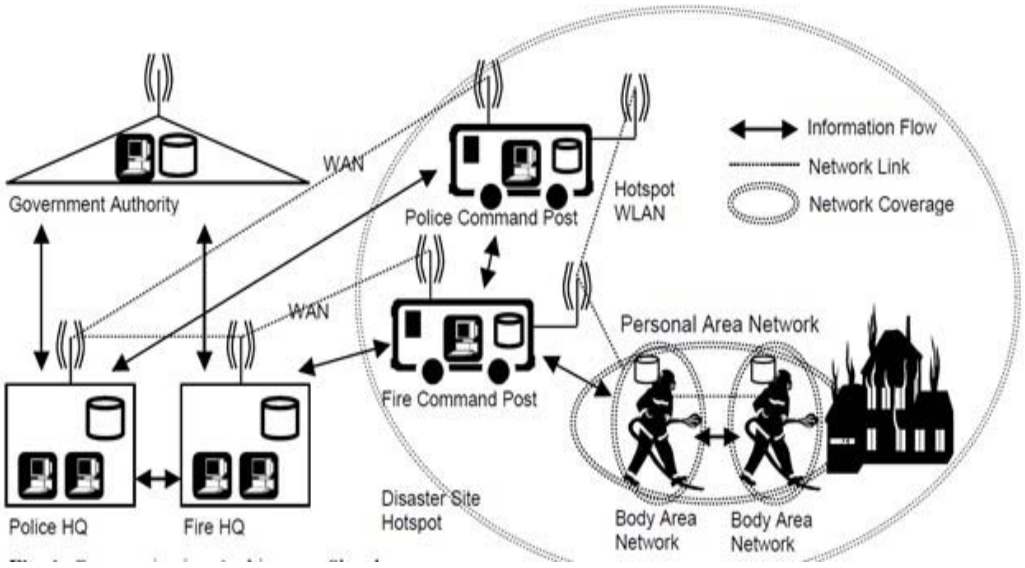


**Figure 1:** Wireless communication architecture [20]

Coordination of information upstream and downstream during disaster management requires constant flow of relevant information on the unfolding disasters [20]. Current communication architecture in most disaster management

scenarios are still very bureaucratic and require smart sensors to be effective as illustrated in Figure I. in this study, we emphasize that the command personnel and those charged with responsibility of rescue in immediate response will get real time feedback on common platform shared also with command center. We expect the survivors to maximize the use of disaster site hotspot to provide real-time update on the status of unfolding events in disaster zone. We have also proposed that the hotspots should be located in public gathering places to maximize the utility and reliability of information delivered since some trend can be established to allow verification of information delivered.

Hot spot communication can be improved through collaborative wireless technology. However, attention should be paid to critical areas in order to ensure information is flowing to key decision making portals as shown in Figure 1. The primary concern in disaster management is communicating the risk to a wider region with updates on unfolding events [21]. Collaborative decision making requires integrated approach with up to date and timely information on important aspects of disaster management such as possible access roads, possible casualty statistics and event status as it changes with time [22]. Such communication web can only be practical on web platform and properly integrated SDI[2].

Large scale disasters can be very destructive and in some cases, communication infrastructure can be destroyed. We therefore propose satellites as the key in facilitating signal transmission in areas where a catastrophic disaster has occurred as illustrated in Figure 2. Transportable VSAT[3] on vehicles with wider area coverage can be deployed to provide regional wireless communication for internet and mobile phone communication. The topology for communication described becomes useful in a catastrophic disaster where all communication systems have been knocked down. The transportable mobile communication can actually make communication available to disaster survivors. The use of mobile communication in disaster management in promoting awareness, communication, coordination and collaboration forms the core pillars of teamwork in disaster management[1].

Effective use of technology can help build situation awareness on the basic geocodes through mapping. The complexities associated with situation awareness for constructive collaboration with possibility of concurrent updates is necessary [23]. Integrating the role of social media in disaster management has been expanded in collaborative social cloud computing [24]. Most disasters are coordinated through established emergency operation center (EOC) which is often assumed to be a physical location. The pressure piles on decision makers to provide information on current situation, an activity which is not possible without use of mobile technologies, which has changed the trend of information flow in crisis management [25].

[2] Spatial data Infrastructure: a data infrastructure implementing a framework of geographic data, metadata, users and tools that are interactively connected

[3] VSAT (Very Small Aperture Terminal) is a satellite communications system that serves home and business users.

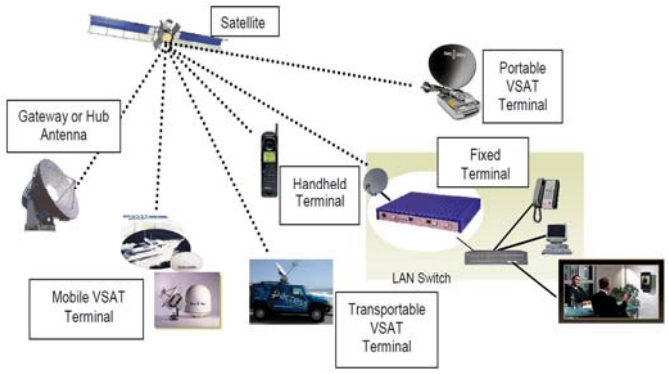


**Figure 2:** Topology for satellite communication in disaster management (Futron Corporation and GVF)

The public will be better served if they can access reliable information of unfolding events which could include pictures, videos and other forms of conversations. Through mobile technology, it would be possible to access geocoded pieces of information, which makes it easier to plan disaster management and rescue operations. The use of mobile technology can therefore be viewed as revolution towards intellectual locations aware alert systems [26] as a means towards successful disaster management and mitigation. In this study, we introduce disaster reporting using open web platform with customized fields that people in disaster zones to report unveiling or new disasters. We also introduce a verification system which allows users of that platform to determine the reliability of such information.

### 2.2 Issues of Mobile Applications in Disaster Management

Major disasters normally distort communication masts and receivers which may hider successful communication. Most mobile applications are developed in foreign language and where illiteracy level is high, face to face communication with officials and central figures may be preferred instead of mobile technology. However, currently use of mobile technology has expanded and literacy levels have also improved in most parts of the world, which still renders the use of mobile technology very relevant.

Disasters can sometimes be highly politicized and issue of reporting information can altered or be restricted depending on the nature of the disaster in question, especially where there is lack of interagency communication [27]. However, mobile technologies can still be used to provide survivors with communication even if international communication is restricted. Real-time reporting of disasters may cause another problem, for example, people crowd themselves at disaster scene or on the way to disaster hampering rescue and other response operations. Actually lack of coordination is a major stumbling block in implementing a successful disaster management among inter-agencies involved [28].

Information overload may lead to gigabytes of data delivered to the actual users [29]. Depending on how the information is presented, some of the information received can be irrelevant especially if does not refer to the disaster in question[30], which can eventually lead to chaos and mixed

reactions during disaster management. Moreover, interactive feedback is needed to allow update of information that users or various survivors have interacted with. In this study, we have proposed that information will be verified by authority body to allow users to access verified information for successful planning of disaster management.

The cost factor of most mobile technologies needs to be considered to ensure that the gadgets are affordable. Developing national or regional applications for disaster can be done on cost reduction approach where governments can source for free skills through crowd computing and volunteered geographic information (VGI). Through these technologies, information can be made cheaply available and the respective governments can invest in hosting the applications on their servers and maintenance of such devices. Information sharing should be developed to reflect the approach described in Figure1. Disaster management portal is used to monitor unfolding events and then the information obtained with respective authorities. It believed that once a communication system is in place such as wireless or mobile telephone masts, then delivering information on web platform should not be a nightmare.

Deploying communication system especially high speed on GMS[4] network and internet in areas previously with no network can be a big challenge [29]. The situation can be worsened when there is lack of coordination between agencies involved disaster management[31]. We however, propose that emergency mobile satellite communication and web 2.0, it is possible to quickly provide such network to residents in Disaster zone [32] and users of the web platform with have no problem in delivering the right information to the survivors.

Security concerns especially use of mobile applications in terrorism activities could lead to a new twist where smart terrorist could direct relief to unwanted regions in pretext that the area is in dire need of urgent attention, while in reality that could be a hoax [33]. However, we proposed that our approach can be used in such situation through use of focal points persons which can be established with local administration to relay reliable information. Therefore, using mobile application in disaster management still remains relevant approach for collecting information for quick crisis management. We have highlighted these issues to show that, there are concerns that need to be addressed while an organization or regional bodies are planning to develop mobile applications for successful crisis and disaster management.

## 3. Methods and data

The mobile platform developed in this study allows users to report information about unfolding disaster using mobile devices and internet web based enabled devices. It makes it easier to plot disaster location on web map without necessarily having mapping skills. The reported information becomes readily available to both survivors and disaster management personnel so that they can make well informed decisions about unfolding events of a given disaster that is being reported. In this study, we have created a platform that allows collection of data through crowdsourcing with the use of mobile and internet web enabled device applications. We believe information gathering and sharing can be effectively achieved through voluntary data collection by use of mobile devices and social media which currently dominate the revolution of web 2.0 and growth in internet use.

### 3.1 Mobile Device Platform for Disaster Reporting Application

In this study, we introduce an approach that uses mobile and web based technology to involve communities to participate in disaster management through crowdsourcing approach. In this platform, the main idea is information sharing across various stakeholders to eliminate bottlenecks associated with bureaucracies in reporting disaster information, especially getting feedback from survivors who are often neglected. The system is self-feeding with real time update as soon as the information is submitted on the web platform.

The mobile disaster feed developed in this study creates a dynamic platform where users of the platform are able to report information about unfolding disaster and also view information about already reported disasters by use of various radio buttons readily available in the web application links. In this platform, we consider disaster as initial input which triggers the use of mobile devices on the interactive platform as illustrated in Figure 3. In this architecture, we used Open Street Map (OSM) link as base layer for showing the location of each disaster. The user will interact with the web platform and report the disaster around them using the customized radio buttons.

Disaster will vary in magnitude and frequency in various locations in the world. Therefore, it is good practice to promote information sharing cheaply though mobile and web applications that are hosted on free platforms to promote disaster reporting, getting alerts and ability of to view already reported information. We have categorized disasters by their nature as the major inputs required to show which type of disaster has occurred. The information is then fed into a mobile device through communication connection such as telephone network or internet hotspots, which give the user an opportunity to interact with the developed web platform directly or through social media. The interactive platform provides the opportunity for the user *to submit report, get alerts or view reported information.* The complete picture is provided by Figures 3, 4, 5, 6, and 7.

The application developed here targets information volunteers especially those passionate of informing others of various disasters happening at various places. We also propose that focal point leaders who can be appointed by local authorities to ensure information can be verified before action be taken are the same information is then freely relayed to disaster portal and made available to wider audience free of charge. The wider audience can access all information being relayed provided they are informed about its existence. The architecture is actually developed to widen access of disaster information to the relevant beneficiaries (survivors) during crisis management.

[4] General subscriber module is *sim* card network system used in mobile phone network communication

The flow of information within the system as described in Figure 3 is meant to relieve the targeted users from the bottlenecks of bureaucracy. When a disaster occurs, whether natural or man-made, information should flow about the disaster to the system through available channels of communication which can be telephone and or internet based through the mobile device platform in stage I of the methodology. Once information has reached the system, the interactive platform integrates all the incoming information and creates as seamless interactions with tools within these platforms that allows the users to acts as sensors of collecting information and relay them to the system. At this stage II, the main process is to ensure information is organized, harmonized, verified and eventually disseminated to the wider audience through customized buttons of get alerts and view reports. The general public with then be able to receive information about unfolding disaster events in stage III. The location data is made available through the use of base map which has been seamless integrated within the application user interface. The end-user will simply click and drag with detailed information on how to use the interface provided in the form of pop up window whenever a user is within the submit data section. In actual disaster scenario, updates and crucial information can be received from survivors within the disaster zone, and where necessary parameters are put into place and the updates can be modified from time to time.

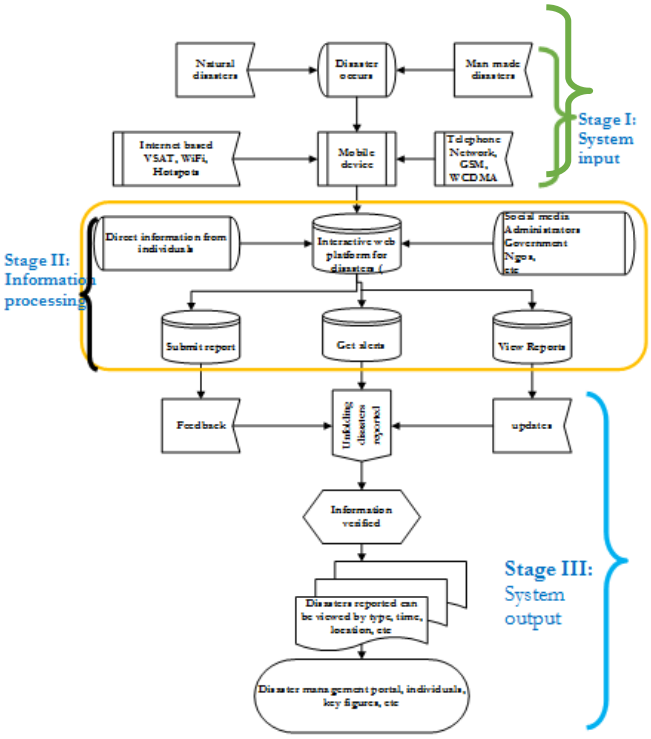


**Figure 3:** Mobile technology architecture for disaster management

The mobile and web platform we have developed here require some form of communication from internet hotspots, WiFi, VSAT, mobile telephone networks either 2G, WCDMA, 4G and in some cases cable if available. This will allow the user to interact with our interactive platform (in this study we call it https://disastersnow.crowdmap.com/reports *click to view the available options*). We have customized three editable data containers can be summarized as follows: The occurrence of a given disaster will therefore elicit some reaction from victims, survivors and sympathizers who may wish to pass information to relevant authorities, relatives, friends and general public ( see stage I ). The information cannot reach a wider audience without assistance from communication technology that makes use of devices that may be available in the aftermath of disaster such as *telephone based i.e. satellite phone, GSM, WCDMA, GPRS* and *internet based such as VSAT, Wi-Fi, Hotspots, etc.* The web interactive platform has been modified with various plugins to receive information from social media, authoritative agencies, NGOs, and individual users.

The system output has been designed with home page and three major information blocks i.e. submit report, get alerts and view reports (see stage II). These components allows the users to interact with system and provide the relevant information, as well as an opportunity to view feedback on information that has been submitted in the form of comments or whether the information submitted has been verified as well as summarized statistical information as shown in Figure 9. The output has also been customized to handle concurrent requests, which allows users to carryout seamless interaction without any conflicts with any of the major information blocks. Information submitted to the system is then harmonized by the various categories of disasters predetermined for those submitting information to choose from using various plugin and radio buttons. The eventual output is seamless flow of disaster information on the portal with capability of showing information analytics such even trend, lineage, type and location (see stage III). A similar type of portal can be developed by NGOs, governments and local authorities to help in disaster management.

### 3.1 Mobile Submit report

This page has open street map link as base layer which been made editable to allow the user to report the disaster location with limited difficulty. This data layer has been customized to allow the system receive information from GSM phone, android platform, IPhone and social media platform like Facebook, Tweeter, Email, Gmail, blogger and several others. Users can report a given disaster as follows:

1) Sending a message to given phone number provided on the site
2) Filling a form provided on the website proving details of *news, source link, external video link and upload photos* with complete details describing the disaster being reported, date and time of occurrence.
3) Since users will be of varied knowledge and experience, we have provided customized options that allow the user to orient them or to use search information deemed to be relevant. A typical mobile disaster reporting form will look like the illustration in Figure 4.

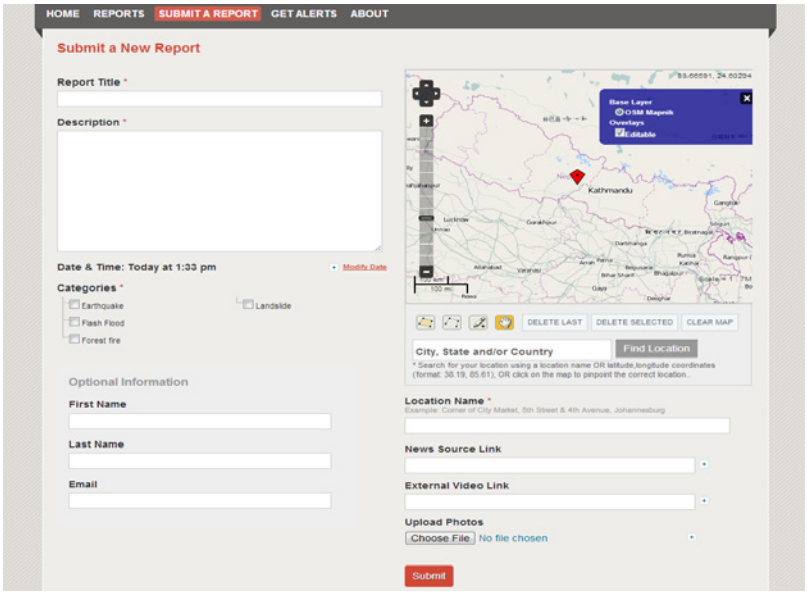


**Figure 4:** Submit report form for mobile disaster reporting

### 3.2 Mobile Submit Report

This platform allows users with mobile and web or internet enabled technology to access information on unfolding disasters depending on their needs. Users can receive alerts as SMS[5], through email address, social media and blogs. The user however, has to select the fields on which alerts are relevant and with possibility of specifying the locations whose information on selected hazards they would wish to receive as illustrated in Figure 5.

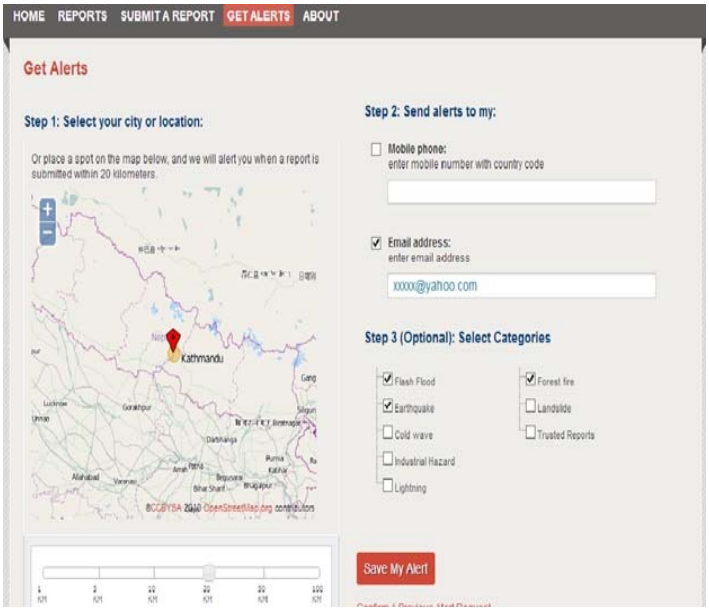


**Figure 5:** Get alerts form developed to allow people to receive information from the website

This platform also allows the user to save alerts and confirm previous alerts. The user can also delete the alerts at will. The platform is therefore, considered user friendly and very objective to information of interest. The same platform will therefore meet the demands of various users at the same time which is very crucial in disaster management and response.

Alerts or warnings as they are commonly known are issued to people in disaster potential areas to prepare themselves to prevent and minimize the damage that can be caused by unfolding disasters. The signal will be triggered by date and time selected by the potential user of mobile platform. The information will then be sent and the user will get information in the appropriate format as per the fields selected. The issue of alert messages is an automated process which can be delivered through various mechanisms from short message services to use of social media. It also our belief that incase such information can be delivered to alarm fitted signal receiver, the alert signal can be used to trigger alarms established in disaster area.

[5] Short message service: text messages sent to mobile phones with max of 160 characters.

### 3.3 View Reports

The web portal allows the user to view information on reported disasters as a list or maps. The information has been customized to allow the users to view information as thumbnail and flash by selecting the disaster by category, location and media used, see Figure 6 and 7. Since, communication can be limited during disasters, we have introduced a field for verification of information and summary of verified data can be made available to users as illustrated in Figure 9. This will improve user confidence in accessing or sharing a certain piece of information concerning a given disasters. Reports can also be filtered depending on available parameter of choice such as statistics by country, disaster type, view, etc. The reports have also been customized to allow users to connect to Email, Gmail, Reddit, Facebook, Blogger, Twitter, Printer, tumblr and even more web enabled applications. This makes sharing of information from website easier and faster within a protracted duration of time.

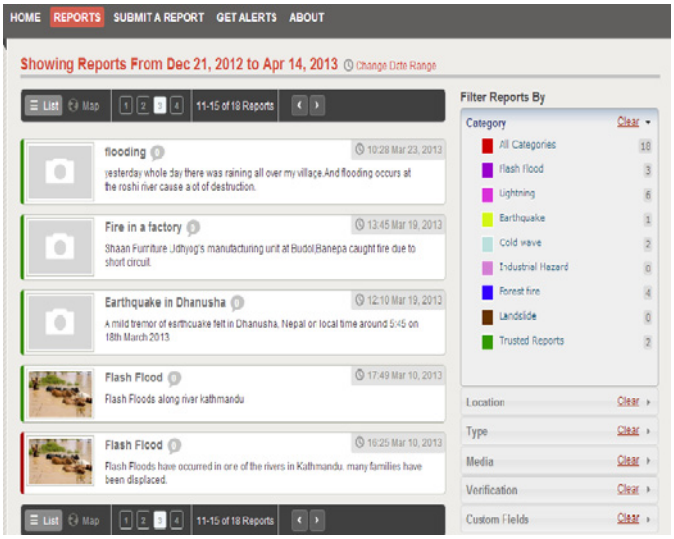


**Figure 6:** View reported disasters as a list

Overcrowding of data can be a serious obstacle in perusal of information available online. We have therefore, incorporated the list view type to show the nature of the disaster and supportive information. This has been developed with complete navigation buttons. Since this is a crowd sourcing platform, chances of clutter on web map are possible and depending on number of people reporting information and showing locations of various disasters, viewing reported information as list is very vital are providing organized information.

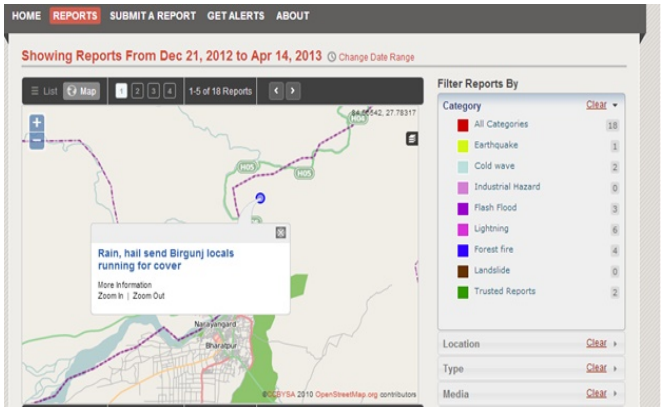


**Figure 7:** View reported disasters on map layout

Map view of reported information can be cluttered at times and therefore, it is advisable to zoom in to the relevant scale in order to see specific locations for which disasters have been reported. For detailed description of the disaster information, the public user can click on more information and will be directed to full details of the disaster that has been reported. The overlay map allows the user to get the local context by zooming in to the point of seeing local physical features such as roads. The system further allows users to download reported information either as CSV or KML as illustrated in Figure 8.

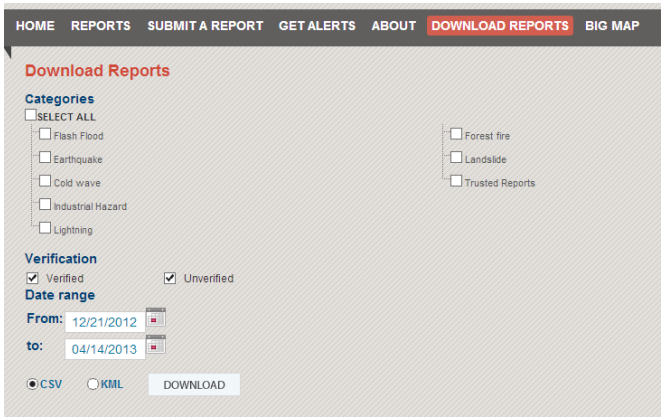


**Figure 8**: Sample screen for downloading disaster information

The downloaded information can further be used perform further analysis or be integrated with other data types to aid in decision making. For example by looking at statistics reported during the testing of the portal, it was possible to generate information various disasters reported as shown in Figure 10. The graphical summary also provides quick overview of the verified and approved information.

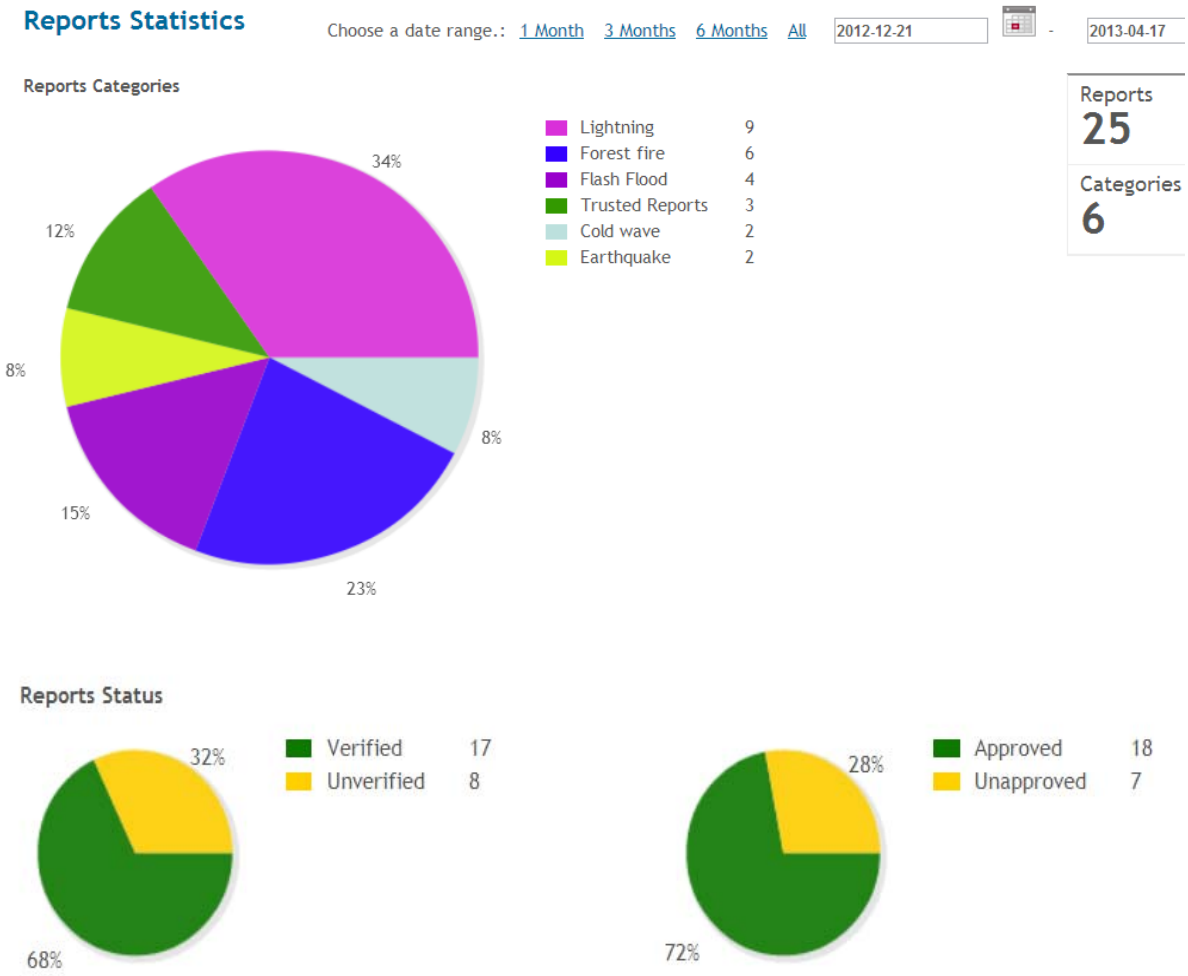


**Figure 9:** Sample status information of submitted for disaster management


**Figure 10:** Country breakdown of visits since launch of application

The system has also been modified to allow users without much skill on statistical analysis to download informative graphical information as shown in Figure 9. Due to its simplicity, users do not need any technical training on how to use it, but only have to follow simple instructions on how to download information. Since the launch of the application, it has attracted people from 18 countries with over 388 views. It is therefore, our belief that this tool would be useful in disaster management all over the world and provides a new approach of using the general population as information volunteers and consumers of the same information at no cost. Moreover, the platform makes it

possible for various stakeholders involved in disaster management to monitor the kind of disaster information that may be streaming within the disaster zone or other disaster unfolding events on their smart phones as illustrated in Figure 11.


## 4. Discussion

Crowdsourcing is seen a major breakthrough in information sharing and data collection through techniques known as voluntary geographic information. In this study, we have developed a platform that allows interactive information sharing through three major information blocks *i.e.* submit reports, get alerts and view reports. It is our belief that the platform creates a new era of disaster communication through use of mobile technologies. The role of the user of this platform is reduced to interaction with the interface; since no computation knowledge or mapping skills are required. Instead, a customized interface with clear instruction on how to report information is provided. Summarization algorithms for crowd sourced data such as interactive summarization technique in the all hazard disaster situation browser(AHDSB) by Zheng, et al., [17] has also been incorporated with geo analytical statistical summary. In this study, attention is paid to disaster reporting especially information dissemination with geo-location on web maps through the developed application to report disasters without GPS[6] enabled phones provided they have internet.

The users of this application will only zoom to the location of the disaster, mark it and report it with possibility of uploading video and picture of the type of disaster which unfolds. This study also suggests solutions to constraints posed in previous studies identified by Souza & Kushchu [16] which were based on principle of GPS triangulation of call masts to identify the location. Therefore, the user does not need to own smart phones or GPS enabled to communicate disaster information.

The approach is further elaborated to exclude the role of phone operators or service providers in negotiation for information retrieval which can be frustrating to access in most cases, since the users have to wait for long before they talk to operator. The primary role of service provider is to ensure the victims have access to network or restoring damaged communication masts and probably a request can be made to service providers to allow victims to have free GPRS[7] data.

The role of social media has been fully integrated in this disaster reporting platform. We have allowed the user to share information about a given disaster on their social network. We believe this will circulate information to a wider audience within a protracted period of time. The information can also be verified easily at no cost as people post their comments about disasters reports on the social network. Integration of the role of mobile technologies with social media in disseminating disaster information has been achieved and it is our belief that disaster management organization and agencies will incorporate these approaches in their new approaches towards disaster reporting and information dissemination.

During disaster management, timely delivery of the right information to the right group of people is the primary goal. This platform provides seamless delivery of such information at no cost provided the targeted audiences are informed about the application. Despite drawbacks such as quality issues associated with VGI, this study further elaborates on the work of Goodchild & Glennon [34] which was based on geospatial data and tools. We believe this approach creates a good platform for information sharing without being limited to technological knowhow of geospatial skills.

## 5. Future Research

In this study, we have not developed a framework for filtering out duplications of information which might be reported by various users. However, we have developed a filter that allows the users to filter information on basis on major categories and provide detailed summary. Moreover, the platform developed here provides a good insight for ensuring information flow to relevant parties and give them a chance to be active participants of information provision and not just consumers of information provided by others far away from the disaster site.

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[6] Global positioning system: a system for finding exactly where you are anywhere in the world using satellites

[7] The GPRS core network is the central part of the general packet radio service (GPRS) which allows 2G, 3G and WCDMA mobile networks to transmit IP packets. The system that allows you to connect to the Internet using cell phones

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