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Communicating With Points, Lines, and Areas.

Analysis of OSM Tasking Manager as Communication Media to Transmit Volunteered Geographic Information in Disaster Response

DAIVA M. BRAZAUSKAITE

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Department of Applied Information Technology
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ABSTRACT

Disaster response requires great amount of communication when it comes to coordination and cooperation, yet communication is not smooth and encounters some problems, one of which is lack of situation awareness. One of the most required information during disaster response which helps to solve the situation awareness problem is geospatial data. This research analyses the media capabilities of OSM Tasking Manager when communicating Volunteered Geographic Information by applying case of Nepal Earthquake in 2015 April as the most recent natural disaster for the analysis. It was first attempted to define the crisis communication and its variables to clarify the scope of analysis. Second it was attempted to evaluate media capabilities in theory by considering the context in which the media is used and communication is taking place as Media Synchronicity Theory suggests. After conducting usability inspection and document analysis actual OSM Tasking Manager capabilities were evaluated regarding conveyance and convergence processes in production function. Results showed that OSM Tasking Manager is a very task oriented communication media that fulfils theoretically required media capabilities. Research also showed that Map Communication Model provided by Hoffman is highly applicable when analysing communication via interactive web mapping platforms.

Keywords: disaster response, Volunteered Geographic Information, OSM Tasking Manager, Media Synchronicity Theory, Nepal Earthquake 2015, Map Communication Model

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API	Application Programming Interfaces
GPS	Global Positioning System
GIS	Geographic Information System
HOT	Humanitarian OpenStreetMap Team
ICT	Information and Communication Technologies
MST	Media Synchronicity Theory
OSM	OpenStreetMap
SGD	Social Geographic Data
VGI	Volunteered Geographic Information

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1. INTRODUCTION

1.1. Relevance of the study

Crises are inevitable. They can happen at any time and they have three main features - they all happen rather sudden, create a situation where there is a limited amount of time for any kind of decision, and they pose threat (Billings et al., 1980; Sellnow and Seeger, 2013; Seeger et al., 1998). However, none of the crises are the same because of the underlying circumstances and the effects they might have. While some of the crises might be seen as turning point for better or worse, there is one specific type of crisis that never creates a positive outcome - disaster (Shaluf et al., 2003). Response to a disaster requires a great amount of cooperation and collaboration, and thus it is unachievable without communication. Yet, emergency managers experience several problems with it. One may identify the technical problems, such as disruption of the communication infrastructures or cut of the power lines, but researchers noticed that recently this causes less problems. It is the lack of situational awareness, common ground or unclear communication pathways that are identified as causing problems when handling emergencies and therefore communication needs to be improved in these areas in order to improve the coordination and collaboration (Lundberg and Asplund, 2011). This research is focusing on one of these problems – lack of situation awareness - and a way to solve it.

One of the features of the natural disasters is that they have a geographical location and impact zones. By providing geospatial data on the road infrastructure, damage, and population distribution, among other relevant information, for spatial decision support becomes crucial and helps to decrease the lack of situation awareness. Mapping impact zones and providing this type of data used to be gathered in the hands of professionals working with Geographic Information Systems. However, due to shortage of these professionals who would be able to map the area and produce maps at rapid speed (Kawasaki et al., 2012) the problem of improving situational awareness was only partly solved. In 2005 Google launched a new mapping service called Google Maps. This, together with the increased numbers of Internet users, improvements in wireless Information and Communication Technologies, and decreased prices in Global Positioning Systems units paved the way for web mapping applications and escalated the phenomenon of Volunteered Geographic Information. Since the growth of public (which is usually untrained and consists of the citizens of the affected areas, and the volunteers from all over the world) participation in providing useful information, such as Volunteered Geographic Information, supported by the Information and Communication Technologies became more visible in disaster response, in recent years it also became more acknowledged by the formal disaster response groups, therefore increasing the speed of gathering relevant spatial data and/or mapping impacted areas (Haklay et al., 2008, Goodchild, 2007; Kawasaki et al., 2012; Zook et al., 2010).

There are several web mapping platforms and applications that are used for Volunteered Geographic Information, the most known are Ushahidi Crowdmap and OpenStreetMap. There are many of researches done analysing them, focusing on the quality of the data, or analysis of the users and their motivation (Horita et al., 2012). But those web mapping platforms are as well the communication media for transmitting the

Volunteered Geographic Information, since interactive map can be understood as communication media. Thus communication technology theories can be applied. If Volunteered Geographic Information should help to at least partly solve the problem of lacking situation awareness, the media used in disaster response should support and increase the communication performance for that matter. However, in the literature there is lack of analysis on how do these web mapping platforms and applications perform as communicative media, what would be the desired capabilities of the media for transmitting specific kind of information, such as Volunteered Geographic Information in this case, and whether the media fulfil these capabilities. This research attempts to analyse one of the platforms, OSM Tasking Manager, which is “designed and built for the Humanitarian OSM Team collaborative mapping” (About Tasking Manager, n. d.), as a communicative channel and view its performance in communicating Volunteered Geographic Information during one of the recent natural disasters - earthquake in Nepal, in 2015 April. Analysis would provide with a valuable framework for analysis of other communication channels and thus research would add up to the fields of crisis communication, and communication technologies as well as fields of geography and cartography.

1.2. Research Question and Aims

Scope:

This research analyses the communication of Volunteered Geographic Information that is transmitted via OSM Tasking Manager mapping tool in the context of disaster response. The chosen case for the analysis is Nepal Earthquake in 2015 April as the most recent natural disaster where OSM Tasking Manager was deployed for the task of mapping the impacted area.

Research Question:

How does the OSM Tasking Manager web mapping application perform in fulfilling desired media capabilities when communicating Volunteered Geographic Information during disaster response in comparison to the theoretically described desired capabilities?

Tasks:

1. Identify the variables in crisis communication by applying Allwood’s definition of communication
2. Introduce the process of crowdmapping through which Volunteered Geographic Information is gathered
3. Describe Map Communication Model and approaches to map use
4. Define desired media capabilities of channels used in communicating Volunteered Geographic Information in disaster response
5. Analyse and evaluate the OSM Tasking Manager mapping tool by applying defined desired media capabilities

Aims:

- Define what would be desired capabilities of communication media which is used to support the communication of Volunteered Geographic Information when performing the task of disaster impacted area mapping

- Evaluate performance of the OSM Tasking Manager crowdsourced mapping tool as communication channel according to previously defined desired media capabilities when supporting the communication of Volunteered Geographic Information in performing the task of mapping disaster impact area

1.3. Structure of the Paper

This paper is divided into seven chapters with the first being an introduction. Second chapter introduces with the previous studies regarding public participation in disaster response, Volunteered Geographic Information, its applicability in disaster response, web mapping applications, and OSM as crowdsourcing tool for Volunteered Geographic Information and communication media. Third chapter gives a theoretical background for this research and is divided into six subchapters, with the first three designed to identify and narrow down the variables of definition of crisis communication, fourth and fifth defining the theories that will be applied for the analysis and the last subchapter is providing with the theoretically defined desired media capabilities. Fourth chapter defines the research methodology applied for the analysis, introduces to the Instrumental Case Study of Nepal Earthquake in 2015 April, data gathering methods, data analysis, ethical and legal considerations of the study, and defines the limitations of the research. Fifth chapter presents the results of the gathered data by defining general communication patterns in the OSM Tasking Manager and the results of each of media capabilities. In chapter six the results are discussed and interpreted in relation to the theories used for the research. The final chapter provides the conclusions and propositions for the future research.

2. PREVIOUS RESEARCH

There are quite a lot of researches done regarding public participation in disaster response. One of the most noted authors in the field of Crisis Informatics is Leysia Palen. The author, together with other colleagues, conducted researches varying from general use of Information and Communication Technologies by the public in disaster response (Palen and Liu, 2007; Palen et al., 2010) to the use of some of the specific Social Media platforms (Sutton et al., 2008). Researches are focused on the public empowerment in disaster response, as how public participation becomes more and more visible during times of crisis, how Social Media comes in front when people seek for information as it was shown during the 2007 Southern California Wildfires (Sutton et al., 2008). Palen et al. (2010) proposed a vision on how future emergency management should support and include public in disaster response and how emergency management should go beyond the monitoring of on-line activity and focus on the needs and roles of citizens. The vision comes from analysing how people truly respond in disasters and crises, rather than the assumptions and some portrayals of the public being helpless (Palen et al. 2010). Palen and Liu in 2007 noted another trend in the use of visual wikis some of which provided with mapping technologies that enabled to link textual and visual information to specific geographic locations. This phenomenon was later more analysed by such authors as Michael F. Goodchild, who analysed public participation in mapping and proposed a definition of Volunteered Geographic Information (Goodchild, 2007).

Authors Horita et al. in 2013 presented systematic literature review on how Volunteered Geographic Information and crowdsourcing is used in disaster response and stated that the knowledge of Volunteered Geographic Information and its way of improving disaster management is increasing. Authors as well noted that after they conducted the systematic literature review, they found that most of the researches are focused on Volunteered Geographic Information used in disaster response phase and by applying or analysing case studies in their research (Horita et al., 2013). For example McDougall (2012) analysed three case studies of The Queensland and Australian Floods in 2010/2011, The Christchurch Earthquake in 2011, and Japan Earthquake in 2011. The paper focused on the impact the volunteered information had, types of information shared and timeliness of the responses, relevance of the initiatives and the contributions that were made and found that volunteered information provided with a unique perspective on these disasters and only the crowdsourced information enabled to get this perspective. Zook et al. (2010) provided with another research on the case of Haiti Earthquake in 2010, where the authors as well analysed the ways the Information and Communication Technologies with main focus on web mapping technologies. Similar research was done by Kawasaki et al (2012) regarding Haiti (in 2010) and Sichuan (in 2008) Earthquake responses and defined the changes in response patterns caused by web mapping platforms.

Regarding the researches of Volunteered Geographic Information, it is often analysed from the perspective of problematique of its quality, reliability and credibility, since the information is often produced by non-professionals (Horita et al., 2012). The issue has two perspectives. The technical perspective would refer to the accuracy of the data as determined by technological means such as accuracy of GPS unit or projection of the map. It as well depend on completeness of the mapped area (the more it is complete the less errors) and the quality assurance provided by the mapper which mostly relies on trust (Haklay et al., 2010). The social perspective would refer to the motivations and subjectivity of provided information (Flanagin and Metzger, 2008). However, as Goodchild and Li (2012), Goodchild and Glennon (2010), and Haklay et al (2010) argued, quality assurance of VGI is fairly based on the number of contributors and can be assured by the processes of crowdsourcing as based on the principle that on interest shared by many people the information will be more accurate, then on the interests shared by a few (Goodchild and Glennon, 2010) thus, the more active mapping of the area, the more accurate the information (Haklay et al., 2010).

Regarding the analysis of mapping platforms research papers tend to focus on two web mapping platforms which are most used in crisis response – Ushahidi Crowdmap and OpenStreetMap. As for example Zook et al. (2010) used a case of Haiti Earthquake in 2010 to define how both mapping platforms were used during disaster response. It defined the processes, achievements, applications and problems that volunteers had to encounter as for example in OpenStreetMap where mappers experienced some legal issues and overlapping tasks (Zook et al., 2010). Crowe (2012) for example focused more on Ushahidi mapping platform, how it developed from simple website that was seeking to gather reports on violence outbreaks to a fully functioning web mapping platform that provides with three components – The Original Ushahidi platform and the Crowdmap, which provides with capability of interactive mapping, and SwiftRiver – allowing to filter and verify the crowdsourced data.

The evolution of OpenStreetMap is described by Palen et al. (2015). Authors stated that while in the early days, important users were the members of OpenStreetMap community, they were directly involved in data creation. However, after humanitarian organizations started to rely on the data created it had to make itself more accessible to outsiders by focusing on usability of the tools, addressing legal questions of usage and distribution of data, and working on attracting new participants. The research described changes made to attract more participants, as well as organizational changes in OpenStreetMap and how Humanitarian OpenStreetMap Team was formed. It as well presented the OSM Tasking Manager and how it is used in mapping areas for disaster response with the case of Typhoon Yolanda as well as how the data changesets can be gathered and analysed, what information it can provide (Palen et al., 2015).

From communicative perspective, authors Mooney and Corcoran (2012) presented a paper which investigated the collaborative nature of spatial data collection in order to answer the question of "how social is OpenStreetMap?" in comparison to similar manner of contributions and contributors of Wikipedia encyclopedia. London and the history of contributions on the area was used as a case study. The analysis indicated that there is limited collaboration among contributors as quite large percentage of areas and features were edited only once or twice. Moreover, study showed that contributors can be categorized into object creators, tagging editors and general editors (Mooney and Corcoran (2012). Same authors Mooney and Corcoran (2014) conducted another research and analysed interaction and co-editing patterns amongst OpenStreetMap contributors by analysing social-network of contributors from seven major cities in OpenStreetMap with an effort to understand whether there are evidence of interaction and collaboration between members of OpenStreetMap that can be quantified, and found that in many cases senior mappers (or frequent contributors) perform a lot of work on their own, however they do interact (edit or update) with new less active contributors.

3. THEORETICAL BACKGROUND

3.1. Crisis Communication and Disaster Response

For the beginning of this research, it is important to define what crisis communication is. There is a vast array of definitions of communication, varying from the most simple ones indicating sender-message-receiver relationship where receiver is a passive agent, to the more complex ones, that take into account contexts, previous experiences, feedback loops and identifying the receiver being a sender at the same time, therefore acknowledging the fact that receiver is not a passive agent after all (Sellnow and Seeger, 2013). One of the definitions that incorporates the complexity of communication is Allwood's (2002), where communication is defined as "transmission of content X from a sender Y to recipient Z using and expression W and a medium Q in an environment E with a purpose/function F" (p. 1). If we would fill in the variables from this definition of communication with the definition of crisis communication suggested by Sellnow and Seeger (2013) we can say that crisis communication is an ongoing process of transmitting messages (content X) among and between groups, communities, individuals and agencies (sender Y and recipient Z) using any available expression and medium (W and Q) in the context of crisis (environment E) with a purpose of preparing, reducing, limiting and responding to threats and harm (purpose/function F).

One of the first variables from the definition would be the context/environment E in which the communication is taking place. Thus, it is important to discuss and clarify distinction between *crisis* and *disaster*. Both words are often used as synonyms, however, when it comes to research, they refer to rather different situations (Boin and Hart, 2007). In the literature that is focusing on crisis management, event or series of events, that are described as crisis, has three main attributes: they violate expectations or come by surprise; they threaten desired goals (such as safety, life, health, security); they require relatively rapid response and have a short decision time (Billings et al., 1980; Sellnow and Seeger, 2013; Seeger et al., 1998). When looking at these features, every disaster fits crisis definition, yet, not every crisis is a disaster (Boin and Hart, 2007). Seeger et al. (1998) distinguished that disaster in research literature is referred to a large scale, non-organizational event triggered by nature or mass technology which affects the society or its subunits and is managed by the community, governments or social groups. In addition to this, if crisis can sometimes be viewed as having positive and negative sides, disaster is then a crisis having a devastating ending with no positive outcomes, quantified in destruction, casualties, injuries, evacuations (Boin and Hart, 2007; Shaluf et al., 2003). However, the most important feature of disasters that is relevant for this research is that the impact of natural disasters (earthquakes, tornadoes, floods etc.) are localized to certain geographical region and its consequences are felt at that specific place and time of occurrence (Shaluf et al., 2003). Even though both terms of crisis and disaster are related, for this research the focus is put on the natural disasters since they have actual locations and geographical impact zones, thus a natural disaster is the context/environment E that the communication is taking place.

This variable can be further narrowed down to the more specific phase in disaster which would be the response, thus the context/environment E can now be defined as *disaster response.* Emergency (disaster) response is one of the four main functions of emergency management, where the communication is arguably the most important function for coordination and cooperation between various groups, individuals and organizations, as well as facilitation of logistics, dissemination of information to the affected public among other important tasks (Sellnow and Seeger, 2013). However, there are several problem areas that degrades communication in disaster response. Sellnow and Seeger (2013) named two general ones: failure in information systems which are important before, during, and after disaster for the distribution of messages; problems related to coordination, such as failure in coordination of activities between agencies due to inefficient communication. Lundberg and Asplund (2011) named five problem areas: disruptions in the communication infrastructure (which might be damaged during disaster); lack of situation awareness (refers to perception and understanding of situation and projection of the possible status with the main key of the problem being obtainability of relevant data quickly and protection of the information that should not be shared); lack of the common ground (such as having shared understanding of the same concepts); form and content of the messages (different tasks require different message formats); unclear communication paths through organization (has to be sufficient when reaching right people at the right time). Problem of the disruption of communication infrastructure closely relates to the failure in information systems, which as Lundberg and Asplund (2011) noted nowadays results in more minor problems. Solving the problems related to coordination which would refer to the rest identified by Lundberg and Asplund is becoming a central communication goal and researchers' interest (Sellnow and Seeger, 2013; Lundberg and Asplund, 2011).

Coordination and collaboration in disaster response is challenging because of uncertainty, risks, sudden and unexpected events, time pressure, scarce resources and all of this can be complicated by the factors such as high demand of sharing timely information (Chen et al., 2008). Traditionally the communication in emergencies was viewed as a static one way (top-down) process with assumptions that receivers are passive and have universal access to mass media channels, reminding of old models of communication. Recent developments in the mobile technologies together with understanding communication as a more complex phenomenon, and development of more complex definitions, led to the change in the view on receivers, who are identified now as active participants in the communication (and as such in information sharing) process (Sellnow and Seeger, 2013). Pechta, Brandenburg and Seeger even proposed a Four Channel Model of Communication (2010, as cited in Sellnow and Seeger, 2013) where the central element is the central positioning of public as participants, since they are the first ones to experience the crisis, and identification of various links between disaster response agencies and the mass media. Model works on the assumption that the integration of new technologies would enhance the richness of information flow since the public becomes a source of real time information (Sellnow and Seeger, 2013). Thus, viewing the public as active participants in sharing real time information via Information and Communication Technologies (ICT) and Social Media can help to solve one of the problem areas in disaster response communication – lack of situation awareness.

3.2. Public Participation in Disaster Response and Volunteered Geographic Information

Public participation in the emergency/disaster response is not a new phenomenon, simply it was not as visible and active as nowadays (Palen and Liu, 2007; Sutton et al., 2008; Palen et al., 2010). What used to be notes with chalk on the sidewalks or spray-painted messages on houses (Palen and Liu, 2007), became communication of short text messages, Facebook posts, pictures on Instagram, tweets, which can be visible worldwide due to social networking sites and other Social Media. All of this is because of the advancements in mobile and wireless ICT, such as mobile phones which support short and multimedia messages, Global Positioning Systems (GPS) (Palen and Liu, 2007) and nowadays new generation mobile devices as smartphones which have embedded cameras, GPS units, various mobile applications that can be downloaded and used for various purposes, growing accessibility to the Internet, and decreased prices in new technologies available to the wider public (Palen and Liu, 2007; Zook et al., 2010). Social Media and ICT not only enabled the ones that are experiencing the emergency to easily connect and share information with others, it also enabled public to self-organize temporary volunteer groups during disaster response and relief period, and provide up-to-date information about current situation in the area among themselves, as well as to the formal response teams (Palen and Liu, 2007; Sutton et al., 2008). It also empowered people outside of the impacted areas to create Internet-based self-organized volunteer groups, and form networked disaster response communities, since the physical proximity is no longer an issue (Palen and Liu, 2007; Kawasaki et al., 2012).

Another important feature that ICT introduced, is that it enabled decomposition of complicated problems and means to simultaneously solve them in a highly distributed manner during disaster response (Palen et al., 2010). Citizen production of information and collaboration, which can be referred to the cloud collaboration or crowdsourcing (process will be presented more detailed in the following chapter) is “the ability of people around the world to collaborate on projects that are often highly ambitious and large in scale” (Zook et al., 2010, p. 11). One of these large scale ambitious projects that are important in disaster response is gathering the geographical information and mapping disaster as this can ensure timely and effective response. Public participation in sharing this type of information and mapping from both people inside and outside of the disaster areas is becoming one of the areas which is probably mostly reshaped by ICT, Social Media, and the shift of users from being passive information receivers to the active sharers (Kawasaki et al., 2012, Zook et al., 2010).

In general sharing of geographic information and web-mapping reaches mid 90’s. However, it allowed only little customization by the end users, not to mention the unpleasant experiences of slow Internet connection, constant refreshing of pages when editing, not a very wide use of Internet in general, and complex editing tools which were adapted from professional cartographers, thus making it not a popular practice among public. This changed in 2005 when Google released Google Maps mapping service where users could manipulate the data and images (Haklay et al., 2008). The new wave of Web 2.0 (which generally describes World Wide Web as a platform where content and applications are continuously modified and updated by participative and collaborative users) together with previously mentioned developments in ICT, less complicated web-mapping technologies, tools, and applications, attracted the public to share geographical information and edit maps more actively (Goodchild, 2007; Kaplan and Haenlein, 2010; Kawasaki et al., 2012). In addition, the growing range of interactions enabled by evolving Web, the drop of prices in GPS units, wide availability of computers, improved resolutions of the satellite images and aerial photographs, and general motivation of participants to cover “white spots” and update or edit inaccurate geographical information were the other key factors for the phenomenon of Volunteered Geographic Information (VGI) to appear (Goodchild, 2007; Kawasaki et al., 2012; Zook et al., 2010). What Goodchild (2007) defined as VGI is a phenomenon of voluntary creating, assembling and sharing of geographic data by individuals using web tools and applications. By using those web tools and applications, users can create their own georeferenced or geotagged (using tag to georeference an image with geographic coordinates) data and information by creating Mashups, describe routes and places in Blogs which are available for a broad public, contribute to a corporate production of maps via crowdsourcing, and communicate information of real time mobile activities via tracking applications (Faby and Koch, 2010).

What is exactly the use of geographic information in crisis management and disaster response? Mapping hazards, locations of occurrences, geographic limits of impact of disasters has a quite long history and is clearly very important in all stages of event (Goodchild, 2006; Thomas et al., 2007). Geographic information and mapping can be utilized in mitigation planning when evaluating mitigation alternatives and in preparedness when planning evacuation routes, in disaster response when coordinating relief efforts, in recovery when gathering information on how to allocate resources (Thomas et al., 2007). These examples are used in practice. In all of the stages, the ability to combine, visualize and model information on human populations and distributions, infrastructures and other relevant spatial data becomes particularly important for decision makers when the stakes are high and there is limited resources and time to act. Here Geographical Information Systems (GIS), Remote Sensing, and GPS serves as a tool for spatial decision making. GIS in particular is recognized as key support tool in crisis management because of its data visualization capabilities (Goodchild, 2006; Thomas et al., 2007). Still most of the conventional geospatial response was gathered in the hands of professionals like governmental agencies or GIS vendors, and most of the disaster responses had centralized emergency operation centres where collection of damage information, map printing and information sharing was conducted in a top-down manner (Kawasaki et al., 2012). However, when citizens become empowered to share VGI via various social networking platforms and web mapping applications, this led to a more decentralized and transparent communication and sharing of valuable geographical information, which was not a matter of professionals exclusively (Sellnow and Seeger, 2013; Kawasaki et al., 2012).

Even though VGI serves as a rather complementary data to the official one provided by professionals, it found its niche in some specific areas during disaster response. The first one, VGI fills in the gap of lack of situation awareness that appear immediately after disaster has struck and until the official response efforts establish their own control and information structures. VGI provides a near real-time information on the disaster areas, broadcasts conditions and status on the ground almost immediately after the event (McDougall, 2012). This information is crucial during this period of time, as for official response teams mapping might take days and weeks, which results in delays, and responding in timely manner is nothing but crucial in emergency situations. Another niche that VGI fills in, is providing fundamental spatial information (such as road infrastructure, street names) where traditional sources do not exist or are not publically available, as it was the case for Haiti Earthquake in 2010 (McDougall, 2012, Zook et al., 2010).VGI benefits lies in its ability to generate large amount of data in rather timely manner and to produce larger quantity of maps in rather short periods of time (Kawasaki et al., 2012; Zook et al., 2010). Another area that VGI can provide valuable data is in analysis of the disaster. Collected data can be utilized to see how disaster unfolded, provide timelines, history of an event, and other relevant data as for example the levels of water during floods (McDougall, 2012).

However, Spyratos et al. (2014) later added that all the geographical information contributed by citizens (what he defined as CCGI - Citizen-Contributed Geographical Data) and shared publically, should be divided into VGI and Social Geographic Data (SGD), thus the authors narrowed down to what is included in VGI. The nature of VGI and SGD is different. While SGD is more socially oriented, as for example geotagged public tweets, VGI, according to them, is data collected "in context of real life or online science-oriented voluntary activities" (Spyratos et al., 2014, p. 2). Thus, even though SGD can be used for the context of scientific applications, VGI is the one that its main purpose is to serve as data for scientific enquiry, and it is therefore has more requirements in terms of contributors and quality (Spyratos et al., 2014). Thus, for this research the focus will be put on VGI that was described by Spyratos et al. and in the crisis communication definition provided in the previous section, VGI refers to the *content* of the message (X). We can as well identify that the *sender* (or *senders*) Y is a volunteer whose level of experience with maps and mapping can vary from professional to none.

3.3. Crowdsourced Mapping

The definition of crowdsourcing first appeared in 2006, where it was used in an organizational context by Howe (2006, as cited in Mazzola and Distefano, 2010) and was described as "the act of company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call" (p. 1). However, the term and the process itself can as well be applied in other than organizational context and later, Gupta and Brooks (2013) described crowdsourcing as the process that "essentially involves taking a complex problem that is difficult and expensive to solve, splitting it up into smaller tasks and then incentivizing people to solve the smaller tasks and consequently the larger complex problem" (p. 180) which generally complies with the previous definition provided by Zook et al. (2010) who defined *cloud sourcing* as "the ability of people from around the world to collaborate on projects that are often highly ambitious in both their scale and scope" (p. 11). During disaster, emergency managers, together with other disciplines, are often overwhelmed by the wide and massive amounts of duties, time pressure and lacking resources, thus often making preparedness and response quite difficult. The use of crowdsourcing process during disasters becomes very beneficial and was already used in few international disasters, such as Haiti Earthquake in 2010 or Japan Earthquake and

Tsunami in 2011 (Crowe, 2012; Zook et al., 2010; Kawasaki et al., 2012). According to Liu's (2014) defined Crisis Crowdsourcing Framework there are 4 types of tasks that a crowd usually helps to solve: crowd-sensing, crowd-tagging, crowd-curating and crowd-mapping. Crowd-mapping is the process that this research is focusing on.

As previously mentioned, one of the large and complex problems during the disaster response is mapping of infrastructure and gathering other relevant spatial data on the impacted area. Because of the limited number of professionals who would be able to cover and map entire areas (Kawasaki et al., 2012), crowdsourcing VGI becomes one of the ways to solve this rather immense task in a relatively short time. Though not always clearly distinguished in the literature, the crowd can generate maps or "crowdmap" (crowdsource the VGI) in two different ways depending on how VGI data is gathered. Zook et al (2010) identified that during Haiti Earthquake in 2010 there were two models applied for crowdsourcing VGI.

The first model for crowdsourcing VGI is supported by such platforms as Ushahidi. Its basic principle is gathering geotagged or geocoded data which crowds spatially tagged on satellite imagery (marked certain features on a map), or VGI provided by other communication media such as emails, text messages, Twitter or web forms and visualizing this data by placing those reports on the map, thus creating crowdsourced VGI data map or crowdmap (Liu 2014; Crowe, 2012; Ushahidi's Mission, n.d). In other words volunteer sends a message with a text or an image via various communication media, the messages are filtered and then put on the interactive map. The example in **Figure 1** shows a crowdmap that visualizes gathered reports about issues in streets of Southern Dublin. Red circles represent reports georeferenced to particular locations in the area and the number in the middle represents number of issued reports. Reports can be filtered according to categories and displayed on the map.

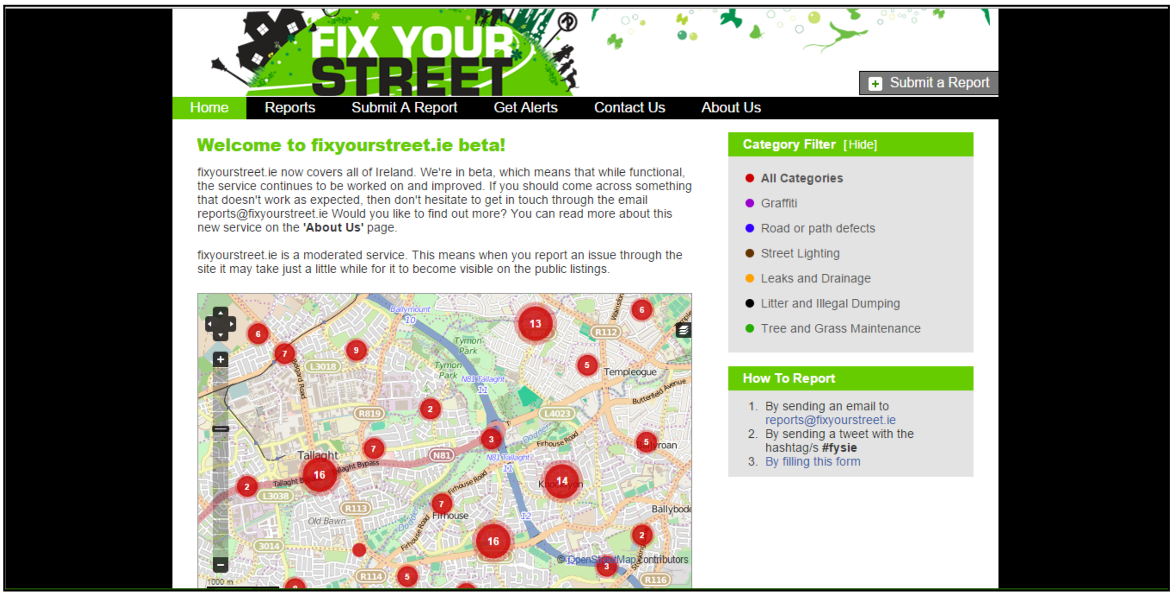

Figure 1 Screenshot of crowdmap supported by Ushahidi platform visualizing gathered reports about issues in streets of South Dublin, Ireland (Home: fixyourstreet.ie, 2015)

The second method is supported by platforms like OpenStreetMap (OSM). This platform takes a different approach towards mapping and gathering VGI. It applies the process of crowd-mapping. Volunteers use professional and/or participatory GIS systems and create maps by drawing, modifying or tracing geospatial features (Liu, 2014) by applying cartographic symbols. These symbols are visualisations of objects and can be expressed in points, lines, and areas, and these in turn can have graphical variables that can be categorized in six basic ways which they can differ:

- Size of the symbol (large to small point, thick or thin line)
- Colour value or lightness of the symbol (different shades of one colour)
- Texture of the symbol (dashed or undashed line, different dashing of the line)
- Colour hue of the symbol (different colours of the symbol)
- Orientation of the symbol
- Shape of the symbol (square point, round point) (Kraak and Omerling, 2010)

Example in **Figure 2** shows university campus at Lindholmen in Gothenburg, Sweden. It shows geospatial features such as roads, paths, buildings, grass areas, parking lots, trees etc.

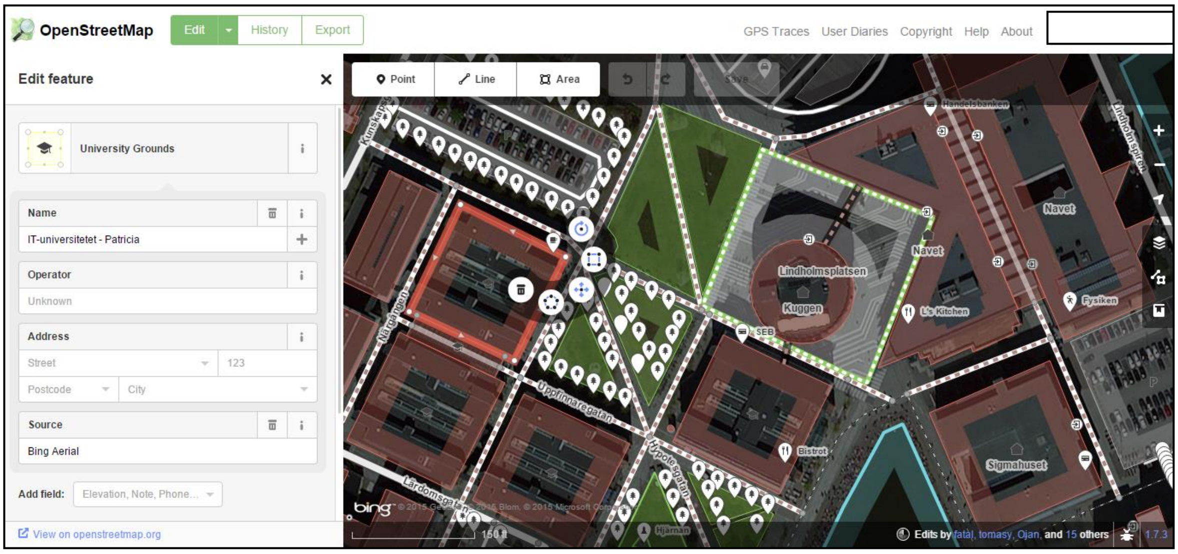

Figure 2 Screenshot of area of Lindholmen in Gothenburg, Sweden mapped using OpenStreetMap (OpenStreetMap, 2015) © OpenStreetMap contributors

When this type of gathering VGI is applied for crisis mapping, OSM Tasking Manager is used. A volunteer is provided with a list of projects. He/she picks one and is provided with an area which is identified as project with a unique number. This area is divided into smaller “tiles” (which would represent tasks). The volunteer then selects a tile and maps spatial features such as roads, houses, residential areas, waterways and other relevant information required by instructions and description of the project (Mirlesse, 2015). Example in **Figure 3** shows one of the crisis maps called project #964 which was created after the Cyclone Pam landed in Vanuatu Archipelago. As seen in the figure, the area of the archipelago is divided into smaller square tiles which represent tasks (green tiles are mapped and verified, yellow tiles are mapped but not yet verified, tiles having no colour are not mapped yet).

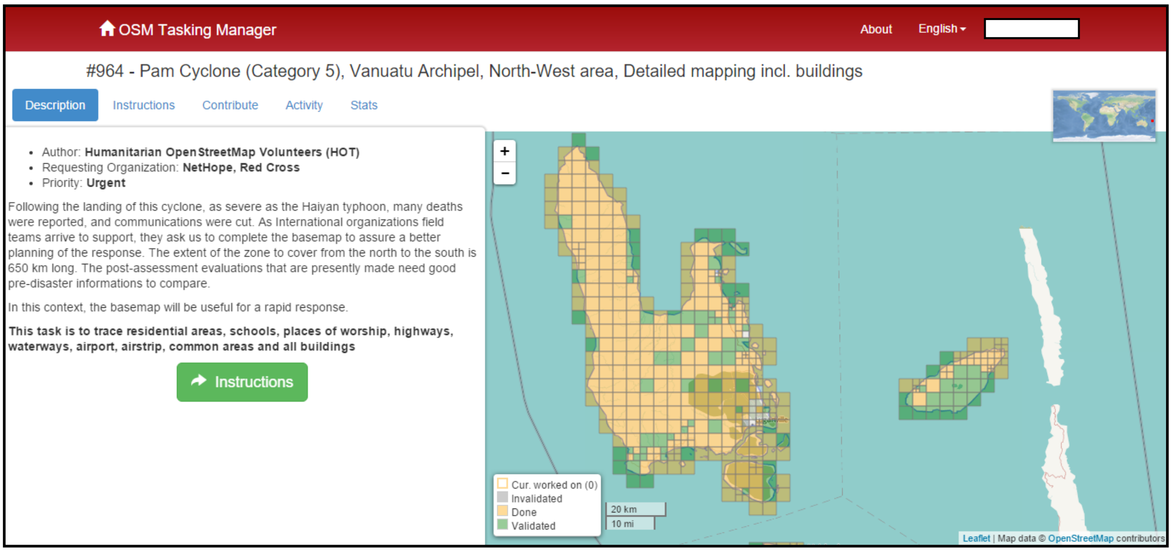

Figure 3 Screenshot of OSM Tasking Manager project #964 (#964 - Pam Cyclone (Category 5), Vanuatu Archipel, North-West area, Detailed mapping incl. buildings, 2015) © OpenStreetMap contributors

Both of the methods can be and are applied when crowdsourcing VGI. One of the most noted cases was Haiti Earthquake in 2010. Ushahidi Haiti Project processed up to 40000 reports that were gathered through variety of sources and 3548 events have been mapped in Haiti (Morrow et al., 2010). During one month (from January 12 to February 12 in 2010) nearly 600 individual contributors were found on OSM database (Soden and Palen, 2014) who, as analysis done in 2010 by Haklay (as cited in Soden and Palen, 2014) revealed, generated a map which had more details on road datasets then both UN and Google Maps regarding urban areas affected by the earthquake. During few weeks after the disaster those hundreds of volunteers made nearly 10000 edits in the region of Port-au-Prince and its surroundings (Soden and Palen, 2014; Zook et al., 2010).

3.4.Map Use and Map Communication Model

According to the International Cartographic Association a map is "a symbolized image of geographic reality representing selected features or characteristics" (1995, as cited in Orford, 2005, p. 189). There are two qualitatively different approaches to map use according to MacEachern:

- Cartographic Communication - according to this approach maps are used to communicate known facts or information to the public and are doing so in a non-interactive environment, thus it is important to communicate those facts in a clear, unambiguous way and the main goal of Cartographic Communication is to produce a single best map (Orford, 2005; Brodersen, 2001).
- Cartographic Visualization - this approach is relatively new and is still evolving. It views mapping as a private activity where a researcher/mapper reveals the unknown geographic facts in an interactive environment and the

emphasis here is put on the researcher/mapper and his/her personal ideas, preferences with the aim of discovering something new (Orford, 2005).

In order to produce a single best map, according to Cartographic Communication approach, keywords *clarity, accuracy, certainty* have to be applied in every step of the map production. Therefore, map production includes a lot of rules and regulations, starting from identifying purpose of the map and audience to gathering and filtering information etc. While Cartographic Communication approach requires a lot of rules (Orford, 2005; Brodersen, 2001), it as well puts a note, that the user of the map is a passive information receiver who is only enabled to read a published, usually paper, map, because of highly discouraged interaction. Therefore, a lot of emphasis as well is given on the cartographer's professional skills and abilities. On the other hand Cartographic Visualization emphasizes the interactivity of the map and thus both, the map maker and the map user, has more freedom since there are very few rules and procedures governing the process. Interactivity also allowed mapmaker to automatically update any relevant changes that he/she made. Cartographic Visualization was brought to a wide public by the developments of Web mapping platforms thus becoming Web Mapping 2.0. It as well blurred the line between map user and mapmaker as one can be both at the same time (Orford, 2005). It seems like these two approaches stand on two different if not completely opposite sides.

However, when it comes to mapping the area affected by natural disaster, or gathering VGI during disaster response, both of the approaches nearly converges. Since as mentioned, during disaster response there is a lot of uncertainty and situation can change rapidly, therefore producing one perfect map is not efficient if not impossible. This leads to the idea that approaching map use as Cartographic Visualization, which encourages interactive mapping and enables constant updates of changes in datasets, seems appropriate and efficient. On the other hand, approach towards map use as Cartographic Communication with the aim of communicating geographic information in a clear way is applicable as well, because *clarity*, *accuracy*, and *certainty* is relevant. This means that when it comes to crowdsourcing VGI during disaster response has to mediate between the two approaches and the media through which it is shared have to consider both sides if to be effective.

Map Communication Model is used to reveal the process of communicating spatial data via map. The simplest one provided by Kolacny (1969, as cited in Hoffmann, 2013) is still used as a basis, though it applies more to the Cartographic Communication approach towards map use as it identifies distinction between mapmaker and map user. Hoffman (2013) took this older model and altered it by identifying the now blurred line between the mapmaker and the map user and identified a new actor in the model which he called *prosumer* – the one who can produce and use the map (merging the two actors into one). It as well introduced new mapping technologies provided by the Web mapping platforms and application programming interfaces (API). In older model the professional cartographer (mapper) was the one who had knowledge and *power* in analysis and visualization methods as well as tools, symbols, base maps and presented this knowledge by using cartographic language to the map user. In the altered model provided by Hoffmann (2013), professional cartographer only provides the knowledge in form of components such as tools, or base maps. Non-professional mapmakers or a *prosumers* can choose and combine them in the manner of their own via Web mapping applications or APIs and design their own map. In other words, a non-professional *prosumer* describes information he/she sees as relevant by presenting the information on the base map, which is usually satellite imagery, in form of cartographic symbols (Hoffmann, 2013). Moreover, *prosumers* can as well provide with various multimedia such as videos or pictures and link them to the map. When other *prosumer* reads this map he/she can as well make changes regarding cartographical presentation or the data and create a feedback loop (Hoffmann, 2013), thus making map communication more active and interactive. Map communication model by applying Web 2.0 technologies is depicted in **Figure 4.**

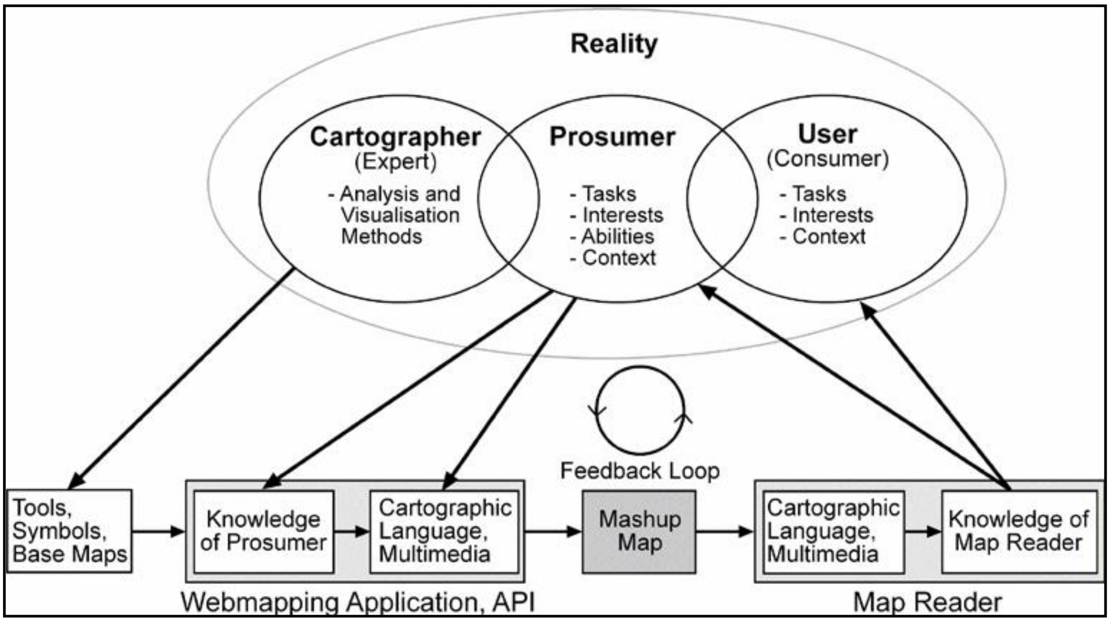

Figure 4 Cartographic Communication in Web 2.0 based on Kolacny model developed in 1969 (Hoffmann, 2013, p. 3 paragraph 3)

This model is applied when it comes to crowd-mapping (the second model of crowdsourcing the VGI) in disaster response and therefore the author of this research considers it useful for the further analysis. It also proves the previously made point that Web 2.0 changed the way the maps can be used.

3.5. Media Synchronicity Theory

Media Synchronicity Theory (MST) focuses on communication performance (Muhren et al., 2009) which "comes from the matching of media capabilities to the communication processes required to accomplish a task" (Dennis et al., 2008, p. 579). MST adapted media capabilities from Media Richness theory and these capabilities, according to MST should be examined in order to analyse whether they support two fundamental communication processes of conveyance and convergence across group functions of production, group well-being, and member support (the last two can also be named as social function) (Dennis et al., 1999; Dennis et al., 2008). Media capabilities are as follows:

- Transmission Velocity or Immediacy of Feedback - media's ability to support rapid feedback that is given between users

- Symbol Variety - number of formats in which information can be communicated that is supported by media
- Parallelism - number of effective simultaneous conversations that can exist
- Rehearsability - how much does media allow sender to rehearse or improve the message before sending it
- Reprocessability - how many times a message can be re-examined or processed during communication event

As mentioned, these media capabilities should support two communication processes:

- Conveyance - the goal of this process is to obtain and disseminate as much relevant information as possible from various information sources
- Convergence - the goal of this process is to agree or to have a shared meaning on obtained information which is generally smaller in quantity then during the conveyance process due to overlaps and similarities

Communication processes should be supported by the media in these group functions:

- Production function - here the level of familiarity with the task is the one that influence types of interactions and information necessary for the completion of the task
- Social function - here the level of familiarity between individuals is the factor that will influence types of interactions and information necessary to complete the task

The graphic summary of the theory with application of Shannon and Weaver classical model of communication (sender encodes message-message is transmitted via media-receiver decodes the message) is provided in **Figure 5**.

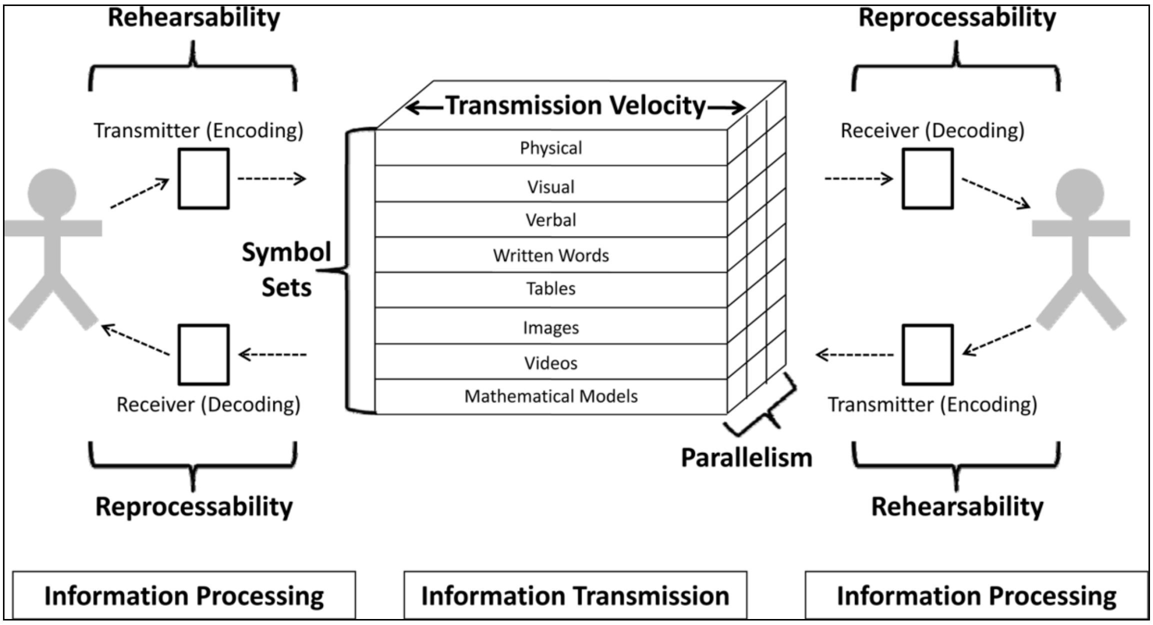

Figure 5 Communication process and media capabilities (Muhren et al., 2009, p. 378)

MST argues that depending on the level of familiarity a group has with the task and between the members themselves, and depending on the communication process, media capabilities should match and enhance the performance of communication. Therefore rather than trying to find the best medium for the task, theory seeks to match supporting media depending on the context of task and group (Dennis et al., 1999; Dennis et al., 2008; Muhren et al., 2009).

MST developed or in fact borrowed its media capabilities from Media Richness Theory and thus both provide with similar sets of them, however, MST theory was seen as more applicable and useful for this research. The aim is to evaluate desired media capabilities both in theory and practice, yet Media Richness Theory does not provide with much of flexibility and adaptation to different type of contexts not tasks. In addition it matches media to the task. The type of task, whether it is a task of uncertainty or task of equivocality, will be used as a form of background in analysis and evaluation of desired media capabilities, yet, the context of group familiarity and task familiarity plays a role when evaluating what communication processes should be supported in order to improve communication of VGI in disaster response.

3.6. Desired Media Capabilities when communicating VGI in Disaster Response

The first section of this chapter provided with the definition of crisis communication which stated that it is an ongoing process of transmitting messages (content X) among and between groups, communities, individuals and agencies (sender Y and recipient Z) using any available expression and media (W and Q) in the context of crisis (environment E) with a purpose of preparing, reducing, limiting and responding to threats and harm (purpose/function F). With the first three sections of this chapter it was attempted to identify and narrow down the variables provided by the definition in order to clarify and theoretically explain the scope and the problem of this research. The variables are defined and summarized in the **Table 1**. In order to reflect two different models of crowdsourcing VGI, two of the variables in the table, expression W and media Q, are presented separately.

Content X	Geographic information or data	
Sender Y	Volunteers, citizens, peers who are inside or outside of the disaster area	
Recipient Z	Other volunteers or citizens, volunteer organizations and teams who are working inside and outside the disaster area	
Expression W	Verbal text messages, pictures, video	Messages created by applying cartographic symbols (in form of maps)
Media Q	E-mail, short message service (SMS) text, multimedia message service (MMS) text, web form, Social Media or Microblogging platforms such as Twitter, Web mapping platforms	Web mapping platforms
Environment E	Disaster response	
Purpose/function F	Increase situation awareness regarding disaster area and help in supporting spatial decision making	

Table 1 Summary of variables for crisis communication definition

It can be stated that the purpose/function F named in the **Table 1** is a task of uncertainty. There is little known about the disaster area, therefore no decisions can be made. In order to solve this problem it is important to gather as much relevant information as possible and for this research the focus is put on the geographic information. Since gathering this information requires rather rapid speed and human resources, which are usually lacking during disaster events, the problem of gathering this information and mapping areas is solved by using the crowdsourcing process as supportive process to acquire relevant geographic information. Crowd as a newly formed group of undefined number of participants and undefined relations voluntarily takes the task, gathers, and sends relevant information using one of the two crowdsourcing VGI models. For this research only the second model of crowdsourcing VGI is analysed. This means that volunteers apply the process of crowd-mapping, sending a message encoded in cartographic symbols via web-mapping platforms.

By stating that the crowd is a newly formed group, we are discussing one of the elements that affects desired media capabilities. Media capabilities should support communication processes of conveyance and convergence happening in production function and social function. Familiarity with the group is closely related and affects the social function, which refers to activities that support group well-being and individual development (Dennis et al., 1999; Dennis et al., 2008). Since the task is done by the crowd, senders and receivers as a volunteer group can have none to limited familiarity with other group members. However, as noted by Pan et al., (2012) who wrote an article on “Crisis Response Information Networks”, “in crisis situation, there is no time for the time-consuming process of developing and nurturing close ties; rather responders must draw upon their existing ties but also quickly establish new ones" (p. 33). Even though the authors were applying this statement to the organizational context of disaster response it still makes sense in applying it to the context of this research. As information is required to be gathered fast, there is no time to get to know each other and create strong bonds. Even though, the social function has undeniable value, when it comes to the context of disaster response, this function serves as rather secondary goal or is not a goal at all. This means that media capabilities (immediacy of feedback, symbol variety, parallelism, rehearsability, reprocessability) should be low or very low when supporting communication processes for social function since the main goal is gathering and sharing VGI. Because social function is not a primary goal, this research will not focus on analysing media's capabilities to support it. To avoid any further confusion media capabilities will be evaluated as how they support production function only.

The production function is related to task familiarity and is affected by how well the members of the group know the task and every steps, processes and technicalities that apply to accomplish it (Dennis et al., 1999; Dennis et al., 2008). If the group takes the task that it is not familiar with, it will spend time on converging which steps, processes and technicalities are needed. Only after a group created a shared meaning and agreed on how the task should be completed, it can move to the execution function – exchange information and convey it to complete the task. Because the problem of situation awareness is solved by partially employing the crowd as a volunteer group, it has to have direct instructions on how the task should be done. This would decrease the time a member of this volunteer group spends in order to understand what and how has to be done. It would also decrease the need from the group member to seek information from other group members. If the volunteer group sometimes has hundreds or thousands of members, this would create mayhem if the task is ill defined. Another important note related to task familiarity is how much of experience does a volunteer have when gathering and sharing information via specific media and how well does he/she know how to create the message. This would require some differences regarding clarity of the instructions provided. However, the conveyance process in production function becomes the main and the most important one when solving the task, as this is the main process through which the VGI is exchanged.

In order to continue with the research and examine performance of the media used to communicate VGI, as stated by Dennis et al. (1999) "the first step is to examine the ability of the media to support the two communication processes across the group functions" as this would mean to define what capabilities would suit best in the described context. By applying this described context of task and group familiarity the desired media capabilities of immediacy of feedback, symbol variety, parallelism, rehearsability, reprocessability, that should support communication processes in group function of production, since as mentioned before the social function is not the primary focus when the data has to be gathered fast. Media capabilities will be defined and summarized in **Table 2**. Argumentation for the evaluation is provided bellow the table.

Media Capabilities		*Conveyance*	*Convergence*
Immediacy of Feedback	*Production function*	Low – Medium	Low
Symbol Variety		Low - High	Low - High
Parallelism		Low-High	High
Reprocessability		High	High
Rehearsability		High	Medium - High

Table 2 Desired media capabilities for sending VGI in disaster response

Argumentation:

- Group can take upon tasks that require different period of time for accomplishing them. Some of them have to be done in a few days, some, which are not as urgent, can take longer time (weeks, months). Thus the ***immediacy of feedback*** might depend on the task urgency. Immediate feedback can help to correct inaccurate messages. However, it should not be too high, because it would mean that it would require senders and recipients to communicate on agreed time (synchronous interaction in massive VGI crowdsourcing is hard to achieve) and create expectations for rapid feedback which might impair the communication performance (Dennis et al., 1999).
- Since the group is, or at least, should be familiar with the task, therefore the ***immediacy of feedback*** for convergence process should be low. There is no need to agree on how the task should be done anymore. However, instructions and information that is needed for the mappers has to be provided in order for them to know how the task should be done as well as to provide with some directions on where to ask for more information regarding the task.
- Different media and different model used to generate the crowdmap might require different ***symbol variety***. The second model for crowdsourcing VGI is a little more complex since it uses cartographic symbols. The instructions of the task defines how many symbols should be used to map the area. Still since applying this model there is only one mean of expression, symbol variety can be considered as low, yet from cartographic perspective it should be medium to high in order to convey required information efficiently.
- For convergence process, ***symbol variety*** again depends on how experienced the mapper is and therefore how much information does he/she need in order to understand the task and the goals. Experienced mapper might require less symbol variety when task is explained, but beginner might need more and also require additional media which would support convergence process for understanding the task.

- If ***Parallelism*** for conveyance process is too high it might be difficult to handle many conversations happening at the same time, thus it should be low to medium.
- For convergence process ***parallelism*** should be high. Even though there is no discussion going on about how to accomplish the task it is important that volunteers would have the access on the task description all at the same time.
- ***Reprocessability*** for conveyance of information should be high. It is important that recipient of the message should be able to analyse the message and validate the accuracy and quality of the information.
- For the convergence ***reprocessability*** as well should be high. Volunteers should always have the ability to look at task description and any additional information more than once.
- ***Rehearsability*** should be high for conveyance process. Message should be created with caution to send the correct and as accurate information as possible. For this it needs the media which would enable to have time and means to correct the mistakes in the message.
- Since there is no need to discuss on how the task should be done, it does not require high ***rehearsability*** (it basically does not require one at all). However, if there is still a need to ask and converge the task again, it seems better to have a higher rehearsability in order to craft message and ask exactly what is needed or to answer exactly what is asked. Low rehearsability of message might lead to misunderstood message and would create more questions.

4. RESEARCH DESIGN

4.1. Research Methods

The approach used in order to conduct this research is a case study. Case study as defined by Blatter (2008) "is a research approach in which one or few instances of a phenomenon are studied in depth" (p. 68) and Stake (1994) stated that "case study is not a methodological choice, but a choice of object to be studied" (p. 236). Because case study is not restricted to the social science research, but is rather used in many practical contexts, there are no basic characteristics for it. Therefore its use can vary from that of a tool to a pedagogical strategy (Blatter, 2008). Stake (1994) defined three types of case studies – intrinsic, instrumental, and collective - depending on the purpose it serves for the researcher. Regarding this research, the type of a case study applied is an Instrumental Case Study. Instrumental Case Study is defined as "the study of a case to provide insight into a particular issue, redraw generalizations, or build a theory" (Grandy, 2010) and the case itself "is of secondary interest; it plays a supportive role, facilitating our understanding of something else" (Stake, 1994, p. 237).

Case Study is seen as an applicable approach for this research since the research focuses on specific conditions the communication is taking place which is disaster response. In order to study the media other approaches might seem probable, however, because this specific context plays a very important role in this analysis, case study is preferred. On the other hand, case itself in this study is only used as tool or instrument and is not of primary concern. The primary concern here is how the media performed in context of disaster response, thus the type of Instrumental Case Study is applied.

Instrumental Case Study is applied to already existing theories that are described. If defining the logical approach applied for this research it would closely relate with the deductive one, since deductive approaches have tendencies to define which data is relevant and has to be collected according to the previously defined theories and concepts (Vogt et al., 2014)

This research is conducted by taking Nepal Earthquake in 2015 April and May as an Instrumental Case Study and the media which used to crowdsource and transmit the VGI is OSM. The case and the media together with arguments of selection will be defined in following sections 4.1.1.

4.1.1. Nepal Earthquake, 2015 April and May, and OSM

On 25th of April in 2015 Nepal was struck by an earthquake reaching magnitude 7.8 and on 12th of May it was followed by an aftershock reaching magnitude 7.3. Epicentre of initial earthquake was located in the mountains to the northwest of Nepal capital city Kathmandu. It was also followed by aftershocks around the city itself. The May 12th earthquake's epicentre was located to the northeast of Kathmandu, towards Mount Everest (2015 Nepal Earthquake, 2015; OCHA, 2015). The Government of Nepal reported a total of 505745 houses destroyed, 279330 damaged by both the initial earthquake and the aftershock. The earthquakes killed 8702 people, injured thousands, and left around 2,8 million in need of humanitarian assistance. 864000 who lost their home are living bellow poverty line in hard to reach areas are of top priority. While some of the people were killed or injured by shockwave, earthquakes trigered lots of landslides and avalanches. Avalanche caused by an earthquake trapped people near base camp of

Mount Everest and its slopes (Beaumont, 2015), massive landslide completely wiped off the valley of Langtang with almost 400 inhabitants (Cadwalladr, 2015) other massive landslide blocked the Kali Gandaki river and people around the area were evacuated because of risk of floods (Burke and Rauniyar, 2015). These are just a few examples of the effects the earthquake had.

Humanitarian organizations and armed forces reacted quickly and worked together in response operations. However, response efforts were challenged because of remote locations, very difficult terrain, many roads were covered with debris. It slows down the relief efforts when it is hard to navigate effectively (Jain, 2015). The capital city Kathmandu was rather well mapped even before the earthquake because of initiative of the OSM community, people involved in Humanitarian OpenStreetMap Team (HOT) and leading Nepalese partner Kathmandu Living Labs who have been digitally mapping the city in order to be prepared for extreme situations. Still, other parts of Nepal were lacking detailed maps. OSM Tasking Manager was deployed. Affected areas were identified, and OSM Tasking Manager was commanded to split those identified areas into tiles (Mallonee, 2015). Since Haiti Earthquake in 2010, HOT team has refined the process of mapping and the OSM tools. By splitting up area into grids OSM Tasking Manager enables people to work in a way that there would be no overlapping (one person maps one grid) (Clark, 2015). The result – in almost two days 4534 volunteers located over 21000 kilometres of roads and over 110000 houses, tagged over 3128 damaged buildings, 1191 damaged roads, analysed 14700 km 2 worth of imagery and the project itself is still continuing (Clark, 2015; Parker, 2015). Impending monsoon rains are expected to further isolate remote villages, some of the resources are getting scarce (OCHA, 2015) and there is still a strong need to locate temporary settlements, roads and other relevant geographic information.

This case study was chosen as one of the most recent major disasters where OSM Tasking Manager was used as media to gather VGI. Moreover, OSM went through a lot of improvements after the year of 2010 and thus using this web mapping platform is becoming a more common practice in disaster response. The main focus on disaster response is put on mapping the areas affected by disaster. There is another project going related to Nepal earthquake which aims to map the area affected by Kali Gandaki river landslide, however, it is more focused on risk assessment, and thus will not be discussed in this research.

4.2. Data Gathering and Analysis

4.2.1. Document Analysis

Data was gathered by applying two methods: document analysis and usability inspection. Document analysis as stated by Bowen (2009) “is a systematic procedure for reviewing or evaluating documents—both printed and electronic (computer-based and Internet-transmitted) material” (p. 27). Documents are texts or images that have been recorded, without researcher’s intervention and take variety of forms, starting from advertisements, attendance registers, minutes of meetings, manuals, diaries and journals, letters, maps and charts, and other forms (Bowen, 2009). Obtaining information from the web site, which in this research is the case, is viewed as a data collection method as well (Marshall and Rossman, 2006). There are five specific functions of documentary material: they can provide background and context, additional questions to be asked, serve as supplementary data, serve as means of tracking change, serve as verification of findings from other sources; and in addition documents is the most effective mean of gathering data when events can no longer be observed (Bowen, 2009). For this research document analysis had a function of serving as supplementary data. There are several advantages of this data collection method which motivated author of this paper to use it (advantages named by Bowen (2009)):

- It is an efficient method, because document analysis is less time consuming and because it requires more of data selection rather than collection
- Many documents are publically available, and are obtainable without author's permission, especially since the advent of the Internet
- Documents are not affected by the research process and are stable, researcher's presence does not alter the object of study

For this research, data was gathered through OSM Tasking Manager. 5 Archived projects (#994, #995, #1003, #1006, and #1023) were selected from OSM Tasking Manager project database. There are ongoing mapping projects for Nepal Earthquake disaster response, however, since the information is still constantly changing they cannot be used for document analysis method. Because archived maps do not appear on the project list they are not active and therefore VGI data gathered is more stable, not edited, which seems suitable document for the research.

Four tasks (tiles) were selected from each of the project (if possible two marked as done and two marked as validated). There are several useful data sets. Each of the task (tile) provides with the list of users who selected it and the time the user locked and unlocked it. This means it provides with chronological order of edits and contributions. Another important data for this research was to know how many of the users sent the message containing VGI (contributed) per one task in the project. In order to view this information, OSM Tasking Manager enables to view the profile of the user and the list of the projects he/she has participated and changesets he/she made. If the user send message containing VGI the project number appears in the list of projects that user has contributed. By selecting option of "review the work", OSM Tasking Manager provides with possibility to view the content of the messages in form of cartographic symbols. Gathered data is presented in the **Appendix 1**.

As noted by Bowen (2009), "document analysis is often used in combination with other qualitative research methods as a means of triangulation" (p. 28). This statement claims that it is necessary to use more than one data source and/or method in order for the study to be credible (Bowen, 2009). Document analysis did not provide with information on media capabilities of parallelism and rehearsability, raised more questions and was only able to serve as supplementary data. It is therefore another data gathering method was used for the research to be complete and answer the research question.

4.2.2. Usability Inspection

Another method used in this research was a form of usability inspection. This research method is used to evaluate the user interfaces (Nielsen, 1995). Usability inspection relies on expert reviews or analysis of interfaces and does not require to observe actual users empirically (Hollingsed and Novik, 2007). The method is usually applied to detect problems in a design, however, it can address other issues such as the severity of usability problems, or the general usability of an entire design (Nielsen, 1995). This method was applicable for this research and was chosen over other methods for these reasons:

1. Observation seemed as improbable for this research. The research was conducted 3 months after the Earthquake in Nepal. Observation often requires active interaction, however, this is hardly achievable during the time when the research was conducted. It also seems more suitable for the analysis of social settings and as mentioned in the previous chapter, social function should not be a primary goal of the task, therefore observation loses its applicability.
2. The method of document analysis did not provide with the information on how the message itself is created, how a sender encodes the message in cartographic symbols, what are the abilities to rehearse the message before sending it. This can hardly be answered with observation (of any type) as well. The researcher would have to experience the same conditions as users and immerse herself in the group, however, since the only participant a researcher can observe is herself, it cannot be called observation.
3. Usability investigation provides with required data, and it is more ethical then covert observation or researcher's participation. It enables to examine what steps the mapper has to take in order to complete the task, how long does it take and other relevant information, without the obstruction of work.

There are 4 methods to conduct usability inspection: the heuristic evaluation, the cognitive walkthrough, the pluralistic walkthrough, and formal inspections (Nielsen, 1995; Hollingsed and Novik, 2007). For this research the cognitive walkthrough was selected as a suitable method for data gathering. Cognitive walkthrough is a more detailed procedure which simulates the user's, or in this case mapper's, "problem solving process at each step through the dialogue, checking if the simulated user's goals and memory content can be assumed to lead to the next correct action" (Nielsen, 1995, p. 377). A cognitive walkthrough is completed in two phases. The preparatory phase requires the researchers (experimenters) to determine which interface will be used, users, tasks to be completed and actions to be taken (Hollingsed and Novik, 2007). All of these were determined by the aim of this research. Users use interface of OSM Tasking Manager and OSM web mapping platform, users are volunteers, the task is to create messages containing VGI and the actions taken are identifying objects on satellite imagery and drawing cartographic symbols which represent those objects to create the message. The second phase is analysis and the evaluation happens by working through the four steps of human computer interaction:

1. The user sets a goal to be completed within the system
2. The user determines the currently available actions
3. The user selects the action that they think will take them closer to their goal
4. The user performs the action and evaluates the feedback given by the system (Hollingsed and Novik, 2007, p. 2).

The slightly adapted to communication field and moderated form of cognitive walkthrough was used in order to gather the data. Its purpose was to review only specific parts of the user interface not the whole platform. Author of this thesis focused only on the process of how a mapper select's the project, the task, and starts contributing, by paying attention whether he/she was disturbed by other mappers and their feedback, how many symbols is he/she provided as tools to draw and thus create message, what were other steps and problems user might encounter while mapping.

In order to conduct the cognitive walkthrough, an ongoing project was selected. The author selected the project #1090 – Nepal Earthquake, 2015, (Additional affected districts). The author then chose four tasks (tiles) for inspection - #156, #157, #158, and #197. Author set a goal to map the necessary information as it was written in instructions of the task. After the task (tile) was chosen the author used the tools provided by OSM mapping platform and created a message containing VGI data, saved the changes and sent the message (uploaded changes). The changes appeared in OSM Tasking Manager. Since there were four tiles, the actions were repeated four times, to get an insight of what volunteer mapper might experience when using the OSM mapping platform tools. While performing the task and doing inspection the author paid attention to the time it takes to create the message, task description and clarity. The author also evaluated the symbol variety offered in form of tools by OSM mapping platform.

4.2.3. Data Analysis

Both data gathering methods provided with useful data sets which were combined and analysed. For evaluation of some of media capabilities the comparison table from Dennis et al., article on "Media, Tasks, and Communication Processes: A Theory of Media Synchronicity" (2008, p., 589) was used (**Figure 6**).

	Transmission Velocity	Parallelism	Symbol Variety	Rehearsability	Reprocessability
Face-to-face	High	Medium	Low-High	Low	Low
Video Conference	High	Medium	Low-Medium	Low	Low
Telephone Conference	High	Low	Low	Low	Low
Synchronous Instant Messaging	Medium-High	Low-Medium	Low-Medium	Medium	Medium
Synchronous Electronic Conferencing	Medium-High	High	Low-Medium	Medium	Medium
Asynchronous Electronic Conferencing	Low-Medium	High	Low-Medium	High	High
Asynchronous Electronic Mail	Low-Medium	High	Low-Medium	High	High
Voice Mail	Low-Medium	Low	Low	Low-Medium	High
Fax	Low-Medium	Low	Low-Medium	High	High
Documents	Low	High	Low-Medium	High	High

Table 3 Comparison of Selected Media and Their Capabilities (Dennis et al., 2008, p 589)

In order to measure the time interval between the messages containing VGI and measure the immediacy of feedback, data gathered through document analysis provided with useful information. Document analysis provided with chronological order of users locking and unlocking the tiles. Each mapper who locked and unlocked the tile was checked whether he/she made any contribution to the task or not. Contributors were identified and the time between each contributor was measured. This time was evaluated as low, medium or high in comparison with the time and scale provided by Dennis et al. (2008, p., 589) where face-to-face is evaluated as high immediacy (feedback can be given in seconds) and asynchronous electronic conferencing as low to medium (feedback can be given after hours or even days). For convergence process, the author viewed comments left by the contributors and analysed message content searching for any question or feedback regarding familiarity with the task or instructions and if any feedback regarding that message was given. Comments as well are registered in chronological order and time evaluation is available. Thus the time between messages regarding instructions was measured and evaluated by applying same time comparison (face-to-face being high immediacy, asynchronous electronic conferencing being low to medium)

To evaluate symbol variety for conveyance process it was relevant to view the cartographic symbol variety of the message, since the message is coded only by using cartographic symbols, not by text or images. In order to evaluate the variety the table from Dennis et al., article cannot be used, since it considers combinations of text, graphs, or images. Map in this research is not considered as an image and the symbols in the map is what is of concern. Thus the symbol variety was evaluated from data gathered through cognitive walkthrough by measuring how many options a mapper is provided with[1]. It was also relevant to consider how many symbols a mapper is asked to use in order to map a tile, therefore the content of instructions was also analysed. Symbol variety would be considered as high if it enables to draw symbols with their varieties (for example if a line can be changed in colour and size, area can be coloured, point can vary in size, shape etc.). For convergence process, the content analysis of instructions was used to evaluate this media capability. The symbol variety was evaluated by investigating how many different forms of expression were used in order to communicate the steps one has to make in order to complete the task. Links were not considered, since they redirect to other webpage which has different set of media capabilities. If the instructions are given only by using one expression, such as text, it will be considered as low (as for example in telephone conference where only one expression can be used – voice) and medium or high if it incorporates several expressions, such as pictures, graphs, text, video.

In order to evaluate parallelism in conveyance function data gathered through cognitive walkthrough was used. It was viewed what happens once the tile is locked, whether mapper can choose other tiles in the same or any other project. If this function is enabled it might be viewed as existing parallelism and then it was measured how many of these “conversations” can be held. Evaluating on how many projects can a mapper work at the same time or on how many tiles also provides with data regarding parallelism for convergence function. It was evaluated if many mappers can view the same instructions at the same time. Parallelism would be considered as high if more than one “conversation” can be held while mapping, same as in asynchronous electronic mail or

[1] Only OSM web mapping tool was analysed. JOSM is a more complex tool not used by beginner mappers, therefore not relevant for this research.

conferencing, and it would be considered as low as in telephone conference if only one "conversation" (only one tile can be edited) can be maintained efficiently and not limited by the media.

In order to evaluate reprocessability it was first considered to view data gathered from cognitive walkthrough. It was evaluated what happens to the message content once it is taken to be edited (once a mapper decides to make the contributions to the task). Since data showed that once edits are done the message is altered and the previous message cannot be viewed, it was decided to measure how long does it take before another mapper takes the task to map, thus when the feedback is given. After time was measured, reprocessability was evaluated by using the comparison table with face-to-face being low reprocessability (if the message is not recorded it is lost and cannot be reprocessed the same way) and asynchronous electronic mail being high (a message in the electronic mail can be viewed several times). Reprocessability for convergence process was evaluated by measuring how many times a mapper can review the instructions and the comments left regarding the instructions.

Finally the last media capability of rehearsability was evaluated by applying the comparison table after data from cognitive walkthrough was gathered. It was measured how much time is given in order to create a message and how many times one symbol can be edited or if it is even allowed. For convergence function it was considered that since comments are allowed when the mapping is done they might be used to send messages regarding task instructions, and thus it was measured how many times a mapper can edit the message and how much time it is given to construct the message. Rehearsability would be considered low if message has to be constructed immediately as in for example face-to-face conversation and it would be considered as high if a message can be constructed and reconstructed or edited as in for example asynchronous electronic conferencing.

4.3. Ethical and Legal Considerations

There were ethical and legal considerations the author had to be aware of when conducting this research. Regarding legal considerations of publishing and using data from OSM and OSM Tasking Manager, OpenStreetMap is an open data, licensed under the Open Data Commons Open Database License (ODbL) by the OpenStreetMap Foundation (OSMF). Under this license, the author was free to copy, distribute, transmit and adapt the data as long as OSM and its contributors are credited. Any data used for this research is marked and credited with "© OpenStreetMap contributors". All the data was gathered under ODbL licence. More information regarding licences are provided in openstreetmap.org and opendatacommons.org.

This research provides with cartography and screenshots of maps. Cartography in map tiles and documentation are licensed under the Creative Commons Attribution-ShareAlike 2.0 license (CC BY-SA). Under this licence author was allowed to: share - copy and redistribute the material in any medium or format, and adapt - remix, transform, and build upon the material for any purpose. No copies of maps under limited license were provided in this paper. All the data was gathered under CC BY-SA licence. More information regarding licences are provided in creativecommons.org.

During this research author did not interrupt any of the activities of the system. Moreover, regarding ethical considerations, no name, surname or pseudonym was used when presenting the data.

4.4. Validity and Reliability

As noted by Brink (1993) “validity and reliability are key aspects of all research” (p. 35) and attention to these aspects of research can assure the trustworthiness and credibility of the findings. Validity refers to the accuracy and truthfulness of the findings and a valid study should demonstrate the reality, what actually exists and what is measured should be measured with a valid instrument. Although there is a disagreement among researchers regarding its applicability in qualitative research, at the same time they realise that there is a need to check the quality and measure the research that is done (Brink, 1993; Golafshani, 2003). As defined by Sellitz (1976, as cited in Brink 1993) “reliability is concerned with the consistency, stability and repeatability of the informant’s accounts as well as the investigators’ ability to collect and record information accurately” (p. 35). Reliability of research depends on consistency, repeatability, and context dependency of the data collection, interpretation and/or analysis (Miller, 2008). Validity and reliability can be affected by errors, which can be categorized in those done by the researcher, by the subjects participating in the project, determined by situation or social context, or done as a result of data collection and analysis (Brink, 1993).

In order to assure validity and reliability of the research, the author evaluated the risk and took strategies to ensure it. Providing negative case analysis, as for example by theoretically evaluating desired media capabilities, author exemplified what would happen in the opposite case (if media capability would be high instead of low), this is provided in argumentation and as well was discussed after the results are evaluated and interpreted in discussion section. In order to assure that results are valid and reliable more than one project and more than one tile in the project was selected in the same case of Nepal Earthquake in 2015 as well as in the same context (disaster response, not risk assessment). Four of the projects were chosen from archived project list for document analysis so that the results would be gathered in same conditions. By applying cognitive walkthrough in an active project it was reflected on data gathered through document analysis and the triangulation method was applied to understand the previously gathered data. The author was assured that the same conditions applied to the archived projects from analysing the content of project description. Lastly, author provided with the detailed descriptions on how data was analysed.

4.5. Limitations of Research

There are few limitations that the author of this research can identify:

- As it is often mentioned in the literature, each case of crisis or in this case disaster, has different underlying circumstances, causes and effects, thus each case is unique. Still each of them can bring the new insights and provide with the new set information, which can be valuable for the future.
- Topics of crowdsourcing, VGI and OSM are rather new and all of them can be dated to the year of 2004-2007 with relevant dates being: 2004 the term

Web 2.0 was introduced by O'Reilly (Kaplan and Haenlein, 2010) and *OpenStreetMap* launches (Haklay and Weber, 2008); 2005 Google launched *Google Maps* (Haklay et al., 2008); 2006 the term of *crowdsourcing* was introduced by Howe (Mazzola and Distefano, 2010); 2007 the definition of Volunteered Geographic Information is introduced by Goodchild (Goodchild, 2007). Therefore, the field might be lacking relevant theories. Quite often the author of the research found that definitions and concepts were confusing or not fully analysed, understood or interpreted and used in various contexts and approaches.

- Author of this study also took into consideration some of the limitations of data gathering techniques, such as document analysis might provide with insufficient detail (since documents are produced for other purpose than research and therefore might lack some important details), sometimes document retrievability can be difficult and thus the access to them later might be blocked or it can be hard to access.
- Even though it was the first experience for the author to use OSM tools and OSM Tasking Manager while conducting a cognitive walkthrough, and author of this study took the steps and tasks of a beginner mapper, the author is an experienced mapper who used GIS software before and thus it could have impaired the cognitive learning curve (it might have shortened the time author took to learn how to use the OSM tools).
- The author of this research analysed only one media. A more systematic approach towards analysis of OSM Tasking Manager could provide with deeper knowledge on communication patterns and processes supported by this media in disaster response context.

5. RESULTS

5.1. General Communication Patterns in OSM Tasking Manager

The data that was gathered provided with an insight to general communication patterns in OSM Tasking Manager. When the volunteer decides to contribute and map the area, he/she selects a project provided from the list at OSM Tasking Manager and a tile. He/She can choose the tile by either clicking the button "Select a task at random" or select the tile by him/herself.

Even though the tiles are colour coded (marked as "done", done and "validated" or "invalidated"), this does not prohibit a volunteer from taking those tasks even though they might be already validated. The volunteer can still contribute. However, when the tile is circled in orange (marked as "currently worked on") the volunteer mapper is prohibited from accessing them. When a volunteer mapper decides to contribute to the tile (either presses the "start mapping" button or "review the work" button) it locks so that other volunteer mapper would not get access to it. This means that only one contributor can map one tile, and this prohibits from two volunteer mappers overlapping with their messages. However, there might be more than one tile that can be locked at the same time and thus it enables many users contribute to the same project at the same time.

The number of contributors who have send messages per project can vary from average 40 to 600 and contributors per tile can vary from 1 to 13. Data showed how many mappers locked the tile and attempted to contribute with the information. Yet, it does not mean that all 13 mappers have actually contributed and send a message which contained VGI. Data shows that a user might lock the tile but have not send any changeset and therefore have not contributed. The actual number of mappers who send a message containing VGI varies in average 1-3, the most usual is two contributors.

In order to map the area, volunteer has to be registered on OSM webpage, only then he/she will be able to contribute. When a volunteer selects a tile he/she locks it and is provided with 120 minutes (2 hours) to map the area. He then selects an "editor" application that will enable to create message. Depending on a task it can either be OSM web mapping platform, or it can be JOSM (a desktop application for OSM written in Java programing language). Both provide with specific tools to create a message, however, JOSM is more complex and not advised to be used by beginner mappers.

How long does it take to map the area depends on difficulty of the area and the task itself (what information does it require). For example if it is only necessary to map some specific features such as places for a helicopter to land as in project #1023 it might be easier and faster, since a mapper is searching for very particular feature (a flat terrain for helicopter), or if the tile only consists of forests and only few roads or rivers, very few buildings (again depending on what does a task require to map), as for example tile #157 in project #1090, it might take only a few minutes. It can as well be affected by cloud coverage when it is even hard or impossible to see features on the map as for example tile #6 in project #1023, where mapper put a comment "*Cloud cover over any potential helipads*". If a project requires to provide with rather lots of information, as for example project #1090, where the mappers are asked to search and map 4 different features (roads, waterways, buildings and residential areas) by using 13 symbols (different symbolic value for each type of road, as for example differentiate highway or path) and the terrain is complex, has a lot of information it might take all the time provided (120 minutes) and the message would still be unfinished. OSM Tasking Manager allows a function to split a very difficult tile into several more for these kind of areas. Author of the work encounter 3 such tiles: #156, #158, and #197 in project #1090.

After the message is created it is saved and then uploaded in OSM Tasking Manager. A mapper unlocks the tile and if he/she feels that there is no other information relevant to be encoded the tile might be marked as done. Other contributors and more experienced mappers evaluate the tile and either approves the message or disapproves and states what is missing in the message, thus providing with a verbal feedback on OSM Tasking Manager. Another way to view the feedback is by applying Map Communication Model adapted for Web 2.0 which states that a mapper creates a message and sends it, then another mapper reviews the information and can further edit it, which is counted as feedback loop. OSM Tasking Manager is a good example of feedback where Map Communication Model describes how messages are transmitted and how feedback works. Thus marking tile as validated or invalidated, adding additional edits is considered as feedback in this research.

Regarding the task familiarity, there are instructions and description of the project provided. It also has additional links to more information, as for example road network (how roads appear in satellite imagery) in Nepal, how it looks and how it should be tagged (different tag means different symbol value). The instructions might as well have pictures and links to videos. As for example project #1023, where a picture of Helipad is shown, or project #1090 that has additional link to youtube.com where the video is used for clarification of how to map a tile.

5.2.Media capabilities

After the description of general communication patterns was provided, media capabilities for conveyance and convergence processes in production function can now be evaluated. Evaluation is provided in the **Table 4**. Following subsections present results in more detail.

		OSM Tasking Manager	
Media Capabilities		*Conveyance*	*Convergence*
Immediacy of Feedback	*Production function*	Very Low - Low	Very Low
Symbol Variety		High	Medium
Parallelism		Low	High
Reprocessability		Medium - High	High
Rehearsability		Medium - High	High

Table 4 Evaluation of media capabilities of OSM Tasking Manager

5.2.1. Immediacy of Feedback

Regarding conveyance process, as noted previously in this research, the feedback is provided either by another contribution, or by validation/invalidation of messages that are marked as “done”.

From the selected samples of projects and tiles the immediacy of feedback can vary from 40 minutes, to 14 days or no feedback at all. The tasks (tiles) that appeared to have the most active exchange of messages (feedback loops) were from projects #994, #995, #1103, and #1006. All of these projects were suited for all levels of mappers, which means there were greater amount of volunteers. Here feedback speed varied from round 40 minutes to round 14 hours (in all types of feedback, contribution, marking task as done and validation). The project #1023 differed from the others as it was suited only for very experienced mappers and did not tolerate any mistakes made. Here the immediacy of feedback varied from 1 to 14 days.

For convergence process in production function, the comments section might be found useful for volunteers, if they find something hard to understand. However, in instructions it is noted if any questions arise regarding project to send an email (email address provided). Thus there were no messages regarding how to participate in a project or which steps to take to complete tasks comments section (or at least not in the tiles selected).

Evaluating the feedback it could be said that it ranges from low to very low (if the highest is immediacy of feedback is in face-to-face communication or telephone conversation, (Dennis et al., 1999; Dennis et al., 2008).

5.2.2. Symbol Variety

The messages containing VGI are only encoded in cartographic symbols. An example of message content is shown in **Figure 7** and **Figure**

Figure 6 Message content over satellite imagery, project #994, tile #580 (OpenStreetMap, 2015) © OpenStreetMap contributors

Figure 7 Message content without satellite imagery, project #994, tile #580 (OpenStreetMap 2015) © OpenStreetMap contributors

Symbol variety can be viewed form three different perspectives. In one way it can be said that here is only one symbol set that can be used to transmit the messages. It only incorporates lines, point and areas, which means symbol variety is limited or low. For second perspective it can be argued that symbol variety is determined by the purpose or goal of the project, as for example in project #1023 where the only needed symbol to use is to draw an area around probable helipads (helicopter landing areas). Thus symbol variety is determined by the task and can vary from low (use 1 symbol) to rather high (using 11 symbols). The third perspective can be understood as cartographic one. If the features can be mapped by applying different symbol values (for example marking river as thick blue line, and stream as lighter blue thin line, path as grey punctured line, lake as blue area, forest as green area etc.) the symbol variety from this perspective can be evaluated as high, since symbols enable to differentiate between different features. Since for this research the Map Communication Model is applied, symbol variety for conveyance process in production function was evaluated as being high. For projects #994, #995, #1003, #1006, mapper were asked to map features ranging from 9 to 11 symbols. While conducting Cognitive Walkthrough it was found that a mapper is provided with 68 possible tags (deeper information about feature), 45 are visible and identifiable on the map (because of variations of the symbol – size, colour etc.). In selected tiles during the content analysis it showed that symbols used per tile varied from 2 to 18. This symbol variety can be evaluated as high. It gives quite detailed mapping and basic features can be identified just by looking at the map, no further actions required.

Regarding convergence of information, the analysis of content of task description and instructions provides an insight on existing symbol variety in order to converge the information on how the task should be completed. Projects which had similar goal (#994, #995, #1003, and #1006) were seemed to be based on the same template and included texts, together with additional links to other websites with explanations. The tasks were mostly focused on mapping roads, therefore the additional link to road system of Nepal was provided with images. The project #1023 used text and images in order to explain the steps and processes for task completion. The author investigated project #1090, which had similar links as in projects #995 or #995 that provided with information on infrastructure. For beginner mappers additional links to descriptions of mapping process and video tutorial was provided. Even though these links are redirecting you to different webpages enabling different types of symbols or expressions (as for example youtube.com for video), it could be said that OSM Tasking Manager as media provides with medium symbol variety as it can include visual and textual expressions.

5.2.3. Parallelism

There is an unlimited number of mappers who can contribute by mapping tiles at the same time. However, after a user selects and locks the tile, no one else can access it. Thus, the mapper sends a message and only one person can view the message, since in order to view the message content another user has to lock it again, thus blocking other users. Only one conversation per project is available. On the other hand, one person can take two different tiles from two different projects at the same time and have several conversations (as in several projects). Yet this seems highly unlikely, as during cognitive walkthrough and document analysis it showed that this kind of parallelism seemed highly inefficient in creating or reading messages. This means a person can, but will probably not contribute or send more than one message at the same time. This mechanism states that there is low parallelism in conveyance process, and proves to be efficient. When the crowdmapping was employed in Haiti, there was no clear system, many contributors could map the same area and thus what one mapper creates, the other one can at the same time delete or edit it. There were a lot of overlapping mapping (Clark, 2015). Splitting up area into tiles and enabling one conversation per tile limited parallelism and increased efficiency of information conveyance.

For convergence process in this particular context low parallelism might impair efficiency. Mappers need to get the same information at the same time. This is provided by OSM Tasking Manager. The instructions as online documents are easily accessible at any time and to many users, which means media provides high parallelism. Regarding how many users can send the message in form of a comment, the amount of same conversation for this is only limited by general tile number per project, as it can be probable that few users can send comment regarding instructions at the same time.

5.2.4. Reprocessability

Reprocessability in conveyance process can be evaluated as rather medium, since how many times the same message can be viewed depends on whether other mapper made changes and edits or not. As for example, when the author inspected the OSM Tasking Manager and mapped the tile #157 in project #1090, the previous volunteer made some mistakes. He/she mapped residential areas and tagged them as buildings, while buildings were not mapped. Thus, the author had to delete the edits made by previous mapper and make new change sets. As author uploaded new changes, the previous changeset (content of the message) was deleted. This indicates that reprocessability of messages containing VGI depends on how active the mapping of the area is. If the feedback (in form of edits) comes 30 – 40 minutes apart, that is how much time one gets to reprocess previous message. Yet, if the project is archived (is an inactive project and does not appear on the project list provided on OSM Tasking Manager webpage), messages are no longer exchanged and are more stable, thus granting higher reprocessability.

Reprocessability for convergence process is high. The mapper can always access the instructions which are provided to complete the task, and comments are always visible as well. There is no option to delete the comment provided for mappers, thus once a comment is made it stays on the chronological list of contributions.

5.2.5. Rehearsability

When a mapper has locked the tile, he/she is provided with 2 hours to create the message. This indicates that there is a time limit to create the message, however any symbol that was created, can be later crafted, adjusted, moved or deleted. As for example when during the investigation author was mapping buildings and simulated to make a mistake by not applying the tool called "square" (in task description it is required that buildings would be made square, and this can be done by applying this tool) and forgot to tag the area as "building". Author was able to do it later by clicking on the mapped feature and filling in missing information, and edit the symbol itself. This indicates that crafting the cartographic symbols has no limits on how many times it can be viewed and changed. However, bearing in mind the time limit of two hours, the user has to decide whether he/she will be able to complete and create required symbols in the time provided. It might be that the tool of "splitting the task" be useful if the area is complex to map, requires more effort to analyse satellite imagery. If the task is not completed in timely manner, VGI might not be uploaded, as it happened during the investigation. The tile #197 in project #1090 was complex, there were a lot of buildings to map, and some roads were not mapped as well. The author took more than two hours and was not able to upload the changes she made, thus the message was lost. By evaluating rehearsability it can be said that for conveyance process it is rather high, however, the time limit has to be considered.

For convergence process the media is providing with the instructions on how to complete the task for project, and as seen, feedback regarding this is low to non-existent. However, a mapper is provided with the comment section where he/she might put the comment regarding the steps taken to complete the task. The message can be crafted, deleted and edited just like any other comment in a website, thus the rehearsability is high.

5.3. Comparison between theoretically described desired media capabilities and capabilities of OSM Tasking Manager

The summary of comparison is provided in **Table 5**.

		Desired Media Capabilities in Theory		**OSM Tasking Manager**	
Media Capabilities		*Conveyance*	*Convergence*	*Conveyance*	*Convergence*
Immediacy of Feedback	*Production function*	Low – Medium	Low	Very Low - Low	Very Low
Symbol Variety		Low - High	Low - High	High	Medium
Parallelism		Low-High	High	Low	High
Reprocessability		High	High	Medium - High	High
Rehearsability		High	Medium - High	Medium - High	High

Table 5 Comparison between theoretically evaluated desired media capabilities and media capabilities of OSM Tasking Manager

- Immediacy of feedback both in theory and practice are low for conveyance and convergence processes in production function in OSM Tasking Manager.
- The media analysed in this research gathers VGI through second model of crowdmapping. VGI is gathered through maps drawn by volunteers in form of cartographic symbols. Symbol variety for conveyance function in theory was considered relevant no matter how or high symbol variety was. Yet when considering cartographic language it should be medium to high. OSM Tasking Manager provides with high symbol variety. For convergence process it was considered that symbol variety can as well vary from low to high depending on user's familiarity with the task. In OSM Tasking Manager case, symbol variety was evaluated as medium
- Regarding parallelism, theory would suggest that for second model of crowdsourcing it should be low to medium – not many conversations happening at the same time. OSM Tasking Manager provides with low parallelism for conveyance process. For convergence process theory suggested that parallelism should be high in order for any information regarding task to be communicated simultaneously. Here OSM Tasking Manager as well provides with high parallelism.
- Reprocessability for conveyance process in theory should be high, means the message content should be available at all time. However OSM Tasking Manager considers feedback in form of message (map editing) and thus

reprocessability of message depends on how active the tile is edited. The reprocessability was medium to high. Reprocessability both in theory and practice was high for convergence process.

- Rehearsability in theory for both processes was considered to be better if providing time and ability to craft the message before sending, especially for conveyance process. For convergence it could have been as well medium, however it might impair smooth task completion. OSM Tasking manager provides with high rehearsability for conveyance process only under some circumstances. Rehearsability for convergence process complies with theory and is high.

6. DISCUSSION

6.1. Interpretation of OSM Tasking Manager capabilities for conveyance process

In theory and practice immediacy of feedback was evaluated and the results state that it is low. What does this provide when communicating VGI in the context of a disaster response? If the main purpose of crowdsourcing VGI is to solve the problem of lack of situation awareness, and if immediacy of feedback provides with better understanding of message, shouldn't it be high? If there is only one contributor per tile, the accuracy of information might be impaired, since as noted by Goodchild and Glenon (2010) "information obtained from crowd of many observers is likely to be closer to the truth than information obtained from one observer" (p. 233). Sure feedback is relevant when more clarification is needed, however, what would be happening if the feedback in production function conveyance process would be high? Too much of feedback as theory and practical experience suggest would require constant communication and constant exchange of messages. This would mean that participators who are mapping same tile would have to be working on the task simultaneously and provide constant feedback. This would in fact limit the efficiency, there would be more time consuming discussion over what to mark as path, whether it is a path or a track. As well it would require all members to be online at the same time which is not even possible. OSM Tasking Manager first of all limits the participation of volunteers per task (in form of tile), there is no possibility to communicate over same tile at the same time. In addition to this volunteers are spread all over the world, in different time zones and cannot be bounded by requirement of rapid feedback in order to send VGI. Therefore rapid feedback would impair the efficiency, but non-existent feedback or prohibited feedback would impair the quality. As document analysis of a few tiles showed, it is enough to have 2-3 contributors per tile to gather enough relevant VGI. Yet there are situations where the messages are marked as done and not validated. It is hard to interpret, whether marked as done still qualifies as good message containing VGI if it is not yet validated. Still, marking as done leads towards more accurate information.

Cartographic symbol variety provided by tools of OSM mapping platform was considered as high and complies with theoretically required. What does high symbol variety provide in the context? The higher symbol variety can be used, the more accurate VGI data is. Whoever uses the map that was produced by volunteers have information on different type of roads, because of different symbols and their varieties are used to draw them. The mapping tools and symbols are enough to provide with what is needed. As for example in case of Nepal Earthquake it was required to first map the roads in order to provide information for logistics in disaster response. It was important to distinguish among paths which are often mapped not as good as the main roads are, but in remote areas, where people do not have vehicles, paths connect one residential area with another and are vital. To distinguish and see which residential areas can be reached by foot or by car is upmost required. Yet, is the amount of symbols provided by tools enough? From the cognitive walkthrough it was considered as yes. Even though it lacks some lines as for example to mark a dam, however, user can draw a line and tag it by him/herself, thus relevant information will not be lost. If the tool would be overcrowded with various symbols, for a non-professional user it would create confusion and would force to doubt which one of the symbols and their varieties to use. OSM provides with high enough symbol variety.

Low parallelism is considered low in theory and is low in practice. Many mappers can be mapping at the same time but not the same tile. Mapping same tile at the same time would cause overlapping and conflicting data. Locking and unlocking tiles prohibits from parallelism. Yet one mapper can actually unlock different tiles at the same time if they are in different projects. However, is this useful? One tile can be sometimes hard to handle if the features are complex, why would one take two tiles? This would impair and affect the quality of VGI and would unlikely increase efficiency. Moreover, since the tiles are locked they prohibit others from mapping them. High parallelism in this context would be seen as non-supportive capability of media.

Reprocessability capability of OSM was evaluated as rather medium to high and in comparison with theoretically defined one, raises questions, whether *medium* is enough? It could be said that it is relevant to review (reprocess) messages that were send. In case of OSM Tasking Manager, reprocessability is bounded with immediacy of feedback, especially with contribution (note that validation or invalidation does not change message content, just changes message status). Anytime the contribution to the map is made (feedback is given) previous message is deleted. Therefore reprocessability was considered as medium. However, while conducting cognitive walkthrough, the author encountered message that had erroneous content. The author edited the tile and clarified the content of the message. Thus it gives an answer. If all the erroneous content (VGI) in messages were left and visible all the time, it would considered as inefficient, overlapping irrelevant and erroneous information. There is no need to keep message and VGI which does not contain correct information. Therefore medium reprocessability and feedback reduces mistakes “written”. On the other hand as soon as project is archived, there is no easy accessibility to it and thus editing is limited, reprocessability of messages is high. In conclusion, reprocessability depends on project status, and even if it is medium, in the context of time and accuracy sensitive context, there is no need to keep irrelevant messages.

Another media capability which was evaluated as being medium and in theory it should be high is rehearsability. Rehearsability is bounded by time limitation of 2 hours. If a message was not created and uploaded in two hours it might be lost. Why user should be limited by time when crafting the message? The answer would be once again, time sensitivity. Message has to be created at rather rapid speed so that data would be presented in timely manner. There is no time for too much of perfection and analysis, or to use irrelevant symbols. OSM Tasking Manager provides with an option of splitting the tile if user feels that he/she will not be able to complete the message in timely manner. This provides with an option and solution to this problem. Even though as author and might be other users as well experienced some kind of disappointment, when all the content of the message is lost, it was valuable experience that gave an insight for this issue. On the other hand, the symbols can be crafted many times if the mapper feels there is a need of correction. Thus rehearsability is not limited by how many edits one can make per tile.

6.2. Interpretation of OSM Tasking Manager capabilities for convergence

OSM Tasking Manager provides low immediacy of feedback and thus complies with theory. However, how to interpret low feedback in this context? OSM Tasking Manager is media with main goal to transmit VGI. Any other messages might disturb and reduce efficiency of the media for this function. Thus, media does not prohibit to send messages regarding questions on how to complete the task, but in instructions and the main OSM Tasking Manager page it redirects to other media for these purposes. Low feedback is considered not because it prohibits it (even though in comparison to face-to-face it wouldn't be high either way), but because communication regarding these questions is redirected to other media, and because there were no messages (at least in the given samples) with questions regarding task.

Theory suggests that symbol variety used to explain the steps and procedures should vary from high to low and might depend on the level of experience volunteer has with mapping. If volunteer has less experience he/she might need more symbols when explaining the task, for more experienced – less. OSM Tasking Manager provides with medium symbol variety in instructions and links to other pages that would explain anything needed, provide visual aid, as well provide with link to email if any questions arise. In the context medium symbol variety aims at providing enough information for all levels of mappers. First of all when explaining the task more text and other means of expression might create a very long instructions list which would become more complex, maybe even harder to read and comprehend. If provided with less symbol variety, for experienced mappers instructions might be clear, but beginner mappers might feel excluded. Aiming at the middle and providing links OSM Tasking Manager does not overflow with lots of complex information and provides enough of it. This also viewed as efficient. High symbol variety can sometimes cause more time consumption when reading and interpreting.

Theory suggests that media should enable high parallelism, and thus OSM Tasking Manager complies with the theory. High parallelism means many conversations can happen simultaneously, and thus in OSM Tasking Manager as media provides with many conversations regarding the description of the task. Many users can view instructions at the same time, thus mappers are not bounded by ques or limitations to access the instructions and this provides with high efficiency. Here same can be said about reprocessability. Both in theory and practice it is high and it is as well related to many users reading the instructions at the same time and having access to instructions at any time they need and view necessary.

Finally, rehearsability regarding convergence process both in theory and practice is high. Even though OSM Tasking Manager is mainly media used for VGI transmission, still some questions regarding task might be asked (although not really happens often). In order to save time for discussion, a mapper has to have enough time and abilities to edit message before sending it in order to ask exactly what is unclear. This might take a few edits before the message for the sender seems clear enough. And since immediacy of feedback is low, it has to be considered that message not specific enough or not clear enough would require another question (feedback) and thus it would impair and affect the mapper in a negative way (mapper does not get the answer, or gets it too late and the answer itself is not enough or does not provide help).

6.3. Evaluation of OSM Tasking Manager in relation to theoretical background

After data was gathered, analysed and compared with theoretically defined set of media capabilities to communicate VGI in disaster response it could be said that generally OSM Tasking Manager meets theoretical requirements and thus perform well in fulfilling theoretically described media capabilities to support communication processes in order to accomplish a task. A more in depth analysis and interpretation of these results in a context of low group familiarity, varying task familiarity and time constrains to convey the VGI for production function provided with more insight of the issue and explain this answer.

There are as well other relevant issues related to the theoretical background, which author views as relevant to discuss in the broader context. As Lundberg and Asplund (2011) noted there are several types of communication problems emergency managers encounter in disaster response. This analysis focused on one of them – lack of situation awareness. Results have proven that OSM Tasking Manager does help to partially solve this problem. However, another problem was defined as content of the message – different tasks require different message formats. It could be considered that OSM Tasking Manager is a good example of solving this problem, however, it has up and down sides. On one hand using cartographic symbols to convey geographic information seems as useful, since once a map is created it does not take much of time to decode – geographical information is send in the most appropriate form. Sending message with the text and address requires to decode the message (especially if it has to be translated), and then place it on the map. Moreover, if there is no regulations how the message should be constructed it might consume even more time. On the other hand, encoding VGI in form of text and images does not require time, while encoding message in form of a map requires more of it as cognitive walkthrough showed.

This partially relates to another claim by Spyratos et al. (2014) who stated that actual VGI and not SGD has to have more requirements in terms of contributors and quality. Even though this research did not focus exactly on quality of the VGI data provided, as Goodchild and Glenon (2010) stated – the more contributors the more accurate data it should be. Accuracy and quality of the data as well relates to the model of map use. As noted for crisis response the media through which VGI is communicated have to consider both Cartographic Visualisation and Cartographic Communication. All of this comes to evaluating OSM Tasking Manager as a tool which should provide or consider some quality control. Even though, the contributors cannot be observed and followed by other users in terms of "right or wrong", the contributors themselves act as quality police in this case through feedback loops (when considering contribution as communication) in conveyance process. Some of the rules and quality is as well assured by the instructions provided on each Project, where it describes what is needed, what steps should be taken. Thus to some extent not only contributors but OSM Tasking Manager provides with mechanisms of quality control.

Overall, OSM Tasking Manager is a very task oriented media, which basically has media capabilities that mainly support conveyance process in production function. As in this case it is exactly what is needed. Yet more analysis of the media would provide with other valuable insights.

7. CONCLUSIONS AND FUTURE RESEARCH

Map Communication Model provided by Hoffmann, proved to be useful for research. The model provides with needed information on interpretation of some gathered data as well as understanding the communication patterns and feedback provided by interactive mapping. The model consider new advancements in map creation and thus adapted it to Web 2.0 conditions. Based on this model communication via OSM Tasking Manager was interpreted. This research also suggests that the map use model should be reconsidered, as cartographic visualization and cartographic communication are combined in crisis mapping by applying crowdsourcing VGI, especially with second model of crowdsourcing. OSM Tasking Manager serves as an example of this type of map use.

MST proves to be valuable theory when analysing media capabilities and how do they help to improve communication performance. However, before conducting research and applying the theory the context becomes most important for evaluation. In this specific case every aspect of the media used, volunteers, task, specific situation restrains, and goal of the task had to be considered. Thus it was relevant to make new evaluation of desired media capabilities in order to conduct analysis that would give useful results.

OSM Tasking Manager proved to be a very task oriented asynchronous media. It matched theoretically described desired media capabilities, thus it could be said that it proves to increase communication performance regarding transmitting VGI (specific message) in disaster response (specific context). Even though some of the media capabilities did not matched completely, after analysis and interpretation of results were discussed it does not seem to constrain or affect communication in negative way. Contrary, it proves that not every media capability evaluated theoretically would be useful in practice. As for example OSM Tasking Manager limits the amount of rehearsability, and theoretically described media capability suggests differently. However, medium rehearsability increases the speed of communication and this is what is needed in disaster response. Media capabilities are very much incorporated into one another and interdependent.

Regarding future research, only one media and one model of crowdmapping was analysed. Author suggests that there is a need to conduct research on supporting media, such as email and OSM HOT IRC Channel #hot in order to evaluate how social function and convergence process in production function are supported. This would provide a more systematic analysis on one of the crowdmapping models and media used for the process.

Author sees it as useful to analyse the first model of crowdmapping as well to have a full picture on how VGI is communicated in disaster response. Comparison between the media could provide with valuable insight on what are the upsides and downsides of each of the model when communicating VGI. Moreover it would as well be possible to analyse how both model are used and how do they complement each other if/when applied.

Perceptions and user experiences would be a very useful information for the media evaluation. This evaluation would provide with helpful insights in both crowdsourcing models from users perspective with ability to improve efficiency and quality of data gathered.

Both models of crowdsourcing can and are as well used to solve other problems in other phases of crisis, as for example mapping risk areas and communicating VGI regarding risk assessment. Analysis of communication and media capabilities of channels would provide with other useful and resourceful data and information.

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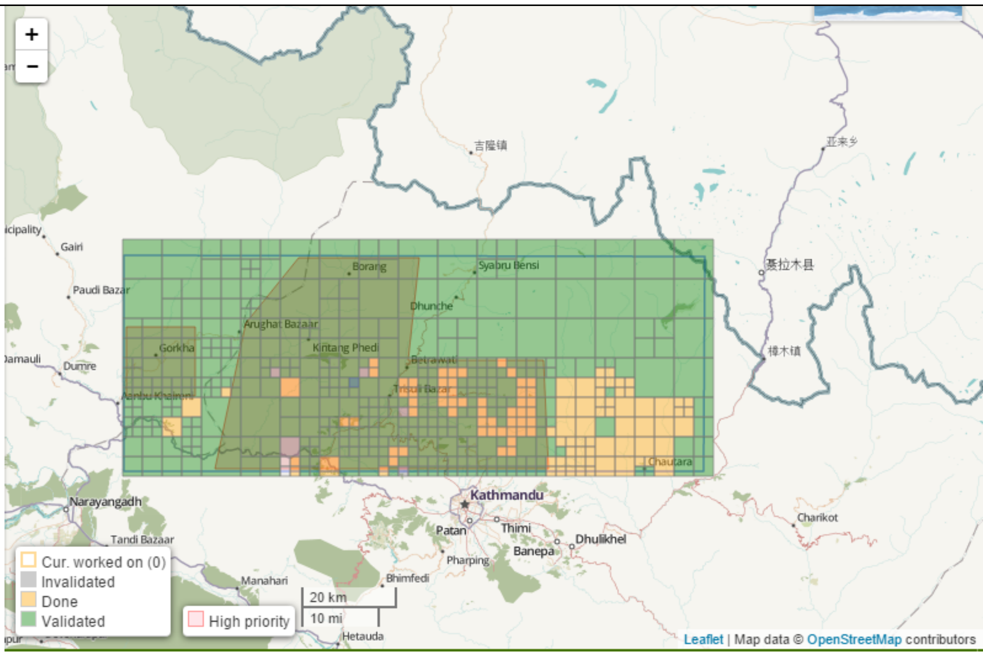
APPENDIX 1

Document analysis. Archived tasks from OSM Tasking Manager

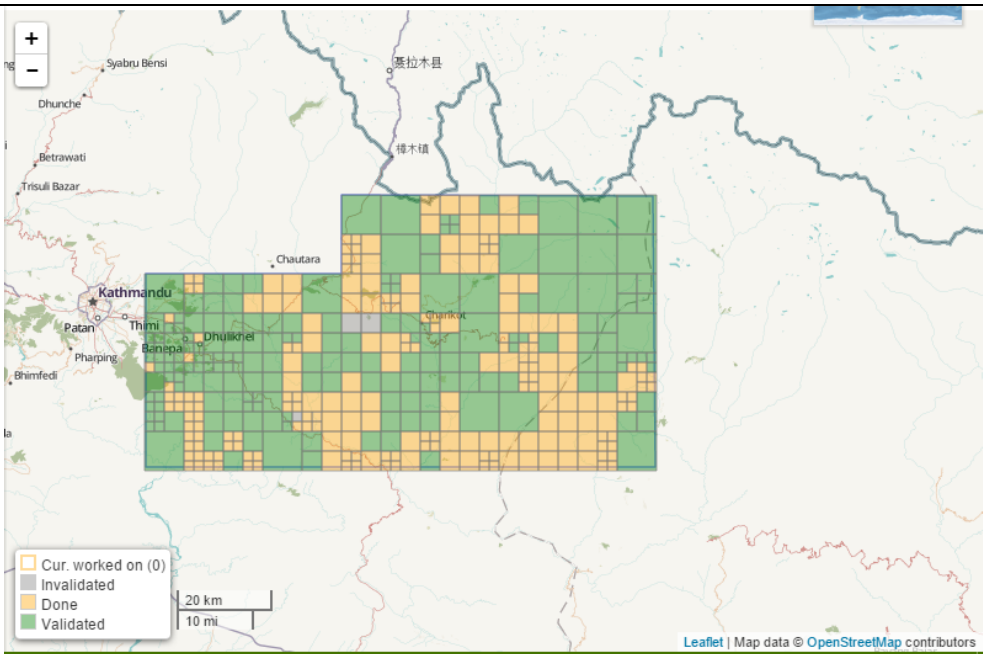
<table>
<tr><td>Task number</td><td colspan="4">#994</td></tr>
<tr><td>Task name</td><td colspan="4">Nepal Earthquake, 2015, Road Network - task 1 (Archived)</td></tr>
<tr><td>Task level</td><td colspan="4">All levels</td></tr>
<tr><td>Mapping Area</td><td colspan="4">

© OpenStreetMap contributors</td></tr>
<tr><td>Task goal</td><td colspan="4">First priority established in the first hours after the Earthquake, is the road network to connect to remote areas.</td></tr>
<tr><td>Objects to map</td><td colspan="4">Roads/Highways
• highway=primary
• highway=secondary
• highway=road
• highway=residential
• highway=service
• highway=pedestrian
• highway=track
• pedestrian suspension bridges
• paths</td></tr>
<tr><td>Symbols to use in the task</td><td colspan="4">9</td></tr>
<tr><td>Any priority areas</td><td colspan="4">Yes</td></tr>
<tr><td>Contributors (marked tiles as done)</td><td colspan="4">622</td></tr>
<tr><td colspan="5">Analysis of mapped tiles</td></tr>
<tr><td colspan="5">Validated (green tiles)</td></tr>
<tr><td colspan="5">Tile #414</td></tr>
<tr><td>User 1</td><td>2015-04-26</td><td>11:28:15</td><td>Not Contributed</td><td></td></tr>
</table>

		11:36:25		
User 2	2015-04-26	11:37:33	Not Contributed	
		11:38:25		
User 3	2015-04-26	11:49:04	Contributed	
		11:52:07		
User 4	2015-04-26	11:52:51	Not Contributed	
		11:54:14		
User 5	2015-04-26	11:58:40	Not Contributed	
		12:05:31		
User 5 (same user)	2015-04.26	12:06:09	Not Contributed	
		12:11:32		
User 6	2015-04-26	12:12:11	Not Contributed	
		12:13:33		
User 6 (same user)	2015-04-26	12:14:46	Not Contributed	
		12:18:45		
User 7	2015-04-26	12:19:05	Not Contributed	
		12:24:28		
User 8	2015-04-26	12:34:40	Not Contributed	
		12:38:04		
User 9	2015-04-26	12:45:44	Not Contributed	
		12:46:59		
User 10	2015-04-26	12:56:28	Contributed	
		13:04:41		Done
User 11	2015-04-28	06:05:45	Not Contributed	
		06:10:34		
User 12	2015-04-28	17:59:01	Not Contributed	
		18:03:55		Validated
User 13	2015-04-28	18:26:40	Contributed	
		18:54:41		

Tile #580				
User 1	2015-04-27	06:15:15	Not Contributed	
		06:18:05		
User 2	2015-04-27	06:38:47	Not Contributed	
		06:41:16		
User 3	2015-04-27	07:18:53	Contributed	
		09:18:55		
User 4	2015-04-27	09:22:30	Not Contributed	
		11:22:31		
User 5	2015-04-27	11:28:14	Not Contributed	
		11:39:09		
User 5 (same user)	2015-04-27	11:40:44	Not Contributed	
		11:47:26		
User 6	2015-04-27	11:51:37	Contributed	
		11:58:01		
User 8	2015-04-27	12:02:55	Not Contributed	
		12:07:43		
User 9	2015-04-27	12:09:06	Contributed	
		12:37:30		Done
Comment: *"Could cover relatively light. Possible that some access routes not plotted but no possibles see. Treat as Done???"*				
User 10	2015-04-27	17:54:12	Not Contributed	
		19:54:13		

User 11	2015-04-28	09:11:57	Contributed	
		09:14:10		Validated
Done, but not yet validated (yellow tiles)				
Tile#534				
User 1	2015-04-27	02:12:54	Not Contributed	
		02:16:17		
User 2	2015-04-27	03:18:11	Not Contributed	
		03:18:55		
User 3	2015-04-27	07:25:45	Contributed	
		09:14:07		Done
User 4	2015-04-27	07:14:06	Not Contributed	
		09:14:07		
Tile #598				
User 1	2015-04-27	14:54:56	Not Contributed	
		14:55:25		
User 2	2015-04-27	15:01:37	Contributed	
		15:14:01		
User 2 (same user)	2015-04-27	15:14:07	Contributed	
		15:14:13		Done
User 4	2015-04-27	15:14:14	Not Contributed	
		15:22:54		

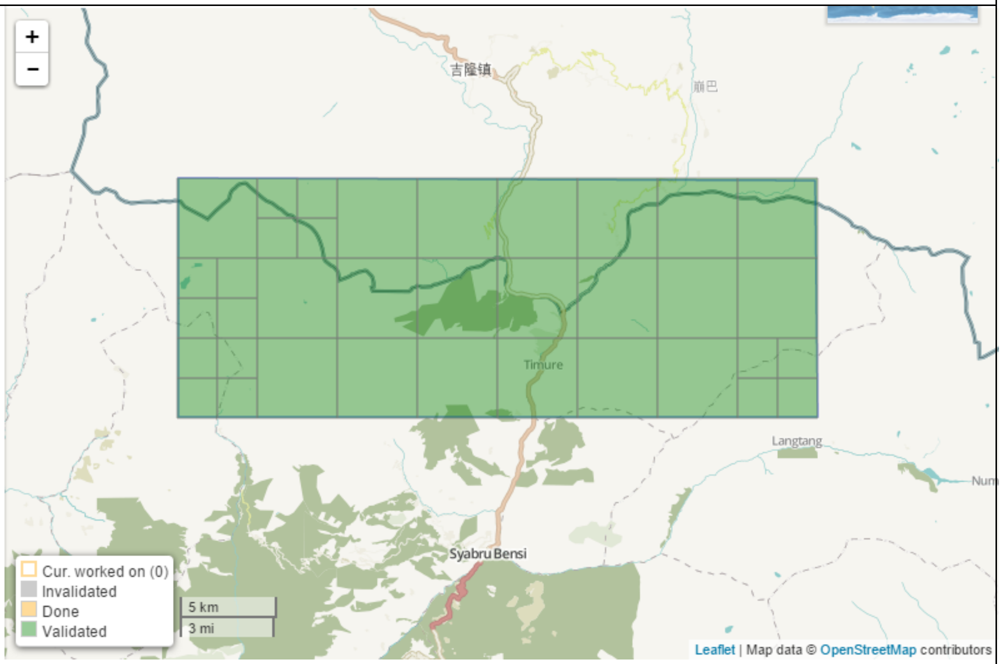
Task number	#995
Task name	Nepal Earthquake, 2015, Road Network - task 2 (Archived)
Task level	All levels
Mapping Area	 © OpenStreetMap contributors
Task goal	First priority established in the first hours after the Earthquake, is the road network to connect to remote areas.
Objects to map	**Roads/Highways** • highway=primary • highway=secondary • highway=road • highway=residential • highway=service • highway=pedestrian • highway=track • pedestrian suspension bridges • paths
Symbols to use in the task	9
Any priority areas	No
Contributors (marked tiles as done)	423
Analysis of mapped tiles	
Validated (green tiles)	

		Tile #336		
User 1	2015-04-26	19:31:37	Not Contributed	
		19:33:24		
User 2	2015-04-27	06:22:10	Not Contributed	

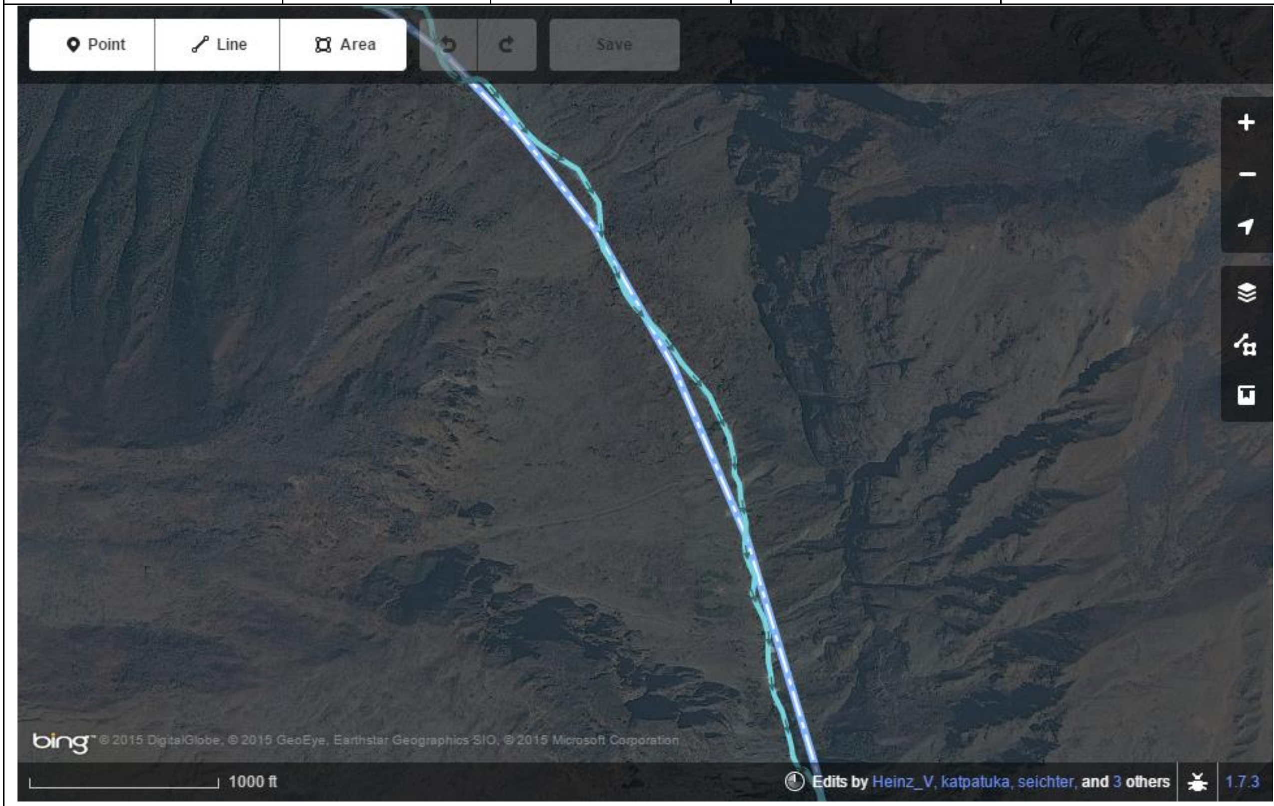
		06:24:16		
User 3	2015-04-27	13:49:33	Not Contributed	
		13:52:28		
User 4	2015-04-27	15:04:21	Contributed	
		15:11:18		Done
User 5	2015-04-27	22:19:20	Not Contributed	
		22:50:23		Validated

Tile #344				
User 1	2015-04-26	19:18:06	Contributed	
		19:19:20		Done
User 2	2015-04-27	16:39:30	Contributed	
		16:49:13		
User 3	2015-04-27	22:49:49	Contributed	
		22:53:24		Validated
Done, but not yet validated (yellow tiles)				
Tile #199				
User 1	2015-04-26	12:44:37	Contributed	
		13:17:40		
Comment: “added buildings and roads”				
User 2	2015-04-26	16:23:31	Not Contributed	
		16:32:04		
User 3	2015-04-26	16:48:35	Not Contributed	

		16:53:09		
User 3 (same user)	2015-04-26	16:58:58	Not Contributed	
		17:05:20		
User 3 (same user)	2015-04-26	17:05:30	Not Contributed	
		17:06:47		
User 4	2015-04-26	19:02:34	Contributed	
		19:16:58		Done
Tile #133				
User 1	2015-04-25	19:22:32	Contributed	
		20:22:06		
User 1 (same user)	2015-04-25	20:28:43	Contributed	
		20:28:52		Done
User 1 (same user)	2015-04-25	20:29:21	Contributed	
		20:53:05		
User 1 (same user)	2015-04-25	21:10:16	Contributed	
		21:10:24		
User 1 (same user)	2015-04-25	21:10:29	Contributed	
		21:14:07		
Comment : *"Almost done on this part"*				

Task number	#1003
Task name	Nepal Earthquake, 2015, Road Network, villages and buildings - task 5 (Archived)
Task level	All levels
Mapping Area	 © OpenStreetMap contributors
Task goal	First priority established in the first hours after the Earthquake, is the road network to connect to remote areas. *In this area, you will mainly find paths plus the Manaslu trekking path already traced. Please revise. Trace also villages and houses*
Objects to map	**Roads/Highways** • highway=primary • highway=secondary • highway=road • highway=residential • highway=service • highway=pedestrian • highway=track • pedestrian suspension bridges • paths **Buildings** • individual buildings **Residential/Settlement areas** • residential areas
Symbols to use in the task	11
Any priority areas	No
Contributors	40

(marked tiles as done)				
Analysis of mapped tiles				
Validated (green tiles)				
Tile #27				
User 1	2015-04-26	12:40:49	Not Contributed	
		12:41:41		
User 2	2015-04-26	12:42:07	Contributed	
		12:44:43		Done
Comment: *"Appears done?"*				
User 3	2015-04-26	12:58:05	Not Contributed	
		12:58:25		
User 4	2015-04-26	13:13:15	Contributed	
		13:14:10		Validated
User 5	2015-04-28	22:31:42	Not Contributed	
		22:33:46		



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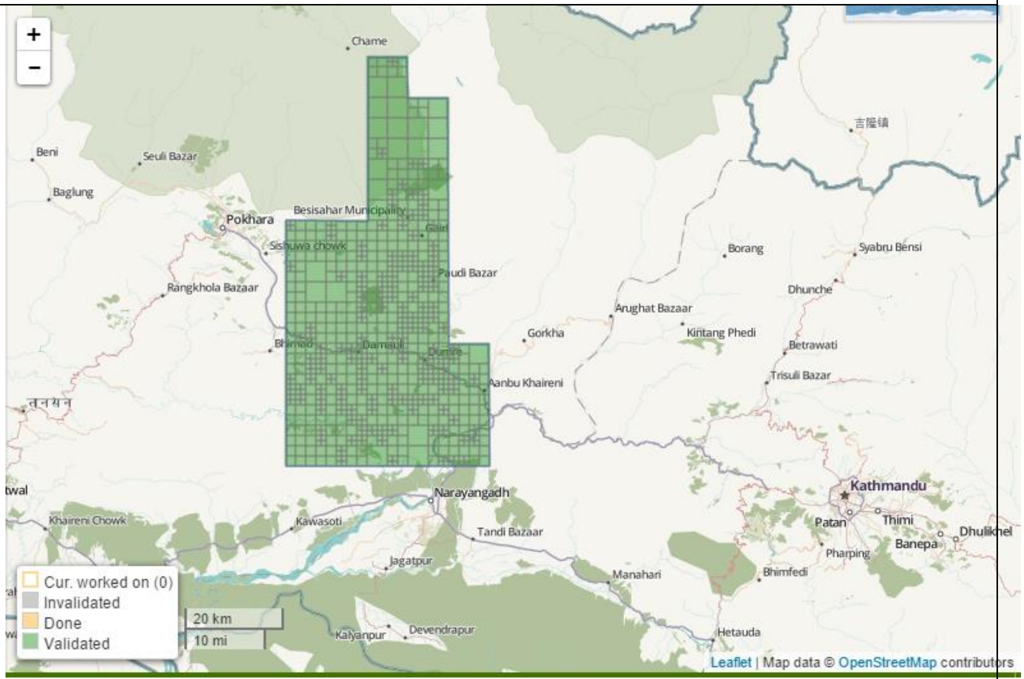
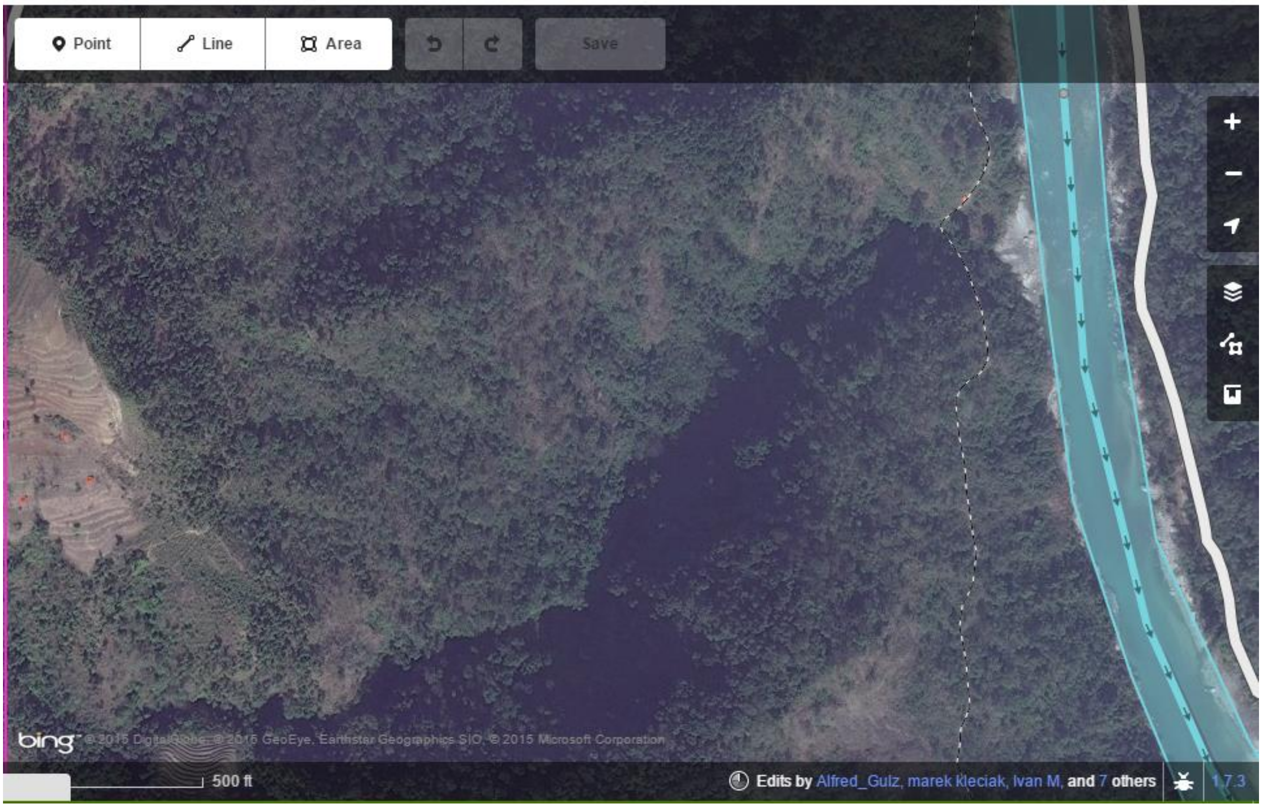
Tile #17				
User 1	2015-04-26	10:56:40	Contributed	
		11:13:53		Done
User 2	2015-04-27	03:11:42	Not Contributed	
		03:15:21		Validated
User 3	2015-04-28	22:24:56	Not Contributed	
		22:27:40		

User 4	2015-04-29	03:19:32	Not Contributed	
		05:19:33		
Tile #5				
User 1	2015-04-26	10:33:44	Contributed	
		11:10:33		Done
Comment: "Lower right part is covered by clouds."				
User 2	2015-04-26	12:14:24	Not Contributed	
		12:20:14		
User 3	2015-04-26	13:55:28	Not Contributed	
		13:58:53		Validated
User 4	2015-04-28	00:26:34	Not Contributed	
		00:33:11		
Tile #7				
User 1	2015-04-26	11:09:18	Contributed	
		11:12:18		Done
Comment: "*There is some cloud cover in the imagery. I did not find any paths or buildings to trace.*"				
User 2	2015-04-26	11:32:03	Not Contributed	
		11:38:42		
User 3	2015-04-26	14:00:10	Not Contributed	
		14:00:31		
User 3 (same user)	2015-04-26	14:00:41	Not Contributed	
		14:00:49		
User 4	2015-04-26	21:54:22	Contributed	
		22:33:39		
User 5	2015-04-26	23:06:21	Not Contributed	
		23:07:02		Validated

Task number	#1006
Task name	Nepal Earthquake, 2015, Residential areas and buildings - task 7 (Archived)
Task level	All levels
Mapping Area	 © OpenStreetMap contributors
Task goal	Our second priority, the buildings
Objects to map	**Roads/Highways** • highway=primary • highway=secondary • highway=road • highway=residential • highway=service • highway=pedestrian • highway=track • pedestrian suspension bridges • paths **Buildings** • individual buildings **Residential/Settlement areas** • residential areas
Symbols to use in the task	11
Any priority areas	No
Contributors (marked tiles as done)	1202
Analysis of mapped tiles	
Validated (green tiles)	

Tile #593				
User 1	2015-04-27	18:36:35	Contributed	
		18:37:52		Done
User 2	2015-04-27	00:49:26	Contributed	
		00:50:29		Validated



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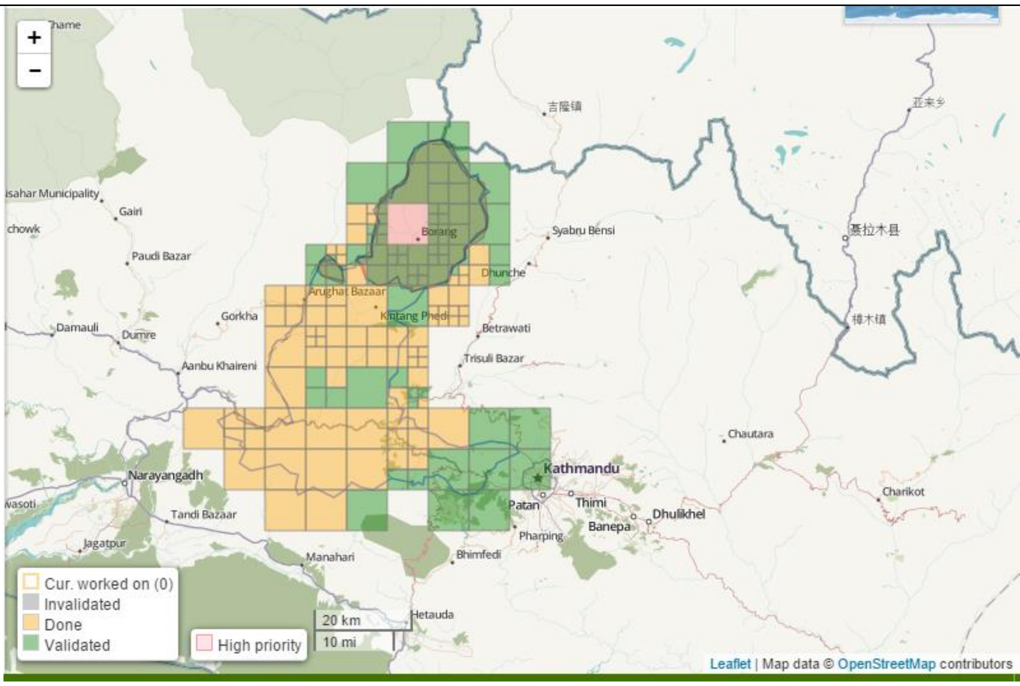
Tile #238				
User 1	2015-04-27	13:50:55	Not Contributed	
		15:50:57		
User 2	2015-04-27	16:43:38	Contributed	
		16:44:04		
User 3	2015-04-27	17:20:22	Contributed	
		17:30:14		
User 4	2015-04-27	17:57:12	Contributed	
		18:03:26		Done
User 5	2015-04-27	21:30:02	Contributed	
		21:35:27		
User 6	2015-04-30	18:22:01	Contributed	
		18:22:32		Validated

Tile #372				
User 1	2015-04-27	06:03:00	Not Contributed	
		06:19:36		
User 1 (same user)	2015-04-27	06:19:49	Not Contributed	
		06:19:58		

User 2	2015-04-27	06:21:41	Not Contributed	
		06:29:05		
User 4	2015-04-27	07:13:50	Contributed	
		07:44:08		Done
User 5	2015-04-27	20:21:26	Not Contributed	
		20:29:51		Validated
Tile #612				
User 1	2015-04-27	20:43:17	Not Contributed	
		20:49:52		
User 2	2015-04-27	20:50:12	Contributed	
		21:03:10		Done
User 3	2015-04-28	20:08:49	Contributed	
		20:50:07		Validated

<table>
<tr><td>Task number</td><td colspan="4">#1023</td></tr>
<tr><td>Task name</td><td colspan="4">Nepal Earthquake, 2015, Pilot task, Helicopters landing and common leisure, Northern Dhading (Archived)</td></tr>
<tr><td>Task level</td><td colspan="4">Very Experienced Mappers</td></tr>
<tr><td>Mapping Area</td><td colspan="4">

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<tr><td>Task goal</td><td colspan="4">Locate potential Helicopter landings</td></tr>
<tr><td>Objects to map</td><td colspan="4">aeroway=helipad</td></tr>
<tr><td>Symbols to use in the task</td><td colspan="4">1</td></tr>
<tr><td>Any priority areas</td><td colspan="4">Yes</td></tr>
<tr><td>Note</td><td colspan="4">Cannot tolerate errors, used JOSM</td></tr>
<tr><td>Contributors (marked tiles as done)</td><td colspan="4">165</td></tr>
<tr><td colspan="5">Analysis of mapped tiles</td></tr>
<tr><td colspan="5">Validated (green tiles)</td></tr>
<tr><td colspan="5">Tile #47</td></tr>
<tr><td>User 1</td><td>2015-05-02</td><td>11:31:47</td><td>Contributed</td><td></td></tr>
<tr><td></td><td></td><td>11:42:28</td><td></td><td>Done</td></tr>
<tr><td colspan="5">Comment: “Extremely rugged terrain. Could not find any possible location. Others requested to search, if I missed.”</td></tr>
<tr><td>User 2</td><td>2015-05-13</td><td>10:38:42</td><td>Contributed</td><td></td></tr>
</table>

		10:47:45		Validated
Tile #82				
User 1	2015-05-02	09:56:12	Contributed	
		10:00:31		
Comment: *“can't get imagery to load.”*				
User 2	2015-05-02	23:27:01	Contributed	
		23:47:46		Done
Comment: *“Some landing zones already identified. Added more. Marking as done for validation.”*				
User 3	2015-05-17	11:22:50	Contributed	
		12:05:13		Validated
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Tile #36				
User 1	2015-05-02	01:58:38	Not Contributed	
		02:14:21		
User 2	2015-05-02	07:24:49	Contributed	
		07:44:49		
User 3	2015-05-03	08:34:00	Contributed	
		10:33:45		Done
Comment: “*I’m pretty sure there are no designated helipads in this area. Also, most of the potential landing sites I found are easily accessible from the main road 7 network. I added two common leisure sites.”*				
User 4	2015-05-05	08:21:06	Not Contributed	
		08:40:19		
User 5	2015-05-13	10:56:13	Contributed	

		11:11:22		
Tile #6				
User 1	2015-05-02	10:23:54	Contributed	
		12:24:02		
User 2	2015-05-03	15:12:00	Not Contributed	
		15:29:21		
Comment: *“Only bad imaginery, could not find any helipads.”*				
User 3	2015-05-05	14:24:10	Contributed	
		14:52:25		Done
Comment: *“Cloud cover over any potential helipads.”*				