A Review of the Capacity for OpenStreetMap Software in Humanitarian Disaster Response: A Case Study Investigating the Humanitarian OpenStreetMap Team Response to the 2015 Nepalese Earthquake

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Abstract

Citizen science includes networks of ordinary people acting as sensors, observing and recording information for science. The Humanitarian OpenStreetMap Team (HOT) is one such sensor network working to empower citizens to collaboratively produce a global picture from free geographic information. The success of such open source software is extended by the development of freely used open databases for the user community. Participating citizens do not require a high level of skill. Final results are processed by professionals following quality assurance protocols before map information is released.

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OpenStreetMap is not only the cheapest source of timely maps in many cases but also often the *only* source. This is particularly true in developing countries. Emergency response to the 2015 Nepalese earthquakes illustrates the value for rapidly updated geographical information. This includes emergency management, damage assessment, post-disaster response, and future risk mitigation. Local disaster conditions (landslides, road closings, bridge failures, etc.) were documented for local aid workers by citizen scientists working remotely. Satellites and drones provide digital imagery of the disaster zone and OpenStreetMap participants share the data from locations around the globe.

For the 2015 Nepalese earthquake, HOT provided a team of volunteers on the ground which contributed data to the disaster response through smartphones and laptops. This, combined with global citizen science efforts, provided immediate geographically useful maps to assist aid workers, including the Red Cross Society and Canadian Disaster Assistance Response Team (DART), and the Nepalese Army.

As of August 2014, almost 1.7 million users provided over 2.5 billion edits to the OpenStreetMap database. Due to the increased usage of smartphones, GPS-enabled devices, and the growing participation in citizen science projects, data gathering is a promising way to contribute as a global citizen. This paper aims to describe the significance of citizen participation in the case of the Nepal earthquake using OpenStreetMap to respond to disasters as well as its role in future risk mitigation.

Introduction and Background

Every year since 1990, over 200 million people have been severely impacted by natural disasters around the world (Sheppard & Landry, 2015). Earthquakes can be devastating, as seen recently in Chile and Japan. Nepal is a country regularly distressed by earthquakes due its position on the constantly shifting Main Himilayan Thrust fault system (Ader, Avouac, Liu-Zeng, Lyon-Caen, Bollinger, Galetzka, & Flouzat, 2012). Kathmandu, Nepal"s capital city, is considered the world"s most earthquake vulnerable city (Caballero-Anthony, Cook, & Trajano, 2015). With this knowledge, an international organization called OpenStreetMap (OSM) and its affiliated arm Humanitarian OpenStreetMap Team (HOT) contributed to the preparation and response of the devastating 2015 Nepalese earthquake. Working in partnership with several global partners including the United Nations (UN), Red Cross, and Canadian Disaster Assistance Response Team (DART), HOT/OSM created maps which enabled aid workers to appropriately distribute their services to people in need. The maps themselves were produced by a massive army of volunteers from around the world, through a contribution better known as citizen science.

The earthquakes that occurred in Nepal on April 25 and May 12 2015, killed more than 8600 people and left over 22000 people injured (Kathmandu Living Labs, 2015; Sheppard & Landry, 2015; Roy, Sathian, & Banerjee, 2015). The first was of 7.8 magnitude and struck approximately 81 kilometers northwest of Kathmandu (Mitra, Paul, Kumar, Singh, Dey, & Powali, 2015; Sheppard *et al*, 2015), while the second was of 7.3 magnitude 40 kilometers west of the capital (Roy *et al*, 2015). Early relief efforts were disrupted and disheartened as damaged buildings that withstood the first quake were reduced to rubble by the second event. The most affected districts were Bhaktapur, Dhadhing, Dolakha, Kathmandu, Lalitpur, Gorkha Lamjung, Rasuwa, Ramechhap, Nuwakot, and Sindulpalchowk (UNOCHA, 2015). It was estimated that 8 million people in Nepal have been affected, including 2.8 million displaced survivors (Khazai, Anhorn, Girard, Brink, Daniell, Bessel, & Kunz-Plapp, 2015). The United Nations (UN) was immediately emphasizing the need for shelter and food from the international aid community. The disaster highlights the importance of effective disaster and risk mitigation strategies from "humanitarian cooperation mechanisms" (Caballero-Anthony *et al*, 2015) to respond efficiently to those in greatest privation.

Nepal required a variety of goods and services stemming from immediate safety requirements, access to emergency services, basic life subsistence necessities, and psychological support. According to a situation report filed on April 30th by the UN"s Office of Coordination for Humanitarian Affairs (UNOCHA), the focus of aid agencies was on providing shelter, food, security, and health for the displaced Nepalese (UNOCHA, 2015). The question, however, for any disaster response, is where to send the goods and services. Which areas are most heavily affected? Who needs the most help? Aid organizations struggle to assess these questions when they first arrive. That"s when citizen science initiated its efforts for Nepal. Using maps created by HOT/OSM crisis mappers, UNOCHA organised a UN Disaster and Assessment Coordination team to provide timely, crucial assistance.

The Humanitarian OpenStreetMap Team (HOT) are the feet on the ground providing OSM maps created by volunteers. OpenStreetMap is considered by the US Geological Survey (USGS) to be "one of the most ambitious efforts at producing a basemap of the world" (Spielman, 2014). With the development of open data, OSM has collaborated with the US government as well as several humanitarian organizations to bring citizen scientists an open-source mapping platform. As the availability of geospatial data becomes available to civilians with hand held access to "geo-enabled mobile devices", an increasingly "mature" map-based platform is produced (Spielman, 2014).

People that consider themselves members of a global society are not content with simply donating money to help with aid relief but rather they want to actively participate. Most HOT/OSM members are stay-at-home citizen science cartographers. Given the history of the country, scientists been expecting the earthquakes before they even happened. Working in partnership with Kathmandu Living Labs (KLL) in Nepal, the organization had already been collaborating on the Open Cities Project funded by the World Bank (Wiseman & Beland, 2015). They were in the process of digitally mapping the city, and that advanced work made quick relief efforts much more timely and effective when the instance came for mobilizing. For the Nepal "task", virtual volunteers traced roads, buildings, and open spaces over aerial imagery while in situ volunteers filled in the finer details. Altogether, this information was used in order to generate maps to assist aid workers.

Once the disaster struck, adding details to online maps in real time, HOT/OSM generated valuable information using open data input from satellite pictures, drones, social media, and orthorectified photos. This geographic information was used to identify passable roads, collapsed buildings and bridges, and potential helicopter landing sites. Volunteers onsite in Nepal verified the maps for use by first responders: the Red Cross Society, the Nepali Army, and UN affiliates. The HOT/OSM organizational platform allows for a huge number of global participants to contribute, which increases situational awareness and improves data management (Meier, 2012; Yuan, Guan, Huh, & Lee, 2013) throughout the crisis period and beyond. Quality control measures are taken but the driving force behind this "big" data collection is Linus" Law – given enough eyeballs, all bugs are shallow (Spielman, 2014; Raymond, 1999).

The Humanitarian OpenStreetMap Team Response in Nepal

It used to be that mapping with OSM was a "by nerds, for nerds" project (Banick, 2015), however with the expansion of user friendly GIS capabilities, it has grown into a community of citizen scientists. OpenStreetMap was conceived in 2005 but HOT did not flourish until the Haiti earthquake in 2010, revealing the organization"s capacities to the global aid community. To be clear, OSM and HOT, while closely affiliated, are separate entities. Humanitarian OpenStreetMap team is responsible for the mobilization of volunteers towards humanitarian efforts, disaster response, and economic development (Wiseman & Beland, 2015). It is an NGO that trains, coordinates, and organizes OSM mappers (Wiseman *et al*, 2015). The "core humanitarian mission" of HOT is "to serve as a bridge between the OpenStreetMap community and humanitarian responders on the ground" (Radford, 2015). It is the interface between the OSM citizen science community and humanitarian agencies. For Nepal, HOT volunteers did the actual damage assessments and that data was stored in OSM software (Girardot, 2015).

When the first earthquake hit, the International Federation of Red Cross and Red Crescent Societies coordinated with KLL"s Nama Raj Budhathoki, HOT Board of Directors member. Once a "situation room" (Kathmandu Living Labs,

2015) was established, coordination of the mapping response could commence. According to Dale Kunce (2015), Senior Geospatial Engineer and GIS Team Lead, American Red Cross relies "heavily on OSM data to do [their] assessments and planning". Their role in the disaster response was to provide "remote mapping and information management support" so as to attain an accurate evaluation of the devastation (Kunce, 2015; Sinha, 2015). Working through HOT, they collaborated with grassroots organization Kathmandu Living Labs (KLL), which had been mapping Nepal and it"s cities in preparation for earthquakes. The American Red Cross, working closely with the Nepal Red Cross Society, analyzed 2011 Nepal Census data and defined where the most people were most likely affected. The Humanitarian OpenStreetMap Team then assembled a specific task manager which split the areas into grids allowing multiple edits at once (Figure 1) (Wiseman *et al*, 2015). The gridded system of mapping allowed remote crisis mappers to perform tasks without the problem of overlapping (Liat, 2015).

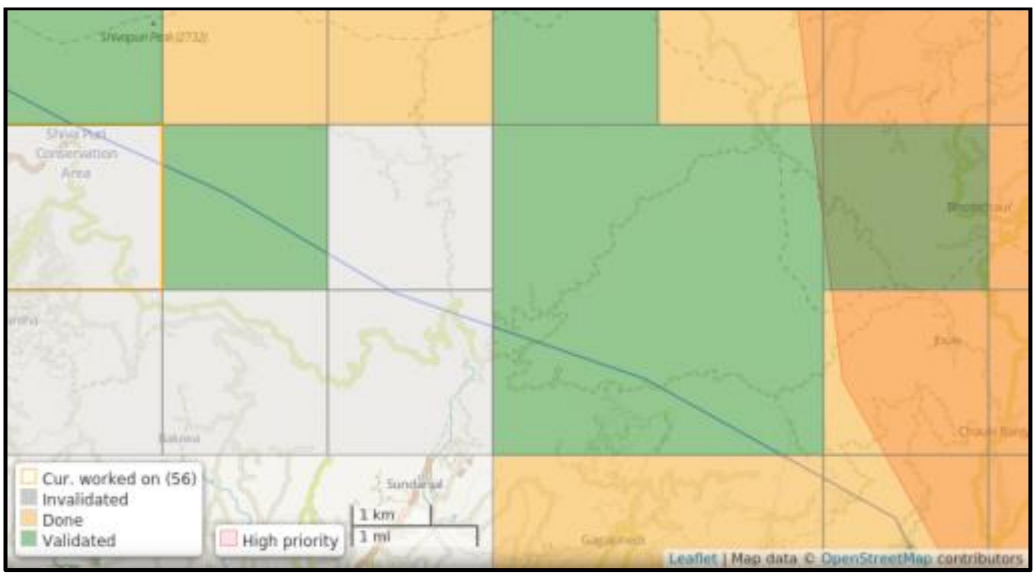

Figure 1: HOT/OSM task grid for mapping Nepal (Source: hotosm.org).

Humanitarian organizations were able to provide various services in cooperation with HOT and OSM crisis mapping volunteers. The provision of an accurate road map is fundamental towards the most urgent needs in any relief effort. Therefore, the first task of volunteers was to map the road networks of Nepal that had not already been previously mapped by HOT and KLL. Most of these roads were rural and outside Kathmandu"s dense city area (Wang, Purnell, & Bhattacharya, 2015).

Dr. Nama Raj Budhathoki asserts that the Nepali Army used the maps of road blocks and displaced people for effective response (Sinha, 2015). The army, in addition to supplying forty helicopters towards the relief effort also used drones to provide imagery which was uploaded for the production of digital maps (Wang *et al*, 2015). Kathmandu Living Labs was called upon by United Mission to Nepal to facilitate mapping potential helicopter landing sites as well as to identify paths with water sources to accommodate aid relief using mule transportation (Kathmandu Living Labs, 2015). Adele Waugaman of the Harvard Humanitarian Initiative confirmed that KLL – using OSM – had already mapped out the health facilities in Kathmandu (Sinha, 2015), expediting the relief process and thus saving more lives. Figure 2a shows a map of Nepal displaying all categories of reports made by HOT volunteers, while Figure 2b shows relief needs that can be further broken down into various categories.

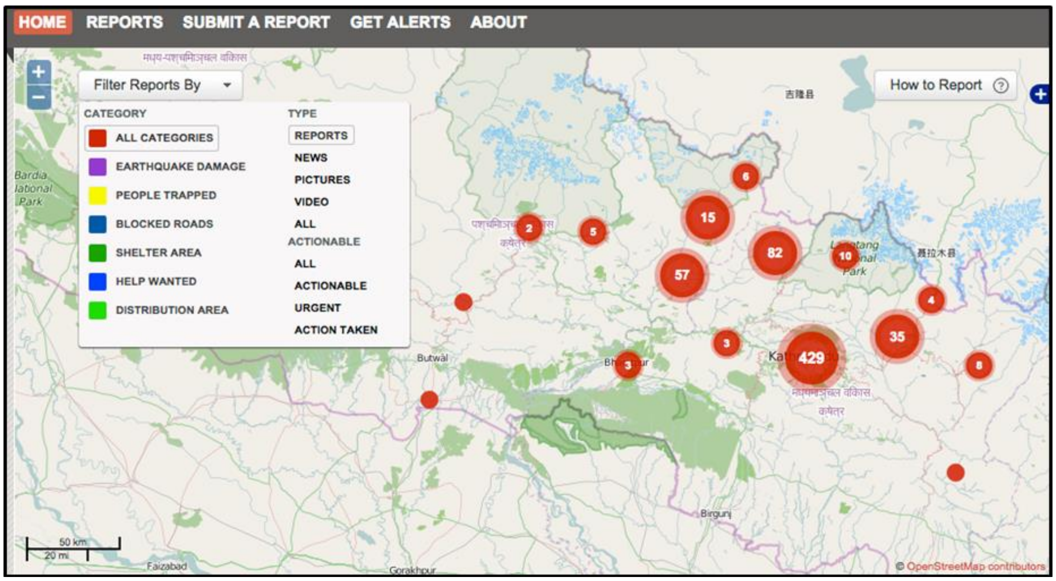

Figure 2a: Reports made by HOT crisis mappers across Nepal; numbers in red circles indicate the numbers of reports made in all categories (Source: Kathmandu Living Labs, 2015).

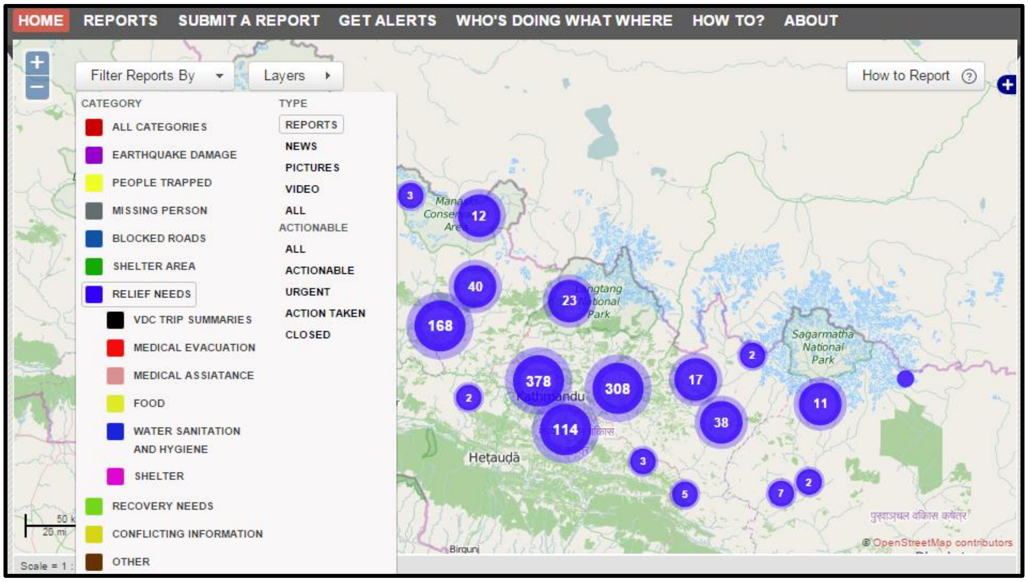

Figure 2b: Relief needs identified by HOT crisis mappers across Nepal; the numbers in the blue circles indicate the number of reports made for relief efforts needed (Source: Kathmandu Living Labs).

Volunteer members of OSM are referred to as crisis mappers. Their work involves remote mapping, or armchair mapping as participants do not have to leave their homes. They simply download the OSM software, trace information from satellite or drone imagery, and upload contributions that create map data to be used in the field. While mistakes are unavoidable, HOT verifiers are capable of identifying and adjusting misinformation. Furthermore, in times of crisis, mapping that is 90% accurate is infinitely better than 0% available. Armchair, or crisis, mapping happens in the following manner (LearnOSM, n.d.):

1. An administrator selects an area requiring updating in OpenStreetMap. The administrator ensures there is suitable satellite imagery available for remote mappers to trace, and creates a project covering the area. The level of detail required and the urgency are specified within the project together with any other information the remote mapper will require. When satisfied, the administrator publishes the project within the Tasking Manager tasks.hotosm.org, although they may also make changes later if required.
2. A remote mapper selects a task square, completes the mapping, and marks the square as complete.
3. A second remote mapper checks that the square is completed to a satisfactory level and marks the square as “validated”
4. Progress of the mapping of the project can be monitored from within the “stats” tab of the project, and the project can be downgraded or archived as required by an administrator.

As described above, the process is quite simple and made accurate by administrative verifiers. The degree of reasonable accuracy depends on the existing data, which is increased as more crisis mappers contribute. The verifiers use a range of quality assurance tools to edit OSM data, which include bug reporting tools, error detection tools, visualization tools, monitoring tools, assistant tools, and tag statistics (OpenStreetMap Wiki, n.d.). The error detection tools, for example, contains Keep Right which displays automatically detected potential errors such as a stream intersecting a roadway where technically a feature is needed like a bridge or culvert (Johnson, 2013). Another useful quality control measure is the monitoring tool UserActivity which generates reports that detect vandalism using statistics of map user activity (Johnson, 2013). Editing tools that the administrative verifiers use create OSM maps of higher quality than several commercial maps available (OpenStreetMap Wiki, n.d.).

The rapid response of volunteers provides a detailed map of road networks and buildings that supports the relief work of humanitarian organizations, expediting the provision of goods and services. Some maps show a visualization of deaths and injuries, as seen in Figure 3, which is “updated each time the Nepali Government publishes new data” (Kathmandu Living Labs, 2015). One of the major benefits of mapping with OSM is its open data license, utilized by smartphones which can access the maps offline (Wood, 2015). During critical days of the crisis, OSM map data was published in offline formats every hour for android phones to download thus leveraging volunteer efforts as much as possible (Kathmandu Living Labs, 2015). The Nepali Government”s Health Emergency Operations Center was assisted by KLL team members who directly uploaded maps to the phones of relief workers.

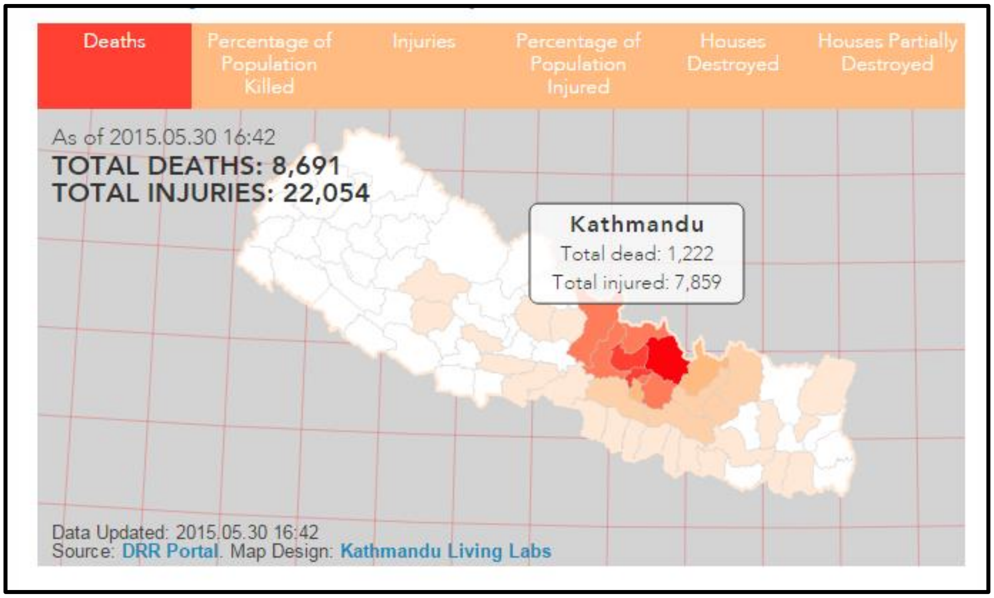

Figure 3: Deaths and injuries due to earthquake; Kathmandu region (Source: Kathmandu Living Labs).

Offline mapping support was essential in the rescue and aid efforts. In remote areas of Nepal where relief workers had no access to the internet, current maps with updated details of the situation were essential. The maps used by Master Corporal Denis Carriere, a geomatics technician with the Canadian Disaster Assistance Response Team (DART), "draw upon millions of points of continually updated crowdsourced data as well as satellite imagery and existing topographical maps" (Ellis, 2015). For this, Carriere relied on OSM geospatial data generated by active, remote crisis mappers that he obtained through HOT members stationed at KLL. Data quality is increased as more people join in the mapping effort to improve the ability of aid workers to operate effectively. The collaboration of "old school tactics" in combination with "new technology" (Ellis, 2015) ensures the advancement and stability of humanitarian aid.

As of April 30th, only days after the first earthquake struck, over 3500 OSM volunteers were actively mapping Nepal (Kathmandu Living Labs, 2015); classifying road networks and conditions, evaluating damaged buildings and identifying open spaces where displaced refugees were converging. Damage assessment was determined by comparing pre-imagery and post-imagery of buildings (Girardot, 2015). Quite simply, if a building appeared in the pre-imagery and not in the post-imagery, it was classified as damaged. Within the first 48 hours, 3 million edits had been made by over 2000 crisis mappers (Kunce, 2015). During the following five weeks of the response, 1.4 million buildings were traced, with volunteers contributing 500-600 edits which added up to 75 buildings per hour (Figure 4) (Dittus, 2015).

Furthermore, contributors mapped over 13 199 miles of new road

(Simons-Steffen, 2015). Figures 5a and 5b show the mappers road contributions before and after the earthquake, respectively. Figure 5b clearly displays a larger network of roads than in Figure 5a that had been added by crisis mappers. There are also more polygons mapped in Figure 5b which had been classified more finely than in Figure 5a. A fine classification gradient is important to relief workers because it allows them to identify areas of use, like helicopter landing spaces or refugee camps, as previously mentioned. According to Tyler Radford (2015), Interim Executive Director at HOT, the HOT response averaged almost 1 million map edits by 1000 volunteers per day in the first 10 days of the crisis.

Figure 4: Building edits made for Kathmandu. Green polygons were added after the earthquake (Source: Kathmandu Living Labs).

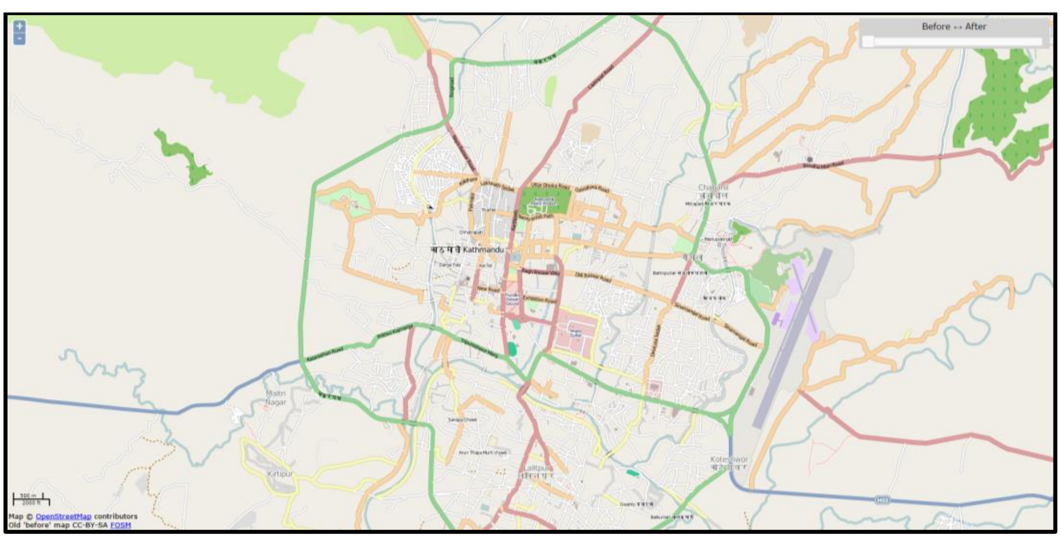

Figure 5a: Roads of Kathmandu mapped before the event (Source: Wood, 2015).

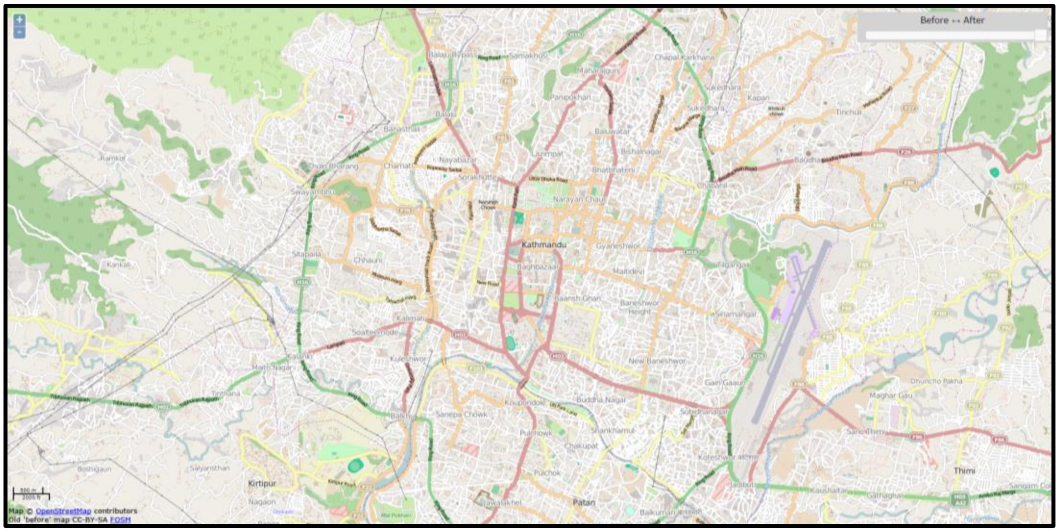

Figure 5b: Roads of Kathmandu mapped after the event (Source: Wood, 2015).

Post-quake Lessons from Haiti and Nepal

The capacity of the Humanitarian OpenStreetMap Team was truly challenged during the Haiti earthquake of 2010, the event in which many of the difficulties of crisis mapping were ammended for effective response to the Nepal earthquakes. Unlike Kathmandu, which had been in the process of being mapped in preparation for an event, half of the capital city of Haiti was missing from the map altogether when the 7.0 magnitude quake struck in 2010 (Meier, 2011). Lessons from the Haiti response were applied to the mapping process in Nepal five years later, which included gaining access to satellite imagery and beginning the mapping process prior to a disaster event, thus saving valuable time, as well as using a finer classification gradient. The crisis in Haiti resulted in greater availability and access to geocoded data (Zook, Graham, Shelton, & Gorman, 2010), information which HOT understood to be valuable in future disaster events and from this lesson began work in Nepal where major earthquakes are certain to strike. In 2010, the National Society for Earthquake Technology estimated that “a large-scale earthquake in mid-Nepal would displace more than 1.8 million people, kill in excess of 100,000, and injure a further 300,000” (Carpenter & Grünewald, 2015), predicting more devastating earthquake events than that experienced in 2015 to come.

It is evident that OSM techniques used in Nepal utilized a much finer classification gradient than that of the Haiti map when Figures 5b and 5c are compared, respectively. This is evident in that Figure 5b has more colors and patterns representing various classes of roads, buildings or spaces, where Figure 5c has fewer indicating that simply recording the features was of greater importance. The aggregation of detailed crowdsourced data is leveraged to provide the maximum benefit to aid workers so that rescue efforts can focus on response rather than researching and cataloging data (Zook et al., 2010). This lesson was clearly applied to the Nepal response in 2015

Figure 5c: Road and building edits made by OSM contributers for Port-au-Prince, capital city of Haiti (Zook et al., 2010).

A finer classification, as mentioned previously, improves the effectiveness of aid responders to achieve their goals which is ultimately to save lives. This is done so by increasing and improving their access to information about the locality of the disaster"s impact (Farthing &Ware, 2010). This includes vulnerabilities like population demographics, roads and routes for emergency access and evacuation, damaged infrastructure as well as landmarks and street names for navigation and context (Farthing & Ware, 2010). The online community was also responsible for classifying buildings into hospitals and schools for possible locations of relief agencies along with open fields like sports stadiums for the convergence of refugees. If the polygons were simply mapped and unclassified, responders would waste valuable time trying to find the information elsewhere. Furthermore, as a "common operational picture" (Farthing & Ware, 2010) was created by the OSM volunteers, relief workers were able to minimize searching the same areas twice. This was a lesson learned from the Haiti earthquake which had a more haphazard approach to the use of volunteer built maps. Centralized information increases the response time of the agencies which translates into more lives saved.

Another key message from Haiti was that disaster relief efforts should not be restricted to the city alone, rather it should include rural areas (Carpenter & Grünewald, 2015). Relief workers addressed this by providing assistance to inhabitants surrounding Kathmandu, thus rural refugees did not have to travel into the city for aid. This was clearly demonstrated in the mapping of vulnerable rural areas prior to the earthquake by KLL and HOT, which were vital in providing information for the relief workers as to where efforts should be directed.

The humanitarian response in Haiti highlighted the importance of using citizen science crisis mapping in a disaster setting and paved the way for HOT"s presence in Nepal. Several months after the Haiti earthquake, the UN"s Office for the Coordination of Humanitarian Affairs actively sought collaborations with volunteer networks and new technologies (Meier, 2011), such as OSM. The use of digital technologies to engage in two way communication with affected communities is a fast evolving sector in the humanitarian response (Sanderson & Ramalingam, 2015). "Humanitarianism in the Network Age" presented by UNOCHA in 2012 posits that aid agencies need to access collaboratively produced data from a holistic range of partners; information is intrinsically a life-saving need for people in crisis (Sanderson & Ramalingam, 2015). The success of the response of relief agencies to the 2015 earthquakes can be partially attributed to the involvement of HOT/OSM volunteers and the lessons applied from Haiti. However, much was still learned from the Nepal crisis, including the need for even more geographic data for future disasters.

Drawing on the lessons learned, HOT collaborated with KLL to create a "roster" of trained dedicated volunteers to take on various roles during future activations (KLL, 2015). The partner organizations were inspired by the global army of volunteers to educate an "elite" class of mappers to assist in future earthquake relief responses. Workshops in Dar es Salaam and Jakarta encouraged crisis mappers that had been involved in the 2015 earthquake "activation" to train with HOT mentors (KLL, 2015). The increased education of crisis mappers may contribute to more accurate information in the field at the time of a disaster thus improving the response of aid workers.

There are several areas of mapping applications that need to be addressed. This includes needs assessment mapping, post disaster needs, casualties and damage, and early recovery and reconstruction (Kumar & Oglethorpe, 2015). The use of publicly available information in initial assessment and mapping in order to create an "integrated disaster geodatabase" requires data acquisition, availability and harmonization issues, data availability and access, national actors and international actors (Kumar & Oglethorpe, 2015). Figure 6 demonstrates that OSM is one of the essential elements in the process of creating an integrated disaster geodatabase that can be used by relief agencies.

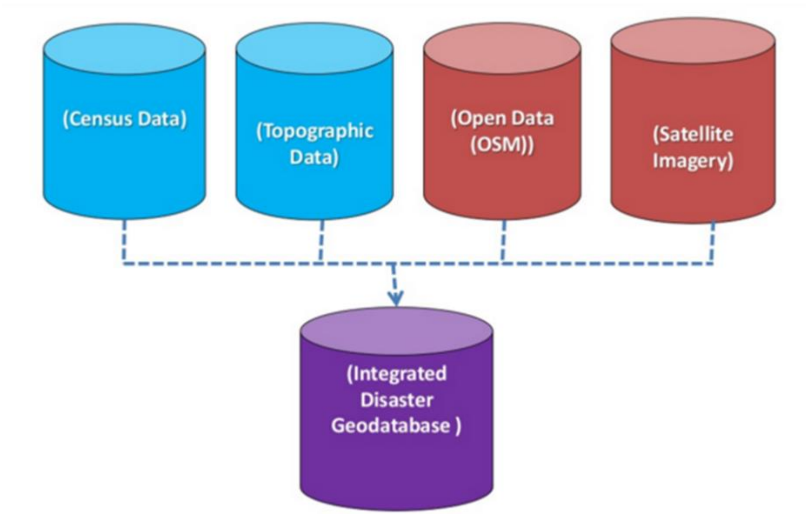

Figure 6: Integrated disaster geodatabase inputs flowchart (Kumar & Oglethorpe, 2015).

Furthermore, in seeing the value of OSM in response to the earthquake, KLL is building on their on-going mapping work utilizing the program. They are collecting exposure data for individual buildings in the Kathmandu Valley which will be shared in OSM and enable the disaster response community to more accurately assess building damage (KLL, 2015). As of 2015, wards 4 and 5 of Kathmandu have already been assessed for building exposure and typology (KLL, 2015). Kathmandu Living Labs (2015) asserts that this exposure data will enable disaster preparation agencies to effectively mitigate building structures thus reducing the number of casualties and potentially saving many lives. In the case of Kathmandu, a dense urban center, critical infrastructure and services play a major role and mapping them in their proximity to operational centers in crucial in a disaster situation (Carpenter & Grünewald, 2015).

In post-quake Nepal, start-up tech-companies are taking the example of HOT/OSM and leveraging the crowd sourcing dynamic for solutions based coordination in an effort to grow the economy (Sthapit, 2015) for disaster resilience. The evidential power of voluntarily contributed geographic information in response to the disaster is shifting communities towards similar innovation-based entrepreneurial responses to gaps and issues in civic planning (Sthapit, 2015). Such responses to gaps in urban planning, for example, would include enhancing access for emergency vehicles by building wider streets as well as legislating more open spaces left for evacuation (Carpenter & Grünewald, 2015).

After the earthquake 2015, NGOs and “civil society” began utilizing OSM and other crowd sourcing solutions for the coordination of future disaster assistance strategies. Enhancing preparedness for disasters must involve a holistic approach from government and community combined to develop risk awareness, and coordinate the capacity for humanitarian response (Carpenter & Grünewald, 2015). This involves the adoption of new partnerships and technologies in order to prepare for a range of possible disaster events (Meier, 2010; Carpenter et al., 2015; Sthapit, 2015). Kathmandu Living Labs and HOT contribute crowd-sourced geographic information as and collect vital information through OSM. This information, mainstreamed and systematically gathered (Sanderson & Ramalingam, 2015) contributes to a well-informed humanitarian community and helps build a disaster resilient Nepal with the goal of saving lives and livelihoods.

The Future Role of Citizen Science and HOT

The integration of new mobile applications and citizen science shows promise for advancing risk mitigation and disaster response. The engagement of broad audiences in humanitarian responses owes much to emerging technologies that revolve around open data. If appropriately utilized, scientists may be capable of integrating “continental-scale citizen science datasets with professional datasets” that can be verified by local observation (Newman, Wiggins, Crall, Graham, Newman, & Crowston, 2012). As people become more aware of the impact of their contribution, they will respond accordingly and increase their involvement.

The Red Cross Society and other major humanitarian aid organizations have the capacity to encourage citizen engagement when volunteers” efforts are rewarded with results. Most people have never heard of HOT or OSM, therefore it is the responsibility of the users of the resulting maps to communicate in detail how their efforts were made successful by armchair mappers. Furthermore, such efforts will encourage more people to become global citizens through the participation of citizen science that is used, in the case of HOT, for humanitarian efforts. Volunteers of OSM and HOT are motivated by how their data contribution is utilized.

Traditionally, online maps were used for simple navigation by the average driver, for example. However, advances in open-source data, mapping technology, and camera equipped drones have increased disaster response capacity. Online mapping now has an important emerging role in “coordinating emergency responses at ground zero” of a disaster (Wang *et al*, 2015). The HOT response to the 2015 Nepalese earthquake is an excellent case in which the principle of crowd sourced data was successfully applied to real-world humanitarian efforts.

The maps produced by OSM volunteers are a wealth of evolving information that cannot otherwise be produced. Using OSM, citizen scientists build continuously updated maps that can be used online or downloaded into navigation devices. Humanitarian OpenStreetMap Team utilizes this advantage through leveraging social media and networks to provide relief agencies with the real-time data they need.

The Red Cross has teamed up with HOT and OSM on an ambitious project to map the entire globe in anticipation of future disasters (Kunce, 2014; Parker, 2015). Preparedness accelerate crisis mapping at the time of a disaster and thus improve the reaction response of relief agencies. Vulnerable communities around the world should be mapped before disaster strikes. The role of citizen science in future risk mitigation will not be an acute post-disaster reaction but a broad component of a comprehensive pre-disaster action plan.

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