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# Living Labs in Commons-Based Peer Production for Crisis Response: Case Study of Nepal Earthquake 2015

**Master Thesis**

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## Abbreviations

| | |
|---|---|
| BPMN | Business Process Modelling Notation |
| CBDRR | Community-Based Disaster Risk Reduction |
| CBPP | Comons-Based Peer Production |
| CSV | Comma Seperated Values |
| DRR | Disaster Risk Reduction |
| ENoLL | European Network of Living Labs |
| GDP | Gross Domestic Product |
| GFDRR | Global Facility for Disaster Risk Reduction |
| GIS | Geographic Information System |
| GNU | GNU's Not Unix |
| GPL | General Public Liscence |
| HOT | Humanitarian OpenStreetMap Team |
| KLL | Kathmandu Living Labs |
| KML | Keyhole Markup Language |
| NGO | Non Government Organization |
| NITC | National Information Technology Center |
| OSM | OpenStreetMap |
| OSMF | OpenStreetMap Foundation |
| P2P | Peer to Peer |
| POIs | Point of Intrests |
| SFDRR | Sendai Framework for Disaster Risk Reduction |
| SMS | Short Message Service |
| UN | United Nations |
| UNDRR | United Nations Office for Disaster Risk Reduction |
| UNISDR | United Nations International Strategy for Disaster Reduction |
| USD | United States Dollars |

# 1 Introduction

## 1.1 Motivation

On April 25th, 2015, a magnitude 7.6 earthquake hit Nepal (Barry, 2015). The earthquake had a devastating effect leaving 8891 people dead, 188,900 people displaced, and 256997 houses damaged, causing economic damages amounting USD 7 billion (Baniya & Gautam, 2019). In the aftermath of the earthquake, different volunteering communities came together to help with the disaster response. Over 6000 global and local digital volunteers came together to create map data used to coordinate relief efforts by organizations like Nepal Army and United Nations humanitarian clusters (Poiani, Rocha, Degrossi, & Albuquerque, 2016).

An important role during this response was played by a local civic tech company Kathmandu Living Labs (KLL) which worked to coordinate the global community of OpenStreetMap mappers, local volunteers and formal response agencies (Thapa, Budhathoki, & Munkvold, 2017). KLL is an institution which belongs to a category of institutions known as a Living Labs. Living Labs are institutions or projects that provide structure and governance to user-centred peer to peer innovations and at the same time test and prototype these innovations in a real-world context (Leminen, Westerlund, & Nyström, 2012). Living labs act as intermediaries in an open innovation ecosystem and usually work in real-life context to cocreate innovations through the collaboration of multiple stakeholders (Leminen, 2015).

The platform used by KLL for creating map data during this response was OpenStreetMap (OSM) (Thapa et al., 2017). OpenStreetMap is a participatory mapping platform where any individual can create an account and start mapping. OpenStreetMap is also a community of thousands of volunteers who peer produce these map data using satellite imagery and local knowledge (Haklay & Weber, 2008). Similarly, KLL was also involved in deploying Quakemap platform, which filled the information gap between the people needing aid and the responders providing aid (Thapa et al., 2017). This platform based on the open-source Ushahidi platform allowed reporting of needs from the field by those in need. The responders could also use the geocoded reports in this platform to plan their relief and rescue operations.

Both of these initiatives – OpenStreetMap and Quakemap - are examples of commons-based peer production as it involved peer production of information that resulted in a platform that was a digital common (Bauwens, Kostakis, & Pazaitis, 2019). Peer produced information and its utility to complement formal channel of disaster response has been a growing area of research in recent times (Palen & Anderson, 2016).

This case provides a unique opportunity to study the role played by living labs in the process of commons-based peer production. Despite the compatibility between living labs and commons-based peer production, the interface between these two is unexplored in academic literature. Similarly, the case also provides an opportunity to observes peer production happening in the time of a crisis and how living labs facilitate this process.

## 1.2 Research Objective

This paper studies the case of KLL and its work during the Nepal earthquake to gain insights on the role of Living Labs in peer production of digital commons, especially during disaster/crisis scenarios. Following research questions has been developed to guide the study.

Research Question 1: What role does a living lab play in the process commons-based peer production?

Research Question 2: How do living labs facilitate commons-based peer production happening after a natural disaster?

With the listed research questions in mind, this study aims to fulfil the following research objectives

RO 1: To explore the interface between living labs and commons-based peer production, mainly the role played by living labs in the peer production process.

RO 2: To examine how those roles play out in facilitating commons-based peer production in the light of disaster response

## 1.3 Structure of the Thesis

The thesis consists of six chapters. The first chapter provides background and the motivation of the study. It also presents the guiding research question and the research objective of the study. The second chapter presents literature related to the different topics that are part of the study. The second chapter explores literature related to participatory disaster management, commons-based peer production and living labs. The third chapter presents the method used to carry out the study, and the data collection and analysis technique used for the study. It also presents the limitations of the methodical decisions taken by the study. The fourth chapter presents a detailed description of the case. It presents a description of different actors involved (OpenStreetMap, Humanitarian OpenStreetMap Team, and Kathmandu Living Labs) and different activities undertaken (mapping in OpenStreetMap, crowdsourcing relief needs in Quakemap) by these actors during the Nepal earthquake. The fifth chapter discusses the findings of the study. The chapter will first present business process models for the peer production cases and discuss the impact that these process had in the overall response. Additionally, the chapter will use the collected data to infer the answer to the research questions presenting the study's finding on the role of living labs in commons-based peer production. Finally, the sixth chapter will conclude the thesis and present further possibilities of research.

# 2 Theoretical Foundation and Literature Review

## 2.1 Disaster

Disaster literature covers a wide array of topics. This section of the study will focus on information communication technology being used for disaster risk reduction, especially using a collaborative approach. First, part of this section will cover the popular disaster management framework both in practice and in academic literature, followed by the concept of risk and why it matters in disasters. Next, it will explore the approach of community-based disaster risk reduction and its implementation for building community disaster resilience. Finally, the last part of this section will cover the emerging field called crisis informatics which deals with how information technology is enabling citizens peer produce data that can be helpful to aid formal disaster management approaches.

### 2.1.1 Disaster Risk Reduction

United Nations International Strategy for Disaster Reduction (UNISDR) defines a disaster as "A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts." (UNISDR, 2009, p. 9). Hazards cause disaster, but exposure, vulnerability, and capacity also play an integral part in determining a disaster (Khan, Vasilescu, & Khan, 2008). These disasters can be either small-scale disaster just impacting local communities or a large-scale disaster which requires assistance at national or international level (UNDRR, n.d.-a). Similarly, disaster may also differ in terms of their probable frequency of occurrence and return period as well as some disaster may emerge gradually over time while others could emerge quickly or unexpectedly (UNDRR, n.d.-a).

Disaster management literature focuses on disaster management phase or cycles where disaster management consists of different phases of a life cycle like risk assessment, prevention, mitigation, preparedness, response, recovery, rehabilitation, and reconstruction with different activities and management actions associated around these phases (Albtoush, Dobrescu, & Ionescou, 2011; Khan et al., 2008; Nojavan, Salehi, & Omidvar, 2018). The number of phases, however, differ in these models ranging from a simple model that just have two phases of pre and post-disaster to complex models having eight different phases (Albtoush et al., 2011). However, several criticisms exist for these conceptual models. First, criticism of the model is the design of the models itself, which revolves around the phases of disaster management, ignoring other aspects of disaster management like hazard assessment and different components of risk management (Nojavan et al., 2018). Additionally, criticism exists regarding the practicality of these models in terms of their impact on metrics like reduction in mortality, the occurrence of technology transfer, and proper economic growth of communities after the relief period (Nojavan et al., 2018).

Post-2015, the UN member states have agreed on the use of The Sendai Framework for Disaster Risk Reduction (UNDRR, n.d.-f). The SFDRR was adopted at third United Nations world conference on disaster risk reduction in Sendai, Japan on March 18, 2015, and was endorsed by the UN General Assembly on June 3, 2015 (United Nations, 2015). The framework is a 15-year, voluntary, non-binding agreement between the UN members states, which recognises that the state has the primary role in reducing disaster risk, sharing the responsibility with other stakeholders like the local government and the private sector (United Nations, 2015).

The single goal of this framework is too substantial reduce disaster risk and losses in lives, livelihoods and health of persons, businesses, communities and countries as well as the economic, physical, social, cultural and environmental assets (United Nations, 2015). The framework suggests seven targets to developed indicators used to measure the progress towards the goal. The seven targets of the framework are (1) substantial reduction in disaster mortality; (2) substantial reduction in the number of affected people; (3) reduction indirect economic losses concerning Gross Domestic Product (GDP); (4) substantial reduction in damages to critical infrastructure, especially health and education facilities; (5) substantial increase in countries with national and local disaster risk reduction strategies; (6) enhancement in international cooperation to developing countries, and; (7) a substantial increase in multi-hazard early warning systems and disaster risk information and assessments (United Nations, 2015).

The United Nations (2015) suggests four priority of action in SFDRR to achieve the previously mentioned goals, and those actions are as follows:

1. First is to understand disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment.

2. Second is to strengthen disaster risk governance to manage disaster risk at the national, regional, and global levels leading to collaboration and partnership.

3. The third is to increase investment from both public and private sector in disaster risk prevention and reduction to enhance the economic, social, health and cultural resilience of persons, communities, countries, and their assets, as well as the environment.

4. Finally, to enhance disaster preparedness for effective response and to "Build Back Better" through integrating disaster risk reduction into development measures.

A primary component in all of these actions is - risk, and these actions mostly focus on understanding, managing, mitigating risks. Adoption of SFDRR by UN and the framework's focus on risk has raised the interest of the academic community regarding risk management. Risk management is overcoming the traditional approach to crisis management by filling the gaps and solving different problems (Nojavan et al., 2018). According to UNDRR risk is "the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, and capacity" (UNISDR, 2009, p. 9). There can be an amount of risk that is acceptable or tolerable for a particular condition as well as there might be some residual risks which remain even after implementation of risk reduction measures (UNDRR, n.d.-b). Another way to view risk is as a function of three elements: hazard, exposure, and vulnerability (UNDRR, n.d.-e). As illustrated in Figure 2-1, the three components of hazard, exposure and vulnerability combine to from risk.

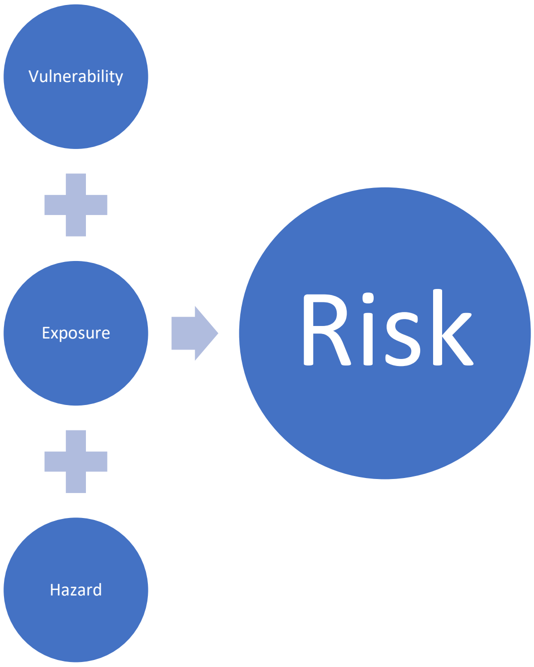



**Figure 2-1** Different components of risk

UNISDR defines a hazard as "a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation" (UNISDR, 2009, p. 17). Natural phenomena may cause a natural hazard; human activities cause human-induced hazards, and sometimes the hazard may be the result of a combination of both (UNDRR, n.d.-d). Similarly, UNISDR defines exposure as "the situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas" (UNISDR, 2009, p. 15). Exposure includes both the number of people and assets as well as the capacity of the exposed element concerning a particular hazard (UNDRR, n.d.-c). Finally, vulnerability is defined as "the conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards" (UNISDR, 2009, p. 30).

Reducing existing sources of risk as well as proactively avoidance of new risks is integral towards making substantial progress in terms of how we deal with disasters in the future (UNDRR, n.d.-e).

### 2.1.2 Collaborative Approach to Disaster Risk Reduction

One of the approaches to reduce disaster risk is community-based disaster risk reduction (CBDRR). Community-based disaster risk management promotes the involvement of local communities in the process of disaster risk management (Y. Liu, Yin, Chen, Wang, & Liu, 2016). The local community should be involved in various activities like community assessments of hazards, vulnerabilities and capacities, and also involved in planning, implementation, monitoring and evaluation of local action for disaster risk reduction. (UNDRR, n.d.-c). CBDRR approaches are useful in building resilience by increasing the awareness of and capacity of the local population to deal with disaster (Y. Liu et al., 2016).

CBDRR is a multi-stakeholder approach bringing together technical knowledge with indigenous knowledge to build community resilience. Having multiple stakeholders collaborate and exchange information is crucial for governing complex problems such as disasters (Djalante, 2012). Similarly, local indigenous knowledge is crucial to coping with disaster risk and their effectiveness come from the fact that they have developed over the generations by communities that are most affected by the disaster (Haque, 2019).

The CBDRR approaches can be nicely complemented with information technologies to impact all the components - vulnerability, exposure and hazard - of risk (McCallum et al., 2016). Open-source mapping technologies can be integrated with existing CBDRR practices like vulnerability capacity assessment to build resilience and plan DRR implementation (W. Liu et al., 2018). Such mapping technologies can be especially helpful in developing countries where geospatial information acquisition can be challenging (Hartato, Delikostidis, & Roiste, 2017).

### 2.1.3 Crisis Informatics

The past decade has seen novel applications of technology in the field of disaster management and disaster response. One of the most significant has been the use of social media and the communication it facilitates between different groups like citizens, formal responders and non-formal volunteer responders (Reuter & Kaufhold, 2018). Another significant development has been the ability of citizens to produce maps using technologies like GPS and OpenStreetMap (Haklay & Weber, 2008). Such technologies have enabled citizens to contribute to disaster by producing geo-aware data that can be helpful for crisis response (Kamel Boulos et al., 2011). The utility of citizen produced data for disaster management has given rise to a new multidisciplinary field of research called Crisis informatics which combines computing and social science knowledge of disasters (Palen & Anderson, 2016). The central principle of this growing body of research is that people tend to create and use standard information and communication technology in creative ways while coping with uncertainty during the time of disasters (Palen & Anderson, 2016).

Volunteer generated information produced by the crowd in a novel, and creative ways are horizontal, semi-structured, real-time, open, geo-aware and more accessible than the traditional form of information (Kamel Boulos et al., 2011). These characteristics make this information to be much more timely, complete, higher quality in terms of information sensitivity, and higher quality in terms of information specificity (Kamel Boulos et al., 2011). These advantages are challenging the notion that only formal agencies can produce information during disasters and also proving that at the time these horizontal forms of information can as well be of substantial utility (Palen & Anderson, 2016).

There is a need to integrate, these citizen-produced crowdsourced data into formal response mechanism. The information from citizens, combined with expert produced knowledge, can counterbalance each other's strength and weakness (Kamel Boulos et al., 2011). Despite the opportunities offered by this new source of information, integrating it into the formal response process can be quite challenging (Reuter & Kaufhold, 2018). The challenges arise in recognising relevant information accurately, reporting the correct information from a large volume of data coming from multiple sources, and the ability to make sense of this data in a meaningful way by the response agencies (Kavanaugh et al., 2011).

## 2.2 Commons and Commoning

This study deals with work done by Kathmandu Living Labs to create map data in the form of OpenStreetMap, utilising digital tools and open source solutions to mobilise and coordinate volunteers spread out globally. The study looks at the literature regarding commons and communing to understand the phenomenon of OpenStreetMap and the open-source tools used during the response.

This section will present the literature on commons and commons-based peer production. The first part of this section will look at the historical context of commons and the ideas behind its governance. Next, it will explore how these ideas of commons translate into the digital world. Finally, it will discuss how information technology is enabling the production of commons in new ways and the existence of a whole ecosystem around it.

### 2.2.1 Commons

Digital library of the commons defines commons as "a general term for shared resources in which each stakeholder has an equal interest. Studies on the commons include the information commons with issues about public knowledge, the public domain, open science, and the free exchange of ideas -- all issues at the core of a direct democracy." (Digital Library of the Commons, n.d.). Commons and the management of commons have been widely studied in economics and has been subject to much debate.

In 1968 ecologist Garrett Hardin published an article in the Science titled the tragedy of the commons, bringing into attention how individuals acting on their self-interest could cause harm to shared resources. The paper discusses an example of over-use of common land for pasture  - first illustrated in a pamphlet published by William Forster Lloyd - where each cattle herder in order to maximise their gains end up depleting the common land by overgrazing (Hardin, 1968). Hardin used this idea to support his argument that overpopulation is an example of the tragedy of the commons and blamed welfare state, universal human rights, and freedom to breed for allowing this tragedy to happen (Hardin, 1968). Hardin argued that humans' conscience could not be relied on to avert this tragedy and regulating human behaviour is the "only way we can preserve and nurture other and more precious freedoms" (Hardin, 1968). Hardin's argument has been disproven, but his paper has been highly influential in the following years (Mildenberger, 2019).

A notable work disproving Hardin is that of economist Elinor Ostrom who was awarded the Nobel prize in economics in 2009 for her work on economic governance of the commons. Through empirical studies, Ostrom found that the tragedy of commons is not as common in the real world because local communities have been able to come up with the answers to the problem of managing the commons themselves. She presented many examples of the community successfully managing the commons for hundreds of years (Ostrom, Burger, Field, Norgaard, & Policansky, 1999). Ostrom argued that instead of a one size fits all approach to regulate the commons, a diverse and complex system that emerges from local knowledge of the communities using commons is much more suitable for governing the commons (Ostrom et al., 1999). In many of these cases, communities have fixed members who can use the commons, and there are regulations set by the community in order to appropriately use the resource by each of its members without depleting the resources (Ostrom, 1990; Ostrom et al., 1999)

Therefore commons are not just shared resources but also the social system for the stewardship of this resources and self-organized communities formed around this system which sustainably manage these resources (Bauwens et al., 2019).

### 2.2.2 Digital Commons

In parallel to the research regarding the physical commons and how to govern it, there was an ongoing hacker movement called free software movement. Richard M Stallman initiated this movement in the 1980s over concerns of not being able to improve and redistribute software collaboratively (Stallman, 1983). Although free software code sharing has been in existence since the 1950s, commercialisation of software and low internet access rate have delayed the full development of this idea until the end of 1980s (Demil & Lecocq, 2006). The free software movement's mission was to provide users of the software with the four freedoms - to use, study, modify and redistribute - software. Two significant projects from the movement were the GUN Project and the GNU General Public licence. GNU Project creates and maintains a set of free software tools which is available anyone with the above mentioned four freedoms intact. The GNU GPL ensures that the software remains free, and people do not restrict the freedom of others while they redistribute the software (“What is free software? ,” 2019).

The free and open-source software movement has brought a significant change to the tradition of software development (Bonaccorsi & Rossi, 2003). The four degrees of freedom it promotes through usage, study, modification, and redistribution of the source code has become a necessity for the whole community of programmers seeking to build better quality software. One such significant example of a free and open-source project is Linux. Started by Linus Torvalds in 1991, Linux was a free and open-source operating system whose code is available to study, modify and redistribute (The info valley, 2020). The operating system is now used to power most of the servers on the web and have enabled other popular open-source projects like Android.

An important distinction between the free and open-source software and their proprietary counterparts is the use of open licenses. There are numerous licences around open software that promote the idea of copyleft. Under Open License, these people started creating a phenomenon which has challenged the long-term firm position of commercial software vendors and the overall market. The open licence moved beyond the realm of software code, and licencing of other creative work has adopted a similar idea of copyleft licencing. The development of Creative Commons licences allowed authors to distribute their work selecting a particular set of conditions like (1) attribution (2) allowing/disallowing derivative work (3) allowing/disallowing commercial use (4) resharing under a compatible licence (Lin, Ko, Chuang, & Lin, 2006).

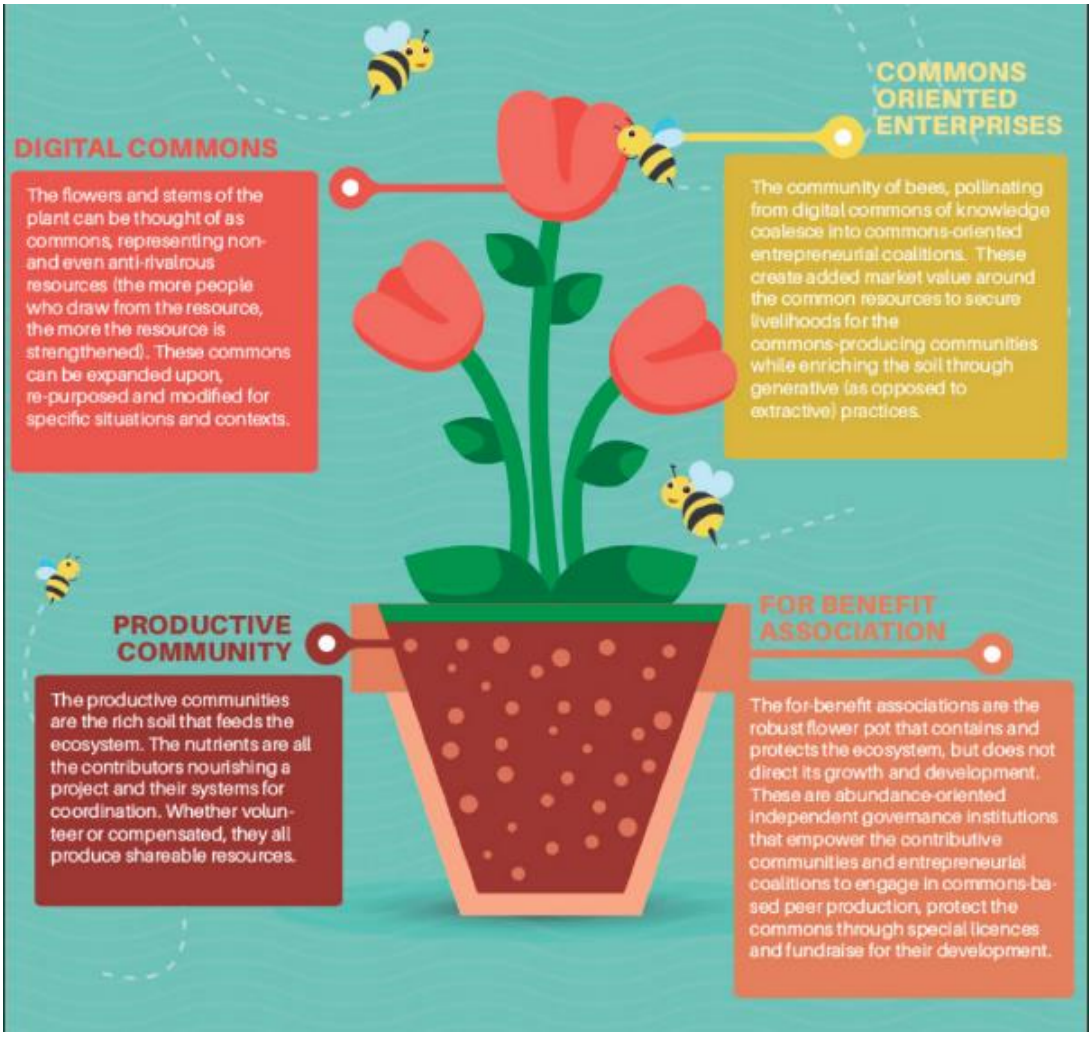
The movement of freedom which initially started with the software, has today spread into many other fields such as open hardware, open data and open access (Lindman, 2014). One of the most popular of such project is Wikipedia, which is the largest free-content encyclopaedia produced collaboratively by users (Yang & Lai, 2010). A distributed production mechanism allowing contributions from a large number of volunteers has made the growth of Wikipedia possible (Bauwens et al., 2019).

### 2.2.3 Commons-Based Peer Production

With the growth in information communication technologies, people can come together for value creation through the means of social production (Benkler, 2006; Benkler & Nissenbaum, 2006). The process is labelled as commons-based peer production when the value created by such means from a commons (Bauwens et al., 2019; Benkler, 2006). "CBPP is based on the open input; a participatory process of coordinating the work; and a commons as output." (Bauwens et al., 2019). Benkler (2006), explains that this social production is creating values (i) in terms of content (like production of free wiki map data in case of OpenStreetMap); (ii) in terms of relevance (like upvoting of useful comments and question in StackOverflow); (iii) in terms of infrastructure (as in the case of P2P file-sharing system).

Many modern-day companies like Uber, Airbnb have utilised this idea to create value without owning the means of production and using information technology as a facilitator. However, their practices which may seem open in principle, does not imply democratisation in consequences and are examples of platform economy (Acquier, Daudigeos, & Pinkse, 2017). The idea of openness and collaboration can change into commercial platforms for worker alienation and contingent work leading to extractive practices (Bauwens et al., 2019). Such extractive practices are observable in platforms like Amazon Mechanical Turk and Uber. What makes commons-based peer production different from the practices present in the platform economy, is its value of collaboration and its purpose to come together and build a community project (Acquier et al., 2017). Authentic CBPP projects can be distinguished by specific characteristics that they exhibit like sharing, intrinsic positive motivation, openness, collaboration, bottom-up innovation, community accountability, autonomy, communal validation, distribution of tasks, and collective ownership of the results (Kostakis, Niaros, & Giotitsas, 2015).

The digital commons that are created by peer production consists of an ecosystem of value creation. The ecosystem consists of the digital commons itself as well institutions in the form of (1) commons-oriented enterprises; (2) productive community; and (3) for benefit association (Bauwens et al., 2019). Figure 2-2 displays a visualization comparing the ecosystem peer production with an ecosystem of a plant in a flowerpot.




Source: (Bauwens et al., 2019)

**Figure 2-2** Commons-based ecosystem of value creation

The plant themselves represent commons, where they may have different non-rivalrous resources like flowers and stems. The utility of these commons is context-specific, and they repurposable and expandable to fit a context when needed. The bees represent commons-oriented enterprises, who make use of commons in a generative way. The use of commons by commons-oriented enterprises adds value to the commons. The soil represents the productive community that nourishes the ecosystem, which consists of volunteers that produce the sharable resources. Finally, the flowerpot represents a for-benefit association that contains and protect the growth and development of the commons. These institutions do not direct the commons but rather engage the commons-oriented enterprises and the productive community in peer production. They are also involved in protecting the commons through licenses and fundraise for their development.

## 2.3 Living Labs

This study looks at Kathmandu Living Labs, an organization established with the idea of the broader worldwide movement of living labs. This section explores the literature on living labs. First, it explores the definition of living labs, looking at its characteristics and role it plays in the innovation process. Next, the study looks at how living labs can be related to commons and commons-based peer production and the need for research regarding the interface of these topics.

### 2.3.1 What are Living Labs?

There are diverse definitions of living labs in the literature. The definition used to define the concept in this study is, “living labs are physical regions or virtual realities, or interaction spaces, in which stakeholders from public-private-people partnerships (4Ps) of companies, public agencies, universities, users, and other stakeholders, all collaborating for creation, prototyping, validating, and testing of new technologies, services, products, and systems in real-life contexts" (Westerlund & Leminen, 2011). This definition also agrees with the definition provided by the European Network of Living Labs (ENoLL) – an umbrella organisation for living labs around the world (Hossain, Leminen, & Westerlund, 2019). The numbers of living labs operating all over the world and the number of research publication around it have significantly grown over the years, many labelling this as a living labs "movement" (Leminen & Westerlund, 2019).

Despite the growing level of interest from scholars, practitioners and policymakers in the past decade, the concept of Living labs still eludes many (Hossain et al., 2019). One reason for this is the multiple meanings associated with the term living labs. The term can be associated with five distinct meanings, as it may refer to (1) an innovation system; (2) a real-life social setting involving technological experimentation; (3) an approach for involving users in the innovation process; (4) organisations facilitating the network, maintaining and developing its technological infrastructure and offering relevant services; or (5) the European living lab movement (Dutilleul, Birrer, & Mensink, 2010). This study will focus on the meaning 4 of Living labs where Living labs are an organisation that facilitate the living labs processes and the meaning 1 through 3 are treated as the system they facilitate, the context they work in and the approach they have respectively.

Additionally, the concept has evolved over time and with different meanings associated with it at different phases of its development. The development of living labs has taken place in three consecutive phases: (1) the beginning phase was living labs were just aimed at observing real-life situations with studies dominated by American scholars (2) the pioneering phase where it spread out to Europe became more active and intertwined with involving the user to co-create in a real-life situation, and (3) the professional living labs phase where living labs became more formalised and started standardising tools and procedure they use (Leminen & Westerlund, 2019). One way to get a better understanding of living labs is through its defining characteristics.

#### 2.3.1.1 Characteristics of Living Labs

One essential characteristic of a Living Labs is that they operate in a real-world setting (Ballon, Pierson, & Delaere, 2005; Gascó, 2017; Hossain et al., 2019; Leminen, 2015; Steen & van Bueren, 2017; van Geenhuizen, 2018). The idea that living labs operate in a real-world environment is unanimously agreed upon by the living labs scholars. However, there is no agreement if these real-world environments include virtual realities or just the physical environment (Steen & van Bueren, 2017). Living Labs are valuable because it allows test and experimentation activities to take place in the real-life context with all its associated complexities (Ballon et al., 2005).

Living labs involve diverse sets of participants from the public sector, the private sector, citizens/end users, as well as educational institutions like universities (Leminen, 2015; Steen & van Bueren, 2017). The involvement of these participants should be as active partners, and they should be able to influence the innovation process (Hossain et al., 2019; Steen & van Bueren, 2017). Studies have categorised these stakeholders differently as providers, utilisers, users and enablers (Leminen, 2013).

Living labs act as a testbed for innovation where users are involved early on in the innovation process (Ballon et al., 2005). Rather than just involving the users in the testing process living labs seek to seek this solutions co-creating with the users (Dutilleul et al., 2010; Gascó, 2017; Steen & van Bueren, 2017). Despite co-creation being an essential aspect of living labs, the practice side shows just a few living labs indeed involve users during the co-creation process (Dutilleul et al., 2010; Steen & van Bueren, 2017). Also, the impact that living labs have on digital innovation by involving users in the innovation process has not been appropriately studied (Ballon, Van Hoed, & Schuurman, 2018).

Living labs also serve as networks for people with a diverse set of experiences, providing them with a space to meet and exchange ideas (Gascó, 2017; Leminen et al., 2012). Also, there is an element of knowledge sharing among the living labs network, and the network that they form may range from local to global levels (Hooli, Jauhiainen, & Lähde, 2016; van Geenhuizen, 2018). Each of these actors associated with the network might have evolving and multiple roles at any given point of time. (Nyström, Leminen, Westerlund, & Kortelainen, 2014)

Sustainability is one of the essential goals of living labs, especially in the context of urban transition for urban living labs (Steen & van Bueren, 2017). Also, in the context of developing countries living labs are motivated by the goal to create new business models for self-sustainability (Hooli et al., 2016).

#### 2.3.1.2 Roles of Living Labs

Now from these characteristics, we can draw out a particular set of roles that the living labs play as intermediaries in an open innovation ecosystem. The following are the different set of roles of living labs identified from the literature.

1. They provide a way to tackle complex real-life problems by working in real-life context and environment with all its associated complexities. (Gascó, 2017; Hossain et al., 2019; Leminen, 2015)

2. They enable open collaboration between multiple actors from different background and with different experiences (Leminen, 2013; Steen & van Bueren, 2017).

3. They engage and motivate users and include them in the overall innovation process (Gascó, 2017; Steen & van Bueren, 2017).

4. They are involved in the development of a sustainable solution for innovation (Steen & van Bueren, 2017).

5. They localise global innovations for a local context (Hooli et al., 2016).

6. They create opportunities for new business models through innovation and user involvement, thus leading to unexpected market opportunities (Hooli et al., 2016).

### 2.3.2 Living Labs and Commons-based Peer Production

Despite the seeming fit between living labs and commons-based peer production, the interface between the two has been almost unexplored in the academic literature. Web of science topic search for living labs and peer production gave just six results.

However, some studies have explored the relationship between commons-based peer production and other similar concepts like hackerspace and maker space (Kostakis et al., 2015; Niaros, Kostakis, & Drechsler, 2017). These study highlight the community-building potential, learning potential, and innovation potential of such spaces being beneficial for peer production (Niaros et al., 2017).

## 2.4 Summary

The research, as well as practice of disaster management, is moving from ex-post to ex-ante and the concept of risk and disaster risk reduction is gaining popularity among both practitioners and academics (McCallum et al., 2016). An essential aspect of DRR is the idea of CBDRR focusing on collaboration and utilization of local knowledge (Haque, 2019). ICT and collaborative technologies are complementary to CBDRR practices (W. Liu et al., 2018). The utility of peer-produced information during the crisis has given rise to a new field of study called crisis informatics (Palen & Anderson, 2016).

Another central idea explored in the literature review was that of the commons. Commons are resources with shared utility and interest to a group of stakeholders (Digital Library of the Commons, n.d.). Communities that form around the common are best suited to manage and govern the commons (Bauwens et al., 2019; Ostrom et al., 1999). The community come up with rules to best utilize the commons for each member, without depleting the commons (Ostrom, 1990). The commons are also present in the digital realm. One example is the free and open-source software enabled by the free software movement and open licensing (Bonaccorsi & Rossi, 2003). Open licensing has also enabled digital commons to go beyond software and move to other creative endeavours (Lin et al., 2006). One example is Wikipedia, which is an immense peer-produced encyclopedia with content in over 200 different languages (Yang & Lai, 2010).

With technologies enabling non-coercive and non-hierarchical social relations at a larger scale, a new mode of production is taking form (Bauwens et al., 2019). This mode of production labelled as commons-based peer production is enabling value creation of content, relevance, and even infrastructures (Benkler, 2006). An ecosystem forms around commons created by peer production. The ecosystem consists of the commons itself as well as the productive community that enriches the commons, institution that protects the ecosystem, and for-profit enterprises that add value to the commons (Bauwens et al., 2019). This ecosystem enables a sustainable economy based on commons as well as protects the commons.

Living Labs are institutions or projects that provide structure and governance to co-create user-centred innovations and at the same time, test and prototype these innovations in a real-world context (Leminen et al., 2012). Living labs act as intermediaries in an open innovation ecosystem and usually work in real-life context to cocreate innovations through the collaboration of multiple stakeholders (Leminen, 2015). Living labs play various roles like providing real-world context, enabling open collaboration, engaging users, localizing innovations, and creating new business opportunities. There seems to a fit between living labs and commons-based peer production, but this area is yet unexplored in the academic literature. Some studies done with similar concepts show that such intermediaries allow community building, learning and innovation potential (Niaros et al., 2017).

# 3 Research Methodology

This section discusses the method used to conduct the study. The first part of the section looks at various design choices made for the research and justifies these choices. The second part will look at how the data was collected and analyzed. Finally, this section will discuss the limitations that are present in the study and the attempt to reduce such limitations.

## 3.1 Research Design

The study follows a single case, case study approach, which is well suited to the exploratory nature of the research questions raised in this study (Yin, 2018). The case study approach will allow the development of in-depth and context-specific knowledge regarding the role played by living labs during the process of commons-based peer production in context to disaster resilience (Yin, 2018). Such context-specific knowledge is vital for developing a nuanced view of reality as well as for the researcher's skill development for research (Flyvbjerg, 2006). Literature relating to the disaster risk resilience, living labs and commons-based peer production were studied, to develop the case study procedures. The design of the case, and later, the analysis of the collected data was done based on the literature study (Yin, 2018). The case study follows a single case holistic study approach (Yin, 2018) where the unit of analysis is Kathmandu Living Labs and the context of the study is Nepal earthquake 2015.

The work done by Kathmandu Living Labs during the Nepal earthquake 2015 is "unusual" and "revelatory" case for commons-based peer production given the context of disaster response. The case has some significant characteristics that make it unique. First, the case is among the few limited cases where an established institution working on the ground is present to support the global humanitarian response and the relief providers during the time of humanitarian crisis. Second, the response from the global community mappers and the remote participation in the activation was the largest among all the activations. These two characteristics make the case something that is not seen in everyday occurrences making is a good case for a single case, case study (Yin, 2018). Finally, since Kathmandu Living Labs has been working on DRR since 2013, this case presents an opportunity to have a holistic picture of its impact in terms of providing the both ex-ante and ex-post impact of living labs in the light of disaster risk reduction. This fact allows the study to observe something inaccessible before; therefore, the choice of case study design (Yin, 2018).

### 3.2 Data Collection and Analysis

Data was collected using semi-structured interviews. Interview data is well suited for the case study because they provide explanations as well are insights form interviewee's perspective (Yin, 2018). The study identified four groups of respondents to get a holistic picture of the case. The groups are (i) local digital volunteers who helped to man and to manage the Quakemap platform (ii) remote volunteers and community mobilizers who were digitally creating maps in OpenStreetMap from all over the world (iii) members of the KLL core team (iv) humanitarian actors who were users of the data created during this phase. Based on the studied literature, guidelines and question have been created for each group of interviewees. The guidelines presented a framework for asking questions to draw out the necessary information for answering the research questions. The guidelines are attached in the Appendix.

In total, nine interviews were conducted covering individuals from the first three groups. The interviews were conducted remotely using Zencaster[1] for recording audio. The interview was done in the language preferred by the respondents. Out of the nine, five were conducted in English while four were conducted in Nepali. Since it was not possible to connect with anybody belonging to the humanitarian responders who were involved in the response, secondary data sources from reports and literature were used to cover the fourth group.

Three interviews were conducted with local volunteers who were among the first volunteers involved with running the Quakemap platform. These volunteers were queried regarding their connection with KLL, their roles as volunteers, workflow, and process of Quakemap reports and support provided to them by KLL. Two core members of the KLL team were interviewed regarding their role and involvement in the whole response. They were also queried on their interaction with the volunteers and relief organizations. Other points of enquiry were on the impact of post-earthquake work on the response and the reusability of the produced data and workflow for future disaster and non-disaster scenarios.

Four global volunteers based on four different geographic locations were interviewed to get the perspective of remote mappers. These remote mappers are also community mobilizers in their respective community and were heavily involved in coordination tasks during the Nepal Earthquake response. The following table provides brief profiles of all the interviewees from whom the data was collected.

[1] Zencaster is a podcasting software and allows audio interviews without the interviewees having to sign up or install any software. The quality of audio is also considerably better as the audio is recoded on the interviewees end with their mic and uploaded to the cloud as the interview is being conducted.

| **Code** | **Gender** | **Group** | **Profile** |
| --- | --- | --- | --- |
| V1 | Male | Local Volunteer | One of the first volunteers for Quakemap. From a tech background, experienced programmer and leads a tech startup in Nepal. |
| V2 | Female | Local Volunteer | Quakemap volunteer joined relatively later but was a central volunteer to defining Quakemap process. From a non-tech background. |
| V3 | Male | Local Volunteer | Quakemap volunteer. Tech background, mobile application developer. |
| K1 | Male | KLL Core Member | Core member of the KLL team during crisis. Involved in strategic planning of the response from KLL side. Currently leads a tech startup in US. |
| K2 | Female | KLL Core Member | Core member of KLL team and a geomatics engineer. Involved in communication aspect of the response from the KLL side. |
| M1 | Male | Remote Mapper | Remote activation lead for the Nepal earthquake response. Several years of experience as a community mobilizer and activation coordinator. Based in Canada. |
| M2 | Male | Remote Mapper | First person to start the discussion in the mailing list. Community leader and mobilizer based in the Philippines. |
| M3 | Male | Remote Mapper | The executive director of the Humanitarian OpenStreetMap Team. Joined as the executive director five days after the Nepal earthquake and based in the US. |
| M4 | Female | Remote Mapper | Researcher and remote mapper. Previously worked with HOT and KLL. Based in Germany. |

**Table 1** List of interviewees for primary data collection

Yin (2018) suggests that a good case study relies on multiple sources of evidence. Various secondary sources were also used to complement the primary data collected from interviews. Humanitarian OpenStreetMap mailing list archives were the first source of this secondary data. The mails from April 25th, 2015 to June 30th, 2015, sent in the mailing list were studied to get a clearer picture of the conversation happening in the community. The mails were also used to understand how the coordination took place after the earthquake. The second source of secondary data was the daily blogs published by Kathmandu Living Labs after the earthquake, labelled as situation reports. The blog posts were used to refine the information provided in the interviews as well as to get a better understanding of the activities conducted by Kathmandu Living Labs on the ground. The last source of secondary data was the Nepal Earthquake 2015 wiki page in OpenStreetMap wiki. The page provided archives of all the tools, tasks and news related to OpenStreetMap during that period and was a valuable complementary resource.

The analysis of case study evidence is not a well-developed field, and there are no established formulas for case study evidence analysis (Yin, 2018). Yin (2018) advises developing a customized way to analyze case study data with an analytical strategy in mind. This study uses the strategy for looking for patterns in the data based on the literature, as suggested by Yin (2018). The data from the interviews were transcribed and coded. The four interviews that were conducted in Nepali was translated during the transcription. The coding was based on a literature study. The coded data were then analyzed for patterns.

The interview data gathered stories from the perspectives of three different group of people. Each of these stories was individually searched for insights into the research question using the above mentioned analytical strategy. The different narratives were also compared and connected to form a shared narrative. Apart from analyzing the interview data, business process modelling techniques were used to get a clearer picture of the process of response and the involvement of different actors in the response. The resulting process diagrams were modelled using the BPMN notations, and they aided in connecting the different stories to come up with a shared narrative. BPMN was chosen as modelling language because of its capabilities in representing complex business process involving multiple actors along with its extensive familiarity and usage in academia and practice (Geiger, Harrer, Lenhard, & Wirtz, 2018).

## 3.3 Limitations

One limitation of the study is the fact that the interviews were conducted five years after the event. On the one hand, the interviewees would have had multiple chances to reflect upon the incident in the past years. However, there is also a possibility that they might have forgotten and missed out details. The study tries to overcome this limitation with the use of secondary data. Details provided in the interviews were corroborated and cross-checked using the secondary data for correctness and accuracy.

Another limitation of the study lies in the selected time horizon for the study. The scope of the time horizon was purposefully limited to the response phase of the event. Covering the time, when KLL was working on community building activities before the earthquake and evolution of KLL during the recovery and rehabilitation would have provided more evidence and better insights but was not possible given the scope of the study.

The interview data misses an important group concerned with the study. The humanitarian responders were the primary users of the produced data. They could provide insights into how the peer-produced data was used for their work and how they integrated it into their existing workflows. Lack of representation of this group in the primary data is a limitation but was significantly reduced using secondary sources. The use of data by these humanitarian organization and the process associated with it were available in official reports.

# 4 Case Description

This chapter will describe the various aspect of the case study. The first section will introduce the OpenStreetMap and OpenStreetMap Foundation. Then it will introduce the Humanitarian OpenStreetMap Team and how HOT activation happens to respond to the global humanitarian crisis. The second section describes how mapping is done in OpenStreetMap and how the Tasking Manager tool is to coordinate mapping during the crisis. The third section introduces Kathmandu Living Labs and provides a timeline of activities it was involved for earthquake response. Finally, the last section will look at Quakemap and an example workflow of a single report in a Quakemap system.

## 4.1 OpenStreetMap and Humanitarian OpenStreetMap Team

OpenStreetMap is a project started to collaboratively create a free wiki map data of the world by Steve Coast in 2004. Thousands of volunteers working to create map data are the primary driving force of the OpenStreetMap project (Haklay & Weber, 2008). As of July 2020, OpenStreetMap has more than 6.6 million registered users (OpenStreetMap, n.d.). These volunteers use GPS enabled mobile devices, satellite imagery and various other open data sources to map in OpenStreetMap. Contributors own the resulting data, and the data is available for anyone to use under the Open Database License (OpenStreetMap Foundation, n.d.-b). The data can be used to create paper maps, digital maps, and various other maps-based services like navigation and routing for both commercial and non-commercial uses. The only condition is that the users of the data must appropriately attribute the original creator and share the derivative work under a compatible open licence (Open Data Commons, n.d.).

The OpenStreetMap Foundation was established in 2006 to protect and support the OpenStreetMap project. The foundation is registered in the UK and acts as the legal entity for the project. Two major works of the foundation are to raise funds for running necessary infrastructure for OpenStreetMap and organizing the annual State of the Map conference. There are various working groups (Licencing, Data Quality, Operations, Engineering and Communications) that look at various aspects of running the OpenStreetMap project (OpenStreetMap Foundation, n.d.-c). There are also special committees (like the diversity and inclusion special committee and the microgrants committee) which are formed to take care of specific issues or work on specific non-recurring tasks related to OpenStreetMap (OpenStreetMap Foundation, n.d.-a).

OpenStreetMap was widely used in the 2010 Haiti earthquake by numerous humanitarian actors prompting the humanitarian sector as one of the leading users of OpenStreetMap. Coordinating this effort of humanitarian mapping efforts in

OpenStreetMap is a team appropriately called the Humanitarian OpenStreetMap Team. The Humanitarian OpenStreetMap Team was registered in August 2010 as a non-profit in the US after observing the benefits of collaborative mapping for humanitarian needs during the 2010 Haiti earthquake.  HOT is actively involved in facilitating volunteers to create map data during a humanitarian response. HOT is also involved in the development of tools used by volunteers to coordinate and create map data during a crisis. Additionally, the Humanitarian OpenStreetMap Team have also been involved in supporting the growth of local communities as well as developing teaching and learning resources for mapping in OpenStreetMap.

Global mapping during a humanitarian crisis is coordinated by having activations which is a way to mobilize digital volunteers. Humanitarian OpenStreetMap was working on developing an activation protocol with their experience in responding to the Ebola crisis. When the earthquake hit an activation was declared by sending a message to the mailing list. Based on the data needs and area of impact of the disaster, the number of leaders and support team is decided. In the case of Nepal Earthquake, the activation was managed by three leads consisting of two volunteers from Montreal, Canada and Manila, Philippines and the local community led by KLL. The three different volunteers were in different time zones which allowed the community to be active throughout the clock.

Once the activation team was formed, they were involved in different activities. One of the major activities was to identify the data needs, areas to be mapped, and priorities of these needs if there are multiple. Based on these needs, mapping tasks were created to allow mapper to coordinate their mapping efforts properly. Also, there was a need to find post-disaster satellite imagery good enough to aid these mapping efforts. This task was especially challenging for Nepal activation because of the cloud and monsoon season. Once the data is created there is also a need to make it available to humanitarian responders on the field. In the case of Nepal activation, there was a site that provided extracts of data downloads of the affected areas, which was updated on an hourly basis.

Another equally important aspect for the coordination team was the communication side of the activation. Once the tasks are created there is a need to motivate the global volunteers to start contributing to these tasks. The activation team is involved in reaching out to these remote mappers and urging them to map the affected area. In the case of activation of Nepal daily updates provided by KLL in their blog played an important role in this. This gave the volunteers a chance to realize that they were working on actual needs and find how the data was used in the field. Another aspect of communication was media relations, where the appropriate person would talk to different media outlets and give interviews.

Once the data requests are fulfilled, the activations go to a closing phase. During this phase, the activation team, with the help of experienced mappers, will review the map data created during the relief. The mapping tasks are completed and archived. The activation team reviews the activation and closes it.

## 4.2 Mapping in OpenStreetMap

Mapping in OpenStreetMap is done by mappers all around the world using different available tools with the help of satellite imagery and GPS. Users need to register for a free OpenStreetMap account and then can use different tools to trace features like roads, buildings, rivers, and land use. The traced geospatial data is then complemented with attribute data that comes from the field. For example, a remote user can trace a road by looking at the satellite imagery and then a local mapper will add things like the name, use and surface type of the road. Figure 4-1 illustrates a remote mapping tool used by OpenStreetMap volunteers to create map data.

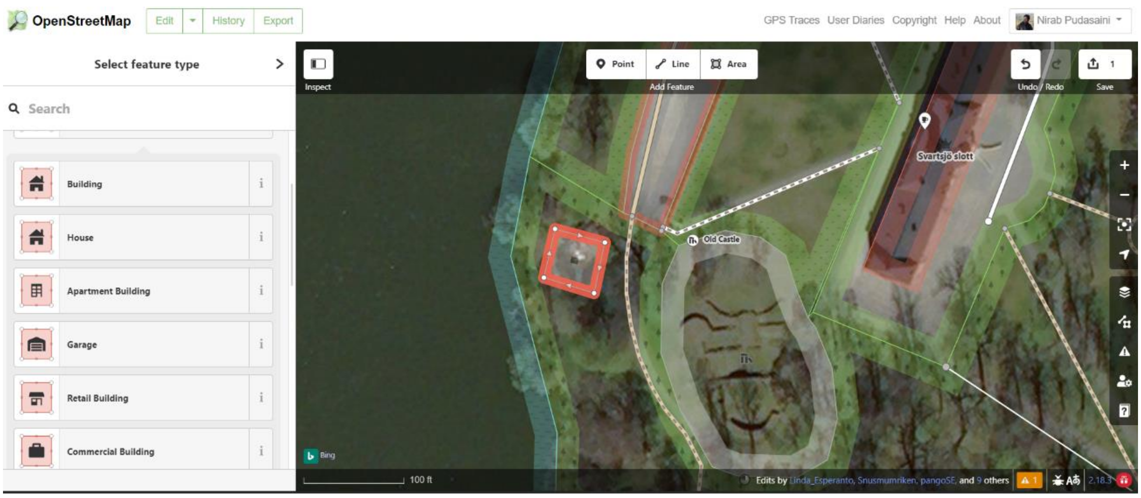



**Figure 4-1** Remote mapping in OSM using satellite imagery

Since this is a global database, there is a set of rules on how each feature is represented in the database. Each feature is represented using key-value pairs known as tags. These tags are based on best practices defined within the community through discussions in the mailing lists and wiki. These best practices are documented and available in the wiki and are called tagging guidelines. This approach to mapping allows a lot of people to work together to build a single database.

This approach to mapping, however, poses a significant challenge to mapping during a crisis. During a crisis, there can be a high concentration of mappers mapping in a single area. This poses a risk that they can be editing the same feature at the same time causing edit conflicts. Also, there can be a risk of duplication of work due to mappers tracing and uploading the same new feature. This will also cause data quality issues as the database will contain multiple data for the same feature. Additionally, it is tough to track the completeness and the correctness of the mapping when the users are distributed and mapping independently.

To overcome these challenges and coordinate the mapping efforts of remote mappers, HOT developed a tool called tasking manager. Tasking Manager is used for coordinating mapping efforts in all humanitarian response involving OpenStreetMap. Tasking manager allows the volunteer coordinating the response to define areas and features that to be mapped. Along with the area and features, coordinators include details like how to carry out the mapping, if this is a task suitable for beginner or an expert, and what imagery to use to do the mapping. Figure 4-2 shows an example of one such task created in the HOT tasking manager for mapping building, roads and waterways for an area that was highly affected by an earthquake.

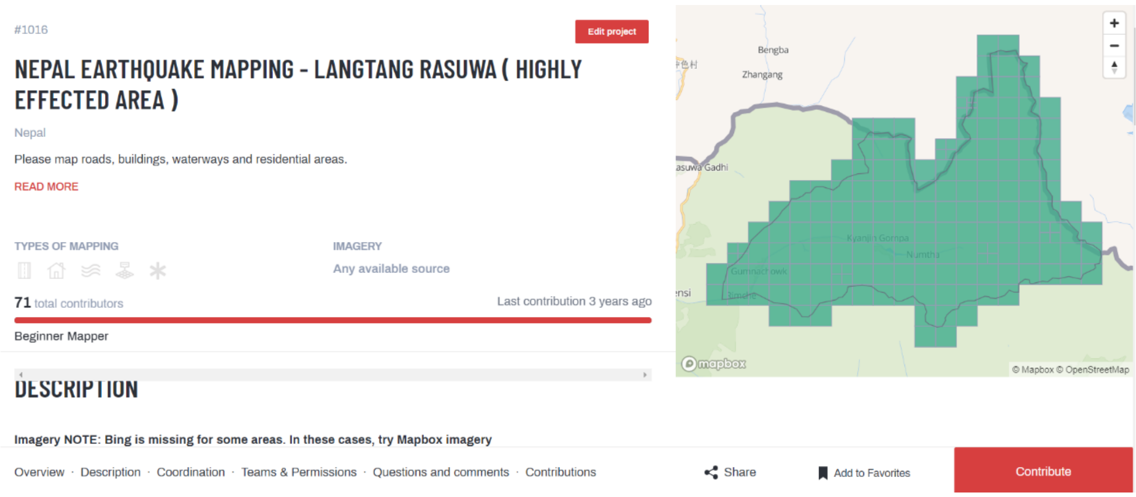



**Figure 4-2** Task created in tasking manager during Nepal earthquake response

The larger area consists of smaller squares which can be picked and locked by a single mapper. The locked indicator informs other mappers that someone is already working in that area and not to duplicate the work there. When the mapper completes mapping all the features described in the task for the square, they can mark the square as complete.

Completed squares are marked in a different colour so that it is easier for volunteers to pick a non-completed task. Experienced users check if the tasks were adequately done by selecting the completed square then validating them. If the experienced mappers find everything complete and correct, they mark the tasks as validated.

### 4.3 Kathmandu Living Labs

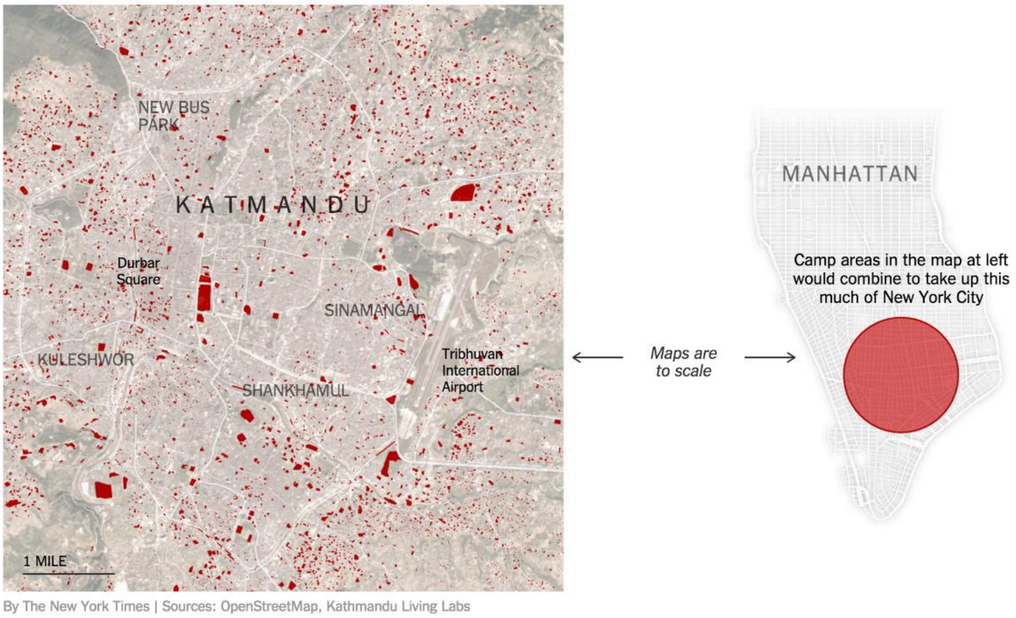
Kathmandu Living Labs started in 2012 as an Open Cities initiative by the World Bank's GFDRR unit. The idea was to collect structural data for all the schools and hospitals in Kathmandu Valley, which would help in understanding the associated risk and assist with disaster preparedness. The data was collected using a participatory and open approach by the team in OpenStreetMap. The team first created base map layers for Kathmandu with road network, buildings, and POIs. The structural data for school and hospitals were collected through field survey by the core team and then added to the created spatial data. The data was made and is freely available from the OpenStreetMap platform. Apart from work done by the core team, there was also an investment in growing the OpenStreetMap community by providing training and workshops to hundreds of volunteers. The community outreach was mostly done by 'mapping parties', especially for students from a different university. Mapping parties were workshop consisting of sensitization presentations and hands-on mapping. When the support from the World Bank ended in 2013, a non-profit institution was registered to utilize the local capacities developed during the project phase.

Kathmandu Living Labs continued in many different projects related to agriculture, disaster risk reduction and governance all centred around open data and OpenStreetMap. Kathmandu Living Labs were working on these projects while the earthquake struck on April 25, 2015.

The core team of KLL got together and started communication with the international volunteer community from the day of the earthquake itself. The initial communication was in the HOT mailing list where the KLL executive director notified about him being safe and still trying to get an accurate assessment of the ground situation. On the day after the earthquake KLL started working from the parking lot of their now damaged office. On the first day, the KLL team tried to get an assessment of the ground situation and deploy of the Quakemap platform, based on the opensource Ushahidi platform. The communication moved from the mailing list to Skype for quicker coordination.

There was a massive response from international mapping community with more than 1500 people involved in mapping the affected area within the first 48 hours. To keep up the enthusiasm and to update the daily situation on the ground, KLL starts communication with a daily blog post titled "situation reports". In the first situation report they explained the four things that they were involved in; (1) coordinating remote mapping efforts; (2) crowdsourcing damages and needs in the field; (3) creating printable maps form resulting OSM data; and (4) assisting relief workers who wanted to use the maps and other GIS services.

KLL started to get more request from volunteers and humanitarian organization for printable maps for relief operation. Among these was a request from Nepal Army for maps of internally displaced persons. This map request was relayed to satellite imagery providers as it required the latest satellite imagery and to remote mappers so that they can identify the camps/tents using the imagery and trace them. The army and other humanitarian agencies used the resulting data to create maps to aid their relief efforts. Figure 4-3 shows one such map from The New York Times using the OpenStreetMap data. KLL also started reaching out to responders Nepal Government's Health Emergency Operations Centre to install OSM offline maps to relief workers phones and to train them on using it. Demand for printable maps kept growing, and KLL launched a website to allow the download of printable maps and offline data for mobile.




Source: (Aisch et al., 2015)

**Figure 4-3** IDP camps mapped by OpenStreetMap volunteers

Meanwhile, KLL's work was getting coverage from both the national and international news media. It also got recognition from the government with the National Information Technology Centre listing Quakemap in its list of relevant local earthquake initiative. The news coverage and NITC listing led to the work getting traction due to gaining of popularity as well as some form of authority. The initial enthusiasm for mapping from remote mapper continued along with the reports coming to Quakemap platform increasing. Figure 4-4 shows a mail sent to KLL, by a user of Quakemap, requesting to close the report after getting the required assistance. This figure illustrates that Quakemap had become a credible platform for reporting needs and also for recognising ground needs.

Thu 4/30/2015 5:59 PM

Milo van der Linden <milo@dogodigi.net>

**Please sign off message on quakemap.org**

To quake@kathmandulivinglabs.org

Click here to download pictures. To help protect your privacy, Outlook prevented automatic download of some pictures in this message.

Hello wonderful people at kathmandulivinglabs,

I entered a report at http://www.kathmandulivinglabs.org/earthquake/reports/view/526 and I am glad to report that help has arrived:

UPDATE: GREAT NEWS!! They have been evacuated from Bamboo Village to Dhunche (15km from Bamboo Village, much safer and easier for helicopters to land). They are now waiting to be airlifted to go to Kathmandu. Let's hope this will happen soon! Thank you all so much for all the messages of support and help. They are much appreciated.

Could you please close the report at http://www.kathmandulivinglabs.org/earthquake/reports/view/526 as I think it is important this one gets no more attention and rescueworkers are not misled by reports that are of no use anymore.

Keep up the good work, You people save lives and I have a lot of respect for the hard work you do!

--

Source: (Kathmandu Living Labs, 2015c)

**Figure 4-4** Quakemap used for requesting rescue

On May 21 there was a second earthquake of magnitude 7.1. Since the space that KLL was working on was no longer available after the second quake, they moved to another space provided by a school. The remote mapping work shifted to mapping landslide affected areas for landslides that were caused by the second quake. KLL continued their response work being involved in other projects like school damage assessment and using UAV for mapping affected areas until the end of October 2015.

## 4.4 Quakemap deployment

On April 26, KLL deployed the Quakemap platform to bridge the information gap between rescue and relief efforts. This platform based on the open-source Ushahidi platform, not only bridged the information gap but also helped inform and expedite relief efforts with the help of reports from the ground. Despite the damage caused by the quake, communication mediums like internet, telephones, and SMS were still functional in many areas. The Quakemap platform utilized these communication means to capture the needs in the ground and facilitate two-way communication between the survivors of the quake and the organizations involved in the relief and rescue effort.

Figure 4-5 illustrates the homepage of the Quakemap platform. This page provides an overview of geolocated reports submitted to the platform. Similarly, the reports can also be filtered using its category or its actionable status. Also, the platform allowed exporting the reports in a CSV and other geo formats like KML. There was also an option to subscribe for new reports or to updates on specific report. However, the main feature of the platform was its ability to allow people to submit local need that was present on the ground.

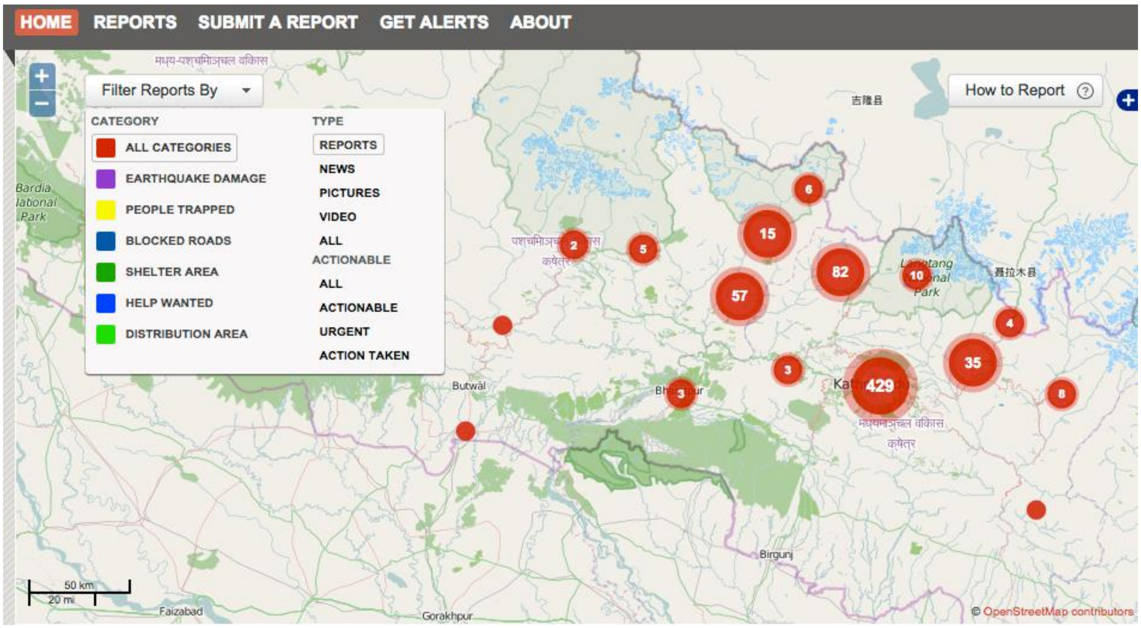
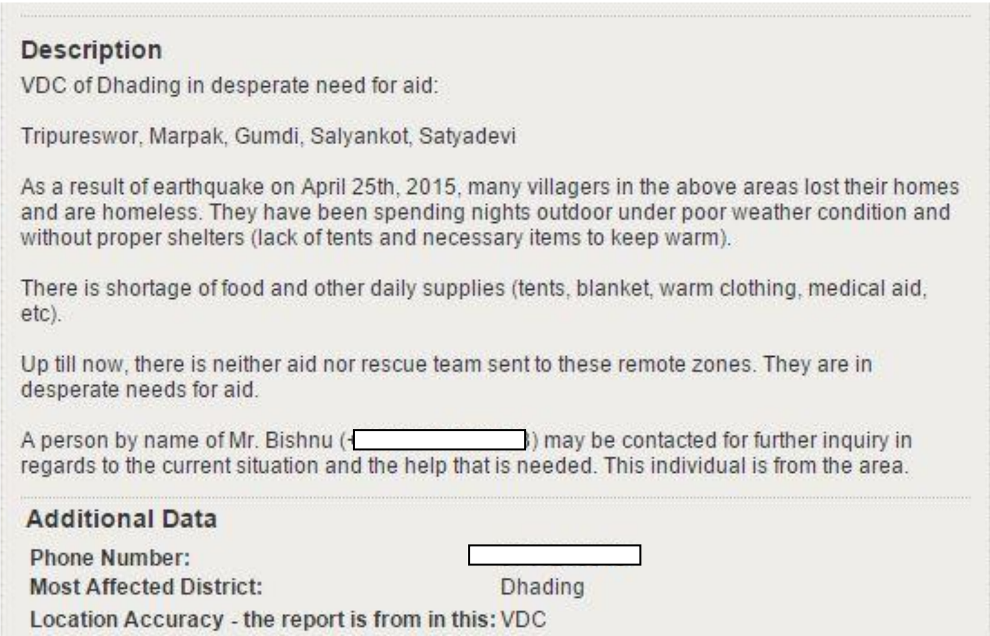



**Figure 4-5** Homepage of the Quakemap platform

This information was fed into Quakemap directly by people and organizations on the ground. The report could be submitted using SMS, email or filling out an online form in the platform. Figure 4-6 shows a report submitted to the Quakemap platform. These reports appeared in the Quakemap system only after going through a validation and verification process. The submitted reports would contain a title, description, and additional information if applicable. The reports would be categorised based on the type of the report. There were also actionable tags to track if the report needed some action, and if it was urgent. Another crucial aspect of the reports was geolocation. Each report had geolocation information, and the granularity of the geolocation could range from a municipality to geographic coordinates.



**Description**

VDC of Dhading in desperate need for aid:

Tripureswor, Marpak, Gumdi, Salyankot, Satyadevi

As a result of earthquake on April 25th, 2015, many villagers in the above areas lost their homes and are homeless. They have been spending nights outdoor under poor weather condition and without proper shelters (lack of tents and necessary items to keep warm).

There is shortage of food and other daily supplies (tents, blanket, warm clothing, medical aid, etc).

Up till now, there is neither aid nor rescue team sent to these remote zones. They are in desperate needs for aid.

A person by name of Mr. Bishnu ([redacted]) may be contacted for further inquiry in regards to the current situation and the help that is needed. This individual is from the area.

**Additional Data**

| | |
|---|---|
| **Phone Number:** | [redacted] |
| **Most Affected District:** | Dhading |
| **Location Accuracy - the report is from in this:** | VDC |

Source: (Kathmandu Living Labs, 2015d)

**Figure 4-6** Example of Report Submitted to the Quakemap Platform

After a report is submitted, it is checked for its locational accuracy and categorized into urgent, actionable, non-actionable reports. Only the approved reports are then acted upon by the Quakemap team. The first step of the process was to verify if the needs depicted in the report are still existing in the ground. A team of volunteers did the verification by contacting the original reporter using the contact number provided in the report. Sometimes, the volunteers may need to make multiple attempts to contact the person submitting the report. Figure 4-7 illustrates a comment updated by a volunteer after an initial unsuccessful attempt and then in the second comment; someone provides updated contact information for the volunteers.

**Comments**

**Ajita** (May 2 2015)
Mobile is switched off . So could not contact

**Jay** (May 3 2015)
Phone network maybe patchy in listed above remote affected areas. Try this contact:+977-[redacted](in addition to +9[redacted])...

Source: (Kathmandu Living Labs, 2015d)

**Figure 4-7** Multiple attempts by quakemap volunteer to contact the reporter

Once, the needs are verified once the volunteers get in touch with the on-ground contact mentioned in the report. The status of the report is changed to verified, and the conversation between the volunteer and the contact is updated in the comments. An example of this is illustrated in Figure 4-8.

**Aayush Khadka** (May 7 2015)
Sefali called Mr. Bishnu this morning who indicated that Ward number 6 and 7 of Tripureshwar VDC were in need of assistance. We called Helping Hands (Mr. Chirag Goyal; [redacted] and they will be following up with Mr. Bishnu directly. We have posted the information provided by Mr. Bishnu to Sefali in the Helping Hands facebook page as well. We were notified by Helping Hands that the best way to ensure they get the information is to post on their facebook group [Link: https://www.facebook.com/groups/1578409882410557/]

Source: (Kathmandu Living Labs, 2015d)

**Figure 4-8** Comment update by quakemap volunteer after contacting the reporter

Quakemap volunteers then matched the report using the location and need data articulated in the report with a list of organizations providing relief activities. Once the volunteer identified the proper organization, they contacted the identified organization with the needs mentioned in the report. The conversation with the organization was then summarized in the comments, as illustrated in Figure 4-8. In the figure, a Quakemap volunteer updates the comment section detailing how they were able to establish contact with a local person and how they have forwarded the help request to one of the response organization.

The responding organization could sign up for alerts for future reports that come into the system. The volunteer would follow up with the organization and check if they have addressed the needs. Figure 4-9 is an example comment providing an update by the responding organization regarding the relief it distributed based on the report.

**Pramendra Khadgi** (May 11 2015)
We went to Dhading Besi and met Bishnu. We delivered 370kg of rice, 25 kg of lentils, 30pck of salt, 3 boxes of oil, 4 boxes of noodles and 3 pcs of tent. We requested Bishnu to post pictures in facebook of distributing food to the villagers.

Source: (Kathmandu Living Labs, 2015d)

**Figure 4-9** Responder confirming aid delivery in Quakemap report

The report is not closed yet despite the relief provider updating about the relief being sent the concerned place. As illustrated in Figure 4-10, a Quakemap volunteer was calling to check if the needs were fully met. After calling the person who made the initial request, she found that tents, mats, and water purifiers were still needed.

**Upasana** (May 20 2015)
Tents, mats , and water purifier urgently needed .

**Leave A Comment**

Source: (Kathmandu Living Labs, 2015d)

**Figure 4-10** Volunteer verifying if needs are met and updating Quakemap report

QuakeMap report gets ‘closed’ only when no further action is required based on the contents of the original report and after also verifying that all the on-ground need is met.

The above section provided an overview of a workflow for one real report submitted to the Quakemap platform. During its deployment, Quakemap received 2031 total reports out of which 1289 reports were actionable (Ushahidi, n.d.-b).

# 5 Findings and Discussion

This chapter presents the findings of the study. The first section of the chapter will present the two cases of commons-based peer production observed in the study. Process of both cases is presented in BPMN models. The impact and use of these commons will also be discussed. The second section of the chapter will present the answer to the research question.

## 5.1 Commons-Based Peer Production During Nepal Earthquake

Peer production was happening in two ways during KLL's response to Nepal Earthquake 2015. One was the production of open geospatial data that was produced by thousands of volunteers around the world. The other was the crowdsourced needs information collected from the ground and the feedback provided by volunteers and responding agencies on the report regarding what action has been taken to address those needs. Both of this peer production activity resulted in a common as an output. The mapping resulted in addition to the OpenStreetMap, which is a free and open wiki map of the world. The crowdsource data collection resulted in the Quakemap platform that was accessible for anyone to add to or get information from to take some action for relief activities related to the earthquake.

The following sections will describe both commons-based peer productions initiative in detail. The section will provide details on the process of the peer production and then present the impact that output of these peer production efforts had in the overall earthquake response.

### 5.1.1 OpenStreetMap and Open Map Data

OpenStreetMap was the platform used to create open geospatial data during Nepal Earthquake 2015. The map data was created by thousands of global volunteers around the world. First Kathmandu Living Labs would interface with the agencies like Nepal Army and UN clusters to find out what map data was needed in what places. This information was conveyed to global coordination team over skype chats. If these areas lacked proper satellite imagery, a satellite imagery coordination team would make the request with the satellite imagery providers to provide images for that region, before starting the mapping. If satellite imagery is available, a mapping task was created using the tasking manager tool providing information on areas to map and what map features to trace. There could be multiple tasks at a single time, and they were marked with high, medium, and low priority based on their urgency. Volunteers are requested to work on high priority tasks first, but they were free to choose the task they want to work.

After this task is defined, the tasking manager tool allowed volunteers to lock a specific subsection of the defined area and start to map. The mapping consisted of looking at satellite imagery and tracing, roads, buildings, and brownfield sites. While that section is locked, no other volunteers can map in that area. Once all the features in the subsection are traced and uploaded the volunteer can mark a task as done. The task can also be unlocked without completing it if the volunteer wants to stop mapping. The task is also unlocked automatically after one and half hour. Similarly, volunteers can also select subsection marked as completed and verify if everything has been mapped correctly. This verification task is usually done by experienced mappers, and once they complete the verification, they mark the subsection as verified. Once all the subsections are mapped and verified, the mapping tasks are archived.

Parallel to the crating map data from mapping tasks, the coordination team made printable maps using the map data and made it available for downloads regularly on a website. The printable maps were updated daily and could be download and printed by the requesting agencies. Additionally, KLL also provided offline maps for mobile and taught the responders to download and use offline maps on their mobile phone. This offline map data was also processed daily and made available on a website by the coordination team. The process is illustrated in detail in Figure 5-1

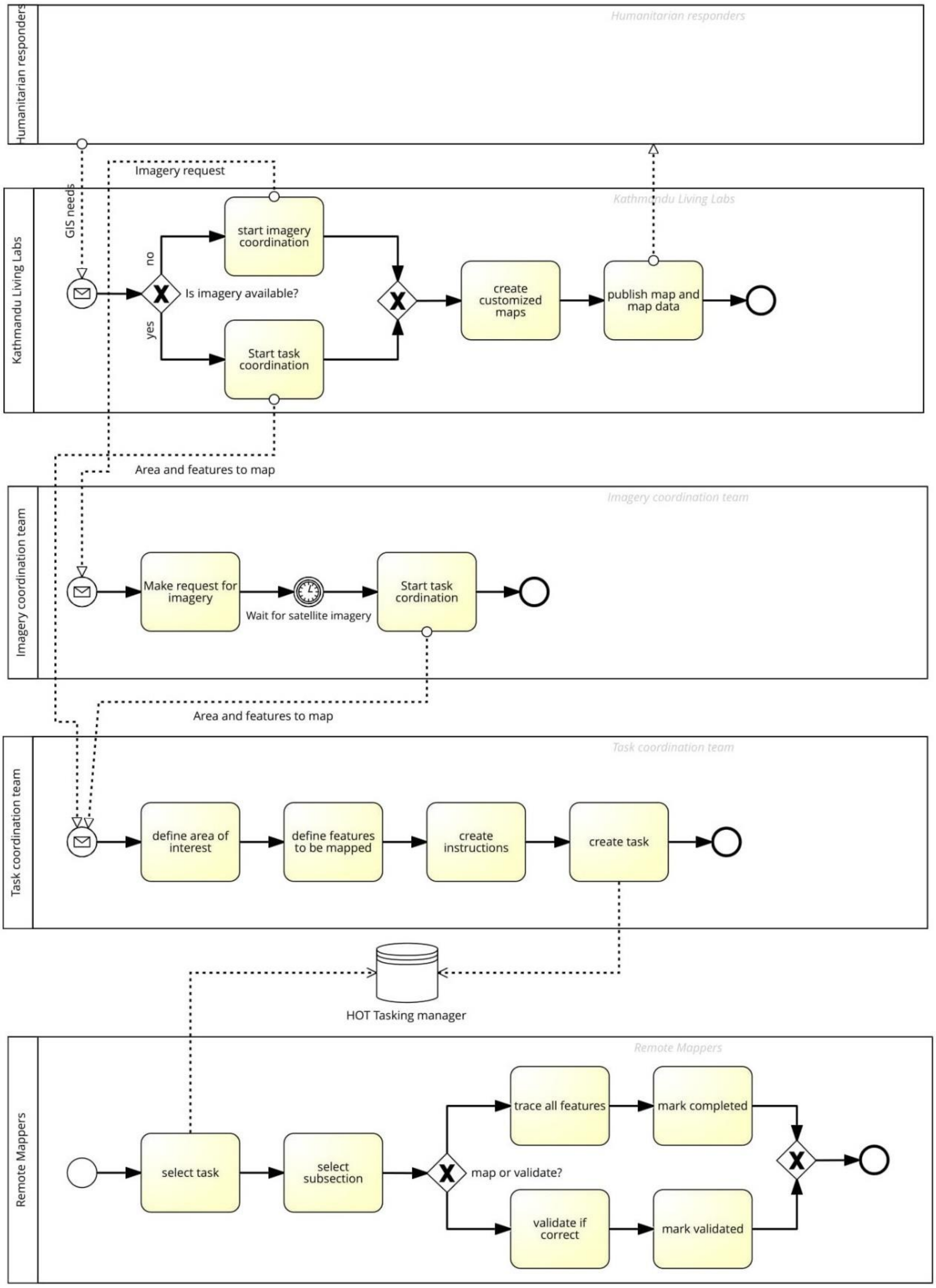
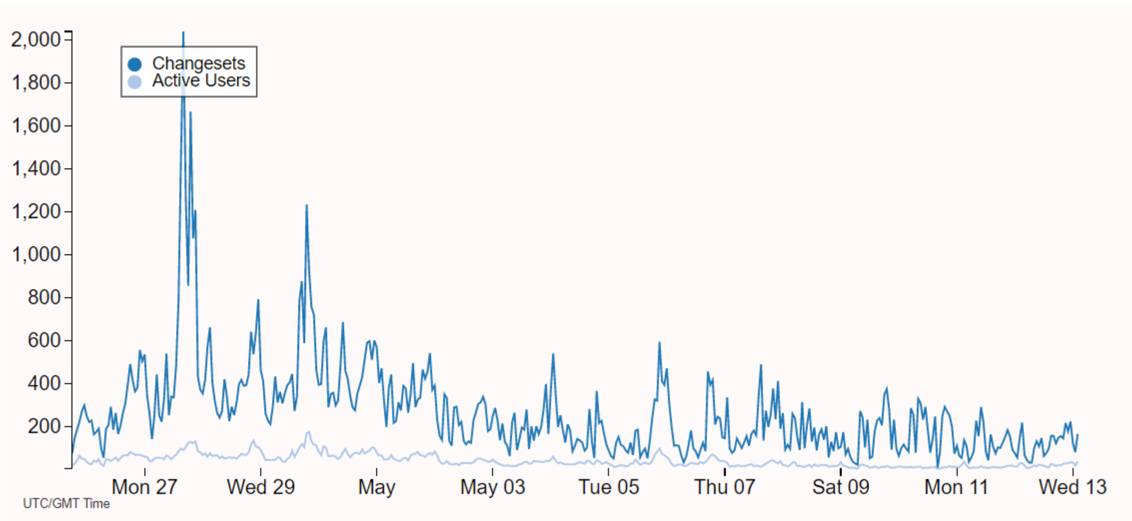



**Figure 5-1** BPMN for OSM task creation and coordination

In response to the Nepal earthquake, over 5,055 global volunteers from all over the world made more than 111,683 changes to the map of highly affected districts of Nepal. Out of all the mappers mapping for the activation, 3,544 of them mappers were new to OpenStreetMap(“Nepal Earthquake Mapping Summary Statistics,” n.d.). Figure 5-2 shows the activity of mapper in OpenStreetMap in the following days of Nepal earthquake 2015.




Source: (“Nepal Earthquake Mapping Summary Statistics,” n.d.)

**Figure 5-2** OpenStreetMap map changes and active users in Nepal immediately after the earthquake

This resulted in much better coverage of map data for many rural sections of Nepal. Figure 5-3 shows an example of a map for one municipality. The figure shows that map gaining considerable detail since KLL started its community-building activity in late 2012. Similarly, the map details have further increased to include small roads and building footprints after the earthquake.

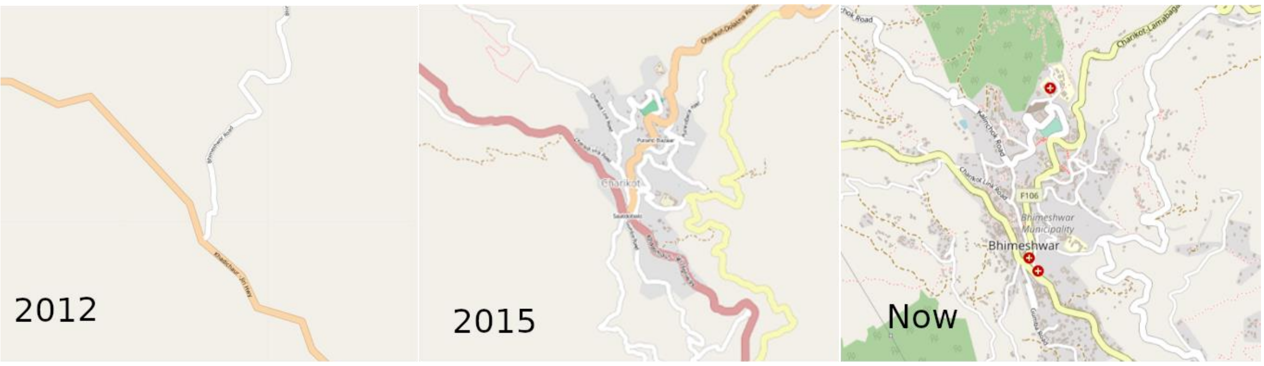



**Figure 5-3** Evolution of OSM of an earthquake affected municipality in Nepal over time

This data was an important resource for a lot of humanitarian organization to plan the logistics of their relief operations. In a report published regarding their earthquake operations, Nepal Army mentioned “Open source communities played a vital role in providing and managing crowd-sourced information. Their contribution in mapping road networks and other infrastructures added valuable information in GIS-based products. Updated open street map data was widely used by security forces in rescue and relief operations.”(Nepal Army, 2015, p. 40)

### 5.1.2 Quakemap and Crowdsourced Relief Data

Quakemap was the crowdsourced platform used to fill the information gap between relief provides providing humanitarian assistance in the field and the people on the ground needing that assistance. The people on the field could submit request or reports to the platform by filling out a form, sending SMS to a certain number, or calling the helpline number. This multiple approaches was adopted to reduce the barrier to submit the report and to allow most people to be able to submit their needs.

After a report is received in the system Quakemap volunteers verify it before it is available to everyone. The volunteers labelled as approvers create reports in the system for email and SMS while edited the reports in the form for clarity. Then they checked the accuracy of the location in the reports. Sometimes there were discrepancies between the description and location which were corrected by the volunteers. Then the report was assigned a correct category based on factors like if it was a request for rescue, assistance in terms of help, or various other things. The category of reports in Quakemap evolved with time and experience with the new category being added and removed. Finally, the report is assigned an actionable status based on if it needed some action or was just an update or report. If the volunteers were able to do this, they would approve the report; otherwise, the reports were closed.

Additionally, the actionable reports could be reports in need of urgent assistance. If the report is urgent, it is forwarded to appropriate responder directly; also the verification process for such reports are expedited. All the approved reports go through the verification process. The verification is done by another set of volunteers called verifiers.

Verifiers call the people reporting to check for accuracy of the needs. If the needs match in the original report, the report is marked as verified. If the needs are different, they update the comments section with the new needs. Once the comment is updated comment approver team update the details of the report like action taken status, verification status, responding organization and action taken. The updating of report details is also done for all the other comments coming from the original or other reporters. Once the report is verified, it is sent to the dispatch team.

Dispatch team is tasked with contacting the responders working on the field for assistance in the report. A proactive approach was put in place so that the reports coming to the Quakemap system lead to some action. The dispatcher identified the correct organization to respond to the request from a w3 (who is doing what, where) list. This matching was done based on the location information present in the report and the type of assistance requested. Once the proper organization is identified, the volunteer contacted the organization to provide the necessary assistance. The volunteers provided responders with the report and queried on their capacity to respond to the request. Based on the response, they updated the information in reports. They also signed the responding organization for SMS alerts if they were interested. Figure 5-4 shows this process in detail using BPMN notation.

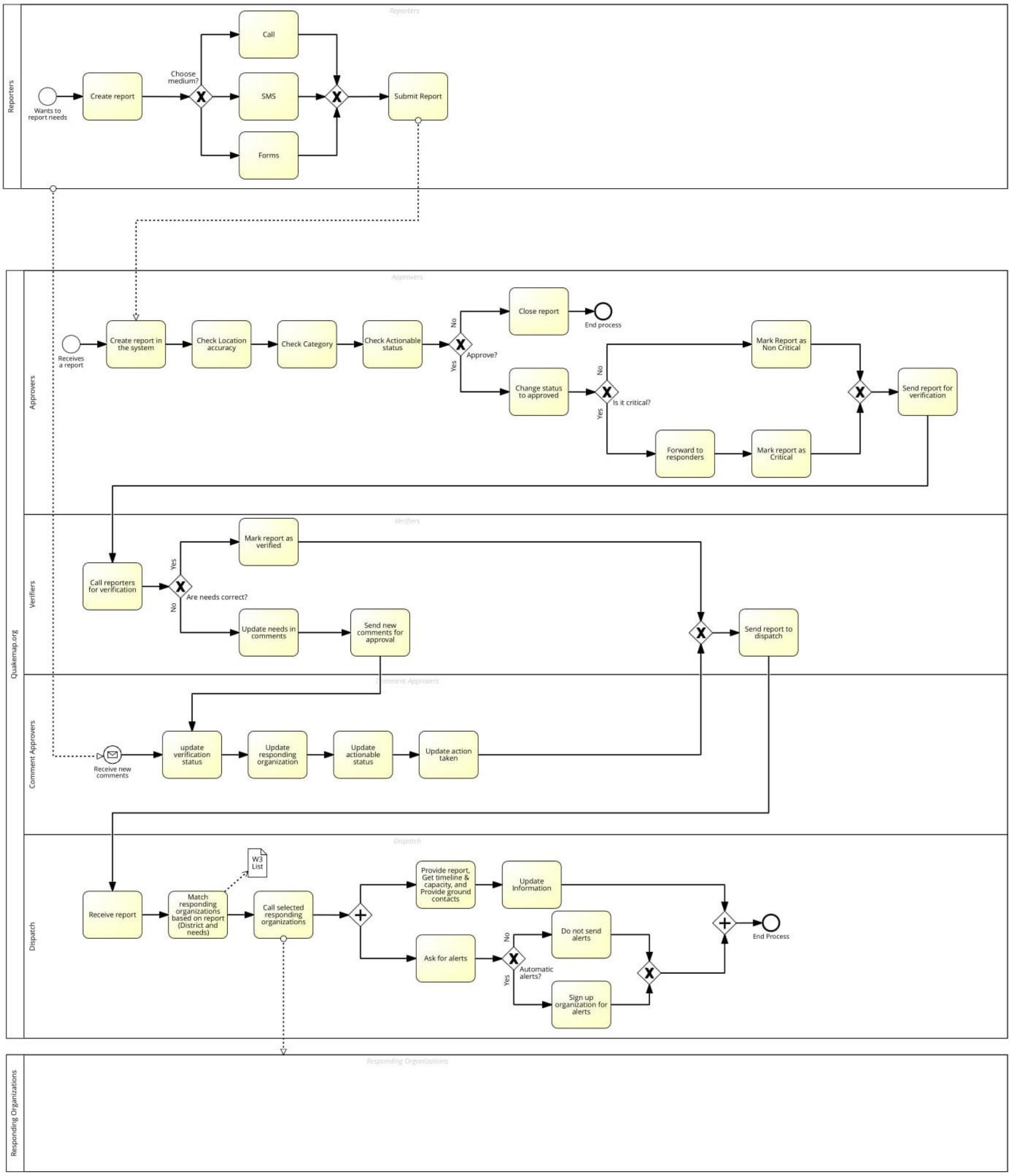
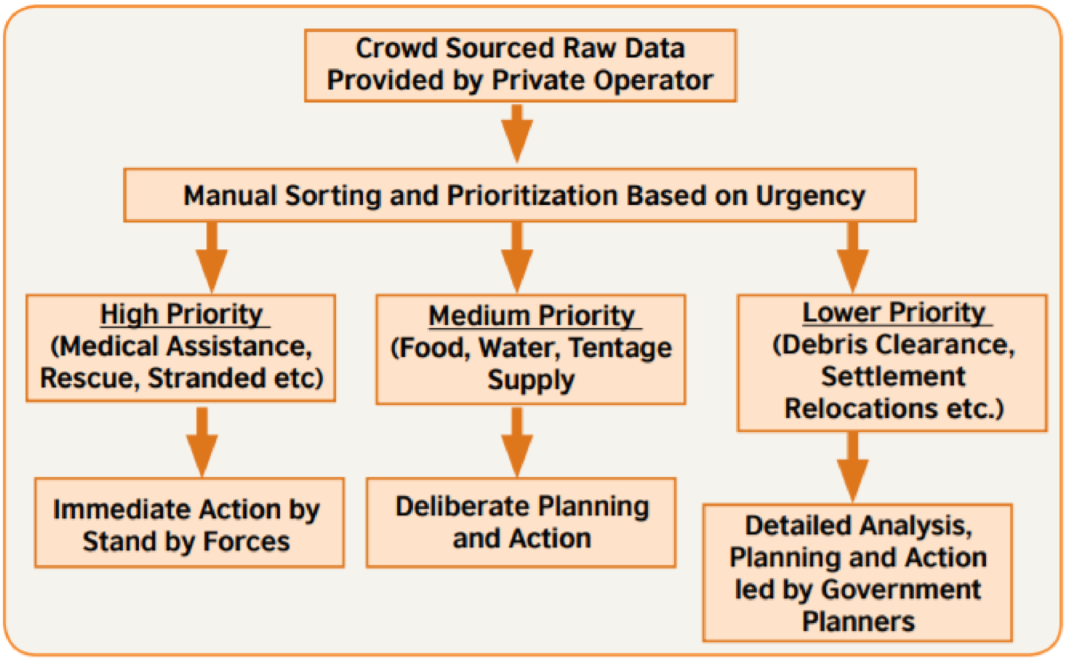



**Figure 5-4** BPMN diagram for the process of Quakemap report

Nepal Army used Quakemap as one of the primary data sources for its search and rescue operations. UN agencies used Quakemap aggregated data to inform its intervention plans and to create visualizations. Independent voluntary groups also used individual reports and responded to them. On a report published by Nepal Army regarding their earthquake response, they mentioned "Crowdsourced data added new dimension in rescue and relief operations. This information helped to identify instant needs of the affected population, gaps in rescue and relief operations, presence of security forces on the ground and ultimately plan for target specific operations. The Nepalese Army further processed the crowd-sourced data and used that information for planning operations." (Nepal Army, 2015, p. 38). Nepal Army did not act immediately upon the reports from Quakemap but developed and internal flow to integrate such data. Figure 5-5 shows the workflow adopted by the Nepal Army to integrate crowdsourced data into the relief operation.




Source: (Nepal Army, 2015)

**Figure 5-5** Nepal Army's Steps in Processing Crowdsourced Data

After receiving the data from Quakemap the army did manual sorting of data and prioritized them based on urgency. The urgency determined what action was taken by the army regarding the report.

## 5.2 Role of Living Labs

This section will look at the role of living labs in peer production. First, the section will discuss the role of livings labs based on the CBPP ecosystem of value creation. The case of OpenStreetMap and Quakemap will be discussed with the lens of CBPP ecosystem of value creation. Then, based on the interview, we provide five different roles played by living labs for value creation during the earthquake response.

As explained in the previous section, there were two different areas where commons-based peer production took place during Nepal earthquake. One was the deployment of Quakemap/Ushahidi platform to collect crowdsourced relief needs from the ground. The other was the production of open geospatial data in OpenStreetMap by thousands of volunteers mapping all over the world. For both of the cases, different components of the ecosystem have been mapped and summarized in Table 1.

| **Digital commons** | **Productive community** | **For-benefit association** | **Entrepreneurial coalition** |
|---|---|---|---|
| Quakemap | Local information volunteers, reporters submitting ground needs | KLL | Nepal army, local relief volunteers |
| OpenStreetMap | Global remote mappers | KLL, HOT | Nepal army, UN clusters, GIS units of responding agencies |

**Table 2** CBPP ecosystem during Nepal earthquake 2015

As already established in the previous section Quakemap and OpenStreetMap can be considered as digital commons. For Quakemap, the resource is the software code used to deploy the platform itself as well as the reports submitted into the system. The platform was modified from open-source Ushahidid to fit the need of earthquake response and reports expanded upon the existing platform to provide value. Similarly, for OpenStreetMap, the resource is the freely available geospatial data. This data can be used to make customized maps and can also be used on mobile phone for offline maps and navigation.

These commons were produced by productive communities of different volunteers. For Quakemap, there were two sets of people contributing to the commons. First was the people who reported the ground needs and sent it to the quakemap system. The second was the information volunteers, who curated these reports, added additional information to them, dispatched them to the responding organisations, and added functionality to the platform as deemed necessary. In the case of OpenStreetMap, the productive community were thousand of global mappers who were mapping to create open geospatial data.

The process of peer production was facilitated by for-benefit associations that acted to protect the common and empower the contributors. For Quakemap this institution was Kathmandu Living Labs. KLL deployed the Quakmap platform and provided infrastructure to run it. Additionally, it engaged the information volunteers and provided them with the necessary support to run the platform. In the case of OpenStreetMap KLL and the Humanitarian OpenStreetMap Team played this role. They worked together to guide the efforts of global mappers and facilitate it using tools like tasking manager. Additionally, they were also involved in strategic communication to motivate the remote mappers to create map data. One fact to note is that under normal circumstances, the for-benefit association for OpenStreetMap would be the OpenStreetMap Foundation and HOT and KLL would be commons-oriented enterprises. However, during the time of disaster response, it was observed that institutions like KLL and HOT switch to act as a for-benefit association temporarily.

There were several commons-oriented enterprises that used these commons in a generative way. For both the cases these were large as well as small humanitarian responders. These responders were making use of the resources of the commons in a generative way. In the case of Quakemap, these organizations used the reports to carry out rescue and relief operation. This, in turn, also provided credibility and validity to the platform leading to its growth and adoption. In the case of OpenStreetMap, these responders used the maps generated to plan for their response operations. The knowledge of this usage, in turn, motivated the map and be more engaged.

The study found that KLL acted as a for-benefit association in the production of digital commons during the time of disaster response. This was different from its role of a commons-oriented enterprise during a non-crisis period. From the interview, the study identified various functions served by KLL in order to fulfil its role.

### 5.2.1 Living Labs as localizers of global technologies

There have been cases of commons-based peer production in the physical realm enabling the ability to think globally and produce locally (Kostakis & Papachristou, 2014). Also, the literature tells that one of the functions served by living labs in the open innovation ecosystem is the localization of global technologies. The study provides evidence of that happening with KLL in both the implementations of Quakemap and OpenStreetMap.

Thousands of OpenStreetMap volunteers were mapping, but for this data to be of any utility it needed to be used by the relief providers. Kathmandu Living Labs facilitated this process by creating printable maps that could be downloaded and printed on papers. Interviewee K2 who was a core member of the KLL team during the response mentioned “We received digitized affected areas with other necessary geographical entities - roads, rivers, boundaries - created by volunteers from all over the globe. Me and my team were responsible for creating maps that can be used by different organizations working on the ground - police, army, volunteers - to provide various responses.”. Apart from making these map data more accessible, they also proactively reached out to the responders and trained them on how to use this data. One example of this was volunteers reaching out to doctors at the government's Health Emergency Operation Center, installing offline maps on the mobile phone, and teaching them how to use the offline maps. Figure 5-6 shows a picture of the KLL team interacting with an emergency response doctor at the Health Emergency Operations Centre.

Source: (Kathmandu Living Labs, 2015b)

**Figure 5-6** KLL volunteers installing offline maps on the doctor's phone

The Quakemap platform itself was a deployment of open source Ushahidi platform, which was developed in 2008 to map reports of post-election violence in Kenya (Ushahidi, n.d.-a). First, the deployment was using the default Ushahidi, but slowly it was localized after the team acquired the knowledge of the needs necessary in the platform for earthquake response. Interviewee V1 who was one of the first volunteers of the Quakemap platform, mentioned “Nepal army was complaining that this platform is difficult for us, so I built an export of the data … making plugin that will generate CSV. We were generating excel and sending it to Nepal army, and they said you are sending us the excel, but it is now old, new reports are not coming, so I built auto-refreshing excel, so that if you open that excel file and if there is new data on the server, it automatically pulls information that was changed. I think it was a new way of combining new technology with the old because the army was familiar with the spreadsheet interface, and the data was there in this Ushahidi interface. How do we link those two? We came up with this good solution, and that became very popular, the army started using that spreadsheet as well.” Features like auto-refreshing exports and location-based exports that were not present were added to the platform later.

### 5.2.2 Living labs as a provider of local knowledge

In the previous section, we looked at how the study provides further evidence on the notion that commons-based peer production is allowing to “think globally and produce locally”. This study provides evidence that the reverse is also true. With local living labs as a medium, local knowledge can be backed by thousands of global volunteers to create map data rapidly. This enables digital humanitarians to think locally and produce globally. Kathmandu Living Labs were not the ones who were creating the map data themselves; they were instead involved in identifying ground needs and relaying that to the huge network of global mappers. As interviewee M2 put it “They do not need to do the mapping what they need is to provide us with information.”.

The study found that local knowledge is crucial for the utility of data produced by remote mappers. For the data to be useful for responders, remote mappers should know what areas are impacted and what features are to be mapped. In the case of Nepal earthquake initial assumption was that it was an urban disaster, but later, when things start to unfold, it was found that the rural areas were impacted much more than the urban areas. Having Kathmandu Living Labs present at the ground allowed this information to be quickly conveyed to the remote mappers and prioritize mapping of most affected rural areas. Similarly, Kathmandu Living Labs also relayed information requests like places where internally displaced people were setting up camps by Nepal Army and possible helicopter landing site in mountainous districts by UN clusters. To map this information, KLL also provided knowledge regarding the terrain and how the camps were set up by internally displaced people, which aided in creating instructions for the remote mapping tasks.

Interviewee M3 emphasized this importance by stating that “Those [local institutions like KLL] are really critical because, without them, we don't really have a direct connection with what is exactly needed. So, it is very easy for HOT to create mapping projects in the tasking manager and ask people to contribute to these projects. But without insight into what data is needed and who might be using that data or which organizations are using it for what purpose, it is really challenging to produce something that actually gets used.”

The study found evidence that living labs can play an important role in providing local knowledge during the process of commons-based peer production.

### 5.2.3 Living labs as an information control centre

An important characteristic of living labs is that it is a multi-stakeholder network bringing in expertise from different actors. These characteristics allowed Kathmandu Living Labs to act as a hub to address the information gap present during the time of crisis. They played the role of becoming a bridge between local and global agencies. Interviewee M2 mentioned “they provided the data that we generated in OSM to the humanitarian agencies. As a remote mapper and a remote coordinator, I think it gives us a sense of accomplishment when you see that data is actually being used on the ground”.

For a global agency, opening a local chapter all over the world would be very costly and resource-intensive. Instead, having a local community that they could work together with and support would be much more feasible. These local community on the ground would know local agencies and talk to them and interact with them. Similarly, for humanitarian responders working in Nepal, it would be much easier to interact with a local institution because of language and cultural similarities. This was evident in the study as Kathmandu Living Labs was acting as a bridge between local and global agencies. For remote volunteers like interviewee M1 “Kathmandu Living Labs were coordinating the local interaction with the government and various agencies in Nepal”.

Because of their competencies and capacities, they were also able to engage and interact with GIS units of humanitarian response agencies. Interviewee M1 remembers “And then various organization came, I remember the Canadian army came and provided KLL with filtered maps. It was quite fantastic to have volunteers, local volunteers that could interact with people like that.”. The Canadian army’s GIS unit was one of many agencies to visit the KLL situation room and interact with them. They also were visited by GIS units form Nepal Army and Nepal Police Force.

KLL was constantly interacting with different groups of people during the crisis. Interviewee K1 remembers “talking to satellite image providers and getting satellite imagery and helping the government, the army what to do with the satellite imagery.”. Similarly, a Quakemap volunteer, interviewee V1 recalls that “after collecting the reports, we started managing workflow, then started labelling and tagging. Do we need to serve it to Nepal army because if we need helicopter rescue, there is nothing that private company can do, or nor regular NGO can do? Only the government or army can do it so; we started sending information to the army and government. By this time many INGO and Nepal Army were working with us. Every day one senior member used to visit us to see the flow.”. Similarly, it was also interesting for global mappers to work with someone who could interact with formal agencies in the ground. Interviewee M1 mentioned “Kathmandu Living Labs was from the country with knowledge of the country. With that knowledge, they were able to work with government agencies. That aspect was quite interesting.”.

The figure below depicts the six group of volunteers that KLL was working with during the time of the earthquake. These six groups were (1) Earthquake victims that needed aid; (2) Nepal Army and other responding agencies providing relief and aid to those people in need; (3) Loosely formed volunteer groups who were also providing aid to those in need; (4) Local information volunteers who were helping run Quakemap and supporting the mapping from the local side; (5) globally distributed remote mappers using satellite imagery to create data and; (6) satellite imagery providers helping with high resolution and up to date satellite imagery.

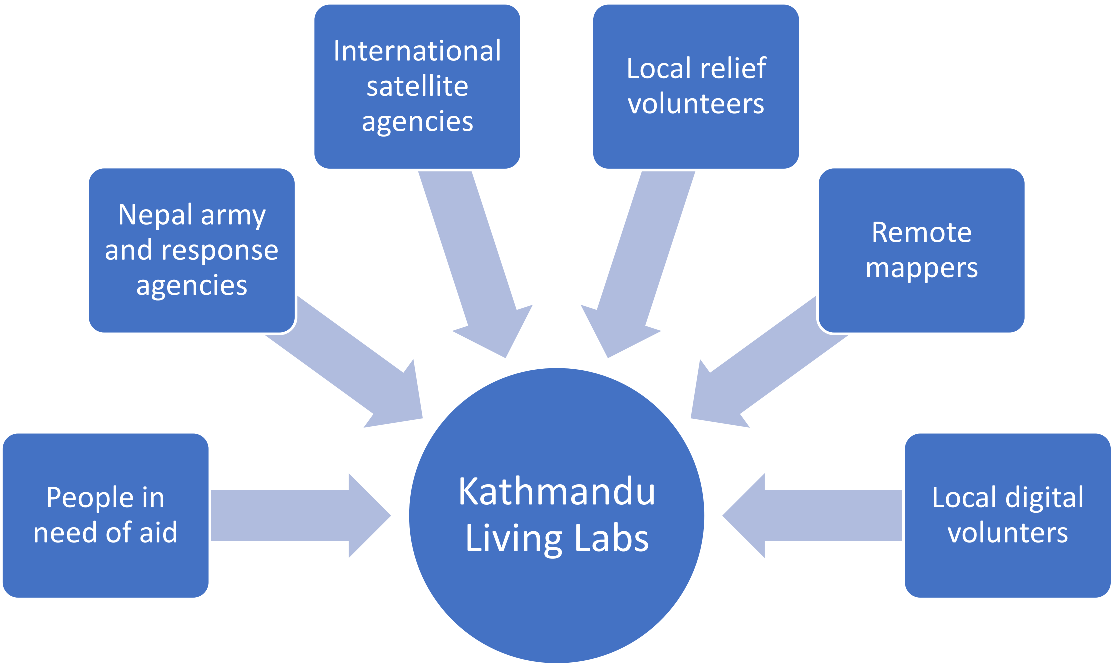



**Figure 5-7** Different groups interacting with KLL during earthquake response

This role of an information hub that stood out during the crisis could also extend beyond the crisis. For example, interviewee M2 who is also an active OSM community mobilizer mentioned that "there's a lot of interest in using OSM, but the government is not really familiar with engaging with volunteer communities. For example, [with local institutions in place] you can have formal engagement, like you have a memorandum of understanding, like a formal contract where you can engage with a systematic and programmatic way of building a data."

We see that living labs can play an important role as a hub between different set of actors in the process of peer production. This can then allow the exchange of ideas or just allow the living labs to act as an information clearinghouse.

### 5.2.4 Living Labs as a community builder

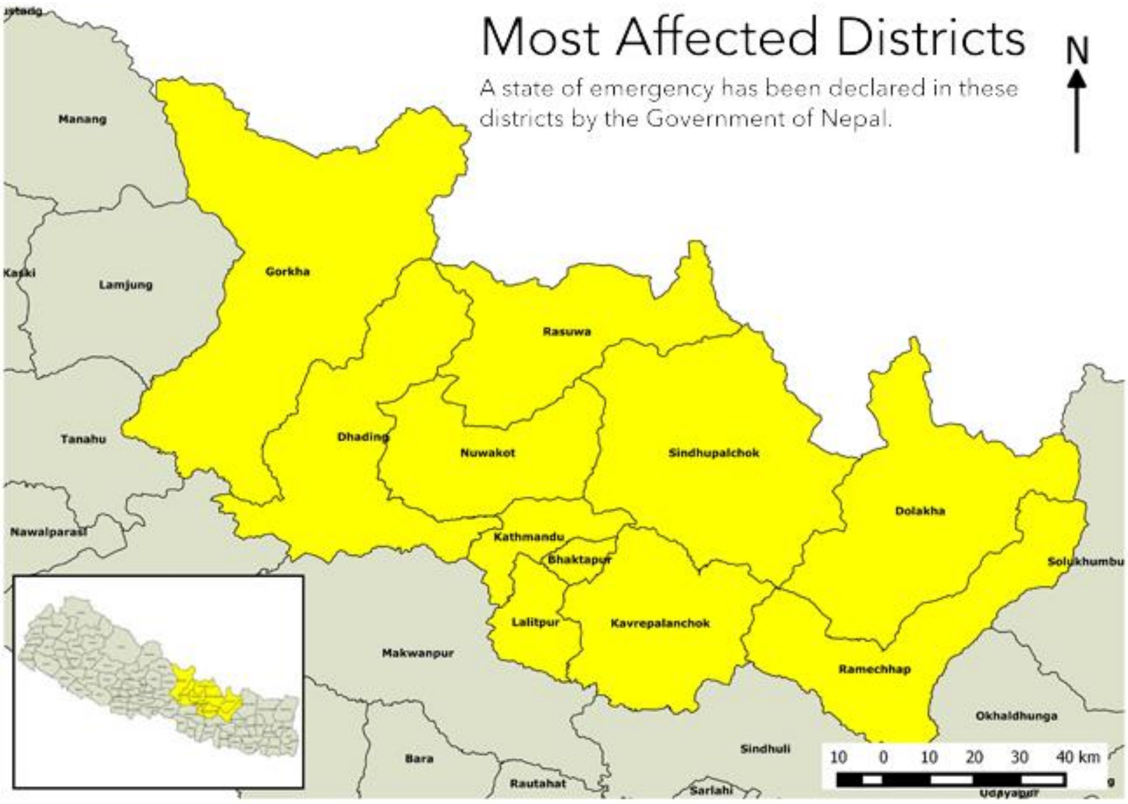
It has been argued that the discourse surrounding the potential of peer production in OpenStreetMap during a crisis is overtly positive and ignores the challenges of data quality (Roeffen, 2015). This study found that community members are aware of these challenges. Interviewee M1, who was the activation lead for Nepal Earthquake said “It is important to mobilize rapidly people, to have skilled people when you have a major disaster. But if you try to extend this model, you do not have enough people to follow up carefully. The way it works often is people organize mapathon around the world. They are doing [this with] 50-100 people. And sometimes they come for three hours, map rapidly and they never come back. They just leave a lot of problems of quality. It is very difficult to maintain quality in such project. It is not impossible, but it is challenging.”.

Living labs have an important role to play in addressing this challenge. One aspect is to have local capacity ready to deal with this challenge and build community in a gradual and organic manner. Kathmandu living labs was already working on building this capacity and doing a lot of training and workshop around OpenStreetMap. Interviewee M2 mentioned that KLL “were building capacity locally, tracing buildings, training people how to use OpenStreetMap.”. This meant that there were people able to communicate with the global community, not only in terms of data needs but also in terms of data quality.

Another aspect of the data quality is validation and cleaning of the data after a major crisis. Kathmandu Living Labs have started to move beyond the traditional approach of mapathons – groups of individuals coming together for an hour, learning, and editing OpenStreetMap – and have started to try innovative approaches like digital internships coupled with leadership training to retain mappers and build a more sustainable community around it (Khanal, Budhathoki, & Erbstein, 2019).

### 5.2.5 Living Labs as a guide for contributions

One important function that Kathmandu Living Labs played was of a guide for contributors. For global mappers, they provided details regarding what is to be mapped and in which area. They also helped in developing instructions on how these features were to be mapped. Interviewee M2 mentioned “We mostly relied on KLL's feedback on where and what to map. So it was me and Pierre who was doing the preparation of the tasks, identifying which areas to map but it was mostly based on KLL's feedback.”. Kathmandu Living Labs had members active in various coordination rooms to provide insights and feedback. Interviewee M1 mentioned the importance of this by stating that “You need somebody to take care of the coordination. To be able to react very fast and bring various people. Like Kathmandu Living Labs was able to….”. The figure below illustrates one such example of where KLL was able to provide a map of most effected districts based on the government-provided data. This was helpful in setting the direction for creating tasks and informing global mappers on the area that was most affected.




Source: (Kathmandu Living Labs, 2015a)

**Figure 5-8** Most effected districts by Nepal earthquake

Similarly, for Quakemap volunteers, KLL provided a way to contribute to something that was already up and functioning. KLL set a broad vision of having a platform to fill in the information gap that was present in the response. They also provide an initial deployment that had various functionalities to do this. Volunteers were then free to define processes and workflow according to their experience.

## 5.3 The Role in the Context of Nepal Earthquake 2015

### 5.3.1 Cold Boot vs Warm Boot

Most of the volunteers that engaged with KLL were already motivated and were actively seeking out ways to contribute. All the interviewed local volunteers were looking for volunteering opportunities, and that was the way they encountered the Kathmandu Living Labs' initiative. For example, when asked about what they would probably be doing if not involved with KLL, interviewee V3 mentioned "If not involved with KLL, maybe through Liverpool Supporter's club, we would have provided the relief collectively. The thought of contributing and helping others was always there in my mind. I could have been involved with my previous organization to gather and distribute the relief". Having an organization already coordinating the response provided them with a quicker way to be useful and to lend in their help.

At the time of crisis, the speed at which things are done also matters. As interviewee V4 put it, "After the earthquake happened, there weren't a lot of volunteering spaces, but people figured out how to do it, It's not that without these spaces at some point during the disaster a group might not immerse that does the work that KLL did, but the thing is delay, the time it takes you to start from scratch to get to that point and also have workplaces or workflows in place that is going to take away the crucial time after the disaster when all of these work is essential.". Their previous experience of working with the OpenStreetMap community and testing out tools like Ushahidi allowed them to quickly deploy these tools and start working immediately. Kathmandu Living Labs were already in touch with the global OpenStreetMap community the same day earthquake hit. The remote lead of the activation interviewee M1 mentioned "I was looking at the mailing list and I can see that few hours after that earthquake we already have started the discussions. Then 7-8 hours later we already got in contact with Kathmandu Living Labs."

Early the next morning, they were able to set up a workspace and forward the image of them working to the international community. This picture of the KLL team working from the parking space served as a motivation for the international community as they could see people they can work together with. Interviewee M2 remembers "At that time, I think in less than 24 hours they were able to set up a command centre outside of their office.". Figure 5-9 shows the KLL volunteers setting up their office outside in the parking lot on the next day after the earthquake because the office was unsafe to work due to the damage caused by the earthquake.

Source: (OpenStreetMap Wiki, n.d.)

**Figure 5-9** KLL Volunteers start working form parking lot within 24 hours of the Earthquake

There were also other various initiatives that tried to fill in the same gaps as KLL did later during the response. However, Quakemap has already gained popularity with local and international media coverage. The KLL initiative also gained credibility as well as an authority because of Nepal army using the reports for their response and the government information portal listing Quakemap as one of the important earthquake initiatives. Interviewee V1 recalls this “So, after KLL launched quakemap, sparrow SMS team also launched the same thing and another organization launched another one-stop portal. But they were launched, one or two weeks after the earthquake. So, what having this space at the presence of KLL did was, it accelerated the coming together of people. So, nobody except KLL was working on this for one week, that’s why quakemap.org got traction.”

### 5.3.2 Utilization of Pre-Built Local Capabilities

Kathmandu Living Labs were already working with OpenStreetMap before the earthquake. The work they did with OpenStreetMap was related to building community resilience with open geospatial data. They were also experimenting with different technologies like Ushahidi and Frontline SMS. This prebuilt capability of KLL proved to be very useful during the Nepal earthquake response.

First, it allowed KLL to quickly act because of its existing skills and network. Remote volunteers were already aware of KLL and the work they were doing before the earthquake. Interviewee M2 mentioned, "So, before earthquake happened I was already aware about KLL initiative in Nepal because there was the project where Nama and KLL team was leading, I think it was world bank supported project building data set in preparation for earthquake". KLL was also in touch with humanitarian agencies because of working in the field of disaster risk reduction. This familiarity coupled with KLL's understanding of how remote mapper could contribute allowed them to properly motivate and guide remote volunteers. Similarly, with Quakemap, the familiarity with the open-source Ushahidi allowed them to quickly it on the next day and start collecting data.

Additionally, the work also provided credibility to the work KLL was doing. Interviewee V1 mentioned "Credibility KLL had as an organization that was involved into mapping and all this stuff, I think that space gives opportunity for people to rally upon an idea. If I had individually started it, that might have been leadership contention, but because I had started with something bigger that was KLL, that was taking place around KLL's supervision, so basically there was no issue of ego. That is why there was high quality of volunteers involved, like people who were doing PhD in physics and because it was started by a non-profit that was already connected to the government". As an institution that had already done this work, it was able to gain the trust of both national and international volunteers. Being able to then mobilize these volunteers properly and do useful work generated trust from the response agencies.

### 5.3.3 A Platform for More Organized from of Response

Peer production takes place either in the form of the crowd where a large number of individuals contribute without much commitment to the production process and without much interaction with peers or in the form of community where contributions are accompanied by peer interaction and the idea of sustaining the community (Haythornthwaite, 2009). The crowd model is necessary in the case of crisis as large data is being generated by different sources, and they can be supplementary for the formal channel of crisis response (Palen & Anderson, 2016). Also, a more community-driven approach is needed at such times because unstructured efforts could lead to duplication of work, wasted resources and confusion. This was also observed in Nepal earthquake when well-intentioned relief volunteers individually tried to gather and distribute aid, resulting in some places having unnecessary excess waste while aid not reaching to other places.

In the case of Nepal earthquake KLL helped make the response more organized. The organizing was facilitated both in terms of local as well as global response. Interviewee K1 who was a core member of KLL, believed that they “drew in people who wanted the earthquake response to be systematic and not just haphazard - just go wherever you know somebody. They wanted to help facilitate the whole thing to be a bit more organized than it was.”

For global mappers, this organization happened because of KLL’s ability to quickly provide local knowledge in terms of what was needed to be mapped where. This information was relayed in real-time using skype groups. Interviewee M1 mentioned “we had a room where we could discuss and exchange, and people purpose various actions, one person says I will start tasking manager ….. and another person would take care of making GIS files for roads, for buildings, for infrastructures ..... another one takes care of bringing the map on phones like android and ios. So we are set up to produce various task like that. Each person takes care of doing a task.”. For all of these tasks, the guide was KLL, and they were providing these groups directions on what to do where.

On a local level, the coordination happened because of KLL’s ability to integrate different sources of information together and have them in a place where their status could be tracked. Interviewee V1 recalled this regarding the early days of operating the Quakemap platform “after the earthquake there were various groups in social media, like WhatsApp group, messenger group and share situation on what is needed, who’s going to help out. There were hundreds of groups, hundreds of spreadsheets and hundreds of WhatsApp groups. So, we thought we could aggregate these in one place.”. After bringing these reports at one place, they were able to add different channels like SMS and phone call to allow people to report. Further organization happened once these reports were forwarded to response agencies and their status was updated and followed up.

### 5.3.4 Strengthening of Institutions

One unintended consequence of this event was strengthening of the institutions both at the local and the global level. KLL was a small team working on small scale projects. As a result of the work, KLL was able to focus their small teams' effort into projects that made a bigger impact. The exposure, confidence, and learnings gained from the experience of earthquake response allowed them later to be a part of the Nepal government's earthquake reconstruction effort. KLL team supported the government of Nepal in the data collection of more than a million household for planning the reconstruction. Our interviewee K1 form KLL stressed on this fact saying "I think, the most valuable thing that was produced was an institution. The level of maturity that KLL gained after the earthquake was immense because of the Quakemap work. I think the most significant thing that came out of that effort was the strengthening of the institution of KLL itself. Then, as a result of that - how strong KLL was able to become as an institution after that - it was able to do this entire thing with the Nepali government, entire reconstruction mapping. That happened after I left, which you think as part of the earthquake reconstruction effort, but one built the other."

This was also true for the Humanitarian OpenStreetMap Team. HOT was in the process of developing an activation protocol with their experience in working on Ebola mapping. The biggest activation of HOT till date allowed them to put those protocols in practice and test them in a real-world scenario. Thus, in a sense, the activation protocol that was developed during Ebola activation was formalized during the Nepal earthquake activation. Interviewee M2 also agreed with this fact and mentioned "Because of KLL Nepal earthquake experience we decided to have structured coordination mechanism, after that event, we went back to the drawing board, identified the experiences, what are the gaps, that's when we had the idea formalize the activation. I think a lot of experiences from Nepal was used to make this activation protocol formalized". HOT also made improvements to the activation protocol based on the Nepal earthquake experience.

# 6 Conclusion

The goal of this study was to explore the role of living labs in the process of commons-based peer production and to see how these roles played out in peer production during a crisis. The study provided descriptions of the two different fronts where commons-based peer production was happening during the Nepal earthquake. First was OpenStreetMap where thousands of global volunteers created map data of the affected areas. This data was used for planning and logistic operation of different humanitarian agencies. The second was Quakemap, where relief needs, and efforts were tracked using the deployment of an open-source platform. This data was also used by humanitarian agencies to plan relief and rescue as well as by relief volunteers to coordinate. Process for both these cases was modelled using BPMN, and their impacts were discussed.

Additionally, the study found that living labs would normally act as a commons-oriented enterprise in the CBPP ecosystem but switched to the role of a for-benefit association during the time of crisis. The study found living labs played five different roles in the process of commons-based peer production. The study found that

1. Living labs acted as localizers of global technologies. They took global innovations and localized them for a specific context.

2. Living labs acted as providers of local knowledge. They functioned as the local and near real-time source of information in the field for global remote volunteers.

3. Livings labs acted as an information control centre. They were an information clearinghouse for the response and acted as a bridge between people in need, local relief volunteers, humanitarian agencies, local digital volunteers, global digital volunteers, and satellite imagery providers.

4. Living labs acted as community builders. They were involved in both ex-ante community building activities as well as are seeking sustainable ways to engage the community and maintain data quality in OpenStreetMap.

5. Living labs acted as a guide for contributors. They were involved in the coordination of volunteering efforts at both the local and global levels.

The study found that during the time of crisis, living labs allowed contributors to act quickly in an organized way due to their pre-built capabilities and network. Being involved in response caused the institutional growth of the living labs itself as well.

The case study showed the utility of ex-ante work done for disaster preparedness during the time of response. The study was, however, limited to the work done by Kathmandu Living Labs ex-post in the response phase of Nepal earthquake. A study covering a longer time horizon from the starting days of KLL to its involvement in the reconstruction work would be much more beneficial to get better insights into the role of living labs in peer production.

The study also sees further areas of research that can be carried out in the future. One could investigate the policy level changes necessary from the government, to integrate these new forms of information within their formal response mechanism. The same case of Nepal earthquake could be further explored to see if there have been any policy changes as such as Nepal faces recurring disasters like floods and landslides. Similarly, the interface between living labs and commons-based peer production could be explored in domains other than a disaster. The study could be fruitful, especially in the domain of urban sustainability, where living labs initiatives seem to be quite popular.

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# Appendix

## A Guiding Questions for Interviewees

### Guiding Questions for Local Volunteers

1. How did the incident unfold for you?

2. How did you encounter KLL and got involved with the work they are doing?

3. What was your involvement with the response? How did you contribute, how was it organized?

4. Did working with KLL help with how you were able to contribute to the response? If yes, how?

5. If you had not met KLL, how would you imagine you would have contributed to the response?

6. Do you think the data/software/workflow you produced during the response would be useful in future? If yes, what things would be most useful? And, in what kind of scenarios?

7. Does having an organization/hackerspace like KLL help with the growth of open-source software like Quakemap and open data like OpenStreetMap? How?

8. Do you think investments should be made in organizations like Kathmandu Living Labs? Why?

### Guiding Questions for Global Volunteers

1. Brief introduction about yourself? Background and how are you involved with the OpenStreetMap project.

2. How do you recall the Nepal earthquake incident?

3. How did you find out about the earthquake?

4. How did you know about the work KLL was doing in the ground?

5. What was your role during the response? What did you do?

6. How were things organized during the response?

7. Did KLL help you with the response work that you were doing? If yes, how?

8. If there were no organization like KLL, would your involvement in the response have been any different? If yes, how?

9. Do you think the work done by KLL during the earthquake can be reused? If yes, why and in what sort of context and scenarios?

10. In your opinion, what impact does having an organization as KLL have in the production of digital commons like OpenStreetMap?

**Guiding Questions for KLL Core Member**

1. Please give a brief introduction about yourself. What was your work/role as a core member of the KLL team?

2. How do you recall the 2015 Nepal earthquake incident? What was your immediate response/thoughts after the earthquake, and how did you come together with the team?

3. What were your roles during the response?

4. What did KLL do to support the local and global volunteers? What was its role/function in the response?

5. How did KLL get the volunteers? What support did it provide them?

6. Do you think the work done by KLL before the earthquake was necessary for the success of the response?

7. How do you see the data and process that was produced/established during the earthquake used in other activities events?

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I hereby declare that, to the best of my knowledge and belief, this Master Thesis titled "Living Labs in Commons-Based Peer Production for Crisis Response: Case Study of Nepal Earthquake 2015" is my own work. I confirm that each significant contribution to and quotation in this thesis that originates from the work or works of others is indicated by proper use of citation and references.

Münster, 10 August 2020

Nirab Pudasaini

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