The Social Life of Disaster Information:   
Cultivating Resources for Emergent Information Infrastructures in Nepal

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# 1. INTRODUCTION

All information systems are local. By this we mean that these systems are situated, relational, and emergent, and that their characteristics are best expressed and therefore understood at the moment and location of use. As a result of the social, physical, and informational convergence that occurs during crisis, study of the use of information systems during these events provide illustrative examples of this principle. In disaster studies, scholars have sought to disrupt the crisis-peacetime binary that characterizes much discussion of these topics [1], framing disasters as temporary departures from everyday life caused by exogenous trigger events. They instead show the ways in which the narrow temporal window we place on events when we construct "disasters" hide both the processes that produce the vulnerability which create the disaster event as well as the span of a disaster's impact, both of which take place over much longer timescales. In similar ways, questions regarding the design, maintenance, and use of information systems supporting crisis management and response must move beyond a narrow focus on the technological artifacts themselves to the contexts in which they are deployed.

To explore these ideas, this chapter discusses the activities of a small network of volunteer and non-profit technology communities in relation to the 2015 Nepal Earthquakes. A result of a multi-year research project conducted in partnership between scholars and practitioners in the United States and a Nepali non-profit technology organization, Kathmandu Living Labs (KLL), this work examines an attempt to reduce vulnerability to natural disasters in an earthquake-prone environment [16]. The earthquakes occurred several years after we began our research project. KLL, an organization that initially was launched to support technology-driven community engagement in disaster mitigation efforts in Nepal, was positioned to serve an important role in the earthquake response as a result of the social and technical resources it had developed over its first few years. The April 2015 earthquake, in a sense, “intervened” in our research site in ways that allowed a unique opportunity to examine the relationship between disasters and informatics, but also suggested broader insights about the information systems that support cooperation between the public, civil society groups, and government.

Brown and Duguid,—in *The Social Life of Information,* from which we borrow our title—warn against a sort of tunnel vision that arises from overly-narrow attention to the technical aspects of information systems. They argue that this perspective “pushes aside all the fuzzy stuff that lies around the edge—context, background, history, common knowledge, social resources” [3]. In this chapter we turn our focus squarely to this “fuzzy stuff,” looking into the ways in which the particular genesis of KLL conditioned the contribution it was able to make during the earthquake response. Certainly, much of KLL’s work during the crisis was improvisational, but it did not emerge *ex nihilo*, or out of nothing [10]. The work that KLL conducted in the years leading up to the earthquake constituted an investment in, or a cultivation of, resources that they were able to call upon to support their activities following the earthquake. Drawing from social science research on information infrastructures, we take a broad approach to understanding the creation and use of information technologies. This lens foregrounds the variety of social and technical resources that actors invoke when they enact information systems and in turn raises new concerns for those working on the design or maintenance of technology systems.

# 2. STUDIES OF INFORMATION INFRASTRUCTURE

Information infrastructure studies in the fields of human-computer interaction (HCI) and science and technology studies (STS) have sought to understand the ways in which information and communication technology have enabled information sharing and work practice in science and other enterprises, as well as contribute to the design of such systems. Progressive views on information infrastructure, such as [2],[11],[14],[19], go beyond the obvious emphasis on the physical infrastructure of wires and cables, and instead see information infrastructure as "set of interrelated social, organizational, and technical components or systems” [2:99]. In addition, these studies note that the "concept of 'infrastructure' as a noun is distracting” [11:491] and instead center practices comprising the work of "infrastructuring" [14]. Donovan argues that study of the infrastructuring of technological systems “unsettles the ontological assumptions of fixity and demands studies in situ in order to capture the ongoing maintanence, preservation, extension, and decay of sociotechnical systems” [4:733]. This shift from a reified to a processual view of infrastructure has two important consequences. First, as discussed in Star and Ruhleder [19], infrastructure is relational. In other words, the components and configurations of an infrastructure are assembled in different ways by its users depending upon users’ position in relation to it and the tasks they seek to accomplish. Second, infrastructures are designed through use: users appropriate available social and technical resources in unexpected or unpredictable ways to accomplish their goals [14].

The root "infra" comes from the Latin for "below" or "submerged." Indeed, scholars have argued that the study of infrastructure is challenging because it so often requires attending to phenomena that, when properly functioning, is effectively invisible to its users. Star and Ruhleder [19] write that one of the characteristics of infrastructure is that "it becomes visible upon breakdown." One well-known strategy for investigating infrastructure is through assessment of such breakdown. However, Pipek and Wulf also point out that infrastructures become visible at the point of use, or when "the opportunity offered by a global infrastructure is met with the creation of and decision to adopt a new local practice” [14:458]. It is with this perspective that the current study is carried out. From this angle, the salient characteristic of infrastructure might not be that it is invisible, but rather that it is normally latent and potential. In Star and Ruhleder's words then, "infrastructures occur" at the moment that their users appropriate the necessary resources to accomplish them.

While humanitarian information infrastructures may usefully be viewed as emergent, the recurring nature of large-scale international disaster relief activations creates the possibility for, innovations in humanitarian technology to become expected assets during responses to future emergencies [18]. Here we focus on the practices of technologists, community organizers, and government officials that cause such infrastructure to emerge. We look at the “creative acts of infrastructuring”[9] that support the creation, sharing, and use of critical information products in the wake of a major natural disaster. In particular, we draw attention to the resources that enabled them to accomplish their infrastructuring activities. Our study thus seeks to identify the resources that humanitarian technologists drew upon to support their efforts toward the infrastructuring of a particular set of information infrastructures. This focus on the resources that support infrastructuring allows us to chart the relationship between the investments made in building local capacities and networks related to information technology with the events that took place during the response to the 2015 Nepal earthquakes.

# 3. THE GENESIS & WORK OF KATHMANDU LIVING LABS (KLL)

The project under discussion in this chapter began in 2012 as part of a larger World Bank program called *Open Cities,* which sought to create partnerships between civil society and government to create and use new technologies and data sources to support disaster-risk reduction activities in several Asian countries.  The Open Cities program, according to the World Bank, works to bring together "stakeholders from government, donor agencies, the private sector, universities, and civil society groups to create usable information through community mapping techniques, to build applications and tools that inform decision-making, and to develop the networks of trust and social capital necessary for these efforts to become sustainable” [24].

In Kathmandu, one of the three cities in which the first phase of the Open Cities program was piloted, the project goal was to support the development of a local mapping community while making school and health facility data for seismic risk assessment publicly available using the OpenStreetMap (OSM) platform for multiple downstream uses [16]. The small team of Nepali technologists worked with local universities and community groups to locate and map all the schools and health facilities in Kathmandu, creating data for nearly 4,000 structures in total. Along the way they trained over 2,000 individuals on mapping using OpenStreetMap, created a detailed geospatial dataset, including roads and buildings of all types, for the Kathmandu Valley, and built personal connections in government, civil society, and the private sector [16].

By the end of the first year, the group—recognizing that they developed a set of capacities that were valuable to not just disaster risk management but a broader range of urban planning and risk management in Nepal—launched a new non-profit technology organization called Kathmandu Living Labs (KLL). When support from the World Bank ended in early 2014, KLL secured funding from several other development organizations to continue their mission, which is to "harness local knowledge, develop open data and promotes civic technologies... [to address] the difficult problems that people face in their everyday lives."[[1]](#footnote-1) KLL’s formation up to this point in time has been described in detail in a prior publication [16].

On April 25, 2015, a major earthquake struck central Nepal, devastating many rural villages and triggering landslides around the country.  During the earthquake and ensuing aftershocks, over 9,000 people were killed and over 1 million rendered homeless.  The disaster triggered major humanitarian response from the Government of Nepal, international organizations and, importantly, local civil society groups, both established and emergent. Following the immediate search and rescue activities, response and relief agencies worked hard to provide relief shelter, quickly re-establish schools and/or temporary learning centers, and deliver medical services to affected areas. Alongside these efforts, informal organizations and voluntary groups like KLL played a crucial role in creating, analyzing and provisioning information to both victims as well as response and relief agencies.

Between 2012 and early 2015, KLL developed key resources that would allow its team to uniquely respond to the earthquake when it struck. During this time they worked on the Open Cities pilot as well as a number of other mapping and technology projects. In doing so, they developed a local team with expertise in GIS, software development, and data visualization. They engaged in community outreach, expanded their internal organizational capacity, and developed strong partnerships with international organizations such as the Humanitarian OpenStreetMap Team (HOT), and a variety of Nepali government, university, and civil society groups. The day after the earthquake, KLL—despite its members spending the previous night outside in an attempt to sleep through the aftershocks—met to discuss what they could do to respond to the disaster. In any crisis, citizens are the first responders [5]. Indeed, Nepal's civil society activation in the wake of the earthquake has been significant, and KLL has played an important role in this.

Working conditions for the team during the response were difficult. KLL’s office was damaged by the earthquake; that damage combined with aftershocks required the team to work outside during the first three weeks of the emergency. Later, they moved to a temporary building provided by a private school. It wasn’t until late June, nearly two months after the earthquake had struck, that KLL was able to move into a new office with the support of the World Bank, the Humanity United foundation, and several crowd-funding campaigns. Despite these challenges, KLL’s small staff and team of over 40 local volunteers continued to work long hours, providing maps and information to responders. Their work during this period received significant local and international acclaim and was featured in prominent media outlets including the New York Times[[2]](#footnote-2), BBC[[3]](#footnote-3), and Wired[[4]](#footnote-4).

# 4. METHOD

The research presented in this chapter focuses on how KLL conducted its work, and how it moved from a group designed to collect data to *mitigate* disasters, to one that became, in the framing of Dynes [5], an “extended organization” that worked to connect the local and international earthquake response efforts. Taken together, KLL’s technological resources, human capacities, and social ties to both local and international communities positioned the organization to 1) mobilize both local response work activity and 2) channel and direct the flood of international volunteer tech community help in close complement. Our research examined how KLL’s work in the years prior to the earthquake functioned to develop the necessary resources for the infrastructuring of emergent information systems during the humanitarian response.

A significant portion of this research was conducted as participant observation by the first author from April through August 2015 with KLL, facilitated by a partnership and prior research collaboration begun in 2012 as part of the Open Cities project [16]. In addition to this embedding within KLL, the first author conducted a series of 40 semi-structured interviews between May 26 and July 10, 2015 with staff and volunteers involved in information management in Nepal across organizations involved in the humanitarian response to the earthquakes. This included individuals affiliated with major UN Agencies and large international NGOs, staff of Nepali and US government agencies, and small local nonprofit organizations including, and in particular, KLL. Interviews followed a protocol designed to uncover respondents’ creation and use of spatial data and map products in support of the earthquake response. Most respondents had interacted with KLL, either directly or through usage of the tools and information that KLL produced, and interview questions also addressed the character of these relationships. When necessary, media, governmental and humanitarian reports were used to supplement the fieldwork.

\*\*\*insert figure 1 here\*\*\*

# 5. FINDINGS: KLL’S WORK AS INFRASTRUCTURING

In this section, we draw on our fieldwork and interviews to describe three projects undertaken by KLL to support the emergence of information infrastructure, demonstrating in each case the ways in which prior investments combined with design-through-use came together to shape the particular solution. Together, these projects comprise the major elements of KLL’s work in providing support to the earthquake response efforts: their launch of the QuakeMap website, their deployment of mobile data collection tools for conducting damage assessment, and their work surrounding the OpenStreetMap community and platform.

**QuakeMap.** The day after the earthquake, KLL launched a new website, QuakeMap, to serve as a tool for connecting responders and the public’s relief needs in quake-affected districts. QuakeMap was a modified instance of Ushahidi[[5]](#footnote-5), an open-source tool that was initially developed in Kenya to allow citizens to report incidents of violence during the conflict surrounding the country’s 2008 elections. It has since been used to facilitate public engagement with crisis response in a number of major disasters and KLL staff had prior experience with the software through their virtual participation in these responses. Within a week of launch, Quakemap had been shared widely through social media and local news, and was included as the first link in GoN’s National Information Technology Center (NITC) Earthquake Relief Portal. Despite several outages due to heavy site traffic in the first few days, the platform performed well throughout the majority of the response. Although a number of similar sites were also put in place in the early days of the response, local efforts quickly consolidated around KLL’s QuakeMap.

Figure 1 shows the 2,017 individual reports from the public were collected, verified and routed to humanitarian organizations based on their location and the type of request. KLL initially envisioned the platform as a hub of verified public reports that would be made freely available to the Government of Nepal and humanitarian actors. However it quickly became apparent that a more structured approach to managing these requests would be needed as the volume increased. The approach adopted placed KLL at the center of the public-to-responder network with significant responsibility. First, reports were gathered from social media and SMS messages to a dedicated hotline, telephone calls to KLL’s office, and information sent in by organizations that were traveling from Kathmandu to the surrounding quake-affected areas as part of the response. These reports were then processed and classified by KLL, who also added or verified geographical information to ensure that they were correctly geo-referenced. When contact information for the report was available (approximately 80% of the time), KLL would make contact to verify the report and gather additional information or updates as necessary.

Members of KLL staff told us that, initially, they had no way of no knowing if or when the reports they were so painstakingly entered into the system were being registered or acted upon by the Nepal government or humanitarian organizations. So they created a new process whereby a “dispatch” team within KLL would organize verified reports into batches based on geographic location and the type of need expressed. These batched reports were then emailed to appropriate organizations including the Nepal Army, humanitarian organizations, and emergent volunteer groups. Over 190 organizations signed up to receive these reports using a Google Form developed by KLL. Once dispatched to relief organizations, reports were tracked individually through follow-up calls to the contact person and the status updated by KLL. When needs were identified as being met, a report was closed. Reports that remained open would be re-dispatched during the next batching process.

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KLL designed and adapted this process on-the-fly, and new technologies needed to be developed and customized in order to enact their design. With the support of local volunteer software developers, KLL developed several custom modifications to the Ushahidi platform that facilitated this emergent workflow. For example, the “KML filter” plugin allowed users to download filtered lists of reports by geographical boundaries in either printable or spreadsheet format. These exports were used by United Nations Office for Coordination of Humanitarian Affairs (UN OCHA) among others to inform and prioritize relief efforts. The “Actionable” plugin application, previously developed by Ushahidi was modified to support closure of reports once KLL had verified that the report had been acted upon or was otherwise no longer relevant to responders. Also, a modification was developed so that new comments or status update on a report would automatically send a message to all previous commenters as well as the author of the report.

The QuakeMap effort also involved labor-intensive outreach work to people who submitted reports to track relief delivery required hundreds of hours of phone calls. The platform received over 2200 reports in the three months it was active, each of which was tracked to closure in the means described above. This was made through the recruitment and management of both local volunteers—as many as 40 during the peak period of the response—as well as remote, international support from Humanity Road, a US-based non-profit organization, which provided strategic advice and daily assistance entering, classifying and tracking reports6. KLL convened volunteers and connected with local and international organizations through their social network in Kathmandu and abroad. One interview respondent familiar with KLL told us that “[I have] been involved with or aware of nearly every major Ushahidi deployment for disaster since 2010. I have never seen anyone collaborate as fast or effectively as KLL did in this one. KLL was collaborating with government, civil society, virtual and on-the-ground responders.”

Mobile Data Collection Tools for Damage Assessment. An immediate need for the government and response agencies working in Nepal was to understand the full extent of damage caused by the earthquake. To accomplish this, a number of organizations mobilized volunteers to conduct disaster impact assessments around the country. KLL designed and developed at tool in the early days of the response that they called KLL Collect. KLL Collect is an application based on Open Data Kit —an open source and widely used tool to support data collection efforts via mobile phones and tablets.  It consists of three components: a mobile app that can be installed on Android devices; a customizable form which details the information to collect and a central database that stores all data gathered by field surveyors.  Survey data can be collected offline and then uploaded once the user is connected via either WiFi or a mobile data connection.

During the study period, KLL Collect was used by volunteers from three organizations. The Nepal Engineers Association (NEA) conducted an on-demand damage assessment of buildings (primarily residential) in Kathmandu Valley.  Some of NEA’s teams used KLL Collect to improve the speed and accuracy of data collection and to eliminate the need for manual data entry on paper forms. It was used by the United Nations Educational, Scientific and Cultural organization (UNESCO) and the Department of Archaeology to collect information on the status of heritage sites after the earthquake. As part of one project, Mercy Corps distributed Non Food Item (NFI) Relief Kits and cash to approximately 20,000 people in quake-affected districts and they used KLL Collect to manage distribution data collection and reporting. For each of these projects, KLL designed customized data collection forms to suit the needs of the assessment; provided training to volunteer surveyors; and assisted the organization with data management and result visualizations.

**Supporting the OpenStreetMap Response.** The third area of work that KLL engaged in centered on the OpenStreetMap (OSM) platform. Maps are vital information products to humanitarian response, yet many countries of the world lack the accurate and up-to-date spatial data [17] necessary to produce them. For the Nepal earthquake, prior research has shown that OSM was the default source of map data for the majority of GIS teams involved in map production during the response. This is equally true of UN agencies, NGOs, and government [18]. While the full discussion of OSM use is beyond the scope of this chapter, the maps that responders created using OSM data were of particular importance. Here we discuss the ways in which KLL played an active role in supporting not just the creation of OSM data to guide disaster response efforts, but also facilitating its use by responding agencies and government.

OSM is global platform where participants work collectively produce a map of the world that anyone can access for their own use. Founded in 2004 by software developers in the UK, it has since become a global community of mappers and an important source of geospatial data for a wide range of purposes in the public and private sectors, Due largely to the efforts of a US-based non-profit organization called the Humanitarian OpenStreetMap Team (HOT), OSM has been an important source of map data for large humanitarian responses including the 2010 Haiti Earthquake [17], 2013 Typhoon Yolanda [13], and the 2014 Ebola outbreak as well as numerous disaster preparedness projects around the world. Organizations including the World Food Programme, the American Red Cross, and Mapaction have come to anticipate that high-quality OSM data will exist for disaster-affected areas in any major emergency and have built their map production workflows that incorporate it. Some of these groups, like the World Bank, have also begun to invest in the production of OSM data in disaster-vulnerable parts of the world where existing spatial data resources are poor.

In the time since KLL begun its activities in 2012, the organization has helped mobilize and train thousands of volunteers across Nepal to produce detailed maps of Kathmandu and several other Nepali urban centers in support of urban planning and disaster risk management.  In addition to training volunteer mappers, KLL partnered with universities to incorporate OSM into curriculum, worked with various ministries to increase adoption of OSM across the Nepal government, and other activities to improve the OSM dataset and grow the community of individuals and organizations with ties to the project. As a result, when the earthquake struck, Kathmandu was already well-mapped. In addition, many people in the Nepal government, universities, and non-governmental organizations were already familiar with OpenStreetMap and using it in their own activities. In the years before the earthquake, therefore, KLL was creating the social and technical resources that would enable the infrastructuring activities that took place during the earthquake response. Through OpenStreetMap, KLL was contributing to an open data commons available to the public for any number of purposes and opportunities that might arise. These resources were called upon by KLL and other organizations following earthquake to support the emergence of an information infrastructure to support the humanitarian response. They did so in several important ways.

First, they supported the adoption of OSM through local outreach. Although many GIS teams within international organizations were familiar with OSM, KLL played an important role in helping local actors incorporate OSM data into their work.  In particular, the Nepal Red Cross (which received introductory OSM training from the American Red Cross and KLL as part of an earlier project) and the Nepal Army were both producing maps using OSM and sought KLL’s technical support. One member of the Nepal Red Cross’s GIS team confirmed that during the earthquake response, she was in frequent contact with KLL, and would directly phone KLL’s director when she needed assistance. This close working relationship was the result of personal connections between the organizations developed prior to the earthquake. Kathmandu University’s Geomatics Department, the GoN Survey Department and the National Geographic Information Infrastructure Project (NGIIP) also relied on OSM for some of their data needs partly due to outreach by KLL conducted prior to the earthquake.

Second, they provided on-demand map production support to several organizations, turning OpenStreetMap data into digital and paper artifacts that could be easily used to support the response. At the request of the Nepal Army, for example, KLL produced a range of base and thematic maps to help guide quake relief operations: They launched a new website to host these maps and provide instructions for downloading OSM data on mobile phones, a frequent request from responders. Interactive maps created by KLL were embedded on websites of governmental agencies such as the National Information Technology Center’s (NITC) Earthquake Response Portal and the Dolakha District Disaster Rescue Committee (DDRC).

Finally, and critically, KLL helped guide the international Humanitarian OSM Team (HOT) community activities, including the mobilization of over 9,000 volunteers from around the world to create new OSM data for quake-affected areas outside Kathmandu Valley via digitization of satellite imagery [18]. In our interviews, HOT members indicated that KLL’s role in their work was instrumental: in large part, they channeled and focused the efforts of those thousands of volunteers in ways that helped the relief work on the ground. Partnering closely with the Humanitarian OSM Team, KLL worked to define target areas for mapping by volunteers and relay specific requests from local organizations e.g., identification of spontaneous IDP camps in Kathmandu and location of potential helicopter landing sites in rural areas.

# 6. DISCUSSION

## Civic Technology & Emergent Information Infrastructure During Crisis.

This research suggest several important findings for the role that civic technology groups like KLL can play in supporting the information needs of humanitarian responders. First, it reveals that crowd-sourced information has emerged as a lifeline and component of the humanitarian information infrastructure.  Many formal relief organizations now expect and depend on volunteer technical communities and the information generated. However, the crowd-sourced information is made much more useful with localized support that can direct this work and help response organizations understand how to make use of it.

Second, in this way, local civic technology organizations can act as important intermediaries between formal and informal parts humanitarian response. During the Nepal Earthquake Response, KLL demonstrated the capacity to coordinate timely information products such as maps and data that proved valuable for surge support. As the offers of help came in from organizations like HOT and Humanity Road, KLL, though challenged by the work it faced, served as a conduit to help articulate the contributions of voluntary technical organizations working remotely with the local needs of the response. Furthermore, in the receipt and distribution of these resources, KLL was a central architect in the shaping of information infrastructure that emerged for the purposes of the disaster response—through creative assemblage of the resources that were available prior to the earthquake that were then deployed by KLL through their acts of infrastructuring.

Third, because civic technology organizations, like KLL and their partners, are becoming valuable resources in humanitarian response in Nepal, they should have their own emergency preparedness plans for when they are called upon to support relief efforts when disasters strike. Activities such as office telephone trees and familiarity with policies and operational guidelines of local, national and international agencies working in disaster response can help KLL and similar organizations in Nepal stay safe and allow them to be more effective during disaster response. Developing such internal plans and capacities will be an important component of the next phase of KLL’s activities.

Similarly, small, independent international organizations like Humanity Road and the Humanitarian OSM Team serve as a bridge between digital communities and formal relief organizations.  Local volunteer organizations are often the best place to respond in the early stages of a disaster (as we see in other volunteer work, see [23]), but will likely lack experience and time to research prior lessons learned [21].  Information and advice on tools and methods needs must not be passively made available but actively presented to organizations on the ground. For example, involving these groups in disaster response simulation exercises and other forms of training and planning may help them understand the information needs of responding agencies as well as develop the social ties that may support collaboration during disaster.

Finally, the widespread reliance upon the OpenStreetMap dataset in cartographic production in support of response effort allowed us to investigate how users of that data thought about relying on volunteered geographic information (VGI) [7] as opposed to traditional, authoritative sources. Our interviews of GIS practitioners and other responders for this study suggested that data quality was not as significant a concern as the scholarly literature on VGI would seem to suggest [8]. Rather, responders focused on other factors, such as accessibility, fitness for purpose, and prior exposure to the dataset. Overall, GIS practitioners evidenced a far more complex calculus when choosing among competing data than the simple matter of “truthfulness” and “accuracy.”  Instead, they were likely to choose datasets based on personal prior experience and recommendations from colleagues or contacts within their professional networks, and to make judgments about data quality in relation to their specific purposes for the data as opposed to absolute precision or accuracy. Together, these findings highlight the important ways in the social relationships and organizational settings in which data is created and managed influence its content, character, and usage.

## Resources for Infrastructuring.

Scholars have pointed to the significant challenges that system designers encounter when seeking to develop and maintain sustainable information sharing platforms over the long-term [15]. Such concerns align with the idea introduced at the beginning of the chapter about the long view of the relationship between society and disasters and how we might navigate the challenges of designing information systems whose usable lifespans transcend shortery cycles of disaster preparedness, response, and long-term recovery. The longitudinal nature of this research provides an opportunity to reflect on these challenges as they arise in our research site. In particular, they allow us to take a broader view of what counts as information infrastructure and the phenomena we should focus on when asking questions about the sustainability, maintenance, and breakdown of technological systems. We argue that the resources that allowed KLL to enact their information infrastructure during the quake were developed prior to their activation during the emergency response. In this section, we discuss three categories of resources deployed by KLL in their work: organizational, technological, and social, in greater detail.

Perhaps the most important resource considered here was KLL itself, as a team of technical experts with skills in information systems and software development and thematic expertise related to disaster, and as an organization with internal procedures and work practices. KLL’s initial geospatial data collection of schools and hospitals devoted significant time to developing partnerships with scientific organizations and individuals within government groups. Importantly, that data was never used for the intended purpose of seismic risk assessment, the reasons for which were outside the control of KLL and beyond the original parameters under which the project was designed. However, because the data were collected and managed as they were, the team involved was able to leverage their skills and connections to launch a new organization at the end of the project. To be clear, KLL never would have been created had the school and health facility data been collected using conventional strategies. Yet the organizational structure they developed prior to the quake was central to their ability to mobilize and respond in its aftermath.

Data is a technological resource for information infrastructure. In this case, the widespread availability of open data supported the emergence of infrastructure during the Nepal earthquake response. Open data are data released to the public in a standards-compliant and machine-readable format under a license that permits usage and redistribution [25]. However, simply making data openly available does not guarantee that it will be meaningfully used. KLL was instrumental in supporting local actors who were unfamiliar with OSM, such as the Nepal Army and the Nepal Red Cross, incorporate it into their work. Many of the GIS teams working for international organizations, however, had prior exposure to OSM through responses to the Haiti Earthquake, Typhoon Yolanda in the Philippines, or other major disasters, and anticipatedthat the availability of detailed OpenStreetMap data for the affected areas in this response [18]. KLL’s work to connect local groups to the OSM dataset was thus one of its most important contributions.

Software code is another category of technological resource that we considered here. In particular, KLL, was able to The QuakeMap website and KLL’s damage collection tools were both customized instances of software that are publicly available under open source licenses, and with large international software developer communities focused on building and maintaining them. Relying on these tools allowed KLL to spend less time and energy developing tools from scratch and instead focus their efforts on understanding the particular needs of their partners in response organizations and customizing the software accordingly. Google Docs and Google Forms, though not open-source, were also important resources for KLL’s work.

Finally, the social networks that KLL had developed, both internationally and locally, acted as another type of resource for their work. The international ecosystem of volunteer technical communities in which KLL participates played a significant role in purveying information during Nepal earthquake response. Our research found that personal relationships and participants' experience working together in other disaster responses facilitated successful collaboration during this event. In a prior paper [16] we reported that the collaboration between KLL and Humanitarian OpenStreetMap community was productive in the aftermath of the Nepal earthquakes, facilitated by a relationship that began several years before. The executive director of KLL was elected to the organization’s Board of Directors shortly before to the earthquake. The KLL team also gained valuable experience with the use of OSM in disaster response through remote support to HOT’s activation following 2013’s Typhoon Yolanda in the Philippines. These relationships between KLL and HOT were invaluable during Nepal’s own disaster.

The local network of connections relationships by KLL before the disaster with government and Nepal Red Cross, Nepal Army allowed them to understand what kind of data and maps were most useful and to direct them to potential users. This network was the result of several years of outreach by KLL to government agencies, universities, and local civil society groups, and private sector tech firms that reached thousands of people. We have argued in previous work that sustained engagement on the part of project designers was necessary to support the development of local technology communities such as the one in which KLL participates [16]. We noted that, too often, interventions like the Open Cities Kathmandu project consist of one-time workshops or technology trainings that do not allow for the establishment of strong personal relationships or iterative approaches to technology implementation. Here we have had an opportunity to dwell on how building those local capacities created the necessary resources to serve as a kind of organizational and data readiness that was tested by the earthquake, and how that further illuminates ideas of what kind of information systems are needed to meet the challenge of building resilient societies.

# 7. CONCLUSION

We have presented the results of a research project about information infrastructures and disaster. During the time period of study, the 2015 Nepal earthquake struck, intervening in our site and revealing important findings about the role of civic technology organizations in disasters. This intervention made Kathmandu Living Labs’ cultivation of resources visible in ways that it might not have been otherwise. The conceptual transition from infrastructure to infrastructuring allows us to study technology deployment in a localized and heterogeneous context. By placing the emergence of infrastructure in the conceptual foreground, we can understand technological systems as being the *outcomes* of situated actions [22] of their users rather than as *products* of technology design. The tunnel vision that Brown and Duguid warn us against in *The Social Life of Information* would otherwise render such phenomena invisible.

This study of KLL’s work during the response to the 2015 Nepal earthquakes shows us that the work they conducted prior to the earthquake: the human and organization capacities they developed, the experience they developed leveraging open data and open source software, and the partnerships they worked to create, all acted as resources that they were able to call upon and assemble in particular ways when needed to support the earthquake response. In doing so, it suggests an approach to information system design that extends its concern beyond the technological artifact [9] and instead to the resources actors call upon during practices of infrastructuring [13]. Such an approach raises a further set of questions about the characteristics of these resources and the ways in which they shape and constrain the possibilities of infrastructural emergence. While the precise character of emergent infrastructure may be impossible to predict, greater attention to the resources that enable emergence may give designers productive ways of thinking about these resources influence what Easterling refers to as the *disposition* of an infrastructure, or the “tendency, activity, faculty, or property in either beings or objects—a propensity within a context”[6]. Further study beyond the scope of this case study is necessary to fully theorize the character of resources and how designers may incorporate them into their work.

KLL’s support of the earthquake response was, of course, not perfect. The resources they relied upon did not seamlessnessly or effortlessly translate to effective information infrastructure for the response, but they did enable KLL to bootstrap quickly in the face of high adversity. KLL has continued to be active in the long-term earthquake recovery process, and the attention the organization has received as a result of their work has brought with it both new opportunities and new challenges. The reconstruction of Nepal and its efforts to build resilience to future earthquakes along with the other social and political challenges it faces will continue for years. The role of organizations like KLL in creating and supporting the required information infrastructure to meet these challenges will continue to grow as an important site of research and innovation in technology and informatics.

# ACKNOWLEDGMENTS

We thank our colleagues in Nepal and the United States for their on-going support of this coordinated research program. We thank participants in post-earthquake Nepal who responded to the disaster. This research was funded by US National Science Foundation grant IIS-1524806.

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Figure 1

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| **Figure 1. Reports submitted to QuakeMap during the Nepal Earthquake Response** |



1. KLL’s formation up to this point in time has been described in detail in a prior publication [15]. [↑](#footnote-ref-1)
2. <https://www.nytimes.com/2015/05/02/world/asia/3-ways-nepalis-are-using-crowdsourcing-to-aid-in-quake-relief.html> [↑](#footnote-ref-2)
3. <http://www.bbc.com/news/world-asia-32603870> [↑](#footnote-ref-3)
4. <https://www.wired.com/2015/05/the-open-source-maps-that-made-rescues-in-nepal-possible/> [↑](#footnote-ref-4)
5. For more information on the Ushahidi platform, see: http://ushahidi.com. [↑](#footnote-ref-5)