Aftermath: Infrastructure, Resources, and Organizational Adaptation in the Wake of Disaster

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Informal and emergent organizations play a vital role in disaster response, and are a central concern to crisis informatics. Prior research in the field has tended to focus on the activities of individual organizations during periods of disaster. Though unsurprising, this focus has led to limited understanding of the origins and long-term trajectories of these organizations or their participation in broader networks of informal response, whose individual membership, ideologies, and practices are often fluid and overlapping. In this paper, we examine the activities of informal organizations that mobilized in response to the 2015 earthquake in Nepal. Drawing on semi-structured interviews with 17 participants, we identify five categories of resources — *funding*, *people*, *information*, *skills*, and *shared values* — that these organizations mobilized to sustain themselves and continue their activities long after the immediate disaster abated. We contribute insights into the adaptation decisions of emergent organizations, guidance in understanding these decisions in relation to their social and historical context, and considerations for how long-term, network-oriented studies can help address some of the contemporary challenges in crisis-informatics research.

CCS Concepts: • **Human-centered computing** → *Empirical studies in HCI*.

Additional Key Words and Phrases: Crisis Informatics, Informal Organizations, Resources, Infrastructuring

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1 INTRODUCTION

Emergent response to crisis is a near-ubiquitous feature of disasters everywhere. Research has shown that informal organizations are a common feature of disasters and have been found to play an important role in providing assistance and advocacy for the needs and priorities of impacted communities [51, 67, 71]. These activities have also been of interest to the CSCW and crisis informatics community, as they form important parts of the disaster information infrastructures through participation in global humanitarian networks [37, 42, 65] and local volunteer mobilization [59, 69]. The majority of this research has focused on individual organizations during moments of crisis. There is a good reason for this, as this is the period when they are most visible and active. However, recent scholarship has identified the need to attend more carefully to the ways emergent organizations evolve and adapt over time, including after and between disasters, to

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better understand the full scope of their contributions, their organizational evolution, and how this impacts the kinds of support they are positioned to provide in future disasters[59, 67].

In response to this need, as well as other recent arguments in CSCW for crisis informatics to take a historical perspective on disasters [56, 58], this study looks at the evolution of emergent and informal organizations that responded to the 2015 Nepal earthquake. Two large earthquakes, along with hundreds of aftershocks, struck Nepal in April and May 2015, causing widespread destruction and affecting more than eight million people [31]. Immediately after the earthquake, members of affected communities, along with Nepalis from across the country and the diaspora, mobilized to rescue victims, distribute immediate relief, and coordinate information sharing [28, 39]. Despite not having prior disaster response experience, local organizers mobilized volunteers and created networks in an attempt to address some of the gaps in the official response led by government and international organizations [39]. In the ensuing months, these volunteers coalesced into new or transformed organizations and continued working alongside the formal disaster response ecosystem. Many of the organizations who emerged during this time made important contributions to humanitarian efforts, and were covered extensively by local and international media at the time [22, 44, 53]. Due to both the severe impacts of the earthquakes and the unprecedented scale of the informal response, the Nepal earthquake have been an important site of study for crisis informatics research [20, 30, 57, 59].

Our study focuses on 12 organizations who responded to the 2015 earthquake and continued their post-earthquake activities for at least one year afterward. We conducted semi-structured interviews with 17 participants in these organizations on topics related to their activities, structure, collaborations, challenges, and future plans during the earthquake and the ensuing six years since. Drawing on prior CSCW research on resources and information infrastructures [2, 12, 19, 20], this study examines the efforts of these organizations to sustain themselves and their activities over time. This approach offers a way to understand organizational change and adaptation in the long aftermath of the Nepal earthquake. We present five categories of resources — *funding*, *people*, *information*, *skills*, and *shared values* — and describe the actions and decisions taken to mobilize these resources as part of efforts to scaffold the information infrastructures necessary to guide the immediate response to the earthquakes as well as longer-term processes of recovery and development.

During moments of crisis, when media attention and donations, volunteers, and other offers of assistance are plentiful, the resources used to support informal disaster response are often widely available. Our examination of resource mobilization over time allows us to identify important dynamics surrounding the efforts of emergent organizations to sustain themselves, or not, when attention fades and these resources become relatively scarce. This approach also provides insights into how individual organizations participate in broader networks in which resources are shared, competed for, or transferred between different groups. These dynamics are critical to understand, because they help to shape the kinds of activities that informal and emergent organizations are able to offer during future disasters, and the kinds of impacts they might have. In a time when disasters are becoming more extreme and many of the original platforms and organizations that characterized crisis informatics research are in flux, it is vital that HCI and CSCW continue to develop conceptual and methodological tools for studying how networks of informal response organizations evolve between and across individual crises.

We draw on our findings to offer three contributions in support of future crisis informatics research into emergent response. We first identify three adaptive strategies that organizations deploy in response to the relative scarcity of available resources between disasters. Identifying these approaches allows designers and researchers to support the work of these organizations in more targeted ways, and provides a framework that can support future studies into organizational

adaptation in the aftermath of disasters. Second, we highlight the crucial point that these organizations are not operating in a vacuum, but attenuate their adaptation to resource availability and the broader historical and political contexts in which they operate. Our study indicates that these situated constraints often appear in the form of what scholars in science and technolgy studies (STS) have referred to as "double binds" [3, 14, 63], and provide examples of how attending to such double binds can help researchers contextualize emergent and informal response to disasters. Finally, we reflect on how crisis informatics research is facing inflection points caused by new dynamics in social media platforms and digital humanitarian response and how our study and findings points to potential new research directions.

2 LITERATURE REVIEW

2.1 Crisis Informatics and Informal Response to Disasters

Crisis informatics is a field of study, initially developed in HCI and CSCW, that combines computing and social science perspectives to study the ways in which information and communication technology can help and constrain humans to respond to natural hazards [41, 58]. Much of this research agenda revolves around informal response during disasters and how those interactions are mediated by information technologies, and how the digital traces created by use of these tools allow scholars new insights into human behavior and collective organization during emergencies. In particular, crisis informatics scholars have extensively studied the use of social media as information source, socio-technical structures and processes of digital volunteerism, and self-organizing and coordination among global volunteer networks [40, 58].

Crisis informatics has both drawn upon, and contributed to, the broader literature on disaster research which historically focused its inquiries on how individuals and groups behave during mass emergencies from the vantage points of sociology and organizational studies. An especially relevant strand of 'disaster studies' research is the study of the informal 'all hands on deck' community response that is a common social reaction at the moment of crisis [11, 13, 61]. Prior work has shown that informal voluntary response occurs when there is observed need, a supportive social climate, availability of resources, and relevant pre-crisis social relationships [11]. Dynes' typology of four types of organization [13] during disaster response has served as an important framework from which to understand such group behavior [11]. As shown in Figure 1, Dynes' typology offers a useful context along two dimensions for considering 1) how organizational temporality (old vs new organizations) relates to 2) the types of tasks that they engage in (regular vs irregular) during crisis response. Established organizations, such as fire departments, are characterized by routine emergency response tasks performed through an existing institutional structure. Extending organizations form new team structures by which they conduct routine types of emergency response work, as in the example of local volunteers joining an existing group for an ad hoc project. Expanding organizations operate within known structures but take part in new types of work, e.g., when a private sector company offers skills and/or physical resources to aid in the response. Finally, emergent organizations are new organizations with novel forms of collective activity, in terms of their structure and their actions.

We focus specifically on Dynes' typology of *Type IV Emergent Organizations* as their evolving social structure and novel forms of work are an area of interest for crisis informatics and CSCW, particularly in the evolution of remote teams of digital humanitarian volunteers, e.g., HOT [42, 57], the Virtual Disaster Desk [64, 65], and Standby Task Force [37]. Disaster research on emergent organizations has shown that they are a staple of all disasters and frequently play a valuable role in delivering assistance and advocating for the needs and priorities of impacted communities [11, 51, 61, 67]. This research notes that they leverage structures, functions, and connections in

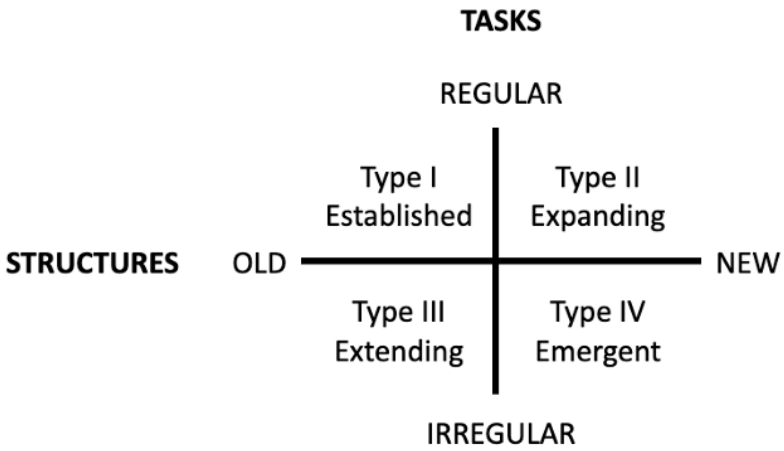

Fig. 1. Dynes typology of group behavior in disasters

interesting new ways [6, 11, 61]. Prior crisis informatics research in cooperative work has also studied the integration (or lack thereof) of emergent volunteer teams into established organizations, e.g., formal emergency response systems [71], as well as their activities over time during long-term crisis situations [12, 49]. However, most of this work revolves around a specific organization, application, or moment of time during the crisis. There are few studies that address the development of local emergent groups in disaster contexts over time [67], especially once the official disaster response period is over and the donor and media attention goes away [58].

Our study addresses this gap through a study of multiple organizations that emerged in response to the Nepal earthquake and their trajectory over a period of the six years following (at the time of data collection) the earthquake. Our approach responds to arguments in crisis informatics and science and technology studies (STS) literature about the limitations of traditional disaster phases and the need to conduct more long-term analyses [58**?**]. For example, Neal argues that traditionally-defined disaster phases (e.g., preparedness, response, recovery, and mitigation) are multilayered and demand better understanding of how organizational functions are experienced differently by different groups and how time intermeshes with their tasks over disaster phases [32, 33]. Similarly, recent research in crisis informatics, drawing from disaster studies, have argued for a need to understand disaster impact and activities in terms of their historical and political origins as well as future repercussions [36, 56, 58]. The efforts of emergent organizations to sustain themselves in the long aftermath of crises provide an opportunity to examine these issues because their emergence is facilitated by social capital and perceived gaps in existing disaster response system [11, 67], they create new structures and forms of work that, research says, have implications for broader and longer-term participation and civic engagement [9, 67].

2.2 Resources, Infrastructures, and Infrastructuring

In this study, we examine the evolution and sustainability of emergent organizations through the lens of resources. The study of resources, and their role in supporting the creation, maintenance, and use of information infrastructures, has been an important focus of research in HCI and CSCW scholarship. Early work in the field was concerned with the ways information and communication technology can be resources, constraints, and enablers for information sharing and work practices

in scientific and other fields [2, 4, 25, 63, 66]. In this study, we turn to the framework of resources outlined in [2], where Ackerman et al. examined different forms of resources and the situated practices surrounding their use to identify recommendations for how information systems and applications could be developed to augment, rather than prescribe, human action. Synthesizing various research, they defined resources as *"an entity that is used in a particular manner to address a recurring need or problem. Its manner of use is characterized by shared expectations, understandings, and practices that have built up during the history of its use in a specific environment"* [2]. We draw from this situated and relational notion of resources to explore how the informal and emergent organizations in our study adopted and adapted resources to remain sustainable in the long aftermath of the disaster.

The concept of resources in HCI and CSCW literature has been closely connected with studies of infrastructure, which expands traditional definitions of infrastructure beyond physical and technical artifacts to include the social practices and institutions within which infrastructures are embedded [25, 62, 63]. In particular, previous work explores how infrastructure is a fundamentally relational concept that is marked by ambiguity and multiple meanings. These new definitions also draw attention to the different ways in which infrastructures are shaped over time—an important consideration for disasters that experience an extended temporal period from the immediate response followed by a less-visible post-disaster phase. For example, Karasti et al., explore the notion of infrastructure time to understand how artifacts and practices change over different temporal scales [23]. Another crucial temporal aspect of infrastructures is what Ribes and Finholt refer to as "the long now" which describes the tensions between developing technical infrastructures under current conditions and its long-term sustainability in the future [48]. As noted in Section 2.1, these concerns and temporalities are especially salient to contemporary research priorities in crisis informatics and disaster studies.

Recent research in CSCW has expanded upon these concepts to advocate for attention to the human actions and social conditions that shape and maintain infrastructures through ongoing and frequently invisible, mundane forms of work. More recent work in HCI has reframed these forms of action as 'infrastructuring' [20, 35, 49, 57]. Infrastructuring has been a particularly useful lens to examine information infrastructures and technology use in environments of resource constraints such as repair work, developing regions, and situations of crisis. In Nepal, Soden and Palen have extensively looked at the infrastructuring practices of a non-profit technology organization, Kathmandu Living Labs, pre and post 2015 earthquake to understand its evolution [54, 57, 59]. Our work builds on prior crisis informatics research by studying the infrastructuring practices of 12 emergent organizations in Nepal as they sought to sustain themselves in the six years following the 2015 earthquake. We show that the resources these organizations drew upon changed over time but were actively cultivated, gathered, and mobilized based on the broader social and political context. Furthermore, these resourcing and infrastructuring practices shape how these organizations evolve, with important implications for the kinds of contributions they can make during future crises.

3 SITE OF STUDY: EMERGENT ORGANIZATIONS IN THE AFTERMATH OF THE 2015 NEPAL EARTHQUAKE

In Spring 2015, two large earthquakes and more than 300 aftershocks hit Nepal affecting 39 of the nation's 77 districts. An estimated 8 million people, almost one-third of the population, were impacted [31]. While Nepal had prepared for an earthquake, the magnitude was much larger than anticipated and the aftershocks hampered rescue efforts. As a result, there was widespread damage in mostly rural areas [50]. In the early days, spontaneous volunteers worked alongside formal

government and international emergency responders to support response and recovery efforts [10**?**].

Over the next few months, many of these volunteers coalesced to form informal and emergent organizations [13] with new operating structures and functions. Our study focuses on organizations who continued their activities for at least one year after the earthquake. These organizations were quite diverse in their composition, structure, as well as activities. They included Nepali youths in Nepal, Nepali diaspora living abroad, along with many foreigners. Some of these organizations formed from existing volunteer, political, or non-profit organizations while others were informal collectives that got together in the immediate aftermath. Most did not have prior disaster response experience and improvised in an ad-hoc way to contribute wherever they saw a need. These activities included — creating digital databases of volunteers, resources, and needs; mapping earthquake affected regions; distributing relief items; as well as helping with construction for damaged buildings. These organizations and their activities received acclaim from both national and international press at the time [22, 44, 53]. Many of these organizations also received significant funding and resources from formal and informal donors who were mobilized by the reports of damage and destruction from the earthquake [28]. The disparate impact of the earthquake and the role of the informal response in mitigating it (or lack thereof) have been an ongoing topic of interest in crisis informatics and disaster studies [30, 52, 55, 57, 60]. However, there have been few studies that look at the long-term evolution of informal response.

As post-earthquake response moved from immediate relief to long-term recovery, the needs of the community and the projects of disaster response changed. The attention of the public, media, and many donors started to fade away. Offices, schools, and economic activities started to resume as normal. And many individual volunteers in these civic organizations who had been motivated to contribute to a crisis event turned to other priorities such as jobs, schools, and other responsibilities. Yet, the impact of the earthquake had not disappeared, and many of the root causes that led to the lack of preparedness continue to persist even today. The emergent organizations that continued to be active, such as the ones in this study, had to learn to adapt and react to these new resource constraints.

4 METHODS

This data is drawn from 17 semi-structured interviews conducted by the lead author between November 2021 and May 2022 with leaders, employees, and volunteers involved with various informal organizations that responded to the 2015 earthquake in Nepal. Interviews lasted between 45 to 90 minutes and were conducted either in Nepali or in English based on the participant's preference. All except two interviews were conducted virtually via the online video-conferencing platform, Zoom. The interviews were transcribed in their original language and, if necessary, translated to English prior to analysis. The interview protocol was designed to explore the interviewees' experiences within these organizations during the immediate response to the 2015 earthquake and their strategies for sustainability in the years since. We asked questions about the various activities undertaken by their organizations, their fundraising strategies, organizational structure, collaborations with other organizations, challenges, and their future plans.

Participants were recruited through personal connections developed through the more than 15 years of collective experience of our team conducting research on disasters and information technology in Nepal as well as snow-ball sampling. Drawing from Dynes' typology [13], emergent organizations were chosen to include those who had unconventional structures and performed new tasks during the earthquake. Further, they had to be active for at least a year after the event. The 17 interviewees represented 12 organizations, of which 10 were active at the time of interview. Table 1 and Table 2 give additional details about the organizations and the participants respectively.

Table 1. Details about emergent organizations in the study

Number of organizations which are	
Formally registered as a legal entity	8
Based outside of Nepal	2
Based outside of the capital city Kathmandu	1
Active at the time of interview	10
Actively working in disaster related projects	4
Actively working with information infrastructures (e.g. open data, mapping)	5

Table 2. Details about individual participants in the study

Number of participants who are	
Founders and leaders of their organization	6
Long-term employees in legally registered organizations	7
Active in more than one organization	5
Actively involved with the same organization since 2015	8
Actively working in disaster related projects	7
Not living in Nepal or are foreigners	6

Following initial discussion of interviews and drawing on our own prior research and experience with the 2015 earthquake response and the civic tech community in Nepal, the authors collectively analyzed the transcript using *reflexive thematic analysis* [5, 8]. After familiarizing ourselves with the interview data, we chose to iteratively analyze our data with open coding. Preliminary codes included, for instance, the activities of these groups, funds, challenges, collaborations, and decision-making. After our interpretive and iterative data, we decided to focus on resources as they captured relationships between organizations' activities, decisions, and their interaction with broader networks. Further,choosing resources as themes allowed us to understand the organizational adaptation of these organizations in the the immediate response to the earthquake in the summer of 2015 when resources were readily accessible and the ensuing years afterwards, when they were comparatively scarce. It also allowed us to put this study in conversation with longstanding issues of concern in HCI and CSCW around the role of such resources in broader efforts to develop and maintain information infrastructures [2]. Through several successive rounds of coding and discussion, we developed our themes describing the five different primary types of resources that these organizations relied upon to accomplish their goals. In the Findings section below, we describe these resources, and the work that organizations did to gather and mobilize them to sustain their activities after the disaster was "over".

Author Positionality The first author is a Nepali scholar in North America whose research draws from Human Computer Interaction and STS to critique and re-imagine information infrastructures in the Global South, particularly in applications related to disasters and climate change. They have personal experience of the earthquake response in Nepal and have worked as an active member and volunteer within multiple civic technology organizations in Nepal, including two that are part of this study. The second author is based in North America and studies social computing in time- and safety-critical information work. They have extensive experience with The Standby Task Force, a global digital humanitarian volunteer organization that provided information support to the

international non-governmental organization (INGO) sector during mass emergencies, including the Nepal earthquake. The third author is an HCI and crisis informatics scholar. Based in North America, they have conducted research in Nepal since 2011, including multiple publications related to open data and information systems in the aftermath of the 2015 earthquake.

5 RESOURCE NEEDS AND HOW EMERGENT ORGANIZATIONS GATHER AND MOBILIZE THEM

5.1 Funding

Funding was both an important resource and a key concern for sustaining their organization for almost all our respondents. A major topic in the interviews was a discussion of the different ways they had to adapt to navigate funding constraints as the earthquake response funds disappeared. Below we describe three approaches used that we identified based on our data.

Many of the technologically oriented organizations formalized and are operating as non-profit organizations or small for-profit companies. Many of them need a continuous stream of funds to cover their needs for full-time staff, office space, and other associated operating costs. They seek these funds through grants or consulting contracts from government, humanitarian, and development agencies. For example, a participant, who belonged to an organization that helped coordination between OSM contributors and government emergency responders during the earthquake, has now started his own organization. This organization builds disaster specific dashboards in partnership with the national and municipal governments. However, not all organizations have continued to find grants for projects related to disaster response and mitigation. In the process, some organizations have expanded beyond projects related to disaster response and mitigation. Some operate as civic tech companies and build mapping services, web and mobile applications, and open data dashboards in partnership with larger NGOs, international foundations, as well as the local governments of Nepal. Others have partnered with communities to run for-profit ventures and generate revenues for themselves and community members. For example, one organization calls itself a "social enterpreneurship" and trains vulnerable women to make and sell jewelry while taking a cut of the profits.

Despite being able to get grants to continue their activities, participants felt constrained by bureaucratic requirements of these larger organizations as illustrated by the quote below:

> *With bigger donors and foundations, you have to have these preset ideas of what you ought to do. And then there's a lot of paperwork involved, right. And then your money is earmarked for certain things. So you can only use it towards those predetermined tasks versus what is needed on the groud [Edited for clarity].*

These organizations also felt constrained by the changing priorities of donor organizations and the need to continuously realign their activities to match the latest concerns. One interviewee expressed this frustration, saying:

> *We cannot always depend on donors' money, we do not know if they will keep giving money. You never know what will happen, they have their own priorities.*

On the other hand, smaller and less formalized organizations, whether out of choice or necessity, tended to organize their structure and activities in ways that reduced the overhead of recurring costs. Their governance tended to also be more informal than their larger counterparts, and participants described how they wore different hats depending on the organizational need to perform what is necessary for their projects. Many of the members of such organizations often had a separate independent career or source of income, so they needed few paid staff. They also designed their projects to be low cost or implementable with materials and team they already had. Often this took the form of designing versatile projects that could easily be adapted, as described in this quote:

> *The core of everything we do is try to build a platform or sort of a low-tech solution that enables everyone to use it the way they see fit. And we continue to modify the access and its approaches as we get feedback.*

This meant they often required less funding, and in short-term bursts, usually tied to the cost of implementing a specific project or activity. These organizations mobilized to solve small scale problems tied to specific communities such as build a library in a rural village, distribute food to daily wage workers during local disasters, and run advocacy campaigns about a local issue. Their funding needs were more amenable to voluntary donations and they have continued to raise money from their networks via digital crowdfunding platforms, social media, as well as personal asks to friends and families. Over the years, some organizations had also developed a variety of creative fundraising techniques as illustrated by this quote from a participant:

> *We had concerts, we had bids, and we had Momo (dumpling) making and film screenings. And, you know, every time we've come up with different ideas*

While some organizations learned to adapt to smaller, more sporadic funding opportunities, or developed tactics to help them navigate donor needs and organizational constraints, a few organizations decided to hibernate, or temporarily discontinue their activities. One respondent told us:

> *We felt like if we filed for recognition, and we went through this whole process, then we would have to qualify and sort of prove everything we had already done. … it was just, we'd have to perform an institution.*

This respondent's group had officially disbanded at the two-year mark after the earthquake when the government required that disaster response organizations formally register or stop operating. However, over the course of the interview, the participant talked about how they were still in touch with former team members as well as how they have continued working with the earthquake-affected community in a personal capacity. The hibernation tactic was common among other informal organizations that discontinued as well; despite disbanding, members reconnected to help during other disasters such as floods, landslides, and the COVID pandemic. For example, another participant who was based in California discussed how his group dispersed after about a year of post-earthquake volunteering but regrouped again to supply ventilators and oxygen during the COVID-19 pandemic after they were able to solicit funds from his prior donors and friends.

5.2 People

Along with funding, another important resource that the respondents repeatedly talked about was people. This included members of the group itself, employed staff for the more formal organizations, as well as the volunteer communities that many of these organizations cultivated and worked with. Respondents in our interviews often spoke in glowing terms about their teammates and listed them as one of the main motivations for their own continued involvement. Many of the participants joined their current organizations because they knew and admired existing members. Others had started their organizations with friends that shared the same goals. Yet others had gotten together through their activities but now considered their teammates as close friends and support system. In all of these cases, the respondents felt a sense of belonging with their team and often described the collective as both a support system and an accountability mechanism.

In addition, individual members brought their own networks to support the group once the abundant publicity during the earthquake went away. This was particularly true of the leaders and founders who would provide access to funding and information through their personal networks. In addition, members of the organizations who lived abroad or were foreigners often provided international publicity, brought more legitimacy, and sometimes even dollars to support the work

of these organizations and to distinguish them from the numerous non-profits that exist in Nepal. For example, in the quote below, a participant, who used to work as a UN consultant prior to joining one of the organizations in a leadership role, talks about how they used their network to get a project when they were struggling:

> *I basically brought in all the local ambassadors and heads of you know, bilaterals, and UN and, and pitched to them .... And that, was when we got our first donor and partner.*

The participant follows up the quote with how their organization has continued working with this first donor and how that first project turned into a stepping stone for other partnerships, including one with a global entrepreneurship network.

However, respondents also talked about challenges in recruitment and retention. They shared about the difficulty in finding staff who aligned with the vision and had the needed interdisciplinary experience. This was specifically true of organizations that had pivoted to work at the intersection of technology and numerous developmental issues. While it was easy for the initial members to understand both the technical problems and social impacts of maps and information dashboards that they built during the earthquake, many participants discovered that the longer term developmental problems that they wanted to tackle post-earthquake required individuals who have a deeper understanding of social issues as well. As one participant described: *"The problem is that we need hybrid managers. And there are very few hybrid managers in Nepal."*

Others talked about the need to compete with larger humanitarian organizations and more established non-profits that could afford to pay more. These challenges often encouraged these organizations to stay small and limited their activity and impact as the following quote illustrates:

> *So we could add more human resources, but then you have to manage those human resources as well. So we just tend to stay small, which is probably one of our limitations, because our stakeholders are asking us to do more, to scale our work to go outside of Kathmandu. And a lot of times we hesitate, because we're like, we don't know if we want to invest in building the infrastructure and the human resources to do that.*

Respondents described various tactics to overcome these challenges. One approach was running fellowship programs. These fellowship programs are both paid and unpaid, targeted to recent graduates and experienced people, and often run for a few months to a year. The fellows provided expertise as well as brought their own source of funding. Even if they never joined the organization as a core member or full-time staff, the fellows become an advocate for the goals and projects of the organization. For example, an organization that builds data platforms for local governments has alumnis from their fellowship programs who are government employees and act as resources and advocates for the parent organization when they deploy their products.

Other organizations created, worked with, and fostered volunteer communities that allowed them to circumvent funding and bureaucratic challenges. These organizations saw volunteer communities as an extension of their organizations who could contribute with ideas, labor, and publicity. As one participant describes:

> *We made this conscious decision to reach out to people, through networks, through schools, through you know, governmental, non-governmental organizations, engineering colleges. Just as a way of, like, telling people- Hey, there's this new, awesome tool, and we need your help.*

For many civic tech organizations, such volunteer communities were especially useful because they helped create other informal communities among interested users who could contribute with data and user-base.

As a result, these organizations spent significant time and resources building online and offline volunteer communities. College students and recent graduates were key targets for such communities. Organizations reached out to schools and colleges and organized training events, meetups, hackathons, and conferences. They also leveraged digital platforms such as Facebook, Google groups, Slack, Discord, and Github to create closed communities where members could discuss projects, share ideas, and provide feedback. Respondents also saw community building as a way to find collaborators, build publicity, and increase their impact as this quote from a participant illustrates:

> *We truly did invest in building a local team, and building our local community of users. And by investing a lot of our energies in that, I think, we built up a sort of credibility and a brand for ourselves within the local ecosystem of being very relevant and very sort of, I want to say, like, truly grassroots.*

Members of the core team and volunteer communities continued to be resources even after they left the initial organization and moved on to different roles. Multiple participants talked about using former teammates who had built professional career in development industry as expert consultants. It was also common for individuals to move from one group or organization to another and then start collaborations with their former teams.

5.3 Information

Many of the respondents also saw information as an important resource that allowed them to access other resources while being relevant and impactful. This is not surprising as many of these organizations had emerged during the earthquake as information brokers who helped relay the needs from affected regions and communities to the official responders and aid providers. They did so by creating information infrastructures in the form of digital and physical maps, information dashboards, forums to connect volunteers with resources, and mechanisms to report and verify needs. Therefore, some of the first activities that our respondents engaged in as a part of their organizations was collecting information about the impact of the earthquake. As the attention to disaster receded, information remained a resource but the forms of information that they needed changed. In the long aftermath, the respondents talked about seeking information about funding, collaborators, and new project ideas.

As they searched for information, these organizations also adapted to design their workflows around maximizing information flow. Many participants described the online and offline channels they had built for encouraging information sharing within and between organizations. They organized both online and offline community events to learn about gaps, needs, and come up with new project ideas. Many of the respondents talked about how they launched proof-of-concept projects based on input from their volunteer communities. They also solicited feedback from their personal network in donor organizations to later turn these prototypes into funded projects.

Others had dedicated members who would cultivate networks that shared information. They had learned which meetings and social events were useful for information flows and planned their activities around those events. For example, one of the participants who held a leadership position at a disaster related civic tech organization, described how they got the idea for their flagship disaster data project at a conference:

> *At that time I had just done my post graduate, then I thought of disaster management portal from India. It made me think that there is not even a basic level of disaster system in Nepal. Then it clicked and I asked one of the government representatives of Kathmandu about it. Then he too said that we only have a DRR (Disaster Risk Reduction) portal. Then we were determined to do it. We said, 'Let's do it. Let's develop it for Nepal.'*

Some of the respondents also talked about how having the right information could help make their project more sustainable. This was often the case for the tech-oriented organizations, whose application and dashboards would only be relevant if they were constantly maintained and updated. However, most donor funded grants were geared towards initial prototypes. Thus, the organizations were constantly seeking information about potential partners and resources that they could hand over the project. In the quote below, a participant describes the challenge of finding the right partner to hand over a crowd-sourcing application and how their efforts to gather information was critical to ensure the project was still active at the time of the interview:

> *So I mean, the original idea was to hand it over to O1. And we, we looked at an O1 site, it kind of does a similar service. But when we looked at O1, we found that they were pretty politically active. And sort of handing over to O2 allowed there to be kind of a monitoring system that was a little bit more independent. Or like it had an independent perception. Like when we talked to [users] in Terai, they said 'oh, we would never report anything to O1'.*

In the above example, the participant and their group gathered information about values of potential partners and their relationship with local communities. This allowed them to select the organization O2 who were more trusted by the local people which ensured that the locals would continue adding information to the application and ensured sustainability of the project.

5.4 Skills

These organizations also tapped into the skill and experiences they gained over time as a resource to find opportunities and continue making an impact. Many of them had started their post-earthquake activities without prior disaster experiences, and many of them included youths in their teens and twenties. Their activities during the earthquake gave them initial publicity and skills which they continued to cultivate in order to gather resources and maintain their activities, even as they diversified their activities to different working areas and geographical locations.

Some of these were specific skills tied to their activities. A recurring theme in the interviews was their reflection on how they had to quickly learn about disaster and disaster response during the earthquake and how that helped them to adapt in the aftermath. For example, organizations that helped with reconstruction and aid distribution on the ground described using the building and operational skills to continue similar activities around building libraries, running skill training programs, and supporting youth engagement. Similarly, organizations that started through digital activities gained technical skills around building resilient software systems, databases, and data sources that could function in earthquake affected areas without reliable internet access. Once their earthquake projects ended, some of the organizations that were building mapping and data tools went to build similar tools for local governments in different parts of the country, including rural areas without internet. Others used the expertise and the publicity gained during the earthquake to partner with regional organizations outside of Nepal. One organization had rebranded itself from open data advocacy group to a capacity builder for data science and Artificial Intelligence. These expansions allowed these organizations to access newer sources of funding as well as stay relevant.

There were also many soft skills that these organizations developed over the years that they utilized as resources. The members of grant-funded formal organizations had become more adept at identifying grant calls, branding their activities and organizations, and building relationships with donors, communities, and government officials. For example, a participant describes a learned skill they had developed — negotiating flexibility in their projects with donors:

> *When we negotiate partnerships, we build in space for what we call adaptations, and we keep, we document our adaptations. And we say, based on this evidence, this is why we are going to pivot and change and adapt our approach.*

Participants also talked about applying the skills that came with building flexible projects to use rapid prototyping as a method for collective decision-making and conflict resolution.

The more informal organizations became more adept at identifying contributions they could make using easily available resources, find more experienced collaboration, and coordinate among team members without a formal structure. For example, one organization composed of an informal network of volunteers operated in a decentralized way with independent volunteers leading advocacy projects on issues of their interest while the organization provided material and logistical support. The participant from the organization explained that this was a technique their group had iteratively developed to increase impact while reducing costs.

5.5 Shared Values

Lastly, a shared value system aligned with the goals of the organization emerged as an important resource for these organizations to form communities of support systems, collaborate with each other, build lasting relationships, and withstand difficult times. A common response from many participants to explain why they continued to work with their organizations despite various challenges was a shared belief in their goals and impact. A participant says - *"When you see the faces of people, you forget your own frustrations, you know?"*

Many of these organizations emerged during the earthquake with a common goal of helping disaster affected communities. In the aftermath, they had to find new values to motivate themselves. For the more informal organizations, this belief often centered around their ability to be flexible and nimble and meet the gaps that were left by larger actors in the ecosystem. The participants often described their organizations and their activities as *"adapting to needs"*, *"changing direction"*, *"being versatile"*, *"innovating"*, *"trying out new things"*, and *"figuring out in the moment"*. In the interview, they gave examples of how they started with an initial idea but quickly modified their deliverables, added features, or changed their projects entirely based on perceived needs and community feedback. For example, one of the organizations received donations to distribute relief items after a massive storm but when they reached the site, they discovered that other organizations were already doing so. So, they quickly regrouped and diverted their resources to help install solar panels which would provide emergency power as well as allow the community to have a more renewable and cheaper power alternative in the long-run. Such examples were common, and the respondents felt such agility was their value add as well as how they differed from more formal organizations as the following quote reveals:

> *These big organizations are like the big trucks that get stuck on the road. When you reach a landslide, you can't go anywhere, you can't go past it, you have to wait for the road to be cleared. Then other people come out and try to intercept you and redirect you and you are like this slow moving beast. But the small humanitarian organizations, the civic tech organizations, and such- They're like motorcycles, and people can get off and push and get through the landslide and continue.*

Similarly, for the more technologically oriented organizations, the shared values often manifested as a belief in using technological innovation to enact social changes, increase participation, and bring accountability. Many members who worked on open data or mapping projects for the local government described how their work was critical to build the necessary technological and civil infrastructure for Nepal to *"help the people of the country be part of the data revolution and improve*

their own lives." Many respondents cited the number of people who have used their apps or participated in their event as a justification of their impact.

Shared value systems became especially important at times of resource scarcity, especially when funding was hard. This is illustrated better with the following example from one of the formal non-profit which suddenly could not get funds that they were expecting. In the quote below, the participant is paraphrasing a motivational speech from their director during a meeting to decide the organization's next steps:

> *Listen, this will lead somewhere down the line but we just need more time. What we mean by that is that we will use whatever resources we have left over a longer period of time.*

After the speech, the team decided to work for half their salary to extend their operational budget to last the next six months. The participant shared that their organization was successfully able to find a new project and source of funding in those six months.

The shared value system around goals and belief often extended beyond the core members of the organization to the broader communities they worked with. For example, a participant who ran a maker-space described a situation where they were going through a financial crisis and considered shutting down the space. However, their community of users rallied around for support and helped find alternate sources of funding because they felt the maker-space and organization was a critical part of the ecosystem. The participant explains:

> *And so that was a testament to the fact that you know, our community is really critical to our survival, because they're the ones that are telling us that there's, there's a, there's a value proposition that we provide for the work that we do.*

Since then, the organization has formalized and has continued to redefine their purpose and goals in consultation with their board and the community of users. At the time of the interview, this organization was in the process of rebranding their maker-space as a design studio. They planned to be a part of a global entrepreneurial network to access newer sources of funding and stay relevant.

However, some participants also felt that the shared value system did not always help their organization sustain and grow. They thought caring about their goals or project areas made them too rigid or limited them from being sustainable as illustrated by this quote from a participant:

> *It might not always work from an actual business, profit, revenue, and sustainability perspective. We, at times, invest a lot of effort in menial tasks and less effort in huge tasks. It is not what actual business-minded people do.*

Others expressed concerns about whether they were living their stated values in the post-earthquake Nepal. A participant felt they had to "*sell emotions rather than products*" to make donors care about their work. Yet others felt unsure if their activities had created as much impact as they had hoped when they started. This concern about impact often competed with the need to capture donor interest as illustrated in this quote:

> *There is no measurement of the success of the output. No one analyzes it, not required for the donors, not required for NGOs. Most are focused on delivering the project than creating an impact. Because of this, it is more focused on the show than creating an impact in my view*

A few informal organizations that hibernated and even disbanded described their struggles with burnout which came from caring too much. For example, a participant described how their group decided to disband because they felt their activities and efforts were "*rooted at a time and place*" and they could not be as invested in a long-term organization. Similarly, another group collectively decided to slow down their activities but remain in touch because they felt burnt out. The participant explains:

> *There were such urgent short term needs. So that's what I mean. I feel like you end up putting so much effort into addressing short term urgent needs in these crisis situations that you don't end up working on long term solutions. Even at that time, we made [inaudible] to say that we can't do these long term housing things because the short term crisis is so acute at the moment. And our resources can only manage the short term. Even our stamina can only manage short term in that situation.*

6 DISCUSSION

CSCW research in the area of crisis informatics [41], in line with disaster studies more broadly, has found emergent volunteer response to be a staple of all disasters, frequently playing a valuable role in delivering assistance and advocating for the needs and priorities of impacted communities [51, 67, 71]. They note that these groups could offer longer-term opportunities for structured and sustained citizen engagement in disasters and some even argue that these groups could be formally integrated into disaster management organizations [51]. Despite this, there have been very few studies that have examined the long-term evolution of emergent organizations between disasters. Our focus on the ways localized and emergent organizations cultivate and mobilize resources helps highlight important processes that shape the kinds of organizations they may become, the kinds of support they can provide during the next emergency, and the broader expectations for their role in the long-term.

Below, we discuss three observations based on our findings. First, we describe three adaptation strategies based on how organizations restructured themselves to meet their resource needs. These approaches provide a framework for identifying the kinds of roles these organizations can play in future disasters and how they can be supported. Second, we note the role of broader social and political contexts in organizational adaptation and use "double binds" [3, 14, 63] as a tool to examine the specific ways these influences play out. Finally, we reflect on ways our research approach and findings show new direction for crisis informatics research to navigate new challenges such as – the changing nature of digital volunteerism and increasing obstacles to gathering social media data on crisis response.

6.1 Organizational Responses to Resource Scarcity in the Long Aftermath of Disaster

Our study of the resource mobilization of these emergent collectives in the long aftermath of the earthquake shows that the organizations had to redefine their structure, goals, and activities to adapt to a resource-constrained environment and remain relevant. These adaptation approaches appear to be examples of strategic learning [29] which include both deliberate planned actions as well as emergent strategies shaped by broader context. While all the organizations evolved, they diverged in what resources they prioritized, and the work needed to gather those resources. Identifying the similarities and differences in how these organizations adapted and evolved, reveals interesting insights about the types of organizations they become, the different roles they can play, as well as how they integrate within the broader context. Below, we identify and describe three organizational adaptation approaches – *enterprising*, *evolving*, and *hibernating*.

6.1.1 Enterprising organizations. Enterprising organizations found and used resources in creative and unexpected ways, often by utilizing their public acclaim from the earthquake response and creating a niche that expanded their access to resources in the aftermath. In particular, they were able to find new purpose and relevance by intentionally redefining their mission, vision, and shared values as a means to orient their work toward new sources of funds and other resources.

Enterprising organizations in our study leveraged their social capital to serve new communities and generate alternative sources of revenue. For example, an organization founded by an American

expat with global digital volunteers used their earthquake acclaim to partner with an American tech company and rebrand as a data science trainer. Likewise, another organization with deep roots in the community redefined itself as a social entrepreneurship and generated profits to continue their other local activities. Prior research demonstrates that such social entrepreneurism performs important functions during the post-disaster rebuilding process, such as outreach, advocacy, and mobilization for other essential local services [7, 45]. What is especially notable here is the lure to move away from disaster related work to more entrepreneurial types of activities in the absence of mechanisms to sustain their efforts, effectively denying the community hard-won skills and knowledge that informs local culturally responsive disaster work.

6.1.2 Evolving organizations. Evolving organizations took a more adaptive approach to sustaining themselves by integrating into the broader network of NGOs and INGOs in Nepal. They parlayed their initial crisis work to develop new resource streams through disaster risk reduction and other development-related projects. Evolving organizations differentiate themselves from their enterprising counterparts by continuing to hew more closely to their previous work in the post-crisis aftermath. They formalized as civic technology organizations and expanded their focus to deliver applications and services to INGOs, local NGOs, and local governments. Alongside, they also changed their organizational structures and workflows to be more formalized and closely integrated with that of the INGOs and NGOs to aid in the service delivery.

This adaptation strategy matches closely with prior HCI research that suggests civic tech organizations can facilitate their sustainability through a focus on solutions, membership growth, institutional integration, and technical improvements that meet community needs [17]. Yet, questions remain regarding how such formalization impact their continued ability to create new structures and fill gaps. While some disaster research shows that formalizing as an NGO is a sustainable path for emergent organizations to continue their grassroots connections [51], it is unclear in our analysis if the evolving organizations in our study do so. The established humanitarian and development networks that these organizations integrate with have been criticized for exclusionary policies and inequitable responses that do not support locally specific realities [27, 38]. More study is needed to understand how these dynamics play out in the long run.

6.1.3 Hibernating organizations. Hibernating organizations paused their activities as resources dried up, with the intention of reassembling when resources could be more easily gathered. These organizations were the most informally structured during the earthquake and continued to remain so in the long aftermath as well. This approach to organizational adaptation differs from the previous two in how the members chose to remain digitally and socially connected without formalizing as an organization. They only mobilized when community needs were apparent. For example, one group continued to reactivate every monsoon to crowd-fund donations and distribute relief kits during local floods. Another mobilized during the COVID-19 pandemic to supply masks, oximeters, and even oxygen tanks.

Hibernating organizations follow the "episodic volunteerism" approach identified by Starbird and Palen in their study of Humanity Road [65] and similarly share a commitment to mobilizing for social good but differ from the larger global organization in their place-based attachment and longer pauses between activities. Similarly, by prioritizing informality and need-based projects, hibernating organizations differ from the other two categories of organizations in their visions of sustainability which values continued impact instead of continued existence of an individual organization. However, this also puts them at a greater risk of disbanding due to challenges of burnout and competing personal and professional demands [9].

6.2 Double binds as a tool for understanding organizational adaptation to context

The organizational strategies described above did not occur in isolation but were shaped by the participants' expectations of where they could get resources, which was in turn influenced by their social location as well as broader social and political contexts of Nepal. In this section, we examine the specific ways these organizations navigate these contexts and resource-constraints using the theory of "double binds" as an analytical tool. Double binds, as introduced by Bateson, refers to the dilemmas that arise when one receives two conflicting demands at different logical levels, often resulting in paradoxes which are difficult to identify or resolve [3]. Extending Bateson's work, researchers have noted that double binds occur in various academic, business, legal, and humanitarian contexts [14, 46, 63]. In particular, our work draws from Kim Fortun who defines double binds as a "situation in which individuals are confronted with dual or multiple obligations that are related and equally valued, but incongruent" and argues that double binds are inevitable in environmental advocacy by middle-class progressives in the era of globalization [14]. We note this to be true for the emergent organizations in our study as well, who were entangled in various double binds as they tried to cultivate and gather resources from local and global donors while advocating for the marginalized and vulnerable communities in Nepal. Below, we give examples of three such double binds that became visible when we directed our attention to changing availability of resources in the long aftermath of the Nepal earthquakes and the tactics that emergent organizations used to navigate them.

A clear example is what we call the double bind of accountability. On one hand, they gathered funds and information from their donors and were accountable towards them. On the other hand, the organizations saw themselves as advocates, mediators, and translators for the vulnerable communities and felt accountable towards them. However, the donors and communities did not always have the same priorities and concerns. Often donors operated in a global context and defined their priorities and working areas based on global development agendas [38]. The participants in our study appeared to be aware of this dilemma and had come up with different tactics to prioritize their ethos of serving communities while getting funds and other resources they needed. For example, hibernating organizations maintained their independence by being willing to pause their activities when value-aligned donors were unavailable. Similarly, enterprising organizations modulated their working areas and organizational structure to find different sources of funding and a more diverse set of donors. Lastly, evolving organizations integrated with the formal NGO network and donor ecosystem but designed workflows that could bridge community needs and donor demands. They sourced ideas for their projects from volunteer communities and reframed them to align with donor driven development agendas. They built flexible prototypes that could be adapted to meet specific local needs while also being marketed as globally scalable. Despite these workarounds, the participants in our study continued to feel constrained and conflicted as evidenced by their complaints about donor demands.

We also identify a second double bind for the evolving and enterprising organizations that arises from the social location of their members which puts them at a contradiction with their goals of grassroots driven social change. Many of these organizations consisted of young, technically savvy Nepalis, who identify as what Irani calls 'entrepreneurial citizens' [18], and are inspired by cosmopolitan rhetoric of technological innovation as a way to shape social change. This had served them well during the earthquake when they leveraged digital volunteers, open data, and social media to fill critical gaps in the crisis information infrastructure [57]. However, in the long aftermath, when needs are not as apparent, their prioritization of innovation and technological tools inherently limits them in the types of communities they can build and interventions they can make. First, focusing on open-data and civic tech applications leads these organizations to pose

political-economic causes of vulnerability in terms that are amenable to technical solutions and expert interventions [26]. Second, critical HCI research shows that technological affordances often create barriers to grassroots inclusivity [15, 34]. In Nepal, the civic-tech interventions during the 2015 earthquake were found to help middle-class digitally connected elites while excluding the needs and contexts of digitally and socially marginalized communities [30, 43, 55]. This is likely to be continued in the long aftermath as well. Despite their goals of grassroots inclusion, digital empowerment, and democratic accountability, none of the organizations in our study seem to have prioritized activities that address digital marginalization such as sourcing volunteers from digitally excluded communities, focusing on the increased adoption and maintenance of the completed projects, and advocating for social and political mobilizations to counter disaster vulnerabilities and structural inequalities.

Lastly, we find that these organizations, like many other humanitarian and development organizations, are trapped in a temporal double bind that creates a conflict between their 'bias to action' versus the long-term structural origins of the problems that these organizations are trying to tackle. In a way, this is understandable. These organizations emerged and succeeded during a moment of crisis to fulfill needs that were time-sensitive. However, much of this disaster response work only provided momentary relief without addressing the historical and structural causes of disaster vulnerability. In fact, the availability of resources and the flurry of activities during a disaster can have a negative impact by drawing resources and attention away from the everyday experience of precarity and inequality that characterizes the lives of many vulnerable communities [36]. This double bind was most evident in the activities of hibernating organizations who repeatedly mobilized similar resources and ran the same kind of relief-activities during local disasters. However, even the evolving and enterprising organizations, who remained active throughout the long aftermath, found it difficult to design projects that address longstanding problems or determine the impact of their interventions. As a result, they tended to gravitate towards proof-of-concept projects with quick turnarounds and well-defined deliverables, and were incentivized by their donors and communities for doing so.

Our analysis of double binds shows the different types of negotiations these organizations engaged in as they made decisions about their organizational priorities, structure, and areas of impact. Fortun states that double binds are an integral part of advocacy work and to ethically navigate them requires one to learn to live within the paradoxes and "dream up new ways of understanding and engaging the world" [14]. Our analysis shows that when organizations are aware of double binds, for example, in their dilemmas on accountability between donors and communities, they have engaged in infrastructuring practices to find alternate resources and procedural workarounds that challenge inequitable donor demands. On the other hand, through their analysis of infrastructures, Star and Ruhleder show that a failure to identify double binds can lead to unforeseen, complex challenges in the organizational goal of infrastructure adoption [63]. Similarly, we note that the organizations' double binds due to their social location and 'bias to action' was causing them to inadvertently entrench existing inequalities despite their motivation and efforts towards structural change. Attending to these double binds and the ways these organizations navigate them can help crisis informatics researchers contextualize volunteer and emergent response to crisis [58, 67] and identify the specific ways social locations and historical and political structures constrain organizational behavior and evolution. Furthermore, the lens of resources (or resource-ing) can be useful for anticipating double binds and designing interventions to support emergent organizations efforts to navigate them in ways that aligns with their values.

6.3 Inflection Points for Crisis Informatics

Prior crisis informatics research has been largely focused on studies that focus on use of social media during crisis events [58]. This is not surprising. Crisis informatics emerged as a research field in the 2000s when the rise of social media and peer-to-peer platforms enabled the general public to be involved in disaster response in different ways and offered promising tools to collect, manage, and share information about disasters [40]. Early crisis informatics research focused on empirical investigation of social media use, evolution of global digital volunteer networks that crowd-sourced data, and tensions between social media facilitated volunteer networks and formal emergency response professionals [40, 47]. Importantly, much of this research was facilitated by the researcher's access to qualitative datasets from public social media sites such as Twitter and Reddit [40].

We note that this type of research, and therefore crisis informatics more broadly, is at at a juncture of several inflection points at the time of our writing. Recent changes to terms of service and APIs in the platforms that were commonly used for digital data gathering and sharing during disasters [21] suggests that the datasets crisis informatics traditionally relied on may no longer be available. It is likely that these changes mean that the platforms themselves may not continue to be reliable mediators for crisis volunteers and formal emergency responders. Furthermore, most of early crisis informatics research focused on activities of specific organizations in individual disasters. Many of these individual organizations that pioneered digital volunteer response and were subjects of crisis informatics research are themselves at a juncture. Some of the original volunteer organizations doing this work at the international scale have recently disbanded, citing a lack of resources to continue their work [1, 68]. Others, like the Humanitarian OpenStreet Map Team (HOT) have grown quite large, formalized, and closely integrated with established institutions [16]. The widespread formalization and adoption of many of the innovative approaches pioneered by early networks of crisis informatics volunteers by the United Nations and other major humanitarian initiatives may also be a contributing factor to the existential questions currently facing both researchers and practitioners in this space [42, 57].

Our study suggests approaches and areas of investigation that may assist crisis informatics researchers in navigating this changing terrain. This paper differs from existing studies of emergent organizations in crisis informatics because of its focus on a longer-term duration (six years) in the aftermath of the disaster and by focusing on multiple organizations that operated within the same local context. This allowed us to identify the dynamic local network of people and resources that helped these organizations emerge and sustain themselves over time. None of the organizations in our study emerged or operated in isolation. Our findings align with prior research that show social and personal networks were important factors for these organizations to emerge [11] as well as for them to sustain over time [17]. Further, these networks are not static and themselves evolve over a longer period of time in ways that would not be visible through a narrow focus on periods of crisis alone. Members move between organizations over time, bringing their own networks, skills, and values to other organizations, amplifying or changing the kinds of impacts they can have [25]. The emergent organizations and their members spent significant time infrastructuring new networks and volunteer communities who shared their mission and vision. Undoubtedly, these networks will continue to impact disaster preparedness and response activities in Nepal, albeit in very different ways than they did during the earthquake in 2015. Crisis informatics research could help answer questions about the impacts they make over time, as well as how these networks might influence new emergent groups and new networks in future disasters by taking a similarly broad localized spatio-temporal view.

Further, we show that these emergent organizations, and the unique interconnected networks that they form, are diverse and shaped by the social location of their members as well as broader social-political contexts. Focusing on these inter-organizational networks, rather than individual groups with singular missions, opens up opportunities for crisis informatics research to foreground the politics of crisis response as a complex, multifaceted social endeavor of cooperation, competition, and connection. Moreover, this lens allows a wider aperture to consider interventions that may help reshape these networks in ways that make them more inclusive and participatory. [58]. For example, the networks of emergent organizations in our study operated in similar ways as the "publics" deployed by LeDantec and DiSalvo to conceptualize participatory civic action [24]. They emerged in the moment of disaster when gaps existed in current governing structures. They aspire to bridge the gap between vulnerable communities and existing authorities, and often collaborate with one another as a way to establish power and agency. Often, the organizations had visions of sustainability where their relationships and activities leave an impact rather than simply consume resources. Yet, as we argue, existing incentives and infrastructures tends to lead these groups towards prioritizing short term projects favored by donors instead of tackling long-standing vulnerabilities. Crisis informatics could draw from existing research in HCI for Development that considers specific challenges of resource-constrained environments to design more equitable and participatory forms of technologies [24, 34, 70, 72]. Such research could also help design interventions and resource infrastructures that can help emergent and informal organizations to obtain necessary resources while being more connected to grassroots needs, communities, and values.

7 CONCLUSION

As we have shown, the adaptation choices that organizations make, in turn, shapes the kinds of organization they become, and thus the sorts of support they are set up to provide, and to whom, during the next disaster. In this paper, we looked at the ways in which the emergent organizations that mobilized in response the 2015 Nepal earthquake evolved and adapted in the aftermath. As donor and media attention faded away, and the resources that these organizations relied upon to accomplish their work became relatively scarce, they were forced to adjust their activities, forms of organization, and mobilization strategies. We identify five broad categories of resources that helped them sustain – *funding*, *people*, *information*, *skills*, and *shared values* – and describe the decisions and actions these organizations took to gather and deploy them. As a result of this focus on resources, and the longer-term perspective we adopt, we are able to observe several distinct strategies that the organizations we studied adopted in order to sustain their work. We are also able to see that these decisions are in-part determined by the particular contexts in which they are working, including the social locations of their members, their personal networks, as well as broader political and historical factors.

These adaptation choices, dynamics, and their impact on future disasters matter as climate change, rising global inequality, and other factors make disasters more frequent and devastating. At the time of this writing, Nepal was preparing for annual monsoon season and the floods and landslides that increasingly unpredictable monsoon rains bring. Some of our participants had gained experience, networks, and skills to be more effective at mobilizing during these disasters. Others felt burnt out at the unending stream of crisis events. Some were too busy working on unrelated projects and finding new revenue sources to be able to meaningfully contribute. Crucially, none of these factors are visible without the longer-term approach we have adopted in this study. The paper is therefore an important step for crisis informatics; it responds to prior calls to attend to long-term activities of informal crisis response organizations, demonstrates the value of doing so, and provides important conceptual and analytical tools that can support future research in the field.

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