

Mapping Silences, Reconfiguring Loss: Practices of Damage Assessment & Repair in Post-Earthquake Nepal

ROBERT SODEN, University of Colorado Boulder

AUSTIN LORD, Cornell University

In the aftermath of major disasters, governments, aid agencies, and affected populations engage in practices of sense-making to gauge the extent and severity of the crisis, direct response activities, and coordinate recovery planning. To understand the conduct and implications of these practices, we examined the official damage assessment implemented by the Government of Nepal following the April 2015 earthquake. In addition, we undertook participatory mapping to examine the consequences of this assessment in the Langtang Valley, a severely-affected area of the country. We argue that the informatics of post-disaster damage assessment in Nepal played a primary role in narrating the events of the 2015 earthquake, legitimating particular paths toward recovery in the aftermath, and limiting opportunities for alternative configurations of social life that emerge during disasters. Our research demonstrates the ways that forms of sense-making afforded by information technologies play central roles in enacting repair-work following crisis and breakdown.

CCS Concepts: • **Groups & Organization Interfaces** → collaborative computing, computer-supported cooperative work; Social Issues

KEYWORDS

Crisis Informatics; Disasters; Infrastructure; Repair; Care.

ACM Reference format:

Robert Soden and Austin Lord. 2018. Mapping Silences, Reconfiguring Loss: Practices of Damage Assessment & Repair in Post-Earthquake Nepal. In *Proceedings of the ACM on Human-Computer Interaction*, Vol. 2, No. CSCW, Article 161, November 2018. ACM, New York, NY. 25 pages. <https://doi.org/10.1145/3274430>.

1 INTRODUCTION

Following major disasters, the government entities and humanitarian agencies comprising the formal crisis response mechanisms of contemporary society engage in a series of practices aimed at describing the scope, severity, and distribution of the event's immediate impacts. Using techniques that range from on-site visual inspection by civil engineers to smartphone applications or crowd-sourced analysis of satellite imagery, statistics are produced such as the

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from Permissions@acm.org.

number of human casualties, buildings and roads damaged or destroyed, crops and livestock affected. These socio-technical processes, increasingly reliant on new technologies, convert the lived experience and condition of individuals, communities, and their infrastructures into information legible to the moral, bureaucratic, and logistic sensibilities that govern crisis response [17]. This process, referred to as 'damage assessment' is an act of *sense-making* about disaster that in turn shapes response and recovery activities [19,68]. In the process, the statistics produced during damage assessment also come to dominate public discourse about the memory and significance of the disaster as well as imaginations of what future 'recovered' life in the affected areas might consist of [19,36,52,55].

For all of their practical significance, the tools used in damage assessment are hardly neutral technologies that provide unbiased or objective understandings of disaster impact. On the contrary, their results are frequently exaggerated or under-reported by both governments and individuals in order to influence the amount of aid delivered or shape public opinion about the events [52,55,69]. On a more fundamental level, these activities produce specific understandings of disaster that reflects a combination of engineering expertise and the exigencies of bureaucratic logic. The reductive quality of this process shares characteristics with what geographer Brian Harley referred to as "cartographic silencing", in which objects and phenomena "outside the surveyor's classification of 'reality' are excluded" [24:98] and thus eliminated from discourse. Harley argues that silences are "affirmative statements, and they have ideological consequences for the societies in question. Such silences help in the reproduction, the reinforcement, and the legitimation of cultural and political values" [24:106].

Our research inquires into the silences produced by the social practices and information systems supporting the Government of Nepal damage assessment that took place following the April 2015 earthquakes, their consequences, and their implications for the types of repair work that were conducted during disaster recovery activities. We find that the damage assessment acted as a kind of inscription device [33] that constructed the infrastructures impacted by the earthquake as targets for specific approaches to repair work. In doing so, the assessment ultimately scripted [1] the kinds of earthquake recovery that took place in post-earthquake Nepal: enabling some, and rendering others unthinkable. Our research combines a qualitative study of the actors and institutions that planned and executed the government damage assessment and participatory mapping activities undertaken in the Langtang Valley, a remote and severely affected part of Nepal. Drawing on fieldwork in each site, we argue that the silences created by the data collection tools and methods of the official damage assessment foreclosed opportunities to address important challenges that the people of Langtang faced in the aftermath of the earthquake.

2 MAKING SENSE OF CATASTROPHE

2.1 Crisis & Broken World Thinking

Over the past decade, the field of crisis informatics has studied technology usage and activities of cooperative behavior and sense-making during moments of crisis [45]. The Latin roots of the word *crisis* meant “turning point,” or “decision,” or “judgment.” As traditionally understood, crises function as breaks in discourse, moments of transition during which old concepts and ways of thinking and being fail and their replacements aren’t yet able to bear the weight we need them to [50]. People who live through crises are struck by the disorientation and the foreshortened view of future horizons characteristic of moments when, in Marx’s phrasing, “all that is solid melts into air.” Yet this view of crises—as being temporally limited and extraordinary events that are triggered by external causes—has unfortunate side-effects, directing attention away from the longer arcs of vulnerability that allow disasters to occur [4,36,65,69] or the multiple ways in which their impacts continue to reverberate through time long after the crisis has ended.

Our means of apprehending contemporary crises are increasingly mediated by information systems and infrastructures that are sometimes global in scale [14]. The design of such systems is therefore a critical area of research. Liboiron, in a study of post-Hurricane Sandy damage assessments, notes the predominance of “data collection and representational practices that emphasize sensational or episodic moments of destruction rather than the structural conditions that facilitate particular patterns of devastation” [36:159]. Recent research suggests opportunities to consider instead the more continual ways in which artifacts and infrastructures are continually emerging [59,53] through creative action [27], being maintained or repaired, or being broken down [9]. Gordillo sees the material remains of prior infrastructure as an “invitation to transformation” and to offer the “possibility of building something better” [22:45]. Such an approach, which Jackson illustratively terms “Broken World Thinking” [28], enables us to consider crisis as a relational or ontological, rather than epistemic, phenomenon and offer approaches to recovery that don’t take the wholeness or permanence of pre-crisis socio-material relations for granted.

2.2 Sense-Making About Repair

Studies of repair decenter HCI’s traditional focus on design and use of technology in order to attend to more rarely noticed temporalities oriented around maintenance, sustainability, and breakdown [28]. In our field site, questions of repair are foregrounded by the recent catastrophe and ongoing efforts to cope with and recover from its effects. The targets of repair in this study are the infrastructures that residents of Nepal rely on as they go about everyday life in a challenging environment. Recent work in repair studies has

shown that these processes are far from straightforward. Repair, as a set of socio-technical practices, is infused with values [25] and particular social and cultural logics. Understandings of what counts as “broken” or “fixed” or choices about what gets repaired are contested and continually negotiated [25,51]. Ribes writes that unless we ask question about “the repair and maintenance of what, serving whose interests, and at the expense of what people? [49:75], focus on maintenance and repair, no matter how well-meaning, may ultimately end up “reproducing the existing social order” [*ibid*].

Repair work, enacted in the present, has complex relations to both past and future. Diagnosis, a precursor to repair, relies upon implicit assertions about a previous, stable, or ideal instantiation of infrastructure, describing a particular and frequently depoliticized past. Repair work is also anticipatory [63] and guided by normative visions of the future, both individual and collective, even if they are frequently left un-articulated. Sense-making about repair thus plays a central role in the practice, and includes activities related to problem recognition, identification of the source or cause, assessing various options for intervention and determining a course of action, receiving feedback and adjusting course throughout repair activities, and finally, determining whether the repair work has been successful. Repair is often associated with tacit knowledge and an ethos of care [9,25,28] associated with human-scale objects like cellphones or copy machines with which it is possible to establish a physical, intimate, co-presence. Here we explore some of the challenges of “caring at a distance” [11:111] that arise when sense-making about the repair of large infrastructures are mediated by other technologies [9,26]—an issue of central concern in disaster response and recovery.

2.3 Mapping as Situated Action

Our research in the Langtang Valley uses participatory mapping activities as a method for interrogating the tools, information standards, and data collection practices used by the government damage assessment.. Building on research in human geography and critical data studies [7,10,18,54], we find that these activities offer a means of studying the data politics of humanitarian technologies. In participatory planning and development, maps have been used as means of supporting inclusive planning processes, incorporating local knowledge into data collection, challenging authoritative framings of spatial phenomena, or resolving disputes over territorial claims [6,46]. Other research has explored the ways in which mapping can support collective remembrance and history making during periods of rapid change [56,71]. Sletto writes that memory is not “simply a retelling of the past but an iterative and unstable co-production of identity and landscape” [56:362]. Mapping can thus be a means of performing alternate or emancipatory memory that undermines official or hegemonic histories. In this view, mapping can be understood as situated

action, equally as important for its performative qualities as for any information artifacts it may yield [6]. In the wake of the Nepal earthquake, where the intensity of the disaster exceeds the enumerative and descriptive capacity of technical assessments, we explore the potential that mapping offers for a generative practice of sense-making—a way to begin to account for losses that are ultimately un-measurable.

3 THIS STUDY

3.1 Nepal Earthquake & Recovery

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. While the country had undertaken significant preparation for a major earthquake in the capital city, Kathmandu, this was largely a rural disaster, and the difficulty of access to remote areas complicated response efforts of the government and international organizations. Following the immediate search and rescue activities, relief agencies worked to provide relief shelter, quickly re-establish schools and/or temporary learning centers, and deliver medical services to affected areas. Alongside formal efforts, informal organizations and voluntary groups played a crucial role in creating, analyzing and provisioning information to both victims as well as response and relief agencies [39,57].

In June of 2015 seven weeks after the earthquake, the international community pledged \$US 4.1 billion dollars in reconstruction assistance to Nepal at a major donor conference held in Kathmandu. The majority of this aid was for the housing sector [23], and delivered in a centralized fashion through the newly created National Reconstruction Authority (NRA). The NRA, with technical assistance from international donors, devised what has been referred to as a plan for "owner-driven" reconstruction whereby households deemed eligible through a house-by-house damage assessment would receive \$2,000 in several tranches. Following the initial damage assessment, inspectors would return several times to verify that home reconstruction was being conducted following government-specified techniques that would help ensure new homes would be "built back better", in order to withstand future seismic activity. Payments would be delivered through electronic bank deposits, following certification by trained engineers that rebuilding was underway in a manner deemed earthquake resistant according to government-produced guidelines. This approach to recovery planning and monitoring, based upon techniques devised following the 2005 Pakistan earthquake, was enabled by emerging

technologies including GPS-enabled tablets, cellular data networks, and open source software.

3.2 Overview of Study Sites & Methods

The Government of Nepal's ongoing housing recovery efforts are enabled and underpinned by a large-scale damage assessment completed during early 2016. To ground our observations of this process, we focused our study of these activities on two sites. The first study site was located in the offices of government and donor agencies in Kathmandu from where the housing damage assessment was planned and overseen. This research is based on participant observation during the planning stages of the NRA damage assessment conducted between May and August 2015, during which time the first author worked for the World Bank as a consultant, as well as interviews and focus groups with key participants, and review of key project documents. By most accounts the damage assessment, though delayed by political infighting within Nepal and conflicts between Nepal and India, was imperfect, but conducted reasonably well given the circumstances. The broader recovery program in which it was embedded was designed with guidance from post-disaster recovery experts from international institutions [31]. Because of this, we argue that it provides an important opportunity to engage with the logics embedded within contemporary humanitarian information systems. The issues raised in the following section stem largely from the assumptions and outlook that guided the design of the damage assessment, rather than particular failures in its implementation.

The second study site was the Langtang Valley in northern Nepal, where the second author was physically present during the earthquake. The author has since been involved with recovery work and is conducting long-term ethnographic research on disaster reconstruction, vulnerability, and infrastructure development [39] in the region. Prior to the earthquake, the Langtang Valley was home to around 600 people and an important site for Tibetan Buddhism. The area is also becoming a popular destination for trekking and is in transition from a pastoral yak-herding community to a tourism-based economy [26]. During the earthquake, five major landslides and avalanches occurred in the Valley, destroying several villages and killing more than 300 people including residents, Nepalis from other parts of the country, and visiting tourists. Funding through the government reconstruction program, for which the damage assessment we studied was designed, did not arrive in Langtang until over two years after the earthquake. In the absence of formal assistance from the government during this period, Langtang residents primarily relied on their own networks and ingenuity, as well as the assistance of a small network of NGOs, to repair and rebuild community infrastructures—trail networks and bridges, community and religious centers, a health post, and a small hydro-

power station—that support everyday life and livelihoods in the valley. For this paper, we conducted qualitative research and participatory mapping in the Langtang Valley in order to understand the ways that the official damage assessment was enacted in this context with what effects.

4 EXPERT DISCOURSE OF DAMAGE

To study the NRA-led damage assessment, we relied on participant observation of the planning process. The first author spent three months in 2015 working as a consultant on the project during the planning phase and interacted with central figures in the Nepal government and international agencies responsible for its execution. Following the completion of the assessment, we conducted four focus groups of engineers who carried out the assessment, with a total of 30 participants, to understand their approach and execution as well as the character of their interactions with the communities where they were working. In addition, we conducted follow-up interviews with several of the individuals who worked directly in Langtang. We also interviewed six residents of the Langtang community who were present for the damage assessment, and interacted with the engineering team, in order to understand their perspectives on the process. Lastly, we conducted a review of various project documents, so as to understand the logics at work in the design of the damage assessment and the specific practices surrounding its implementation. These methods allowed us to study the Government of Nepal-led damage assessment, the narrative of the earthquake it produced, and the vision of recovery it contained.

The Government of Nepal's housing damage assessment began in December 2015 and was completed by May 2016, just over one year after the earthquake. The government intended that the assessment "would be based on the principles of equity, inclusion and community participation through an owner-driven reconstruction (ODR) approach to build back better" [23]. The assessment was carried out by a workforce of over 1700 engineers, trained in Kathmandu and sent into the rural areas with tablet devices to record detailed engineering data on the condition and level of damage faced by private houses along with comprehensive demographic data of the residents. The engineers, many of whom were in their early 20's and just out of undergraduate, were teamed up with "social mobilizers," often residents of the communities being assessed, who could help navigate the social and geographic terrain of the area and interview homeowners and photograph the current status of the house for verification purposes. The assessment teams relied heavily on these social mobilizers to navigate unfamiliar areas, locate houses to be surveyed, and identify and interact with their owners.

The assessment teams used the tablets to collect information about houses and their owners, record GPS location of the house, and photograph its condition at the time of the assessment. The results were transferred to

government servers in Kathmandu over the cellular network and entered into a database where they were used to assess individuals' eligibility to receive financial assistance to rebuild their homes. The tablets utilized open-source software, based on OpenDataKit, and customized by a local technology organization [58], to implement the damage assessment survey. The survey captured the location of the house and basic information about its owner and residents, its construction type and materials, and a damage classification that detailed the buildings as being either: 1) undamaged; 2) partially damaged; or 3) completely destroyed. In the analysis that follows, we describe how the data collection practices and information standards mandated by the design of the government damage assessment and encoded into the application used by the surveyors constructed a particular understanding of what happened during the earthquake, what constituted damage, and with what consequence.

4.1 Figuring Loss

The Nepal government damage assessment, described above, identified the number of residential houses that were partially damaged or completely destroyed during the earthquake. While such information is fundamental to an earthquake reconstruction program solely focused on providing funds to individuals for rebuilding their homes, its limitations when considered in the broader context of post-disaster Nepal are readily apparent. As a way of introducing some of these gaps as well as the conditions under which the assessment occurred, we introduce data collected from two of our interviews participants. The first was with an engineer, one of the members of the surveying team who conducted the assessment in Langtang. The second was with a community member who was present in the valley when the assessment happened and assisted the surveyors with their work. For purposes of clarity and narrative presentation, we limit the data presented to just these discussions. However, the themes highlighted in the narrative align with the findings from the other interviews and focus groups conducted with damage assessment teams and members of the Langtang community.

The survey team, relying on tools and training oriented toward inspecting the condition of individual residential houses, was unready to deal with the totality of the destruction caused by the landslides in some parts of the Langtang Valley. The engineer told us that:

I had not seen such collapse. I was there with just two days' experience. I thought there would be some damage. That's how I felt. But when I reached [Langtang]... nothing was there. Everything was a flat plain. I was very surprised to see that. It shouldn't have collapsed like that. I thought small houses could be seen. But there were no houses.

The community member registered the surprise of the surveying team as well, telling us:

They were shocked. 'Oh there are houses here?' they said... Our home is totally buried under. It's totally flat now. We were also shocked, before there were houses here, people also.

The Langtang community's refusal to stay still in the intervening period between the earthquake and the assessment also highlighted issues with the assessment design. Many residents were still living in Kathmandu with relatives or a camp for people displaced during the earthquake and thus not present for the assessment. Others had moved around in the valley, erecting temporary shelters using corrugated iron, tarps, or other materials delivered by helicopter or donkey to the valley. Still others had already begun rebuilding their homes, making it difficult to demonstrate the levels of damage caused by the earthquake. The engineer relayed these challenges to us, saying:

There were temporary residents in a place called Kyangjin. They weren't permanent residents. They were there for 6 months for work. In times of tourist season, they stayed there. And rest of the time, they stayed in [other places]. Some people reconstructed their house; those with partial damage. When you don't have place to stay, you have to rebuild and cannot wait forever for the government.

Language difficulties compounded the confusion and the ability of the assessment team to build rapport with the community. Many of the residents of Langtang speak a local dialect of Tibetan, whereas the surveying team was counting on being able to communicate in Nepali. This was compounded by the fact that the software on the tablets carried by the team was in English. The engineer told us that at one point early in the assessment he phoned his supervisor in Kathmandu, saying that:

The working situation is very bad here. Should the government see this from different perspective? Or should I do the data collection?' ... [his supervisor replied that] 'You have already reached there... Please coordinate with the house owners to find out about the land and what was there.'

These difficulties led to concern amongst the residents of Langtang who were present at the time that they would be deemed ineligible to receive recovery assistance. The community member said:

Some people were afraid. Because they thought 'oh, maybe we will not get [government assistance] if I don't give the correct answer.'

Ultimately, residents were able to produce enough pictures of the area prior to the earthquake that the assessment team was willing to accept their version of events and record information about the 116 houses destroyed in the valley and their residents. The engineer was nonetheless left unsatisfied. He had been forced to deviate significantly from the information standards and collection practices prescribed by the assessment. Yet he still felt that the information gathered was incomplete, and in any case did not adequately capture what had occurred in Langtang. Nor did he feel that empowered to address this gap.

What I was feeling, I will go to government bodies and make a different separate report on Langtang. Later, I couldn't do it. I feel very sad about Langtang. Before, there were houses there; there were places. Now it is like a desert...

5 MAPPING SILENCES IN THE LANGTANG VALLEY

To supplement observations of the Nepal government's damage assessment, we organized a series of mapping workshops and map-based interviews with members of the Lantang community. In total 42 community members participated in these workshops – about one fifth of the surviving residents of the valley, representing a diversity of age, gender, and livelihoods – were involved in around 25 hours of collective mapping activities. This work took place both in the villages of the Langtang Valley and in Kathmandu, where some of the displaced survivors were residing prior to reconstruction. These workshops were conducted during three research trips to Nepal in May 2016, January 2017, and July 2017. Mapping activities were designed both to gather information and to guide conversations about the past, present, and future of Langtang Valley. These maps and conversations focused on historical settlement patterns, the location of cultural and religious sites, the oral record of past landslides and avalanches; perceptions of future risk, the impacts of tourism on development; challenges faced during post-earthquake recovery, and participants' hopes for the future.

The purpose of the mapping activities was thus three-fold. First, they provided an opportunity to elicit local narratives of the disaster and its impacts that we could compare with information from the official damage assessment. Second, the mapping activities served as a sort of dialogic probe [5] to help more clearly understand the information needs of the residents of Langtang as they chart their own pathways to recovery following the devastating earthquake and landslides. Third, they facilitated the collection of historical data on social and spatial change in the Langtang Valley, including oral histories that describe past disasters and chronic vulnerabilities. Each session was recorded and transcribed, and the first and second author collaborated on a process of open coding to develop a series of thematic memos that considered the



Figure 1: Community members working on cultural map of Langtang Valley in Kathmandu in May 2016



Figure 2: Mapping the history of landslides in the Langtang Valley in January 2017



Figure 3: Reconstruction process map of Langtang Village created in May 2016

relationship between the NRA-led damage assessment and localized understandings of disaster and recovery in Langtang.

In the following sections, we consider the gaps that emerged between these different modes of reckoning loss, drawing on the findings that emerged from the mapping activities and interviews conducted with surviving residents of Langtang. Building on Harley's concept of 'cartographic silencing' [24] we present these gaps as *silences* created by misalignments between the narrative of loss produced by the technology supporting the government damage assessment and the lived experience and expressed ideas of the Langtang community. The silences related to 1) ongoing landslide danger; 2) everyday and collective practices of repair; 3) trauma suffered by the earthquake survivors, and; 4) the rapidly changing vision of 'the good life' underway in the Valley. These silences in the post-disaster damage assessment are not just blank spots on a map, but holes in the official narrative of the disaster that shape patterns of long-term reconstruction.

5.1 Silence 1: Ongoing Landslide Danger

The damage assessment conducted by the Government of Nepal, as discussed above, was designed to capture information about the status of individual houses made uninhabitable by the earthquake. The totality of the devastation caused by the avalanches in Langtang, which buried the village of Langtang and made it impossible to determine the existence of individual structures, was beyond the scope of what this assessment was able to encapsulate. While the assessment included a single box for 'landslide' as one of six potential geo-technical risks that could be assessed at each property, surveying teams received little guidance on how to judge this complex issue and as a result it was not used in practice. This inability only represents part of the conflicting understandings of safety between residents and the Government of Nepal's assessment that surfaced in the aftermath of the event and appeared during our mapping activities. More fundamentally, the assessment understood the earthquake as a one-time event, whereas the mapping process unearthed a longer and more continuous history of hazard, risk, and adaptation about which the damage assessment was silent.

For example, according to local oral histories, the village now referred to as Langtang was relocated from a site slightly further up the valley, just below the present village of Mundu, after a large landslide occurred there roughly 200-250 years ago. This area is still marked by a series of long *mani* walls² that mark the extent of the past avalanche – essentially a local form of damage assessment

² Constructed from stones inscribed with the Buddhist mantra *om mani padme hum*, these walls are often built along paths in the Himalayan region as an offering to local spirits or to demarcate specific sacred sites or boundaries.

and materialized social memory that speaks to long-term risks [16]. According to our interviews, when the last major earthquake struck Nepal in January 1934, it destroyed several houses throughout the valley and killed six people. Roughly thirty years ago, a very large avalanche occurred near Langtang village in the early winter season during the national festival of Dashain that killed 2-3 people, and blew the roofs off houses on both sides of the village, with snow reaching nearly a kilometer away. And in 2007, an avalanche near the village of Sindhum damaged all fifteen houses in that settlement and killed two people. As one resident summarized:

*Avalanches and landslides happen every year, maybe every 2-3 years. This is normal for us.*³

The history of earthquake and landslide danger in Langtang is thus one of continuous negotiation, adaptation, and uncertainty, rather than a punctuated equilibrium that an isolated focus on major events like the 1934 and 2015 earthquakes would portray. In the wake of the 2015 earthquakes, several scientific studies and independent technical assessments of the Langtang Valley were completed by Nepali agencies and international expert teams [20,29]. These studies sometimes provided uneven and sometimes-conflicting guidance on the relative exposure and safety of different areas of the valley. Given the significant uncertainties inherent in landslide hazard modeling, few scientists were willing to make firm claims either way, fearing accountability or blame should their models prove to be inaccurate. These challenges reflect common patterns of communication difficulty between technical experts and communities' lived experience with risk [73]. Constrained by the indecision of the government and the land-use restrictions of the Langtang National Park that surrounds them, the displaced residents of the Langtang Valley faced difficult and limited choices about where to rebuild. One resident told us:

The government says that Langtang is still not safe on the news... If they say it is not safe, then they should give us land elsewhere where it is safe. We are left like raw meat, they haven't killed us completely nor have they cooked us

Another participant expressed frustration with the assessment and recovery programs lack of attention to landslides and avalanches, an observation we heard multiple times:

³ A few participants also told us that people in Langtang used to know where avalanches would occur because they would come more regularly, but that people began to forget these past lessons and to build guesthouses in unsafe areas as tourism increased.

Earthquakes did not destroy our houses; the avalanches are what destroyed our houses. We need to make a plan about how to be safe from avalanches.

The assessment was ill-equipped to consider one of the most significant questions about recovery in Langtang: landslide danger and the politics of post-earthquake land-use and resettlement in the Valley. This silence has complicated active debates in the Valley over the safety during future events, the delineation of acceptable risks, and community self-determination during the reconstruction process.

5.2 Silence 2: Everyday & Collective Acts of Repair

As with many communities across the Nepal Himalaya, the people of Langtang have been negotiating situated cycles of disruption, damage, repair, and adaptation for centuries. Such ongoing work of maintenance and repair is necessary to make life possible in a harsh environment like the high altitudes of Himalayan mountains. In response to past events like landslides and storms described in the previous section, residents of Langtang told us that they have rerouted paths and shifted the location of houses, repaired and reinforced walls, secured roofs and bridges, and reconnected local infrastructures. In November of 2014, when an avalanche occurred just below Langtang Village in the middle of the night, it took locals just a few days to repair the 5-6 buildings that were damaged and reconnect transmission lines from the local micro-hydropower project. Just one week prior to the April 25, 2015 event, locals responded quickly to another small avalanche that occurred in Sindhum, nailing the roofs back on a dozen houses. One interviewee told us:

We use the old materials for the roofs [wood and stones] instead of the tin roofs, because they don't fly off as easily and are easier to repair.

When people pointed to places during the mapping activities and described the damage that occurred, they also described the work that was required in response. Much of what they discussed related to material practices of repair that went beyond individual homes covered by the government damage assessment. Instead they often discussed practices related to the repair of collective infrastructures such as restoring trails throughout the Valley, rebuilding important community assets such as bridges, the yak cheese factory, or the hydro-electric plant, repairing and rerouting trails, and rebuilding the monastery and *mani* walls throughout the valley. Such work was typically carried out collectively, coordinated through formal committees or informal work parties organized along lines of kinship or shared habitation—an extension of traditional practices of mutual aid referred to as *parmo* [31] used to deal with past damages and scarcities, reanimated in the wake of the disaster.

Despite the scale and intensity of the April 25th event in Langtang, much of the material repair work required in Langtang after the 2015 earthquake was in many ways familiar. This kind of practical and place-based knowledge of adaptation and repair, both emerging from a specific local history and similar to other patterns of ‘living and dying with glaciers’ in the Andean region [8] is integral to the post-earthquake recovery work that is ongoing in Langtang. And yet, critically, there was no way to input data about past damage, past knowledge, or information about prior means of recovery into the tablet devices and information systems used by the NRA assessment teams. As such, the assessment was effectively silent on these collective methods of recovery and everyday practices of repair, obscuring and devaluing these processes.

5.3 Silence 3: Trauma & Care

Given the intensity of the tragedy in Langtang, people in the Valley face ongoing struggles with mental health, as experienced by many disaster-affected communities worldwide [4]. However, the government damage assessment conducted in Nepal makes no attempt to account for mental health issues or their social effects. Unfortunately, this kind of damage is often overlooked or subordinated to other concerns in the wake of disaster. This silence also diminishes the importance of the practices of post-traumatic care that allow communities to begin other kinds of repair work. This was true across Nepal, but particularly so in Langtang, where the intensity of the disaster and the loss of life was extreme. In Langtang, the community seeks to address these issues using the ceremonies and funerary rites of the Tibetan Buddhist tradition as a means of coping, providing individual and collective forms of care [37].

For the Langtang people, these funerary rites are perhaps the most significant and immediate form of repair work, used to help orient the community during the process of death and dying. Over a period of forty-nine days, the community undertakes a recursive and recombinative series of social and ritual actions that provides a narrative for the social process of ‘a good death’ and a way of guiding the souls of the deceased forward toward reincarnation. These practices, referred to as *ghewa* and common in this region of Nepal, facilitate a “transmutation of life” [12:160] that is also a form of community reproduction and societal repair. By engaging the entire community in collective cycles of remembering and forgetting, these rites provide a way of metabolizing grief and trauma—they serve as technologies of repair that shape and define spiritual or psychological aspects of post-disaster recovery. While these ceremonies typically follow individual deaths, their cyclicity and rhythm has helped provide continuity and balance in the wake of the tragedy.

According to several participants in our mapping activities, further rituals will also be necessary to repair ruptures in the social fabric and to restore strained relations with local deities that protect the community from harm. In the Langtang Valley, moral and social relations must also be carefully and

ritually maintained to prevent misfortune within a precarious environment [31]. In the aftermath of the earthquake, many people cited these ritual practices of repair as essential to long-term of recovery and the future health of the community. One individual told us:

If we do these ceremonies, then the village will prosper.... only one or two people will get sick and die. If we continue doing like this, nothing like last year [referring to the avalanches] will happen again to us.

Amid the extreme disorientation following the earthquake, these funerary ceremonies and everyday rituals were again used to help make sense of the damage and destruction that had occurred. These acts helped the Langtang people to process their own incomprehensible loss, to reassert the social bonds that shape their collective cultural identity, and to reorient themselves and their community in relation to a possible future. While attempting to rebuild their material lives, they also seek to repair and restore social damage caused by individual and collective trauma. These are practices of care that “underpin the ongoing survival of things as objects in the world” [28:230], yet they were silenced by official practices of damage assessment that followed the earthquake.

5.4 Silence 4: Changing Visions of the ‘Good Life’

The Nepal government damage assessment was fixed at a single point in time, designed to restore the stability of a particular temporal frame: the order of things at the time of the earthquake, as understood from the perspective of the government. This kind of sense-making, oriented around the restoration of a vision of the pre-existing state of affairs, which is itself not necessarily a neutral or equitable outcome, assumed a stasis that did not exist in Langtang. The valley, as both a landscape and a community, is changing. While some of the residents would seek to recover the past order of things, or to restore trajectories plotted before the earthquake, others’ aspirations track alternative valences. Ways of ‘imagining the good life’ [34] *were* changing rapidly, leading to conflicting ideas of what ‘building back better’ meant in Langtang.

Conducting research on post-disaster recovery in the wake of the similarly devastating co-seismic avalanche that occurred in Yungay, Peru in 1970, Oliver-Smith used the term ‘negotiated traditionalism’ to describe the ways in which the community collectively sought to achieve a ‘continuity of meaning’ that could connect the damaged past with the imagined future. His analysis highlighted the way that the past is a “necessary element in the present, necessary for our efforts to impose a structure of logic on altered circumstances. It is crucial for creating and coping with change. The people of Yungay, then, must be seen as involved in a struggle to link their destroyed past to their present misery and insecure future [43:17].”

During our participatory mapping exercises in Langtang, we also elicited local perceptions of what the ‘post-recovery’ future might look like. These exercises prompted frequent discussion about the varied shapes of differently imagined futures. These conversations often centered around the ways that tourism has become increasingly central in their social and economic lives, accompanied by a decline in yakherding [31,61]. Meanwhile, the majority of young people now go to schools in Kathmandu, prompting anxieties about their future interest in traditional livelihoods and cultural practices: in coming home. Tellingly, there are no schools operating in the valley now. Speaking to these transitions, one yakherder explained:

There are only a few of us ghotalo [herders] left now. Future generations wont do this work because they are clean and they think this is dirty.

Conversely, a wealthy hotel-owner who was in the midst of reconstruction reflected:

Before I wanted to make big money and send my children to Europe or USA, but not now... now I want them to come back here. The earthquake taught me something.

Desires for material comfort, development, and greater connectivity still color imaginations of the future, just as they did before the earthquake [34]. Debates over the scale and scope of infrastructure development continue, mixing with hopes for internet connectivity, proposed hydropower projects [38] and a potential access road aimed at increasing tourism. In Mundu, the one village in the entire valley where traditional houses still remain, people are divided as to whether they should repair their homes (now symbols of a ‘traditional’ or lost past) or deconstruct them and build new based on the modern government-endorsed designs. Caught between longing for that which is lost and desires for a new post-earthquake future, they are engaged in their own kind of ‘negotiated traditionalism.’

Amid rapid social change and the disruptions of disaster, the past is frequently used as a resource to imagine stability or to articulate new kinds of future-making projects [43,55]. In this way, memory and the work of recall becomes a method of reorientation amid uncertainty, a way of reckoning loss while being forced to reimagine possible futures. In constructing their own narratives of damage and loss, Langtang community members are also reconfiguring their relationship to the past. Many people in the community, particularly the older generations and those who lost their entire families, hope to recover a future that resembles the past. And yet, it is also true that the ruptures of the disaster, the influx of resources and attention that accompanied the humanitarian response, and policies designed to encourage Nepalis to ‘build

back better' after the earthquake have also created new possibilities for realizing differently imagined futures. The damage assessment, designed to facilitate a national process of 'building back better,' is silent regarding these contested processes of social change.

6 DISCUSSION

In Langtang, as in many places across Nepal, the work of repair began immediately in the wake of the April 2015 disaster, even if it was often illegible within the frame of official processes of damage assessment. In this section of the paper, we draw upon research within STS, anthropology, and HCI to reflect on the broader discursive and material impacts of the Nepal government's damage assessment. We explore the gaps generated by misalignments between the formal damage assessment and local repair practices, that we have described here as silences, in order to investigate the relations between sense-making, repair, and the informatics of damage. We argue in the section that follows that, as a result of these silences, the government damage assessment has: 1) had outsized influence on public memory of the disaster; 2) scripted particular kinds of repair work that crowded out local recovery practices; and 3) constrained opportunities for hopeful reconfigurations of social life that crises can afford.

6.1 Public Memory of Disaster

Critical studies of disaster have shown how, over time, official statistics come to dominate public memory of disaster [36,55]. These statistics are used to narrate the impact, and compare the relative magnitude of the event against other disasters in the historical record, creating the illusion of commensurability across diverse and fundamentally singular phenomena. The impacts that are not measured, or are less indexical, such as the experiences of the Langtang Valley described above, in turn fade from historical memory. The persistence of the official data, produced through processes like the government damage assessment, provides an important example of how disaster statistics, designed and created for use in one context can live on and shape thought, practice, and imagination in other contexts for which they may be less appropriate [15]. The production and circulation of such statistics constitute important forms of memory work.

Memory work is a central component of diagnosis, a critical act of sense-making that guides repair. Through the development of a common understanding of what a target of repair was in the past, memory shapes the criteria for what constitutes successful repair practice. It can also help develop the cultural resources necessary to navigate the uncertainty-laden environments of crisis and breakdown by providing rich examples from other contexts. Orr highlights the importance of anecdotes describing past repair jobs, traded among technicians as "war stories," as providing important narrative

context and grounding that more abstract technical manuals could not [44]. A recent study of humanitarian logistics also pointed to the importance of narrative to supporting work in that context [26]. The reductive quality of official disaster statistics produced by the Nepal housing damage assessment, and the kind of memory work these statistics in turn support, has serious consequences, as described in this paper.

6.2 Scripting Repair

The damage assessment, by narrating loss in the particular fashion described in the preceding sections, shaped and constrained the kinds of recovery practices that could be considered. As a result of the assessment's focus on the status of individual dwellings, owned by "heads of household," post-disaster recovery work in Nepal was largely oriented towards aiding with the restoration of these homes, while rendering other communal possibilities for reconstruction illegible or illegitimate. Recovery work is thus circumscribed to be relatively short-term: determined complete once individual homes were rebuilt. Its success or failure will ultimately be judged based on the perceived efficiency and fairness with which individual, atomized homeowners are able to rebuild their houses. This script for repair aligns well with the Nepal government's bureaucratic incentives towards uniform management of recovery at a national scale and the reassertion of state authority in a period of crisis [17]. However, it failed to account for the range of needs, aspirations, and ongoing practices occurring in Langtang.

Sociologists of technology have long argued that the design technological objects inscript, or encode, arguments about the users of the technology and the context in which such usage would occur [1,3,32,67,72]. Akrich writes that "many choices made by designers can be seen as decisions about what should be delegated to a machine and what should be left to the initiative of human actors" [1:216]. The extent to which technologies resist such delegation might help to account for what scholars describe as the fluidity of such objects, or their ability to be re-shaped to fit multiple, sometimes unpredictable purposes in local contexts [35,48]. Redfield, echoing HCI research in the area of design for appropriation [13], argues that ambivalence and doubt are well-suited to humanitarian design because [48:19] they facilitate local adoption in complex and uncertain circumstances. However, these characteristics are exactly what the bureaucratic logics underpinning the Nepal government damage assessment were intended to avoid. The assessment's deployment of a uniform standard that could be applied efficiently across the hundreds of earthquake-affected communities in the country meant that it was incapable of meaningfully describing local site conditions in any one of them.

The work of diagnosis was thus delegated to the script embedded within the design of the damage assessment, rather than the agency of affected people in Langtang. Such delegation suited the needs of the centralized NRA housing

reconstruction program, but it also delegitimized local initiative and crowded out other recovery processes. Local NGOs and humanitarian agencies, many of which were active during the immediate response phase and closer to “the ground” than the national government, were not involved in the damage assessment and were largely excluded from the formal reconstruction activities. The considerable delay between the April 2015 earthquake and the time when assistance through the government program finally reached affected families – over two years in Langtang – also left many communities in a liminal state, where they feared that pursuing immediate actions needed for local recovery would risk disqualifying them from program eligibility. Many residents of Langtang did eventually begin to rebuild prior to receiving government assistance, but not without significant anxiety, delay, and effort spent trying to understand the complex details of the recovery program.

6.3 Cracks & Careful Reconfigurations

Damage, in both material and information form, reveals cracks in the existing order, denying the essential wholeness or inevitability of prior social relations [22,52]—a recognition that may be difficult to recognize during more stable periods. These cracks can prove generative, amenable to reassembly in creative ways through careful practices of repair [28,34]. Angell has argued that over the long history of Istanbul, earthquakes have been recurring forces that have helped to shape and reshape the city [2], acting as instigators of both destruction and renewal. From this perspective, post-disaster recovery work can be about more than just the restoration of pre-existing structures and relations—it instead provides an opportunity to reconfigure them. Cracks create new surfaces, with attendant possibilities for new kinds of attachments and patterns of relations. Crises, or infrastructural breakdowns, by revealing these cracks, offer opportunities to reconfigure prior constellations [22] of social and material relationships. The notion of crisis as opportunity is not a new one, however, much of the recent attention this idea has received [30,40,50] has focused on less hopeful manifestations.

As demonstrated here, damage assessments, such as the one practiced by the Government of Nepal, can work to seal these cracks before they can be deployed as resources in support of reconfiguration of socio-material arrangements. This may be especially true when certain forms of informatics intervene in sense-making about repair. In Langtang, for example, the assessment focused attention solely on reconstructing homes, ignoring the vulnerabilities created by regulations prohibiting people from relocating their homes outside of already-settled areas of Langtang National Park, many of which were felt to be unsafe or clearly uninhabitable. The opportunity to create a holistic plan for reconstruction that could address long-standing tensions with

the Park was subordinated to the demands of the larger state-driven reconstruction process.

The narrative created by the damage assessment yields a bifurcation [64] between that which can be measured in objective terms and more affective relations associated with an ethos of care. Returning to Redfield's concern with ambivalence raised above, ambivalence, uncertainty, and doubt might seem somewhat dubious goals for design to aspire to. This is especially true in the realm of informatics where such characteristics are typically considered as flaws to be erased. However, Redfield makes the argument that design that incorporates uncertainty can invite questioning, further engagement, and the concern that characterize care [48]. Similarly, Gaver et al. write that ambiguity in design supports "deep appropriation" of technologies "by impelling people to interpret situations for themselves, it encourages them to start grappling conceptually with systems and their contexts, and thus to establish deeper and more personal relations with the meanings offered by those systems" [21]. A damage assessment that accomplished this would then allow for narrative, affect, multiplicity, and uncertainty. It would support the agency of affected peoples in sense-making and diagnosis, rather than delegate these tasks to tightly scripted classificatory schemes. It would seek to expose and engage with, rather than elide, the cracks.

If practices of care are, as scholars argue, ontological work of shepherding, maintenance, and sustainability that necessitate thick, situated connectivity, and densely woven networks [11,41,42], then this raises questions about the opportunities for care at scale [11,26]. Our experiences of, and connections with, large-scale infrastructures are often mediated by informatics that describe the condition and activity of these infrastructure. Yet the consequences of such mediation are so far under-examined in our field. What sorts of sense-making are facilitated by such relations? How do formal standards for assessing artifacts and infrastructures interact with alternate ways of knowing? Is care truly "other to technology" as some have suggested [41]? Or can we envision the design of new practices that offer the hope of re-centering affect in a supposedly objectified world [66]? The reshaping of possible worlds in the aftermath of crisis and disaster *is* care work, though it is often not undertaken as carefully as we might imagine.

Rebecca Solnit, in her book, *A Paradise Built in Hell*, discusses the "beautiful communities" that come together in solidarity during disaster to perform the needed care work to address disruption [60]. Drawing on decades of research in disaster sociology, she shows that in contrast to popular discourses of affected populations acting either as helpless victims or dangerous mobs, during periods of crisis people instead more frequently act altruistically and with common purpose. Such behavior, Solnit argues, provides a glimpse of what social life could look like, were it configured otherwise. Contemporary practices of damage assessment, as demonstrated by this study, support a kind of disaster

recovery that is oriented toward restoring pre-quake conditions. Aligned with engineering expertise and the bureaucratic logics of the state, it fails to support locally driven recovery processes, or provide the opportunity to reimagine dominant modes of sociality. HCI has the potential to support the development of a new, more *care-ful*, informatics that enable alternate practices of sense-making about crisis, and design technologies that support, rather than usurp, the agency of local communities attempting to navigate and reconfigure post-disaster recovery landscapes.

7 CONCLUSION

The government-led housing damage assessment portrayed the Nepal earthquake as a temporary disruption, to be resolved through engineering expertise and bureaucratic procedure, in an otherwise steady trajectory toward the future. In the process it has silenced the lived experiences of the survivors, masked social and political contributions to disaster vulnerability, and limited the extent to which communities can shape their own recovery. By directing the narrative of what could be counted as lost during the disaster, the data collection tools and methods deployed by the damage assessment also scripted a series of implicit arguments about what kind of society should be rebuilt. Our participatory mapping activities helped to identify issues that had been silenced by the official mode of assessing damage, but were nonetheless critical in shaping the nature of the social and material repair work undertaken in post-earthquake Langtang. Such silences are an inescapable feature of any attempt to represent our complex and messy world through socio-technical practice [70]. To borrow from Korzybski's famous phrase, the map is not, and never can be, the territory. HCI and CSCW research has previously taken up the complex politics of technology's role in producing in/visibility [62]. As the role of ICTs in disaster management continues to grow, improving our collective ability to recognize and engage with such politics is essential.

ACKNOWLEDGEMENTS

This work was funded in part by US NSF grant IIS-1524806, the Stanford Urban Resilience Initiative, the World Bank, a U.S. Foreign Language & Area Studies Fellowship, and an Allen Holmberg Research Travel Grant from the Department of Anthropology at Cornell University. The authors would like to thank all of the participants of this study. In particular they would like to recognize the support of Lhakpa Jangba, Temba Lama, Nima Lama, Ningmar Dongba, the Langtang Memory Project, and Kathmandu Living Labs.

REFERENCES

1. Akrich, M., 1992. The De-Description of Technical Objects in Bijker and Law (eds.) *Shaping Technology/Building Society: Studies in Sociotechnical Change*.

2. Angell, E., 2014. Assembling disaster: Earthquakes and urban politics in Istanbul. *City*, 18(6), pp.667-678.
3. Bijker, Wiebe E., et al. *The social construction of technological systems: New directions in the sociology and history of technology*. MIT press, 1987.
4. Blaikie, P, et al. *At risk: natural hazards, people's vulnerability and disasters*. Routledge, 2014.
5. Boehner, K., Gaver, W. and Boucher, A., 2012. 14 Probes. *Inventive Methods: The happening of the social*, 185.
6. Bryan, J., 2011. Walking the line: participatory mapping, indigenous rights, and neoliberalism. *Geoforum*, 42(1), pp.40-50.
7. Burns, R., 2014. Moments of closure in the knowledge politics of digital humanitarianism. *Geoforum*, 53, pp.51-62.
8. Carey, M., 2005. Living and dying with glaciers: people's historical vulnerability to avalanches and outburst floods in Peru. *Global and planetary change*, 47(2), pp.122-134.
9. Cohn, M.L., 2016. Convivial Decay: Entangled Lifetimes in a Geriatric Infrastructure. In *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing* (pp. 1511-1523). ACM.
10. Crawford, K. and Finn, M., 2015. The limits of crisis data: analytical and ethical challenges of using social and mobile data to understand disasters. *GeoJournal*, 80(4), pp.491-502.
11. de la Bellacasa, M.P., 2017. *Matters of Care: Speculative Ethics in More than Human Worlds*. University of Minnesota Press.
12. Desjarlais, R., 2016. *Subject to Death: Life and Loss in a Buddhist World*. University of Chicago Press.
13. Dourish, P., 2003. The appropriation of interactive technologies: Some lessons from placeless documents. *Computer Supported Cooperative Work (CSCW)*, 12(4), pp.465-490.
14. Edwards, P.N., 2010. *A vast machine: Computer models, climate data, and the politics of global warming*. Mit Press.
15. Elwood, S. 2006. Critical issues in Participatory GIS: Deconstructions, reconstructions, and new research directions. *Transactions in GIS* 10, no. 5: 693-708.
16. Emerman, S.H., 2017. The use of lichenometry for assessment of the destruction and reconstruction of Buddhist sacred walls in Langtang Valley, Nepal Himalaya, following the 2015 Gorkha earthquake. *Arctic, Antarctic, and Alpine Research*, 49(1), pp.61-79.
17. Fassin, D., 2011. *Humanitarian reason: a moral history of the present*. Univ of California Press.
18. Finn, M. and Oreglia, E., 2016, February. A fundamentally confused document: Situation reports and the work of producing humanitarian information. In *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing* (pp. 1349-1362). ACM.
19. Fortun, K., 2009. *Advocacy after Bhopal: Environmentalism, disaster, new global orders*. University of Chicago Press.
20. Fujita, K., Inoue, H., Izumi, T., Yamaguchi, S., Sadakane, A., Sunako, S., Nishimura, K., Immerzeel, W.W., Shea, J.M., Kayastha, R.B. and Sawagaki, T., 2017. Anomalous winter-snow-amplified earthquake-induced disaster of the 2015 Langtang avalanche in Nepal. *Natural Hazards and Earth System Sciences*, 17(5), p.749.
21. Gaver, W.W., Beaver, J. and Benford, S., 2003, April. Ambiguity as a resource for design. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 233-240). ACM.
22. Gordillo, G.R., 2014. *Rubble: The afterlife of destruction*. Duke university press.
23. Government of Nepal. 2015. *Nepal earthquake: Post-disaster needs assessment*. National Planning Commission.
24. Harley, J.B. and Laxton, P., 2002. *The new nature of maps: essays in the history of cartography*. JHU Press.

25. Houston, L., Jackson, S.J., Rosner, D.K., Ahmed, S.I., Young, M. and Kang, L., 2016, May. Values in repair. In *Proceedings of the 2016 CHI conference on human factors in computing systems* (pp. 1403-1414). ACM.
26. Jack, M. and Jackson, S.J., 2016, May. Logistics as Care and Control: An Investigation into the UNICEF Supply Division. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (pp. 2209-2219). ACM.
27. Jack, M., Chen, J. and Jackson, S.J., 2017, May. Infrastructure as Creative Action: Online Buying, Selling, and Delivery in Phnom Penh. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (pp. 6511-6522). ACM.
28. Jackson, S.J., 2014. 11 Rethinking Repair. *Media technologies: Essays on communication, materiality, and society*, pp.221-39.
29. Kargel, J.S., Leonard, G.J., Shugar, D.H., Haritashya, U.K., Bevington, A., Fielding, E.J., Fujita, K., Geertsema, M., Miles, E.S., Steiner, J. and Anderson, E., 2016. Geomorphic and geologic controls of geohazards induced by Nepal's 2015 Gorkha earthquake. *Science*, 351(6269).
30. Klein, N., 2007. *The shock doctrine: The rise of disaster capitalism*. Macmillan.
31. Lallemant, D., Soden, R., Rubinyi, S., Loos, S., Barns, K., Bhattacharjee, G. 2017. Post-disaster damage assessments as catalysts for recovery: A look at assessments conducted in the wake of the 2015 earthquake in Nepal. *Earthquake Spectra*. Forthcoming.
32. Latour, B., 1986. Visualization and cognition. *Knowledge and society*, 6(1), pp.1-40.
33. Latour, B. and Woolgar, S., 1986. *Laboratory life: the construction of scientific knowledge*.
34. Lim, F.K.G., 2008. *Imagining the good life: negotiating culture and development in Nepal Himalaya* (Vol. 20). Brill.
35. Law, J., 2004. *After method: Mess in social science research*. Routledge.
36. Liboiron, M. 2015. Disaster Data, Data Activism: Grassroots Responses to Representations of Superstorm Sandy, *Extreme Weather and Global Media*. Eds. Diane Negra and Julia Leyda. Routledge.
37. Lord, A., 2016. Citizens of a hydropower nation: Territory and agency at the frontiers of hydropower development in Nepal. *Economic Anthropology*, 3(1), pp.145-160.
38. Lord, A. 2017. Humility and hubris in hydropower. *Limn*, 9(1) [Online]. Available from: <https://limn.it/humility-and-hubris-in-hydropower/>
39. Lord, A. and Murton, G. 2017. Becoming Rasuwa Relief: Practices of Multiple Engagement in Post-Earthquake Nepal. *HIMALAYA, the Journal of the Association for Nepal and Himalayan Studies*, 37(2).
40. Masco, J., 2017. The crisis in crisis. *Current Anthropology*, 58(S15), pp.S65-S76.
41. Mol, A., Moser, I. and Pols, J., 2010. Care: putting practice into theory. *Care in practice: On tinkering in clinics, homes and farms*, 8, pp.7-27.
42. Murphy, M., 2015. Unsettling care: Troubling transnational itineraries of care in feminist health practices. *Social Studies of Science*, 45(5), pp.717-737.
43. Oliver-Smith, A., 1986. The 1970 Yungay Earthquake: Post-Disaster Change in an Andean Province of Peru. *Investigating Natural Hazards in Latin American History*, 25, p.107.
44. Orr, J.E., 1996. *Talking about machines: An ethnography of a modern job*. Cornell University Press.
45. Palen, L. and Anderson, K.M., 2016. Crisis informatics—New data for extraordinary times. *Science*, 353(6296), pp.224-225.
46. Peluso, N. L. 1995. "Whose woods are these? Counter mapping forest territories in Kalimantan, Indonesia." *Antipode* 27.4: 383-406.
47. Redfield, P., 2013. *Life in crisis: The ethical journey of doctors without borders*. Univ of California Press.
48. Redfield, P., 2016. Fluid technologies: The Bush Pump, the LifeStraw® and microworlds of humanitarian design. *Social studies of science*, 46(2), pp.159-183.
49. Ribes, D., 2017. The rub and chafe of maintenance and repair. *continent.*, 6(1), pp.71-76.
50. Roitman, J., 2013. *Anti-crisis*. Duke University Press.

51. Rosner, D.K. and Ames, M., 2014, February. Designing for repair?: infrastructures and materialities of breakdown. In *Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing* (pp. 319-331). ACM.
52. Schäfers, M., 2016. Ruined futures: managing instability in post-earthquake Van (Turkey). *Social Anthropology*, 24(2), pp.228-242.
53. Semaan, B. and Mark, G., 2011. Technology-mediated social arrangements to resolve breakdowns in infrastructure during ongoing disruption. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 18(4), p.21.
54. Shelton, T., Poorthuis, A., Graham, M. and Zook, M., 2014. Mapping the data shadows of Hurricane Sandy: Uncovering the sociospatial dimensions of 'big data'. *Geoforum*, 52, pp.167-179.
55. Simpson, E., 2013. The political biography of an earthquake: Aftermath and amnesia in Gujarat, India. Hurst.
56. Sletto, B.I., 2014. Cartographies of remembrance and becoming in the Sierra de Perijá, Venezuela. *Transactions of the Institute of British Geographers*, 39(3), pp.360-372.
57. Soden, R. and Palen, L., 2016. Infrastructure in the Wild: What Mapping in Post-Earthquake Nepal Reveals About Infrastructural Emergence. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (pp. 2796-2807). ACM.
58. Soden, R. and Palen, L. (2018). The social life of disaster information: Cultivating resources for emergent information infrastructures in Nepal. In Eric Welch (Ed.) *Research Handbook on E-Government*. Edward Elgar. Forthcoming.
59. Soden, R., Sprain, L. and Palen, L., 2017. Thin Grey Lines: Confrontations With Risk on Colorado's Front Range. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (pp. 2042-2053). ACM.
60. Solnit, R., 2010. A paradise built in hell: The extraordinary communities that arise in disaster. Penguin.
61. Spoon, J., 2013. From yaks to tourists: Sherpa livelihood adaptations in Sagarmatha (Mount Everest) national park and buffer zone, Nepal. In *Continuity and Change in Cultural Adaptation to Mountain Environments* (pp. 319-339). Springer, New York, NY.
62. Star, S.L. and Strauss, A., 1999. Layers of silence, arenas of voice: The ecology of visible and invisible work. *Computer supported cooperative work (CSCW)*, 8(1-2), pp.9-30.
63. Steinhardt, S.B. and Jackson, S.J., 2015. Anticipation work: Cultivating vision in collective practice. In *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing* (pp. 443-453). ACM.
64. Stengers, I., 2011. Thinking with Whitehead: A free and wild creation of concepts.
65. Tierney, Kathleen J. Towards a Critical Sociology of Risk. *Sociological Forum* 14 (1999): 215-242.
66. Tsing, A.L., 2015. The mushroom at the end of the world: On the possibility of life in capitalist ruins. Princeton University Press.
67. Verbeek, P.P., 2005. What things do: Philosophical reflections on technology, agency, and design. Penn State Press.
68. Weick, K.E., 1988. Enacted sensemaking in crisis situations [1]. *Journal of management studies*, 25(4), pp.305-317.
69. Wisner, B., 2001. Risk and the Neoliberal State: Why Post-Mitch Lessons Didn't Reduce El Salvador's Earthquake Losses. *Disasters*, 25(3), pp.251-268.
70. Wood, D., 2010. Rethinking the power of maps. Guilford Press.
71. Wood, E.J., 2003. Insurgent collective action and civil war in El Salvador. Cambridge University Press.
72. Woolgar, S., 1990. Configuring the user: the case of usability trials. *The Sociological Review*, 38(1_suppl), pp.58-99.
73. Wynne, B., 1989. Sheepfarming after Chernobyl: A case study in communicating scientific information. *Environment: Science and Policy for Sustainable Development*, 31(2), pp.10-39.