

Anatomy of disaster recoveries: Tangible and intangible short-term recovery dynamics following the 2015 Nepal earthquakes

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ABSTRACT

The April/May 2015 Nepal earthquakes and aftershocks had catastrophic impacts on rural households living in biophysical extremes. Recoveries from natural hazards that become disasters have tangible and intangible short- and long-term dynamics, which require linked quantitative and qualitative methods to understand. With these premises in mind, we randomly selected 400 households in two accessible and two inaccessible settlements across two of the highest impacted districts to assess variation in household and settlement recoveries through tangible impacts to infrastructure and livelihood and intangible impacts to place attachment and mental well-being. We conducted household surveys, in-depth interviews, and focus groups over two ten-week intervals at 9 months and 1.5 years after the earthquakes and returned at 2.5 years to share and contextualize results. Previously, we used non-metric multidimensional scaling ordination to illustrate associations among recovery indicators, demographics, and adaptive capacity domains composed of multiple variables. Results indicated that socio-economic status, hazard exposure, livelihood, and displacement influenced recovery outcomes the most. Here, we triangulate and broaden those findings with 797 surveys, 40 interviews, eight focus groups, and eight research return workshops to illustrate the tangible and intangible dynamics of short-term recoveries through three interconnected and multi-faceted thematic sections: 1) inequality; 2) hazards, livelihood, and displacement; and 3) place, uncertainty, and mental well-being. Our contributions include: 1) providing a linked quantitative and qualitative dataset with a random sample collected at two short-term post-disaster time intervals; 2) illustrating how inequalities shape tangible and intangible recovery dynamics; and 3) documenting linkages between recovery and nascent transformations.

1. Introduction

Disaster recovery has both tangible and intangible dynamics that help to illustrate a household or settlement's ability and intention to adapt to these circumstances, what this adaptation looks like, and the time it takes to do so. Examples of tangible impacts include damage and destruction to local infrastructure, exposure to natural hazards, place-based livelihood disruption, and displacement. Intangible impacts can encompass place attachment to ancestral settlements and mental well-being in contexts of uncertainty. Disasters also illustrate pre-existing

social and economic inequalities [1] and often impact the poor and vulnerable the most [2–4]. Disaster events are also opportunities for social inequalities [5] and human-environment relationships, such as farming and herding practices, to shift into new configurations. From an integrated social and environmental systems perspective, natural hazards that become disasters and their cascading effects can cause an acute disturbance or perturbation to the system, which can in turn stimulate the system to adapt and/or transform into a new state. Recovery from these events has multiple dimensions, both short- and long-term [6], tangible and intangible. Ethnographic and survey research after

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disasters can help to uncover these dynamic, plural, and hybrid ways that communities understand and respond to these natural hazards [7, 8], assisting with future planning and response.

The catastrophic April/May 2015 earthquakes and aftershocks in Nepal represent an opportunity to better understand tangible and intangible aspects of rural disaster recovery in the developing world. The disaster killed and injured thousands and damaged or destroyed hundreds of thousands of houses and buildings. It triggered landslides that covered agricultural fields and pastures and blocked access to forests and roads, disrupting the lives of millions. In total, the earthquakes killed nearly 9,000 people, injured more than 22,300, and damaged or destroyed more than 750,000 private houses and government buildings, and approximately 30,000 classrooms [9]. There were more than 400 additional earthquakes and aftershocks with a magnitude of 4 or greater within nine months after the initial event, and more than 4,000 landslides triggered within one year [148]. Estimates for the total damages and losses caused by the earthquakes reach NPR 706 billion (US\$ 7 billion), which pushed 2.5 to 3.5% of the population into poverty [9]. While these impacts arose in the weeks and months following the earthquakes, recovery will unfold over years and decades.

In previous research, we used non-metric multidimensional scaling (NMDS) ordination to quantify and interpret patterns in recovery [10]. We systematically explored those associations to understand the relationships among patterns of recovery, demographics, and five domains of adaptive capacity, including: *hazard exposure*, *institutional participation*, *livelihood diversity*, *connectivity*, and *social memory*, each consisting of multiple variables [11]. We developed the critical recovery indicators and domains of adaptive capacity through a pilot study, our previous ethnographic research, and published studies [12,13]. Hazard exposure encompasses biophysical vulnerability such as landslide proximity and risk and impeded access to farms, pastures, forests, and firewood collection areas. Institutional participation focuses on the influence of participation in the governance system and other formal and informal institutions. Livelihood diversity includes the roles of income heterogeneity and varied patterns of resource use. Connectivity encompasses linkages between households and external actors in receiving recovery assistance and the flows of outside ideas. Social memory includes experiences with previous natural hazards and the roles of local knowledge and practice in the recovery. The recovery indicators encompass a household's ability to return home from temporary shelters, issues rebuilding homes, access to basic services that existed prior to the earthquakes (i.e. electricity, cell phone, and internet) and impacts on herding, farming, forest product collection, and market participation (e.g., wage labor and tourism) (see Fig. 1 for conceptual relationships between five domains of adaptive capacity and recovery indicators).

We found that household recovery was heterogeneous with each settlement having its own starting point in the recovery and that their recoveries were either stagnant or moving in positive or negative directions. We also identified several patterns that indicated associations among recovery trajectories, exposure to natural hazards, livelihood, and displacement [10,11]. In this paper, we triangulate the findings of the NMDS analysis with results of a qualitative content analysis that brings to life trends identified in the quantitative approaches while also providing greater insight into recovery dynamics. Moreover, the qualitative content analysis illustrates intangible recovery dynamics not observable in the quantitative results. Bearing in mind that recovery is a dynamic process, differs by context, and extends beyond surface markers, such as the rebuilding of housing units [14,15], to touchstones of everyday life, we argue that it is critical to pay attention to both tangible and intangible recovery dynamics as they both affect the lives and opportunities of survivors following disasters. Moreover, tangible and intangible dynamics interact to create new forms of vulnerability or adaptive capacity, potentially leading to transformation. These effects of disaster are not observable from solely assessing either tangible or intangible dynamics with a single research method. Together, the data from the quantitative and content analyses over two time intervals

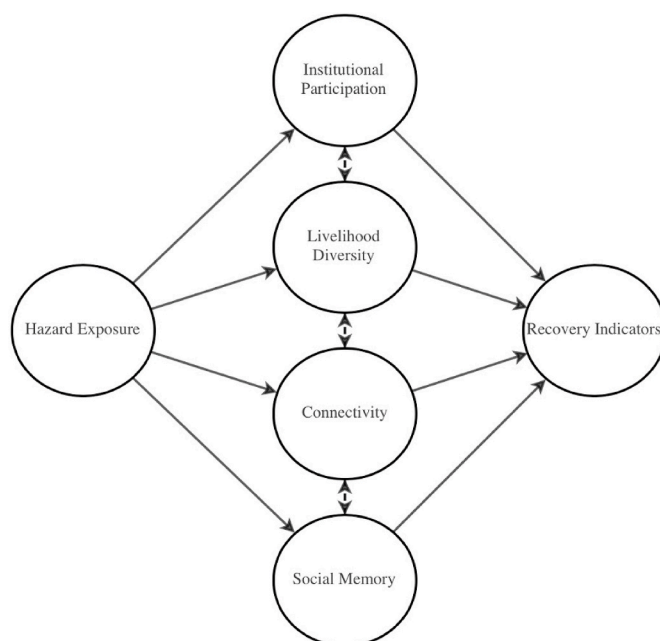


Fig. 1. Conceptual model of five domains of adaptive capacity and recovery indicators. Hazard exposure acts on four mitigating interrelated household characteristics that then influence recovery indicators.

provide a holistic picture of patterns and variations in this context across multiple sites. Our dataset has the breadth and generalizability of a fairly large random sample complemented by the depth and nuance of ethnographic interviews and focus groups with key consultants over the same time period. It also captures short-term change dynamics during which households, settlements, and systems may undergo rapid shifts. Complementary methods help to sketch the anatomy of this disaster with temporality.

This study illustrates the tangible and intangible dynamics of short-term household and settlement recoveries through three interconnected multi-faceted thematic sections that build on one another to contextualize short-term recovery dynamics: 1) inequality; 2) hazards, livelihood, and displacement; and 3) place, uncertainty, and mental well-being. First, we illustrate how the earthquakes brought into focus and amplified pre-existing social and economic inequalities. The earthquakes exposed structural and spatial inequalities that broadly shaped recovery outcomes in tangible and intangible ways. Second, we show how inequality is associated with the primarily tangible recovery dynamics of hazard exposure, place-based livelihood disruption, and experiences of displacement. Third, we highlight how intangible dynamics are disproportionately experienced by those of traditionally lower socioeconomic status in vulnerable geographies. These include the interrelations among place attachment, uncertainty towards the future, and mental well-being. Collectively, we provide a robust and holistic conceptualization of short-term disaster recovery dynamics. These results also show evidence of nascent transformations in everyday life. Better knowledge of these short-term recovery dynamics can lead to increased understanding of recovery and transformation over the long-term, assisting with future disaster preparedness and response. We contribute to the disaster and development aid literature in three ways: 1) providing a linked qualitative and quantitative dataset collected with a random sample at two time periods immediately following a disaster; 2) illustrating how inequalities shape recovery dynamics in tangible and intangible ways; and 3) documenting linkages between recovery and nascent transformations.

2. Disaster recoveries

2.1. Disasters, households, and settlements

Hoffman [16] states that people live in multiple types of environments, such as the physical terrain, the modified environment they sculpt, the built environment of houses, roads, etc., and their cultural environment. These environments are intricately connected, and a change in one will cause a change in the others. Our project takes these dynamic human-environment connections into account by employing a systems perspective to address interdependencies between humans and the environment with dual feedbacks [17]. A systems approach views human populations as in constant, shifting relationships with the environment, where human actions impact the environment, and the environment reciprocally acts on humans. In rural disaster contexts in the developing world and other analogous situations, systems approaches illustrate critical interrelated social and environmental factors, such as exposure to natural hazards and place-based livelihoods where there is strong place attachment, such as the case with many Indigenous populations. We borrow from Oliver-Smith & Hoffman [18]: 4) to define a disaster as: “a process/event combining a potentially destructive agenda/force from the natural, modified, or built environment and a population in a socially and economically produced condition of vulnerability, resulting in a perceived disruption of the customary relative satisfactions of individual and social needs for physical survival, social order, and meaning.” A vulnerability framework is often used to understand how natural hazards act on populations to become disasters; from this perspective, vulnerability is the degree to which a population is susceptible/unable to cope with adverse natural hazard effects (e.g., Ref. [7,19]). We view natural hazards as acting on interplaying vulnerabilities—bio/geophysical (e.g., constant landslide threat), social (e.g., economic inequalities), structural (e.g., architecture), and procedural (e.g., state capacity)—which in turn act on households integrated into linked social and environmental systems, rather than on the population as an isolate.

The household scale is our primary unit of analysis. We view settlements and clusters of settlements as secondary foci. Many of our impact measures are at the household level, a common focus of monitoring and evaluation where aid and government relief are coordinated. In this study, the household is a key space for understanding how intermediary variables, such as livelihood diversity and social memory, affect recovery outcomes. It is also thus a key interface to understanding integrated social and environmental system dynamics. Households and communities in disaster contexts are never completely stable and influenced by history and power [20]; therefore, we consider earthquake recovery as a dynamic process with variation expected within and across study sites and in terms of both pre/post-earthquake conditions. Indeed, disaster risk reduction and response are often driven by development practices prioritizing economic growth over social and environmental values [21]. Time compression is the primary difference between disaster recovery and regular development [22]. Disaster recovery goals may also trap a population in waiting for help rather than taking proactive recovery steps themselves; our research found some evidence of such dynamics [10]. We address such concerns, using mixed-methods, multiple sites, a temporal research design over the short-term that is conducive to future longitudinal analysis, and community outreach.

2.2. Recovery and transformations in everyday life

Previous research illustrates recovery as a highly dynamic, non-linear, and context-specific tangible and intangible process with no clear end point [15,23]. It includes the physical, built, and human environments and can be viewed as both short-term solutions to issues of rebuilding in addition to long-term shifts that may increase resilience to future hazards. Recovery includes “differential processes of restoring,

rebuilding, and reshaping the physical, social, economic, and natural environment through pre-event planning and post-event actions” [24]: 237). To best understand recovery dynamics, the focus is therefore on the process and not necessarily the outcome [25]. Importantly, returning to a pre-disaster state may not be appropriate for certain communities or may perpetuate pre-existing unequal power dynamics, failing to deal with root causes that created these inequalities in the first place [26]. This is especially important to keep in mind when utilizing terms such as resilience, which can forward neo-liberal economic agendas [20]. A focus on people first, as well as equity, money, and resources are key components to recovery as those with higher socio-economic status tend to return to desirable pre-disaster levels more quickly [15,27]. Conversely, those on the lower end of the economic spectrum who are the most vulnerable, often remain there throughout the recovery process [28], especially individuals from poorer nations [29]. There is a tension involved in recovery planning between quickly adapting planning in a post-disaster setting while also having a long-term strategy that betters the community with appropriate outreach, community-based organizations, and local input [15,27]. Local involvement in recovery is critical [30] as is information sharing and communication between institutions to make informed decisions [31]. A complex and fluid understanding of social networks also helps illustrate recovery dynamics [32]. Importantly, time compression is the fundamental difference between disaster recovery and development. This time compression can exacerbate social inequalities, shift power dynamics (e.g., interactions between individuals and the state), and foster the emergence of nongovernmental organizations (NGOs) to fill gaps not provided by the state, such as social services [22].

Research on recovery indicators of previous disasters in other contexts has included economic, environmental, infrastructural, and social indicators. These indicators may be tangible surface markers, such as number of housing units or infrastructure built over time [14,23], or intangible touchstones of everyday life, such as place attachment and mental well-being [33]. Research methods that account for quantitative and qualitative approaches may therefore be best suited to assist in capturing both these tangible and intangible recovery dynamics. Often, research is biased towards the tangible effects of disasters [34], ignoring the numerous intangible ways in which people experience disasters and subsequent recovery processes. One area where recent work has sought to ameliorate this is in the field of cultural heritage preservation following disasters (e.g. Ref. [35–38]) as well as in economic valuations that seek to quantify the value of intangible losses following disasters [39,40]. While other researchers seek to understand how both tangible and intangible preparedness measures impact resilience when disasters occur [41,42]. The profound intangible senses of loss and grief that people experience after disasters impact abilities to adapt or transform following disasters [43], thus necessitating inquiry into these dynamics. Our research sought to understand both the tangible and intangible dynamics of disaster recovery through in-depth quantitative and qualitative approaches that enabled a broader and deeper view into people’s experiences in the short-term following a disaster. This research thus moves beyond economic and monetary indicators into personal and community experiences and the lingering disaster impacts thereof.

We consider *recovery* as extending from the immediate relief and restoration of basic services directly following the disaster to the reconstruction and potential (albeit rare) betterment period, which can overlap and take many years, depending on circumstances. These phases are fluid and externally imposed conceptions of recovery phases may differ from those experienced by survivors [20,44–46,143]. We attempt to avoid the trap of viewing recovery as a return to a certain prior state by considering the constant force of change prior to and after the disaster, highlighting the role of reflexivity or recognizing the role of the observer in shaping recovery assessments [25]. To understand household and settlement recovery we focus on the role of *adaptive capacity*. Adaptive capacity in this sense is the ability and intention/desire of a household to adapt to natural hazards and their cascading effects [47,

146]. Adaptive capacity can also be multifaceted; for example, a community may be more resilient immediately following the disaster but lacking adaptive capacity in the long-term [48]. In addition, a longitudinal approach recognizes that a population may experience additional natural hazards that cascade from the original disturbance (e.g., landslides) or new hazards altogether. Our research attempts to navigate this complexity with quantitative research that identifies associations among critical recovery indicators, demographics, and five domains of adaptive capacity over two time intervals. Complementing this inquiry into tangible recovery dynamics are qualitative approaches that assessed primarily intangible but also tangible dynamics up to 2.5 years after the earthquakes.

Disasters can also drive short- and long-term changes, leading to *transformations in everyday life*. Transformation involves elements of fundamental restructuring of individuals, institutions and regimes [25] and can be both deliberate and/or adaptive [47]. Gibson et al. [49] propose five indicators of transformation triggered by disasters. These include: interactions between actors, external actor intervention, system-level change beyond efficiency to include governance and goals, behavior beyond coping strategies established, and behavior extending beyond established institutions. Further, these authors argue that transformation could serve as a tool in the development of disaster risk management and climate change as an alternative to treating risk and development as disassociated, serving as a leverage point into policy adaptation and more sustainable development. Pelling [50] adds that research on transformation should consider 1) unit of assessment, 2) viewpoint of observer, and 3) distinguishing between intention, action, and outcome. System thinkers also argue that more resilient systems are able to renew and reorganize when transformation occurs [51]. Transformation does not happen at adaptive limits, but can be actively sought after [52]. Transformation is often related to root causes of vulnerability, which disasters can bring to light. We define a transformation in everyday life as a change in a household's human-environment dynamics, such that there are significant changes to the human impact on and relationship with the physical landscape, including essential structures, processes and feedbacks. This stems from our focus on the household as an analytical unit and as something embedded within an integrated social and environmental system. Social indicators of such transitions may include shifts in herding, farming, and forest product collection strategies and intensities, economic opportunities that emerged in the earthquakes' aftermath, more institutional participation, and robust connectivity. This may also include the role of hybridized local and global knowledge and practices (e.g., use of appropriate technologies) in these dynamics. Transformations in ways of understanding and relating to the environment and interactions between social actors are also considered. To capture short-term processes of change triggered by the disaster, the methodology includes two short-term time intervals and research return workshops at 2.5 years.

Our pilot research, information sharing meetings, mixed quantitative and qualitative methods, and research return workshops helped us to integrate local perspectives on recovery into our research design, ensuring that our use of terms like "recovery" and the scale at which we assess them parallel the ways the terms are used in practice and not only theoretically to ensure that our research is both pragmatic [53], and reflexive [25,50]. It is also our goal to traverse the "academic and practitioner divide" [54] and "develop dialogues of knowledge" [55] by using terminology accessible to all actors. We recognize that externally enforced conceptions of recovery may be used to forward neoliberal policies or agendas [56]. For example, the discourse on "building back better" may push a population to recover a particular way and not engage with root causes that caused the hazard to turn into a disaster in the first place [20,26]. The state may also use a disaster to exert their authority, such as asserting itself as a sovereign power [56]. There is evidence in Nepal after the earthquakes that government and humanitarian agencies made assertions about previous, stable, and ideal state conditions before judging damages, which in turn shaped their

interventions after the earthquakes [57].

3. Study sites

Nepal offers a rural example of a disaster context where nearly 80% of the population relies on subsistence agropastoralism, hunting, and forest product collection in largely geographically isolated plain, hill, and mountain areas [58]. There are many examples of nascent market integration depending on accessibility to goods and services. The contemporary state has relied on centuries of exploitation through taxes, rent, and labor from non-Hindu ethnic groups, such as Tamang and Dalit populations in this study. These Indigenous peoples have often been excluded from education, civic rights, and economic opportunities [59]. Historically, the state institutionalized the Hindu hierarchy in the form of a civic code called *Muluki Ain* which categorized many non-Hindu ethnic groups as alcohol drinkers, enslavable, and untouchable [60]. The land and labor of many of these ethnic groups, particularly the Tamang, were appropriated by the feudal-like state in the 19th and 20th centuries excluding them from regional and national domains of influence [61,62]. This kept these populations at a distance from the economic center of Kathmandu and in relation to power and local opportunities [63]. The earthquakes brought the centuries of systemic exploitation of these peoples to the surface, with the most marginalized often feeling impacts the most. Our research uncovered some of these dynamics.

Nepal has been in a consistently fragile political and economic state; for example, the 2006 revolution, its reliance on aid from China, India, and others, and a proliferation of development agencies prior to the disaster [64]. The lack of locally elected governments until 2017 stifled the voices of diverse communities, hampered service delivery, and stalled disaster-preparedness and other needed systems [65]. The Nepal Government raised four billion U.S. dollars in the immediate relief phase after the April 2015 earthquakes; however, it showed its lack of state capacity by taking nine months to initiate the rebuilding program, and much of the funds remained unspent and difficult to access within the first three years after the earthquakes. Financial and normative technical requirements and higher rebuilding costs further slowed the reconstruction rate and caused more household indebtedness in some locations [66]. State inability to respond to such disasters is well documented in other countries/contexts (e.g., Ref. [29,67,68]). As evident in recovery elsewhere (e.g. Ref. [69]), government aid distribution and International NGO (INGO) and local NGO coverage have also been difficult to track and coordinate centrally. The majority of aid distributed during the immediate relief phase was in more accessible areas, a typical pattern in state response to disasters (e.g., Ref. [48,70]).

In the spirit of comparative research, we selected two districts, Gorkha and Rasuwa, as study sites (Fig. 2). Gorkha and Rasuwa are two of 14 districts identified as highly earthquake-impacted by Nepal's government; both were catastrophically damaged in April/May 2015. Gorkha was the epicenter of the April 2015 earthquake, and Rasuwa was decimated by earthquake-related landslides and also experienced the highest number of deaths per capita. We selected two administrative areas, called Village Development Committees (VDCs), to contrast in each district. VDC boundaries by and large follow the physical landscape and group together settlements as clusters of resource users sharing a watershed or common topography (e.g., settlements that stretch from the top of a hill down to the river). Our project thus uses these clusters of resource users as the boundaries of the integrated social and environmental systems in the study areas. Each VDC includes settlements with internally and externally defined boundaries where households share physical infrastructure, common pool resources, and work exchange. Our team had connections with some of the settlements and local leaders through previous conservation and development work conducted by The Mountain Institute, an international NGO. Starting in 2016, the VDCs selected for our study were reorganized into larger municipalities composed of additional VDCs.

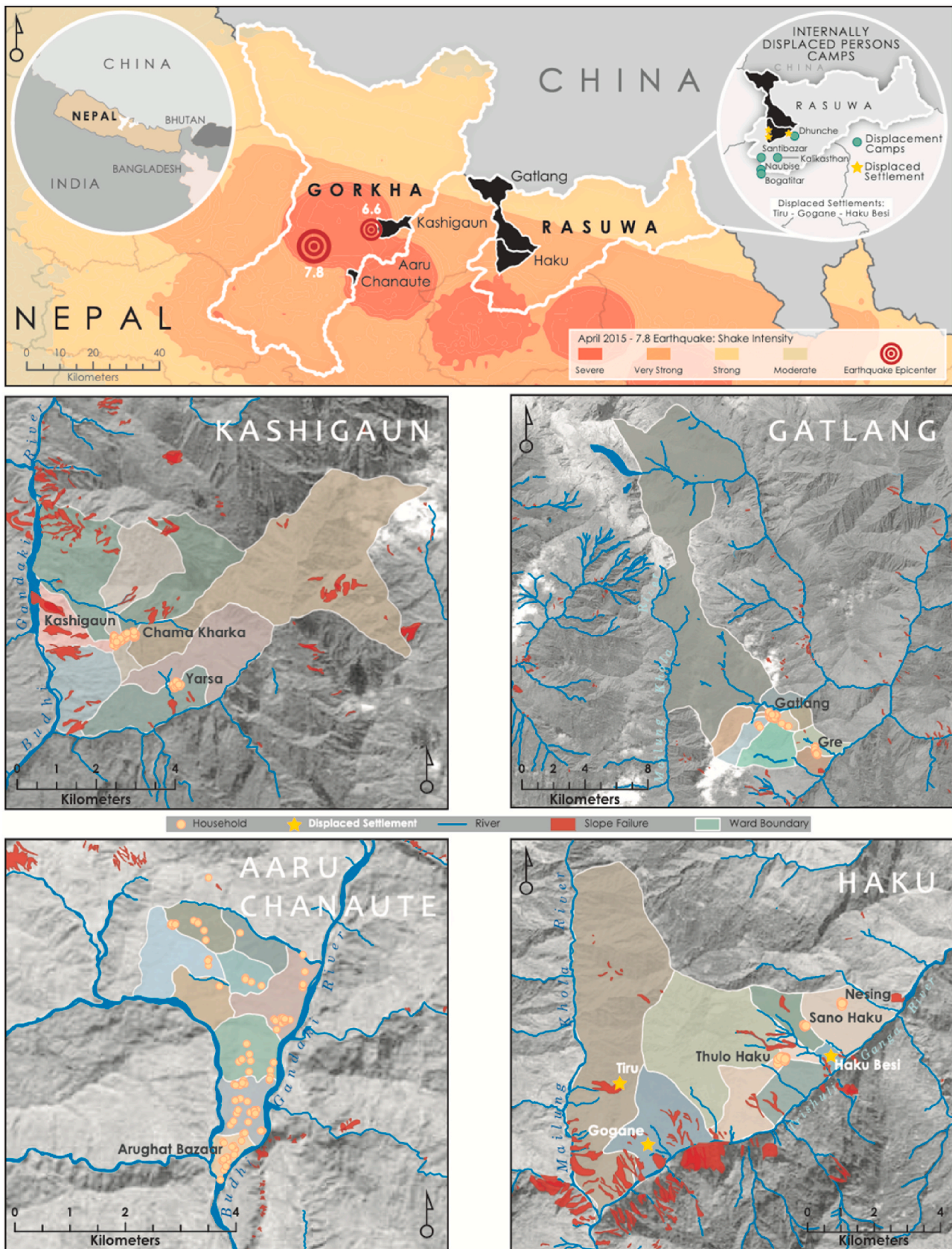


Fig. 2. Map of study area with shake intensity from the April 2015 Nepal earthquake with selected Village Development Committees and Internally Displaced Persons Camps (see upper right). Proximity of settlements to slope failures (landslides) also illustrated [137]. Map by Alicia Milligan. Adapted from Ref. [10].

Within each district, we selected a cluster of settlements near the road with more market-based livelihoods and international and national non-governmental organizations and one far from the road with less NGOs and more reliance on place-based agropastoralism. The two VDCs we selected as representative case studies in Gorkha were the more-accessible Aaru Chanaute and less-accessible Kashigaun. Kashigaun is a two-day walk from Aaru Chanaute. The Gurung/Ghale ethnic group almost exclusively populates the VDC [71,72], which has three settlements: Yarsa, Kashigaun, and Chama Kharka. Residents generally practice agropastoralism and work as wage laborers. There is sparse aid in this area. Aaru Chanaute has a concentration of households in the market area and others that depend more on agropastoralism and wage labor. In Rasuwa, we selected the more-accessible Gatlang and less accessible Haku. Gatlang is road-accessible, has two settlements (Gatlang and Gre), and is populated by the Tamang ethnic group. Gatlang residents are predominately agropastoralists, though some households also work in tourism, which is a growing livelihood option. Many INGOs and NGOs provided relief materials in Gatlang after the earthquakes. Haku is less-accessible and a one-to three-days walk from Gatlang. Similar to Gatlang, the Tamang ethnic group populate Haku [61,73,74]. Haku has seven settlements, three of which were completely relocated to seven different IDP camps, inhabited for two or more years.

4. Methods

4.1. Data collection

This mixed method quantitative and qualitative design aimed to elicit multiple measures of varying depth, of recovery indicators and five domains of adaptive capacity, allowing for both triangulation and in-depth illustration. Mixed quantitative and qualitative research has a debated history in social science research. This is in part over the tensions of perceived objectivity and subjectivity [75] as well as over the differing epistemological and ontological assumptions that different types of research carry with them. These tensions suggest that the different types of knowledge multiple methods produce is incompatible [76] or that their different result types complicate interpretation [77]. However, others argue that there is strength in combining methods in that it allows for researchers to check the validity of their findings through comparing multiple types of data [76,78,79]. Validity and reliability can be achieved through careful research and integrated research design, from the creation of questions through to data analysis methods [80], which this study considered when designing and carrying out its approach.

The field team consisted of the Principal Investigator, two Project Coordinators, five local and Kathmandu-based Research Assistants, and four Translators. We met in Fall/Winter 2015 with local leaders and government representatives to help select study sites and obtain an accurate census for drawing a random sample. We also carried out pilot research in the form of in-depth interviews and focus groups to select recovery indicators and domains of adaptive capacity. Once site criteria were satisfied, we selected locations that appeared more “typical” of earthquake impacted VDCs and not incomparable outliers with exceptionally devastating experiences. The random household sample was based on local censuses collected by VDC staff after the earthquakes and provided to project staff during the pilot study. Households were then selected using a random number generator. We conducted an inductive content analysis in Atlas.ti software to analyze findings from the pilot studies to guide the design and analysis of our quantitative survey. The role of the information sharing meetings and research return workshops was to introduce the project to each site and share preliminary and final results, while also differentiating our research from government and aid community projects. These meetings were important in defining the integrated social and environmental system [81] and identifying appropriate recovery indicators. These types of meetings were indeed found to assist in the integration of different knowledges into disaster

recovery efforts [82]. Information presented was intended to be understandable and useful for audiences at the national, regional, and local levels, in the appropriate language. We also provided accessible products relevant to various audiences (e.g., handout with graphics in Nepali and multi-page brochure). The first series of meetings described the research phase in Nepali and the local languages of Gurung or Tamang. Each participant received a one-page project explanation in Nepali and team contact information. The second series of meetings was held after the first data collection phase. We presented results from the prior research phase and solicited feedback to inform our interpretation.

The household survey used structured and semi-structured questions to track household demographics, recovery indicators, and the five domains of adaptive capacity: hazard exposure, institutional participation, livelihood diversity, connectivity, and social memory (see Table 1 for methods summary). At 9 months, we enrolled 400 randomly selected households from the four communities (100/settlement). At 1.5 years, we were able to re-contact 397 of the original 400 households. The team strove to locate the specific respondent who participated in the first phase, but designed the survey to be able to be taken by any household member over the age of 18. The survey included measurements on 34 recovery indicators as well as 175 other variables divided across the five domains of adaptive capacity and demographics. The survey used ordinal, yes/no, and multiple-choice questions for the quantitative data and semi-structured short answer responses for the qualitative data. The semi-structured qualitative questions build on the quantitative responses (e.g., “describe difficulties you are having accessing your agricultural fields”) related to the recovery indicators and adaptive capacity domains (see Ref. [10,11,83]).

Qualitative responses from the 797 surveys at 9 months and 1.5 years, 40 in-depth interviews at 9 months, 8 focus groups at 1.5 years, and 8 research return workshops at 2.5 years provided a complementary dataset to compare, interpret, and expand the trends observed in the quantitative results. In-depth interviews and focus groups focused on the same domains of adaptive capacity and recovery indicators as the household survey, which were developed with community input. Focus groups and interviews were intended to explore the tangible and intangible dynamics of the recovery at greater depth. Key consultants (10/VDC) were enrolled for interviews from the original participating communities, using quota sampling of age and gender. Focus groups used reputational sampling, including representatives from government, local institutions, and aid agencies. Interviews were conducted in Nepali, Gurung, and Tamang and were recorded, translated, and fully transcribed for analysis. Interview and focus group questions incorporated the following themes related to the recovery: 1) earthquake impacts to household and community; 2) worries, hopes, challenges, and threats; 3) perceptions of natural hazard risk; 4) role of institutions; 5) integration of local perspectives into decision-making practices; 6) livelihood impacts and transitions; 7) relationships with government and outside aid; 8) roles of local knowledge and institutions; and 9) emergence of new opportunities.

The research return workshops on the local and national scales helped with the interpretation of results and provided updates at 2.5 years after the earthquakes (Fig. 3). All newly elected government officials from the four VDCs were invited to attend the local workshops. These workshops thus served as a conduit for us to share information with the local government. Our hope was that these individuals would communicate results to their constituents and use the findings to inform their decisions. On the national scale, the workshops helped bring local and global actors in dialogue. After we presented preliminary results, each local government representative had the opportunity to share their perspectives on the study and their situation in general. This was followed by a question and answer period with the panelists and an opportunity to privately write questions or comments. All workshops were recorded and fully transcribed.

Table 1
Data collection methods, data types, research period, sample size, data analysis method, and topics (variables).

Data Collection Method	Data Type	Research Period(s)	Sample Size	Data Analysis Method	Topics (Variables)
Household Survey	Quantitative and Qualitative	January–March 2016; October–December 2016	n = 400; n-397	Descriptive statistics; NMDS; Inductive Content Analysis	Recovery indicators (34 total) Demographics (35 total) Hazard exposure (12 total) Institutional participation (12 total) Livelihood diversity (73 total) Connectivity (16 total) Social Memory (27 total) Qualitative follow-up questions based on quantitative survey responses
In-Depth Interviews and Focus Groups	Qualitative	January–March 2016; October–December 2016	n = 40; n = 8	Inductive Content Analysis	Earthquake impacts Worries, hopes, challenges, and threats Perception of hazard risk Role of institutions in recovery Role of local perspectives in recovery Livelihood impacts and transitions Perception of government and outside aid Role of local knowledge in recovery Emergence of new opportunities
Research Return Workshops	Qualitative	October–December 2017	n = 8	Inductive Content Analysis	Triangulation of prior results with participant and key consultants' perspectives and experiences Interpretation of key findings and updates

4.2. Data analysis

We used Atlas.ti software to employ grounded theory to analyze the qualitative data from the 797 surveys collected as well as the transcripts from 60 h of in-depth interviews, 12 h of focus groups, and 10 h of research return workshops. Grounded theory is an inductive content analysis method, which views the world as complex with multiple factors affecting any situation [84]. Grounded theory begins with open or free coding in which the analyst reads through all materials and begins to identify themes [85,86]. We used the identified themes to come up with large code groups, each housing numerous subcodes. Subcodes were used to identify nuances and subcategories within the broader themes [87]. While one team member primarily conducted the coding process, the open coding process was collaborative and consistent communication was maintained throughout the process to discuss any coding questions and to maintain transparency [88]. Through this

qualitative analysis, we sought to deepen and contextualize the quantitative survey results gathered [84,89], situating them within their social, historical, and political dynamics [90].

Table 2 illustrates select themes, code groups, and their definitions discussed in this paper. We provide the quantitative and qualitative results illustrated in this paper side-by-side in SM 1. We share additional themes and code groups outside of the scope of this paper in Ref. [83].

5. Results and discussion

5.1. Previous research and contextualization of study sites

Prior research on the short-term recovery dynamics following the April/May 2015 Nepal earthquakes helped to inform these research findings. Hea et al. [91] studied at the epicenter of the April 2015 earthquake in Gorkha, near and similar in geography to two of our study



Fig. 3. Research return workshop in Kathmandu with the project team, local government, international and national non-governmental organizations, academics, and media. This meeting served as a pathway for exchanges between project participants to discuss and interpret findings. Francis Klatzel, November 2017.

Table 2
Select themes, code groups, and code group definitions from interviews, focus groups, and research return workshops.

Theme	Code Group	Definitions
Inequality	Structural Violence	Socio-economically marginal ethnic groups and religions suffered the most severe impacts
	Spatial Inequalities	Lack of relief due to accessibility/perceptions of village condition based on accessibility/bias in relief and recovery towards charismatic tourist sites Difficulty of roads/transport of goods/have to carry everything to less accessible villages/expense of rebuilding due to inaccessibility
Hazards, Livelihood, and Displacement	Hazard Exposure	Continued landslides/threat of landslide/danger in going to pastures, fields, and forests
	Place-Based Livelihood Disruption	Extreme earthquake impacts on agropastoral practices for herders, non-irrigated field (bari) farmers, and forest product harvesters Loss of livelihood/lack of livelihood diversity/change in livelihood
	Displacement	Earthquake displaced agropastoral livelihoods and entire settlements into camps/camps are stagnant without new flows of funds or ideas
Place, Uncertainty, and Mental Well-Being	Place Attachment	Symbolic roles of home and settlement and their damage and destruction
	Uncertainty Towards the Future	Uncertain future in all settlements, camps, and planned dam inundation zone
	Mental Well-Being	Earthquakes caused worry, anxiety, trauma, depression, and suicide Earthquakes caused communities to work together and live more in harmony

sites, and found that the earthquakes impacted already impoverished vulnerable communities that were not safe from natural hazards prior to the events. Geologic risks from landslides, landslips, and falling boulders threatened the area. The lower socio-economic status of the population impacted their response, creating a strong possibility that afflicted populations in this, and analogous contexts in Nepal, will become more disadvantaged over the reconstruction process, reinforcing the importance of understanding vulnerability in relation to recovery. Also at the epicenter, He [92] argues that recovery needs in local communities were diverse and shaped by individual and communal action, as well as expectations of resources from the government and other aid agencies, and the accessibility of these resources regardless of earthquake impacts. Preference was shown by communities for sustainable long-term aid and not short-term solutions. Hülssiep et al. [93] illustrate that the primary root causes of vulnerability in Nepal prior to the earthquakes, which highly influenced impacts and recovery trajectories, were caste, ethnic group, and gender. Political instability also drove these causes. The physical environment (buildings and infrastructure), local economy and livelihood, social environment, and politics of leadership were all interrelated forms of vulnerability, both tangible and intangible.

Nearby and in two additional highly impacted districts, Arabinna et al. [94] assessed recovery using qualitative methods to understand social, economic, physical, and psychological dimensions found that a low percentage of communities showed evidence of early or better recovery. The major drivers of short-term recovery dynamics were natural resource endowments, physical connectivity, access to external

development services, entrepreneurship, social homogeneity, and local economy. There was no single factor that was attributed to early or better recovery outcomes, but rather an assemblage of factors. In another highly impacted district, collective action was not found to necessarily translate into effective government engagement to meet reconstruction goals; however, improvement in social status was predicted to potentially lead to positive social change. Social inclusion groups that existed prior to the disaster were also found to be more effective afterward than newly formed groups [95]. Some aspects of social capital aided relief response through determining and improving response, granting information access as well as providing access to staff and resources, and increasing community acceptance [96].

Research on livelihood recovery within the first two years after the earthquakes among Newar settlements in Kathmandu Valley found that household and livelihood recovery were not mutually exclusive and that household assets (e.g., cultural, social, economic, physical, human and natural) and strategies for generating capital played a crucial role in recovery. Strategies for generating capital varied by household and were reinforced by strong socio-cultural ties at the community level [97]. Kotani et al. [98] argue that residential status was an indicator of recovery up to 2.5 years after the earthquakes in one rural location, as certain households returned to unrepaired houses whose living conditions did not improve thereafter. These findings reinforce, according to the authors, the importance of early financial aid to help heavily impacted households navigate the crisis more effectively. Mitchell et al. [147] add that there were problematic land tenure related issues because reconstruction programs only used formal land titles, which impacted unrecorded and unregistered households and squatter settlements. Daly et al. [99] argue that in Kathmandu Valley rapid urbanization in the early recovery increased challenges in disaster management and that the centralized disaster governance structure hindered housing reconstruction. This led to the creation of ad hoc national reconstruction agencies that overlooked local actors in spite of widespread calls for decentralization of the reconstruction process. Lastly, food security and nutrition remained stable or improved after the earthquakes, most likely from ongoing relief programs [100].

We found that within our 400 household sample the earthquakes damaged or destroyed the primary home of 396 (99%) of the interviewed households (18% damaged and 82% destroyed). These same households were also unable to return to their homes within 9–11.5 months after the events. After 1.5 years, only 44% had been able to return to their homes from temporary shelters. All infrastructure (micro-hydropower plants, schools, hospitals, health posts, monasteries, temples, and communal buildings) were damaged or destroyed by the earthquakes or related landslides. By 1.5 years, less than 40% of this infrastructure was rebuilt. There were marked differences at this time in the number of households able to return home—as high as 92% in the less-accessible VDC Kashigaun and as low as 8.0% in the more-accessible VDC Gatlang, contrary to expectations. These homes were patched back together; none of these households that returned home rebuilt their primary houses according to the new building codes created by the National Reconstruction Authority after the earthquakes. The earthquakes also forced the relocation of 64 households in the sample (16%) to seven internally displaced persons (IDP) camps; by 1.5 years, 63 of these 64 households were still in camps. There were also spatial variations between accessible and inaccessible settlements in each VDC defined based on their proximity to road, trail, or helipad. By this criterion, 44% (176) of the sampled households were accessible and 56% (224) were inaccessible. At 2.5 years, most households in our sample were participating in the government reconstruction program. The only way to receive funding allotments was to rebuild according to the new codes. Those that had started to rebuild were constructing significantly smaller structures than their original house before the earthquakes. This was largely due to the inflated costs of transporting building materials to less accessible locations. This caused the government aid to be worth far less than intended, resulting in people modifying the housing designs

recommended under the newly formed building codes.

Recovery dynamics were tangible and intangible, requiring different types of information to assemble holistic narratives of the situation and how it changes over time. In our previous analysis, we found that households from historically marginalized ethnic groups and religions with lower socio-economic status and literacy before the earthquake were having more difficulty. Hazard exposure, livelihood, and displacement from place-based livelihoods and settlements into camps, influenced recovery outcomes the most. Herders, non-irrigated field farmers, and forest product collectors were struggling, while irrigated field farmers and those with access to various businesses and tourism ventures had better recovery outcomes. Negative recovery outcomes functioned in non-linear ways depending on experiences of displacement. Non-linear refers to variables that functioned irregularly, such as recovery indicators showing variation in negative recovery outcomes for households relocated to displacement camps compared to those that remained in the settlements. For example, households displaced to camps lost their livestock whereas households that persisted in their settlements had impacts to livestock health, behavior, and productivity. There was evidence of both rapid changes and stagnation in the short-term that may lead to transformation in the long-term [10,11]. We now enrich and add to the quantitative results with the qualitative content analysis, creating a more holistic picture of how inequality shapes tangible and intangible recovery dynamics for highly impacted rural populations. We discuss three thematic sections, each with multiple intertwining components that build on one another: 1) inequality; 2) hazards, livelihood, and displacement; and 3) place, uncertainty and mental well-being.

5.2. Inequality

We observed various tangible and intangible recovery dynamics that illustrated and perpetuated aspects of social inequalities that existed prior to the earthquakes [101,102]. Treating the catastrophic events as a “focusing event” or “revealing crisis” [103–105], dynamics of structural violence and spatial inequalities already in play prior to the disaster come into view and are amplified. Indeed, research illustrates that the poor and most vulnerable feel the impacts of disasters the most [2,3], especially women, the elderly, and children [4]. Time compression from disaster recovery has also been found to exacerbate social inequalities [22]. Tangible and intangible dynamics of earthquake impacts were evidenced through both structural violence and spatial inequalities.

5.2.1. Structural violence

We consider structural violence in disaster recovery as repeated and systematic harm, such as the perpetuation of poverty through barriers to receiving relief and recovery materials, caused by policies and interventions that have historically privileged certain groups over others and can be driven by profit over what survivors identify as their actual needs. They are power dynamics embedded in the political and economic organization of the social world that can cause direct and indirect harm to historically marginalized peoples [106–108]. Ethnic groups and religions with lower socio-economic status and literacy had the worst outcomes in the quantitative analysis [11]. These same individuals have less market access and rely more on place-based agropastoralism in extreme montane geographies. They are the most socially vulnerable. Structural violence and spatial inequalities thus interrelate. All of these factors highlight root causes of inequity in Nepal, consistent with other studies [91,93]. In-depth interviews and focus groups made visible the impacts and repercussions of the state’s structural and historical marginalization of certain ethnicities and religions. In the case of relief access, inequalities were tangible (e.g., building materials, food, etc.) and intangible (e.g., access to information). Several households complained about problems in accountability and transparency when it came to government and NGOs aid distribution and relief materials. People perceived that personal relations and proximity to power guided

access to relief and reconstruction. Multiple participants shared stories of educated “clever people”. Clever people knew the right contacts in the right places and were able to take advantage of the relief; by contrast, those who did not were often excluded from relief. These effects were magnified especially for historically marginalized ethnic groups, such as Tamang and Dalit, who have less representation in local, regional and national government and lower participation in business ventures despite being the numerical majority in Rasuwa. According to one member of a Dalit household, having access to the right information was difficult for people from Dalit families, mostly because other villagers did not inform them and minimally interacted with them.

In Haku, one male consultant in his late twenties shared that local leaders were unable to understand governmental processes and therefore did not put pressure on the concerned authorities to address the problems causing their area to be left behind. He stated “our place has always lagged behind others in development, politics, and education. When people lag behind others, the place also lags behind. Unless people can change, the place can’t change.” For people who have figuratively and literally remained farther from the state, voicing their demands is a challenge. A male consultant in his mid-forties from Aaru Chanaute expressed similar concerns. He called those at the margins with very little access to resources *Nimukha*, which translates as “no mouth” or voiceless. He eloquently describes what structural violence looks like in everyday recovery dynamics, especially when government relief has been top-down and enmeshed in bureaucratic processes that can be inaccessible to people who do not speak the Khas-Nepali official language:

We, the poor and voiceless (*nimukha*) people do not know many hurdles of laws and regulations. Many do not know how to advocate in the court and legal matters. Some cannot express what they have in their heart and mind. Those groups of people are the poor, orphans, children, Dalit, those who are subjected to injustices, those who were excluded by the past regime, and those who suffer socially and cannot live their lives in socially just ways.

5.2.2. Spatial inequalities

Structural violence is also observable through spatial inequalities, where the poorest ethnic groups often live in more geographically marginal conditions [1] with severe hazard exposure. There were feelings that the inaccessible settlements had less access to immediate relief after the earthquakes. Further, in-depth interview and focus group consultants shared that the condition of an area was often evaluated by the government and aid community by the state of the more accessible settlements. This means that they receive less relief than they need since the perception is that things are in a better state than they actually are. This form of elite capture obfuscates those that need help and makes them invisible to the state. One female consultant in her early forties from Aaru Chanaute shared with us:

Only if they [government representatives, aid organizations] had come to see places further up from the bazar, they would have said “Oh, there are people in such condition here as well”. And, they would have known about our conditions. They only visit the bazar and go back. They don’t see what had happened to the people living up here. They don’t know who needs to be helped and who is in difficult conditions.

There was also a feeling that the Nepal Government and aid organizations were biased towards charismatic developed trekking areas that provide economic benefit to a minority of Nepalis. There is a road to Langtang National Park from Kathmandu that passes through the small newly developing city of Dhunche before going in a different direction. Visitors to Gatlang need to pass through the National Park entrance in Dhunche, and pay the entry fee, before heading west to Gatlang. There were perceptions that Langtang, a popular tourist destination, was

receiving more attention than Haku even though both had catastrophic impacts from the earthquakes. This could be due to centralized decision-making in Kathmandu overlooking the local circumstances in Haku and prioritizing economic development on a national scale, dynamics observed by Daly et al. [99]. At our workshop in Thulo Haku, one participant shared that “Langtang has already been rebuilt and revived, but Haku is still suffering ... nothing has been done in Haku compared to Langtang.” Bias in recovery towards more developed areas with higher socio-economic status is evident elsewhere [109]. These types of perceptions and feelings are some of the intangible impacts of the earthquakes.

In the quantitative results, road access generally correlated with a household being able to return to their primary home and/or restart their agropastoral practices as well as some positive recovery outcomes [10]. Consultants from focus groups and interviews also identified tangible aspects of spatial inequalities such as poor roads and difficulty in transporting goods as aspects of spatial inequalities. Consider the following from an interview with a male in his mid-forties from Haku:

... our place is a remote place. There is no possibility that any transportation would come here. Therefore, it's only us who have to go to Dhunche to receive relief aid. In other places, the organizations came to the villages and distributed relief aid. But for us, we have many problems here. Since ours is a remote place, we have to reach Dhunche, Gatlang and Gre even to see motor vehicles [and therefore receive aid distributed from vehicles].

Along these lines, in our workshop in Kashigaun, consultants shared that some households had not received tangible relief or rebuilding funds because the government contracted engineers missed their households when examining their locations. In other Nepal contexts, these dynamics forced some households to move near new roads sensing they will have better access [110].

Spatial inequalities were reiterated as critical factors shaping recovery in our research return workshops, especially by participants in inaccessible Haku and Kashigaun. In Haku, we learned that transporting construction materials was costing 3–4 times more than to transport the same materials to accessible areas. However, roads also created vectors for aid dependency, which when contingent on the capacity and opportunities afforded to the population at the road head, may help or hinder recovery (see Refs. [10,11]). Some households were waiting for higher quality building materials transported from the road rather than using local resources or creating new innovations. In our workshops, participants suggested that earthquake rebuilding funds from the government should consider geographic accessibility as one criterion in determining how much each household receives. Taking into account Pelling's [50] criteria for transformation of intention, action, and outcome, and using the household as the primary unit of analysis, the institutionalized constraints of structural violence and spatial inequalities shaped intentions and actions evidenced in relief and recovery efforts. This has the potential to lead to outcomes that represent early signs of transformations in everyday life, including shifts in housing and infrastructure, livelihood, such as herding, farming, or outmigration for wage labor or other opportunities, or changes in institutional participation, such as creating or serving on local committees. These changes may also represent new behaviors that extend beyond coping mechanisms and interactions between social actors, leading to transformations [49].

5.3. Hazards, livelihood and displacement

The structural violence and spatial inequalities experienced in short-term recovery were also associated with exposure to natural hazards, disruptions of place-based agropastoral livelihoods, and experiences of displacement. These nested dynamics were primarily tangible, such as physical exposure to natural hazards and inability to access pastures,

fields, and forests, but also intangible, including fears of returning to resource gathering areas vulnerable to landslides. They interrelate, especially for households practicing agropastoralism in extreme mountain ecosystems, making them some of the most vulnerable. These factors are also place-based, reinforcing the importance of a systems perspective in understanding reciprocal human-environment relationships. Hazard exposure for agropastoralists with place-based livelihoods in biophysical extremes is, in part, a product of structural violence and spatial inequalities that are reinforced by the Nepali state. These power dynamics keep these mostly non-Hindu populations away from economic opportunities in perilous geographies.

5.3.1. Hazard exposure

Exposure from natural hazards correlated highly with recovery outcomes in the quantitative analysis. The earthquakes and their cascading effects greatly impacted access to grazing areas and forests across both time periods. Households in the most marginal geographies had the most hazard exposure [11]. This exposure appeared to stay the same or get worse over the duration of our study. Similar impacts in other districts have been reported [91,111]. In the in-depth interviews, consultants shared that seismic damage from the earthquakes caused severe natural hazards and a series of cascading effects that exposed people to even more vulnerable and uncertain situations on the biophysical landscape. For example, landslides caused by the earthquakes continued to activate from monsoon rains causing hazards in all settlements that persist year-to-year (Fig. 4). A male teacher from Aaru Chanaute explains some of the tangible impacts of hazard exposure:

The earthquake had created many cracks in the land. You can see these scenes – lands have cracked everywhere. The land surface has sunk down. So if it rains heavily, there is a serious risk of landslides. If we will get only mild rain, then perhaps it will not affect that much. If it rains heavily for a longer duration, it can wash away the cracked lands, causing landslides. And, there is possibility of another loss and damages in the area. Because the rocks inside the earth have been shaken and weakened. When the landslides occur, flooding will come as well.

In Haku, households displaced to camps because of catastrophic landslides felt that blasting for a nearby dam made the land more vulnerable to landslides from seismic activity, a process evident elsewhere [112,113] (Fig. 5). There was also perceived risk of rocks falling down from the hills while an individual works in their fields and pastures. Thus, these tangible biophysical effects translate into intangible fears and worries for affected communities. According to a female in her sixties from Kashigaun:



Fig. 4. Forest product collectors from Kashigaun VDC carry fodder for livestock over a continually reactivated landslide caused by the earthquakes (see arrow). Jeremy Spoon, October 2016.



Fig. 5. Catastrophic landslides in Haku VDC caused by the earthquakes that covered entire settlements and forced relocation to displacement camps. Jeremy Spoon, March 2016.

It is not always possible to stay safe ... we have to [go to the forest to] collect fodder and firewood. The rocks may hit us; the landslide may sweep us away. The earthquake has shaken all of the land; the land has become like the thin membrane of the cooked rice separated from the rice pot.

Intangible household fears are palpable and manifested in their reluctance in wanting to go back to the forests or steep slopes where there is often more firewood and fodder for grazing. Some also reported abandoning fields because farmers were too afraid of the natural hazards to continue looking after their crops. Households in Gatlang who stayed in the temporary shelters the longest were exposed to a severe wind-storm that caused additional damage because they remained in structurally vulnerable housing. In our workshops, participants from Kashigaun explained that the cumulative and continuing damage from landslides had been far worse than the damage from the earthquakes. Exposure to natural hazards has indeed directly impacted those reliant on place-based agropastoral livelihoods.

5.3.2. Place-based livelihood disruption

The quantitative analysis found that herders, *bari*, or non-irrigated field farmers, and forest product harvesters were struggling the most. *Khet*, or irrigated field farmers, and households participating in various businesses and tourism enterprises had better recovery outcomes [11]. The qualitative information from the surveys documented tangible earthquake impacts such as at 9 months grazing areas and the trails and roads to them were often blocked by landslides. There were cracks and landslides throughout the project area making it difficult to shepherd animals to appropriate food sources. Some even sold all of their livestock because they had no place to graze them. At 1.5 years, the landslides continued to impact access to grazing and fodder collection sites. Some reported diseases and other health issues, leading to further livestock loss. Some also claimed to not have enough money or resources to raise livestock as they did before the earthquakes. In our workshops, participants commented that households with less diversified livelihoods that relied more on herding and forest product harvest, such as Gatlang households, were having more difficulty recovering compared to farmers and business owners. Epstein et al. [111] document similar impacts to grazing in adjacent districts.

Survey participants reported catastrophic tangible impacts to their *bari* at 9 months. They shared that cracks and fissures damaged their terraces and that landslides covered some of the fields entirely. There were also reports of water shortages and drought. Some left their *bari* barren since the damage was beyond repair. In the words of one farmer “cracks are everywhere in my fields and [they are] not suitable for

ploughing so it [the field] has been left fallow ...” At 1.5 years, *bari* fields remained devastated and most were unable to return to the state they were in before the event. The monsoon rains made things worse, activating landslides and expanding cracks. Survey responses showed that there were physical, financial, and labor constraints preventing *bari* recovery. Labor issues included an inability to find farmers and herders who practice *parma*, or work exchange, to provide reciprocal labor. Displacement from primary homes and from settlements also prevented *bari* recovery. For households that farm and herd just enough to survive, no longer having space to farm due to the cracks and landslides and shrunken access to grazing areas pushed them and their families outside the village to live in “other’s place” where they can be seen as encroachers, adding another layer of marginality onto already marginalized people.

5.3.3. Displacement

Environmental displacement is similar to development-induced displacement and resettlement—both with often dubious outcomes [114]. Our quantitative analysis found that displacement was a strong factor in shaping recovery outcomes. Displacement had two tangible forms: 1) displacement from primary homes and agropastoral lifeways within the settlements and 2) complete household displacement from settlements into temporary camps [10]. Indeed, the poor often experience displacement the most [115]. Displacement also challenges place-based connections that are integral to Nepali ways of life. Displacement can lead to a fundamental restructuring of everyday life and deep rooted changes of individuals, institutions, and regimes [25]. Relocation is thus problematic without the support of the population [27]. Residential status was also found to be a key component in recovery from this earthquake and therefore reinforces the challenges afforded by displacement [98]. Our in-depth interviews illustrated that displacement and temporary resettlement in camps, particularly from Haku, caused some to feel like they lived in “other’s place.” Households who used to grow their own food now had to pay for food in camps since agriculture was not feasible. For those who were able to farm in the camps, landowners often took portions of crops. Some displaced on other’s lands also had to pay rent to landowners and used the reconstruction funds from the government for this purpose. The earthquake through displacement thus solidified and reinforced structural hierarchies, especially among the poor. In the words of a female in her mid-forties from Haku:

If the earthquake had not come, we would live by doing farm work and raising cattle. We would have sent our children to school. But now we are not in a condition to go back to our village. We don’t have our village and our place. Since we are living in other’s place, we have to leave any time if they ask us to leave this place. Now we have become like a crazy person walking in the street.

Another female from Haku shared: “my *man* (heart-mind) thinks and does many things. Sometimes, I feel like crying. We are living in other’s places and we are facing so many difficulties.” Indeed, displaced households living in temporary shelters on other’s lands, live with a constant fear of eviction. In our workshops, Haku participants also shared that displacement from the cooler higher elevations to warmer lower elevations in the camps caused difficulty in daily life. They added that they are currently paying rent and feel unsure about whether their settlements are safe to return to or not. Some were also starting to use pesticides in their marginal agricultural plots to get a quick yield at an unfamiliar altitude (Fig. 6). Displacement from ancestral lands thus tangibly and intangibly affected recovery. These short-term recovery dynamics may also lead to certain long-term transformations, such as shifts in social interactions, livelihood practices or complete relocation after experiencing a liminal period in displacement camps. There were also coping strategies for agropastoral and market practices that may evolve into new lifeways altogether [49,50].



Fig. 6. Displacement camp in Rasuwa District 1.5 years after the earthquakes. Most households displaced to camps had to pay rent to landowners, and if allowed to farm, cultivated crops at lower elevations than they were accustomed to, at times with pesticides instead of the previously organic approaches they used in their higher elevation settlements. Jeremy Spoon, November 2016.

5.4. Place, uncertainty, and mental well-being

There are certain intangible recovery dynamics not observable in our quantitative analysis. We found in the interviews and focus groups that those with traditionally lower socio-economic status in vulnerable geographies had strong sentiments of place attachment and uncertainty towards the future. There was also evidence of mental health impacts, such as being *dukkha*, troubled or tense, or *pagal*, mad/crazy, anxious, and depressed. These intangible recovery dynamics intertwine with one another and are, in part, spurred and amplified by other tangible and intangible impacts caused by inequalities, hazards, place-based livelihood disruption, and displacement. They also illustrate significant place-based connections that influence intangible recovery dynamics.

5.4.1. Place attachment

The destruction of homes and usurping of more stable relationships with the environment as well as not knowing the future appeared to cause mental health issues. These connections were especially observable for households displaced entirely from settlements to camps, but also existed for those displaced from their primary homes to temporary shelters and disrupted from practicing their agropastoral ways of life. Place attachment is an emotional bond between individuals and a particular space that develops within the environmental, political, economic, social, and cultural context that people live within [116]. This sense of place is especially critical to consider in the case of Indigenous communities, where cultural identity and place are often interconnected [33]. An interruption in “territorial belonging,” especially for Indigenous peoples in Nepal, has broad implications in place constructions after the earthquakes on the individual, communal, and national scales [110]. The role of the natural environment was found to be a critical component of livelihood recovery in Kathmandu Valley [97]. Research also found that “placelessness”, due to loss of land, impacts identity [117] and causes fragmentation [118]. Place attachment may prevent one from leaving their community despite the hazards it may hold [119]. There is also evidence that those with more long-term place attachment have the worst experiences with natural hazards that become disasters [144]. Place connections are also considered critical to sustainable long-term recovery [30].

Participants displaced to camps pointed out that they had concerns over whether they would be able to continue with the social and cultural life they had prior. There was fear of losing culture, religion, and identity, which included habitation and constant interaction with their ancestral lands now covered by cracks and landslides and thus

permanently altered. There was also palpable lamenting over displacement from the land of family and ancestors, such as this statement from a Haku focus group:

If we had not been displaced from our village because of the earthquake, then we would have been very happy there no matter what the village looks like. It is the place of our parents and grandparents – we own things there.

One’s place attachment can be tied to their emotional connections to that place. Households not only grieved the loss of their land and material home, but also the eroding of social relationships and identity embedded in the landscape. According to a focus group participant from Haku:

Now with the resettlement in a new place, I may have a new house but it will be difficult to continue the kind of social and cultural life and its ethos we used to have in the village. We will be without culture; we will be without our religion. We will be without our identity and we will be without the sense of and practice of community that we used to have in the village.

In our workshop at the Bogati-taar displacement camp (Haku VDC), participants shared that they wanted to stay together and if resettled required a new area where they can all live together and practice the same culture.

The earthquakes and their cascading effects threatened place-based connections among families, communities, and their ancestral lands, dynamics evident elsewhere where natural hazards are forcing relocation and changes in everyday life [120,121]. Not only did it damage and destroy the root of each family, the physical house, but also generated a significant amount of uncertainty and mistrust to the larger physical world that intertwines in their social and cultural life. Some felt that the land changed from being a protector to a destroyer. Others explained that the earthquakes are an example of human morality being out of balance. Many characterized the land as an actor. Thus, place attachment, an intangible aspect of participant’s lives, held great influence in their perceived abilities to live meaningful, fulfilling, and secure lives following the earthquake.

5.4.2. Uncertainty towards the future

Button [122] argues that uncertainty is not a commonly addressed topic due to difficulty in analyzing it. He suggests that uncertainty plays a large role in disasters and is often downplayed or dismissed. Uncertainty about the future was pervasive in our interviews, focus groups, and workshops. In the settlements, households felt that what was once stable was now unstable, especially the land that they rely on for herding, farming, and the collection of forest products. It did not appear that this level of uncertainty was something these households planned for in everyday life as evident elsewhere [123]. Households felt that another earthquake could come any time and that the damages from the initial earthquakes were not going away, and at times, worsened. This uncertainty can cause mental health impacts. In the words of a male from Kashigaun in his early sixties:

Even now, if the earthquake comes, there is no option for us to survive. Last time, we somehow survived. If the earthquake repeats like the last time, then where can I jump when everywhere is cracked? It [the land] will be washed away by the landslides. Where can I run away? Where can I hide? This is what I worry. If the earthquake, like that of the 2072 [2015] comes, it will be difficult to survive. Our hill, steep slopes and lands, all have cracked and are weak. I think we will not survive if the earthquake comes again.

In Aaru Chanaute, a planned hydropower project caused some of the households to be in a liminal state, unable to rebuild, but yet to be resettled. Many households in the market area are in the planned inundation zone of the dam. Before the earthquakes and continuing

afterward, the government barred these households from selling their homes and land and also prohibited building any new infrastructure within the area. Property values plummeted after the earthquakes. Some felt they overpaid for land in the market area and are now stuck because of the dam project. One focus group participant explained:

The other disadvantaged groups are the *Lekaali* (people from the uplands). They had sold their lands in the mountains at the price of potatoes and have bought land here [in Aaru Chanaute] at the cost of gold. They had settled here by building houses, by buying land with high prices ... because of the drowning [planned dam inundation], we are the most vulnerable victims. It has affected us more than the earthquake.

Practically all households were damaged or destroyed in Aaru Chanaute. There was uncertainty whether to rebuild or wait for resettlement. A female from Aaru Chanaute in her mid-forties explained it this way:

People are worried that there is no good prospect for tomorrow in this place. The earthquake has already damaged the place. Done! It has been devastated. Should people reconstruct the damaged houses and continue to live here? I, myself, could have built a one-story house there. I could have managed the money somehow. But, it is said that the place will be a water dam tomorrow. What will this dam do tomorrow? I cannot simply spend money on building if there is no certainty.

Workshop participants reiterated these sentiments about their liminal state. This anxiety is no doubt fueled by their place attachment and the uncertainty of what their future holds. A participant brought this to life by explaining that “the dam is like another earthquake to us.” Indeed, resettlement because of dams has had severe impacts on communities with an established sense of place causing deep emotions of loss and grief [142].

5.4.3. Mental well-being

The effects of disasters on mental well-being can be substantial [124], especially the transitional period when in temporary settlements and houses [125]. There was strong evidence in the interviews and focus groups of mental health impacts and their relationships to not only place attachment and uncertainty, but also as byproducts of more tangible effects like inequalities, hazard exposure, place-based livelihood disruption, and displacement. The destruction of homes and settlements interrupted human-environment relationships and the base physical manifestation of the household—the physical home. Uncertainty about whether the earthquakes would return, what to do if there are more earthquakes or landslides, whether or not to rebuild, and how much to invest, caused fear and worry. Participants experienced distress over another earthquake coming by mere thunder shaking the galvanized tin walls of haphazardly rebuilt homes and temporary shelters. Others experienced an inability to sleep alongside excessive stress, and shifting daily behaviors that were both a byproduct of and contributor to decreased mental well-being. In our interviews and focus groups these symptoms were perceived as severe for households displaced from their homes and settlements and for those whose livelihoods are land-based. Displacement causing mental health decline and post-traumatic stress disorder (PTSD) has been observed after the 2015 Nepal earthquakes [126,127] and elsewhere [128–131,139]; and can last years [132]. Uncertainty towards the future has also been linked to PTSD, both after disasters [133] and in displacement camps [134]. For some, going back to *bari* affected their mind and they worried rocks could come rolling down at them as they dug in the soil. In one case, a key consultant explained that his daughter-in-law was more soft spoken before the earthquakes; however, afterward, she became more assertive and has a high temperament, similar to other people in the village who have shown significant and rapid changes in emotions.

In colloquial Nepali, having worries and suffering is called *dukha* or trouble/tension. When one has *dukha*, they cry and lose their appetite, as shared by this female from Aaru Chanaute: “How can we cook and eat in such situation? We cooked food but we had no appetite. We were 24 people living together for a week but we could not even finish the 3 kg rice.” The mental stress and tension are made sense of in the everyday emotions of fear, anger, anguish, and sadness. This is also understood by some as the earthquake taking one’s *sato* (soul/inner spirit) away, which causes them to not be their usual selves. The association of having tension, not being one’s usual self, and the conceptualization of being mad or *pagal* is also prevalent in the interviews. According to a female in her mid-forties from Haku who was in a displacement camp:

When people used to come to our village, we used to think, “What happened to them?” Now we have become like the crazy persons. Maybe, they had also suffered like this and therefore had come to our place. People don’t go to other’s place to live if they don’t have worries. We have worries like: where to go? Where to live? We cannot return to our place. If we want to live here, the local people don’t let us live here.

Being *pagal* is associated with having suffering and worries. Interview participants shared that not being able to stay in one place, instability, and having the risk of being evicted off of someone else’s land makes some roam around without a fixed destination and act *pagal*. Having a permanent place to stay and a sense of stability was thus considered critical to one’s mental well-being and their ability to recover. A male in his mid-twenties from Gatlang explained that he would choose to eat just *khole* [thin porridge made with rice, flour, and salt] everyday, in exchange for the permanence and safety that a home provides, which would appease his heart-mind. This liminality affected one’s ability to go about their day-to-day activities, and the trauma of the earthquake and the everyday reminder of loss impeded one’s livelihood, as explained by a female in her early fifties from Kashigaun:

People were scared of going to the farms due to the earthquake. We abandoned the cornfields in the lower land (*byansi*) like that [because we were afraid to go there to look after the crops]. I had thought, “this season, I would not be able to harvest any amount of corn (*jaat*)” and I actually got nothing from there.

The connections between place attachment and uncertainty indeed affected mental well-being. These mostly intangible dynamics were only observable in our qualitative approaches. We learned that something trusted, like the firm ground holding everything together, was no longer being seen the same way, causing people to lose confidence in the ground beneath them. The cracked earth and landslide scars served as a material form of this fear, re-traumatizing actors daily, a cruel existential reminder that something as firm as the ground can be just as fragile and perishable. Indeed, re-traumatization through these environmental indicators reinforces uncertainty and can generate feelings of loss and grief [135].

Despite the numerous traumatic experiences that the earthquake and its aftershocks imposed, some participants still managed to identify some more positive experiences related to earthquake recovery. Looking towards the future, survey respondents shared that there had been positive outcomes related to individual and group mental well-being, especially the community coming together in more harmonious ways and that they had gotten to know one another better. Fostering collective identity following the earthquakes in Nepal was identified as one way in which communities reduced the post-traumatic stress that follows disaster [127]. There were also statements on how communities were more prepared for the next earthquake now that they have had this experience. Some shared that new earthquake resilient structures were built and new trails, schools, and hospitals/health posts were constructed and that villages were cleaner. According to one participant: “we’re living and working in harmony; [there has been] realization in

the community that no one should be overlooked and discriminated against." And another pointed out that "People got to know each other, got knowledge on many things which were unknown about before the quake." Research shows that disasters can stimulate the emergence of new "communities of circumstance" that work together in post-disaster settings, which endure or decline depending on context [3]. Mental health challenges that intertwine with strong place attachment and uncertainty towards the future may also shape intention and actions leading to nascent transformations in everyday life [50], such as changes in how households and settlements relate to and interact with one another and the environment, potentially impacting social interactions and environmental practices within the integrated social and environmental system [49,51]. The earthquake itself acted as an opportunity for creating systemic change within Nepal's mental health system [136].

6. Conclusion

The 2015 Nepal earthquakes and their cascading effects caused catastrophic damage to life and property. Recoveries from such a disaster can span years and potentially decades. In some cases, conditions were improving, whereas in other cases they appeared to be getting worse. Stagnation and rapid change in the short-term may lead to transformation in the long-term [10,11]. This research triangulated quantitative findings (e.g. Ref. [10,11]) with qualitative evidence from in-depth interviews, focus groups, and research return workshops. It illustrated how inequalities shape tangible and intangible recovery dynamics under three interrelated themes that build upon one another: 1) inequality; 2) hazards, livelihood, and displacement; and 3) place, uncertainty, and mental well-being. Our discussion on inequality illustrated how structural violence and spatial inequalities were causing and perpetuating harm against the poorest and most marginal, which then lead to the primarily tangible impacts of exposure to natural hazards, place-based livelihood disruption, and experiences of displacement. Lastly, these same marginal populations experienced intangible dynamics that included how strong place attachment, uncertainty toward the future, and mental well-being interrelated and were amplified by tangible impacts. Through this mixed quantitative and qualitative approach, we contribute to the disaster and development aid literature in three ways: 1) providing a linked qualitative and quantitative dataset collected with a random sample at two time periods immediately following a disaster; 2) illustrating how inequalities shape recovery dynamics in tangible and intangible ways; and 3) documenting linkages between recovery and nascent transformations. The research illustrates how quantitative and qualitative information can reinforce one another to assemble a holistic picture of tangible and intangible recovery dynamics over the short-term following a disaster. Different types of information was also learned from these distinctive approaches. The quantitative information provided patterns that the qualitative data unpacked and explicated. This study also shows how there is certain information that is best communicated through qualitative methods. The short-term results are also conducive to a long-term longitudinal analysis, especially because short-term recovery cannot be discussed in isolation from long-term recovery.

These findings help to illustrate the heterogeneity of disaster recovery on the households and settlement levels and provide contextualization for broader patterns observed in large surveys. This approach and these results can help governments, practitioners, and communities to understand the complexity of disaster recovery and how tangible and intangible factors intertwine. This type of information can then provide contextualization to recovery plans that include factors such as local capacity and institutional centers of power [24], especially when balancing swift decision making with thoughtful post-disaster recovery planning [15,27]. This study also illustrates the dynamics and depth of short-term change through household perceptions, intentions, experiences, and actions [50,52], serving as potential leverage points for more equitable and environmentally sustainable decision making [49].

Without a focus on short-term tangible and intangible recovery dynamics uncovered through linked quantitative and qualitative methods, policies and outside recovery interventions risk overlooking critical social, cultural, and environmental factors, which may assist with navigating the dynamic tangible and intangible recovery process over the short- and long-term and help with future preparedness and response. This awareness may also facilitate more equity and desired futures by identifying root causes potentially leading to transformational processes that disrupt structural violence, spatial inequalities, perilous hazard exposure, displacement, and mental trauma experienced by the poor and most marginal.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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