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Understanding Short-Term Household Recoveries from the 2015 Nepal Earthquakes: Lessons Learned and Recommendations

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Understanding short-term household recoveries from the 2015 Nepal earthquakes: Lessons learned and recommendations

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ABSTRACT

We assess tangible and intangible disaster recovery dynamics following the 2015 Nepal earthquakes and aftershocks in order to understand household adaptive capacity and transformation. We randomly selected 400 households in four communities across two highly impacted districts for surveys and interviews at 9 months and 1.5 years afterwards and returned at 2.5 years to share and discuss results. We found that household recoveries were heterogenous, context specific, and changing. Tangible hazard exposure, livelihood disruption, and displacement and intangible place attachment and mental well-being influenced recoveries. We also illustrate challenges related to government programs, housing designs and codes, and outside aid.

1. Introduction

The April/May 2015 Nepal earthquakes and aftershocks caused catastrophic damage to life and property, killing nearly 9000 people, injuring more than 22,300, and damaging or destroying more than 750,000 private houses and government buildings and approximately 30,000 classrooms [54]. Within nine months of the earthquakes, Nepal experienced more than 400 additional earthquakes and aftershocks with a magnitude of 4 or greater, and within one year, more than 4000 landslides triggered by the initial events [75]. In 2015 and 2016, the earthquakes pushed an estimated 2.5 to 3.5% of the population into poverty and caused approximately NPR 706 billion (US$ 7 billion)[1] in damages [54]. Recovery from these events is complex and multidimensional, unfolding over the short and long-term [60]. Tangible and intangible dynamics help to illustrate a household's ability and intention to adapt to these circumstances, what this adaptation looks like, and the time it takes. Disaster events may also influence transformations in everyday ways of life [80–82]. Better understanding of these multi-faceted short-term recovery dynamics can help to inform policy and future interventions.

To address this need, we conducted research on recovery dynamics during the first two and a half years following the 2015 earthquakes. Our project's main objective is to understand tangible and intangible short-term household recovery dynamics. Specifically, our analysis addresses the following two research questions: 1) what factors contribute to household natural hazard adaptive capacity? and 2) at what point do households transform after disasters? Examples of tangible impacts include exposure to natural hazards, place-based livelihood disruption, and displacement. Place attachment to ancestral settlements and mental well-being are examples of intangible impacts. To illustrate short-term disaster recovery dynamics, we combined a complex, integrated social and environmental systems approach with mixed quantitative and qualitative ethnographic methods and community outreach over two short-term time intervals. Addressing disaster recovery as a multidimensional phenomenon that unfolds over time compels researchers to consider many different factors and their interactions. Borrowing from the resilience literature [87], we selected five *domains of adaptive capacity* composed of many variables using the *rule of hand*, which advises choosing three to five key domains to best understand integrated social and environmental system function and change. Including

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too many domains can make the dataset too fuzzy. We selected our critical recovery indicators, demographics, and domains based on a pilot study, insights from the anthropological and social science literature on disaster [19,20], as well as our team's long-term ethnographic research and community collaborations in Nepal [80–82].

We use Oliver-Smith and Hoffman's definition [60] of 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." Thus, hazards, such as earthquakes or landslides, act on existing vulnerabilities to create disasters. Vulnerabilities can be bio/geophysical (e.g., constant landslide threat), social (e.g., economic inequalities), structural (e.g., architecture), and procedural vulnerabilities (e.g., state capacity). After a hazard turns into a disaster, it is best to focus on process and not necessarily outcome [42,61]. Returning to a pre-disaster state may not be desirable for a certain population, perpetuating root causes that helped to make the hazard a disaster in the first place [9].

The Nepal Government's Post-Disaster Recovery Framework illustrates the vision and strategic objectives that guided government recovery interventions. It was prepared under the leadership of the National Reconstruction Authority (NRA), in consultation with key stakeholders, to provide a systematic, structured, and prioritized framework for implementing the recovery. The framework aims for a sustainable, resilient, and planned recovery by supporting the country's development agenda [58]. The framework had stakeholder input and instructed the government to conduct a "social impact and vulnerability analysis" to inform their Disaster Risk Reduction strategies; however, vulnerability was by and large related to natural hazards, such as dangers from earthquake activated landslides. The policy seemingly did not account for the situated cultural and spatial heterogeneity in the everyday lives of Indigenous and rural populations in highly impacted areas, evidenced by the development of generic household designs that fail to account for limited livelihood strategies or local knowledge. The framework also had few indicators of vulnerability like geographic marginality, illustrated by the NRA providing the same rebuilding funds to households without road access and with high hazard exposure, where inflation is high from transport costs compared to those in less geographically vulnerable locations. Indeed, the total amount budgeted for the social impact and vulnerability analysis in the 2016–2020 priority recovery plan was 0.00083% of the total budget (NPR 180.6 billion or US$ 1.8 billion) or NPR 1.5 million equivalent to US $15,000 [58].

We define *recovery* as a process extending from the immediate relief and restoration of basic services directly following a disaster to the longer-term reconstruction of living conditions and livelihoods (and potential improvement, where appropriate), which can overlap and take many years depending on context [26,35,44]. These phases are fluid. We recognize that externally imposed conceptions of recovery phases may differ from those experienced by survivors [9]. We consider recovery from the earthquakes as dynamic processes with no distinct end point, accepting the constant force of change prior to and after the disaster [49]. It is also important not to accept a certain recovery state as a given, since this may obscure the role of inequality and other power dynamics in creating the disaster in the first place [9]. We recognize variation within and across settlements each with different states prior to the earthquakes, therefore trying to incorporate insider and outsider conceptions of recovery in our approach. We included insider and outsider perspectives in the development of the study, especially in domain and variable selection, through a pilot study at the onset of the project, previous research by the authors (e.g., [76–79]), and published studies. Insider perspectives include those from earthquake survivors; whereas, outsider perspectives encompass those of the researchers and outside actors, such as the government or aid community.

In order to understand tangible and intangible recovery dynamics, we focus on the role of *adaptive capacity*, which signifies the ability and intention of a household to adapt to natural hazards and their cascading effects [40,59,67]. Adaptive capacity can also be multifaceted; for example, a community may be more resilient immediately following the disaster, though lacking adaptive capacity in the long-term [86]. A longitudinal approach also recognizes that a population may experience additional natural hazards that cascade from the original disturbance (e.g., landslides) or new hazards altogether (e.g., severe weather). We also consider long-term recovery in our analysis since short-term recovery cannot be viewed in isolation [21]. Future research by the authors will add to this discussion.

Each domain of adaptive capacity was comprised of multiple variables identified by researchers and community members as important elements of adaptive capacity. These include: *(1) hazard exposure, (2) institutional participation, (3) livelihood diversity, (4) connectivity, and (5) social memory*. Hazard exposure incorporates biophysical vulnerability such as proximity to landslides and threats, and encumbered access to farms, pastures, forests, and firewood collection areas. Institutional participation focuses on the impact of participation in the governance system and other formal and informal institutions. Livelihood diversity focuses on the roles of income heterogeneity and varied patterns of resource use. Connectivity includes connections between households and external actors and agencies in obtaining recovery assistance and the flows of outside ideas. Social memory encompasses knowledge based on experiences with previous natural hazards and the functions of Indigenous and local knowledge and practice in the recovery. The recovery indicators include ability to return to home from temporary shelter, issues rebuilding home, access to basic services that existed in each location prior to the earthquakes (electricity, cell phone, and Internet) and impacts on herding, farming, forest product collection, and market participation (e.g., wage labor and tourism). Fig. 1 illustrates the conceptual relationship between the five domains and recovery indicators. Note that hazard exposure acts on the other four mitigating interrelated domains, which in turn affect the recovery indicators (see [82] for a full list of variables in each domain).

Our research explored demographics, the five selected domains, and critical recovery indicators on the household and settlement levels using information-sharing meetings, surveys, in-depth interviews, and focus groups over two ten-week research phases at about 9 months (phase 1) and 1.5 years (phase 2) after the earthquakes. We also returned at 2.5 years to discuss preliminary results and interpretations. The term "phase" refers to the research-time interval in which we conducted the survey, consistent with other publications developed from this project. The term is not intended to signify the phases of the disaster risk management (DRM) cycle (preparedness, relief, recovery, and mitigation) [85]. This paper focuses specifically on short-term dynamics of the recovery phase in the DRM cycle. The NRA was officially established in December 2015. Prior to this, the Nepal Government used the National Disaster Response Framework to guide their response during the relief phase (Government of Nepal 2013). We waited nine months to start information collection until the NRA was established and the national reconstruction program started. This is the time that the government shifted their operations from relief activities to the short- and long-term recovery phase. This phase primally centered on the rebuilding of housing and critical infrastructure. We therefore consider the start of the NRA program at nine months to be the transition between relief and recovery phases, which parallels Nepal government operations.

At 2.5 years, nearly all households had received one tranche (incremental payment) of the total NPR 300,000 (US $3000) promised to each household to build an earthquake-safe home according to the newly developed building codes. The first tranche included eligibility, verification, and enrollment with a payment of NPR 50,000 (US $500). These payments began in July 2016, between phases 1 and 2 of our research. Two additional tranches were paid out for completion of the house foundation to the *plinth* level at NPR 150,000 (US $1500). The plinth level is a reinforced cement concrete, timber, bamboo, or other approved construction material band. It was evaluated after the completion of the foundation and covers the entire wall [58].The third tranche was paid for upon completion of construction up to the roof-band level at NPR 100,000 (US $1000). The roof-band level is an upper level of reinforced cement concrete, timber, bamboo, or other approved construction material. Evaluation occurred before the placement of the roof beams [58]. Payments were made to households

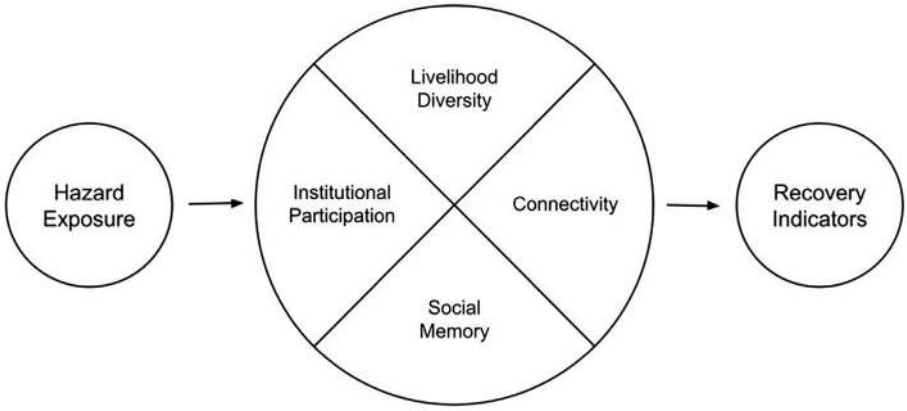

Fig. 1. Conceptual model of five domains of adaptive capacity and recovery indicators. Hazard exposure acts on four mitigating interrelated household characteristics that influence recovery indicators.

only after inspection by the NRA. These funds were typically transferred directly into the beneficiary's bank account [56,84]. Access to bank accounts for our household sample differed depending on the location of the bank or associated automated banking machines, which could be a one- to three-day walk from a household's settlement. Most households had received the second tranche by our research return workshops at 2.5 years. The study therefore focuses only on short-term recovery dynamics (0–2.5 years) and does not provide information on the payouts of all three tranches and the completion of the newly constructed homes. Future research by the authors will focus on long-term recovery in years 5–10 after the earthquakes.

We used non-metric multidimensional scaling (NMDS) ordination to analyze quantitative data [50] and inductive content analysis to analyze the qualitative data [11]. NMDS is a statistical method widely used in ecology to analyze complex datasets comprising many variables and to identify underlying patterns of variation. Here, we use NMDS to identify households that exhibit similar patterns of recovery, and explore how specific recovery indicators contribute to those patterns. Inductive content analysis searches for the frequency and salience of emergent themes in interview and focus-group transcripts (see [80–82] for further discussion on these methods).

At phases 1 and 2, we found that households in each of the four locations had different starting places in the recovery and moved in both positive and negative directions between the two research intervals. Recovery indicators with the strongest associations with patterns of recovery suggested that exposure to natural hazards, livelihood, and displacement influenced recovery success [80]. We explored these associations systematically using NMDS to help "map" the relationships among the recovery indicators, demographics, and domains of adaptive capacity [82]. The inductive content analysis triangulated and enhanced the trends identified in the NMDS, illustrating how inequality shapes tangible and intangible recovery dynamics. Assembled together, the data from the NMDS and content analysis provide a holistic picture of short-term recovery patterns and variations in this context across multiple sites [81].

In this paper, we summarize the key findings from Spoon et al. [80–82] that are relevant to policymakers and practitioners. We also provide new quantitative and qualitative evidence from the NMDS, descriptive statistics, and content analysis of surveys, interviews, focus groups, and research return workshops. The new results include household perceptions of government relief, the national reconstruction program, and outside aid. We also add local conceptions of the government-approved earthquake-safe housing designs, building codes, and disaster preparedness. We conclude with guiding principles and recommendations for applied research and interventions in disaster contexts. We then share Nepal-specific recommendations developed using the guiding principles and recommendations.

2. Methodology

2.1. Site selection

We use a systems perspective to address interdependencies between human populations and the environment with dual feedbacks [87]. A systems view characterizes humans and the environment in constant flux, where humans act on the environment and it in turn acts on humans. In rural and Indigenous contexts, systems approaches help to illustrate critical interrelated social and environmental factors, including hazard exposure and place-based livelihoods with strong place attachment, common to many of the world's Indigenous peoples [13,35,48].

The household is our primary unit of analysis. Many of our impact measures are at the household level, a common focus of monitoring and evaluation where aid and government relief are coordinated. Nepali households are traditionally multigenerational with the eldest member of the family serving as the head of household. Recently, however, nuclear families are becoming more common [88]. In needs assessment reports and in the post disaster recovery framework for the distribution of relief and recovery materials and funds, the Nepal Government used the household unit. However, the Post Disaster Needs Assessment ([54]: 4) did not offer a clear definition for household, stating that in reconstruction "the total number of houses to be reconstructed has been calculated on the basis of number of households made homeless." Shneiderman et al. [73] argue that the Central Bureau of Statistics adopted the definition of household based on United Nations guidelines, defining a household as: "arrangements made by persons, individually or in groups, for providing themselves with food or other essentials for living." Thus, a household may consist of one or more persons who may be related or unrelated, and may have a common budget. Two factors must be present in this household definition: 1) dwelling under one roof, and 2) eating together. This definition allowed some households to claim their separate kitchen as a different household unit in practice, obtaining additional benefits. Further, NRA's Private Housing Reconstruction Grant Distribution Procedure, 2072 [58] stipulated that households needed to have legal certificates of land ownership predating the earthquakes to be eligible for the housing reconstruction grant. In some settlements, monasteries own the land that people live on, in an arrangement called the Guthi system [69], leading to some individuals not having legal certificates for land ownership (see [52] for a discussion of land tenure problems after the earthquakes). We therefore define a household as a physical residence under one roof where household members typically, although not exclusively, share economic resources and have kinship relationships. We defined households similarly to the Central Bureau of Statistics in order to identify households to include in our study; however, we diverged from this definition by also including households without legal certificates for land ownership, where the household had maintained

residence in their home for multiple generations. Thus, we treat the settlement and clusters of settlements as secondary foci.

To account for variation in the key parts of our conceptual approach, as well as links to the broader context, we selected two districts, Gorkha and Rasuwa, as study sites (Fig. 2). Both had severe earthquake impacts: Gorkha was the epicenter of the April 2015 earthquake with 412 killed, 1034 injured, and 55% of buildings destroyed [62], and Rasuwa was decimated by earthquake triggered landslides, with 430 deaths (the highest number of deaths in relation to the entire population), 753 injured, and 95% of buildings destroyed [63]. We selected two administrative areas of that time, called Village Development Committees (VDCs), to contrast in each district. In each district we selected an accessible VDC near the road with more international and national non-governmental organizations (NGOs) and market-based livelihoods and one far from the road with less NGOs and more reliance on agropastoralism. In Gorkha, we selected as representative case studies the more-accessible Aaru Chanaute and less-accessible

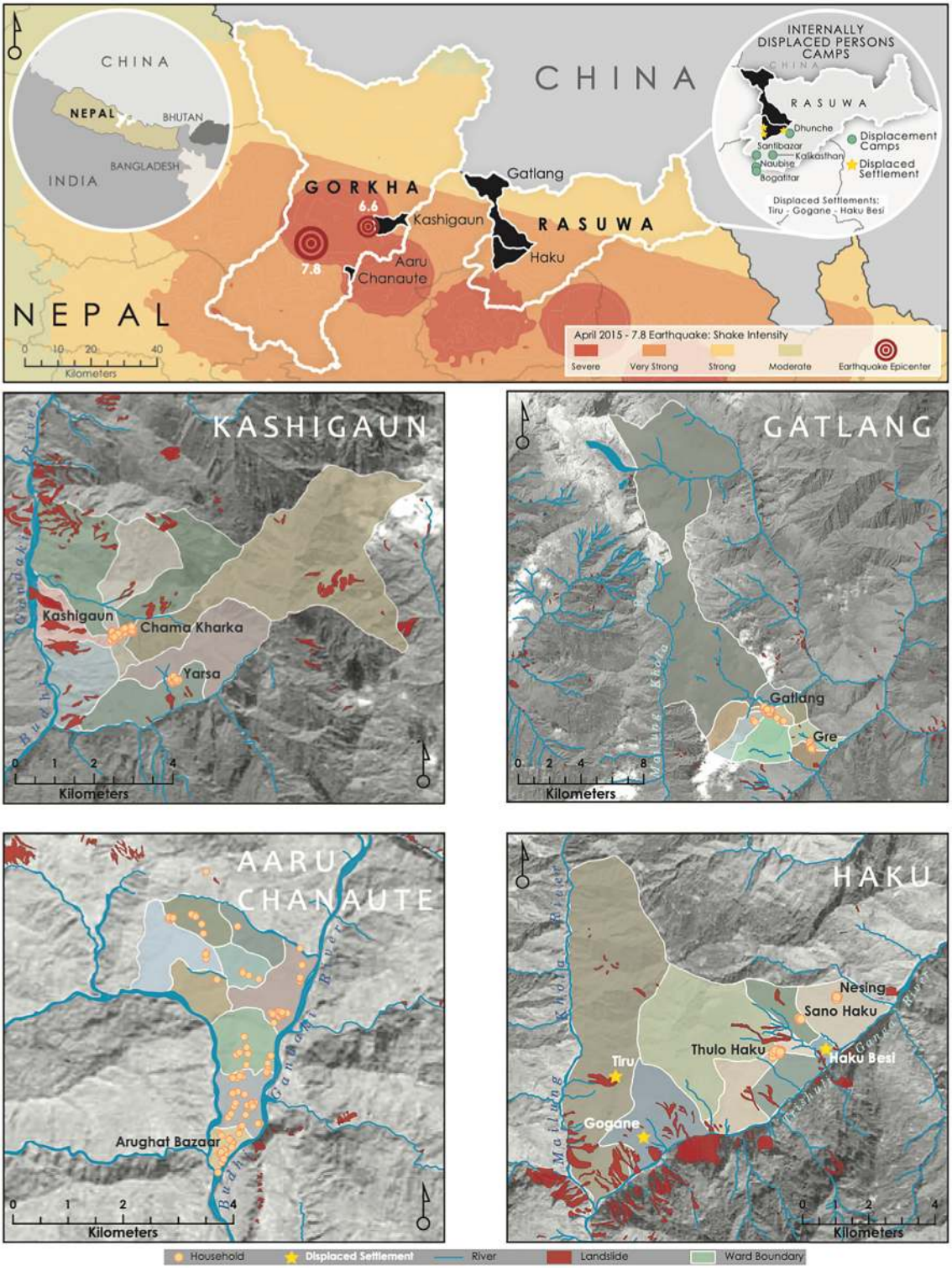

Fig. 2. Map of study area with shake intensity from the April 2015 earthquake with selected Village Development Committees and Internally Displaced Persons Camps (see upper right). Proximity of settlements to landslides also illustrated [38]. Map by Alicia Milligan. Adapted from Spoon et al. [80].

Kashigaun. Aaru Chanaute has the most heterogenous ethnic, linguistic, and religious population in our sample, with primarily Newar, Brahmin, and Chhetri ethnic groups that live with multiple generations in the same home using the same kitchen. Households all have road access and practice mostly *khet* (irrigated) agriculture, limited pastoralism and forest product collection, and have various small-scale businesses. Part of Aaru Chanaute is in the inundation zone of the planned Budi Gandaki dam. Kashigaun is primarily the Buddhist Gurung ethnic group with some Dalit households. Households are multigenerational, with some generations and/or nuclear families living in the same houses but using different kitchens. They practice *bari* (non-irrigated) agriculture, pastoralism, and forest product collection. Conversion to Christianity is increasing in Kashigaun, especially after the earthquakes (see Section 3.2). In Rasuwa, our sites included the more-accessible Gatlang and less-accessible Haku. Gatlang is mostly comprised of Tamang households all accessible by road that practice *bari* agriculture, pastoralism, forest product collection, and some emerging tourism enterprises. Gatlang residents practice more herding than farming. Haku is also primarily Tamang households with largely agropastoral livelihoods on the biophysical margins. Haku had catastrophic landslides that forced three entire settlements into displacement camps for 1.5–2.5 years or more. Haku also experienced an increase in conversion to Christianity after the earthquakes (see Section 3.2). Both Gatlang and Haku residents live primarily in multigenerational homes; however, similar to Kashigaun, there is typically a separate kitchen for different generations and/or nuclear families. Though Aaru Chanaute, Kashigaun, Gatlang, and Haku are currently part of rural municipalities under new administrative divisions, the administrative unit, VDC, is used for convenience. In the new rural municipalities, each VDC selected for this study is now one or two wards. The new municipalities are: Aarughat Rural Municipality (Gorkha District; includes Aaru Chanaute VDC as two wards), Dharche Rural Municipality (Gorkha District; includes Kashigaun VDC as one ward), Aamachodingmo Rural Municipality (Rasuwa District; includes Gatlang VDC as two wards and part of Haku VDC as two wards), and Uttar Gaya Rural Municipality (Rasuwa District; includes part of Haku VDC as one ward).

Once sites satisfied our criteria, we selected locations that appeared more "typical" of earthquake impacted VDCs and not as outliers with exceptionally devastating experiences not comparable to others. Outliers included sites where all households were relocated to internal displacement camps because of catastrophic earthquake and landslide-related impacts. For example, one VDC in Gorkha had the top of a mountain fall and subduct multiple settlements, completely destroying the built environment. We also omitted VDCs that did not have all of the houses and critical infrastructure damaged or destroyed, which we considered typical. Lastly, we omitted VDCs where an external aid institution offered unique, often charismatic interventions, such as rebuilding an entire village before the national reconstruction program began. To select the random sample households, we utilized local censuses collected by VDC staff after the earthquakes and provided to project staff during the pilot study; we then selected households using a random number generator. We utilized an inductive content analysis in Atlas.ti software to assess the pilot study data in order to guide the design and analysis of our quantitative survey.

2.2. Data collection

Our field team consisted of the Principal Investigator (Spoon), two Project Coordinators (Rai and Basnet), five local and Kathmandu-based Research Assistants, and four Translators. Our Project Coordinators already had some rapport in these communities through previous conservation and livelihood-related NGO projects. We met in Fall/Winter 2015 with local leaders and government representatives to help select study sites and obtain the census for drawing the random sample. We also carried out exploratory interviews and focus groups to select recovery indicators, demographics, and domains of adaptive capacity. The role of the information sharing meetings was to introduce the project to each site and share preliminary results. They were also opportunities to differentiate our research from government and aid-community projects. The first series of information sharing 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 follow-up 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. We generally had great interest from those in attendance at the meetings to learn about the project and its preliminary results. Importantly, we attempted to ensure even gender representation and that multiple generations from as many interested families as possible attended regardless of whether they were included in the random sample.

For all surveys, interviews and focus groups, we received prior and informed consent from each participant [11]. The research team gave participants a handout in Nepali explaining the study and its potential risks and intended benefits, with contact information for the research team throughout the study period (see Table 1 for methods summary). The household survey tracked recovery indicators, demographics, and five domains of adaptive capacity. At phase 1, we enrolled 400 randomly selected households from the four communities using the local census provided by the VDC. We selected 100 households from each VDC. At phase 2, we were able to re- contact 397 of the original 400 households. We strove to locate

Table 1
Data collection methods, data types, research periods, sample sizes, data analysis methods, and topics (variables). From Spoon et al. [80].

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

the specific respondent who participated in the first phase, but designed the survey to be taken by any household member over the age of 18. The sample sizes for each VDC from each phase were as follows: Aaru Chanaute (phase 1, n = 100; phase 2, n = 98), Kashigaun (phase 1, n = 100; phase 2, n = 100), Gatlang (phase 1, n = 100; phase 2, n = 99), and Haku (phase 1, n = 100; phase 2, n = 100). The survey included 34 recovery indicators and 175 variables divided across demographics and the five domains of adaptive capacity. Each domain contained variables identified by researchers and community members as important elements of adaptive capacity. By utilizing a fairly large random sample, our results should represent much of the variation within and support inferences about the broader population in each VDC (see [80,82] for further discussion on the quantitative methods).

In total, we conducted 797 surveys between phase 1 and phase 2, 40 in-depth interviews at phase 1, eight focus groups at phase 2, and eight research return workshops at 2.5 years. In-depth interviews and focus groups used semi-structured interviews to explore the tangible and intangible dynamics of the recovery at greater depth. We enrolled key consultants from the household sample for in depth-interviews from each VDC (10 per VDC) through quota sampling of age and gender. The focus groups used reputational sampling, including key consultants from the household sample as well as representatives from government, local institutions, and aid agencies. We did not mix household members with non-household actors in the focus groups so that we could compare responses from different perspectives without them influencing one another. We carried out interviews in Nepali, Gurung, and Tamang. They were recorded, translated, and fully transcribed for analysis. Qualitative interviews helped to triangulate quantitative results as well as add new insights only observable through qualitative methods (see [81] for further discussion on linked quantitative and qualitative methods).

The eight 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. We invited all of the newly elected government officials from the four VDCs to attend the local workshops. These workshops thus served as a conduit for us to share information with the local government. On the national and international scales, the workshops brought into dialogue local government officials, aid representatives, academics, and the media to discuss project results and next steps.

2.3. Data analysis

Our team examined the quantitative household survey data in the software program PC-ORD, which provides extensive tools for non-metric multi-dimensional scaling ordination [51]. NMDS is an exploratory technique allowing us to identify households that exhibit similar patterns of recovery and to link these patterns to specific hazard exposures and forms of adaptive capacity. Unlike other statistical analyses, NMDS requires minimal assumptions about the relationships among variables (linear or non-linear) and can be used with multiple variable types (numeric, dichotomous, ordinal) [50]. By incorporating information from multiple variables, NMDS is useful in analyzing different aspects of complex, multidimensional phenomenon like disaster recovery. NMDS provides measures for the direction and strength of associations among the recovery indicators, demographics, and five domains of adaptive capacity (see [80,82] for further discussion on the NMDS analysis). Specifically, we use the coefficient of determination (R^2), which measures the amount of variance in overall patterns in recovery associated with a single recovery indicator, to identify which indicators drive patterns of recovery. We use $R^2 > 0.050$ as an indicator of a substantial association and discuss less substantial associations with an $R^2 < 0.050$ where appropriate.

We used Atlas.ti for our content analysis to organize into groups and codes qualitative responses from 797 surveys and transcripts from 60 h of in-depth interviews, 12 h of focus groups, and 10 h of research return workshops. To analyze the qualitative data, we employed grounded theory. Grounded theory is an inductive content analysis technique, viewing the world as complex with each situation affected by multiple factors [11,18]. To identify emergent themes, we began with open coding [16,22], then used the themes to designate code groups, each with multiple sub-codes. We then identified specific nuances and subcategories using the code groups and sub-codes [91]. The analytic team maintained consistent communication to discuss any issues and maintain transparency throughout the process. Examples of our larger code groups include: social and spatial inequality, hazard exposure, place-based livelihood disruption, displacement, mutual aid, government rebuilding program, outside aid, housing reconstruction, place attachment, uncertainty towards the future, and mental well-being (see [81] for further discussion on inductive content analysis as well as code groups and their definitions).

3. Results and discussion

We now discuss our general quantitative and qualitative results across nine cross-cutting topics useful to policymakers and practitioners, illustrating aspects of adaptive capacity. We discuss the results from topics 1–5 and parts of 8–9 in other publications [80–82], summarizing them here. We introduce new information in Tables 2 and 3, topics 6–7, as well as parts of 2–3 and 8–9. Most of our discussion treats the recovery as a whole, although we do share some results specific to each VDC. We provide select linear associations among recovery indicators, demographic variables, and domains of adaptive capacity in Table 2 and key descriptive statistics from the household survey that help to contextualize the sample in Table 3. We describe the full quantitative and qualitative results in SM 1.

3.1. Recovery indicators

We consider recovery as having multiple dimensions, consistent with results of similar studies on short-term household recovery from the Nepal earthquakes [5]. Fig. 3 is a scatterplot that shows patterns among households in relation to two dimensions of recovery, identified using NMDS with 34 indicators of recovery. Each household's location on the x-y plane is determined by the similarity of their responses to the 34 indicators. By comparing one household's location with another, we can compare patterns of recovery across households. By examining which recovery indicators had the strongest associations and where they exist in the x-y plane (represented by these lines on Fig. 3), we can see what each axis represents. In this case, the x-axis illustrated positive or negative recovery indicators, such as presence or absence and severity of agropastoral impacts. The y-axis showed the degree of displacement from primary house and place-based livelihoods as well as to displacement camps (see [80,82]). In Fig. 4, each household has two points representing their responses at each phase. By comparing a household's location on the figure at each phase, we can see changes in recovery across time. To highlight patterns in recovery across VDCs, we added centroids in Figs. 3 and 4 that represent the average position of households in each VDC.

The results show that each VDC had its own starting place in the recovery and was either static or travelling in a positive or negative direction between the two phases (Fig. 4). Households from Aaru Chanaute (VDC 1) had the best starting point in the recovery of all locations (see Section 3.2); however, they did not change much between the phases. This was largely due to the planned Budi Gandaki dam (see Sections 3.4. and 3.5). Although starting in a compromised position, Kashigaun (VDC 2) was heading in a positive direction in phase 2. We attribute this in part to their operationalizing of Indigenous knowledge through work exchange (see Section 3.8). Gatlang (VDC 3) was heading in a negative direction and Haku (VDC 4) remained relatively stagnant, with a large proportion in displacement camps (see Section 3.5). Gatlang's challenges may be due to dependence on outside aid and the road (see Section 3.6). All settlements took steps to return to their place-based agropastoral livelihoods in phase 2. The 34 recovery indicators thus serve as the base ordination to view associations with demographics and the five domains of adaptive capacity that follow [80,82]. These results are comparable to two nearby districts where early social, economic, and psychological recovery were rare [5].

Table 2
Select linear associations by demographic or domain of adaptive capacity between NMDS dimensions of recovery (Axis 1, Axis 2) and each variable. Linear associations are represented by a correlation coefficient (r) and R square (R^2) for each axis, with bold indicating $R^2 > 0.050$. Full linear and non-linear results for all 209 variables in the study available in Spoon et al. [82].

Select variables by demographic or domain of adaptive capacity Questions are Yes/No unless otherwise noted	Axis 1		Axis 2	
	r	R^2	r	R^2
Demographics				
Aaru Chanaute (VDC 1)	**0.400**	**0.160**	0.037	0.001
Kashigaun (VDC 2)	−0.120	0.014	**0.228**	**0.052**
Gatlang (VDC 3)	−0.009	0.000	0.087	0.008
Haku (VDC 4)	**−0.267**	**0.071**	**−0.351**	**0.123**
Internal displaced persons camp (phase 1)	**−0.242**	**0.059**	**−0.418**	**0.174**
Internal displaced persons camp (phase 2)	**−0.245**	**0.060**	**−0.413**	**0.171**
Accessibility	0.096	0.009	0.193	0.037
Buddhist	**−0.279**	**0.078**	−0.098	0.010
Hindu	**0.296**	**0.088**	0.072	0.005
Tamang	**−0.229**	**0.052**	**−0.211**	**0.044**
Newar	**0.234**	**0.055**	0.009	0.000
Brahmin/Chhetri	0.190	0.036	0.108	0.012
Gurung	−0.094	0.009	0.120	0.014
Ghale	−0.021	0.000	0.114	0.013
Home owners (phase 1)	0.029	0.001	0.042	0.002
Home owners (phase 2)	0.171	0.029	**0.421**	**0.177**
Microcredit loans	0.163	0.027	0.084	0.007
Literate	0.144	0.021	0.065	0.004
Household size-log (larger)	−0.072	0.005	0.137	0.019
Hazard exposure				
Household has significant impacted access to grazing areas (phase 1)	**−0.497**	**0.247**	−0.015	0.000
Household has significant impacted access to grazing areas (phase 2)	**−0.328**	**0.108**	0.145	0.021
Household has significant impacted access to firewood collection (phase 2)	**−0.289**	**0.084**	0.072	0.005
Household has significant impacted access to forest product harvest (phase 1)	**−0.249**	**0.062**	−0.089	0.008
Household has significant impacted access to forest product harvest (phase 2)	−0.150	0.023	0.134	0.018
Household has significant impacted access to agricultural fields (phase 1)	−0.220	0.048	−0.207	0.043
Household has significant impacted access to agricultural fields (phase 2)	−0.197	0.039	0.019	0.000
Household has threats from landslides (phase 1)	−0.186	0.035	0.036	0.001
Household has threats from landslides (phase 2)	−0.211	0.044	−0.053	0.003
Livelihood diversity				
Household total bovine (yak, cow, yak/cow hybrids)-log (phase 1)	**−0.469**	**0.220**	0.039	0.001
Household total bovines (yak, cow, yak/cow hybrids)-log (phase 2)	**−0.238**	**0.056**	**0.267**	**0.071**
Household total sheep, goats, and pigs-log (phase 1)	**−0.458**	**0.210**	−0.074	0.005
Household total sheep, goats, and pigs-log (phase 2)	−0.214	0.046	0.184	0.034
Household total chickens-log (phase 1)	**−0.289**	**0.084**	−0.219	0.048
Household total chickens-log (phase 2)	0.037	0.001	0.189	0.036
Household has *bari* (non-irrigated) fields (phase 1)	**−0.353**	**0.125**	0.037	0.001
Household has *bari* (non-irrigated) fields (phase 2)	−0.206	0.042	0.080	0.006
Household has *khet* (irrigated) fields (phase 1)	0.094	0.009	−0.008	0.000
Households has *khet* (irrigated) fields (phase 2)	0.211	0.044	0.059	0.003
Household practices work exchange in agriculture (phase 1)	**−0.254**	**0.065**	−0.039	0.002
Household practices work exchange in agriculture (phase 2)	−0.074	0.005	**0.229**	**0.053**
Household primary livelihood is a business (phase 1)	0.197	0.039	−0.013	0.000
Household primary livelihood is a business (phase 2)	0.149	0.022	−0.055	0.003
Household does not practice herding (phase 1)	**0.394**	**0.155**	−0.076	0.006
Household does not practice herding (phase 2)	0.130	0.017	**−0.326**	**0.106**
Social memory				
Household used traditional architectural knowledge in recovery (phase 1)	0.097	0.009	0.187	0.035
Household used traditional architectural knowledge in recovery (phase 2)	−0.100	0.010	0.139	0.019

3.2. Demographics and accessibility

The NMDS analysis found that the strongest associations with negative recovery outcomes were for those in Haku and internal displacement camps, as well as Buddhists and Tamang households (Table 2). These findings illustrate how the earthquakes and cascading events amplified existing power dynamics where social inequality and spatial dynamics interrelate–a process common in disaster contexts [24,31]. Many of Nepal's Indigenous and rural populations were characterized by the state institutionalized Hindu hierarchy using the *Muluki Ain*, which categorizes several non-Hindu Indigenous and rural groups as alcohol drinkers, enslavable, and untouchable [29,92]. In the 19th and 20th centuries, the feudal-like Nepal state excluded these groups from regional and national domains of influence and exploited their land and labor [28,36,83]. Indeed, the root causes of vulnerability prior to the earthquakes were caste, ethnic group, and gender [37]. This social inequality resulted in spatial dynamics, where these populations settled and adapted to extremely challenging biophysical conditions on steep Himalayan slopes. Connections between social inequality and spatial dynamics (e.g., [25, 70]) and their amplification during disasters have been documented in Nepal (e.g., [32]) and elsewhere (e.g., [1,7,31]). These geographies thus create high hazard vulnerability to earthquakes and landslides, which the 2015 earthquake and aftershocks brought to the surface.

The strongest associations with more positive recovery outcomes, indicating some adaptive capacity, included households from Aaru Chanaute, Hindus, Newar, Brahmin, and Chettri ethnic groups, and households that took microcredit loans (Table 2). These loans were accessible primarily to households in Aaru Chanaute because of their proximity to banking

Table 3
Select responses for the entire sample and selected Village Development Committees from household surveys at phase 1 (n = 400) and phase 2 (n = 397).[a, b]

Variables	Total sample phase 1	Total sample phase 2	Aaru Chanaute phase 1	Aaru Chanaute phase 2	Kashigaun phase 1	Kashigaun phase 2	Gatlang phase 1	Gatlang phase 2	Haku phase 1	Haku phase 2
Household had a damaged or destroyed primary house	99%	–	99%	–	100%	–	100%	–	98%	–
Household able to return to primary home from temporary shelter	1%	44%	4%	48%	0%	92%	0%	8%	0%	27%
Settlement had damaged or destroyed infrastructure (micro-hydropower plants, schools, hospitals, health posts, monasteries, temples, and communal buildings)	100%	38%	100%	42%	100%	63%	100%	38%	100%	25%
Households relocated to internal displacement camps (64/400 total households)	16%	16%	0%	0%	0%	0%	0%	0%	64%	63%
Household is having issues trying to rebuild house	55%	92%	52%	81%	82%	94%	51%	99%	37%	96%
Household used personal funds to rebuild house	55%	42%	78%	41%	73%	74%	43%	7%	44%	18%
Household took a loan to rebuild house	–	16%	–	12%	–	17%	–	15%	–	18%
Household received aid from the government during the recovery[a]	95%	19%	92%	3%	91%	68%	100%	0%	99%	6%
Household received aid from non-governmental organizations during recovery[b]	89%	4%	89%	0%	86%	8%	89%	2%	91%	5%
Settlement had landslide threats caused by earthquakes	55%	88%	38%	64%	79%	100%	44%	90%	59%	97%
Household herding ability impacted by earthquakes	56%	67%	61%	39%	68%	74%	66%	82%	60%	72%
Household farming ability impacted by earthquakes	–	75%	–	48%	–	78%	–	79%	–	93%
Household *bari* (non-irrigated field) impacted by earthquakes	53%	71%	27%	32%	64%	82%	43%	76%	78%	94%
Household members participate in credit and savings groups	9%	35%	25%	63%	0%	6%	7%	40%	6%	30%
Household was pessimistic about the recovery	79%	73%	68%	80%	90%	65%	81%	62%	77%	87%
Household sought information about disaster preparedness	3%	18%	10%	8%	1%	24%	1%	27%	0%	13%
Household received information about disaster preparedness	1%	23%	4%	22%	0%	41%	1%	22%	0%	7%
Community opinion is perceived to be taken into account in recovery	40%	66%	53%	45%	67%	82%	20%	40%	21%	58%
Community using new ideas from government in recovery	1%	12%	4%	11%	1%	29%	0%	8%	0%	1%
Community using new ideas from INGOs/NGOs in recovery	1%	17%	4%	19%	0%	30%	0%	16%	0%	3%

[a] Aid received up to phase 1 from the government included two types of cash grants to earthquake-affected households: (1) emergency grants for funeral costs (NPR 30,000 or US $300) and the construction of temporary shelters (NPR 15,000 or $150); and (2) winter cash grants (NPR 10,000 or USD $100) to help people make adjustments to their temporary shelters and buy clothes and blankets. Aid received from the government in phase 2 included the first tranche payment in July 2016 as part of a government reconstruction grant. Priority was given to "red-card" holders with "fully damaged" houses. Later, an NRA-led Central Bureau of Statistics survey reassessed damaged houses to identify beneficiaries for private housing reconstruction grants of NPR. 300,000 (USD $3000) and retrofitting grants of NPR 100,000 (USD $1000) [73].

[b] Aid received in phase 1 from outside aid organizations (international and national non-governmental organizations or NGOs) and international agencies included quick relief materials, temporary shelters materials, maintenance and reconstruction of drinking water, temporary toilets, etc. Aid received in phase 2 included the reconstruction of public infrastructure, health posts, school buildings, drinking water taps, and community buildings as well as trail maintenance.

institutions in the market area of Arughat at the road head (Fig. 2). Indebtedness through loans after the earthquake was common in highly impacted areas [47]. Households with higher literacy also weakly correlated with positive recovery outcomes (Table 2). Factors leading to negative impacts included severity of landslides and livestock survival, health, behavior, and productivity. Households that practiced work exchange to rebuild their homes and work in agricultural fields (e.g., Gurung ethnic group), home owners, and larger households, were able to return to their homes and adapt their agropastoral practices most rapidly in phase 2, illustrating adaptive capacity that helped them restart livelihood activities (Table 2). We also observed increased conversions to Christianity, especially for younger generations of Tamang peoples in Haku. For example, at phase 2, 17.0% of Haku residents were Christian for a mean of 1.3 years with an even shorter duration in the camps at 9.1 months. The content analysis found that households perceived problems of accountability and transparency in government and NGO aid distribution. Local governments felt that they had a lack of understanding of national government reconstruction policies and processes. Tamang, Dalit, and other traditionally lower income ethnic groups shared that they lacked a voice in government actions due to perceived knowledge gaps [80–82].

Regarding accessibility, in our sample 46% of households were considered more accessible near roads, trails, and helipads (54% less accessible). In the NMDS analysis, accessible households were strongly associated with less displacement, indicating they had an easier time adapting and restarting their agropastoral practices (Table 2). Households in inaccessible settlements mostly took reconstruction loans from family and friends with low interest (i.e., 73% of total loans from family and friends); households in accessible settlements mostly took bank and microcredit loans; some felt that these loans should be forgiven by the government. As discussed previously, microcredit and other bank loans were largely unavailable for inaccessible settlements, thus motivating loans from family and friends. Tamang, Gurung, and Dalit peoples were located primarily on the biophysical margins and lacking access to credit, illustrating how certain Indigenous and low caste populations do not have the same economic opportunities as more accessible and privileged groups, such as Newar and Brahmin/Chhteri ethnic groups. Those with access to bank and microcredit loans had better recovery outcomes, which signals some adaptive capacity. The content analysis illustrated that inaccessible households and settlements lacked access to relief and recovery materials and programs. Road conditions affected access to relief and recovery materials and programs, while distance from the road head influenced reconstruction expenses, especially for sand, cement, and iron rods.

3.3. Hazard exposure

Households with the most hazard exposure were also from the poorest and most marginal ethnic groups and religions (Tamang, Gurung, Dalit, and Buddhists) (see Section 3.2). The marginalization of these populations to the geographical margins has historically impacted their opportunities to participate in local, regional, and national economies beyond subsistence agropastoralism in perilous locations, such as those with landslide vulnerability [29]. Households with impeded access to grazing areas, firewood collection, forest product harvest, *bari* fields, and threats from landslides had the strongest associations with negative recovery outcomes across both phases in the NMDS analysis (Table 2). Research near the earthquake epicenter in proximity to two of our study sites with similar geographies found a comparable result with the earthquakes and cascading effects catastrophically impacting impoverished communities with high geologic hazard vulnerability risk prior to the events [32]. The content analysis added that households perceived danger in returning to pastures, fields, and forests due to extreme earthquake impacts, such as inundation by landslides. Further, households that remained in temporary shelters and camps were being exposed to new hazards, such as severe windstorms, while in their vulnerable states [80–82].

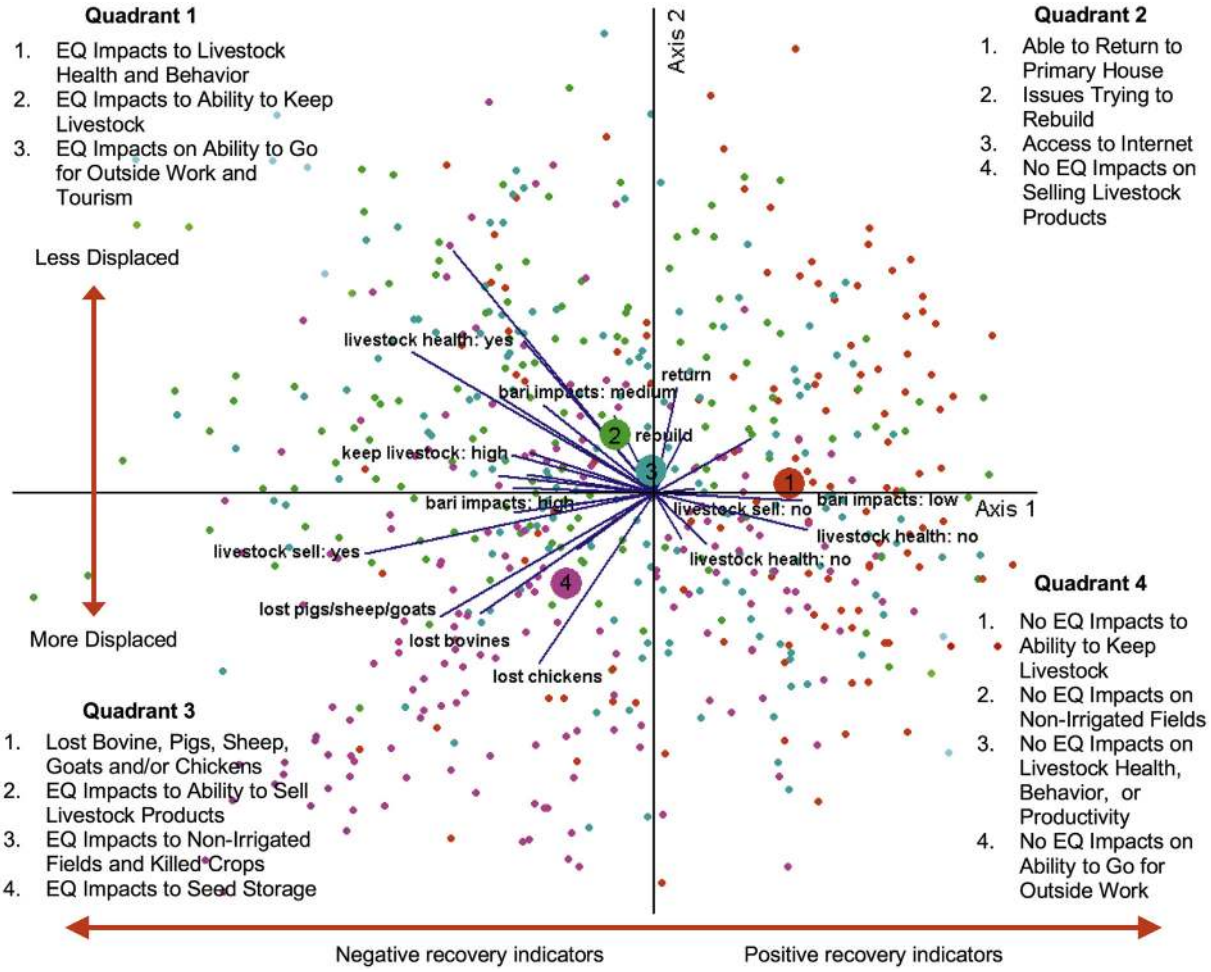

Fig. 3. NMDS scatterplot of recovery indicators for entire sample (N = 397 households) across both time periods with centroid (average positions) of households in each VDC. Lines represent indicators that are most strongly associated with the two dimensions of recovery. Notes added to each quadrant highlight variables that characterize these parts of the recovery space (VDC 1 = Aaru Chanaute; VDC 2 = Kashigaun; VDC 3 = Gatlang; VDC 4 = Haku). From Spoon et al. [80].

3.4. Livelihood

Research on short-term livelihood recovery within the first two years of the earthquakes illustrates the interrelation of the household with livelihood. Household assets (e.g., cultural, social, economic, physical, human, and natural) and capital generating strategies played a critical role in recovery [17]. The NMDS analysis indicated that households whose livelihoods focus on livestock (bovines, sheep, goats, pigs, and chickens) and *bari* agriculture had the strongest associations with negative recovery outcomes (Table 2). Households with *khet* agriculture, households that did not practice agropastoralism, and households that participated instead in various businesses and tourism ventures had strong associations with more positive recovery outcomes, suggesting a degree of adaptive capacity (Table 2). The content analysis added that impacts to fields, farms, and forests included cracks, fissures, and landslide cover, and that livestock also had health and productivity issues. Households lost or changed their livelihood because of the expense in restarting after mitigating earthquake impacts. Households with a single livelihood strategy with catastrophic impacts, such as herding in Gatlang, struggled compared to households with more diverse livelihood options containing more adaptive capacity (Table 2 and Fig. 4). Households generally lacked access to capital to start or continue businesses and felt that the earthquakes reversed development progress and created a lot of debt, consistent with other studies [47]. Herders were keeping their livestock in hot, corrugated and galvanized iron sheds, causing them to lose weight. They were also purchasing more low-cost chickens at phase 1 to replace the cows, goats, and sheep that they lost. In Aaru Chanaute, households that relied on breaking stones and gravel mining in the Budi Gandaki dam inundation zone were concerned about losing their livelihoods after relocating from the area.

3.5. Displacement

Displacement from Indigenous homelands can have profound impacts on recovery, as Nepali identity is intimately connected to place [74] and affects the poor the most [2]. After the earthquakes, some households with catastrophic impacts sought refuge in nearby public and private open areas. As time progressed, households that could not go back to their settlements because of earthquake impacts generally paid rent to private landowners and waited for the government resettlement program to begin. In the camps, the Nepal government and different international and national NGOs provided basic relief materials, including food and drinking water, as well as temporary shelters and schools. These entities did not govern the camp; instead, residents nominated or elected their own leaders. The VDC and district government then provided assistance for any issues not resolvable by the camp leadership. Displacement from homes, settlements, and agropastoral ways of life correlated highly with negative recovery outcomes (Table 2) and the speed of recovery (see Section 3.1) in the NMDS analysis. There was also a lack of flow of new ideas into the camps across both phases (Table 3). Displacement to camps after disasters often impedes recovery and compounds impacts [71]. Research on displacement also

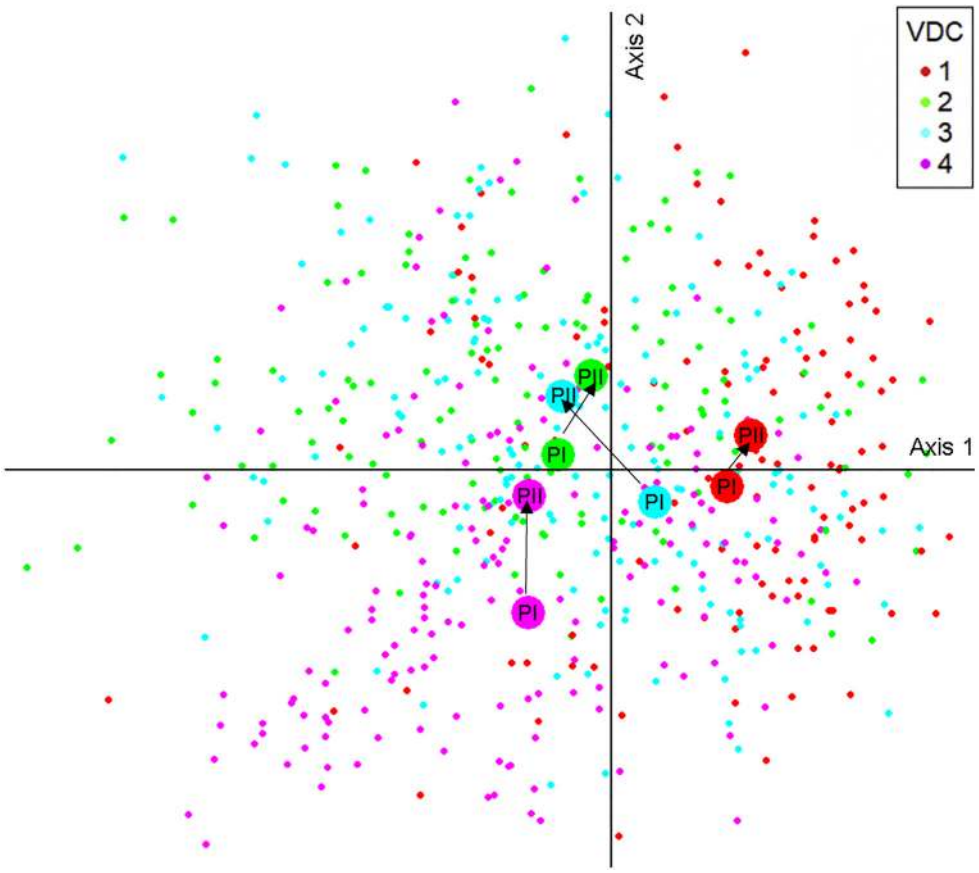

Fig. 4. NMDS scatterplot of recovery indicators for entire sample (N = 397 households) at phase 1 and phase 2 with centroid (average positions) of households in each VDC across both time periods (VDC 1 = Aaru Chanaute; VDC 2 = Kashigaun; VDC 3 = Gatlang; VDC 4 = Haku). From Spoon et al. [81].

illustrates that it impacts livelihoods in general outside of disaster contexts [68]. The content analysis indicated that households displaced to camps felt they were living as outsiders in "other's places" and were often forced to pay rent. Households living in camps were having trouble adjusting to agropastoralism at lower altitudes and some decided to use pesticides to protect their plants against insect threats they were not accustomed to at higher elevations, where they practice organic farming. Households unable to farm on their own lands because they were inaccessible, damaged, or destroyed were engaged in poorly compensated wage labor outside the area. Issues encountered in the camps included difficulties in properly raising children and procuring healthy foods. There was also a lack of privacy. Aaru Chanaute households being resettled from the camps and the future Budi Gandaki dam inundation zone wanted to be relocated together, to continue collectively practicing their culture. They also desired close proximity to former settlements to continue practicing their place-based ancestral traditions [80–82].

3.6. Government relief/reconstruction, outside aid, and institutional participation

The NMDS analysis (Table 2, Gatlang; Fig. 4) and descriptive statistics (Table 3) illustrated that settlements with high representation of outside aid prior to and during recovery did not necessarily have associations with the best outcomes over the short-term. We argue this may result from dependency on outside aid and resources transported by the road. It may also be influenced by the pace of initiating a national rebuilding program, which can be slow [46]. Expectations of resources from the government and outside aid agencies in tandem with road access may have influenced recovery outcomes, as observed at a nearby site [33]. In the case of Gatlang, only 8% of households had returned to their primary house from temporary shelters by 1.5 years. Instead of rebuilding on their own, these households appeared to wait for expensive resources from the road, such as concrete, sand, and iron rods, as well as outside aid, which was prolific in the area immediately after the earthquakes and then withdrew. Conversely, in Kashigaun, 92% of households had returned to their homes by 1.5 years; however, few, if any, rebuilt to code (Table 3). Waiting for help as victims instead of rebuilding as survivors may, thus, trap populations in a vulnerable state. In Gatlang, this vulnerability became evident during an erratic windstorm that severely impacted temporary shelters while households waited to rebuild [80,82]. Some populations may use their visibility for their own advantages [65]. Communities waiting for aid rather than helping themselves has been documented elsewhere [55].

Outside aid interventions can prevent communities from developing relationships and cohesiveness [66], disrupt social networks [15], create or amplify social inequalities [4], and impede achieving more general sustainable livelihood goals [14]. Some see the combination of natural hazards and development as lessening social capital and eroding social networks [90]. According to Kotani et al. [46], returning from temporary shelters to primary homes did not necessarily create a robust recovery, as living conditions improved minimally after the household return. This reinforces the need for government and/or outside aid interventions. However, these interventions need to be informed about local culture, power dynamics, history, place, livelihood, and institutions.

The origin of household assistance in the recovery did not correlate with recovery outcomes in the NMDS analysis (phases 1 & 2 combined: R^2 = 0.001–0.016). Households remaining in their villages received more help from family and friends across both phases; whereas, households in camps received help from the aid community in phase 1 and lacked any significant assistance in phase 2. Most households received the initial relief

funds from the government in phase 1 (95%). Households that remained in their settlements used new ideas from the government and aid community in the recovery; however, the camps lacked a flow of new ideas. Overall, outside aid decreased significantly from phase 1 to phase 2. Assistance from the government decreased from 95% to 19% between phases 1 and 2; NGO aid lessened from 89% to 4% (Table 3). Outside aid from international and national NGOs and international agencies included small cash grants, food, basic relief items (e.g., blankets and tarps), and building materials. Roughly half of the households felt that their opinion was being considered in the recovery across both phases, with 40% feeling this way in phase 1 and 66% in phase 2 (Table 3).

The content analysis added that households had strong hopes for the success of the government reconstruction program. Households considered the program confusing, with funds difficult to access and biased towards more accessible settlements with market connections. Fear arose that households misused the first payment and needed to repay it. Indeed, Kotani et al. [46] observed in one location that the slow pace of receiving rebuilding funds caused certain households to remain stagnant in their unrepaired homes without improvement, reinforcing the importance of early financial aid to more effectively navigate the crisis. Some households needed to spend the first tranche on the demolition of their old house and were worried that the next tranche would not be enough, especially in inaccessible settlements. They also feared that using the funds for purposes other than home construction would disqualify them from the program. Households suggested that rebuilding funds expand to include landslide mitigation, trail reconstruction, and the transport of building materials. They also stated that if the government cannot cover these expenses, outside aid organizations should. Government-contracted engineers conducted insufficient assessments of earthquake damages. The long delay in starting government rebuilding programs caused hardships, forcing some households to rebuild their homes on their own with loans in order to restart their lives more quickly. Households also felt that government instability caused the reconstruction program to be unstable.

Research illustrates that the governments and the aid industry can overlook local institutions in disaster recovery contexts using a “one size fits all” approach [9,66]. In our study, households considered most outside aid as temporary and unsustainable, viewing some relief items as irrelevant. According to a participant from Aaru Chanaute, the NGOs “provide a hungry person a comb of banana instead of one mana (half kg) of the roasted soybean and corn that the person actually needs.” Money was considered more useful than relief materials, such as blankets and clothes, which can be coopted by “clever people with the right connections” leaving others without any. They also felt some outside aid programs engage communities with preplanned programs developed without local input, thus duplicating one another. After these initiatives, the programs did scant follow-up and tracking. The perceived lack of transparency and accountability was especially pertinent with NGOs that arrived in Nepal after the earthquakes. Projects funded by outside aid appeared more interested in accessible areas and community buildings rather than individual homes, especially in Gatlang and Aaru Chanaute. All external aid projects need to coordinate with the government; however, external assistance is not evenly distributed across Nepal's earthquake-impacted populations, with accessible areas receiving more assistance. This may be a result of accessible areas getting more media attention, having more efficient transportation, and being less expensive. These preferences may thus illustrate the interests of the donors and foreign NGO actors more than on-the-ground needs of the affected populations—this being common in disaster recovery contexts [41,93]. Importantly, households preferred skills-based training related to improving livelihoods, such as earthquake-safe carpentry and masonry, rather than receipt of relief materials. For instance, in Gatlang houses rebuilt to code after the earthquakes needed to be constructed by skilled carpenters and masons, which were outsourced due to a lack of local skilled labor. Lastly, representatives from the aid community suggested that local governments coordinate at the District level to address problems faced by inaccessible households.

3.7. Housing designs, building codes, and disaster preparedness

The NMDS analysis (Table 2) and descriptive statistics (Table 3) showed that households utilized some Indigenous and local knowledge of traditional architecture to return to their primary houses faster in both phases; however, these repaired and rebuilt homes did not meet the new building codes. Households had issues rebuilding their homes, which increased from 55% in phase 1 to 92% in phase 2 (Table 3). The content analysis found that households considered rebuilding funds insufficient to meet building codes, causing them to construct extremely small houses that meet the new codes. The NPR 300,000 (US $3000) allotted to each household in a series of payments was not considered adequate to fund house rebuilding, especially at higher-elevation less-accessible settlements where inflation is significant due to transport charges. Confusion abounded about how to integrate local innovations into the new building codes, such as decreasing the height of the house for safety in future earthquakes. Some households felt that constructing homes that satisfy the new building codes was more problematic than the earthquake itself because of the cost of building materials in inaccessible locations and the difficulty in blending traditional architecture and local knowledge with new housing designs to meet building codes. Culture and architecture are intimately connected in settlements at biophysical extremes, especially for Indigenous and rural populations in our study area (e.g., [30,37]). The traditional built environment has structures suitable to climate, local economy and livelihood, and communal activities. The spiritual world of the population is also situated in this physical space. The new housing designs were created external to the specific settlements and imported through the rebuilding program. The rebuilding program generally focused first on housing, which in turn did not account for other cultural factors, such as livelihood or place attachment, which are critical to Indigenous and rural everyday life.

Participants shared that cheaper traditional architecture made from local materials, such as wood and rocks, was not considered earthquake safe compared to structures built with iron rods, sand, and cement. They added that housing designs did not reflect their traditional architectural style and ways of life and that they appeared to lack local input, such as where to keep livestock. The relationship between culture and architecture was considered vital, expressing the identity of each settlement. Generic housing designs appeared to obscure these relationships. Furthermore, some local residents considered new housing designs unsuitable for the climate at higher elevations. There was interest in learning how to build houses in traditional styles that are earthquake safe. Yet some living in settlements with steep slopes, an abundance of earthquake-triggered landslides, and debris from damaged and destroyed houses, were having difficulty identifying rebuilding locations. Certain households made significant financial investment into their temporary shelters, which affected how much they could invest in new permanent houses. Many households were in debt from rebuilding expenses. The majority of the people desired earthquake-resistant homes but lacked disaster preparedness training and awareness. There was an increase in household information sharing about disaster preparedness, from 1% in phase 1 to 23% in phase 2 (Table 3). There was also a perception that rebuilt homes should be one story, to lessen any damage in the next earthquake.

In Gatlang, social class and housing designs appeared to interrelate. Those with higher socio-economic status rebuilt with concrete and those with lower status rebuilt with wood. This difference changed the aesthetic of the homogenous “black village” that existed prior to the earthquakes where each house had similar construction. Gatlang is a key destination on a cultural heritage themed trekking route. The change may in turn impact tourist desires to see the homogenous “traditional” looking village. Participants in the local research return workshop explained that Gatlang's culture should be protected by letting residents build traditional houses using traditional skills rather than following the new building codes that deviate from the local designs, inhibiting their ability to build their traditional houses. The new designs are indeed causing the aesthetic of the village to change, which may have financial implications on the local tourism industry.

3.8. Cooperation, work exchange, and mental well-being

Certain households in Kashigaun expedited their return to their primary homes through the use of *parma* or work exchange by co-rebuilding (Table 2), evident in the NMDS analysis (see Section 3.5). Some Gurung and Tamang households also utilized *parma* in agriculture to return to their agropastoral practice faster in phase 2, illustrating strong associations with less displacement (Table 2). Many households in Gatlang used this strategy for agropastoralism but not for rebuilding their homes. Indeed, various studies demonstrate social capital and social networks are important components of disaster recovery [3,27,86], including studies in Nepal following both the 1934 [12] and 2015 Nepal earthquakes [23,34,64]. The content analysis also illustrated the adaptive capacity of the Gurung, and to a lesser extent, Newar ethnic groups of varying socio-economic statuses using cooperation and work exchange as unskilled laborers to rebuild homes, pool funds for communal betterment, and to "live more in harmony" in the short-term during the recovery. According to one Kashigaun participant "now holding hands on hands and shoulders on shoulders, we should help each other by practicing *parma*." Households also cooperated to help the most marginal, such as the elderly and children. In Kashigaun work exchange was utilized as a safety net in a time of need, especially for the poorest and most vulnerable.

Disasters can substantially affect mental well-being in negative ways, particularly when households are in temporary shelters or camps [57,89]. In this study, the majority of the households were pessimistic about the recovery in both phases, i.e., 79% in phase 1 and 73% in phase 2 (Table 3). The content analysis showed key intangible recovery dynamics not visible in the other techniques, especially for the most marginal. Households had strong symbolic place attachment to their physical homes and ancestral settlements, common in many Indigenous and rural contexts [35]. Destruction of the physical home and settlements in turn influenced negative mental well-being through daily re-traumatization. Households perceived the future as highly uncertain in all settlements and camps, and the planned dam inundation zone, negatively influencing mental well-being. New social constructions of *dukkha* (trouble/tension) and *pagal* (a mad person) emerged during the recovery. *Dukkha* in this sense is mental trouble or tension manifested through the emotions of fear, anger, sadness, and anguish. To some, this is understood as taking one's soul or inner spirit away, causing them to not act like themselves. *Pagal* is associated with having suffering or worries and acting "mad" or "crazy." Both *dukkha* and *pagal* were manifestations of negative mental well-being, especially for rural and Indigenous peoples with strong place attachment and high levels of uncertainty towards the future. Further, active landslides caused by the earthquakes, cracks, and fissures, as well as damaged and destroyed homes and infrastructure, can create re-traumatization for place-based peoples as reminders of the initial trauma and its cascading effects, which threaten these communities years after the first event, evident elsewhere [10]. Indeed, after the Nepal earthquakes post- traumatic stress disorder (PTSD) was documented in rural and Indigenous communities [39,53], which can last years [6].

3.9. Transformations in everyday life

Transformation in disaster contexts may be both deliberate and/or adaptive and can include a fundamental restructuring of individuals, institutions, and regimes [49]. Transformation often relates to root causes of vulnerability, which disasters bring to the surface and amplify [67]. Coupled together, the NMDS and content analysis illustrate that hazard exposure, especially landslides and highly-impacted fields and pastures, place-based livelihood disruption, and displacement may drive transformative change. The static nature of displacement camps may continue the process of transformation started by the earthquakes when resettlement occurs. New skills, such as carpentry and masonry for earthquake-safe housing and sewing/tailoring, learned after the earthquakes may bring opportunities for building adaptive capacity and improving standards of living. Emergent household and settlement disaster preparedness trainings may also assist with future hazard planning and response. Certain households identified that the catastrophe inspired the building of new earthquake-safe structures, trails, and infrastructure, such as schools and health posts/hospitals. Collectively, these changes may also influence transformations in everyday life over the long-term.

Focusing on each VDC (Fig. 4), Aaru Chanaute, which had the best starting point in the recovery across the sample, appeared to change little across the two phases due to a planned dam which will cause many households to relocate and start new lives. Kashigaun households had the best recovery outcomes between the phases and incorporated outside ideas, which may influence new hybrid knowledge and practices. The settlement's less accessible location further from the road may stimulate the use of social capital through work exchange and openness to new ideas. Gatlang households had the worst recovery outcomes across the phases, taking the longest to return from their temporary shelters to their primary houses, causing them additional hazard exposure. Change or stasis may be influenced by their reliance on herding and dependency on the road and outside aid. Lastly, Haku households–especially those in displacement camps–were stagnant and appeared to lack opportunities to return to their settlements, fields, pastures, and forests. One settlement (Sano Haku) is being relocated because of geological vulnerability. Transformative change triggered by the catastrophic earthquakes may thus occur after resettlement [49].

4. Conclusion and recommendations

Recovery from the catastrophic 2015 Nepal earthquakes and their cascading effects spans years and potentially decades. Conditions were improving for some, while remaining static or getting worse for others. To better understand tangible and intangible recovery dynamics and adaptive capacity in the short-term, we employed a quantitative NMDS analysis and qualitative content analysis. The NMDS analysis found that each household and settlement had a different starting point in the recovery and was either stagnant or moving in positive or negative directions [80]. Socioeconomic status, hazard exposure, place-based livelihood disruption, and displacement influenced recovery outcomes the most. Herders, *bari* farmers, and forest product harvesters had the strongest associations with negative recovery outcomes; *khet* farmers and households that had businesses had the strongest associations with positive outcomes, appearing to have more adaptive capacity [82]. Previous content analysis on the surveys, interviews, focus groups, and research return workshops illustrated inequality-shaping tangible and intangible recovery dynamics. Stagnation and rapid change in the short-term may lead to transformation in the long-term [81]. Here, we add new quantitative and qualitative information from the NMDS, descriptive statistics, and content analysis. The new results include household challenges in accessing government relief and the national reconstruction program as well as perceptions of outside aid as unsustainable. We also add local challenges and opportunities related to the government-approved housing designs, building codes, and disaster preparedness.

Understanding short-term household recoveries in Nepal and rural and Indigenous disaster recovery contexts in general can contribute to crisis- and transformative-learning [43,72], encourage multi- and poly-vocality [9], engender local-global linkages and communication among households, settlements, government institutions, and outside entities [45], and provide development opportunities [8]. These findings and their interpretations can help to change "one size fits all" relief and recovery policies and interventions that do not account for cultural and biological diversity, history, livelihood, place, or inequalities.

Based on these assembled results, we provide the following guiding principles as well as general and specific recommendations to inform short and long-term disaster recovery generally, and recovery in Nepal specifically, and help build household adaptive capacity to future hazards. The guiding principles and general recommendations could be useful to policymakers and practitioners when conducting research or learning about ongoing contextual factors in places where they work. These suggestions could help to shape needs assessments and diverse types of interventions by governments, international agencies, and NGOs.

4.1. Guiding principles

1. Consider how power and history shape current realities to produce disasters by identifying root causes.
2. Consider recovery as a non-linear process that occurs over the short and long-term, with no specific end point.
3. Consider recovery as tangible (e.g., livelihood) and intangible (e.g., place attachment and mental well-being).
4. Consider both where a household starts in the recovery and where they are headed.
5. Consider culture, livelihood, and place as integral to recovery.
6. Consider using an integrated social and environmental systems perspective to understand rural and Indigenous everyday life, and life in disaster recovery.
7. Recognize that recovery includes a combination of planning and swift decision-making.

4.2. General recommendations

4.2.1. Outreach

1. Conduct outreach, information sharing, and rapport building prior to and throughout any research process.
2. Conduct pilot studies or exploratory consultations to ensure site and variable selection as well as analytic techniques are appropriate.
3. Integrate research return as primary method before interpretation of final results.
4. Make results accessible to multiple audiences in diverse forums.
5. Foster relationships with participants and stakeholders after study completion to assist with future collaboration and understanding the dynamics of change.

4.2.2. Methodology

1. Do not take the easy way out to define recovery indicators and drivers of change. Utilize multiple inputs to select domains and variables (e.g., previous experience, pilot studies, literature). Recognize that disaster recovery is multidimensional and changing over time with no specific endpoint.
2. Utilize the rule of hand to identify three to five key domains of system function [87].
3. Employ mixed methods to ensure an appropriate research universe (e.g., tangible and intangible dynamics) and opportunities for information triangulation.
4. Select data-analysis techniques appropriate for each context.

4.2.3. Pre-disaster research on vulnerabilities

1. Identify sensitive and vulnerable points (e.g., social inequality, poor state capacity, weak infrastructure, extreme exposure to natural hazards) in integrated social and environmental systems using the best ethical practices.
2. Recognize trend of amplification of preexisting power dynamics when disasters occur.
3. Recognize the relationship between social inequality and spatial dynamics.
4. Utilize research as an opportunity for awareness raising and partnership building.

4.3. Nepal-specific recommendations

We developed the following Nepal-specific recommendations using the guiding principles and general recommendations shared above.

1. Consider integrating into the national reconstruction program landslide mitigation, trail repair and construction, and transport expenses for building materials, which affect the size and design of rural earthquake-safe houses. Outside aid organizations could cover or share these costs if the National Reconstruction Authority cannot.
2. Ensure that assessment of earthquake damages include inaccessible settlements and not solely accessible settlements near or on the road.
3. Ensure that traditionally lower-caste ethnic groups and religions with low literacy receive representation and have a voice in community reconstruction planning. Recognize that these populations of lower socio-economic status are living in inaccessible and vulnerable geographies. They had the most catastrophic earthquake-related impacts and rely on these unstable extremes for their livelihoods.
4. Build capacity of local government representatives to understand the national reconstruction program. Consider enacting co-learning opportunities between local government officials from different municipalities.
5. Ensure that resettled households and settlements stay together in the new locations and in proximity to old settlements, if possible, so that they can practice their place-based culture and traditions.
6. Create opportunities in inaccessible settlements to co-design earthquake-safe low-cost housing that meets the building codes and reflects local traditional building approaches and uses local materials.
7. Build capacity of marginal households with single agropastoral livelihoods to create diversity in livelihood opportunities that will be more resilient to future hazards. Households with market connections also need low interest loans to start or continue businesses.
8. Consider local institutions and their related practices, such as *parma,* cultural traditions that include social capital, such as communal fundraising and sharing on Nepali festivals and holidays, as well as Indigenous and local knowledge of architecture, farming, pasture, and forest management in future relief interventions and recovery programs, especially with inaccessible populations.
9. Require outside aid organizations to provide skill-building along with relief materials and to not duplicate projects. They should also get local input when reconstructing infrastructure instead of using generalized designs. Outside aid also needs to be better tracked so that it is equitably distributed.
10. Focus disaster preparedness on multiple hazards beyond earthquakes, especially landslides.

Declaration of Competing Interest

None.

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Appendix A. Supplementary data

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