



PROGRESS IN **DISASTER** **SCIENCE**

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EARTHQUAKE
RECONSTRUCTION
AND **RECOVERY**
SPECIAL ISSUE

VOL I

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The Prime Minister



Message

I would like to express my appreciation to the Progress In Disaster Science (PDS) of Elsevier Publishing, for collaborating with the National Reconstruction Authority (NRA) to publish this seminal special issue. Our future generations and indeed, the entire global community, will benefit from the conclusions to be found in the papers included in this issue. It is my hope that future leaders and implementers of post-disaster reconstruction and recovery operations will find this research useful and that the knowledge gained from this issue will save their both time and resources in the conduct of their reconstruction work.

In Nepal, we had to undertake this massive post-earthquake recovery and reconstruction during a period of significant political transition. Reconstruction in far-flung settlements not connected with the outside world or connected only by earthen road, as well as our pervasive poverty and Nepal's limited resource base, presented huge recovery challenges. However, our national determination and above all, the resilience and dedication of our people, were key to carrying out this reconstruction and recovery effort successfully.

The published articles form a solid basis for a reform agenda, which the Government of Nepal (GoN) will review and implement in due course. Given our country's vulnerability to multiple disaster risks and hazards, we have no time to waste. Disaster-resilient sustainable development is a national axiom, which will be further strengthened with the empirical findings encapsulated in this special issue of PDS.

The pace and caliber of the reconstruction undertaking would not have been possible without the whole-hearted dedication of the Nepali people. I salute their determination and their resilience. Equally, I would like to acknowledge the National Reconstruction Authority for its commendable leadership. I also take this opportunity to recognize most warmly our development partners, who supported us during our hour of need in the immediate aftermath of the earthquake and who continued to accompany us, for over half a decade, in the arduous reconstruction process. I deeply appreciate the dedication of the authors to their research and analysis, reflected in this special issue, which would not have been realized without the contribution of many supporting organizations and individuals who likewise deserve our thanks. All these visible and invisible efforts lead in a common direction - towards a prosperous Nepal and towards Nepalis who are once more able to be joyful and to have hope in the future.

K P Sharma Oli
10th April 2021



National Reconstruction Authority



Foreword

This special issue of *Progress in Disaster Science* partly covers the lessons that we have learned during the course of the massive reconstruction effort required after the devastating 2015 Gorkha earthquake. We have learned a great deal through the process of reconstructing over 800,000 houses, 50,000 classrooms at 10,000 schools, 1200 health institutions and some 1800 cultural and historical monuments. In addition, NRA-led efforts have also resulted in the rebuilding of 750 government offices, including buildings used by security agencies, over 1500 drinking water systems, and also the reconstruction of approximately 800 kilometers of roads.

In the private housing sector, we followed a number of core principles. Build Back Better was the first and foremost one. All those involved in rebuilding infrastructure under the guidance of the National Reconstruction Authority (NRA) have adopted this principle stringently. All reconstructed private houses are characterized by enhanced disaster-resilience. Similarly, our approach to conserving heritage monuments and sites adheres both to principles for protecting our heritage, but also to standards for maximizing earthquake resilience. Schools, hospitals and other government buildings constructed under the NRA umbrella are not only earthquake-resilient, but also are user-friendly, convenient and functional.

The "Owner-Driven Approach" was another principle that we adopted, on a scale rarely seen before, if at all in the world. Through this approach, we tried to make individual households fully accountable for the construction of their houses. This sense of ownership, we believe, will help to create an environment conducive to sustainability. Through this approach, we also injected cost-efficient and resilient construction technology into earthquake-affected settlements. From now on, we are hopeful that all houses in Nepal, irrespective of their geographic location, will be constructed with earthquake-resilient technology. The significant progress achieved was made possible by empowering all earthquake-affected households, bolstering the practical, hands-on skills of construction workers and sharpening the technological prowess of our technicians.

Our aim has been to record all these hard-earned lessons, not only for Nepal's future generations, but also for the international community. To help us to achieve that objective, we have chosen to collaborate with *Progress in Disaster Science*, a scientific journal known for its objectivity and through which we can share lessons that are grounded in rigorous research and analysis. Through this means, we believe that we have been able to achieve our goal of being accountable and responsible to the national and international communities.

I take this opportunity to thank all the government officials associated with our mammoth organizational structure, our development partners, private sector institutions, non-governmental and community organizations, academic institutions and individual experts, all of whom have contributed to the recovery process. Without their whole-hearted support, reconstruction on such a massive scale would not have been realized. I congratulate all the contributors of articles and others who worked towards preparing this special edition.

Sushil Gyawali
Chief Executive Officer
National Reconstruction Authority



National Reconstruction Authority



Acknowledgements

A number of distinguished personalities contributed to bring this Special Issue of Progress in Disaster Science to fruition. NRA initiated preparations for the International Conference on Nepal's Reconstruction in the second half of 2019, when we organized thematic workshops intended to encourage potential authors to work on the scientific articles. These initiatives were meant to assimilate NRA's lessons and to prepare for their presentation in the International Conference on Nepal's Reconstruction (ICNR-2021). We would like to acknowledge all individuals and institutions that have enabled us to reach this far.

I would like to extend NRA's heartfelt gratitude to Rt. Hon. Prime Minister K.P. Sharma Oli for his relentless encouragement, guidance and support for Conference preparation. Our appreciation is due to Mr. Sushil Gyawali, the NRA Chief Executive Officer, for his strategic acumen. The ICNR Organizing Committee members guided us from the beginning of the ICNR preparatory activities.

The contribution of Prof. Rajib Shaw as the Journal Editor-in-Chief has been a lynchpin of this publication. Prof. Dr. Tara Nidhi Bhattarai (Volume Editor-in-Chief), Dr. Nigel Fisher, Prof. Dr. Ram Manohar Shrestha and Mr. Jitendra Bothara assisted us in reviewing the substance and structure of the articles. Mr. Jitendra Bothara, the Volume Editor Manager, not only played the crucial role of interlocutor between the ICNR Secretariat and the PDS Management, but also managed the peer reviewing process. Similarly, all peer reviewers worked to the highest academic and professional standards, to assist the authors in completing their contributions. We thank you all.

Dr. Chandra Bahadur Shrestha, NRA Executive Committee Member and ICNR Convener, has led the ICNR Secretariat since its conceptual stage. We acknowledge his commitment, drive and dedication. Mr. Manohar Ghimire, Under Secretary, contributed as Member Secretary of the Secretariat. Dr. Adi Walker, Director of the European Union (EU)-funded NEARR Facility, represented the Development Partners at the Secretariat, with the support of Mr. Shyam Sundar Sharma and Mr. Sandeep Gurung. The facility provided initial financial, technical and logistical assistance to ICNR preparatory activities. We are thankful to both the EU and the NEARR Facility for their support. The contribution of Mr. Pradip Acharya and Mr. Janardan Nepal in organizing our many meetings likewise merits our recognition and thanks.

Finally, we are grateful to our Central Level Project Implementation Units (CLPIUs -Building, GMaLI and Education), governmental institutions and development partners for their explicit and implicit support.

Mani Ram Gela
Secretary

National Reconstruction Authority



National Reconstruction Authority

About this publication



As the ICNR Convener, I am grateful to the Conference Steering Committee, Editorial Board, Organizing Committee and ICNR Secretariat. This volume would not have seen the light of day without their persistent contributions.

The National Reconstruction Authority (NRA) has aimed to capture its best practices through four routes: scientific, corporate (known as the Compendium), institutional and open. This publication of the special issue of Progress in Disaster Science (PDS) is rooted in the scientific route. The results of all these efforts will be concluded and presented in the International Conference on Nepal's Reconstruction (ICNR). The ICNR may not be realized during 23-25 April 2021 as originally planned, due to the protracted impact of the Covid19 pandemic. Nevertheless, we are still determined to organize the Conference later in 2021, given that NRA's term expires in December 2021.

Altogether, there will be two volumes of the Progress in Disaster Sciences and three volumes of Vikas, a national journal, with a combined total of over fifty articles. All these articles were realized through a series of 11 thematic workshops which took place between November 2019 and March 2020. A National Symposium on Nepal's Reconstruction (NSNR - 2020) was organized August 24-28, 2020 when all selected articles received feedback from renowned experts in their respective fields. The Editorial has shed outlined the peer reviewing process.

Out of a total of twelve articles, four delve into the socio-economic dimensions of the housing sector. One of them addresses the NRA model of resettlement, which has the potential for replication nationwide. It argues that a policy-level arrangement has to be worked out for utilizing land abandoned by migrated households, where disaster-prone vulnerable people can be resettled. This arrangement will not only save lives and properties from disaster but also boost the productive base of the rural economy. The second housing article describes the bartering of labor between neighbors that proved instrumental in overcoming financial constraints. The other two articles deal with communication media and inclusive owner-driven reconstruction for poor and vulnerable households.

Three articles feature housing technology. In one paper, the digital image correction technique illustrates the advantage of the seismic band in limiting the propagation of cracks and in improving the structural integrity of masonry. The second study finds that 15.2% houses were non-compliant with the building code. The third technological article argues that the country needs a debris and waste management plan for future reconstruction initiatives.

The first livelihood article concludes that remittances provided the only meaningful coping strategy that helped households to recover their livelihoods in post earthquake Nepal. Another livelihood article finds that while interventions contributed to improving beneficiaries' livelihood status in the short-term, longer-term sustainability proved to be much more elusive.

The first of the remaining two articles argues that community-centric heritage conservation has proven to be successful. Finally, the last paper deals with the psychosocial impact of the Gorkha Nepal earthquake on the Nepali-speaking community in the USA and reminds us of the importance of assuring psychosocial support for disaster-affected people in Nepal too.

All these articles will be of interest to national and international policy-makers, particularly when they are faced with the challenges of post-disaster reconstruction. Practitioners, academicians and civil society members will equally find the research and lessons learned of interest.

Chandra Bahadur Shrestha
Executive Committee Member, NRA
Convener, ICNR

Editorial

This special issue of the Progress in Disaster Science (PDS) journal has been published in association with the National Reconstruction Authority (NRA) of Nepal, an organization established by the Government to lead and coordinate reconstruction following the 2015 Mw 7.8 Gorkha, Nepal earthquake. The special issue records the progress achieved during the earthquake recovery process, in the belief that the significant achievements highlighted will be useful at national, regional and international levels, as a means of helping others to prepare for earthquake and other disaster events in the future and to mitigate the resultant impacts likely to be encountered.

The papers published in this special issue were initially presented at the web-based National Symposium on Nepal's Reconstruction – 2020 (NSNR – 2020) organized by the NRA to provide a professional platform to share lessons learned from Nepal's multi-dimensional reconstruction experience. In all, 115 abstracts were received for the NSNR - 2020. These were reviewed by the editorial board instituted by the NRA. The analysis and suggestions provided by the board facilitated the writing of full research papers, following the NSNR – 2020 guidelines. In spite of the Covid-19 pandemic situation, 62 completed papers were submitted for the NSNR - 2020. These were assigned for a double-blind peer-review process. At the same time, the papers were presented thematically in the webinar (NSNR – 2020), during which authors received suggestions and feedback from audiences, panelists and facilitators. The papers of those authors who addressed reviewers' comments and seminar feedback satisfactorily were given two options for the publication of manuscripts: in *Vikas*, a journal of the National Planning Commission (NPC) of Nepal, and in the PDS journal.

The papers submitted to the PDS journal were reassigned for a double-blind peer-review process and accepted following the protocols of the journal. The peer reviewers were selected from an international pool of experts in relevant fields, which included practitioners, researchers, academicians, and disaster management specialists.

The papers included in the PDS journal cover a number of important areas of reconstruction, ranging from private housing to governance, to cultural heritage, livelihoods, economic recovery, social impacts, disaster risk reduction and other cross-cutting issues. We believe that the papers will be useful to researchers, policy makers, students and general practitioners engaged in the field of disaster management. Most importantly, they will serve as a mirror reflecting how Nepal completed its reconstruction after the 2015 Mw 7.8 Gorkha, Nepal earthquake.

We are grateful to the NRA and PDS journal for entrusting us with the role and responsibilities of the guest editorial board. We are also thankful to our distinguished reviewers for their comprehensive comments and timely responses.

Guest Editorial Board

Rajib Shaw (Journal Editor-in-Chief)

Tara Nidhi Bhattarai (Volume Editor-in-Chief)

Jitendra Bothara (Volume Editor Manager)

Nigel Fisher

Ram Manohar Shrestha

Table of Contents

Message from the Prime Minister	iii
Foreword	iv
Acknowledgements	v
About this publication	vi
Editorial	vii
1. Articulating strategies for developing disaster resilient settlements from the experience of the Tadi rural municipality of Nuwakot District <i>Chandra Bahadur Shrestha, Lekh Prasad Bhatta</i>	1
2. Building typologies and code compliance issues of reconstructed houses after 2015 Mw 7.8 Gorkha, Nepal earthquake: Experience from Dhading District earthquake <i>Rajesh Kumar Shrestha, Hari Ram Parajuli, Bipul Poudel</i>	14
3. Post-earthquake reconstruction: Managing debris and construction waste in Gorkha and Sindhupalchok Districts, Nepal <i>Rajib Khanal, Prem Upadhaya Subedi, Rupesh Kumar Yadawa, Bikram Pandey</i>	26
4. Reconstruction assistance in rural Nepal after the 2015 Gorkha Nepal earthquake through Aarma Parmah approach – A case study in Bijulikit, Ramechhap District <i>Devraj Gautam, Gustavo Cortés</i>	34
5. An assessment of livelihoods program in earthquake affected areas of Nuwakot district, Nepal <i>Jharendra Bahadur Singh, Jaysingh Sah, Sanjib Dhungel</i>	45
6. An assessment of livelihood recovery status of earthquake-affected households in Nepal: A study of coping strategies and their effectiveness <i>Nirmal Kumar Raut</i>	56
7. Conditional cash transfers and embedded extension: A mechanism to restore and promote adoption of improved goat shelters in emergency recovery <i>Prachanda Kattel, Krishna Mohan</i>	66
8. Community led post-earthquake heritage reconstruction in Patan–issues and lessons learned <i>Rupesh Shrestha</i>	76
9. An analysis of use and effectiveness of communication channels, media and tools in post-earthquake private housing reconstruction in Nepal <i>R.K. Sharma, A. Baskota, M. Timalisina, K. Sen Oli, H. Adhikari</i>	87
10. The 2015 Nepal earthquakes and psychosocial impact among Nepali speaking population in the United States of America <i>Surendra Bir Adhikari*, Dharma N. Bhatta, Deelasha Rayamajhi, Ruchi Adhikari</i>	96
11. Effects of horizontal seismic band on seismic response in masonry structure: Application of DIC technique <i>Santosh Yadav, Hala Damerji, Reinold Keco, Yannick Sieffert, Eugénie Crété, Florent Vieux-Champagne, Philippe Garnier, Yann Malecot</i>	101
12. Community-based participatory approach in cultural heritage reconstruction: A case study of Kasthamandap <i>Rija Joshi, Alina Tamrakar, Binita Magaiya</i>	109
Contributors	118



Regular Article

Articulating strategies for developing disaster resilient settlements from the experience of the Tadi rural municipality of Nuwakot District

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ABSTRACT

About half of the Tadi Rural Municipality (TRM) land area is vulnerable to natural disaster and 12% of total 3582 households live in such areas. This study intends to develop strategies for resettling vulnerable people in safe locations with livelihood provisions based on the lessons drawn from TRM families affected by landslides triggered by the 2015 Gorkha, Nepal earthquake. The study is based mostly on secondary information but also carried out focus group discussions for primary information. This study has recommended that the people from vulnerable settlements should be resettled with government support making land belonging to absentee landlords available to the resettled families through the land bank system.

1. Introduction

Globally, Nepal is considered to be the 11th most vulnerable country in terms of earthquakes [2] and 30th in terms of floods and landslides [23]. The Ministry of Home Affairs [22] suggested that more than 90% of the population faced high risk of both floods and landslides. Between 1971 to 2015, floods and landslides killed 40,000 people, injured 75,000 and affected another three million [22]. Nepal's Gross Domestic Product (GDP) loss attributed to natural disasters is in the range of 0.10 to 354.38% annually [1]. The loss was exceptionally high – 354.38% – was in 2015 after the Gorkha, Nepal earthquake.

Tectonic forces, complex geology, topography and climatic forces are mainly responsible for the majority of natural disasters. Tectonic force is generated from the continental collisions between the Indian and Eurasian plates. This action has generated linear belts of cracks (thrusts) parallel to the Himalaya [40], making tectonic zones of different characteristics such as the Tibetan Tethys Himalaya, the Higher Himalaya, the Lesser Himalaya, the Siwalik, and Terai plain. Each zone consists a variety of rocks. The Higher Himalaya comprises of highly metamorphosed rocks such as; schist, gneiss and granites. The Lesser Himalaya is composed of soft phyllite and schist and brittle dolomite and quartzite rocks, which are also fragile. Similarly, Churia range comprises sandstone, mudstone, and conglomerate which degrade with the heavy rainfall and climatic variations. The Terai plains are composed of the youngest alluvium deposits of sand and gravel. The Terai is highly vulnerable to flooding. The topography in the Himalayan belt is determined by tectonic forces which lift up mountains, and

climatic forces that cause erosion which is exacerbated by human interventions. The climatic pattern is a result of prolonged dry spell followed by heavy summer monsoon rainfall with some cloud outbursts that cause floods.

The Tadi Rural Municipality (TRM) is located on the Lesser Himalaya where all macro-level factors impact the terrain. Landslide is the prominent feature in TRM. More than 31% people live in landslide areas and more than 52% people live on the steep slopes exceeding 30°, more than 3% people live in the flooding areas, and the remaining 13% people live with other vulnerabilities [42]. There are overlaps among those factors as well.

The 2015 Gorkha earthquake of MW 7.8 and its aftershocks killed 8790 people, injured 22,300 and affected eight million people from 32 of Nepal's 75 districts [6]. The earthquake had killed 40 people and injured 175 people at TRM [26]. Other contributors for death and injury were fire, landslides and epidemic. In 2015, 50 people were killed, and 181 were injured by disasters. The natural disasters caused damages valued at about US\$ 300,000 in 2015 and 59% of that was due to landslides followed by epidemics (41.15%) and fire (0.41%) (TRM [26]). Fatalities from future earthquakes can be reduced by providing reliable information about hazard estimates and following building codes thoroughly [7]. Resettlement of the vulnerable population is one of the best long-term strategies for disaster risk reduction, not only for saving lives but also for reducing the future response and recovery costs. Although the resettled households can avoid the threat of natural disasters and escape poverty, resettlement itself entails certain social risks [4] and therefore, needs attention.

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Against this backdrop, this study intends to formulate a set of strategies for evacuating people from vulnerable settlements for resettlement in safer locations with proper livelihood provisions. While selecting the criteria for relocation, it is necessary to study future possible land use such as mining of stone and sand and other industrial activities. The resettlement areas were unsuitable for displaced communities as suggested by comparisons of existing and predicted landscape character due to mining operations (Moomen et al. [26]). In Nepal, local governments are responsible for resettling vulnerable households in safe locations [13]. A resettlement project at the Kharanitar for households displaced from Umleni – one of the landslides affected settlements in TRM – was taken as a case for this study. The households were provided with some livelihood opportunities, which have been taken as reference for proposing future strategies.

In TRM some people were living in extremely vulnerable settlements, while people from safer areas had been abandoning land and heading to either urban centers or migrating to other countries [27]. This paper intends to formulate a win-win strategy for both groups of people.

This paper reviewed policies, laws, regulations and the best practices around the world in the area of resettlement of vulnerable households. The MoHA formulated the Disaster Risk Reduction National Policy – 2075 (2018), Disaster Risk Reduction and Management Act – 2074 (2017) and Disaster Risk Reduction and Management Regulation – 2076 (2019). MoHA also prepared the Disaster Risk Reduction National Strategic Plan of Action (2018–2030). All these policies, laws and action plans have emphasized that improper land use has been the cause of casualties and destruction of property annually during natural disasters. Hence, all development interventions have to be viewed from a disaster perspective and all preventative measures have to be adopted. Achievement of this goal largely depends upon whether one can interfere on land use policy, which has to be followed by constructing engineered and appropriate structures. In parallel to the disaster related legal documents, the Government of Nepal (GoN) also enacted Land Use Policy – 2075 [25], Land Use Act – 2076 [14], Land Act (Amendment) – 2076 [15]. The Land Use Policy – 2075 (2015) intends to achieve sustainable land management for ensuring developed and prosperous livelihoods. This policy has provided a legal environment for ensuring implementation of land use plans at the federal, provincial and local levels. As it stands now, the country's low development can be largely attributed to improper land use. Even Nepal's Maoist conflict (1996–2006) was largely embedded on land issues [29]. The previous Land Use Act [10] dealt mainly with ownership issues and land use was only mentioned for the purpose of land rent. Otherwise, the land use was not discussed, which is one of the reasons for inadequate interventions in the land use pattern in the country. However, the present paper deals with the impact of improper land use on natural disasters. In this connection, the Land Acquisition Act 1977 [11] was also reviewed. As NRA had implemented the project, the Act Related to Reconstruction of Earthquake Impacted Infrastructure [12] was also reviewed.

Finding land for resettlement is much easier in China. The 2008 Wenchuan Earthquake of Mw 7.9 affected more than 260,000 sq. km and 30 million people [9]. It had killed 69,226 people and another 17,923 were officially reported missing [45]. The recovery was viewed as an opportunity to improve regional infrastructure, increase access to the mountainous areas, and expand urbanization of existing cities, such as Dujiangyan. In general, economic development policies revolved around a few simple concepts: close down industries in the mountains and promote tourism in those areas while promoting development of industrial parks in new industrial areas. People were shifted to the newly urbanized areas at a cost of US\$ 147 billion, which was approximately equal to the entire GDP of Sichuan Province in 2007, or about 20% of all Chinese government revenue in 2007 [19]. By May 2010, all housing reconstruction was finished, including almost two million units of new rural housing, 290,000 units of new urban housing, and untold millions of repaired units [46]. The speed of reconstruction and the organization required to accomplish it was remarkable by any measure. This was possible because the central government made reconstruction its overwhelming priority. This was a highly successful model in China but one also extremely difficult to replicate in Nepal.

Land acquisition in Nepal is not as easy as in the People's Republic of China (PRC). The Constitution of Nepal [34], guarantees the right to property that has made the task of land acquisition quite challenging. One legal challenge to the acquisition can halt the process for a long time making the adoption of the Chinese model untenable. Other countries like Pakistan also experienced similar difficulties in land acquisition and in the resettlement process. The resettlement in Balakot in Pakistan turned out to be real fiasco [3] as it had not materialized even after 15 years of the 2005, Kashmir earthquake. Local people's reluctance to allow new settlers to settle in their vicinity [36] was the reason for non-completion.

Although Fig. 1 was developed for Ethiopia, having a different context from Nepal, the basic philosophy of the model is replicable. It shows that the resettlement process is influenced by the physical, social, political and technological factors. It also demonstrates that the human bio-physical environments are related to the resettlement processes. The first box indicates the human environment including demography, settlement morphology, land use, cultural system, health facility and cultures. The second box includes the biophysical environment: geomorphology, soil, topography, vegetation, climate and energy. The biophysical environment is extremely important for the wellbeing of human beings as it determines the quality of air, water, food and shelter. Inappropriate biophysical conditions also expose people to floods, drought, hunger, diseases and deaths.

In terms of technology, the laboratory analysis and suitable shear tests are necessary for understanding the cause of landslide problem [38]. The concept of seismic topographic amplification should be considered to understand the damage due to earthquakes-induced slope failure in mountainous terrains. High precision Digital Elevation Model (DEM) is required for analyzing the earthquake-induced shallow slope failure potential [16]. The GoN will need to work for acquiring all required information in the future.

2. Data and method

All secondary sources of information related to the landslides triggered by the earthquake were reviewed. All relevant literature of the TRM was scrutinized, particularly the TRM's periodic plan and resettlement scheme. Maps relevant to the landslide hazard were used including detail review of topographic maps, google earth images, available reports and published geological map from the Department of Mines and Geology [8]. Landslide

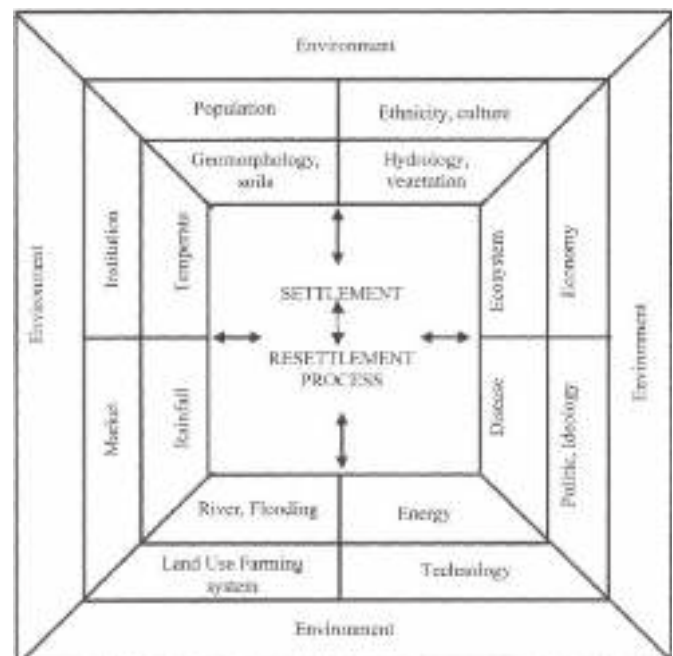


Fig. 1. A concept model on resettlement process [44].

data and other geo-disasters of the earthquake affected settlements were collected from a number of different national and international sources. The data gaps were reduced by using focus group discussions, direct interviews with NRA officials and officials of the TRM. An intensive field observation of landslide and flooding areas was also done.

Secondary information was collected from available maps. The geographic location of landslide was identified from the MoHA report. The landslide locations were located on the topographic map and Google Earth map. In the field, the landslide was studied through NRA standard questionnaires [31]. The description of DMG report [41] was also corroborated. Some of the digital maps were used from the UKAid-funded landslide study implemented by the Durham University.

Moreover, both authors were closely involved in the reconstruction process. The first author is one of the policy and decision makers at the NRA. The second author is one of the geologists who had surveyed a number of earthquake triggered landslides after the 2015 Nepal earthquake.

2.1. Study area

The TRM is located at the distance of 55 km North-west from the Kathmandu City and 22 km East from Bidur, the Nuwakot district headquarters (TRM [26]). TRM is connected with a 11 km long Provincial Road to the Puspahal Mid-hill Highway. It borders Dupcheswor Rural Municipality on the East, Suryagadi Rural Municipality on the West, Naukunda Rural Municipality of Rasuwa District on the North and Panchakanya Rural Municipality on the South. It has six wards (lowest administrative unit) and a total area of 69.79 sq.km. The agricultural land covers more than 54%, followed by forest (13.76%), water inundated area (0.4%), rocky area (0.49%) and others (31.24%). The irrigated land is 1080 ha. The population size in 2020 increased by 1.33% from 2015 and reached to 4032 households and 19,952 people. The population density was around 285.9 per sq. km (TRM [26]) Nearly 22% people lived outside of the TRM either in

other urban centers in the country or abroad. Nearly 23% people were involved in agriculture and livestock, followed by daily wage labor (10.87%). A negligible number of people were involved as in formal jobs and more than 4% were unemployed. More than one-fifth of the population were absentee landlords and nearly 12% people were tilling land on sharecropping arrangements. Fig. 2 shows the location map of TRM.

There were 20 commercial firms of agriculture, livestock and poultry businesses at TRM and they employed 45 people. Eighty agricultural, livestock, cooperatives with 1452 members were operational at TRM. One hundred and seven business enterprises were operating and had transactions of nearly US \$ 500,000 in 2015. About one fifth of households were below the poverty line and more than two-thirds of the population did not have sufficient food for the whole year. More than 74% people were literate.

Out of 4032 households, nearly 58% had constructed their houses of stone masonry in mud mortar and more than 37% had stone rubble masonry in cement sand mortar. A negligible number of households had houses with framed structures and wooden poles. In terms of roofing, most households (83.58%) had CGI sheet roofing followed by RCC roofing (13.94%) (TRM [26]).

2.2. NRA's guidelines for field investigation of vulnerable settlements

The NRA had issued guidelines for the field investigation of earthquake-impacted vulnerable settlements: assessment of geological, geomorphological, engineering geological, geotechnical, and pertinent social parameters [30]. The objective of these guidelines was to evaluate the state of geohazards, mainly all types of landslides, in pre-declared vulnerable settlements, and classify them as Category I where no interventions are required; Category II where some mitigating measures were required and Category III which were unsafe settlements and had to be shifted. The study team comprised of engineering geologist, landslide engineer or geotechnical engineer or earthquake engineer or civil engineer and watershed engineer.

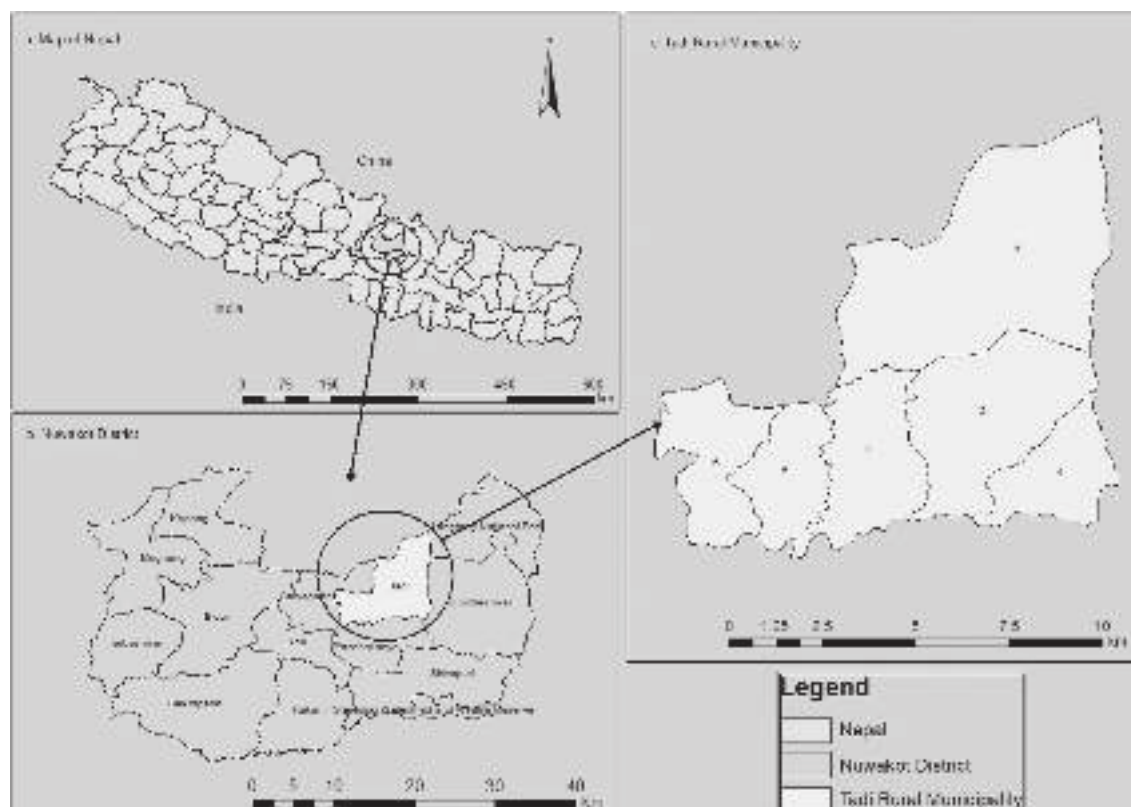


Fig. 2. Location map of Tadi Rural Municipality.

3. Results

This section discusses the landslides at TRM, geological assessment of the Urleni Village, and the NRA resettlement policy.

3.1. Landslides in Tadi rural municipality

Before the promulgation of the current constitution (LBMC 2015), the present TRM had five Village Development Committees (VDCs): Urleni, Ralukadevi, Sundaradevi, Narjamandap and Kharanitar. The VDCs were the lowest level of local governments as defined by the previous constitution [17]. Unstable slopes and surfaces became more susceptible to landslides after the 2015 earthquake, and these are exacerbated by rainfall and further work on the land system. Hence, vulnerable areas of TRM were delineated and modeled in landslide run-out extent maps are prepared as shown in Figs. 3 and 4 [43]. It shows landslide concentration on the northern steeper slopes of TRM within the catchment of Darkhu Khola.

As shown in Table 1 and Fig. 3, the geohazard problems were concentrated in Urleni and Narjamandap VDCs. Table 1 shows settlement wise geo-hazard problems and recommendations. Out of 16 total landslides at TRM, 15 landslides were located in those two former VDCs. All landslides, irrespective of size, were counted. There were certain sections where the slope exceeded 40° . The Fig. 4 shows the run-out extent, which means

the probability of debris coverage by landslide. Such areas were defined as vulnerable.

3.2. Geological assessment of the Urleni Village

The settlements where geological assessment was conducted within the Urleni Village were: Kalche, Thing Tol, Syangtan Tol, Chihan Dada and Chhelun (Fig. 5). Because of similarity to Urleni in terms of geological features, the outcome of the studies on Narjamandap and Sundaradevi are not discussed separately. These villages are located at foothills of steep slope with angle in the range of 20° – 40° (Silwal [26]). Mostly old landslides had been reactivated and fresh shallow sheeted mud slides were also observed in this area. The elevations of the study area range between 2808 m amsl at Bhalu Khop Danda and 1000 m amsl at Darkhu Khola. This area is drained by the Darkhu Khola and its tributaries that confluence with the Tadi Khola forming the dendritic drainage pattern. Forest land, grassland in steep slopes below the cliff and other areas are cultivated. Upper part of the steep slope is barren.

The Urleni area lies in the Higher Himalaya [8] which consists of garnet-biotite gneisses, kyanite biotite gneiss, garnetiferous mica schist, augen gneiss, micaceous quartzites and thin bands of marble. The rocks are dipping towards the east with the range of angle between 25° and 35° . These rocks are moderately to highly weathered, thinly to massive banded with lots of fractures and joints. The area consists of thick colluvial

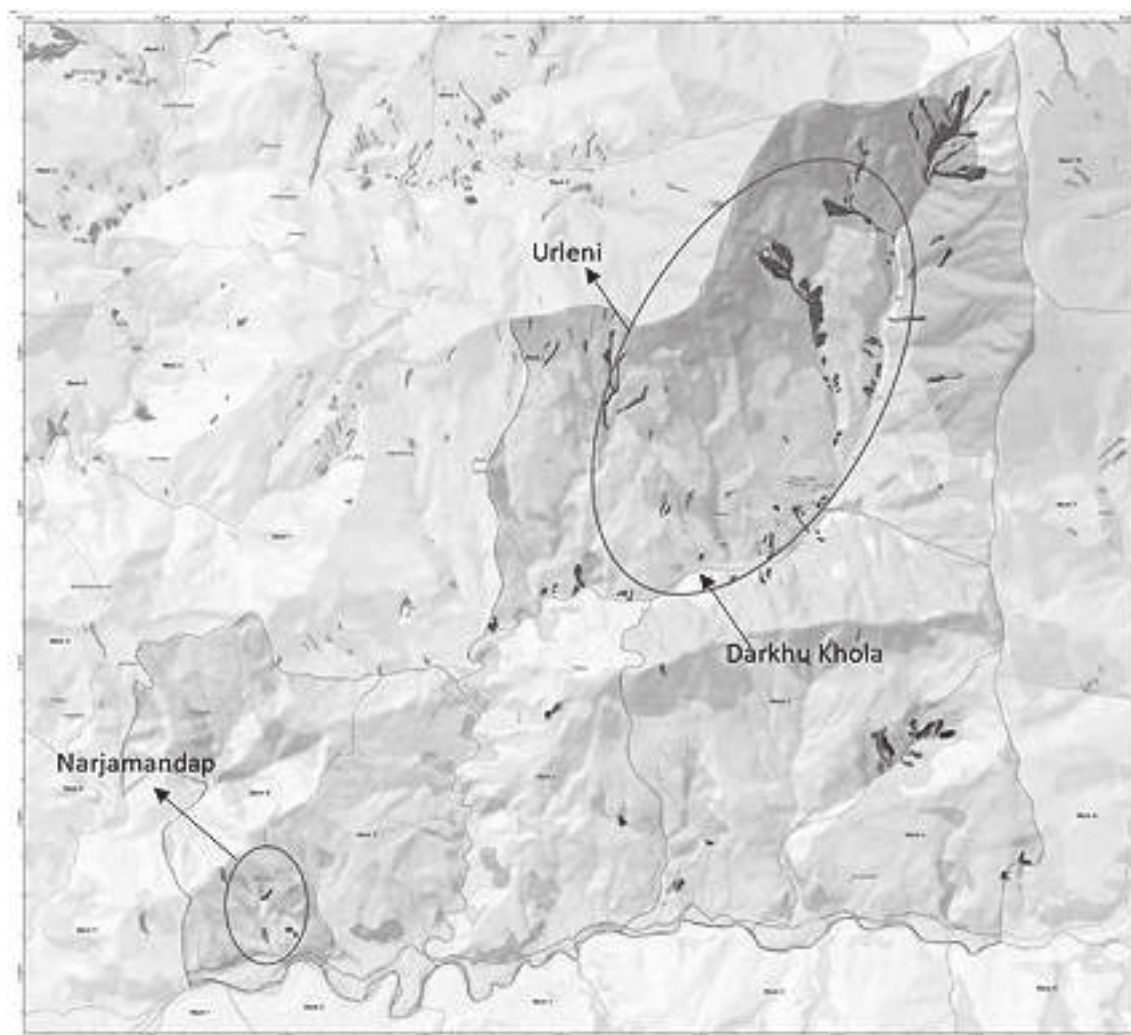


Fig. 3. Distribution of landslides in TRM, [43].

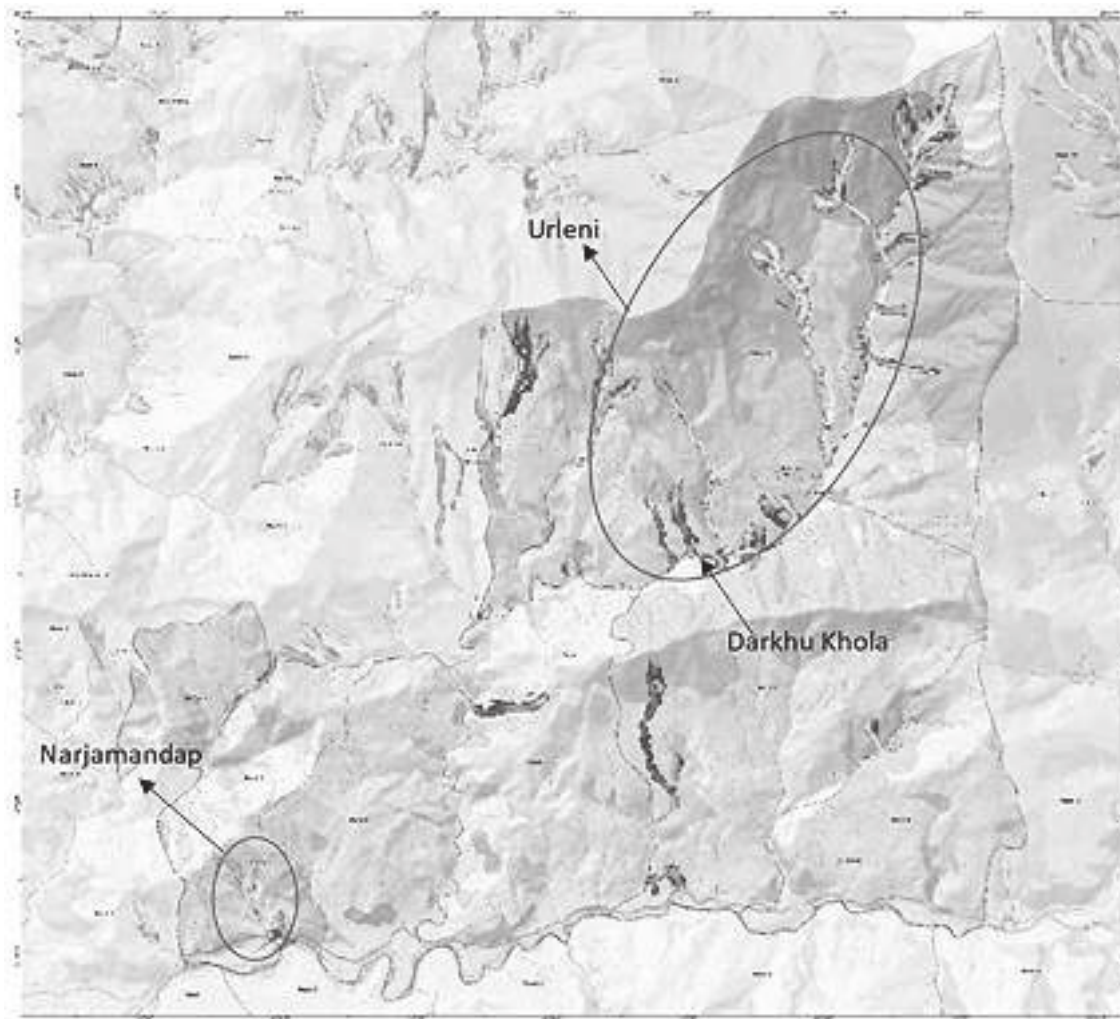


Fig. 4. Run out extent model of TRM [43].

brown to reddish brown soil with thickness ranging from 1 to 5 m with fragments of gneiss, augen-gneiss and schist and clay minerals. The Topographic Map of Uurleni with indication of studied sites is shown in Fig. 5 (Silwal [26]). The common geological hazards in Uurleni were mudslide, rock fall and gully erosion due to improper drainage management.

Kalche: This settlement is located on the steep eastern flank of the Uurleni Village and is composed of 1.5 m thick colluviums and residual brown to reddish brown soil. Tension cracks and landslide were observed in this area (Fig. 6). The landslide was first initiated in 2014 monsoon and reactivated after the 2015 earthquake. The landslide dimension is 20 m wide, 70 m long and 1–5 m deep. Altogether 56 households were at risk, among them six households were directly below the landslide (Fig. 7). Visibly subsided 5 m long, 1–5 m wide and 0.1–0.3 m deep tension cracks were observed in the crown part and cultivated land had subsided about 1 m. No seepage was observed. Figs. 6 and 7 show all the landslide features.

Chihan Dada: Fig. 8 shows the landslide on the upslope. This settlement is located on brown colluvial soil with 1–5 m thickens. Slow slide movement and shallow mud slide with 5 m long, 0.5–1 m wide and 1.5 m deep crack and 1 m of subsidence were observed on the upper part of the slope. The landslide was initiated in 2014 and reactivated by the 2015 earthquake. Boulders of banded gneiss, schist were randomly distributed and could fall down on the Chihan Danda settlement. Unmanaged drainage induced gully erosion and caused a shallow mudslide.

Thing and Waiba Tol: Thing Tol is located on the 1–3 m thick brown colluvial soil. The 2015 earthquake triggered shallow mudslide and resulted in cracks (Fig. 9). Unmanaged runoff was the major cause of the landslides. A number of boulders of gneiss were overhanging above the 20 houses.

Syangtan Tol: Having an elevation of 1583 m amsl, it is the lower part of the Kalche village (Fig. 10 and Fig. 11). A landslide 50 m width, 100 m long and 1–3 m depth was first observed in 2014 and it was further aggravated by the 2015 Gorkha earthquake. Cracks of 1–5 m length, 0.5 m width and 1 m depth were observed in the crown, in the cultivated land upslope. Vulnerable boulders with high probability of sliding down due to steep slope were observed. Fig. 10 and Fig. 11 shows boulders and shallow slides on downslope of houses.

Chhelun: This settlement lies below the south facing steep slope with a length of 600 m. However, the settlement itself is located on the gentle slope on thick brown colluvial soil. A 30 m wide and 100 m long landslide occurred on upslope of settlement a long time back but was reactivated by the 2015 earthquake. Banded gneiss and augen-gneiss were exposed. Rock fall and rockslide were the major problems.

Almost all settlements studied had some commonalities. All of them were located either on the steep slope greater than 30° or on the foothill of the steep slope greater than 45°. Secondly, the original landslide took place earlier and the 2015 Gorkha earthquake aggravated the slide. Based on the views from the focus group discussions and key informant survey, it was concluded that the 2015 destruction could have been minimized if proper slope management had been adopted after the 2014 landslides.

Table 1
Landslides in Tadi Rural Municipality.

Former VDC	Settlement Name	Geohazard problems	Recommendation
Urleni-1 ^A	Kalche	rock fall, mud slide, tension cracks	relocate
Urleni-1 ^A	Chihan Dada	gully erosion, mud slide	relocate
Urleni-1 ^A	Thing, Waiba Tol	mud slide, cracks, gully erosion	relocate
Urleni-1 ^A	Syangtan Tol	cracks, shallow slides	relocate
Urleni-4 ^A	Chhelun	rock fall, rock slide	relocate
Narjamandap-6 ^A	Thapa Gaun	poor surface drainage	mitigate
Narjamandap-8 ^A	Talo Sangle	shallow slide, rock fall	mitigate
Sundaradevi-2 ^A	Suntali Sunar (individual)	unstable slope	avoid construction
Narjamandap-4 ^B		deep seated slide, tilting trees	mitigate
Narjamandap-4 ^B	Amare	deep seated slide, tilting trees	mitigate
Narjamandap-6 ^B	Saman Tole	cracks on cultivation land, shallow slide	mitigate
Narjamandap-2 ^B	Sahare	shallow seated slide	mitigate
Narjamandap-7 ^B	Dotel	shallow seated slide	mitigate
Narjamandap-7 ^B	Puwakhok	shallow seated slide, creeping soil	mitigate
Narjamandap-4 ^B	Sathyia	deep seated debris flow	mitigate
Urleni-4 ^B		rock fall, rock slide	mitigate

Source: ^A (Silwal [26]) and ^B Joshi [20].

Note: The study was conducted before the new demarcation of the local government, and therefore, the references to the previous administrative units.

Further, unmanaged water runoff from cultivation of water intensive crops could have been the major cause of the landslide. The landslide caused 80 households to resettle.

3.3. NRA resettlement policy

The DMG (Silwal [26]), conducted the geological study and categorized all settlements into three categories following NRA's requirements as: no intervention required; settlement can continue in situ with

infrastructural intervention; vulnerable settlements which need to be resettled. For the category III settlements, there are two options for beneficiaries: with NRA land grant of US \$ 2000 they could buy land at their convenient locations; if there were more than 10 beneficiaries, NRA supported the development of integrated settlements for which it provided grants for land and infrastructure. The grant amount ranged from US \$ 3000 to \$ 5000 per household depending on the geographic region. Nuwakot was a hilly district and US \$ 4000 per household was applicable (NRA [26] a).

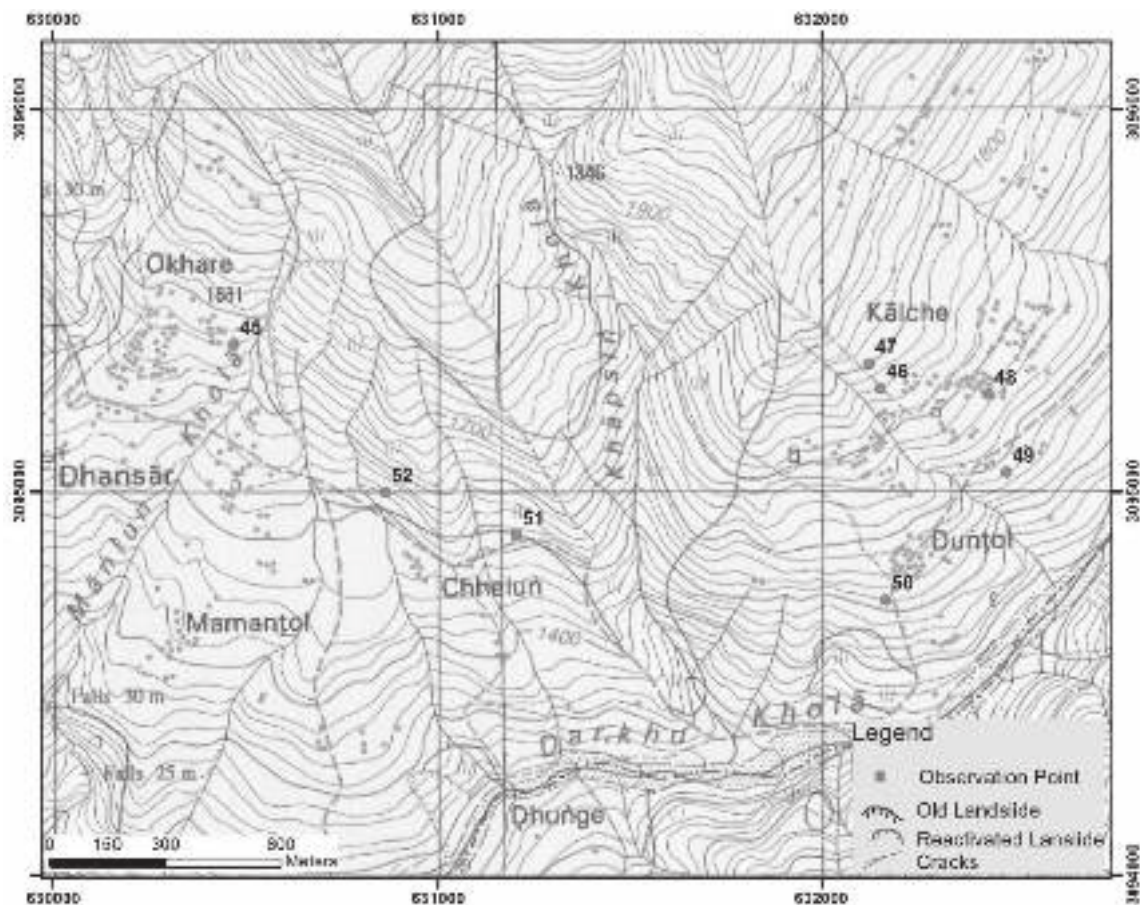


Fig. 5. Topographic map of Urleni with location of studied sites (Source: Silwal [26]).



Fig. 6. Open cracks observed in the ground situated up slope from the Kalche settlement (Silwal [26]).

3.4. Process of resettlement from Urlen to Kharanitar

The Urlen Village was declared as a Category III settlement and vulnerable households wanted shelter. The beneficiaries identified Kharanitar as an appropriate location for them to settle and the suitability was later confirmed by the NRA through geological studies. The integrated settlement, which includes physical, social, economic and cultural infrastructures, was developed with joint support of the NRA, Oxfam Great Britain, United Kingdom Agency for International Development (UKAid) and the TRM. The NRA funded land

acquisition by providing US \$ 2000 per household as land grant for the displaced households and for infrastructural support. Oxfam provided technical and financial support for housing reconstruction and livelihood. UKAid provided a water supply system through its reconstruction project [35] and the TRM constructed a 500 m access road to the settlement. Individual households contributed labor for housing reconstruction. Figs. 13 and Fig. 14 show imagery of resettlement site and newly constructed houses.

Oxfam adopted a participatory approach for housing reconstruction at the resettlement site. It formed an Integrated Settlement Development



Fig. 7. Shallow slide on the upslope of Kalche (Silwal [26]).



Fig. 8. Landslide on the upslope of Chihan Dada (Silwal [26]).

Committee from the participating households. Under the leadership of that Committee, Oxfam supported housing construction for 71 households for an ethnic community of Tamang. Among them, 68 households were married man led families, two widows and one single woman. Fifty-eight percent have a family size of 4–7 members, 27% of 8–10 members, 10% more than 10 members and 5% 1–3 members. Fifty-six percent of the population was literate [33]. The families had access to 2000–3000 sq. ft. of leased land for farming and they also worked at construction sites and agricultural fields as wage laborers. They earned US \$ 3000 on average

annually by selling farm products in Satbise at a distance of 4 km, Bahun Besi at a distance of 3 km and Bidur Bazar at a distance of 21 km. Fig. 14 shows settlers engaging in livelihood initiatives.

In Urleni, all of the families had land, which was sufficient for subsistence farming. But for the new settlers in Kharanitar, the individual household income was not sufficient for livelihood. With NRA's land grant of US \$ 2000, each household purchased 1369 sq. ft. of land which is enough to build a simple house. They were detached from their social institutions and natural resources and that might have increased their level of



Fig. 9. Landslide observed at Thing Tol (Silwal [26]).



Fig. 10. Failed terraces and boulders on down slope of house [41].

vulnerability. There were also social challenges to integrate in the new environment. It required some infrastructural intervention where the local communities could also have benefited. The water supply scheme was provided not only to the new settlers but also to other local people, which enhanced harmony between the two communities. The use of natural resources, waste disposal, and sharing of natural resources could be potential flashpoints between the new settlers and the local people.

The traditionally practiced subsistence farming has been the mainstay of the new settlers. Some others were engaged as wage laborers, carpenters and trekking helpers. Reported household income was around US \$ 3000

per year but only 30% of the households were financially secure to meet their food and other livelihood needs. Hence, the issue of livelihood has to be handled with utmost priority [33].

4. Discussion

As the objective of this study was to develop a set of strategies for people evacuated from the vulnerable settlements for resettlement with shelter and livelihood provisions, this section deals with the socio-economic context for the resettlement at TRM, methodology for



Fig. 11. Shallow slide on the downslope of Syangtan Tol [33].

delineating vulnerable areas and resettlement in Nepal's new legal environment.

4.1. Socio-economic context for resettlement

Just 55 km away from Kathmandu Valley and 32 km from the district headquarters, the TRM is a suitable location for cash crops production for sale. Moreover, the wholesalers visit the farm gates, which made things simpler for producers. Fig. 12 shows the resettlement site at Budeniphant, at E 06–29–150 and N 30–89–500 with an elevation of 701 m amsl. This area comprises rock sequences of Lesser Himalaya. The bedrock of phyllite was observed in road cut slope. Cultivable land comprises ancient alluvial deposits. No geohazard was observed. The local government had connected this site with a dirt road from an asphalt road located 200 m away.

There are 22% absentee landlords at TRM. Consequently, about one fourth of the land area had gone barren. Traditional arrangement of share cropping was not prevalent in the rural environment as youth tended to go away from their villages. Similarly, the people who lived in the vulnerable settlements found it difficult to cultivate land at distant locations. It was essential for farmers to have farmlands within a distance of about one kilometer for transporting manure and harvesting the crop. As 52% of the population lived in steep slopes and 31% in areas vulnerable to landslides, it was urgent to relocate the people or adopt some mitigating measures to protect them from landslides. The 22% land of the absentee landlord was available for 31% people living in the landslide area. Under these circumstances, the concept of a land bank can become a win-win solution for both the landlords and tenants. With establishment of the land bank, GoN intends to intervene the land's demand and supply situation [32]. The vulnerability assessment of the available land will be required. The new integrated settlement is shown in Fig. 13.

4.2. Delineation of vulnerable areas

The steep slope, improper land use pattern, weak rock types and associated discontinuity, soil type and its depth and rampant urbanization are main influencing factors for slope instability in the Nepal Himalaya [5]. In addition, human activities, such as disturbing drainage patterns, destabilizing slopes, removal of vegetation, etc. may also cause hazards.

It is necessary to understand that stability of slope is governed by slope angle, geology and moisture condition [37]. In terms of slope angle, any land having slope greater than 30° is considered unsafe [28]. It is considered that convex curvatures of slope are more stable as they disperse the runoff more down the slope, whereas concave slopes concentrate water and cause impoundment [39]. Normally no structure is recommended on soft clay unless significant efforts to improve bearing capacity are in place. Since, soil strength plays an important role in foundation design, its properties need proper analysis. Similarly, the strength of rock varies with the degree of weathering condition and orientation of rock beds plays a significant role in direction of subsurface rain water flows direction, which governs the failure conditions. Excessive presence of surface and subsurface water indicates relative vulnerability of the location. Proper drainage management helps to control erosion activities. Numbers of shallow slides can be stabilized by appropriately designed drainage structures. Some land use types such as rice fields contribute additional vulnerability. Previous landslides, localized faults and cracks and flooded areas should be avoided; these can be interpreted using aerial photographs. Sites with signs of slow mass movements can be distinguished by observing tilting trees and disturbed slope terrain. Although the variables seem quite simple, it requires professional inputs from a geotechnical engineer and a geologist to assess vulnerability properly. Based on NRA's extensive experimentation, criteria for vulnerability that can be adopted are: slope angle and shape, soil type,

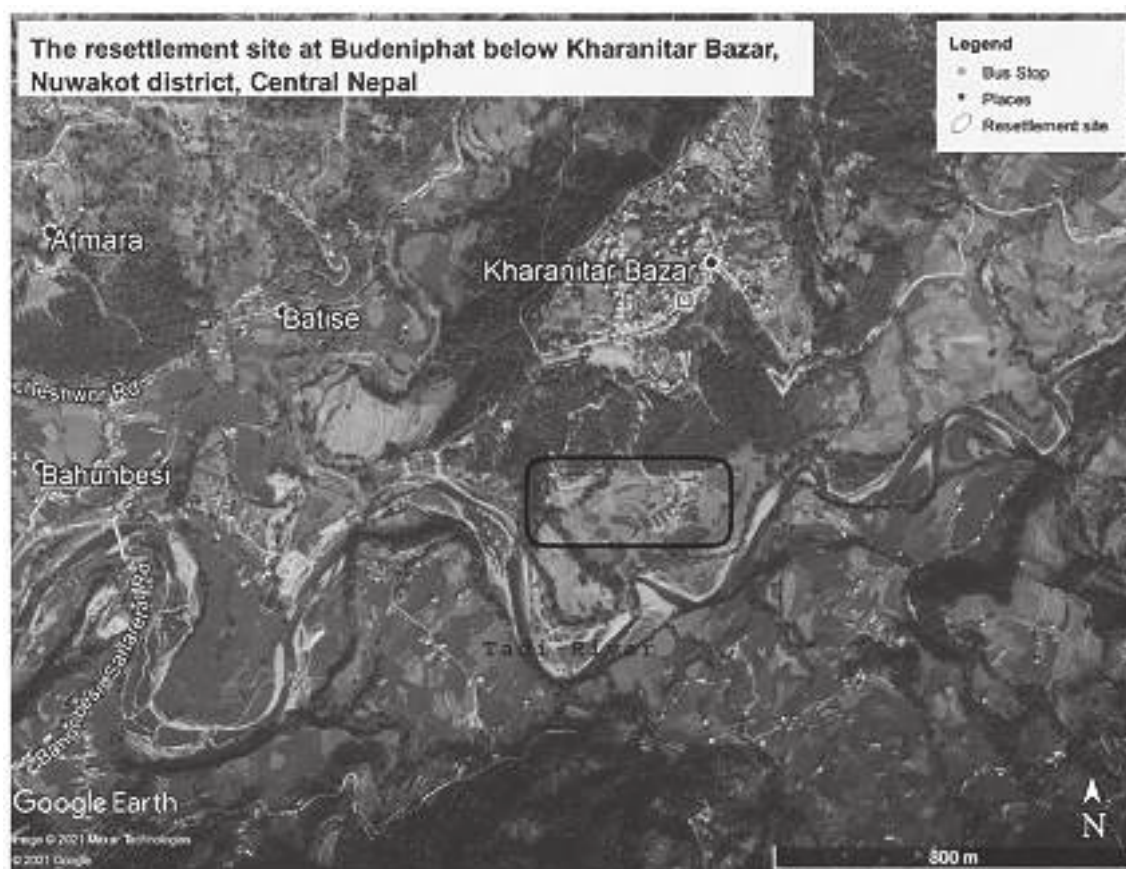


Fig. 12. Resettlement site at Budeniphant, Kharanitar (marked).

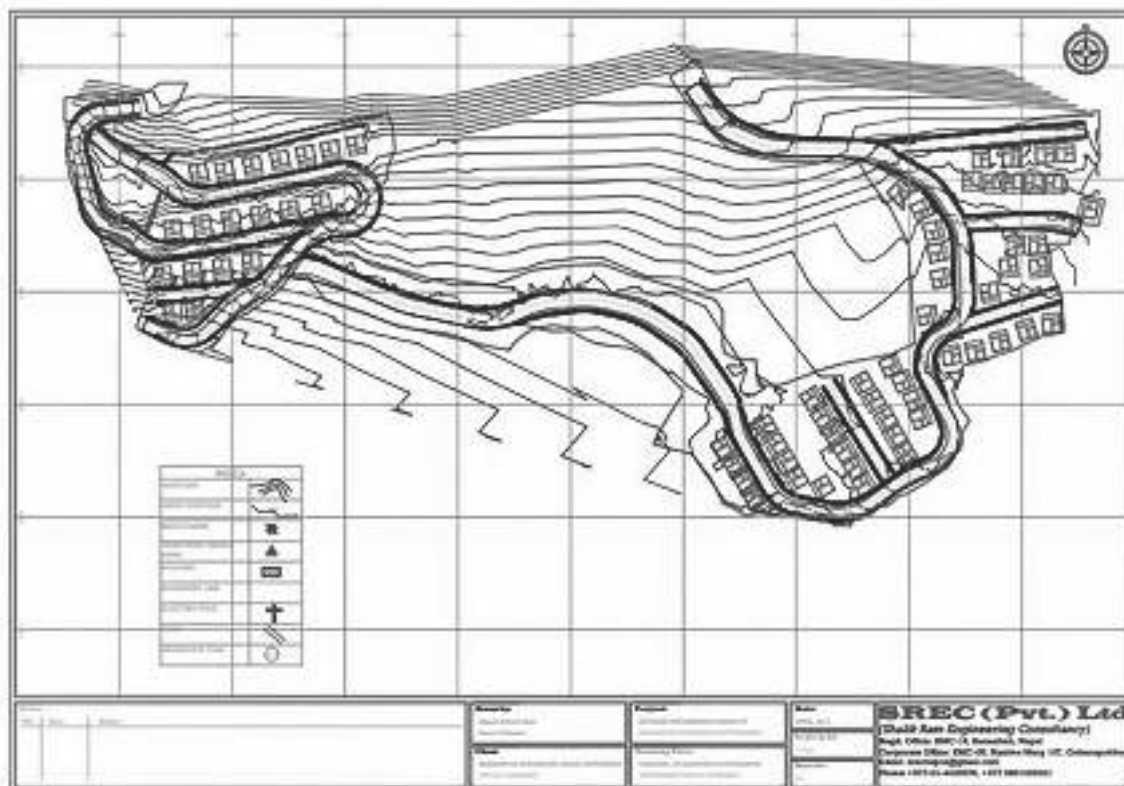


Fig. 13. Newly constructed integrated settlement at Budeniphath, Kharanitar.

rock type, structure and strength, discontinuities orientation, drainage condition and history of site (movement, old landslide, flood plain etc.).

4.3. Resettlement in the new legal context

NRA resettled the earthquake triggered landslide victims by using the authority of land acquisition that was bestowed by the Act Related to the Reconstruction of Earthquake Damaged Infrastructure 2072 [12]. In the new context, such land use related activities have to be implemented by the local governments. Three different types of legal instruments were enacted more recently: Local Government, Disaster Management and Land Use. The National Planning Commission (NPC) issued a directive for the preparation of local level annual plans and budgets, which is founded on the requirements in the Constitution of Nepal (LBMC 2015), Local Governance Act – 2074 and National Natural Resources and Financial Act – 2074. The directive mandates the local governments to prepare short, medium- and long-term plans and these plans are required to incorporate disaster prevention and reconstruction activities. In parallel, the MoHA issued another Guidelines for the preparation of preventative and reconstruction plan [24]. The striking difference between the NPC and MoHA directives is that the district doesn't have any role in the NPC directives as Nepal does not have a district level government. However, the MoHA directives have a very clear role at the district level as the District Disaster Management Committee (DDRC) plays a prominent role in planning and implementation of disaster management. The MoHA operation is top down and the local governments follow the bottom-up approach. The provisions of each guidelines are different and there is ambiguity in terms of real implementation. The National Disaster Risk Reduction and Management Authority (NDRRMA) may follow MoHA guidelines whereas the local governments may implement NPC guidelines. The provincial government had not become active in disaster management. However, the Constitution of Nepal 2015 has vested some role of disaster management also to

provincial governments. This contradiction may take quite a few years to resolve.

More recently, the Ministry of Land Reform and Management (MoLRM) introduced Land Use Policy and Act, which has provisions for classifying land into various classes such as residential, industrial, agricultural, forest and so on 2015. It is also mentioned in the Act that the MoLRM will prepare land use maps within one year of enactment. Based on that map, each local government is expected to prepare its land use plan. There are three inter-related issues here. First: what are the factors that need to be considered for defining the type of land use? Second: what is the appropriate methodology for preparing the land use plan? Third: how will the land use plan be implemented? The response to the first question is rather technical. For example, determination of land use depends on agro-climatic and ecological data such as rainfall data, major landform types, rock exposures, dominant soil type, slope gradient, soil drainage condition, slope aspect, soil texture, frost hazard, erosion status, water resources, and major land cover types. The agro-climatic and ecological information are juxtaposed with major land cover types such as cultivated land, forest, marsh land, etc. Based on this information land use plans can be prepared [21]. However, it is not only a technical issue but also a socio-political agenda, which must be endorsed by the local government. It means before approval by the local government, there would be need for community discussions to ease the approval process.

In terms of methodology, it is rather straightforward. At the initial stage, the technical team needs to work and set the basis for land use planning. In the second stage, the political stakeholders need to be involved in the decision making and implementation.

The most difficult aspect is the implementation of the land use plan. Under the present laws and regulations how the local governments will be able to implement the land use plans is not very clear. The people who live in vulnerable areas need to be evacuated but how will they be resettled? How will land be organized for them? What will be the medium

for listening to community voices, and what will the grievance redressal process be? It can be particularly difficult because appropriate land for settlement in the mountainous region is extremely scarce. All appropriate lands are cultivated and owned by the local people.

There is no clarity in the policy for abandoned land. Against all these odds, the Land Use Regulations – 2076 has generated a glimmer of hope with the provision for having a Land Bank. In this connection, through the TRM, NRA presented a model on how people from landslide prone areas can be settled in the areas of absentee landlords. NRA procured land for the homestead and house construction was supported by Oxfam according to NRA's rule. The NRA would have provided a housing grant if Oxfam had not provided the support. UKAid provided a water supply system and the TRM provided a budget for approach road construction [18]. Limited support was provided by Oxfam for livelihood purpose. The households were engaged in sharecropping arrangements with absentee landlords. This model has a potential for nationwide replication with site specific adjustments. This is a unique example how the local government, in collaboration with the central government and NGOs, can devise solutions for addressing a major problem faced by a segment of the society.

The proposed model for vulnerable households also offers livelihood opportunities (Fig. 14). In Fig. 14, women are receiving training on various hands-on skills that can be instrumental for generating self-employment opportunities.

Based on the proven experience derived from TRM, there exists a viable prospect to replicate this approach at other settlements. After concluding the land use planning, the local governments will need to evacuate people from the vulnerable settlements. The TRM led the entire process of land acquisition and resettlement, and also contributed for the approach road construction. A serious consultation and interaction should be undertaken with the vulnerable settlement people for their professional engagement based on skills they have. The local governments have to liaise with the commercial banks for loans. The land bank initiative has to be operationalized as soon as possible. The vulnerable people may wish to adopt farm or non-farm occupations. They may wish to initiate such enterprises jointly or collectively. Based on that, the local government should develop a support mechanism. After ascertaining the demand side management, the supply side arrangement has to be

ensured. For example, the terms and conditions for land banking have to be elaborated. Concluding agreement between the lessee and lessor would start a real production system. However, continual nurturing of budding entrepreneurs would also be essential.

5. Conclusion

The NRA's resettlement model applied in TRM demonstrated that vulnerable people can be resettled in a safe location with livelihood opportunities. This intervention was introduced in a very special circumstance of post-earthquake reconstruction. However, a resettlement policy can be introduced in the context of recently introduced local-level planning directives, disaster and land-related policies, laws and regulations. Local governments have to prepare a land use plan based on their own planning criteria but they will need to adhere to the recommendation of the federal government. The vulnerable areas need to be delineated based on slope, rock & soil type, structure and its strength, discontinuity orientation, drainage condition and history of site for natural disasters. On this GoN has to introduce the land bank act and regulation with the provision allowing local governments to have authority to acquire land from absentee landlords and hand it over to potential beneficiaries including vulnerable households. The land provided to vulnerable households should be used livelihood activities with the government providing irrigation facility, water supply and sanitation, settlement infrastructure such as road, drainage and electricity. In addition, easy access to bank loan would also be essential. This practice will benefit the land owner by providing certain financial benefits while retaining ownership. The internally displaced community can also not only find shelter but also livelihood opportunities in the safe locations. This can also benefit the national economy through sustainable growth.

Declaration of Competing Interest

We both Chandra Bahadur Shrestha and Lekh Bhatta declare that this work is not published previously. The "International Conference on Nepal's Reconstruction" has published its abstract which was done so in



Fig. 14. Vocational Training for Sustainable Livelihood.

consultation with PDS Editorial Board. The paper is approved by all authors explicitly and if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright holder.

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Regular Article

Building typologies and code compliance issues of reconstructed houses after 2015 Mw 7.8 Gorkha, Nepal earthquake: Experience from Dhading District earthquake

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ABSTRACT

After the 2015 Mw 7.8 Gorkha, Nepal earthquake, the Government of Nepal founded the National Reconstruction Authority (NRA) which is dedicated to the reconstruction of buildings and infrastructures in the earthquake. The NRA developed a policy to provide three-stage grants to the house owners to reconstruct their damaged house in owner-driven principle. To receive the grant, a building should be seismic resistant complying with building code NBC 105. Based on NBC 105, various prototype model buildings, minimum requirements and guidelines were formed. However, due to the lack of availability of expert engineers for designing the buildings, the owner built the houses according to their style and requirement. From the investigation of houses built in Dhading district, out of a total of 53109 houses reconstructed, 4.01% of buildings were constructed without following the minimum requirements and mandatory rule of thumb. Those buildings were required to check against NBC 105 with structural analysis. Structural engineers were deployed to assist the house owners to check the seismic capacity of buildings. The research presents the existing scenario of reconstructed building typology and discusses the major non-compliance issues prevalent in load-bearing and frame structures. A comparison of pre-and post-Gorkha earthquake housing typology is made by qualitative analysis of field data and an evaluation of the inspection level at which noncompliance mostly occurs is also illustrated in this research. The research shows out of the total buildings about 15.2 % of buildings are non-compliant according to the building code and could not be recommended for tranches.

1. Introduction

On 25 April 2015, a massive earthquake of magnitude 7.8 Mw [1] struck Nepal with an epicenter in Gorkha with series of aftershocks. The disaster caused 8790 deaths, about 800000 residential buildings were severely hit. The Post Disaster Needs Assessment (PDNA) identified 31 districts as earthquake-affected districts, out of which, fourteen districts were categorized as severely affected and seventeen districts as moderately affected districts [2]. Dhading is one of the severely affected districts. Fig. 1 shows the geographical coverage of damage area in 31 earthquake-affected districts

The Government of Nepal (GoN) classified the earthquake victims into two categories as reconstruction beneficiary and retrofitting beneficiary. Reconstruction beneficiaries receive NPR. 3,00,000 grants and retrofitting beneficiaries receive NPR. 1,00,000 grants. Both the beneficiaries are set to get the first tranche (NPR.50,000) after agreement signing. The second tranche (NPR.1,50,000) is provided after construction up to the plinth level (1st inspection) and the third tranche (NPR. 1,00,000) after construction up to the roof band level (2nd inspection) for the reconstruction beneficiaries.

Retrofitting beneficiaries, however, are set to get the remaining amount (NPR. 50,000) as the second tranche after the completion of retrofitting [3].

Nearly eight months after the devastating earthquake, the government constituted the National Reconstruction Authority and it took almost one year for the deployment of engineers at the field level [4]. By this time, many people had already rebuilt or repaired their damaged houses in seek of proper and safer shelter. The beneficiaries who didn't immediately reconstruct houses were initially reluctant to build earthquake-resistant houses as prescribed in the NRA guidelines due to high cost and unclear grant distribution policy of NRA. The government published different design catalogs, checklists for the aid of beneficiaries and support the reconstruction. As these design catalogs also could not address the actual needs and intentions of the people, they started to construct their buildings as usual without aligning to the new standards. As a result, buildings did not comply with the standards set by NRA and releasing grants became problematic. The problem got amplified when field technicians were also incapable of fully understanding the norms of the NRA. So, to resolve all these problems, the NRA recruited 27 structural engineers as district

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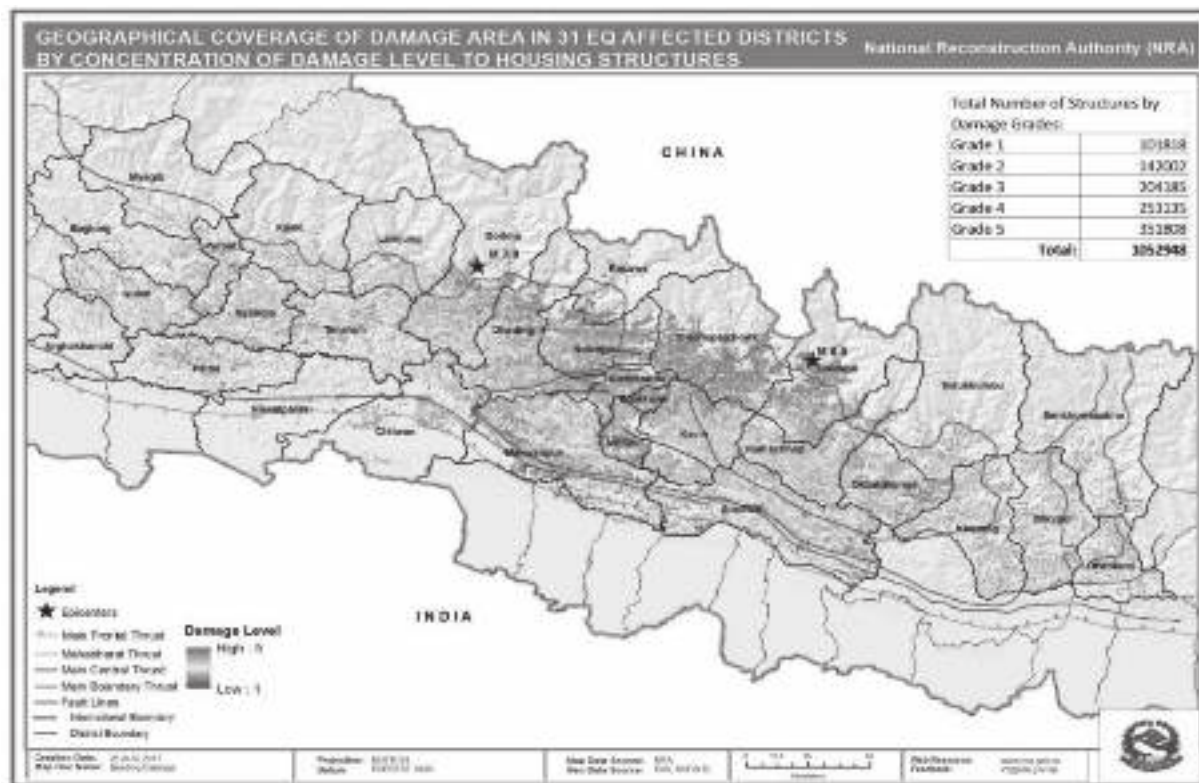


Fig. 1. Geographical coverage damage area in earthquake-affected districts (Source: [11,17]).

support engineers (DSE) on 15 May 2017 for the most affected 14 districts. The main purpose of hiring DSE was to support field-level technicians on technical issues and solve non-compliance issues. After the presence of DSE in the district, most of the noncompliance issues were solved at the district level and to address the unsolved issues, it was forwarded to the central level.

After the Gorkha earthquake, several post-earthquake studies have been published focusing on different aspects of reconstruction. HRRP [5] presented examples of newly built houses of different typologies in the earthquake-affected districts along with construction technical issues and level of assistance received by house-owners. Bothara et al. [6] discussed expected challenges of reconstruction after the Gorkha earthquake, strategy to tackle the challenges, different types of building materials and building typologies. Similarly, Adhikari & D'Ayala [7] presented the range of prevalent building typologies of pre-and post-earthquake residential houses, their distribution, and noncompliance issues mainly focusing on the stone masonry with mud mortar. Most of the existing literature discusses building typologies based on construction materials but in this research building typologies not only based on construction materials but also based on construction practice have been presented. Some new building typologies evolved just after the Gorkha earthquake and the research compares the pre-and-post - Gorkha earthquake housing typology. The study also highlights the major non-compliance issues prevalent in load-bearing as well as frame structures and shows the stage of construction at which non-compliance mostly occurs. The main motivation of this study is to identify the building code implementation during the reconstruction process after the Gorkha earthquake and to document the recommendations made by DSE to solve non-compliance issues.

2. Research methods

The research is carried out based on data collected by district support engineers (DSE) working in Dhading. Data were received in the form of different inspection sheets, assigned formats and photos from field technicians

and social mobilizers who were primarily responsible for collecting the data. A sample of the format used by DSE for data collection is shown in Fig. 2. DSE also conducted regular joint field visits with focal engineers, monitoring and evaluation expert, housing recovery and reconstruction platform (HRRP). During field visits, direct interviews were conducted with local bodies, field technicians, and beneficiaries. The data obtained from the field analyzed and reviewed qualitatively to categorize the building typology based on construction practice and construction material.

After checking the compliance of the building as per inspection sheets, field technicians reported the non-compliant buildings to DSE. Structural analyses were performed using software like SAP 2000 v20, ETABS v2015 to check compliance against building code NBC 105 for 2131 collected sample data. Noncompliance issues were also received from partner organizations and third-party monitoring agents (TPMA). As per the field visit report submitted by TPMA to the district office, they conducted 5666 spot checks at different inspection levels to evaluate the compliance of buildings with standard inspection sheets. Besides investigating documents published by the NRA, other governmental and non-governmental agencies, solutions obtained from district-level and central-level seminars are also included in the research.

The research illustrates major housing typologies and noncompliance issues of Dhading district specifically based on collected sample data. The strength of the paper is that it brings firsthand practical experience from the earthquake-affected areas but the study cannot be generalized over other 31 earthquake-affected districts. The situation could be different from practices in other districts which is the main limitation of this study.

3. Building typology

This section discusses the construction patterns that are prevalent in the earthquake-affected districts before and after the Gorkha earthquake with the main focus on building construction typology in Dhading after the Gorkha earthquake. According to Gautam et al. [8], RCC, unreinforced masonry (URM), rubble stone construction, adobe construction were

S.No	Name of Owner	Address	Tale	Building type	No. of Storey	Material	Reason of non compliance	Beam		Column	Remarks	
1	Ramesh Achikari PA no. 30-34-2-0-343	Naubise-2	Kokrala	RCC	2.5	M20 Grade of concrete	Size of column less than 12"x12"	9"x14"	6-12mm dia bar	9"x12" 4-16mm dia bar 2-12mm dia bar		
3	Kade Baniya PA no. 30-34-8-0-360	Naubise-7	Naubise	Stone masonry in mud mortar	1.5	Mud mortar, wooden band, stones	Attic height more than 3 feet					
Signature:												
Engineer's Name:												
Contact no:												

Fig. 2. Sample format for data collection.

dominant construction systems of Nepal. About 95% of damage is shared by URM, random rubble and adobe construction, so the Gorkha earthquake is more devastating towards such buildings in comparison to RCC buildings in the affected districts. The post-earthquake reconstruction shows that load-bearing structures are found in rural areas and frame structures in urban areas but gradual changes in building types are noticed after the Gorkha earthquake. Load-bearing structures are replaced by RCC structures with the common perception that any type of RCC structure is more earthquake resistant compared to load-bearing masonry structures[9].

The NRA inspection website data of Dhading shows about 53% of reconstruction houses are SMM, 34% are brick masonry, 12 % are RCC frame structures and 1% consists of other type structures like block masonry, dry stone masonry, confined masonry, etc. [10]. Fig. 3 provides an indicative comparison of pre-earthquake and post-earthquake housing typologies in 31 earthquake-affected districts. Stone in mud masonry (SMM) is the primary construction type in both cases. The building typologies presented in this section are the indicative and major types only. The following sub-sections provide information about the reconstruction building typologies in the Dhading district.

3.1. Based on the construction practice

Based on construction practice, the building typologies can be categorized as column building structures and composite structures, the details of which are described below. These building types are evolved after the Gorkha earthquake which became predominant over other types.

3.1.1. Column building structures

In these types of structures, columns are cast at corners and wall inter-sections to replace the cornerstones of masonry buildings. The size of

columns can vary with sizes such as 230mm x 230mm, 230mm x 300mm or 300mm x 300mm and with different rebar specifications. The building with RCC columns and flexible roofing can also be categorized under this type of structure. Generally, the RCC column with flexible roofing results when the house owner initially starts to construct the RCC building but later installs flexible roofing due to financial problems. Fig. 4a shows an under-construction column building structure with concrete blocks as masonry units and Fig. 4b shows a completely constructed building with bricks as masonry units. Such types of buildings can neither be categorized as the load-bearing structures nor as frame structures. Since walls are intercepted by the presence of columns at different locations, the box effect is not developed fully like load-bearing structures. Also, columns are not connected by slabs and beams, they do not act like frame structures, Hence, these structures do not perform well during earthquakes but the addition of columns has only increased the cost of construction and weight of the building.

3.1.2. Composite structures

There are two types of the composite structure. Firstly, the combination of materials (load-bearing walls at ground floor and timber or steel frame with CGI covering at first floor, Fig. 5a). Secondly, the combination of load resisting system (RCC at ground floor and masonry with flexible roofing at first floor, Fig. 5b). The first one is more prevalent in different parts of Dhading. After the Gorkha earthquake, people constructed such types of houses since they realized that load must be reduced on the upper floor to lower the effect of the earthquake. Such a house can be advantageous as it avoids the heavyweights on the upper floor. But the upper floor must be well connected with the first floor at floor level and cross-bracing should be provided on the upper floor to enhance seismic safety. To assist construction and support field technicians for the inspection of these houses, the NRA published a hybrid structure manual on 25 September 2017 [11].

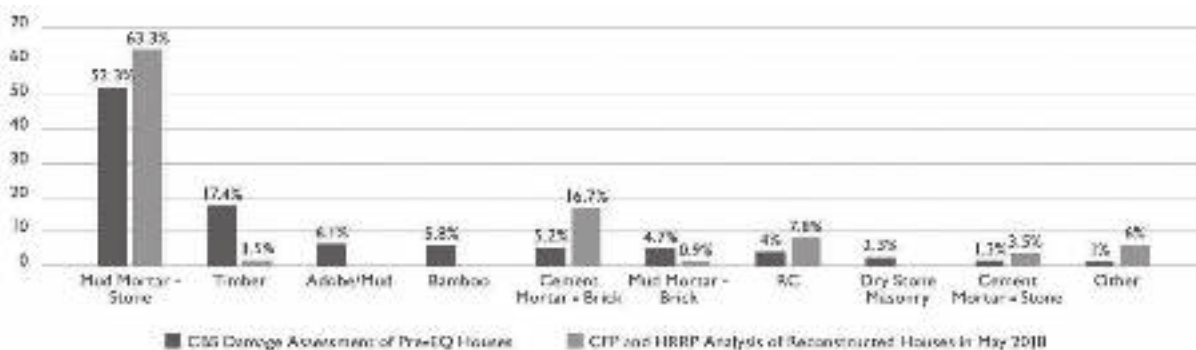


Fig. 3. Comparison prevalence of pre-and post-earthquake housing typologies (Source: [5]).



Fig. 4. Column building structures with (a) concrete blocks in cement mortar (b) bricks in cement mortar.



Fig. 5. Composite structure with (a) load-bearing walls on the ground floor and timber frame in the first floor (b) RCC frame at the ground floor and flexible floor at the first floor.

3.2. Based on the construction floor plan

The building typology described in this section is a one-room building as shown in Fig. 6 which is found in a larger number than other multiple-room buildings. Based on data collected in the district office, nearly 35% of newly reconstructed buildings consist of only one room. The main reason behind this is the low amount of grants received by the community member. They perceived the grant as compensation to cover the reconstruction cost of the damaged house rather than assistance. The inclusion of a one-room building among 17 model houses in Design Catalogue: Volume I [12] and the tight deadline for grant disbursement by NRA at different times further promoted the construction of this type of building. Later, the NRA's 119th executive committee decided the minimum carpet area for the one-room house to be 11.137 m² [13]. Most of the people have misused the grants by constructing uninhabitable single-room houses taking the advantage of such delayed announcement. The beneficiaries would have got their functional habitat and the construction of one-room

buildings could have been under control if the NRA had set up rigid criteria like only vulnerable groups could construct such buildings.

3.3. Based on construction materials

Based on construction material, the building typology in the Dhading district can be categorized into stone masonry, brick masonry, RCC framed structures, dry stone masonry and concrete block structure.

3.3.1. Stone masonry

These are the most common type of buildings found in rural areas of Dhading. Stones are either bonded with cement or mud mortar (Fig. 7). Walls are normally 350-450mm thick and constructed in multiple wythes. The height of the building can be one story or two-story depending on wall thickness, type of mortar used and type of horizontal band. Flooring is normally timber joist or bamboo with mud plaster and the roof is generally constructed with rafters and CGI or tiles covering.



Fig. 6. One room building with stone in mud mortar and flexible roofing.



Fig. 7. Two-story stone masonry building in mud mortar.

3.3.2. Brick masonry

Walls are load-bearing in these buildings. Bricks are either bonded with cement or mud mortar. Wall construction is double brick with no cavity and is normally 230mm or 350mm thick. The height of the building can be one story or two stories depending on wall thickness. The floor system is usually mud on bamboo or timber joists (Fig. 8) and sometimes reinforced concrete (generally in urban areas). The roof structures are timber or steel with CGI or tiles in some cases, a sloped roof is built using RC slabs.

3.3.3. RCC framed structures

These buildings are constructed by the cast in situ concrete columns, beams and slabs (Fig. 9). They have a brick wall or block wall as infill walls and can be pre-engineered or engineered. There are two common ways to construct RCC buildings; the walls can be done first or the walls can come afterward. RCC structures are most prevalent in the urban area,

but they are becoming more common in rural areas where access to engineering support and quality materials is limited.

3.3.4. Dry stone masonry

These types of houses are found especially in the Northern part of Dhading, Ruby valley rural municipality. In these structures, the walls are constructed using only stone and no mortar is used. For dry stone construction, the stones are required to be better prepared or dressed as there is no mortar to accommodate gaps in the stones. Most of the dry-stone masonry houses are single rooms where timber is used as horizontal bands and vertical posts (Fig. 10).

3.3.5. Concrete block masonry

Block production factories have evolved just after the Gorkha earthquake in the southern part of Dhading near to the highway where cement is readily available. These blocks can be hollow concrete blocks (Fig. 11a), solid blocks,



Fig. 8. Single story brick masonry building in cement mortar.



Fig. 9. RCC frame building with different column sizes.



Fig. 10. Dry stone masonry building with timber bands and vertical post.



Fig. 11. Block masonry buildings in cement mortar (a) hollow concrete blocks (b) interlocking blocks.

compressed stabilized earthen blocks, interlocking blocks (Fig. 11b). The size of such blocks also varies. Buildings made with these blocks and cement mortar fall under this category. Most of the locally made hollow concrete blocks do not meet the specifications prescribed in NS 119/2042 [14]. Design Catalogue: Volume II also includes approved designs for two-story hollow concrete block confined masonry and masonry building [15].

4. Noncompliance issues and their resolution

“Build Back Better” is the main slogan of the NRA which reflects its primary objective of building a multi-hazard resilient community through socio-technical assistance and grants. This section deals with the resolution of non-compliant structural issues in the context of a major disaster when the owner-driven housing reconstruction (ODHR) approach has been adopted. In this approach of reconstruction, house owners themselves are primarily responsible for the construction of the houses according to their style and requirement and the NRA provides technical support and grants in three-stage. To receive the housing reconstruction grant, a building should be seismic resistant complying with building code NBC 105. Based on NBC 105, various prototype model buildings, minimum requirements and Mandatory Rules of Thumb (MRT) were formed which provide ready-to-use dimensions and details for various structural and non-structural elements for certain building types. Minimum requirements (MRs) are mentioned in the inspection check sheet as shown in Fig. 12 [16].

After checking the compliance of structures according to the inspection guidelines, the inspection team recommends the tranche for compliant structures or forwards noncompliant structures to DSE. Now, DSEs perform certain checks, structural analyses and provide recommendations for the tranche release if the structure is compliant with NBC 105 otherwise, they suggest some correction method to make structures earthquake resistant and code compliant. The tranche can be released after the application of the process. Due to a large number of non-compliant structures being non-eligible for a financial grant, the NRA published a correction and exception manual [11]. This manual is prepared to introduce the exceptional

cases, other than those mentioned in MRs and several correction measures along with their step-by-step procedures for mitigation measures. Beneficiaries whose houses were considered as non-compliant will get a chance to make their house compliant if their house falls under any case of the exception or adopt the appropriate corrective measures mentioned in this manual. On the other hand, this manual is helpful to all the engineers who are working for the reconstruction and are deployed by GoN for inspection. As many exceptional cases and tolerance were introduced in this manual, it will help them to fill up the inspection check sheet. Most of the masonry buildings were corrected as per the E/C manual as their processes are more simple and cheaper but the correction method could not be applied in the case of the RCC structures due to the expensive and sophisticated process for correction. This created a milestone for the management of resolution of noncompliance issues, especially in case RCC structures. The tendency of the beneficiaries is towards getting tranches without applying correction methods. Beneficiaries who hesitated to correct the buildings tried to find out loopholes, and they constructed one-room houses just to receive tranches. So, the provision of sufficient mobile masons with appropriate training on correction and retrofitting techniques would have solved this issue to some extent. A layout of the whole process is provided in Fig. 13.

4.1. Major non-compliance issues

The major noncompliance issues prevalent in both load-bearing structures and RCC frame structures at different stages of construction are discussed in this section. Major non-compliance of the building was noticed to occur mainly after getting the third tranche while some non-compliance cases were observed even at the start of the construction. According to the investigation of the Dhading district, DSE collected 2131 non-compliant houses of 53,109 total reconstructed houses [10] which shows 4.01% of buildings are constructed without following the minimum requirements and mandatory rule of thumb. Beneficiaries even after getting all the tranches, performed additional construction activities in the houses

Name:		Date of Inspection		D: M: Y:	
Address:		Grant Agreement No.			
District:		Municipality:		Ward:	
House No.:		Plot No.:		Land Use No.:	
I use the design from design data sheet.				Design No. BMC-1.1	
I hired design by house owner.				Technique and Construction material	
I fill construction by design from P.A form				Construction of roof and materials	
Technical Assistant:		☐ YES, ☐ NO		Organization ☐ Govt, ☐ NGO	
Trained Masons used:		☐ YES, ☐ NO		Soil type ☐ Hard, ☐ Medium, ☐ Soft	

MR No.	Category	Description	Comply to MRs		Remarks
			YES	NO	
1	Site selection located away from	Geological fault or Rupture Area	☐	☐	
		Slope Steep > 20°	☐	☐	
		Landslide susceptible Area	☐	☐	
		River bank and Water logging Area	☐	☐	
		Rockfall Area	☐	☐	
		Liquefaction susceptible Area	☐	☐	
2	Shape of House	No. of stories	☐	☐	
		Span of Wall	☐	☐	
		Size of room	☐	☐	
		Proportion	☐	☐	
3	Materials	Brick	☐	☐	
		Mortar	☐	☐	
		Concrete	☐	☐	
		Roof	☐	☐	
		Timber	☐	☐	
		Continuous Roofing	☐	☐	
4	Foundation	Depth below GL	☐	☐	
		Base	☐	☐	
		Width	☐	☐	
		1 story	☐	☐	
5	Vertical member	Started right from the foundation	☐	☐	
		Placed at all corners, junctions of walls and openings	☐	☐	
		Reinforcement	☐	☐	
		Anchorage	☐	☐	
6	Plinth	Height from GL	☐	☐	
		Thickness	☐	☐	
		Width	☐	☐	
		Reinforcement	☐	☐	

Fig. 12. Sample of inspection sheet for brick masonry in cement mortar.

without consulting field engineers. Most of the beneficiaries added stories more than prescribed in MRs and some added roofs without constructing a gable band. All of these additional construction activities undertaken without consultation with field engineers also made their buildings non-compliant. Fig. 14 shows an example of noncompliance RCC building and Fig. 15 shows load-bearing noncompliance masonry building. The major noncompliance issues found in Dhading are listed as followings:

RCC frame structure:

- Column size < 300mm x 300mm
- Reinforcement in column < 8 nos. (4-16Ø + 4-12Ø)
- Plan and elevation irregularities
- Panel area > 13.5 sq. m.
- Column spacing < 2.1m & > 4.5 m

Load Bearing Structure:

- Absence/discontinuity of horizontal and gable bands
- Absence of vertical reinforcement
- Positioning and size of the opening
- Larger attic height

4.2. Structural assessment and resolution

As stated earlier, District support engineers (DSE) are responsible to check the compliance of structures as per building code. The compliance check of a building is done primarily by structural analysis using software like SAP 2000 v20, ETABS v 2015 as per criteria mentioned in NBC. The non-compliant houses are categorized based on their noncompliance issues and structural assessment is performed case by case.

4.2.1. Case studies

Two samples of structural modeling of typical non-compliant buildings are presented to show how DSE solved the noncompliance issues. A residential 2 storied RCC building with a story cover is shown in Fig. 16 The plinth area of the building is 75.6 m² and its height is 8.25 m. The building is located in steep sloppy land; hence an isolated foundation is provided in different elevations in one of the grids. Further, the extra beams are also provided at a distance of 0.91 m below the first story beam to connect the foundation at the elevated level and columns. The column between the extra beam and first story beam is shorter than other columns at the same

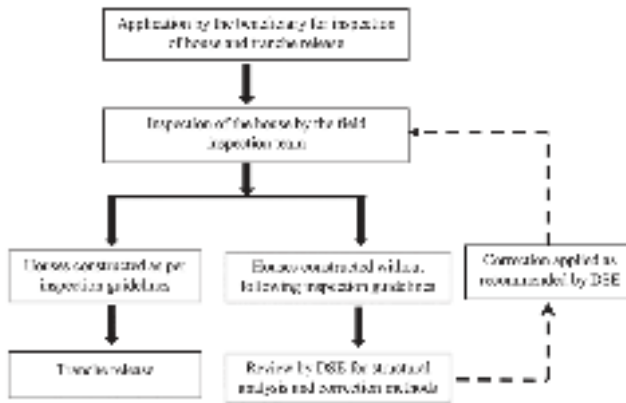


Fig. 13. Flow chart for the inspection procedure and resolution of noncompliance issues.



Fig. 14. RCC building with 230mm x 230mm column.



Fig. 15. Masonry building with no gable band.

floor level and the building does not meet the minimum requirements (MRs). The three-dimensional image of the building showing the first story beam, extra beam and shorter column is provided in Fig. 17. The shear force variation in grid 1-1 of the building while analyzing under load combination (Dead Load (DL) + 1.3*Live Load (LL) + 1.25*Earthquake in X-direction (EQx)) is shown in Fig. 18. After the structural analysis, it is found that the building is compliant with NBC 105 specifications but the variation of shear force shows that it is necessary to check the short column effect.

Massive variation in shear force can be observed in Fig. 18 between shorter columns and ground floor columns. This is just a representative illustration, and it is the same for other grids as well. By observing this massive variation,



Fig. 16. A real picture of the building with the beam at different heights.



Fig. 17. The three-dimensional figure of the building.

we can conclude that the columns between the extra beam and first story beam exhibit a short column effect [18]. Despite experiencing a short column effect, the demand for lateral ties determined from the software in those columns is however not exceptionally high. The maximum lateral ties demand calculated by the software is $332.53 \text{ mm}^2/\text{m}$, meaning that even 2-legged 6 mm bars at the spacing of 170 mm will be sufficient. This type of requirement is usually fulfilled in residential RCC buildings of Nepal. Hence, even noncomplying with norms of IS 13920: 2016, columns can be safe in shear resistance while analyzing it through numerical models depending upon the specific cases. But, if we follow the norms of IS 13920:2016, we ought to provide special confinement reinforcement of diameter at least 8mm as lateral ties over the full height of short columns at a spacing not more than 100 mm.

Another illustrated example consists of a typical residential two-story brick masonry building with a plinth area of 24.48 m^2 as shown in Fig. 19. The masonry building has two rooms with a 250 mm thick wall and the total height of the building is 3.34 m. Doors and windows are located at a distance of less than 600 mm from the corners of walls and it is 2 story building with 250 mm walls on all floors. According to MRT, the thickness of the wall on the ground floor should be 350 mm for 2 story building and the location of the opening should be 600 mm away from the corners of the wall which makes the building non-compliant. So, the structural analysis is required to check compliance of the building with the building code. The three-dimensional image of the building simulating the original building is provided in Fig. 20.

In the model, compressive stress, shear check, inplane check and out of plane check of the building are performed. Material properties of the brick masonry building calculated as per IS 1905: 1987 are tabulated in Table 1 and the stress obtained from the numerical modeling is shown in Figs. 21 and 22. These stresses are used to perform various checks as summarized in Table 2. The building passed all the checks and is safe for residential purpose.

Although both the buildings do not meet criteria as per MRs and are non-compliant, the buildings passed all the checks and are compliant to NBC 105 requirements which mean a building found non-compliant based on MR or MRT may be found compliant to relevant codes if a specific design is conducted. In other words, in some cases, MRs are seeking higher demand than proposed in NBC 105. So, the concerned authority should prepare MRs that it is compatible with the criteria outlined in the building codes.

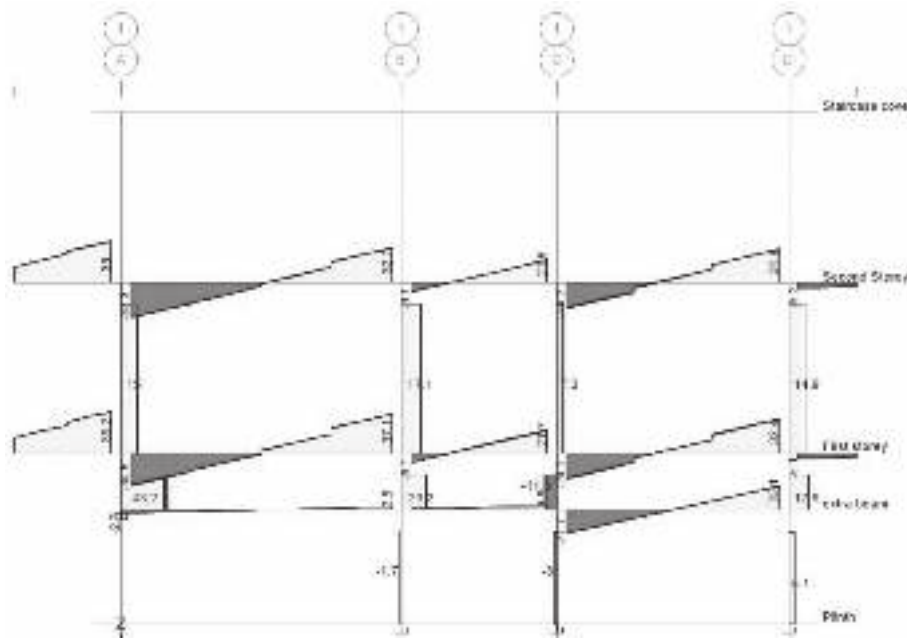


Fig. 18. Shear force distribution in grid 1-1 under DL + 1.3LL + 1.25EQx.



Fig. 19. Brick masonry building.

4.3. A scenario of non-compliant buildings

Fig. 23 shows the number of different types of non-compliant buildings at the end of July 2020. Though most of the houses in Dhading are load-bearing structures, non-compliance cases in RCC buildings are higher than in masonry buildings. The main reason behind this is due to lack of trained mason for construction of RCC buildings in rural areas. Also, correction methods for masonry buildings are quite simple, easily acceptable by house owners and exception rules described in the C/E manual provided some flexibility over MRT, noncompliant cases for masonry buildings are reduced by large numbers. The comparison in terms of numbers between



Fig. 20. 3D representation of brick masonry building.

compliant and non-compliant buildings is presented in Fig. 23. From this figure, it is seen that out of the total buildings there are only 323 (about 15.2 %) buildings are non-compliant according to the building code.

The TPMA conducted different field visits and made a total of 5,666 spot checks to evaluate the compliance of buildings as per the inspection sheets. According to the field visit report, only 301 reconstructed buildings are noncompliant. As indicated in Fig. 24, the least noncompliance (0.45%) occurs at the first inspection level when the construction reaches up to the plinth level and the highest noncompliance (8.74%) occurs at the second inspection level when the building is above the plinth level and below roof band level. Noncompliance at the third inspection level which is after the construction of roof band level is about 7.09% is significantly larger in comparison to the first inspection.

5. Recommendations from DSE

Based on structural analysis, literature reviews and solutions obtained from the central level seminars, DSE made the following recommendations to simplify the tranche releasing process. The efforts made by DSE to solve typical non-compliance issues are described in Table 3:

6. Conclusions and recommendations

The paper is the outcome of the firsthand practical experience from the earthquake-affected areas. The paper in general presents experiences gained during the rural housing reconstruction and non-compliance issues and their resolution. Following conclusions can be drawn from the research:

Table 1
Properties of the brick masonry building.

S.N.	Description	Grade	Unit	Remarks
1	Wall thickness	230	Mm	
2	Masonry Strength	M1		
3	Brick strength (2 nd class)	10	N/mm ²	IS 1905:1987
4	Basic compressive strength	0.96	N/mm ²	
5	Stress reduction factor	0.73		
6	Shape modification factor	1		
7	Allowable compressive stress	0.50	N/mm ²	

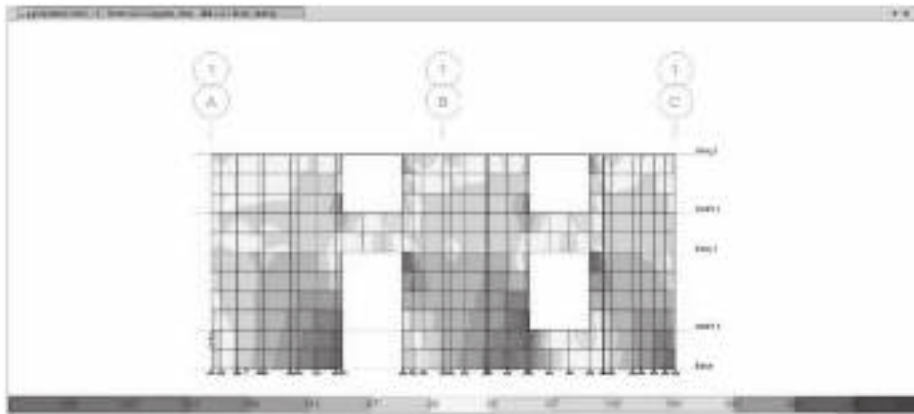


Fig. 21. Compressive stress check at Grid 1.



Fig. 22. Shear stress check at Grid 1.

- i. Nearly 35% of newly constructed buildings fall under the category of one room. Beneficiaries didn't perceive grants as assistance but rather as compensation provided to cover the reconstruction cost of their damaged house. Some beneficiaries also constructed a one-room house just to receive tranches as their previously reconstructed houses were non-compliant.
- ii. Some unusual building typologies like corner columns, composite structures are seen after the Gorkha earthquake in different parts of Dhading. Dry stone masonry and stone masonry buildings are mostly found in the northern rural areas whereas RCC frame and block masonry buildings are mostly seen in the southern urban areas.
- iii. The non-compliant buildings do not always mean they cannot be recommended for grants. Only 15.2% of the total non-compliant buildings

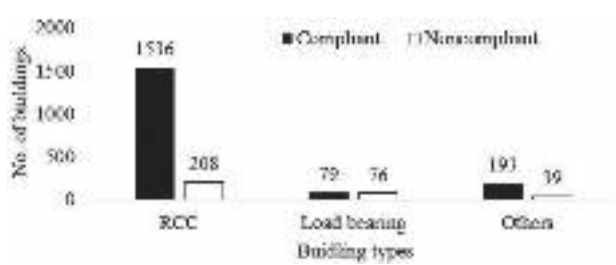


Fig. 23. A scenario of compliant and non-compliant buildings.

Table 2
Output parameters of the brick masonry building.

S.N.	Description	Demand	Capacity	Unit	Remarks
1	In-plane analysis				
i.	Maximum Compressive stress	0.44	0.50	N/mm ²	Safe
ii.	Tensile force	21.89 x10 ⁶	58.37 x10 ⁶	N	Safe
2	Maximum shear stress	0.025	0.56	N/mm ²	Safe
3	Out of the plane analysis				
	Moment at				
i.	Sill level	5.85 x10 ⁶	7.13 x10 ⁶	N-mm	Safe
ii.	Lintel level	6.13 x10 ⁶	14.25 x10 ⁶	N-mm	Safe
iii.	Sill level first floor	5.68 x10 ⁶	7.13 x10 ⁶	N-mm	Safe
iv.	Roof level	3.94 x10 ⁶	7.13 x10 ⁶	N-mm	Safe

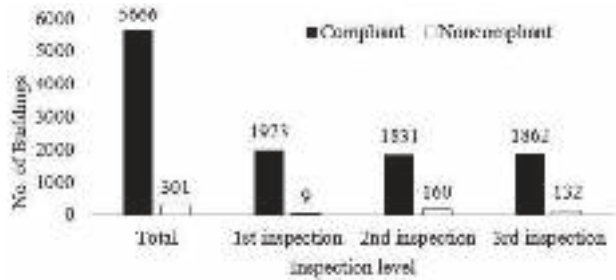


Fig. 24. Stage of noncompliance of buildings.

Table 3
Solution of typical non-compliance issues.

S.N.	Typical noncompliance issues	Explanation	Solution
1.	RCC frame structure with 10mm rebar in vertical member(column).	As per IS 456, it is not allowed to use rebar less than 12 mm in compression members.	The structure is analyzed as a framed structure with infill walls not analyzed as a bare frame structure.
2.	Lack of horizontal bands and vertical reinforcement in load-bearing structure.	Horizontal bands and vertical reinforcement are required to take the lateral load.	Correction is provided as per exception and correction manual and structural analysis.
3.	Corner columns instead of single vertical rebar and building with RCC columns and flexible roofing.	Columns used at different locations of the wall only replace cornerstones but do not take gravity loads and act as frame system unless it is connected by beams/slabs.	At first, structural analysis is carried as a load-bearing structure and the effect of columns is not taken into consideration. Later, the rebar required to take tensile stress is compared against the rebars in columns.
4.	Discontinued horizontal/roof bands	Discontinuity of the horizontal band is mainly due to the presence of a timber main beam at the floor level.	Place timber main beam after casting roof band or correction of a band connecting the discontinued band.
5.	Absence of roof /gable bands.	The gap between the top horizontal band and rafter/purlin is filled with two or three layers of masonry units with mortar.	The masonry above the band has a very small height. It is also restrained by vertical elements on sides so failure is unlikely to happen in this zone (Exception)

were found to be structurally unsafe according to building codes and could not be permitted to receive tranche. However, these unsafe non-compliant buildings can be recommended for tranche after the application of correction/retrofitting methods as suggested by DSE.

- iv. Load-bearing structures are the major housing typologies before and after the Gorkha earthquake. About 87% of reconstructed buildings are load-bearing structures like stone masonry and brick masonry.
- v. Most noncompliance occurs at the second inspection level which is about 8.74%, presumably due to the absence/discontinuity of horizontal bands and improper location of bands. Noncompliance at the third inspection level is about 7.09% which might be due to the absence of gable bands and modification in the houses after getting the third tranche.

The study shows the majority of the noncompliance issues are encountered after the third inspection. It would have been better if the third tranche was released after the completion of the house rather than after construction up to roof band level. This would check beneficiaries constructing houses haphazardly after getting the third tranche. The trend construction of building with columns has evolved in the rural parts of Dhading just after the Gorkha earthquake with the common conception that column performs well during earthquake. So, the NRA should have included the confined masonry construction in their mason training programs with sufficient guidelines to promote its construction rather than the RCC structures and column building structures. Overall, the authors would like to recommend raising the awareness program before implementing such reconstruction programs so that noncompliance issues could be minimized and financial assistance provided by the government could be fully utilized to construct a multi-hazard resilient community.

Intellectual property

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Research ethics

We further confirm that any aspect of the work covered in this manuscript that has involved human patients has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript.

IRB approval was obtained (required for studies and series of 3 or more cases)

Written consent to publish potentially identifying information, such as details or the case and photographs, was obtained from the patient(s) or their legal guardian(s).

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Regular Article

Post-earthquake reconstruction: Managing debris and construction waste in Gorkha and Sindhupalchok Districts, Nepal

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ABSTRACT

The 2015 Mw 7.8 Gorkha Nepal Earthquake had severely damaged buildings producing massive amount of debris. This paper assessed the amount of debris generated and construction waste during post-earthquake housing reconstruction in the earthquake most affected two districts. The study was carried out between April 2017 to December 2019, in Gorkha and Sindhupalchok districts of Nepal. The questionnaire survey were conducted in 17,814 households (Gorkha: 4896 and Sindhupalchok: 12,918) that were reconstructed after the earthquake. The sample household was selected randomly and the amount of debris and waste generated from each household was visually estimated. A z-test was performed to determine the quantity of debris and waste generated in each household at district as well as local administrative level. The result showed significant difference between the total amounts of debris generated in two districts - Gorkha ($m = 17.03 \text{ m}^3/\text{HHs}$; $SD = \pm 10.15$) and Sindhupalchok ($m = 21.61 \text{ m}^3/\text{HHs}$; $SD \pm 8.92$). Construction waste that was produced in construction sites in Gorkha and Sindhupalchok were $1.11 \text{ m}^3/\text{HHs}$ and $1.59 \text{ m}^3/\text{HHs}$ respectively. Proper management of debris and waste was lacking due to the absence of policies and guidelines on debris and waste in Nepal. However, individuals reused 57.96% of generated debris for housing reconstruction. The study recommends for preparation of debris and waste management plan for the future reconstruction activities.

1. Introduction

Disaster causes the damage of property, collapse of buildings and infrastructures (Lindel and Prater, 2003) resulting in the production of massive quantity of debris (Karunasena, 2011). Management of demolished parts and waste is one of the great challenges after earthquake, especially in earthquake affected rural areas of Nepal. Due to the lack of disposal site and limitation of financial resources, reusing construction material of demolished part (debris) and construction waste has attracted considerable attention. A study showed with proper demolition and recycle technology, 80–90% of the total debris from the demolished buildings can be recycled and are also economically feasible [17]. Moreover, these recycling technologies can easily implemented and controlled. Rafee et al. [32] indicated that the estimation of debris is a highly important strategy for debris and waste management. Effective debris management during recovery and rebuilding has valuable impacts on social, financial and environmental aspects [6]. Removal of debris in the earthquake affected areas was the first priority [11] and was organized through the local government in Gujarat Earthquake [15]. However, the household and local government are not well capacitated enough to respond to such catastrophic evidence and immediate service delivery for debris

removal and its management [1]. This paper presents the use pattern of debris during the reconstruction of houses in Nepal.

Nepal is considered as a vulnerable nation to the earthquake and its aftermath. United Nations Development Programme [30] considered Nepal as the 11th most earthquake prone nation in the world. This was proven right on 25 April 2015 at 11:56 AM local time (+5:45 GMT) when the 2015 Mw 7.8 Gorkha Nepal Earthquake of 7.8 moment magnitude (Mw) shocked Barpak of Barpak Sulikot Gaunpalika (GP) of Gorkha District. Similarly, on 12 May 2015, a 6.8 Mw earthquake hit Sindhupalchok District causing a mass shockwave throughout 14 mid and high hill districts of Nepal [22]. Combined with several aftershocks, these devastating events claimed 8700 lives and massively destroyed houses and infrastructures [22]. The destruction was widespread dismantling residential buildings, religious and public infrastructures. Large population were left homeless who sought shelter either in makeshift tents or tarpaulin [7]. Although Nepal had faced the similar earthquakes in the past in 1255, 1505, 1934, 1980 and 1988 with magnitude higher than 6.5, but could not stop the destruction [18]. Similar to past earthquake events, many houses were buried and local residents were made homeless with huge economic losses and long term social effects.

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Earthquakes cause different levels of damages. One such example is subsequent production of significant volume of debris from the demolished building [2]. Around 755,549 residential houses were damaged by the earthquake [22], resulting in production of high amount of debris. The potential to recycle or reuse the debris is sometimes overlooked to clear affected areas quickly [21]. However, during the process of reconstruction is underway, the major challenge and opportunity is the management of debris at individual HH and local administrative level. In addition to varied geographical challenges in Nepal, there is a lack of awareness and preparedness among the individuals, scarcity of proper technology, lack of proper disaster management plan and coordination among agencies to carry out debris management at such magnitude [18].

Post-disaster debris cleanup and management in developing countries are mostly done manually, resulting in difficulties to mankind those who are already suffering from the stress of the disaster [28]. Generally, the debris is dumped in landfills which can be costly both environmentally and economically [10,19]. It is observed that additional land for the reconstruction of house in the affected area is inadequate and enough resources to move to other places. Therefore, to continue the process of reconstruction, it poses the urgency for the removal of debris.

A study showed that infrastructure in the rural villages of Nepal was adversely affected in comparison to the towns and cities mostly because of the inferior quality of houses [22]. The predominant house type - unreinforced masonry (especially mud mortar) house, were largely destroyed due to its seismic vulnerability [23]. Among all houses affected, fifty-eight percent of them were with low strength masonry made either from stone or brick masonry with mud mortar, without seismic-resilient features. These intrinsically weak and brittle buildings suffered widespread damage and collapse throughout the 14 districts that experienced intense ground shaking [23].

Debris management begins with the removal and temporary storage of debris near the site. The final phase of debris management happens during reconstruction, as the debris is either disposed or recycled for use during

reconstruction [21]. Most portion of debris, from a demolished house, can be reused for reconstruction or making temporary shelter, retaining walls, boundary and land reclamation in shallow areas. Reducing and reusing earthquake related debris has financial and environmental advantage which can reduce the overall cost of debris management and reconstruction process [6,17,21]. Moreover, in the rural area, people use bare hands to remove debris, which is also the ignorance of risk to one's health. Debris removable in rural areas is usually done with no or minimal safety equipment that can cause minor or major injuries, resulting to infection [7]. Therefore, reconstruction could be hindered [2]. Nonetheless, post disaster debris and waste management is an important aspect, however, the government of Nepal and its agency (National Reconstruction Authority, NRA) has not paid enough attention towards its implementation. There is lack of study prioritizing the assessment of generated debris generated due to earthquake and construction waste produced during housing reconstruction. This study focuses on the household level debris and waste management practice which is significant and can provide insight value in debris and waste management plan in the future.

The main objectives of this paper are- (i) to assess the amount of debris and waste generated from the demolished house, and (ii) to measure the reuse status of the debris and waste during the housing reconstruction using predesigned questionnaire in two districts of Nepal. To our knowledge, this study for the first time, is the reflection of the debris and waste management practice in Nepal. The findings presented here will help to prioritize the debris and waste management practices in future calamities.

2. Methodology

The study were conducted in two adversely affected mid-hill districts of Nepal (Gorkha and Sindhupalchok) between the periods of April 2017–December 2019 (Fig. 1). Gorkha lies 145 km in the west to the country capital (Kathmandu) whereas Sindhupalchok lies 82 km east.

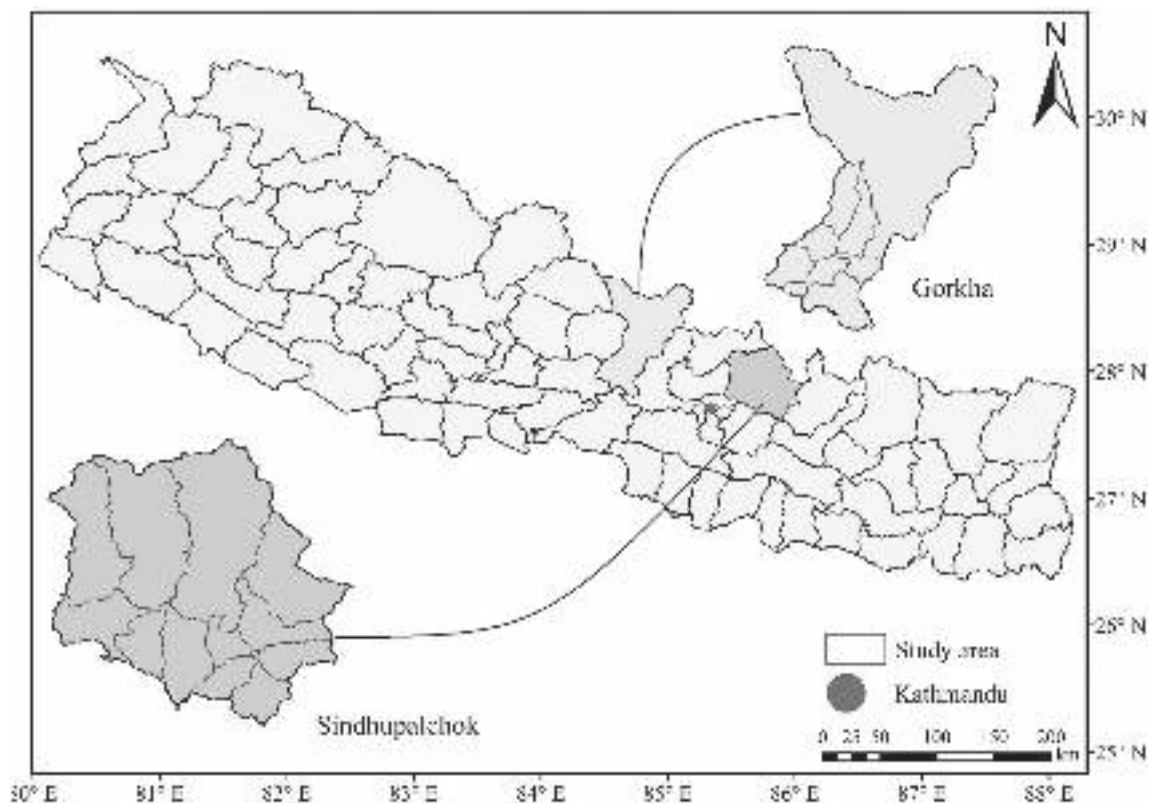


Fig. 1. Map of study area.

2.1. Questionnaire survey

The questionnaire survey was conducted by the assigned Technical Assistance Team (TA Team), which comprises a team of one Social Mobilizer (SM) and a Civil Engineer. Information was collected from the households (HHs) identified as reconstruction beneficiaries by NRA. Random sampling technique was used for the survey.

This survey were conducted in 18 wards of five local administrative levels of Gorkha and 91 wards of 12 local administrative levels of Sindhupalchok district. Four GPs and 1 nagarpalika (NP) of Gorkha and nine GPs and three NPs of Sindhupalchok were the study sites (Fig. 1). The survey was done in each ward at quarterly-basis. Twenty seven HHs were surveyed in each quarterly period by assigned SMs of TA team in each ward.

During the survey period, priorities were given to the houses that were under construction during the time of the TA Team's visit to gather information related to debris and waste management. However, during the time of survey, it was not feasible to find 27 under construction houses in a ward. Therefore, the houses that were newly constructed were also included in the survey. The questionnaire included information like- general information (includes the demographic information of the house, information on debris (provide the quality and quantity of the generated debris) and waste (consists the types and amount of wastes).

2.1.1. General information

The general information included information regarding HHs head name, gender, address, caste and ethnicity. The total sample size surveyed this study were 17,814 HHs (4896 in Gorkha and 12,918 in Sindhupalchok). Among the total, 21.8% (3889 HHs) of household heads were female headed, 78.2% (13,923) were male headed and 0.0% (2 HHs) were third gender headed (Table 1).

Among the overall surveyed households, Janjati HH heads were the dominant. 44.6% HH heads were Janjati (excluding Newar and Thakali) followed by Brahmin-Chhetri-Newar-Thakali (42.8), Dalit (10.1%) and others (2.5%).

2.1.2. Debris

In this study, debris is defined as demolished parts of a damaged building or house by the earthquake. It may be in the form of stone, wood, mud, etc. The total amount of debris of an earthquake affected house is calculated from the sum of debris of stone, wood and mud. Since, majority of the damaged house type were SMM (Stone Masonry with Mud Mortar), brick quantity from the demolished houses were not consideration in study. Quantity of debris was obtained based on visual estimation or as per beneficiary's response (in case of debris already reused or disposed). For more accuracy during visual estimation, measuring tape was used to calculate approximate area (length $\times$ breadth) and height of debris. The quantity of debris generated depends upon the size of demolished house. Debris quantity was calculated in cubic meter (m^3).

Table 1

Household head survey status in Gorkha and Sindhupalchok districts.

Name of district	Gorkha	Sindhupalchok	Total (Overall)
Number of wards	18	91	109
Number of household sampled	4896	12,918	17,814
Household head			
1. Gender			
Male headed	75.2% (3681 HHs)	79.3% (10,242 HHs)	78.2% (13,923 HHs)
Female headed	24.8% (1215 HHs)	20.7% (2674 HHs)	21.8% (3889 HHs)
Third Gender headed	–	0.0% (2 HHs)	0.0% (2 HHs)
2. Caste and ethnicity			
Brahmin-Chhetri-Newar-Thakali	32.4% (1584 HHs)	46.8% (6043 HHs)	42.8% (7627 HHs)
Janjati	49.3% (2415 HHs)	42.8% (5534 HHs)	44.6% (7949 HHs)
Dalit	16.4% (801 HHs)	7.7% (995 HHs)	10.1% (1796 HHs)
Others	2.0% (96 HHs)	2.7% (346 HHs)	2.5% (442 HHs)

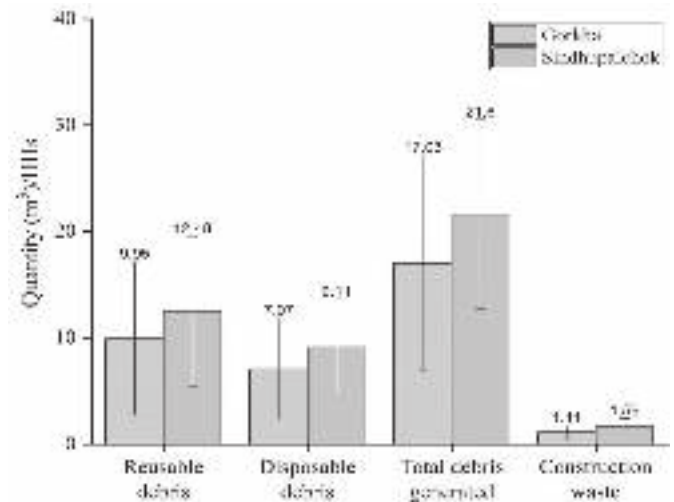


Fig. 2. Comparison of reusable, disposable, and total debris along with amount of constructed waste generated during post-earthquake reconstruction in two district of Nepal. Error bar $\pm$ SD. The number above the error bar is the mean of the respective variables.

Based on the use of debris, it is categorized as reusable and disposable debris. The debris used only for reconstruction of new earthquake resilient house is considered as reusable debris. The remaining debris is categorized as disposable debris. The disposable debris are mostly dumped or used in construction of temporary shelter, shed, filling pits, etc.

2.1.3. Waste

Here, waste is defined as the remaining and wastage of construction materials during and after the reconstruction of house. Quantification of construction waste were also obtained based on afore mentioned visual estimation method. Waste types were also recorded. Construction waste includes cumulative volume of plastics, cement bags, scarp metals, plaster, cement, wood, stone, bricks, sand, aggregate and CGI sheets remaining after reconstruction. The waste also includes loss of construction material during transportation from storage to construction sites. Waste generated was calculated in cubic meter.

2.2. Analysis

Simple statistics were used to determine the amount of debris and waste in two districts and at administrative levels. To evaluate the differences in quantity of debris generated, debris reused, debris disposed, and waste generated, a Z- test were used. Z-test is performed to find to determine if two population means are different when the sample size is more than 30 [29].

Table 2

Quantification of debris and waste generated in Gorkha and Sindhupalchok district of Nepal.

	Gorkha (<i>n</i> = 4896)			Sindhupalchok (<i>n</i> = 12,918)			z-test for equality of means	
	Mean	SD	σ^2	Mean	SD	σ^2	Z - score	<i>p</i>
Reusable debris	9.95	7.21	51.91	12.48	7.07	50.11	-21.04	<0.001
Disposable debris	7.07	4.77	22.79	9.11	4.51	20.42	-25.86	<0.001
Total debris generated	17.03	10.15	103.11	21.60	8.92	79.63	-27.70	<0.001
Total waste	1.11	0.64	0.41	1.59	0.80	0.65	-41.20	<0.001

SD Standard Deviation, σ^2 variance, *p* level of significance, Z-score measurements to describe the value's relationship to the mean between two groups.

All the analysis were performed in R [25]. Graphical representation was done in Origin Pro 16 (OriginLab, Northampton, Massachusetts, USA) whereas the maps were generated from Arc GIS 10.3 (ESRI Inc., Redlands, California, USA).

3. Results

In an average, each individual HH used 57.96% of total debris that were generated from the demolished house during the reconstruction. Most of the houses demolished in the study area were made of low strength stone masonry with mud mortar. A Z-test was conducted to compare the mean of quantity of debris and waste generated by the individual household in two districts. There was a significant difference between the total amounts of debris generated in two districts - Gorkha ($m = 17.03 \text{ m}^3/\text{HHs}$; Standard deviation (SD) = ± 10.15) and Sindhupalchok ($m = 21.61 \text{ m}^3/\text{HHs}$; SD ± 8.92). Similarly, significant differences were noticed in quantity of debris disposed by the households in Gorkha ($m = 7.07 \text{ m}^3/\text{HHs}$; SD ± 4.77) and Sindhupalchok ($m = 9.11 \text{ m}^3/\text{HHs}$; SD ± 4.51). On the other hand, the result showed significant differences between the amount of debris reused in Gorkha ($m = 9.95 \text{ m}^3/\text{HHs}$; SD ± 7.21) and Sindhupalchok ($m = 12.48 \text{ m}^3/\text{HHs}$; SD ± 7.07) districts of Nepal. Moreover, there was a

significant difference in amount of waste generated at the construction sites in Gorkha ($m = 1.11 \text{ m}^3/\text{HHs}$; SD ± 0.64) and Sindhupalchok ($m = 1.59 \text{ m}^3/\text{HHs}$; SD ± 0.65) (Fig. 2 and Table 2).

In Gorkha, the highest quantity of debris was generated by Ajirkot GP (21.30 m^3/HH) and the least by Siranchok GP (11.40 m^3/HH). Likewise, in Sindhupalchok, the highest quantity of debris was produced by Jugal GP (33.10 m^3/HH) and the least by Chautara Sangachokgadi NP (19.60 m^3/HH) (Fig. 3). The demolished houses in Ajirkot GP and Jugal GP were comparatively larger in size resulting more debris generated as compared to other GP or NP of Gorkha and Sindhupalchok districts respectively.

In Gorkha, the highest amount of construction waste was generated by HHs of Barpak Sulikot GP (1.20 m^3/HH) and lowest by HHs of Siranchok GP (Fig. 3). Likewise, in Sindhupalchok the highest quantity of construction waste was generated in Lisankhu Pakhar GP (2.10 m^3/HH) and lowest by HHs of Sunkoshi GP (0.40 m^3/HH) (see Annex I).

The major types of construction wastes include polythene, sacs, scarp metals, stones, cement and its mortar, effluents, electric wires, PVEC pipes, etc. Usually, the effluents are drained to nearby area. Open defecation by HHs and construction workers were not noticed.

The amount of debris and waste generated by an individual HH showed a significant differences in quantity of debris generated, reusable debris, disposable debris, and the amount of waste generated at the construction sites in administrative region of both studied district of Nepal. On an average, highest amount of debris were generated in GP (20.75 m^3/HHs ; SD ± 10.79) than NP (19.94 m^3/HHs ; SD ± 7.99). A significant difference was noticed in the amount of debris generated in two administrative areas. Similar pattern were noticed in amount of debris that are disposable in the areas. On the other hand, the amount of reusable debris in GP (11.89 m^3/HHs ; SD ± 7.79) is marginally higher than NP (11.69 m^3/HHs ; SD ± 6.56), but no significant differences were noticed ($p = 0.052$). However, the amount of waste generated in NP (1.53 m^3/HHs ; SD ± 0.75) was relative higher than GP (1.39 m^3/HHs ; SD ± 0.81) and showed higher significant differences (Fig. 4 and Table 3).

We compared the mean amount of debris and wastes generated in GP of Gorkha ($n = 4491$) and Sindhupalchok ($n = 4431$). The result showed that

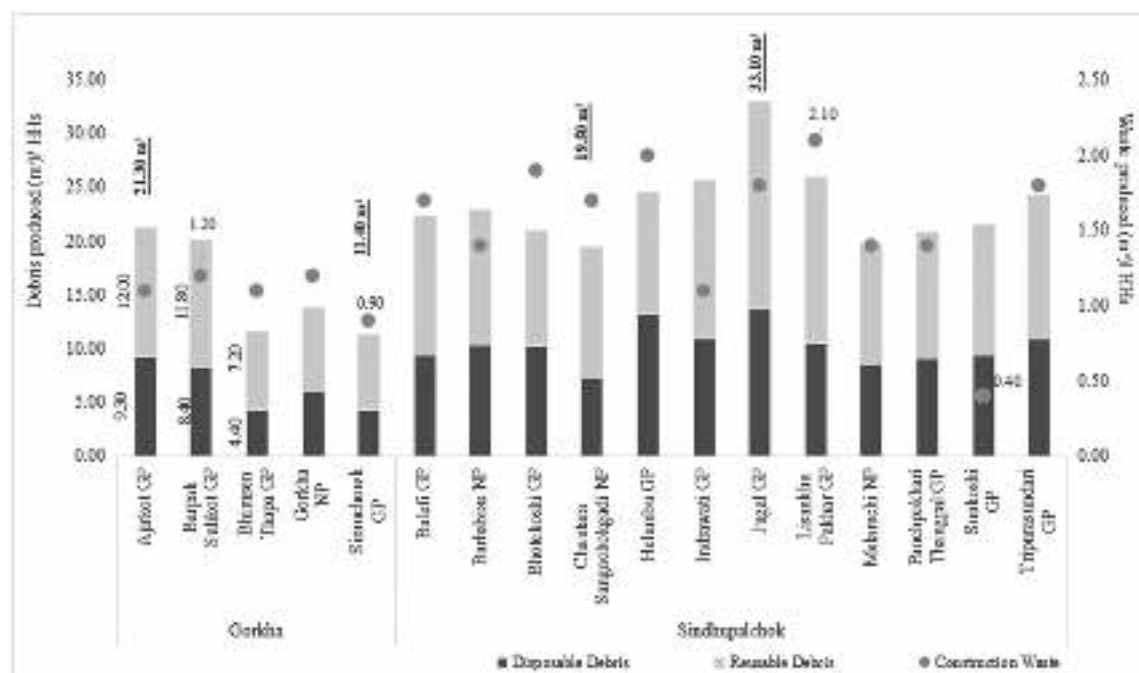


Fig. 3. Average quantity of debris and waste produced per HH at GPs and NPs (overall) (Underlined and bold values represent amount of debris generated (sum of reusable and disposable debris)).

Annex I

Quantity of debris and waste generated in each wards of Gorkha and Sindhupalchok districts.

Ward	Reusable debris (m ³ /HH)	Disposable debris (m ³ /HH)	Construction waste (m ³ /HH)
Gorkha			
Ajirkot GP			
3(Hansapur)	14	9.7	1
4(Simjung)	11.7	8.9	1.2
5(Muchhok)	10.3	9.4	1.1
Barpak Sulikot GP			
1(Barpak)	16.8	9.6	1.2
2(Barpak)	14.8	9.2	1.2
3(Swara)	10.7	8.8	1.2
4(Saurpani)	12.7	8.4	1.1
5(Takumajh)	13.1	10.6	1.4
Lakuribot)			
6(Takukot)	10.2	9.9	1.2
7(Panchkhuwa)	7	7.6	1.2
Deurali)			
8(Pandrung)	9.2	3.2	1
Bhimsen Thapa GP			
1(Masel)	7.3	4.2	1.1
5(Baguwa)	7.1	4.5	1.2
Gorkha NP			
1(Taple)	7.6	6.5	1.2
2(Taple)	8	5.7	1.2
Siranchowk GP			
1(Kerabari)	7.9	7.3	0.9
7(Shreenathkot)	7.4	2.4	0.8
8(Jaubari)	6.1	3.2	1.1
Sindhupalchok			
Balefi GP			
1(Jalbire)	16.8	12.3	1.9
2(Fulpingkot)	13.9	9.4	1.7
3(Fulpingkot)	14.8	8.8	1.7
4(Fulpingdanda)	14.1	8.9	1.6
5(Fulpingdanda)	14.5	9	1.6
6(Mankha)	10	9.2	1.7
7(Mankha)	9.3	9	1.7
8(Mankha)	10.6	9.1	2
Barhabise NP			
1(Ghorthali)	12.7	13.2	1.4
2(Karthali)	12.1	9.6	1.5
3(Barhabise)	11.5	10.9	1.7
4(Barhabise)	10.4	10.8	1.6
5(Gati)	12.9	9.3	1.6
6(Gati)	13.5	9.4	1.5
7(Ghumthang)	14.5	12.9	1.1
8(Maneswnara)	14.2	8.7	1.2
9(Ramche)	12	9.2	1.2
Bhotekoshi GP			
1(Listikot)	12.6	13.5	2
2(Tatopani)	8.2	9.2	2.1
3(Tatopani)	8.1	6	2.1
4(Fulpingkatti)	12.9	13.4	2
5(Marming)	12.3	9.3	1.4
Chautara Sangachokgadi NP			
1(Syaule Bazar)	11	6.6	1.9
2(Batase)	11.1	6.2	2.1
3(Batase)	11.4	6.1	1.6
4(Kubhinde)	12.8	7.8	1.8
5(Chautara)	13.9	7	1.8
6(Pipaldanda)	13.7	8.9	1.6
7(Sanusiruwari)	13.8	9.4	1.9
8(Irkhu)	13.9	9.8	1.8
9(Kadambas)	14.4	8.5	1.9
10(Sangachok)	10.3	6.3	1.4
11(Sangachok)	10.4	6.3	1.4
12(Sangachok)	10.4	6.2	1.4
13(Thulo)	11.6	7.6	1.6
Sirubari)			
14(Thulo)	10.9	7.4	1.5
Sirubari)			
Helambu GP			
1(Helambu)	9.6	11.8	2.4
2(Kiwool)	11.4	15.1	2.2

Annex I (continued)

Ward	Reusable debris (m ³ /HH)	Disposable debris (m ³ /HH)	Construction waste (m ³ /HH)
3(Palchok)	12.5	18.2	2.1
4(Mahankal)	11.4	13.3	2.2
5(Mahankal)	11	13.5	2.3
6(Ichhock)	10.5	10.1	1.3
7(Ichhock)	13	11	1.4
Indrawati GP			
1(Simpalkavre)	10.7	9.6	1.7
2(Kunchok)	10.9	10.4	1.4
3(Kunchok)	11.2	10.2	1.5
4(Nawalpur)	14.1	10.8	1.1
5(Bandegaun)	17.7	8.5	1
6(Bandegaun)	15.3	10.2	1
7(Sipapokhare)	28.2	12.7	1.1
8(Sipapokhare)	27.8	13.1	1.1
9(Bhotasipa)	15.8	9.6	1.5
10(Bhotasipa)	9.9	9.6	1.4
11(Bhimtar)	7.9	13.4	0.5
12(Bhimtar)	8.4	13.5	0.4
Jugal GP			
1(Selang)	19.3	11.5	1
2(Golche)	18.9	10.6	2.3
3(Gumba)	20.4	13	2
4(Pangtang)	14.4	15.2	2.2
5(Baramchi)	18.2	15.9	1.6
6(Hagam)	21.9	14.2	1.9
7(Hagam)	22.3	16.1	1.6
Lisankhu Pakhar GP			
1(Thulo)	16.1	11.8	2.2
Dhading)			
2(Lisankhu)	11	10.1	2.3
3(Lisankhu)	9.4	8.7	1.8
4(Attarpur)	16.9	11.8	2.3
5(Jethal)	18.4	10.4	2.2
6(Petku)	19.9	10.7	1.7
7(Thulopakhar)	16.1	10.5	2.2
Melamchi NP			
1(Bhotechaur)	10.1	11.6	1.4
2(Bhotechaur)	9.5	10.8	1.7
3(Haibung)	8.8	10	1.6
4(Thakani)	11.6	8	1.7
5(Sindhukot)	10.9	8.1	1.6
6(Talamarang)	12.3	7.2	1.2
7(Dubachour)	13.5	8.6	1.6
8(Dubachour)	14.9	8.5	1.6
9(Jyamire)	12.5	5.9	1.3
10(Shikharpur)	12	6.1	1.2
11(Melamchi)	9.6	8.9	1.4
12(Bansbari)	9.3	8.9	1.2
13(Fatakshila)	10.2	8.8	1.4
Panchpokhari Thangpal GP			
2(Baruwa)	11.7	9.2	1.4
Sunkoshi GP			
6(Thumpakhar)	12.4	9.4	0.4
7(Pangretar)	12.1	9.4	0.4
Tripurasundari GP			
1(Ghorthali)	15	10.4	1
2(Chokati)	15.3	11.9	1.2
3(Dhaskun)	13.2	10.1	2.1
4(Piskar)	17.1	12.9	3.1
5(Tauthali)	10.7	10.7	1.5
6(Tekanpur)	9.1	10	1.8

the highest amount of debris were generated in GP of Sindhupalchok ($m = 24.21$, $SD \pm 10.11$) than in Gorkha ($m = 17.32$, $SD \pm 10.27$). Similar trends were found in the amount of reusable and deposited debris. The average amount of wastes generated in GP of Sindhupalchok were also higher than GP of Gorkha district (Fig. 5a).

Similarly, the average amount of debris generated in NP of Gorkha district ($n = 405$, $m = 13.83$ m³/HHs, $SD \pm 8.13$) was significantly lower than Sindhupalchok ($n = 8487$, $m = 20.24$ m³/HHs, $SD \pm 7.89$). Resuable debris, disposable debris and amount of waste also follows the similar

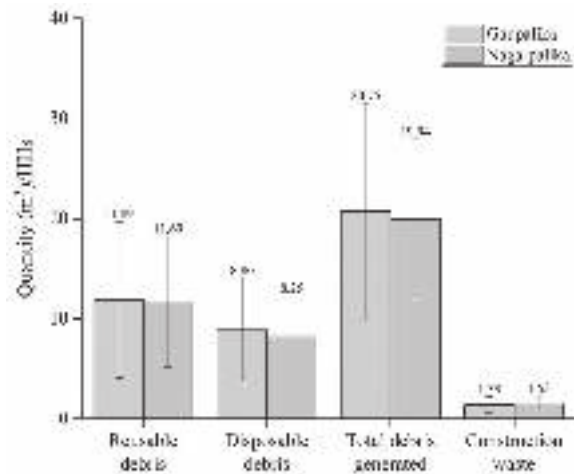


Fig. 4. Comparison of reusable, disposable and total debris along with amount of construction waste generated during post-earthquake reconstruction in GPs and NPs of Gorkha and Sindhupalchok districts. Error bar $\pm$ SD. The number above the error bar is the mean of the respective variables.

trends (Fig. 5b). On the other hand, GP of both Gorkha and Sindhupalchok

Table 3

Quantification of debris and waste generated in GP and NP of Gorkha and Sindhupalchok districts.

	Gaupalika (n = 8922)			Nagarpalika (n = 8892)			z-test for equality of means	
	Mean	SD	σ^2	Mean	SD	σ^2	Z - score	p
Reusable debris	11.89	7.79	36.13	11.69	6.56	42.91	1.93	0.052
Disposable debris	8.86	5.22	27.12	8.25	4.05	16.49	8.43	<0.001
Total debris generated	20.75	10.79	115.79	19.94	7.99	64.33	5.61	<0.001
Total waste	1.39	0.81	0.38	1.53	0.75	0.57	-9.54	<0.001

SD Standard Deviation, σ^2 variance, p level of significance, Z-score measurements to describe the value's relationship to the mean between two groups.

showed higher amount of debris and waste nagarpalika of respective districts (Fig. 5 c and d).

Assigned debris and waste disposal site was not observed in the study area, due to which beneficiaries were self-responsible for debris and waste management. Some houses were partially demolished and were used as store house or cattle shed whereas a small number of houses were yet to dismantle.

Optimum utilization of debris helps to reduce the adverse impact on natural environment. Wood, stone, mud, etc. from demolished houses were mostly reused. Usually, woods were reused in form of wooden band, door/window panels, furniture and form-work where stone were used for wall construction, foundation, soling, and gravel making. Mud was mostly utilized for land/road filling.

4. Discussion

Large amounts of debris may be generated after seismic events and could constitute serious environmental and logistic problems [12]. The result showed more than 50% of debris generated from the demolished houses were used during housing reconstruction after earthquake, especially in rural areas. The results of Sarkar [27] also support our findings. Disposal and reuse of the debris are main objectives of post-earthquake reconstruction process [27]. Debris management, for developing countries, is the actual challenge because of the limited technical and financial capacities [16]. During post-earthquake reconstruction and recovery in developed

countries during Marmara Earthquake (1999) in Turkey [4], Kobo earthquake (1995) in Japan [9] modern available technologies were used for debris management. However, in Nepal, applications of technologies for debris management were not reported [26]. The study areas are located in remote localities of Nepal. Lack of facilities (for example road accessibility, use of technology) is one of major factors that determines post-earthquake activities. In Gorkha and Sindhupalchok districts, beneficiaries were self-responsible for debris and waste management. UNDP [31] reported that the earthquake of 2010 in Haiti led to the accumulation of around 10 million m^3 of debris (approximately $33.33 m^3/HH$), where, the management of debris was the most challenging issue. However, our findings show comparatively less quantity of debris generated from demolished houses ($20.34 m^3/HHs$). The quantity of debris generated per HH mostly depends on the size and types of the house. Similarly, the amount of debris generated in Sindhupalchok is higher than that of Gorkha. Size of demolished house in Sindhupalchok might be larger than Gorkha. Sindhupalchok has many small towns, the houses were constructed with thick wall structure made up of stone and mud mortar. To adapt with the cold environment in rural high hills in Sindhupalchok, houses were constructed with locally available materials. Therefore, the amount debris generated were higher in Sindhupalchok. The advantage of using locally available materials (like wood, stone, mud etc.) is cost effective and environment friendly that can further be reused after demolition. Murreddi and Ali [20] stressed that recovery comprises removal of debris and assessment of debris is immediate challenges for reconstruction after disaster ultimately contributes to environmental management. A large number of people used debris materials for housing reconstruction in Nepal [5] which ultimately contributed to reducing the environmental degradation. Similar to our findings, previous studies have also suggested the reuse of debris material for reconstruction have both economic and environmental advancement ([2,26]. Moreover, our study also agrees with previous findings where it was suggested to promote recycle of the debris by reusing the materials for reconstruction or reclamation of landfill site [8,27].

The commencement of reconstruction could only be feasible with the clearance of debris at the initial stage that further provides the open area and salvage materials to the beneficiaries. A study indicated that disaster debris management starts immediately after the disaster and continues for long time during reconstruction [24]. Various factors determine the effectiveness of management process, most of which are associated with environmental, economic and social impacts [3]. The management or removal of debris requires both time and money, so there is a need of proper debris management plan. As suggested by Dugar et al. [8], the best management practices of debris are the recycle, reused and reduce strategies. Similar techniques were adopted by the individual household in the study sites. However, the mechanisms of management process is not promising in Nepal due to lack of technical and financial resources [8]. After demolition of the houses by an earthquake, management of the debris poses difficulties mainly due to lack of proper management sites. Our studies showed that individuals household were responsible for the management of their own debris due to lack of management sites, thus, allocation of proper debris management sites at local levels will be commendable for the better management practice. Similar findings were reported in previous studies conducted in Iran [3] and Nepal [8].

Estimation of total volume of debris to manage disaster waste provides necessary information on management of hazardous debris, application of technologies, and dispose in land fill area [16], but such scenarios were not reported in the study areas. According to our findings, the amount of debris and waste varies from district to district, and between GP and NP (Fig. 5). This might be due to ward level mason training and awareness programs by government and support organizations. Therefore, the issue of the debris and waste management is mostly site specific. PDNA [23] in its initial reports pointed out that the demolished houses were built from low strength masonry were cleared first compared to the concrete structure. Our study also reported the same findings where the low strength structures were removed first followed by concrete structures. Similar to debris management practice, the individual households were also responsible for waste

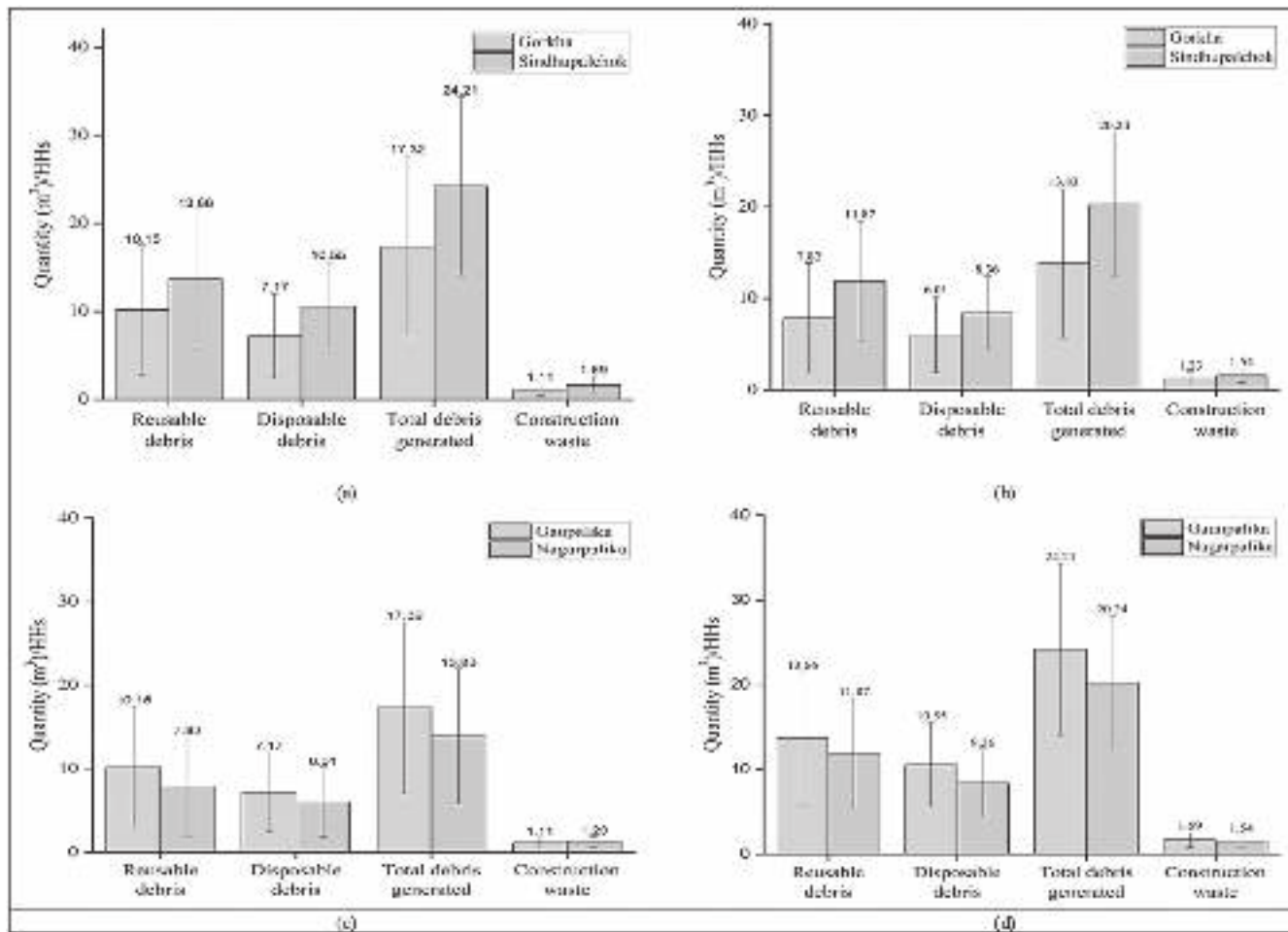


Fig. 5. Comparisons between mean of amount of debris generated, reused, disposed and amount of wastes generated in (a) GP of Gorkha and Sindhupalchok districts, (b) NP of Gorkha and Sindhupalchok districts, (c) GP and NP of Gorkha, and (d) GP and NP of Sindhupalchok. Error bar $\pm$ SD. The number above the error bar is the mean of the respective variables.

management. The individual houses treated their waste either by incineration, land filling or composting but as the cumulative volume is less, the impact on environment might be negligible, Giusti [13] also reported similar practices in waste management that is effective on protection of environment. Hirayama [14] pointed out that not only the household level and local level government are enough but the need of central government intervention to manage the debris is observed for emergency debris removal and treatment immediately after disaster.

However, it is recommended to adopt the safety measures to reduce potential health hazards during debris or waste management.

5. Conclusions and recommendations

The volume of reusable debris during housing reconstruction were significantly high. Most of the generated debris were local materials like stone/rubble, wood, mud, roofing and other vegetative debris. Despite of lack of specific policy and guidelines relevant to debris and waste management, overall status of reuse of debris in the study areas were satisfactory; more than 50% debris have been reused or recycled for housing reconstruction. It is noteworthy that, optimization of debris can reduce the adverse impacts in the environment. Therefore, problems associated with debris and waste management have to be considered with priority during reconstruction period after disaster. The study recommends to establish the

debris and waste management strategy and guideline and to prepare debris and waste management plan at community level by local administrative based on those national debris and waste management strategy and guidelines by implementing agency.

Declaration of competing interest

None.

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Regular Article

Reconstruction assistance in rural Nepal after the 2015 Gorkha Nepal earthquake through Aarma Parmah approach - A case study in Bijulikot, Ramechhap District

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ABSTRACT

In the aftermath of the tragic 2015 Gorkha earthquake, the Government of Nepal invited International non-governmental organizations (INGOs) to support with highly needed humanitarian aid. Medair, a Swiss based INGO, arrived soon after, providing emergency relief and staying to aid in the reconstruction of private houses owned by vulnerable people in Ramechhap. Medair covered 1312 households in this region, providing technical assistance, quality assurance, and supporting the community in other ways required to accomplish the project. The Aarma Parmah approach which was already employed by the communities for agriculture was used for reconstruction purposes. The main objective of this paper is to describe how Aarma Parmah, a traditional and indigenous method of labour exchange, was successfully employed in reconstruction and how it was one of the main factors for finalizing the works on time and with a high quality. This research also investigated how Aarma Parmah supported in ensuring that no one was left behind and what were the effects on communal harmony and social cohesion as a result of following the Aarma Parmah approach in reconstruction.

Medair, in association with local partner Community Development Society (CDS), designed and implemented the project using Aarma Parmah clusters at the centre. A series of surveys conducted during the project implementation and one additional survey a year after completion assessed the perception and satisfaction of the community regarding Aarma Parmah. The surveys were conducted using Kobo software to register the answer of the interviewees. The most relevant results obtained from the analysis are hereby presented. The project was successfully completed, mainly due to the Aarma Parmah approach which led to improved acceptance by beneficiaries, to overcoming financial obstacles and to reaching all families, effectively leaving no one behind. The knowledge of construction and build back better methodologies will be used to cope with future disasters and will be transferred to future generations.

1. Introduction

1.1. Earthquake aftermath and emergency response

On 25 April 2015, a 7.6 magnitude earthquake struck Nepal, followed by another severe 6.8 magnitude aftershock on 12 May [20]. In the following weeks persistent and at times significant aftershocks and landslides continued to destroy buildings, infrastructure, and livelihoods, affecting millions of people. According to the Post Disaster Needs Assessment [20] there were over 8790 casualties and 22,300 injuries. It was estimated that the lives of eight million people, almost one-third of the population of Nepal, were impacted by these earthquakes. Of the country's 77 districts, 31 were affected, including 14 which were declared as 'crisis-hit' for the purpose of prioritizing rescue and relief operations. 17 neighbouring districts were declared as

partially affected [20]. The names of earthquake affected districts are shown in Table 1.

In the 31 affected districts, it was reported that 498,852 private houses were fully destroyed and 256,697 private houses were partially damaged. The total value of disaster impacts (damages and losses) caused by the earthquakes was estimated at NPR 706 billion (7 billion USD) [20]. In view of such a large scale of devastation, the Government of Nepal undertook various immediate initiatives for rescue, relief and reconstruction works. At the same time the Central Natural Disaster Relief Committee (CNDRC) made an appeal to the international community for effective search, rescue, and relief activities [4].

Medair, a Swiss based non-governmental organization (NGO), deployed its emergency response team to Nepal on 27 April 2015 within 48 h of the disaster, and started relief distributing activities at Sindhupalchowk district. From January 2016 to June 2016, Disaster Risk Reduction (DRR)

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Table 1
Earthquake affected district names and classification.

Categories	District Name	Number of Affected Districts
Crisis Hit	Kathmandu, Bhaktapur, Lalitpur, Makawanpur, Kavrepalanchowk, Sindhuli, Okhaldhunga, Gorakha, Dhading, Rasuwa, Nuwakot, Sindhupalchowk, Dolakha, Ramechhap,	14
Partially Affected	Solukhumbu, Khotang, Bhojpur, Sankhuwasabha, Dhankuta, Chitawan, Nawalparasi, Tanahu, Lamgunj, Kaski, Parbat, Syanja, Palpa, Argakanchi, Gulmi, Baglung, Myagdi	17

(Data Source: [20])

training was provided to communities with the aim of increasing their preparedness during disasters, and to explain basic ways for building earthquake resistant houses. The International Federation of Red Cross and Red Crescent's (IFRC) Participatory Approach to Safe Shelter Awareness (PASSA) module [11] was followed in combination with the mason training curriculum developed jointly by the Department of Urban Development and Building Construction (DUDBC) and the National Society for Earthquake Technology (NSET) [6,18], and with the house design catalogue [7]. During that period, 218 individuals of four Village Development Committees (VDCs) at Sindhupalchowk district, 243 individuals of five VDCs at Okhaldhunga district, and 150 individuals of three VDCs at Ramechhap district were trained on PASSA [11]. Similarly 94 Masons at Ramechhap and 89 Masons at Okhaldhunga were trained following DUDBC's curriculum [6]. Furthermore, two demonstration model houses were built for masons and community members to learn about different earthquake resistant features following DUDBC's design catalogue [7] at Ramechhap and Okhaldhunga districts respectively.

1.2. Reconstruction project

With the aim of rapidly reconstructing buildings which sustained physical damages, the government of Nepal established the National Reconstruction Authority (NRA) on the 25th of December 2015, a government body responsible for the post-earthquake reconstruction. In April 2016, the NRA endorsed NGO mobilisation guidelines [16] that paved the way

for NGOs to execute various post-earthquake reconstruction and rehabilitation works. Based on the guidelines, a housing reconstruction assistance project was proposed to support the reconstruction of 310 houses in two of the wards in Bijulikot, Ramechhap. Under a tri-party agreement between the National Reconstruction Authority (NRA), Central Level Programme Implementation Unit (CLPIU) and Medair, work began in July 2016. Furthermore, a partnership was established with Community Development Society (CDS), a local NGO who helped in the implementation of the project.

During the initial project, affected families as well as local and district stakeholders requested that the project be extended. Based on the needs in the community, it was agreed to extend the project and cover all remaining wards in Bijulikot, supporting an additional 953 households. The project was successfully completed and handed over to local authorities in April 2019. A map of Bijulikot and its wards is shown in Fig. 1.

1.3. Aarma parmah

People of Bijulikot VDC were accustomed to share labour while working in agriculture (Source: Focus Group Discussion (FGD) conducted by Medair, July 2016). Different terms have been used by different ethnicity groups in Nepal to describe labour exchange. *Ngalok* by Sherpas in Khumbu region [1], *porima* or *orima porima* by Hiroshi Ishii at Parbat region [9], *Nogar* by Gurungs in western regions, *pareli* by by ethnic Llimbus [14], *bola* or *parma* by Newars of Kathmandu [3].

Fortier [9] mentions that it is quite difficult for researchers to provide an actual and clear definition of the Nepalese labour reciprocal system. Fortier also mentions that according to Hiroshi Ishii, *parima* is a form of one to one labour exchange and similarly according to Hitchcock: "The most common kind of work group is formed on the basis of what is called *porima* or *orima porima*".

In rural Nepal, the practice of labour exchange for agricultural purposes has been seen as ancient and widespread. There is a long tradition of helping each other in Nepalese society [21]. Aarma Parmah involves people trading their work in the field, reciprocating an equal amount of labour force and time. Erasmus [8] explains that reciprocal exchange labour usually results in a rotation of services during phases of the farming cycle so that similar tasks as well as equal amounts of time are exchanged [8]. Individuals can help one another in the process of sowing, ploughing, cultivation and harvesting. When a farmer needs help, he or she will receive at least one person from each household within the agreed Aarma Parmah

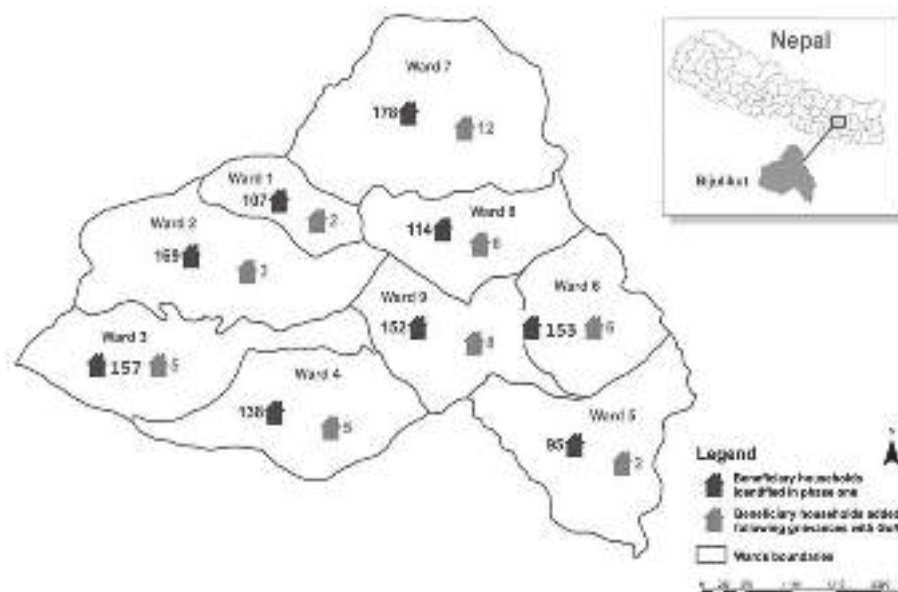


Fig. 1. Map of Bijulikot (study area) identifying the sub-divisions or wards and the number of beneficiaries in each ward. (Data and Map Source: Medair).

group, so that activities can be accomplished. The farmer will then reciprocate the help received by sending the same number of able members of his/her household to each of the households that provided help, when help is requested.

Labour exchange systems have been practised not only in Nepal but also in different places around the world. Erasmus [8] provides some examples of labour exchange in Haiti, Colombia, Ecuador, Peru, Chile, Mexico, Japan, South Africa, Guatemala and China.

Based on the employment of Aarma Parmah in reconstruction for more than three years and closely monitoring the process, and the working style of different Aarma Parmah groups in the study area, we could define Aarma Parmah as “a group of people living nearby that organise themselves to help each other finish a similar set of tasks within their communities.” Similarly it can be also defined as a “group effort or a means of combining forces during peak labour periods to complete their similar set of tasks.”

Most of the indigenous associations function like formal cooperatives in their overall purpose, working together to achieve mutually desired economic ends but they are structurally less formal, based on traditional concepts of mutuality and community [14]. People in the study area are composed of heterogeneous communities of different caste and ethnic groups. Data from National Planning Commission [5] Central Bureau of Statistics show that 53% of the population are ethnic groups, 32% are Chhetris, 8% Dalits, 3.5% Brahmins and the remaining 3.5% are from other groups. Vanek (1969) and Hansen and Erbaugh (1987) [3] emphasize that indigenous knowledge is an important natural resource that can facilitate the development process in cost effective, participatory, and sustainable ways [3]. The use of the traditional and indigenous system of Aarma Parmah was emphasized in the reconstruction sector through significant community awareness campaigns. Features of the Aarma Parmah approach used in agriculture and the revised approach used for reconstruction are shown below, highlighting similarities and differences.

Key features of the traditional Aarma Parmah Approach used in agriculture

- People reciprocate their farming labour when the Parmah is requested by another party.
- People prefer to reciprocate within their tribes or caste.
- In most of the cases reciprocation is done in the same rotation of services during phases of the farming cycle (eg, cultivation, sowing, harvesting).
- No clear schedule for reciprocating their labour. Sometimes reciprocation is done following next year if help is not requested by another party or first party failed to provide when requested.
- No structured group; members are not defined properly.
- Reciprocating family member can be different but should be of same gender, similar nature of job is reciprocated- *ropar* for *ropar* (the one who plants the agriculture), *bause* for *bause* (the one who prepares the land for cultivation) and *hali* for *hali* (the one who ploughs the land).
- Reciprocation was done from one family member to another family member-generally between two households.
- Easy to calculate or remember the labour numbers to reciprocate.
- Vulnerable families also need to engage physically.

Source: - FGD conducted with beneficiaries of Bijulikot VDC by Medair – July 2016.

Key features of Aarma Parmah Approach used in Reconstruction

- Structured Aarma Parmah Group (also called cluster group) with an accepted team leader per group.
- Cluster team composition of between six and 15 households.
- Cluster composition was based on the geographical location, all the ethnic groups and castes residing in certain geographical location were involved in the group.
- Reciprocation to be done during the period of the cluster reconstruction (before construction was fully completed).
- A clear schedule of the cluster (i.e., houses to be built in sequential order). Preferences provided to vulnerable families.

- Group members involved in demolition, transportation of materials, reconstruction
- Group members borrowed construction materials within their cluster.
- Support to vulnerable families (i.e., vulnerable family member not necessarily to participate physically in reconstruction activities). Vulnerable families supported through other activities they could perform.
- Difficult to calculate the days worked in different cluster member houses for different reconstruction activities.

Source: - FGD conducted with beneficiaries of Bijulikot VDC by Medair – December 2019.

In a baseline survey conducted in July 2016 during the project start-up phase, people in the study area were asked if they were interested in employing the Aarma Parmah approach for reconstruction. Out of 813 respondents, 71% of beneficiaries mentioned that they were willing to work in a cluster system based on Aarma Parmah principles. Given that the majority of the people preferred to work in clusters, the system was employed. Later on, having seen the progress made by households in the cluster system, and having seen how the system worked and its potential benefits, all remaining households decided to join, totalling 118 clusters with an average of 10 to 11 households.

The NRA also recognized the benefits of labour exchange and provided guidance to form reconstruction community groups [15]. Their aim was to manage community participation for reconstruction purposes and to create ownership of the reconstruction at a community level. This guideline clearly mentioned that the reconstruction groups formed at local level were to coordinate the reconstruction works implemented at community level. The Aarma Parmah groups that were formed for reconstruction purposes were also an integral part of the reconstruction community groups.

The whole Bijulikot VDC was divided into small clusters consisting of six to fifteen earthquake affected households based upon the number of houses within that community. Earthquake affected private houses refers to those houses which were damaged from the earthquake and were eligible to receive the grants for reconstruction or retrofit [17]. For each cluster one person from each house participated in the group. The role of the cluster was to exchange labour within the group, assisting each other with the demolition of damaged houses and construction of new ones. Tool kits were distributed to each cluster and training was provided on the use of the tools. These tool kits enabled safe and efficient demolition of damaged homes, allowing salvaged materials to be used in new house construction as well.

The formed Aarma Parmah groups, or clusters, started with activities that required less skill under the direct supervision of technical personnel. Such activities included demolition, transportation of materials and reconstruction of the houses to the plinth phase. Houses which consisted of elderly people or people who couldn't do physical work did not participate in the working team but could volunteer in preparing lunch or serving water to the workforce. The work force constructed the house of every people in the cluster, including that of those members being physically unable to work. This cluster system also helped in formulating the owner driven approach, giving authority and plenty of discussion time to determine whose houses to build first and which house model from the pre-approved government catalogue [17] had been chosen by the families. Houses in this catalogue had been designed considering local materials and using engineering features to increase the seismic safety.

This study investigated whether Aarma Parmah was indeed one of the main reasons why most of the families in the study area were able to finalize reconstruction of their houses with the provided grants of NPR 3,00,000 (3000 USD), and aligning with the government timeline and quality. This study also investigated how Aarma Parmah helped ensure that no one was left behind and what were the effects of communal harmony and social cohesion observed in the community during the reconstruction. The methodology is first explained, followed by the results, discussions and conclusions.

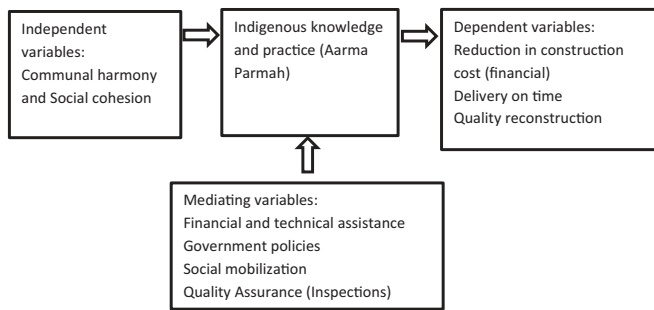


Fig. 2. Conceptual framework of the research.

2. Methodology

This study is based on a qualitative and quantitative analysis of the data, collected from July 2016 until April 2020. The qualitative analysis is an integral part of the study whereas the quantitative is supplementary. Both highlight the context and significance of the Aarma Parmah approach. Field observation, case studies, reports, surveys, key informant interviews (KII) and FGDs were used to triangulate the data. Field observations are the personal perception of the authors, based on the three years of project implementation. Data from previous surveys was used with due permissions from Medair. The conceptual framework of this study is shown in Fig. 2, highlighting the independent, mediating and dependent variables of the study.

Two surveys were carried out during the project implementation, in July 2017 and February 2018. These surveys included questions regarding the quality of the works, beneficiaries' experience, adherence to international humanitarian standards, and the Aarma Parmah process. The first survey covered 299 households (HHs), while the second survey included in this study covered 824 HHs. A number of enumerators went to each household to conduct the survey, using Kobo software [13] programmed into tablets to record the answers. These enumerators were trained on how to use the software as well as briefed on the questionnaire. Collected data were uploaded from the tablets to a server and downloaded for further analysis.

Questions related to Aarma Parmah in the two surveys were mainly formulated to learn about beneficiaries' involvement in clusters, their feeling while they were associated with clusters to finalize their reconstruction, how often they were having meetings to discuss progress made, challenges needed and way forward to build their houses in their clusters. Questions also investigated if the cluster system helped them in reducing the cost of reconstruction, the effects in communal harmony while working in clusters and whether or not they were interested in performing future communal tasks through the cluster system.

To meet the objective of the study, a third survey was conducted on April 2020 to investigate the effects of Aarma Parmah one year after project completion. Due to the COVID-19 pandemic, data were collected through mobile phone. 36 samples were drawn from the Medair database of 1312 HHs in the VDC for the purpose of the survey. Out of the 1312 beneficiaries, phone records were available for 511 families, representing all wards of Bijulikot VDC. A random sampling selection was used to choose a sample of four families from each of the nine wards, totalling 36 surveys. The random sampling was carried out using the Microsoft Excel random function. Note that the sampling process ordered all the people in each ward with a phone number, allowing the random selection of additional members when one of the top four members in a given ward could not be reached. The data were collected and recorded by means of a web-based data collection technology called Kobo [13].

In order to increase the quality of the data received by the telephone survey, enumerators were provided training on how to: 1) obtain accurate information in the telephone survey, 2) use the web-based application (Kobo), 3) uphold ethical issues, also bearing in mind the fact that respondents can be under stress on this COVID-19 pandemic, and 4) proper

translation of some crucial words while asking in Nepali language, such as communal harmony- *Samudiyak Sadhav* and social cohesion-*Samajik Melmilap*.

The questionnaire used in the phone survey was developed considering three main factors: 1) questions that were asked in the initial surveys during project implementation, 2) questions based on the research objectives of this study, and 3) based on literature review, to enhance the general knowledge of exchange labour. Questionnaires were formulated with open-ended, closed-ended, partially open-ended and rating-scale questions based on the nature of the questions [12].

The phone survey evaluated how Aarma Parmah helped in the reconstruction process in Bijulikot VDC, and whether there were other benefits to the approach. The questions asked people about their house reconstruction status, whether Aarma Parmah was in practise before the reconstruction project and if it was used for the reconstruction. Another question investigated if the Aarma Parmah approach introduced for reconstruction was similar to what they practised before for agriculture. Interviewees were also asked if they were engaged in the Aarma Parmah clusters; those who were involved were further asked demographic information about the cluster, the activities conducted through the formed cluster, how the cluster was useful for them in finalizing their reconstruction, and if they were able to save money by working in clusters. Finally, social aspects were also investigated, including how the cluster helped in improving communal harmony, how the clusters helped the vulnerable people of their communities in completing the reconstruction and their rating of the cluster system.

3. Results

In a survey conducted in July 2017, it was found that out of 299 respondents surveyed at wards 3 and 6 of Bijulikot VDC (out of 310 targeted), 99% said that they were familiar with the Aarma Parmah cluster system that was implemented for the construction works, and only 12% of those did not participate in a cluster meeting, those who were staying out of the community were not able to participate in the cluster. 82% felt that working in clusters reduced the overall costs of demolition and reconstruction, 96% said that it improved the harmony within the community and 95% mentioned that they would like to continue to use the cluster system in the future.

In another survey conducted in February 2018, out of 824 respondents surveyed at wards 1, 2, 4, 5, 7, 8 and 9 of Bijulikot VDC (out of 1002 targeted), 99.6% said that they were familiar with the Aarma Parmah cluster system that was implemented for the construction works and only 2.7% of those did not participate in a cluster meeting. 60% felt that the cluster reduced the overall costs of demolition and reconstruction, 62% said it had improved the harmony within the community, and 87% mentioned that they would like to continue to use the cluster system in the future as well.

The most recent survey carried out as part of this research, as described in the Methodology section, was conducted on April 2020, one year after the end of the project completion. The intention was to understand the perception of the community on Aarma Parmah, as used for reconstruction, and how it has impacted to the lives of community members. The results of the survey are illustrated in detail below. Out of the total surveyed

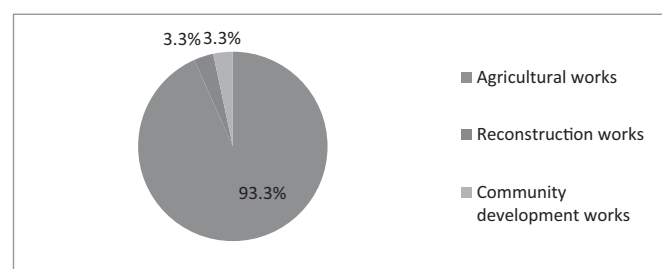


Fig. 3. Purpose of Aarma Parmah in the community.

Table 2
Cluster group composition.

Cluster Member	Lowest no. of members	Highest no. of members	Average
Male	3	12	7.4
Female	0	6	2.7
Total	6	15	10.1

population, 25% were female and 75% male, while 69.4% were general beneficiaries, 22.2% were trained masons, 5.6% were members of a PASSA group and 2.8% were elected ward representatives.

People were asked if they practised Aarma Parmah in the community before the project intervention. 50% of the respondents answered affirmative, 33.3% of beneficiaries mentioned that their community practised it occasionally and 16.7% mentioned that they had not practised Aarma Parmah in their communities. Respondents who answered that Aarma Parmah was used in their communities were further asked about its purpose. 93.3% mentioned that they used Aarma Parmah for agricultural purposes, whereas 3.3% mentioned for community development and another 3.3% for reconstruction works, as shown in Fig. 3. When asked how the cluster system introduced compared to the Aarma Parmah approach in use before, 5.6% mentioned that it was similar, however 41.7% of the respondents mentioned that it was different. This was expected as reconstruction dynamics were different and activities included soft-side components and training. During an FGD conducted in July 2016, beneficiaries of the study revealed that most of the people were accustomed to the practise of Aarma Parmah. It is to be noted that from this FGD major features of traditional Aarma Parmah were figured out, analysed and discussed with beneficiaries to implement Aarma Parmah in reconstruction. Key features of Aarma Parmah used in agricultural purpose and Reconstruction purpose have been presented in the introduction.

94.4% of the respondents replied that they had participated in the Aarma Parmah Group (the previous two surveys had shown a 99% and 99.6% participation rate, respectively). Of the 5.6% of the respondents that were not involved in the cluster, the main reason given for not been involved was that the respondent's grant claim was finalized later on and almost all the houses of their area had been completed. Thus, they had no other option but to hire labour to complete their house. Some respondents explained that they were staying in Kathmandu for work, so they hired a local contractor.

The cluster composition was also investigated. It was found that the cluster with the highest number of members had fifteen members, while the one with the least number had six members. The group with the highest number of male members had twelve members while the one with the least number had three. For female members, the group with the highest number had six, while one group had none. The average cluster size was 10.1 members, with 7.4 male members and 2.7 female members on average (see Table 2). It should be noted that each member represented his/her household.

When asked about what activities were conducted through the cluster, 63.9% of respondents mentioned that they were involved in transporting materials. More specifically, transporting construction materials such as cement, sand, rebar, CGI sheets and stone, for example, usually transported

from the nearest road to houses under construction. Some of the beneficiaries needed to carry those materials for more than 2.5 hrs. 55.6% of beneficiaries mentioned that they were actively involved in construction activities, usually as non-skilled labours, 41.7% of respondents mentioned that they demolished their vulnerable house with the help of cluster members. Finally, 19.4% of respondents explained that although they were part of a cluster they did not participate in reconstruction activities within the cluster and instead constructed using a local contractor to build their house. In total 80.6% of beneficiaries were actively engaged in the cluster, supporting each other for reconstruction activities. A summary is shown in Fig. 4.

As shown in Fig. 5, respondents who worked in the cluster system were also asked to mention its financial benefits. 63.9% of beneficiaries mentioned that they were able to save money through labour sharing. 61.1% of respondents mentioned that they benefitted from transportation of materials and 13.9% respondents mentioned that they benefitted in other ways such as the masons' training that was organized for clusters and the motivation to finalize constructions that came from the cluster.

Those respondents who were engaged in different kinds of reconstruction activities through clusters were asked how much money they were able to save by conducting those activities through the Aarma Parmah approach. For demolition activities, the lowest saving was NRs. 10,000 (100 USD), the highest saving mentioned was NRs. 50,000 (500USD), and the average saving per house was calculated as NRs. 26,666 (266 USD). It should be noted that the salvaged materials after demolition of their previous unsafe houses were also utilized for the construction of their new house and the value of that saving has not been considered here.

Similarly, the lowest saving for reconstruction of houses was NRs. 25,000 (250 USD), the highest saving mentioned was NRs. 1,20,000 (1200 USD), and the average saving was calculated as NRs. 53,250 (532 USD). For transportation of materials, the lowest saving was NRs. 5000 (50 USD), the highest saving was NRs. 30,000 (300 USD) and average saving was calculated as NRs. 9696 (97 USD). For those houses reconstructed using the Aarma Parmah approach, an average of NRs. 89,612 (896 USD) was saved per family. Table 3 shows a summary of the savings for the different phases and the total savings.

Similarly, 19.4% of respondents mentioned that there were vulnerable families [17] within their clusters and that all families with vulnerable individuals had been supported and empowered to finalize their shelters. The final project evaluation conducted by Nepal Social Welfare Council [22] supports the finding that most vulnerable people (the elderly and those with disabilities) were able to reconstruct their houses due to Aarma Parmah, ensuring that nobody was left behind in Bijulikot VDC. When asked in which ways vulnerable families were supported, 71.4% percent of respondents mentioned that their cluster helped in transportation of the construction materials of vulnerable families from the main road to the houses. 57.1% of respondents mentioned that they provided labour from the cluster to support the reconstruction of the houses, 28.6% mentioned that they were able to provide skilled masons from the cluster to help finalize the reconstruction of those vulnerable families and 42.9% of respondents mentioned that vulnerable families were supported by other means such as finding a local contractor for those families to complete

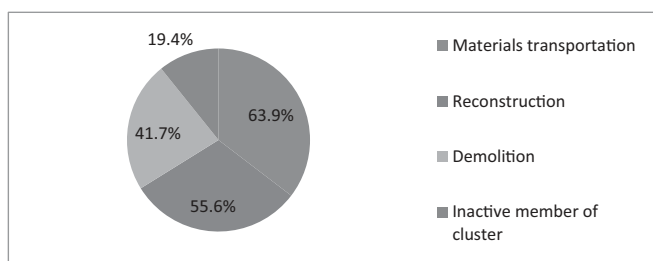


Fig. 4. Activities conducted through cluster (Aarma Parmah).

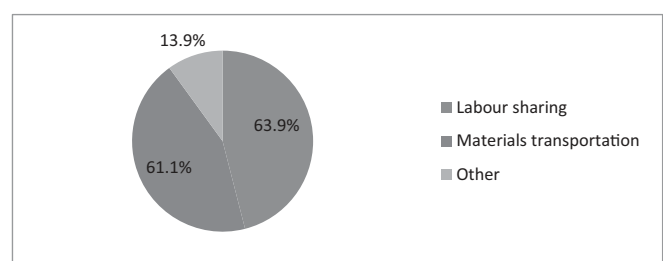


Fig. 5. Financial benefits of cluster system.

Table 3
Reconstruction savings.

Task	Respondents	Lowest Saving	Highest Saving	Average Saving Amount
Demolition	41.6%	NRs 10,000 (USD 100)	NRs 50,000 (USD 500)	NRs 26,666 (USD 266.66)
Reconstruction	55.5%	NRs 25,000 (USD 250)	NRs 1,20,000 (USD 1200)	NRs 53,250 (USD 532.5)
Materials' transportation	63.8%	NRs 5000 (USD 50)	NRs 30,000 (USD 300)	NRs 9696 (USD 96.96)
Total		NRs 40,000 (USD 400)	NRs 2,00,000 (USD 2000)	NRs 89,612 (USD 896.12)

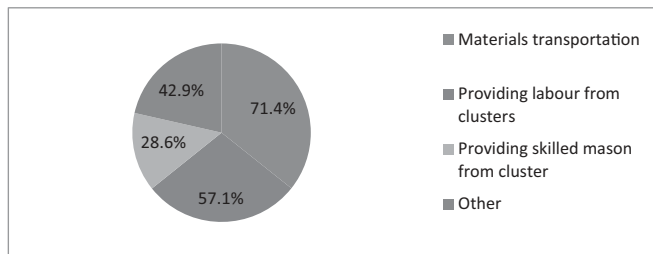


Fig. 6. Means of support to vulnerable households.

the house reconstruction within the provided grants and supervising the construction of the house. These results are summarized in Fig. 6.

The effects of Aarma Parmah on the social cohesion of the community were also investigated. 33.3% of respondents mentioned that their relation with neighbours was improved significantly due to cluster activities. 27.8% mentioned that their relation with neighbours improved slightly, whereas 38.9% of respondents mentioned that the relation with neighbours was unchanged (see Fig. 7). Respondents mentioned that misunderstandings between cluster members were directly resolved between the involved members and the cluster team leader, preventing any escalation and further negative effects.

It was interesting to see that 91.7% of respondents mentioned that communal harmony was maintained inside their communities as a result of the Aarma Parmah approach. In places where mixed castes resided, it could be seen that all the people from different castes were equally participating in their reconstruction works. Also, when respondents were asked to evaluate the social and cultural bonding among the people of their locality as a direct effect of the cluster, 22.2% catalogued the bond as very high, 66.7% catalogued it as high, and 11.1% mentioned it was low (see Fig. 8). During field observation, the first author had witnessed in one instance that some of the families who were not speaking with other neighbours for more than five years due to personal conflict were talking freely and helping each other in the reconstruction tasks.

33.3% of beneficiaries mentioned that they were able to conduct some of the activities through their cluster in joint efforts after project completion, whereas 66.6% mentioned that they did not conduct any further activities through the formed clusters. Respondents who mentioned that they have continued some tasks are mainly in agricultural works, but also in

community development works like road improvement, clearance and water supply maintenance. Furthermore, 25% of respondents mentioned that they are still continuing cluster meetings and 75% of respondents mentioned that they have not conducted any cluster meetings after the project was finalized.

Respondents were asked about what system of work they preferred. 75% answered that the Aarma Parmah approach, 16.7% replied paid labour and 8.3% mentioned that both of them would be effective. Similarly, 33.3% of respondents rated this approach as very high, 55.6% as high, and 11.1% of respondents gave it a low rating. Meanwhile, 86.1% of respondents mentioned that they are willing to continue practicing Aarma Parmah in the future. The remaining 13.9% of beneficiaries did not show any willingness to continue Aarma Parmah for other types of work in their communities. A similar question had been asked in surveys in July 2017 and February 2018, with 95% and 87% of respondents, respectively, stating that they would be willing to continue employing Aarma Parmah in the future.

The following question was asked to those answering negatively about the Aarma Parmah: what are the primary reasons for rating the Aarma Parmah low and not desiring to continue in future? Some people believed that Aarma Parmah approach is costly as they needed to provide additional efforts in helping reconstruct other houses. They also believed that expenses incurred in serving lunch to Parmah members would have been equal or close to the amount that needs to be paid to hired labour. Another reason was that for some cases people were staying in cities and it was easier for them to hire masons to build their houses rather than been involved in groups. Others mentioned that due to the unavailability of younger generations at their home, they felt it would be difficult to reciprocate. Similar to these findings, Gulliet [10] explains that during peak periods, family labour is usually not sufficient and other forms must be recruited. If there is available manpower and the needed cash, then contractual labour paid in cash is often recruited. Furthermore, in families with few family members and a shortage of time, then the reciprocal system is not preferred and they have the necessity to seek paid labour from the locality [3].

4. Discussion

The analysis of the results from the surveys has helped understand how people that participated in the cluster system benefited from it and how the system was perceived. This section expands some of the key areas revealed

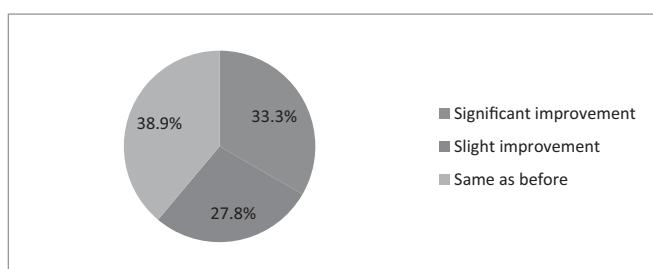


Fig. 7. Relation with neighbours within clusters.

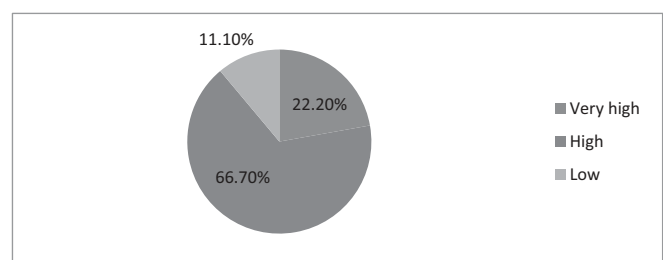


Fig. 8. Rating of social and cultural bonding.

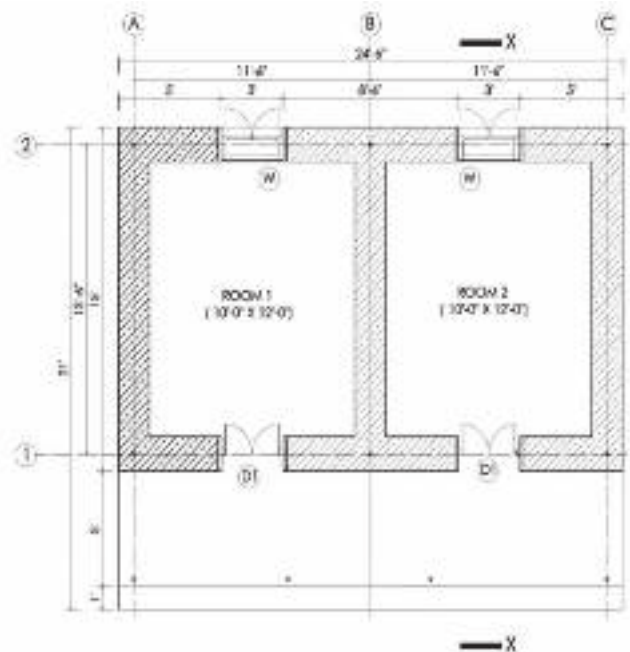
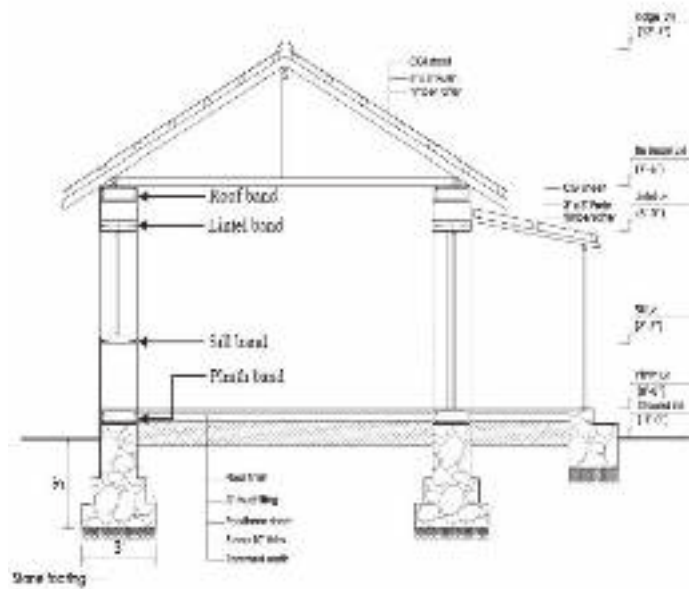


Fig. 9. Plan view and cross-section of a typical two room stone masonry house.

by the surveys, namely the financial savings that enabled people to finish their construction with the limited amount of funding provided by the government and the social harmony within the clusters and the community.

One of the key benefits from working in clusters was the financial savings which enabled most people to finalize their house construction without the need of borrowing money. The given grant of NRs 3,00,000 (3000 USD) was seen insufficient to build a house if the family was to hire the labour to construct it. Labour costs for a typical two room stone masonry house with attic floor (shown in Fig. 9) would cost an average of NRs. 1,75,000 (1750 USD) when built by a contractor. As shown in Table 4, labour costs added to the cost of construction materials and transportation would have been NRs. 5,75,000 (5750 USD) which is more than most families were capable of financing and would have slowed down or even stopped the project. Thus, working together was a necessity to save the money and construct the houses within the provided grant. A success story is given in Table 6.

In the recent phone survey, discussed in the results section above, people were asked how much they saved for each of these activities by working in clusters. The results revealed that people were able to save an average of NRs. 89,612 (896 USD) per household. This amount is shown in Table 5. (rounded to NRs. 90,000 [900 USD]), along with other sources of income such as the grants provided by the government, savings from the reuse of salvaged materials, and additional funding provided (NRs. 35,000 [350 USD]) for transport of materials.

Comparing these two tables it can be seen that there was an average deficit of NRs 50,000 (500 USD) when building a typical two room house (see Fig. 9), which was selected by more than 80% of beneficiaries. This deficit

Table 4
House construction costs breakdown.

Description	Cost, NRs. (USD)
Demolition of old house	50,000 (500)
Materials	3,00,000 (3000)
Transport	50,000 (500)
Labour	1,75,000 (1750)
Total	5,75,000 (5750)

Source: - Medair.

Table 5
Financial management breakdown.

Description	Cost, NRs (USD)
Grant provided	3,00,000 (3000)
Salvaged materials (eg, stone, timber)	1,00,000 (1000)
Savings from Aarma Parmah	90,000 (900)
NGO support for transportation from Manthali to the nearest road head	35,000 (350)
Total	5,25,000 (5250)

Source: - Survey (April 2020) and Medair data.

was usually absorbed by the family, using their own savings. It should be also noted that in the recent survey respondents mentioned that their saving from Aarma Parmah ranged from 40,000 (400 USD) to NRs 2,00,000 (2000 USD), averaging NRs. 89,612 (896 USD) per household. This

Table 6
Success story.

It has been more than eleven years that the husband of Sita* moved to India. He has not returned back, neither communicated once he left to India. She looks after her four children and their education. Like her other neighbours, the earthquake of 2015 left her homeless. She recalls having to stay with her small children in cattle shed for more than one year after her house collapsed. For building the house, once the Government of Nepal announced the financial grant aid, other people in nearby villages were searching for masons to reconstruct their house but she did not face that problem. She had enough manpower from Aarma Parmah as she was associated with a cluster. To return her fair share (parmah) of the work from the masons, she worked providing mud and stone. Now she owns a beautiful two-room earthquake resilient house. Her clusters constructed 10 earthquake resilient houses and did not pay any wages to hire extra masons. Members of the cluster explained how they constructed their earthquake resilient houses by helping each other, and how project field engineers supervised and guided the construction as per government norms. This allowed the cluster to save labour cost and thus was easier for them to reconstruct their houses within the cash grants provided. *Success story of cluster in Bijulikot, 2018 by Medair*

* Actual name has been changed for ethical and privacy considerations.

fluctuation of saving corresponds to the fact that some of the clusters fully adopted Aarma Parmah until the completion of their houses, others completed their plinth or sill band through the Aarma Parmah approach and used hired masons afterwards.

Now that the financial benefits have been discussed, it should be reemphasized that the savings due to Aarma Parmah enabled the majority of the people to build. Alternatives to Aarma Parmah included self-reconstruction or contracting works to a mason. However, both of these methods had very significant challenges. First, it would have been nearly impossible for the typical family to rebuild by themselves, as the stonemasonry system is fairly complex, requires special skills and is fairly labour intensive. The other alternative, paying for labour, would have also been prohibitive for the majority of the families, as has been shown in the analysis above. Also, given that reconstruction of the houses was going on all over Ramechhap district, the demand for construction materials was more than the supply, resulting in scarcity of construction materials and construction delays. However, this was managed through sharing of materials among cluster members until demand could be met with sufficient supply. Thus, Aarma Parmah was indeed a reason why families were able to rebuild, motivating each other, sharing labour (Fig. 10.), expertise and construction materials, and not spending the significant amount that would have been required to rebuild using paid labour. This reality was well captured in the survey, with 75% of the people stating that they preferred the Aarma Parmah method over paid labour for working.

A UNESCO report [19] which looked at forms and patterns of social discrimination in Nepal concluded that discrimination is inherent in the denial of entry, services, access to common resources, social relationships and participation. Discrimination also results in forced labour, dominance, commitment of atrocities, social boycott and attitudinal untouchability. The survey showed that even after all the community engagement some cases of discrimination still existed (11.1%), but the majority of people set aside their social status (88.9%) and worked together for the good of their community, increasing social and cultural bonding leading to communal harmony. Field observation has also noted that many trained Dalit masons were freely working in upper caste family houses without any hesitation and vice versa. People normally work together within their caste but do not work with other castes normally; however, due to the enormous need to complete the reconstruction of the VDC within the timeline provided by the government, it was important to collaborate beyond their traditional ways. Thus, having social harmony within the communities was necessary to ensure collaboration among the people and a timely reconstruction. Fig. 11 shows the typical activities undertaken for the construction of each house.

Questions were asked in the survey to evaluate how people perceived social harmony in their communities, whether the cluster system had



Fig. 10. Cluster members involved in demolition activities and classifying the salvaged materials.

improved relations with neighbours, whether it played a role in maintaining communal harmony, and their ratings on social and cultural bonding as a direct effect of working in clusters. It is evident from the survey that people were satisfied with the Aarma Parmah approach and 92% affirmed that it helped them in maintaining social harmony of the communities. Social harmony was maintained since people were in need of working together for a common good. Also, whenever discrepancies arrived between members of a cluster, these were solved directly by the members and the team leader. This allowed for problems to be treated rapidly, without giving time for escalation. Furthermore, 61.1% of participants explained that the relationship with their neighbours had improved, of which 33.3% mentioned a significant improvement.

Another very important benefit is that vulnerable families [17] were also able to finalize the reconstruction of their houses even if they were unable to reciprocate the help that was demanded in the Aarma Parmah approach. The NRA provided a list of the extremely vulnerable families (65 households) in Bijulikot VDC. 86% of those beneficiaries were able to complete their house; whereas 9% of beneficiaries were found deceased and the remaining 5% had other reasons for not building. In the most recent survey people explained that vulnerable families were helped with the transportation of the construction materials to their houses, with labour support, including skilled masons and with supervision of the works.

In some instances, vulnerable people were also empowered from this approach. As an example, one blind man who helped to complete the reconstruction of his house within his clusters later on started working as a mason in his community. This meant that he was involved in income generation activities and that the community accepted him as a construction worker.

Another significant benefit observed was that people worked together to clear numerous landslides which were blocking the main road at Ward three of Bijulikot VDC. Initially, people were waiting for the VDC grant to clear the landslide for a period of three months before the project team engaged them in the cluster approach. More than 100 people from 12 different clusters joined to clear the landslides in a three-hour period; it turned out to be a much easier task than people had imagined. The road clearance helped them transport construction materials to their houses. This is just one clear example of how helping each other with collective efforts can be utilized for development in many forms.

Now that the benefits have been discussed, it should be mentioned that significant efforts were made in order to introduce the Aarma Parmah approach to the community (see Fig. 12). Although a large part of the community had already used the system for agriculture, the system was used in reconstruction which is very different. Plus members of Aarma Parmah groups, or clusters, were different from their agriculture peers. Thus, a great effort was made to engage communities, to train them, and to empower them to recognize the benefits and successfully complete the reconstruction. These efforts included community meetings, household to household visits, but also social events like a football match which helped in bringing the community closer together. The next paragraphs further explain the process followed to introduce Aarma Parmah in the VDC.

The process of Aarma Parmah started with PASSA training [11] sessions at ward level and project plan briefings and orientations which helped in building trust within the local community, leading to the formation of clusters of six to fifteen households depending upon the geographical location. The cluster was instructed clearly about their goals, approach of helping each other and especially helping vulnerable families of their clusters. Furthermore, each cluster selected one team leader who was responsible for conducting regular meetings within their cluster, preparing a schedule of house construction of their clusters, and solving any disputes raised while working together within their clusters.

Regular cluster meetings were held to discuss the need of each of the houses to be constructed, and to establish the construction order. First priorities were given to the families that were still staying at temporary shelters and to the vulnerable families. As clusters began to understand the owner-driven house reconstruction that they would be engaged in, they selected masons from their wards to participate in training provided as part of the project. 152 masons were trained following a seven-day curriculum at

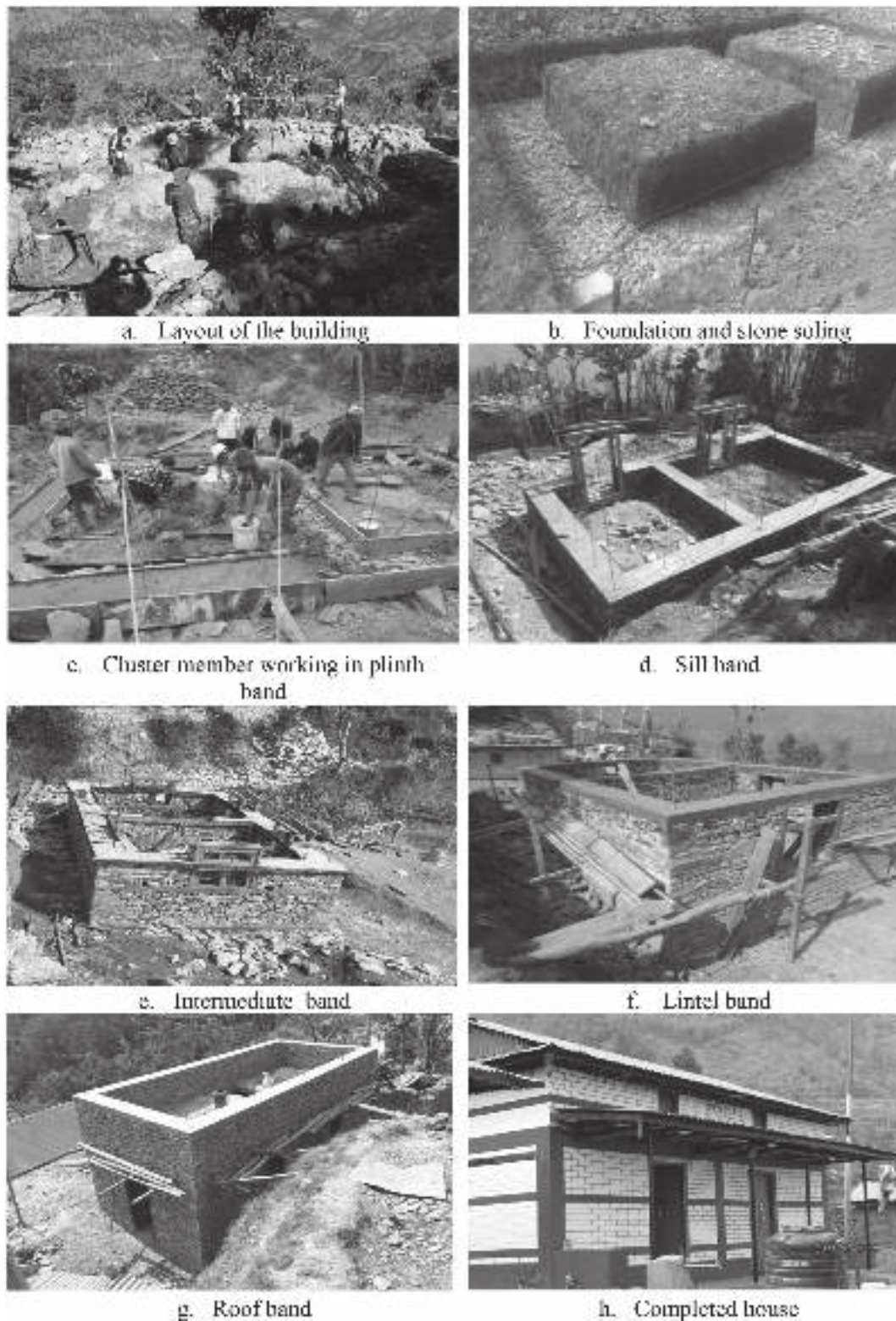


Fig. 11. Activities undertaken for reconstruction.

Bijulikot VDC (see Fig. 13), and thus, were ready to work in the reconstruction of houses in their respective clusters. Project field engineers provided guidance and supervised the reconstruction works. Training of masons was an essential aspect that allowed the reconstruction works to be finalized on time and with a high quality. There were not enough masons in the community, thus, delays would have been inevitable. But even

experienced masons were not accustomed to the number of earthquake resilient measures that were introduced by the government in order to build back to a higher earthquake safety standard. These trainings, combined with the fact that families worked together and shared labour and knowledge through Aarma Parmah, will undoubtedly result in knowledge on build back better methodologies that will be transferred to future



Fig. 12. Community engagement and orientation.



Fig. 13. Mason Training to community members-Practical exercise on layout of building.

generations. KIIs with the president of ward no three of the study area also emphasized that previously the building construction technology was transferred from one generation to another, but was lacking the earthquake resistant features. Now that more than 1300 houses were built by the community, the hope is that these earthquake resilient building technologies will be sustained in the communities and transferred to future generations.

5. Conclusions and recommendations

The adaptation of the Aarma Parmah farming process of labour exchange was very successful in the earthquake reconstruction. Aarma Parmah was key in the disaster reconstruction process and future research should consider exploring this form of labour further.

This investigation found that Aarma Parmah saved families an average of 90,000 (900 USD), allowing most families to finish their reconstruction with the amount of NPR 3,00,000 (3000 USD) provided by the government. Similarly, Aarma Parmah was instrumental in ensuring that most vulnerable people (the elderly and those with disabilities) houses were also reconstructed. It also increased social cohesion within neighbours, was key in achieving community level activities such as road clearance, and allowed the communities to finish their house reconstruction on time and to a satisfactory quality which increased resiliency.

While the results of the described project are very favourable, the conclusions were drawn from only one experience in a rural location in Nepal, showing the potential of the system beyond agriculture, but also underlining the need for future research in more locations.

Although this research showed the successful use of Aarma Parmah in a rural setting, the system is inherently affected by modernization. The traditional and indigenous system which could benefit communities in the future through collective labour is vanishing. In our field experiences we observed that people who had the financial resources or who were staying at cities preferred to construct their houses by hiring a local contractor rather than being engaged in a cluster. This trend is also observed in

other countries. For example, a paper by Charles J Erasmus [8] mentions that although exchange labour survives among poor families in most of the rural western South America, it was disappearing back then, with mainly older people remembering the practise. Arun Agrawal [2] also mentions that the indigenous knowledge is disappearing over the world as a direct result of the pressure of modernization. He also suggests greater efforts must be made to save, document and apply indigenous strategies of survival.

The Aarma Parmah approach is not only for agriculture or reconstruction; it also proved very effective in sharing the knowledge and conducting community level activities that benefitted the entire community. Hence it is recommended for DRR practitioners and researchers to further investigate Aarma Parmah academically. "Indigenous knowledge has value not only for the culture in which it evolves, but also for scientists and planners striving to improve conditions in rural localities" [23].

Declaration of Competing Interest

None.

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Regular Article

An assessment of livelihoods program in earthquake affected areas of Nuwakot district, Nepal

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ABSTRACT

A study was conducted in Nuwakot district to explore how the transition from relief to livelihoods restoration was managed and whether efforts were timely, socially justifiable and adequate to promote sustainable livelihoods of the earthquake victims. A transition period existed between relief and livelihood recovery support, which not only ensured survival of the victims but also paved way for livelihood interventions. Supports were timely and socially justifiable but with questions. Livelihoods of the beneficiaries improved in general while achievement of sustainable livelihood was limited to a few. Synergy among multiple support providers prevailed specially after introduction of one-door policy.

1. Introduction

1.1. Background

The 7.6 Richter scale earthquake of 25 April 2015 and subsequent major aftershocks caused massive damage in the country. Thirty-two districts were affected with 14 districts severely hit including Nuwakot (Fig. 1). A total of 8970 persons were reported dead with 195 missing and 22,302 wounded. Number of families affected were 1,072,093 in terms of their house damaged, including 773,095 houses that were unsuitable for living. Besides, scores of public buildings and community infrastructures were also severely damaged. Similarly, industries, communication networks, road networks, tourism sector and agricultural sectors were also badly affected. Economic loss was estimated to be about NRs. 706.4 billion (DRR, 2017). Life of about eight million people got affected to varying degree in affected areas [5,6].

Government of Nepal took firm steps towards transitioning from relief phase to recovery phase. The National Reconstruction Authority (NRA) was constituted on 25 December 2015 with a mandate to manage, oversee and coordinate recovery and reconstruction work in the earthquake affected districts. In May 2016, the NRA brought a new Post Disaster Recovery Framework [7], which laid out strategic recovery objectives to:

- Restore and improve disaster resilient housing, government buildings and cultural heritage;
- Strengthen the capacity of people and communities to reduce their risk and vulnerability and enhance their social cohesion;
- Restore and improve access to services and improve environmental resilience;
- Develop and restore economic opportunities and livelihoods and re-establish productive sectors;
- Strengthen capacity and effectiveness of the state to respond to the people's needs and to effectively recover from future disasters.

Many bilateral/multi-lateral donor agencies pledged their support for recovery and reconstruction objective of NRA. A multi-donor trust fund of \$3.2 billion was established with support from various donor agencies and humanitarian organizations [9]. Non-governmental organizations (NGOs) played important role in recovery and reconstruction efforts. About 38 NGOs undertook various projects related with reconstruction and recovery. Some of the NGOs include ActionAid, Oxfam, UN/WFP, DFID, OXFAM, UNICEF, ACF, GIZ, Red Cross, SAPPROS Nepal, Mott MacDonald, Share and Care, CARDSAN, JICA, Nepal Green Tara Foundation, Rotary Club Australia and KCDC.

The Ministry of Agriculture and Livestock Development also undertook livelihood restoration responsibility. However, it was difficult to collect

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Fig. 1. Earthquake affected districts in Nepal (21 May 2015) Source: Nepal Earthquake Housing Reconstruction Multi-Donor Trust Fund Annual report 2015–16.

nationwide information on this subject due to COVID-19 pandemic. In Nuwakot district, the district agriculture development office supported the victim families with 40 thrashers, 85 maize pilling machines, 55 mini tillers, 150 irrigation facilities and 16,443 postharvest storage bags during 2073/74 (as reflected in its annual program for the year). However, no disaggregated data was available about the characteristics of the beneficiaries in terms of quake victims and vulnerability.

1.2. Problem statement and rationale

NRA identified several challenges that obstructed the pace of its operation including recruitment of personnel and building their capacity; securing financial resources needed for reconstruction and rehabilitation; motivation of human resources belonging to different agencies; high expectation and low capacity of beneficiaries; unwillingness of the people to leave their current home place and get relocated to new place; lack of coordination among responsible agencies; remoteness and disrupted transport infrastructures; lack of skilled/trained manpower in the affected area [8,9]. Besides, absence of elected local government and weak database at local level caused severe difficulty in data collection, documentation and information sharing at local level. At later stage, elected local governments came in place but the elected officials took time in learning about the business.

Despite the challenges, NRA and its allies demonstrated commendable efforts in managing the complex recovery and reconstruction tasks although the pace of task completion is marked by delays. About 88% of the reconstruction work got completed in five years, while the vulnerable households, in general, lagged behind in reconstructing their houses mainly due to their inability to meet cost sharing or due to lack of appropriate construction site. The NRA took measures to provide additional grant assistance to address this issue but the most vulnerable ones continued to be left behind. Similarly, implementation of livelihood recovery by various agencies has shown mixed results with inadequacy of support on one hand and sustainability of the livelihood results on the other. In this situation, it is pertinent to explore the reasons behind these lacunas.

The Post Disaster Recovery Framework 2016–2020 has focused on the recovery of lost properties and promotion of resilient infrastructure reconstruction but has ignored the pre-existing socio-economic disparities among the affected population [10]. Inadequacy also existed in livelihood support in terms of goal, package definition, target coverage and coordination arrangement. Weak governance, lengthy bureaucratic process, lack of long-term commitment among NGOs and wait-and-see attitudes of the affected people have weakened the community's capacity and ability to rebound. Poor coordination among major reconstruction actors also influenced the promptness of work in terms of recovery work [11].

Local community institutions, built before/after the recovery interventions, served as a knowledge base and capacity for providing social and micro-financial support to the victim families to cater socio-economic

needs of the people, mostly on group collateral. Micro-finance banks provided banking support to the poor households through self-help groups and community institutions to undertake various types of micro-enterprises in agriculture as well as non-agriculture sectors. However, there is a lack of study on their role in helping earthquake victims attain sustainable livelihood. Studies have carried a great deal of analysis on reconstruction aspect while less attention has been paid to examine whether livelihood of the earthquake victims has been restored or restored sustainably. Information is also lacking about whether the supports were timely, adequate and socially justified from the perspective of attaining sustainable livelihood. In addition, scant attention has been paid to understand how effective was the transition from relief to livelihood restoration and whether affected vulnerable households got left behind in the development process.

1.3. Research questions and objectives

In light of above, it is pertinent to examine the livelihood recovery interventions carried out by multiple support agencies and the change in the life of the beneficiaries taking into account the process, input and output dimensions for which this study was carried out guided by the following four specific research questions

- What changes occurred in the livelihoods of the victims?
- Was there any improvement in the livelihood status of the victims?
- Was the support timely, socially justifiable and adequate?
- Were there emergence of helpful social capital or institutions?

Following four specific objectives were identified, in order to address above research questions:

- To determine improvement in livelihood status of the earthquake victims.
- To assess the effectiveness of the livelihood recovery support in terms of its timeliness, social justification and adequacy.
- To examine if there is any improvement in the capacity of affected and vulnerable people for improved income and employment opportunities.
- To assess coordination mechanism and synergy among the multiple actors in the support delivery.

1.4. Significance of the study

This study will be useful in decision-making in several dimensions of livelihood restoration in context of post-disaster rehabilitation and recovery efforts. It will also help define a process to ensure rapid transition from relief to livelihood recovery; define appropriateness and timeliness of livelihood supports; and suggest a mechanism for optimum coherence, coordination and complementarity among service providers and stakeholders for efficient delivery of the support.

2. Materials and methods

2.1. Conceptual framework

Emergency relief can be considered as the provision of essential needs to individuals, families and communities in the immediate aftermath of an emergency, while emergency recovery focuses on the provision of life support and essential needs to people affected by an emergency. In all cases, the *relief* phase of a disaster transitions into the *recovery* phase, when systems are in place and people are no longer worried about survival but can turn to rebuilding their lives [2].

According to Chamber and Conway [1], a livelihood comprises the capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from the stresses and shocks and maintain or enhance its capabilities and assets both now and in the future without undermining the natural resource base. Frankenberger (1996) on the other hand defines a household livelihood as secured and adequate if it has sustainable access to income and resources to meet basic needs.

The Sustainable Development Goals (SDGs), initiated by the United Nations has strengthened focus on vulnerable section of society through 'leave no one behind' (LNOB) concept. This concept ensures that the vulnerable groups are attended first while the remaining target joins the course automatically.

DFID has utilized human capital, social capital, physical capital, natural capital and financial capital to define sustainable livelihood framework taking vulnerability, strategy and process into consideration [3]. This study adapts the same five factors used by DFID while using local specific variables to reach the objectives as depicted in Fig. 2.

For triangulation purpose, international definition of income level for poverty (\$2/day/person) and ultra-poverty (\$1/day/person) was used in this study in specific context. Social security has been recently used to support families/individuals living under critical condition, which is defined in terms of vulnerability. It includes senior citizens, persons with disability, single women, widows, ethnic groups such as *Raute*, *Dalit* etc. Considering poor/ultra-poor in the vulnerable category, a wider category of 'vulnerable group' was considered in this study for developmental/rehabilitation purpose.

2.2. Study area

Ideally, it would be better to cover all hard-hit districts for study but time and resource constraints led to opt for one representative district that was severely affected and accessible with rural municipalities in which recovery support was provided by many agencies for a fairly long implementation period and in which there was at least one agency working with the aim of leaving no one behind (LNOB). To this end, Nuwakot district purposely selected together with its four rural municipalities namely *Shivpuri*, *Tadi*, *Kispang* and *Dupcheshwar* municipalities for this study (Fig. 3).

The earthquake caused severe damage to infrastructure, life and livelihood in the study area. A total of 45,706 buildings were fully/partly damaged, 399 persons lost their life, 634 persons were wounded, and 150 families needed relocation due to landslide and geo-hazard caused by the quake in study area [4]. It is estimated that earthquake affected almost 99% of the vulnerable population. However, data on number of affected families that required livelihood support was not available.

Just after rescue and relief stage, significant livelihood activities could not be launched immediately due to trauma, damaged/unorganized livelihood infrastructures, and lack of data on affected families. In such situation, dozens of agencies, under their own modality, launched a series of

activities, including vocational training, cash for work, food for work, distribution of temporary rehabilitation package, and small input packages. This support was effective in keeping severely affected families in survival mode and at the same time repair of damaged community infrastructures important for full fledged livelihood creation support.

2.3. Data sources and collection methods

This study focuses on the assessment of livelihood recovery of the targeted earthquake affected community groups, which serve as the major primary data source. Target groups were categorized in term of receiving livelihood recovery support from (a) only government program, (b) development agencies without LNOB concept, (c) development agencies with LNOB concept, (d) mature groups with longer engagement in livelihood interventions, (e) groups relocated from other area and resettled in the study area, or (f) control groups which had not received any livelihood support. A total of 60 beneficiaries, representing the above six categories were selected for the survey. Both primary and secondary data were collected from the field to address the research questions.

Primary data were collected using focus group discussions (FGD), key informant interviews (KII) and direct observation of the livelihood interventions in the field. FGD was conducted with 60 beneficiaries on five dimensions of livelihood mentioned as shown in Fig. 2. Each dimension consisted a set of questions weighing 1 to 5, where 5 marked maximum/best score based on their perception/experience. Key informant interviews (KII) were conducted with the individuals who have first-hand information about the livelihood recovery support to the target groups. The key informants include *Palika* officials (Chairperson, Vice-Chairperson, Ward Chairperson, Agriculture Officer), representatives of local cooperatives, agricultural input suppliers/Agro-Vet/private sector market actors, *Palika* level NRA staff, and *Purnima-Sambodhan* project staff. Direct observation of the livelihood interventions were carried out in the field to assess the impact of the interventions in the livelihoods of the target groups and collect success stories, which were mainly used for triangulation of the information collected by using other methods and tools.

The research team used a set of questionnaires as interview guide while facilitating FGDs and KIIs. The KII questionnaires comprised of two parts: The first part captured details of the respondent's involvement in the livelihood recovery support, while the second part captured the perception and experiences of the respondents about livelihood support provided by various organizations. Besides, a snap survey was conducted in participation of 18 persons from 6 community groups that participated in FGD. The

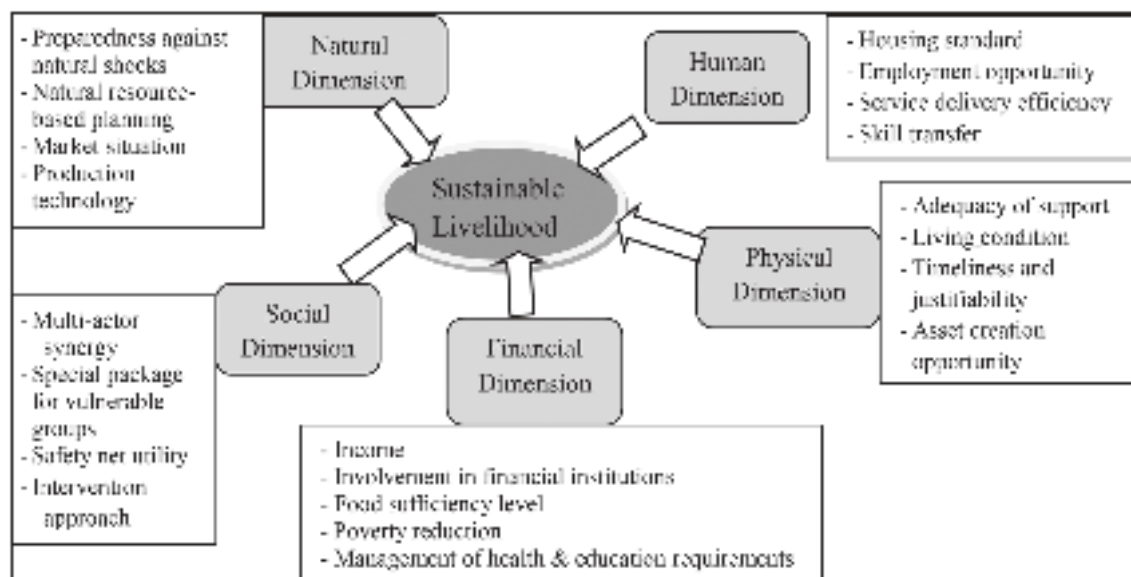


Fig. 2. Conceptual Framework for Assessment of Livelihood through Five Dimensions.

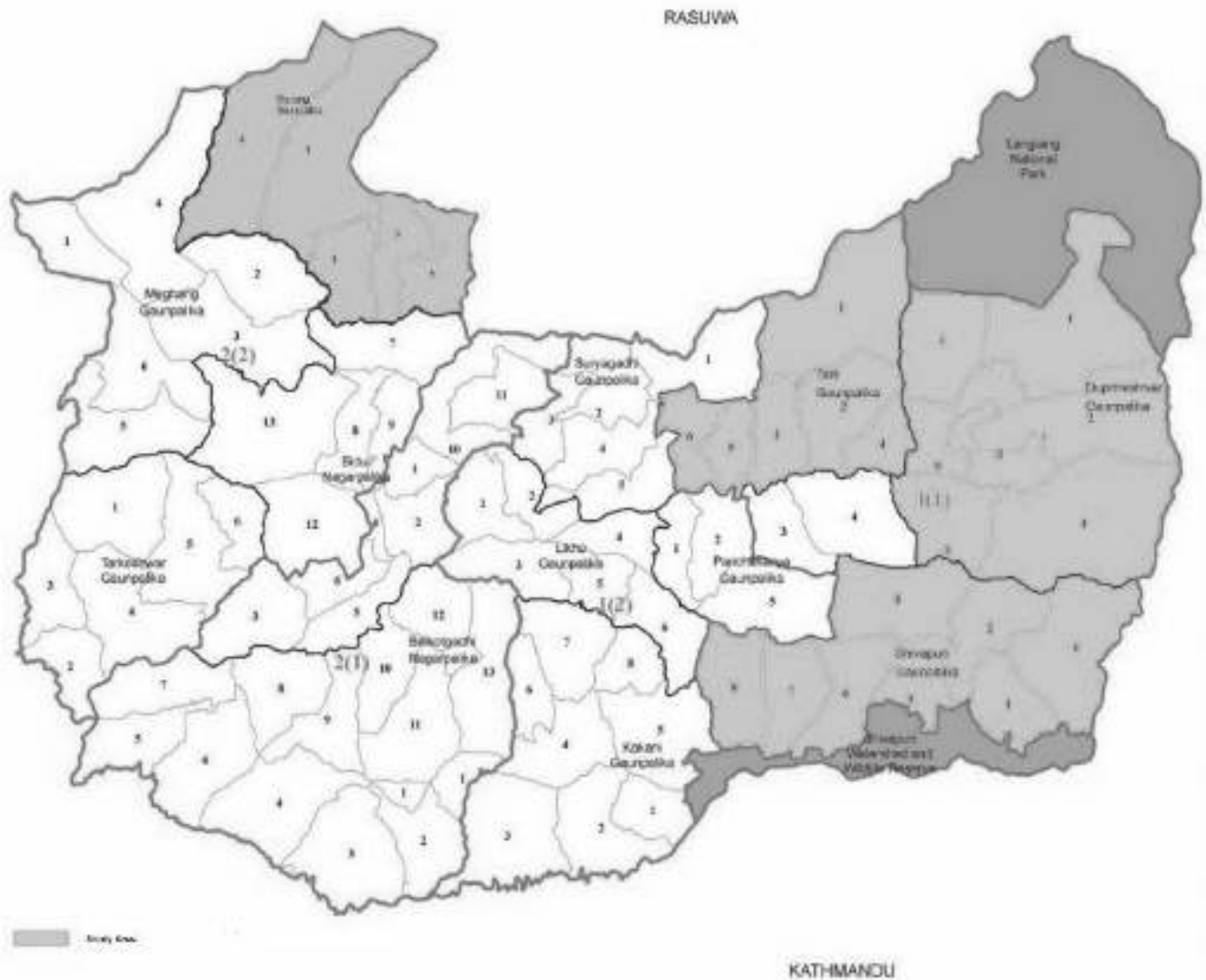


Fig. 3. Map of study area.

main purpose of the snap survey was to capture the income and expenditure status of the respondents as a result of the livelihood recovery support, which was again used for data triangulation purpose.

In addition to the primary information, secondary information was also collected from relevant agencies in the study area and in Kathmandu in the form of progress reports, case studies, policy documents and group records/files. Relevant literature and policy documents were also reviews to gather required secondary information.

2.4. Timeframe

The field data collection including the survey was carried out during the first quarter of year 2020. For comparison purpose, data were collected for the period before 2015 earthquake and the year 2019.

2.5. Data analysis

The information collected through both sources were checked, sorted, coded, classified and triangulated from different sources in order to validate them. Percentage method was used to analyze data. Findings were

tabulated/categorized and interpreted along with tables, charts, diagrams and graphs.

3. The results and discussion

Key results pertaining to livelihood interventions carried out in the study area were analyzed in terms of five livelihood dimensions - human dimension, social dimension, physical dimension, natural dimension and financial dimension. Each dimension consisted of a set of variables each of which weighed by the respondents using 1–5 scale, 5 being the highest, to mark the change due to recovery interventions. The results are described in this section.

3.1. Human dimension

Human dimension marked the change that took place in housing standards, employment opportunity, knowledge and skills, and service delivery efficiency. They are:

Change in the housing standard of the beneficiaries was found to be modest in general with 30% of the respondents considering the change

Table 1
Change in the housing standard of the people.

SN	Perceived change in the housing standards	% Response (N = 60)
1	No change	17.0
2	Just felt or only little change	53.0
3	Change realized	0.0
4	Change visible	30.0
Total		100.0

Source: FGD 2020.

being visible (Table 1). Majority of the respondents however, perceived the change as not visible. About 17% respondents did not see any change. During the KII and spot check, it was found that the living condition of the beneficiaries changed in at least 80% of the households due to completion of housing reconstruction.

Change in employment opportunity occurred in the families due to recovery interventions. About 62% families experienced increase in employment opportunity, securing employment for at least 3 to 6 months in a year (Table 2). There is still to do more to ensure employment round the year.

Community members were supported by different agencies in providing inputs for livelihood recovery, such as low cost plastic tunnel, livestock shed, surface irrigation canal, vegetable seeds, cage poultry farming, bee keeping and drip irrigation. Household members from some households have also gone for foreign employment and receive remittance, while few other on social security allowances provided by the government and daily wages for their livelihood.

Changes in skills and knowledge - Skills and knowledge of beneficiaries in undertaking livelihood activities was found to be increased (Table 3). The result shows that about 62% of the people trained to undertake income generating activities used their knowledge and skills in gaining income and employment, while some of them even transferred the knowledge to others. KII supported such utilization of training imparted by different agencies during livelihood interventions.

Change in service delivery efficiency: The support delivery mechanism was found positive in delivering the livelihood recovery support to the earthquake victims. About 79% of the respondents perceived support delivery as efficient having felt/realized increase in efficiency (Fig. 4). It was found that the people received support from various agencies but the delivery mechanism was not very systematic due to lack of coordination among the implementing agencies (Box 2).

In summary, the support brought positive change in: (a) housing standard due to availability of new/reconstructed houses through NRA support; (b) skill/knowledge of beneficiaries due to trainings from various support agencies; (c) employment opportunities due to grant in cash or kind and loan support; and (d) market facilities due to emergence of local markets. Maximum impact was seen where multiple support was provided in adequate quantity for a longer period of time and with close monitoring and regular backstopping from government as well as development agencies.

3.2. Social dimension

The results of livelihood recovery support were analyzed from social perspective considering usefulness of safety nets provided to the beneficiaries,

Table 2
Involvement of family members in livelihood activities.

SN	Change in employment opportunity on livelihood options	% Response (N = 60)
1	No change	17.0
2	Only a few days' employment in a month	21.0
3	Secured employment for at least 3 months in a year	12.0
4	Secured employment for at least 6 months in a year	50.0
5	Secured year round employment	0.0
Total		100.0

Source: FGD, 2020.

Table 3
Change in the skills and knowledge.

SN	Change in skill and knowledge on livelihood interventions	% Response (N = 60)
1	No change	21
2	Gained skill and knowledge but not utilized/practiced	17
3	Utilized/practiced the skills/knowledge gained	32
4	Utilized/practiced the skills/knowledge gained and partially transferred	30
5	Fully transferred the skills/knowledge to others	0
Total		100

Source: FGD, 2020.

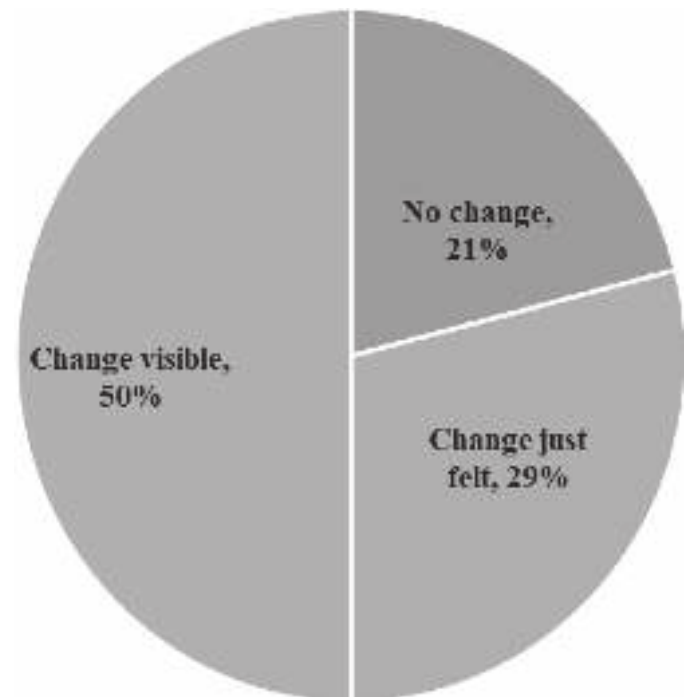


Fig. 4. Support delivery efficiency. Source: FGD, 2020.

synergy among multiple actors supporting them, and special support package dedicated to vulnerable groups.

Safety-net utility: Social safety net provided to internally displaced persons (IDPs) to ensure sustainable livelihood was considered useful/effective by 62% of the respondents (Fig. 5). KII informed that social safety net program was a pride for the vulnerable people.

Special package for vulnerable: The government agencies provided special support package to targeted vulnerable groups to ensure their

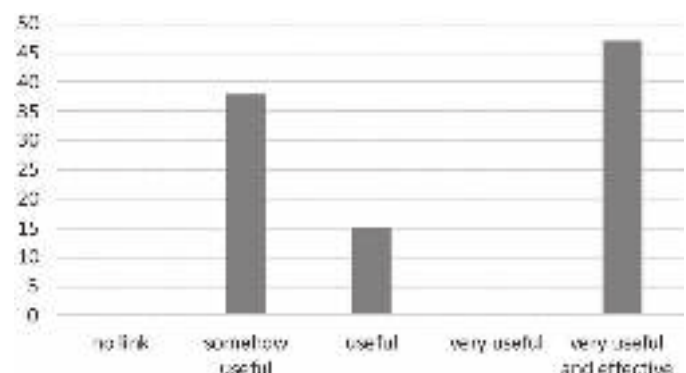


Fig. 5. Social safety net support to ensure sustainable livelihood. Source: FGD 2020.

Table 4
Special package for targeted vulnerable groups from government.

SN	Special package for vulnerable	% Response (N = 60)
1	No idea	29.0
2	Let's see what we will get	21.0
3	Targeted people will get something	50.0
4	Targeted people are active in livelihood activities	0.0
5	Targeted people have sustainable livelihood	0.0
Total		100.0

Source: FGD, 2020.

livelihood recovery. Perception of the respondents towards this special package was positive in general with about 50% respondents trusted in such a package while another 50% were either unaware of such program or skeptical about it (Table 4).

Livelihood intervention approach: Exposure of the community members to tailor-made approaches considering leave no one behind concept was felt as helpful by 80% of the beneficiaries (Table 5). KII also supported this finding.

Multi-actor synergy: Besides government agencies, at least one dozen non-government support agencies were active in the study area including UNICEF, Oxfam, GIZ, ACF, Red Cross, UNWFP, SAPPROS Nepal, Share and Care, DFID/Purnima. They have provided support in different thematic areas, such as health, education, shelter, livelihood, food security, nutrition, etc. Multi-actor synergy was not very effective due to policy conflict and interest of the actors, and biasness and low management efficiency at the local level. On several occasions, organizations worked in isolation without letting rural municipality know about the area they worked and kind of support they provided. It caused resource duplication, competition and confusion among different parties. However, situation improved significantly after the newly elected municipal authorities took charge of the coordination responsibility by enforcing 'one door' policy in 2018. As a result, synergy among multiple actors involved in the livelihood recovery interventions was positive and effective as opined by 62% of respondents (Table 6).

In summary, it could be deduced that: (a) social programs such as safety net and special package for the vulnerable proved to be useful to provide relief to the target groups; (b) multi-agency synergy worked well under 'one door policy' of the local government; and (c) tailor made approach in the process of recovery intervention was found effective.

3.3. Physical dimension

Changes in the physical dimension was measured in terms of timeliness and social justifiability, adequacy of support, asset creation opportunity and change in living condition.

Timeliness and justifiability: In general, support provided by the agencies under various programs reached deserving families on time as reported by 50% of the respondents. However, 17% did not get support despite their eligibility and hence perceived that the support was not distributed in socially justifiable manner. Another 33% respondents opined that the efforts were delayed (Table 7). KII indicated that the efforts reached the beneficiaries on time in general, but not always in a socially justifiable manner. In many cases, better-off people reaped the benefits while vulnerable people,

Table 5
Tailored made approach.

SN	Livelihood intervention approach	% Response (N = 60)
1	No idea	0.0
2	As usual (not very helpful)	20.0
3	Helpful	50.0
4	Helpful and practiced	30.0
5	Helpful, practiced and found effective	0.0
Total		100.0

Source: FGD, 2020.

Table 6
Level of multi-actor synergy.

SN	Change in level of multi-actor synergy	% Response (N = 60)
1	No change	0.0
2	Little changes	38.0
3	Positive change	32.0
4	Positive and effective change	30.0
5	Positive and highly effective change	0.0
Total		100.0

Source: FGD, 2020.

Table 7
Timeliness and social justification of the support.

SN	Timeliness and justifiability	% Response (N = 60)
1	No support received	17.0
2	Support delayed	33.0
3	Support reached on time	50.0
4	Support reached on time and somehow manageable	0.0
5	Support reached on time and was well managed	0.0
Total		100.0

Source: FGD, 2020.

Table 8
Adequacy of support for sustainable livelihood.

SN	Adequacy of support	% Response (N = 60)
1	Not adequate	38.0
2	Somehow adequate	32.0
3	Adequate	15.0
4	Adequate and utilized	15.0
5	Sufficient and fully utilized	0.0
Total		100.0

Source: FGD, 2020.

who could not raise their voices and did not have access to information, were again left behind.

Adequacy of the support: The findings suggest that, in general, the livelihood recovery support was inadequate to attain sustainable livelihood as reported by 70% of the respondents (Table 8). Only 30% of the respondents reported the support as adequate although only half of them utilized the support towards attaining sustainable livelihoods. KII indicated that the support was not enough for the beneficiaries to reach sustainable livelihood level and the problem lied with the beneficiaries themselves as about 50% of them did not continue their business activity after the support agency left the area. The study found that some of the beneficiaries discontinued the activity because the input-output market linkage did not work well after the support agency left (Box 1).

Asset creation opportunity: Support provided by the various development agencies and local governments resulted in creation of community assets (e.g. water supply, irrigation system etc.) and household assets (e.g. agricultural tools/equipment, plastic tunnel, animal stock etc.) that would contribute to livelihood improvement in the area. It was confirmed by 62% respondents who claimed that assets creation did take place (Table 9). KII also confirmed that such assets were created in the area.

Table 9
Opportunities for asset creation.

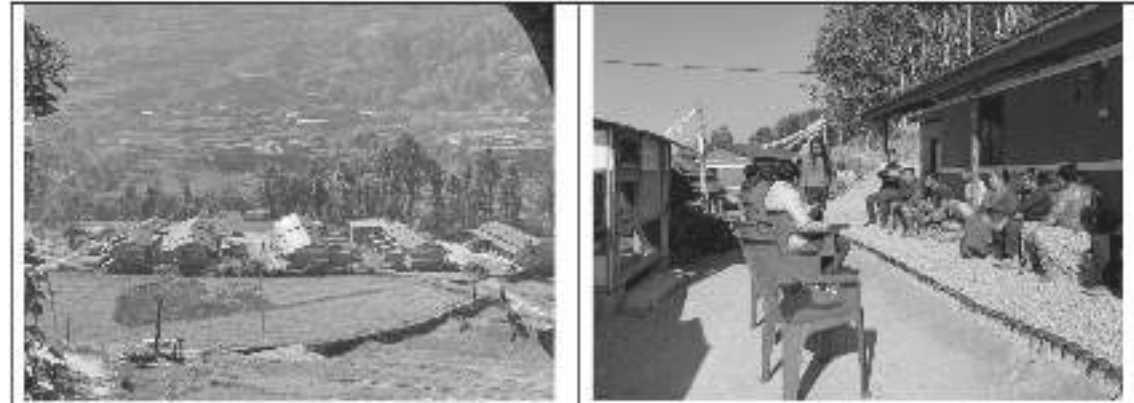
SN	Asset creation opportunity	% Response (N = 60)
1	No change	17.0
2	Under process	21.0
3	Asset created only once	0.0
4	Somehow successful	62.0
5	Fully successful	0.0
Total		100.0

Source: FGD, 2020.

Box 1

Namuna Basti of Internally Displaced Persons (IDPs)

Namuna basti of *Tadi* is a new home for 72 families relocated from their previous settlement, which was damaged by landslide in 2014 and hit for the second time by the 2015 Earthquake, making the place unsafe for living. About 22 *ropani* land was purchased by the government for the resettlement. After taking care of area for the public utilities such as road connection, drinking water supply, electricity supply, each family was allocated a homestead of 0.4 *ropani* land. In 2016, construction of houses began as per the standard design of NRA, and the families moved in their homes in 2017. The IDPs received training on weaving, beads (*pote*) making, and agriculture and poultry farming together with input support including vegetable seeds, poultry pane and chicks. Now, 24 families have poultry pane in front of their houses and some of them are rearing pigs as well. Most of the support came from Oxfam, followed by *Tadi* Municipality and DFID/Purnima CF-LNOB Project.



The beneficiaries, in general, are satisfied from the support they have received. They have abandoned weaving and beads making work due to lack of market, but have continued poultry and pig raising, which are suitable both for home consumption and a small earning. Many of them survive through leasing in land (*adhiyaa*), farming on the remaining land in their previous settlement, which gives them livelihood for 6 months only. For the remaining six months, they survive on selling of physical labour in the nearby construction sites. They also received a relief package (Rs. 10,000 cash, tent/plastic and blanket) during the transition period. According to the respondents, the support was adequate for the transition phase, but it was received delayed (after 3–4 months of the earthquake). The study found that the residents are still not prepared for similar disaster in future because they have hand to mouth problem and cannot think about disaster preparedness in such problem. They have appreciation for housing reconstruction support, however, are still dreaming about sustainable means of their livelihood.

Source – spot visit during field data collection

Box 2

Coordination mechanism at local level

Elected body did not exist at local level at the time of the 2015 earthquake in Nepal. The existing Village Development Committee (VDC) Secretary, as ex-officio Chairperson, led the Local Disaster Risk Management Committee (LDRMC) with representatives of local political leaders as its members. The role of LDRMC was to find and rescues injured people; settle them in a safe zone and collect food/relief materials and distribute them. The structure was not strong enough to handle huge coordination and monitoring task to ensure delivery of relief and recovery support in effective and socially justified manner. After local election in 2017, LDRMC was restructured as Disaster Preparedness and Response Committee (DPRC), chaired by *Palika* chair and membered by Sectorial committee representatives. For a short period DPRC could not function effectively because the officials had to learn to run the business and set the office environment.

In 2018, *Palika* adopted 'one door policy' to deal with recovery related matters in terms of integrated planning, coordination, synergy, and experience sharing and innovative ideas development at local level. This policy enhanced accessibility of target population to the support agencies and relevant government entities, making effective monitoring and joint reporting. However, its potential has not been realized fully due to lack of database, equipment and trained personnel.

Change in living conditions: Majority (70%) of the respondents felt just a little change in living conditions of the community due to sustainable livelihood interventions whereas 15% respondents realized the change and utilized livelihood interventions to improve their living condition (Table 10).

However, KII reported that signs of improvement were visible due to sustainable livelihood efforts. In some settlements, however, living condition did not change much because the people followed only subsistence way of living and did not usurp the given opportunities. It was difficult to make them realize and change their behavior towards sustainable livelihood. But the case stories of elderly people, member of food insecure households, poor single women and others vulnerable people suggest that significant improvement in the livelihood of the vulnerable families was possible through consistent and concerted support using LNOB concept as demonstrated by *Purnima-Sambodhan* support (Box 3).

In summary on physical dimension, it could be deduced that supports provided by various agencies to the affected families were in general socially justified and timely with some delay and resource misallocations.

Table 10

Change in living condition of the community.

SN	Change in living condition of the community	% Response (N = 60)
1	No change	0.0
2	Just a little	70.0
3	Felt positive change	15.0
4	Change realized and utilized	15.0
5	Change fully utilized	0.0
Total		100.0

Source: FGD, 2020.

Box 3

Life of vulnerable families get improved.

Tirtha Bhujel, elderly person from Dupcheshwar-3, has bought a he-buffalo for the breeding purpose from the income (Rs. 70,000) he earned from commercial vegetable farming under low cost plastic house support. Now, he is earning an average of NPR. 1000/day by giving the breeding service to buffaloes in his locality.

Krishna Kumar BK, a poor farmer of Tadi-3, was a seasonal labor worker. His family used to stand below 3-months food sufficiency level. After the project intervention, he fully utilized his small land area for vegetable cultivation. Now his family has moved to 6-month food sufficiency level. With increased income, he saves Rs. 100/month in a cooperative, pays for education of his children studying at local English medium school and meets other household expenses.

Parbati Rai, single woman of Tadi-5, is earning NRs 8000/month and saving NRs.1000/month at *Nirdhan* Microfinance. Through the regular earnings she can meet family expenses, purchase inputs for vegetable farming and medicine for livestock.

Bed Bahadur Mijar, poor farmer of Tadi-2, earns more than 120,000/- in a year from vegetable farming. He saves NRs 50/month in *Samaj Pariwartan* Inclusive SHG and NRs.1000/month in *Sana Kisan* Microfinance, Tadi. He can meet his family expenditures besides paying for agriculture inputs. He has expanded his vegetable farming enterprise. Now his food sufficiency level is at 9 months level.

Source: *Sambodhan Annual Report, 2019*.

Lack of all-party acceptable database, transportation difficulty, inadequate administrative capacity and information flow weaknesses, favoritism etc. were the reasons for the delay and disparity.

3.4. Natural dimension

Changes in natural dimension was measured in terms of preparedness against natural shocks, natural resource-based planning, market situation and production technology efficiency.

Preparedness against natural shocks: Role of DPRC is not only to manage crisis situation but also to prepare the local communities to be prepared against natural shocks and stresses. To this end, about 35% of the respondents reported that they were working on this front, while 15% had just started talking about it (Table 11). It shows that preparedness is still long way to go.

Natural resource-based planning and implementation: It is a key area to ensure use of natural resources without damaging the environment. This front had not yet gained attention in the study area as only 15% respondents said that the community members had not only realized this idea but also had started practicing it, while 35% had grasped the idea but had not practiced it yet (Table 12).

Market situation: Availability of input output market services related to livelihood interventions was explored. The situation was found to be

Table 11

Preparedness against natural shocks and stress.

SN	Preparedness against natural shocks	% Response (N = 60)
1	No change	50.0
2	Just started to talk about it	15.0
3	Aware and working on it	0.0
4	Worked and prepared	35.0
5	Prepared and adopted positive coping mechanism	0.0
Total		100.0

Source: FGD, 2020.

Table 12

Trend of natural resources based planning and implementation.

SN	Natural resource-based planning and implementation	% Response (N = 60)
1	No change	50.0
2	Realized the importance	35.0
3	Realized the importance and started practicing	15.0
4	Realized and practiced	0.0
5	Fully realized and practiced	0.0
Total		100.0

Source: FGD, 2020.

Table 13

Availability of market services.

SN	Market situation	% Response (N = 60)
1	No change	21.0
2	Market available but far	17.0
3	Market available nearby	50.0
4	Market available and using sometime	0.0
5	Market available and using regularly	12.0
Total		100.0

Source: FGD, 2020.

satisfactory, as 62% of the respondents reported that market services are available at nearby communities/locations (Table 13). KII reported that due to federalism and local governments, several market centers have emerged recently in the area with a number of private sector service providers. However, such markets are still immature in nature.

Production technology efficiency: Low cost income generating technologies were made available by some development agencies to affected families as a part of the livelihood intervention, so that they could save time and earn more. This intervention was found effective, as 62% respondent saved time and utilized the saved time in other productive works (Fig. 6).

In terms of natural dimension, it can be deduced that return to pre-quake situation under support of multi-actors and community effort was a natural process. In this context, a need for preparedness against natural shocks was being felt in the area, and a trend appeared in natural resource-based planning and implementation under auspices of support agencies although its value was yet to be appreciated by population at large. The low-cost production technology with assured input-output market is a necessary condition to enable the affected families to reach sustainable livelihood level.

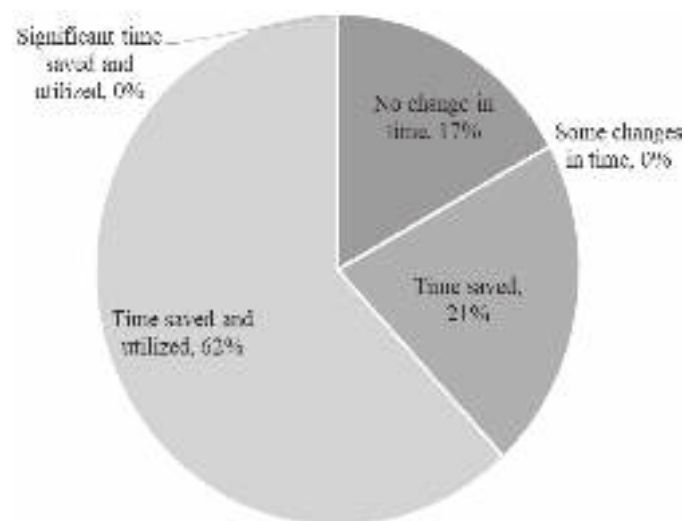


Fig. 6. Time Saved through use of Low Cost Technology. Source: FGD, 2020.

3.5. Financial dimension

Effect of livelihood support on financial health of the beneficiary households was explored in terms of income, involvement in financial institution, food sufficiency, reduction in poverty and managing health and education needs.

Involvement in financial institutions: The beneficiary households got membership in local financial institutions as per the condition of the support agencies. It was reported that several households were already involved in one or the other form of financial institutions in their locality. Still, they were asked to join saving-credit group promoted by the agencies, which caused duplication and difficulty on the part of the poor households to save in more than one groups. KII indicated that financial institutions were providing service in the study area, but poor people had difficulty in accessing their services due to high interest rate, procedural difficulties, and lack of mortgage.

The study finding indicated that local financial institutions were perceived as a need for sustenance of livelihood by 412% respondents. The remaining respondents were either unaware about the value of such institutions or joined them as a condition to receive recovery support (Table 14).

On the other hand, the snap survey showed that credit accessibility and borrowing was high in the area (Table 15 and Table 16). This finding leaves a room for further study on this subject.

Trend of household income: There was an increasing trend on income of beneficiary households due to the livelihood interventions, as perceived by 42% respondents, while 58% respondents reported no change in their income stream (Table 17). Token supports, such as a few packets of vegetable seeds or 5–10 poultry chicks or a piglet or a few kids of goats, would not make a big change. Those who undertook visible IGA, such as commercial vegetable farming, did experience significant increase in their income.

This finding is also supported by the snap survey on income of the target households, which considered all sources of income (including foreign employment, service, trade, farming, security allowance from Government etc.) before earthquake and in 2019. The analysis indicated that there was visible movement of the households from extreme poverty to poverty level while movement to out of poverty level was very low (Table 18). This result also triangulated from the finding of FGD and KII.

Income less than \$1/person/day; [#] Income between \$1–\$2/person/day; [@] Income more than \$2/person/day.

Increase in food sufficiency: The livelihood interventions raised food sufficiency level in at least half of the households as perceived by the respondents (Table 19).

Reduction in poverty: All respondents perceived that poverty decreased to varying level among at least half of the households due to livelihood interventions (Table 20). KII confirmed that the livelihood support did reduce the poverty level in the area but not for all households. Also, such reduction not necessarily mean that the supported households came out of the poverty.

Confidence in managing health and education needs: Due to the livelihood interventions and increased awareness, beneficiary households were able to manage their health and education needs, as reflected by 56% of the respondents (Table 21). KII confirmed that nutritional status in the community had increased and the school enrollment and regular attendance had also increased. Their attention on health service is not as high yet

Table 14
Need of institutions in sustenance of livelihood efforts.

SN	Involvement in financial institutions	% Response (N = 60)
1	No idea	17.0
2	May be needed	41.0
3	Needed	15.0
4	Much needed	27.0
5	Very much needed and active	0.0
Total		100.0

Source: FGD, 2020.

Table 15
Household access to financial resource.

SN	Access to financial resource	% Response (N = 18)
1	No access	5
2	Neighbor support at need	5
3	Community group support at need	23
4	Local cooperative	39
5	Bank	28
Total		100

Source: FGD, 2020.

Table 16
Annual borrowing from financial institutions.

SN	Borrowing from financial institutions	% response (N = 18)
1	Family do not borrow from other source	32
2	Family borrow up to 25,000	50
3	Family borrow up to 25,001 to 50,000	6
4	Family borrow up to 50,001 to 75,000	6
5	Family borrow up to 75,001 to 100,000	6
Total		100

Source: FGD 2020.

Table 17
Trend of household level income.

SN	Trend of household income	% Respondent (N = 60)
1	Decreasing	0.0
2	No change	58.0
3	Increasing	42.0
4	Doubled	0.0
5	More than doubled	0.0
Total		100.0

Source: FGD, 2020.

Table 18
Change in household income after earthquake (N = 18).

Variable	Unit	In 2015	In 2019
Av. family size	No.	5.5	5.5
Income range	Rs.'000	40–180	140–890
Av. Income	Rs. '000	105	326
Below extreme poverty*	%	89	22
Between extreme poverty – Poverty [#]	%	11	67
Above poverty [@]	%	0	11

Source: FGD, 2020.

Table 19
Increase in food sufficiency level.

SN	Increase in food sufficiency	% Response (N = 60)
1	No change	0.0
2	25% HHs increased	28.0
3	50% HHs increased	72.0
4	80% HHs increased	0.0
5	100% HHs increased	0.0
Total		100.0

Source: FGD, 2020.

Table 20
Reduction in poverty.

SN	Reduction in poverty	% Response (N = 60)
1	No change	0.0
2	25% HHs reduced	48.0
3	50% HHs reduced	52.0
4	80% HHs reduced	0.0
5	100% HHs reduced	0.0
Total		100.0

Source: FGD, 2020.

Table 21

Confidence in managing health and education requirement.

SN	Confidence in managing health and education needs	% Response (N = 60)
1	No confidence and plan	0.0
2	Thinking about it but lack information	44.0
3	Realized the importance and thinking to plan	56.0
4	Realized the importance and planned to manage	0.0
5	Well planned and fully utilized	0.0
Total		100.0

Source: FGD, 2020.

because there is only one hospital in the rural municipality, which is not easily accessible to all the people residing in that municipality.

On financial dimension, it could be summarized that income level of beneficiary households increased in general with high proportion of them coming out of extreme poverty, but proportion of those coming out of poverty remained very low. It was reflected through increased involvement in financial transactions, increased food sufficiency level, reduced poverty level and enhanced capacity to meet health and education expenses. The positive changes could be only partly explained by livelihood interventions with a part coming from non-intervention sources.

3.6. The inter-relationship between the five dimensions of livelihood

All five dimensions of livelihood have shown positive changes or practices on the earthquake affected communities, except preparation against natural shocks on livelihood of earthquake victim in the study area. In financial terms, poverty is reduced to some extent with increased household income and increased access to financial resources. From natural dimension point of view, the beneficiary households have saved time and utilized the save time in other productive economic activities. However, there is no change on natural resource based planning and preparedness against natural shocks. Likewise, physical dimension has also improved significantly with felt change in the living condition of the support recipients, and the support has successfully created assets. Although support was not adequate but it has on time. In terms of social dimension, multi-sector synergy generalized as positive and effective, livelihood intervention approach found helpful, special package for vulnerable group was very help during the transition phase and the social safety net was very useful and effective. Finally, in human dimension terms, the beneficiaries have realized the change on support delivery efficiency and practice, and the support it has partially transferred the skills and knowledge generating employment opportunity. The respondents also felt positive change in housing standard, which is important in terms of improving their living condition.

4. Conclusion and recommendation

4.1. Conclusion

This study was carried out to explore (i) timeliness, justifiability and adequacy of recovery interventions to enable sustainable livelihood; (ii) changes in the livelihood status of the beneficiary households; (iii) emergence and utilization of social capital/institutions; and (iv) level of synergy among multiple recovery service providers. The research was carried out along five core areas of livelihoods – human, social, physical, natural resource and financial dimensions. Based on the results obtained, following conclusions are drawn:

- Timeliness** - The recovery supports were timely in general with some delays due to trauma, transportation difficulty, lack of data and weak management/coordination capacity of the local government;
- Justifiability** – Delivery of supports were socially justified in general. However, misappropriation and misallocation of resources did take place to some extent due to biasness, vested interest and weak information flow;

- Adequacy** – Combined recovery supports provided by multiple actors were inadequate in general from the perspective of sustainable livelihood achievement. Nonetheless, they were adequate to bring most of the victims to pre-quake level normal life. There was tendency among many agencies to use ‘hit and run’ approach with quick hand-outs. A few agencies which followed multi-sectoral integrated approach, allowed adequate time for follow up, backstopping and stepwise interventions did demonstrate the possibility of sustainable livelihood achievement;
- Capacity building** - Capacity of the beneficiaries increased in general in terms of asset creation, skill enhancement and institutional linkage thereby leading to increase in employment and income opportunities;
- Institutional development** - Formation of saving-credit based SHG/CO was a requirement for many support agencies. But difficulty appeared when the households had to join two or more SHGs/COs to be eligible for the support(s) offered to them. Many of them lacked surplus income to save. Also, credit service was relatively inaccessible for the poor households due to high interest rate and mortgage requirement charged by some of the financial institutions;
- Coordination, synergy and reporting** – Weak synergy existed among multiple support agencies until elected local government came in place in 2017. Quality of coordination, monitoring and reporting improved after the municipalities adopted ‘one door policy’. This improvement could be further enhanced with proper database, trained manpower and availability of needed equipment at the municipalities;
- Livelihood status** – In general, livelihood of the affected households improved to pre-quake level with most of them coming out of extreme poverty as a result of the livelihood recovery supports and non-supported economic activities of the affected households. Factors of living conditions including housing, food sufficiency level, health and education were found improved. However, proportion of households attaining sustainable livelihood or \$2/person/day level was negligible, which calls for rigorous delivery of the livelihood recovery support for livelihood resilience.

4.2. Recommendations

Results of this study have policy implications for effective implementation of the livelihood interventions in context of disaster situation such as earthquake.

4.2.1. Recommendation for Local Level

- Fully digitalized multi-purpose database should be established at local level:** A detail settlement and household level database should be developed and maintained at local government level. The database should include elements of SDGs, disasters and other concerns. This database will serve as time saving tool for planning and monitoring of development activities undertaken by multi-agencies.
- Coordination, monitoring, reporting and recognition mechanism should be in place:** A strong ‘one-door coordination mechanism’ should be in place at local government level. Role of DPRC could be expanded to this end. The coordination during transition and livelihood recovery should be in framework of database, target definition, sustainable livelihood and LNOB concept. Monitoring should be done in terms of ‘which target got what, how much and from whom’. It follows the logic that the reporting of each support agency should be in the same line – in a digital form such that report of all support agencies could be easily aggregated at the beneficiary level. This system will avoid the risk of undesirable duplication, misappropriation and left-out problems. This will also enable each support agency to receive due recognition in their efforts.

4.2.2. Recommendation for the policy level

- Transition should be pre-defined:** A transition between relief and recovery is recognized as inevitable and its duration varies with situation. This provision ensures survival of the affected population (through temporary shelter,

food supply, employment, vocational training, psychological boosting etc.) and at the same time prepare ground/infrastructure for recovery/reconstruction phase.

- *Livelihood recovery should be pre-defined:* Level of livelihood recovery should be pre-defined to the level of sustainability and should be considered as a milestone for each target family covered by the support agencies (alone or jointly). Demand driven, multi-sectoral, integrated and LNOB should be the binding policy with a defined period during which the sustainable livelihood objective could be achieved with multi-year planning. Whether to support non-victim vulnerable families residing in the affected area is a matter of policy but should be considered positively to the extent possible.
- *Defining institutional and financial linkage:* The support agencies should be required to follow the policy of 'participation in one financial institution'. Beneficiaries should not be forced to form anew group if such a group already exists in the locality, and if the beneficiary household is already a member there. Also, a concerted effort will be needed on the part of the agency to ensure poor households get access to borrowing from such institutions.
- *Conducting a large-scale study:* The recommendations of this study are based on the findings of a small study. It warrants a national level study on the subject to reach widely acceptable conclusions and recommendations.

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Declaration of Competing Interest

None.

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Regular Article

An assessment of livelihood recovery status of earthquake-affected households in Nepal: A study of coping strategies and their effectiveness

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ABSTRACT

The main objective of this study is to empirically analyze the effectiveness of various coping strategies adopted by the household after the 2015 earthquake in Nepal. The study uses empirical approach exploiting treatment-control and before-after design for analytical purpose. The study finds that the households in the earthquake affected areas are recovering their livelihood. The most important ex-post coping strategies were remittances followed by borrowing and sale of assets. The effectiveness exercise, however, identified remittances as the only effective coping strategy that helped households recover their livelihood in the post-earthquake Nepal.

1. Introduction

Nepal was struck by two major earthquakes of 7.8 and 7.3 Richter scale on April 25 and May 12 2015, respectively, and followed by more than 400 aftershocks. These earthquakes had a severe impact on people's assets and livelihood, causing a severe socio-economic impact on people and communities [1]. According to Post Disaster Needs Assessment (PDNA), the lives of one-third of the population was affected with 8790 deaths and 22,300 injuries, and the total value of damages and losses estimated was about USD seven billion [2]. A total of 32 districts were affected, out of which 14 districts were highly affected while others were less affected as shown in Table 1. In addition to its direct impact on private and public infrastructure, it indirectly resulted in the worsening socio-economic, psychological, health, environmental and various other effects. Of more importance is the effect of earthquake on people's livelihood.

A natural disaster has a disproportionate effect, particularly on the rural population's livelihood in developing countries. The effect on livelihood¹ is usually direct and adverse; this is because the rural population mostly depends on agriculture, and natural disaster would potentially destroy the agricultural system like agricultural infrastructure (e.g., arable lands, irrigation system, and rural roads) including that of the stored seeds, field crops, and farm equipment. This means that the risk of food insecurity

among the rural population is high [3]. Nepal's earthquake resulted in about USD 283.7 million worth of damage in the agricultural sector, with maximum losses in hills and mountains of the affected areas due to the burial of stored seeds, damage of agricultural lands, and destruction of storage structures [4]. Likewise, 94 million workdays and Nepalese Rupees (NPR) 17 billion of personal income were estimated to be lost, affecting 2.29 million households and 5.6 million workers [5]. These indicate that the disaster had a severe effect on people's livelihood. In such a case, any private efforts towards recovery of this severe loss in livelihood would remain suboptimal without public intervention. This is because households' ability to insure against vulnerabilities to natural disasters is limited by inefficient insurance and credit markets in developing countries [6].

Households in developing countries adopt several coping strategies to mitigate the adverse effects of natural disasters mostly through increased labor force participation, selling livestock, private transfers, and diversification of income [7–10].² However, some strategies may not be able to insure affected households against the natural shocks either because the shock is of an unprecedented scale or because of the households' technological, environmental, and economic constraints [11,12]. Hence, it is extremely important to understand the type and effectiveness of coping strategies adopted by households.

This study assesses the livelihood recovery status of earthquake-affected households, identifies coping strategies adopted by these households, and more importantly documents the effectiveness of these strategies. This study is important in the following three respects. First, it updates our understanding of the livelihood recovery profile of the earthquake-affected

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¹ Livelihood in this context is related both to the means and ends of income. Means indicate various sources of income that the household depends for living while ends represent both the quality and quantity of household consumption. However, for the empirical purpose of this paper, livelihood here is represented by the latter. In other words, household with high consumption expenditure is assumed to have better livelihood.

² See Skoufias [39] to understand more about the mechanisms for risk management from crises and natural disasters.

Table 1
Earthquake affected districts in Nepal.

Highly affected districts	Okhaldhunga, Dolakha, Ramechhap, Sindhupalchok, Kavrepalanchok, Sindhuli, Bhaktapur, Kathmandu, Lalitpur, Rasuwa, Nuwakot, Dhading, Gorkha and Makwanpur
Less affected districts	Sankhuwasabha, Bhojpur, Dhankuta, Khotang, Solukhumbu, Chitwan, Tanahun, Lamjung, Kaski, Parbat, Baglung, Myagdi, Syangja, Palpa, Gulmi, Arghakhanchi and Nawalparasi

Source: NRA website, Accessed on 22nd April 2020 (<http://www.nra.gov.np/en/pages/view/fk2lRwucsHVwn9q-LAxpTW9mGJgRz25rUWNDHdbkYk#:~:text=Highly%20Affected%20Districts,%20CDhading%20Gorkha%20Makwanpur.>)

households in Nepal. Second, it provides insight into the effectiveness of livelihood coping strategies adopted by these households. And third, it applies an empirical method to assess livelihood recovery status and to understand the effectiveness of the coping strategies. This study is also important from the point of view of disaster risk reduction (DRR). Understanding types of coping strategies and their effectiveness help designing safety net programs; signaling what sort of public policies and interventions works best during post-disaster periods, and guiding the society/state to invest in strategies that can be localized to the particular context.

2. Review of literature

Several studies discuss the type of ex-post coping strategies adopted by the household. These studies mostly identify borrowing, private transfers, dissaving, sale of assets, public transfers, and reallocation of household resources, especially labor, as the common strategies [13–18]. Few studies relating to Nepal's earthquake utilize qualitative approaches to understand the recovery path of earthquake-affected communities in different study areas, and document the use of physical and social capital/networks, reduction in consumption expenditure, connectivity, access to natural resources, entrepreneurship, cash, and food aid, and increased labor demand (and hence incremental wages) as the major enabling factors to resilience and recovery [19–21]. Although these studies help provide insights into the status of recovery and identify the coping strategies, they mostly cover few earthquake-affected areas in Nepal which may not be generalizable to other areas. Also, these studies are either descriptive or exploratory, limiting their ability to test the research hypotheses statistically.

One recent study by Thorne-Lyman et al. [22] uses similar survey data used in this study and empirically assesses the nutritional resilience of children under 5 years old in earthquake-affected areas of Nepal. The study uses 2014 and 2016 waves of survey and tests whether the anthropometric measures of children improved after the earthquake. The study finds that the growth measures of children either remained comparable or improved after the earthquake. An important concern of this study is that not all villages in the earthquake-affected districts were equally affected. Only one village in each earthquake-affected district was selected for the study; however, except for the Thuman village development committee (VDC)³ in Rasuwa, all other villages in other districts were either unaffected or less affected. Another concern is that the study compares the nutritional and growth outcomes before and after the earthquake only in earthquake-affected areas. Hence, it is difficult to attribute any changes in outcomes to the earthquake. There is no comparison/control group; hence we cannot establish a causal link between the earthquake and the study outcomes. This study addresses both the concerns by making an exogenous distinction between affected and unaffected villages, and thus establishing a causal relations between identified variables.

As discussed earlier, several studies analyze the impact of natural disasters and document the households' response strategies but limited evidence exists suggesting whether these strategies are effective to recover their livelihood. All these studies record the effectiveness in countries outside of

South Asia. To the best of the author's knowledge, few studies in South Asia empirically document the effectiveness of coping strategies. In addition to analyzing whether the households have recovered their livelihood and what coping strategies they used, this study also documents whether the coping strategies were effective.

3. Data and method

3.1. Approaches to the study

This study uses secondary data and applies empirical methods to answer the research questions. The Difference-in-Differences (DiD) model is used as an empirical strategy that exploits before-after and treatment-control design to identify the impact of natural disaster on selected outcome variables. The results from the analysis are then presented using tables and graphs.

3.2. Data and study area

This study uses the first (2013) and fourth (2016) rounds of cross-section data of PoSHAN Community studies. This is a nationally representative household survey conducted using stratified random sampling [23]. The survey selected seven VDCs/districts from each of three agro-ecological zones and three wards from each selected VDC/district.⁴ For analyzing data, this study uses the questions asked to the households relating to their socio-economic and demographic characteristics, food security situation, household total consumption expenditure, and coping strategies used to smooth food consumption. The survey also collected information relating to the household agricultural practices, health, and nutritional status of 0 to 5 years children and women of reproductive age. The survey did not collect information on the health and nutritional practices of the elderly and disabled because this was beyond the scope of the study. The study uses this data set because it offers an opportunity to utilize the before-after and treatment-control design to assess the impact of the earthquake on the household's livelihood.

The main challenge using the PoSHAN community data is to distinguish between affected and unaffected villages since most of the villages sampled in the survey are unaffected. This study utilized the measure of earthquake intensity estimated by the National Society for Earthquake and Technology (NSET) [24] and further follows the standard literature to distinguish between affected and unaffected villages [25,26]. The measurement is based on earthquake shaking intensity that uses Modified Mercalli Intensity (MMI) scale constraining between MMI V (as lowest) and MMI IX (as highest).⁵ Following Paudel and Ryu [25] and Chaulagain, Gautam, and Rodrigues [26], this study defines treatment village as a village with shaking intensity of at least MMI VII and a control village with shaking intensity of lower than MMI VII. According to this classification, Thuman VDC in Rasuwa district can only be categorized as treatment (affected) village from the survey as shown in Fig. 1. This study then chooses Thulopakhar and Saipu VDCs in Sindhupalchok and Ramechhap districts, respectively, as control (unaffected) villages. These two unaffected villages are chosen because they are in many ways identical to the treatment village. For example, all chosen treatment and control villages fall within hilly regions of Bagmati Province,⁶ and possess comparable socio-economic characteristics. This kind of symmetry between treatment and control groups is quite important to run a DiD model, the empirical strategy used in this study. The

⁴ One VDC was selected from each district. A total of 21 wards were selected from each agro-ecological zone or a total of 63 wards across the country. The interviews were conducted with 4286, 4947, 3199 and 5097 households respectively from the surveys in 2013, 2014, 2015 and 2016 respectively.

⁵ Government of Nepal, for the purpose of prioritizing disaster aid and relief, divided the affected districts into five categories: "severely hit", "crisis hit", "hit with heavy losses", "hit" and "slightly affected" [2]. However, it should be noted that the villages within each district were struck by the earthquake of varying intensities. I use this variation in intensity measured by MMI scale to identify the impact of the earthquake across time and households.

⁶ The new constitution of 2015 divides the country into seven provinces. Bagmati province is one of the seven provinces in Nepal and has mostly hills and mountains.

³ VDC was the lower administrative division of Nepal. Each district constituted several VDCs. After the adoption of federal system in 2015, Nepal is now administratively divided into provinces, districts, and municipalities.

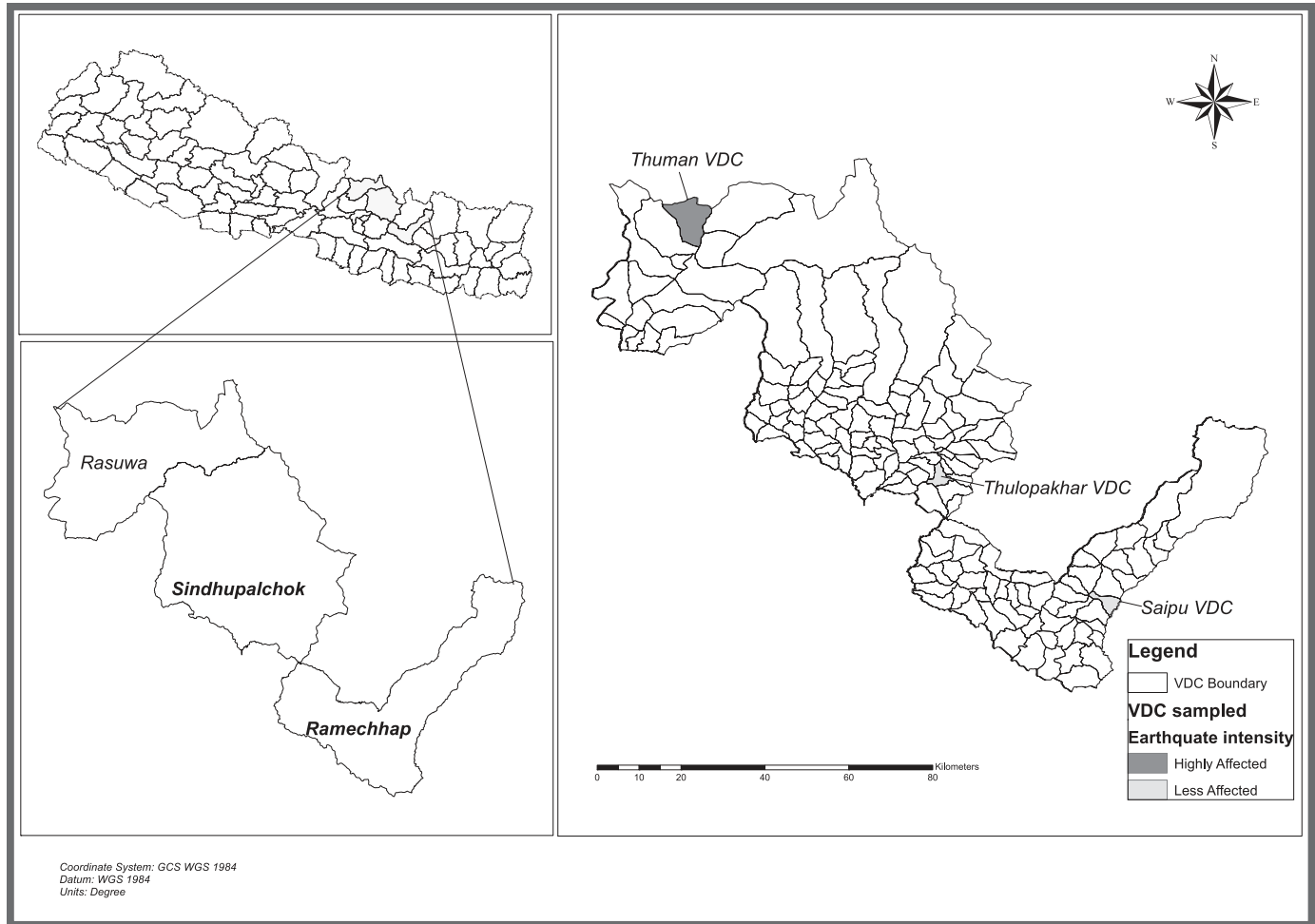


Fig. 1. Earthquake affected and non-affected VDCs selected for study. Source: Calculated from PoSHAN Survey 2013 and 2016

idea is that the difference in outcomes between treatment and control villages should emanate only due to the fact that they are variously affected by earthquake, and not due to other factors (such as place, ecological zone, and socio-economic characteristics) that confounds the effect of the earthquake on those outcomes. Hence, this study uses a pooled cross section sample of 281 households (See descriptive statistics in Annex Table 1).⁷

3.3. Data analysis

This study conducts regression analysis based on DiD method [27] to answer the research questions formulated above in Section 1. The biggest attraction of DiD method is its simplicity and its potential to address many of the endogeneity problems that typically arise when comparisons are made between heterogeneous groups/individuals [28]. Here the comparison is made between the outcomes across treatment and control groups before and after the natural event.⁸ The basic DiD model is expressed in Eq. (1). This is the model we use to assess the livelihood recovery status and identify the coping strategies.

$$Y_{ijt} = \alpha + \beta_1 \text{affected}_j + \beta_2 \text{affected}_j * t_t + \beta_3 X_{it} + d_j + t_t + \epsilon_{jt} \quad (1)$$

In Eq. (1), Y_{ijt} is the outcome of interest. For example, consumption expenditure of household i in village j at time t . It may also represent the particular coping strategy adopted by the household. In that case, it takes the value 1 if the household adopts the particular coping strategy and 0 if

otherwise. affected_j is the dummy for a village highly affected by the earthquake as defined above; it is equal to 1 and 0 if otherwise. $\text{affected}_j * t_t$ is an interaction between affected_j dummy and time dummy t_t . Hence t_t is a time dummy equals 1 if the observation is from the survey year 2016, i.e., after the earthquake and 0 otherwise. X_{it} is the vector of other household characteristics that are controlled in Eq. (1). For example, the equation controls gender, marital status, age, age squared, and years of schooling and caste of the household head. d_j represents district fixed effect. The district fixed effect captures the effects of unobserved heterogeneity at the district level. ϵ_{jt} is the random error term clustered at ward level. This is to allow any correlation across the households within a particular ward. Here, the coefficient of interest is β_2 which yields the estimate of the impact of the earthquake on a particular outcome chosen on the right-hand side of Eq. (1). This is also called the DiD coefficient. If the coefficient is positive and significant for the equation that evaluates the effect of the earthquake on consumption expenditure, this means the households are recovering (or are in the recovery process), while the negative coefficient would mean that they have not recovered. Likewise, for the equation on coping strategies, a positive and significant coefficient would mean that the household's probability of adopting a particular coping strategy is higher.

The effectiveness of a particular coping strategy is tested by using Eq. (2) expressed below.

$$Y_{ijt} = \alpha + \delta_1 \text{affected}_j + \delta_2 S_i + \delta_3 \text{affected}_j * S_i + \delta_4 \text{affected}_j * t_t + \delta_5 \text{affected}_j * S_i * t_t + \delta_6 X_{it} + d_j + t_t + \epsilon_{jt} \quad (2)$$

In Eq. (2), Y_{ijt} is the household consumption expenditure. S_i is the particular coping strategy adopted by the households; $\text{affected}_j * S_i$ is the

⁷ This sub-sample is derived after accounting for missing values and various other concerns in the survey.

⁸ For details on DiD method, see [27,40]

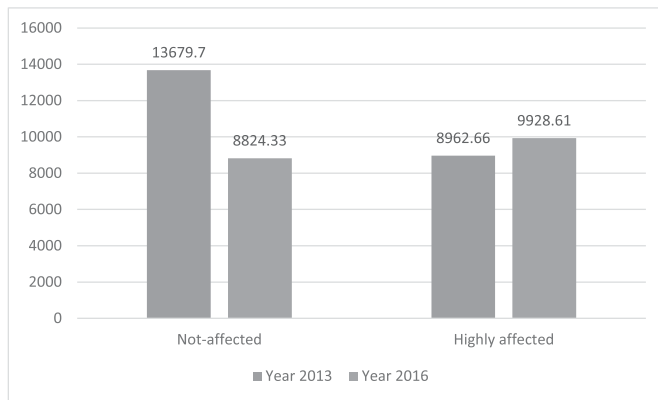


Fig. 2. Effect of earthquake on consumption expenditure by year and earthquake intensity (in NPR). Source: Calculated from PoSHAN Survey 2013 and 2016

interaction between affected_j dummy and the particular coping strategy S_i ; affected_j * t_t is the interaction between affected_j dummy and time dummy t_t ; and affected_j * S_i * t_t is the interaction among affected_j dummy, the particular coping strategy S_i , and time dummy t_t . Here, the coefficient estimate δ_5 shows whether the particular coping strategy is effective or not. This is the DiD coefficient here.⁹ If the coefficient is positive and significant, the coping strategy is interpreted as effective. Other variables are as defined in Eq. (2) above.

4. Results

4.1. Results

4.1.1. Effects on consumption

The results in Fig. 2 show that the households' consumption expenditure¹⁰ in the affected areas increased by about NPR 1060 in the year after the 2015 earthquake; the consumption expenditure was NPR 8963 in the baseline year 2013 that increased to NPR 9923 in the year 2016. This indicates that these households have gradually improved their livelihood after the earthquake. Surprisingly, the same in the non-affected areas have deteriorated. The DiD statistics in Box 1 shows that the improvement is significant after controlling for geographical fixed effects. The DiD coefficient becomes insignificant after district fixed effects are accounted for. This is based on the before-after comparison between affected and non-affected areas. Hence, it can be inferred that the households in the earthquake-affected areas are in the process of recovery of their livelihood. So long as the DiD coefficient is positive, this is true even if the coefficient is insignificant in the specification that controls for district fixed effects (full regression results of both the estimates are presented in Annex Table 2).

4.1.2. Adoption of coping strategies

This section presents the results based on Eq. (2) relating to the households' probability of adopting a particular coping strategy (full regression results are presented in Annex Table 3).

4.1.2.1. Remittance. Remittance is one of the most important coping strategies in developing countries. In Fig. 3 below, we observe that the receipt of remittances in earthquake-affected areas in Nepal increased after the 2015 earthquake. About 15.40% of the households received remittances in the baseline year 2013 that increased to 35.40% in the year 2016. This means that the households receiving remittances more than doubled after the earthquake. The same in the case of non-affected households decreased, although marginally. The decrease in remittances in non-affected areas is because the need to maintain the lost livelihood in these communities

⁹ Since this coefficient involves interaction term of three variables, it is also called triple difference estimator or more generally Difference-in-Difference-in-Differences.

¹⁰ Consumption expenditure is inflation-adjusted.

Box 1

Difference-in-Differences results for consumption expenditure.

Difference-in-Differences = 0.637** (0.236).

Robust standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Note: The DiD estimate is derived from regression equation with log of real consumption expenditure as a dependent variable. Except for DiD variable, i.e., a dummy for highly affected VDC, time dummy, and interaction between them, the equation also controls for other household characteristics such as gender, marital status, age, age squared, years of schooling, and caste of the household head. Here, DiD estimator is the interaction between a time dummy and a dummy for highly affected VDC. Error terms are clustered at the ward level. Geographical fixed effects are controlled. A separate estimate controlling for district fixed effects is presented in Annex Table 2.

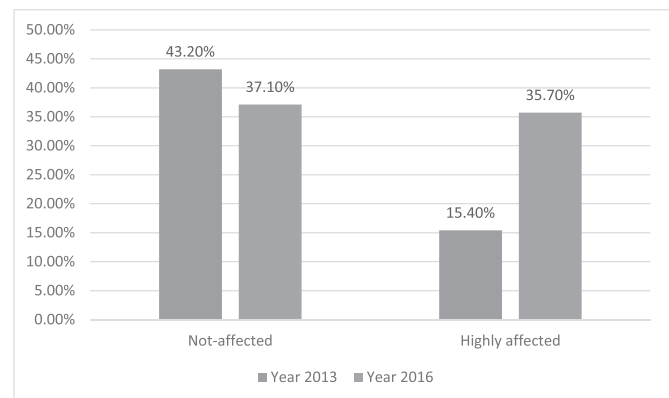


Fig. 3. Remittance as a coping strategy. Source: Calculated from PoSHAN survey 2013 and 2016.

Box 2

Difference-in-Differences results for remittances.

Difference-in-Differences = 0.296*** (0.060).

Robust standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Note: The DiD estimate is derived from regression equation with the receipt of remittances as a dummy dependent variable. Except for DiD variable, i.e., a dummy for highly affected VDC, time dummy, and interaction between them, the equation also controls for other household characteristics such as gender, marital status, age, age squared, years of schooling, and caste of the household head. Here, DiD estimator is the interaction between a time dummy and a dummy for highly affected VDC. Error terms are clustered at the ward level. District fixed effects are controlled.

were lower than in affected areas. The DiD estimate in Box 2 shows that the increase in remittances in the affected area is statistically significant at 0.01 level. The result shows that the households' probability of receiving remittances in the earthquake-affected areas increased by 30 percentage points vis-à-vis the households in the non-affected areas. This means that remittance was an important coping strategies that the households resorted to after the earthquake.

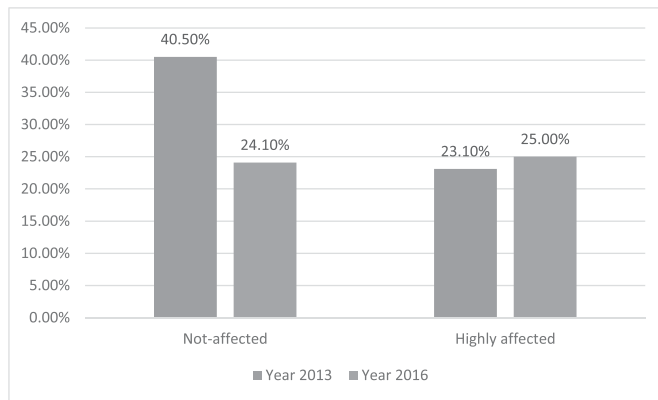


Fig. 4. Loan as a coping strategy. Source: Calculated from PoSHAN survey 2013 and 2016.

Box 3

Difference-in-Differences results for loan.

Difference-in-Differences = 0.201** (0.076).

Robust standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Note: The DiD estimate is derived from the regression equation with a loan taking as a dummy dependent variable. Except for DiD variable, i.e., a dummy for highly affected VDC, time dummy, and interaction between them, the equation also controls for other household characteristics such as gender, marital status, age, age squared, years of schooling, and caste of the household head. Here, DiD estimator is the interaction between a time dummy and a dummy for highly affected VDC. Error terms are clustered at the ward level. District fixed effects are controlled.

4.1.2.2. Loan. People may need to borrow cash or kind to smooth their consumption. Fig. 4 shows that the borrowing increased in earthquake-affected areas in Nepal in the year 2016 vis-à-vis the baseline year 2013. The increment was, however, marginal; loan receiving households increased by 2 percentage points. Interestingly, the DiD estimates in Box 3 show that this increase is statistically significant at 0.05 level. The result exhibits that the households' probability of receiving loans increased by 20 percentage points in the earthquake-affected areas vis-à-vis non-affected areas. It can thus be inferred that borrowing was also another important coping strategies the households adopted.

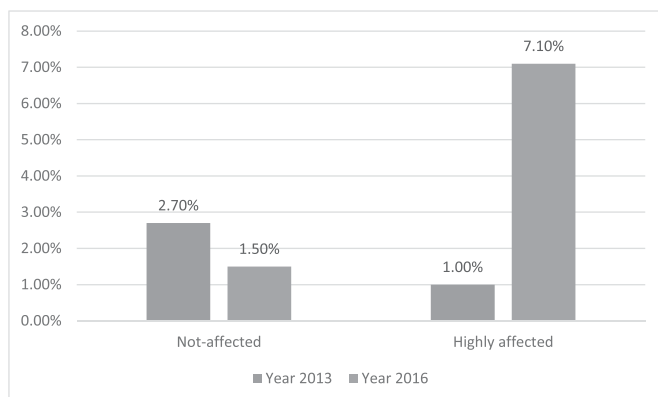


Fig. 5. Sale of assets as a coping strategy. Source: Calculated from PoSHAN survey 2013 and 2016.

Box 4

Difference-in-Differences results for sale of assets.

Difference-in-Differences = 0.099** (0.0339).

Robust standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Note: The DiD estimate is derived from the regression equation with the sale of assets as a dummy dependent variable. Except for DiD variable, i.e., a dummy for highly affected VDC, time dummy, and interaction between them, the equation also controls for other household characteristics such as gender, marital status, age, age squared, years of schooling, and caste of the household head. Here, DiD estimator is the interaction between a time dummy and a dummy for highly affected VDC. Error terms are clustered at the ward level. District fixed effects are controlled.

4.1.2.3. Sale of assets. Households may need to sell their household assets to stabilize their consumption after the natural disaster. For example, households may resort to selling land, house, farm equipment, and other assets. Fig. 5 shows an appreciable increase in sales of assets in earthquake-affected areas in Nepal by about 6 percentage points. In the baseline year 2013, about 1% of the households sold assets to cope with the adverse effects of natural disasters which increased to 7.10% in the year 2016. In non-affected areas, on the other hand, the sale of assets decreased after the earthquake. The DiD estimate in Box 4 is also consistent with the findings from descriptive statistics. The households' probability of selling assets increased by about 10 percentage points in earthquake-affected areas vis-à-vis non-affected areas. It is also statistically significant at 0.05 level.

4.1.2.4. Sale of livestock. In addition to the question about the sale of assets, the survey also separately asks whether the households sold their livestock after the earthquake. Fig. 6 shows that the households selling livestock increased remarkably in the affected areas, whereas it decreased in the non-affected areas. Nearly 1% of the households sold livestock to cope with natural shocks before the earthquake in the year 2013 which increased to 3.60% in the year after the earthquake in 2016. However, the DiD estimate in Box 5 shows that this increase in the sale of assets is not statistically significant. This indicates that the selling of livestock was not an important coping strategy after the earthquake.

4.1.2.5. Paid wage work. Labour force participation is another way to support the livelihood in disaster-hit areas. Fig. 7 shows that the households reporting working in a paid job declined in both the earthquake-affected and non-affected areas. This declined from 46.10% to 39.20% in affected areas while the same in non-affected areas declined from 40.50% to

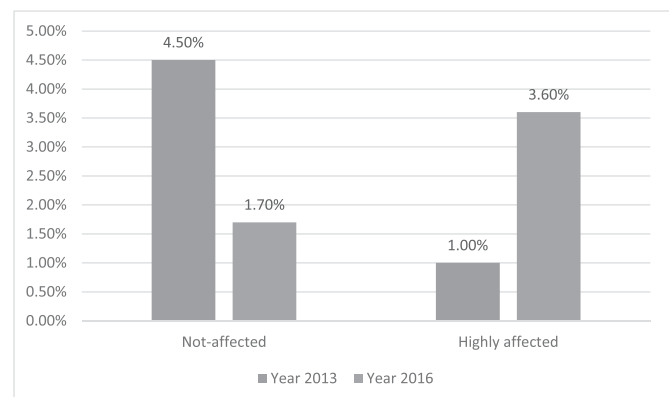


Fig. 6. Sale of livestock as a coping strategy. Source: Calculated from PoSHAN survey 2013 and 2016.

Box 5

Difference-in-Differences results for sale of livestock.

Difference-in-Differences = 0.066 (0.039).

Robust standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Note: The DiD estimate is derived from the regression equation with the sale of livestock as a dummy dependent variable. Except for DiD variable, i.e., a dummy for highly affected VDC, time dummy, and interaction between them, the equation also controls for other household characteristics such as gender, marital status, age, age squared, years of schooling, and caste of the household head. Here, DiD estimator is the interaction between a time dummy and a dummy for highly affected VDC. Error terms are clustered at the ward level. District fixed effects are controlled.

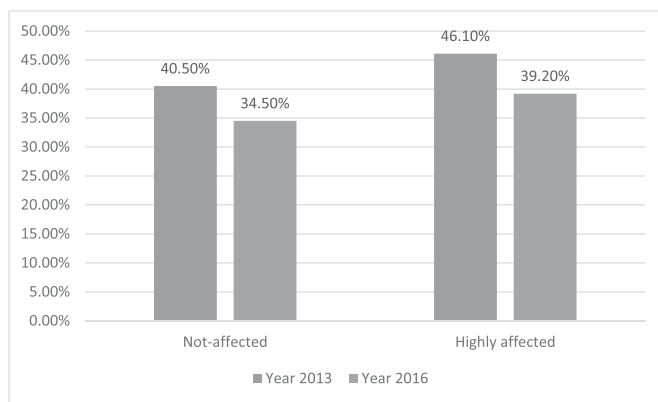


Fig. 7. Paid wage work as coping strategy. Source: Calculated from PoSHAN survey 2013 and 2016.

Box 6

Difference-in-Differences results for wage work.

Difference-in-Differences = 0.004 (0.0191).

Robust standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Note: The DiD estimate is derived from regression equation with paid wage work as a dummy dependent variable. Except for DiD variable, i.e., a dummy for highly affected VDC, time dummy, and interaction between them, the equation also controls for other household characteristics such as gender, marital status, age, age squared, years of schooling, and caste of the household head. Here, DiD estimator is the interaction between a time dummy and a dummy for highly affected VDC. Error terms are clustered at the ward level. District fixed effects are controlled.

34.50%. The DiD estimate in Box 6, although positive, is not significant. This means that paid wage work was not an important coping strategy.

4.2. Effectiveness of coping strategies

This study also assesses the effectiveness of the important coping strategies in recovering livelihood in the earthquake-affected areas. As identified earlier, Table 2 shows that remittance, loans, and sale of assets were

the most important coping strategies. The effectiveness analysis further shows that remittance was the only effective coping strategy for the households to smooth their consumption and livelihood. This means that borrowing did not play an effective role (full regression results are presented in Annex Table 4). Due to the insufficiency of the data related to the sale of assets used in the effectiveness Eq. (2), the comparison was possible only between the remittances and borrowing.

5. Findings and discussion

The study finds that the households in the earthquake-affected areas are in the process of recovering their livelihood. Since the post-earthquake survey was conducted nearly one year after the earthquake, it is plausible to assume that the households adopted various strategies to cope with the adverse effects of the earthquake on livelihood. The study shows that the receipt of remittance, borrowing, and the sale of assets increased significantly after the earthquake while the sales of livestock, paid wage work, and other strategies did not increase as much. In Table 2, these “significant” strategies are therefore ranked in order of the magnitude of the DiD coefficient estimated using Eq. (1). Hence, remittance stands out to be the first, borrowing the second, and selling assets as the third important coping strategy. The effectiveness analysis, however, shows remittances as the only effective coping strategy.

The findings of this study are consistent with several other studies that show social networks/capital as the crucial strategy to cope with the disaster in developing economies. Social capital helps cushion the adverse effects of shocks by enhancing access to transfers and remittances.¹¹ For example, Tse, Wei, & Wang [29] show that the government aid and private transfers (remittances in cash and kind) increased significantly in households with a larger network after the Sichuan earthquake in China in 2008. Similarly, Nakagawa & Shaw [30] show that the community with social capital and a tradition of community activities helped earthquake-affected communities recover faster after the Kobe and Gujarat earthquakes in Japan and India, respectively. In the context of Nepal, social ties have been a part of people's lives. In particular, it is a common practice to help affected households, either climatic or otherwise, through private transfers, usually by a family member or by an acquaintance. The World Bank [31] also indicates that Nepal experienced a significant increment in the receipt of remittances after the earthquake (year-on-year growth rates in remittance were 4.8% in March 2015 and 11.2% in June 2015). Various other macro and micro literature suggests that remittances increased significantly in response to natural disaster [32]. A micro-level study conducted by Rayamajhee & Bohara [33] after the Nepal earthquake also shows that the households suffering from major house damages from the earthquake received remittances. These are the evidence of strong social networks within and outside the country that resulted in increased growth of remittances.

Not only does the receipt of remittances increase in the affected households, but also it helps in effectively recovering their livelihood. Remittances have not only helped Nepalese households to maintain their consumption standards but also have played an important role in improving the investment in physical and human capital [34,35]. Remittance is one of the major sources of income of a Nepalese household. Nearly 53% of households receive remittances in Nepal [36]. During periods of crisis, natural disaster and otherwise, households use remittance money to maintain the consumption standards they used to enjoy during pre-crisis periods. Other farm and non-farm activities, which are other major sources of household income, are either disrupted, or their operation remains suboptimal during such periods. In addition, unlike borrowing, a household's receipt of remittances is usually unconditional, easing households to spend according to their priority. Hence, remittances act as insurance at times of crisis, mostly in developing countries. This also explains why remittance was the most effective coping strategy during Nepal's earthquake [37]. This

¹¹ Social capital is defined as a function of trust, social norms, participation, and network.

Table 2
Summary of the results of coping strategies and their effectiveness.

Coping strategies	Remittance	Loan	Sale of livestock	Sale of assets	Paid wage work	Consume seed	Consume wild food
Difference-in-Differences coefficients	0.296*** (0.060)	0.201** (0.076)	0.066 (0.039)	0.099** (0.034)	0.003 (0.019)	0.006 (0.053)	−0.005 (0.047)
Rank	First	Second		Third			
Effectiveness ^a	Effective	Not Effective		NA ^b			

Robust standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

^a Effectiveness is computed by testing whether a particular coping strategy has been able to smooth consumption of the particular household. Here, real per capita household consumption expenditure is regressed on several control variables as mentioned above. The equation also controls the interaction between the dummy for a particular coping strategy adopted by the household and the dummy for highly affected VDC and their interaction with a time dummy. Effectiveness is thus reported by a coefficient of the interaction of three dummy variables: dummy for a particular coping strategy adopted by the household, dummy for highly affected VDC, and a time dummy.

^b Analysis for the effectiveness of sale of assets as a coping strategy cannot be carried out due to lack of sufficient observation.

result is consistent with Akampumuza & Matsuda [13], who also show remittances as an effective coping strategy in Ugandan households affected by natural shock. Hence, remittance serves to insure the households against the disaster-induced risks of falling into poverty by providing support to replenish their important sources of livelihood, productive assets, and increased investment in health and education.

Borrowing is another important coping strategies that households adopt after a natural disaster. This is obvious in credit-constrained households since they are more likely to face liquidity crunch in the post-disaster periods. Not only do they need to meet their consumption needs but also to replenish their stock of productive assets they may have lost. For example, livestock is a major source of rural livelihood. In the case of livestock loss, households may borrow hefty sums to buy or add to the existing stock of livestock. The borrowing, however, is not effective for livelihood recovery. This may be because the households may need to borrow at exorbitant rates, usually from informal sources such as money lenders. Borrowing from informal sources mostly at unfair terms (for example, at exorbitant rate of interest) is common in developing countries, including Nepal [38]. This has the effect of increasing their cost of borrowing. Limited access to borrowing from formal financial institution is common in developing countries because of the poorly functioning insurance and credit markets in such economies. In addition, formal institutions are less willing to lend to the affected households because they do not have the collateral required or their capacity to repay the loan and interest is limited. Hence, it is most likely that borrowing may have helped households to meet their short term needs only (including consumption) after the earthquake but have remained ineffective as a coping strategy in the long term.

Some households sold assets after the earthquake, but it was not effective for livelihood recovery. This is because the poor households have limited assets that they can offer for sale; further, during the post-disaster period, the value of such assets is usually lower due to distress sale. This limits the potential of this coping strategy to help in the process of recovery effectively.

6. Lessons learned

There are several important lessons one can learn from this study. First, social capital and networks have an important role in building resilience against shocks. This not only increases the probability of the receipt of remittances but also highlights the importance of bonding and cohesiveness within communities. Second, the ineffectiveness of borrowing points out the need to ease access of rural households to formal credit and insurance markets during the periods of a natural disaster. A clear guideline for formal financial institutions outlining their roles and (corporate) responsibilities, particularly in the post-disaster period, should be developed. The Government should provide subsidies on the loans extended by financial institutions to the poor households in the affected communities. Third, there is a need to diversify the livelihood strategies; dependency on remittances may not be sustainable when international market today experiences economic shocks of various types, natural and otherwise. The current COVID-19 pandemic is a good example of the health shock that affected almost all Gulf countries and Malaysia, where

most Nepalese migrants work. Fourth, upskilling and prioritizing employment in reconstruction work to the earthquake-affected households may help increase participation in paid wage work and play an effective role in restoring livelihood. In addition to the reconstruction of damaged/destroyed infrastructure, the Government should also invest in building new infrastructure critical to generate economies of scale arisen from reconstruction activities.

7. Conclusions and recommendations

7.1. Conclusions

Earthquake of a massive scale, and their consequences are unpredictable. Nepal was hit by an earthquake of this unprecedented scale. It was unfortunate that there was not sufficient preparation with regards to both adaptation and mitigation. Although several institutions, both public and private, are working towards disaster risk management in Nepal, their efforts towards livelihood recovery of the earthquake-affected households remained poor. It is important to understand the effects earthquake had on livelihood and the coping options available to the households to recover their livelihood. It is more important to identify what recovery strategies work best since this helps economize the use of resources and smoothen and quicken the recovery process. Hence, this study attempts to understand the livelihood recovery situation of the earthquake-affected households, identify the ex-post coping strategies, and, more importantly, assess the effectiveness of these coping strategies. The study concludes that only a few coping strategies are effective in the recovery process, although households resort to several of them. Other coping strategies may fulfill the household's short-term consumption needs but may not be as effective in the long term. This indicates a complex recovery process where various factors interplay to determine the course of recovery. For example, borrowing may help cover the short-term requirements, but they may not work in the long term, and in the extremes, they may even make households worse. This suggests a severe institutional problem in developing countries; e.g., institutional borrowing options are limited due to inefficient insurance and credit markets. In this light, this study proposes few recommendations in the next sub-section.

7.2. Recommendations

Recovery assessment constitutes an integral part of disaster risk management literature, where several instruments and their indicators are developed to understand the status of the process of recovery. Livelihood recovery is one of the several instruments. Hence, this study points out the need to design evidence-based DRR strategies.

This study points out a need for a coordinated public and private efforts towards economic recovery. The privately initiated efforts need a push from the Government. Although the Government made several economic recovery plans after the earthquake, they did not play a significant role. One reason may be the lack of coordinated effort through community engagement at all stages of the recovery process. Another reason may be that there was more focus on infrastructural recovery than economic

recovery. National Reconstruction Authority's role towards recovery and reconstruction of damaged infrastructure has been praiseworthy. However, its role towards economic recovery was limited by the scope of work. In times of natural disaster, it is big learning that there is a need for a different institutional framework dedicated towards the recovery of non-infrastructure losses and damages such as economic, social, cultural, and psychological recovery. This need also arises because of their unique institutional challenges and specific approaches required to deal with such challenges.

This study covers limited coping strategies in few earthquake-affected areas. This is due to the inability of the researcher to collect primary data due to the COVID-19 situation. Hence, it would be helpful to extend this research by increasing the coverage both in terms of affected areas and coping strategies. Few examples of other coping strategies are farm diversification, use of mechanization in farm and non-farm activities. There is also a need to

apply alternative qualitative and quantitative methods to validate the findings of this study.

Declaration of Competing Interest

None.

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Annexes

Annex Table 1

Summary statistics (mean) of the variables used in the empirical analysis.

Variables	Year 2013		Year 2016	
	Not Affected	Affected	Not Affected	Affected
Dependent variables				
Real consumption expenditure (in Rupees)	13,679.71	8962.657	8824.325	9928.60
Coping strategies				
Remittance (= 1)	0.432	0.154	0.371	0.357
Loan (= 1)	0.405	0.231	0.241	0.250
Sale of assets (= 1)	0.027	0.010	0.015	0.071
Sale of livestock (= 1)	0.045	0.010	0.017	0.036
Paid labor work (= 1)	0.405	0.461	0.345	0.392
Consume seed (= 1)	0.072	0.115	0.017	0.071
Consume wild food (= 1)	0.036	0.038	0.000	0.000
Independent variables				
Head male (= 1)	0.667	0.692	0.672	0.821
Head marital status (= 1)	0.901	0.923	0.948	0.893
Head age	43.919	34.61	41.156	36.786
Head age squared	2197.378	1267.077	1946.328	1519.214
Head years of schooling	3.198	2.88	3.482	3.214
Brahmin chettri (= 1)	0.153	0.000	0.164	0.000
Mountain (= 1)	0.586	1.000	0.569	1.000
Hill (= 1)	0.414	0.000	0.431	0.000
Observations	111	26	116	28

Annex Table 2

Regression results of the effect of earthquake on consumption expenditure.

	(1)	(2)
VARIABLES	Log of consumption expenditure	
Affected village (= 1)	− 0.620*** (0.134)	
Year 2016 (= 1)	− 0.302*** (0.0569)	0.0121 (0.0862)
Affected village*year 2016	0.637** (0.236)	0.535 (0.474)
Household head male (= 1)	− 0.0394 (0.128)	0.274** (0.108)
Household head married (= 1)	0.340** (0.144)	0.0947 (0.252)
Household head age	0.0724*** (0.0201)	0.0185 (0.0149)
Household head age squared	− 0.000652** (0.000197)	− 0.000141 (0.000120)
Years of schooling completed	0.0437** (0.0168)	0.0203 (0.0194)
High caste (= 1)	− 0.0152 (0.115)	− 0.213 (0.162)
Mountain (= 1)	0.484*** (0.135)	

Annex Table 2 (continued)

	(1)	(2)
District fixed effects	No	Yes
Constant	6.608*** (0.578)	7.897*** (0.589)
Observations	290	281
R-squared	0.184	0.147

Robust standard errors in parentheses.

*** $p < 0.01$ ** $p < 0.05$ * $p < 0.1$.

Annex Table 3

Regression results of the probability of using various coping strategies.

Variables	(1) Loan (= 1)	(2) Remittance (= 1)	(3) Sell livestock (= 1)	(4) Sell Assets (= 1)	(5) Paid wage work (= 1)
Affected village (= 1)	–	–	–	–	–
Year 2016 (= 1)	– 0.172** (0.0526)	– 0.0565 (0.0337)	– 0.0284 (0.0210)	– 0.0268** (0.0111)	– 0.0660 (0.0897)
Affected village*year 2016	0.201** (0.0758)	0.296*** (0.0600)	0.0659 (0.0399)	0.0990** (0.0339)	0.00357 (0.191)
Household head male (= 1)	0.0861 (0.0813)	– 0.350*** (0.0768)	0.0294** (0.0118)	– 0.00845 (0.0139)	0.0712 (0.0506)
Household head married (= 1)	– 0.0723 (0.0970)	0.0185 (0.162)	0.0172 (0.0175)	0.0323* (0.0150)	0.174* (0.0785)
Household head age	0.00929** (0.00364)	– 0.00278 (0.0126)	0.00377 (0.00421)	0.00314 (0.00257)	0.00481 (0.0111)
Household head age squared	– 0.000147*** (4.02e-05)	4.73e-05 (0.000156)	– 4.66e-05 (3.94e-05)	– 2.44e-05 (2.18e-05)	– 6.43e-05 (0.000117)
Years of schooling completed	– 0.0175 (0.00981)	0.0112 (0.00949)	– 0.00469** (0.00191)	0.00189 (0.00241)	– 0.0135* (0.00643)
High caste (= 1)	0.0329 (0.0636)	– 0.0517 (0.0903)	– 0.0227* (0.0119)	0.00963 (0.0348)	– 0.0287 (0.116)
District fixed effects	Yes	Yes	Yes	Yes	Yes
Constant	0.337* (0.151)	0.589** (0.232)	– 0.0464 (0.105)	– 0.0918 (0.0631)	0.184 (0.337)
Observations	281	281	281	281	281
R-squared	0.153	0.167	0.037	0.041	0.038

Robust standard errors in parentheses.

*** $p < 0.01$.** $p < 0.05$.* $p < 0.1$.

Annex Table 4

Regression results of the effectiveness of coping strategies.

Variables	(1) Log of consumption expenditure	(2)	(3)
Affected village (= 1)	–	–	–
Year 2016 (= 1)	0.0167 (0.0814)	0.0737 (0.0705)	0.0807 (0.0911)
Remittance (= 1)	0.0881 (0.191)		
Affected village*year 2016	0.432 (0.513)	0.469 (0.559)	0.448 (0.520)
Affected village*remittance	– 1.038** (0.358)		
Affected village*year 2016*remittance	0.802** (0.248)		
Loan (= 1)		0.357*** (0.0914)	
Affected village*loan		– 0.273 (0.352)	
Affected village*year 2016*loan		– 0.000728 (0.397)	
Sale of assets (= 1)			2.637** (1.114)
Affected village*sale of assets			– 2.436* (1.260)
Affected village*year 2016*sale of assets			–
Household head male (= 1)	0.295**	0.256*	0.314**

(continued on next page)

Annex Table 4 (continued)

	(1)	(2)	(3)
Household head married (= 1)	(0.0944) 0.116 (0.259)	(0.126) 0.120 (0.271)	(0.114) 0.0305 (0.250)
Household head age	0.0181 (0.0159)	0.0163 (0.0156)	0.00827 (0.0146)
Household head age squared	− 0.000130 (0.000131)	− 0.000101 (0.000129)	− 5.86e-05 (0.000127)
Years of schooling completed	0.0243 (0.0219)	0.0250 (0.0183)	0.0153 (0.0171)
High caste (= 1)	− 0.219 (0.162)	− 0.220 (0.146)	− 0.233** (0.0897)
District fixed effects	Yes	Yes	Yes
Constant	7.845*** (0.590)	7.768*** (0.624)	8.156*** (0.581)
Observations	281	281	281
R-squared	0.166	0.175	0.251

Robust standard errors in parentheses.

Note: The coefficient for the interaction (term) between a dummy for affected village, sale of assets, and survey year 2016 is not reported because of the lack of sufficient observations for its estimation.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

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Regular Article

Conditional cash transfers and embedded extension: A mechanism to restore and promote adoption of improved goat shelters in emergency recovery

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ABSTRACT

Reconstruction of damaged goat shelters was a key need for communities in the Gorkha district, which was the epicenter of the earthquake in 2015, as lack of shelters led to distress sale of goats and reduction in herd size. Additionally, existing shelters caused diseases in goats due to poor ventilation and hygiene features. Drawing on its global experience and expertise in livelihoods, cash, and markets especially in emergency situations, CRS supported conditional cash transfers, provided in two tranches (upon beneficiary choice and construction completion), along with extension (group orientations, mentoring) focused on shelter design principles, to help poor households critically depending on income from goats reconstruct hygienic goat shelters. CRS promoted two simple, cost-effective design principles while facilitating the reconstruction of goat shelters, i.e., a raised platform and provision for ventilation. A study was undertaken to assess the effectiveness of conditional cash transfers combined with a targeted extension on the adoption of improved goat shelter principles by earthquake-affected households, through 100% visual verifications, household surveys, focus group discussions (FGD) with beneficiaries and non-beneficiaries, and key informant interviews with stakeholders. The study reported that 99% of beneficiaries adopted the hygienic shelter principles promoted by the project based on the conditionality. Beneficiaries co-invested on an average of \$80–100 in addition to the \$100 received from the project. A 20–30% increase in herd size among most beneficiaries was reported after the reconstruction of goat shelters due to the availability of safe space. The study showed strong ownership by the beneficiaries which was evident from the maintenance and up-keeping of the goat shelters. Households, who had not received cash from the project, have also started adopting the design principles mainly due to the low-cost and simple nature of the design principles. Which project has provided them with flexibility in using the material of their choice based on the local context.

1. Introduction

1.1. Background

The Gorkha earthquake of 25 April 2015 had enormously impacted Nepal with the overall economic impact on production and service sectors, such as agriculture, industry, tourism, and trade. It had both direct and indirect impacts on people's livelihoods, agriculture, and agrobiodiversity [2–14]. This massive disaster led to a large-scale loss of life and livelihoods for communities in Nepal's Gorkha District, which was also the epicenter of the earthquake. One of the key impacts of the earthquake was on the livelihoods of poor and vulnerable households was damage to their livestock shelters. About 36% of livestock shelters were destroyed by an earthquake (Agricultural Livelihoods Impact Appraisal, 2015) leading to distress sales of animals and a reduction in herd sizes, especially among vulnerable households for whom livestock was a key source of income. They could not afford to rebuild their livestock shelters immediately after the

earthquake due to the lack of funds and other competing priorities, such as rebuilding their homes and restarting their agricultural activities. (See Figs. 1–5.) (See Tables 1 and 2.)

The contribution of the agricultural sector to the Gross Domestic Product (GDP) of Nepal is 33%. Out of this, the contribution of the livestock sector is 26.8% and goat contributes 20% in national meat production and has a share of about 12% in total livestock GDP (Value Chain report, 2012). Goats are extensively reared by rural communities in Nepal and are estimated to be more than 10 million in numbers (Krishi dairy [6]). Goats are particularly preferred as they can produce offspring in a short period of time and attain marketable weight by 12–16 months providing quick cash flows for households. Goats are also a good source of meat (protein) and waste is used extensively as organic manure. Goat is a preferred source of cash income especially for economically poor people; therefore, it is called “Poor Man's Cow”. A typical smallholder farmer earns from 15,000 to 20,000 rupees (NPR) annually from the sale of their goats (Nepal Living Standard Survey, 2012).

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Fig. 1. Traditional goat shelters built low to the ground and without good ventilation Photo by CRS staff.



Fig. 2. CRS staff orienting beneficiaries on improved shelter designs. Photo by CRS staff

According to the District Livestock Support Office (DLSO) Gorkha, about 6100 goats died in Gorkha district in the devastating earthquake (Annual Progress Report [1] & Jaishi et al. [1]). A Post Disaster Needs Assessment (PDNA)¹ conducted by CRS showed that communities reported a mortality of 60% of their goats due to earthquake. Most of the mortality was due to injuries followed by diseases. Families also reported that it would take them at least two to three years to save enough money to fully rebuild their goat shelters. Families living in rural and remote communities in Gorkha had little or no access to credit from formal financial institutions. Credit from informal sources such as savings groups or loans from friends and relatives was either limited in amount or had high-interest rates. In addition to this, the PDNA also found that the existing goat shelters had poor design (inadequate ventilation and poor drainage system) which contributed to respiratory disease among goats, low herd productivity, and, ultimately, leading to reduced income.

¹ The Post-Disaster Needs Assessment (PDNA) is a methodology for identifying the affected communities' physical damages, economic losses, and costs of meeting recovery needs after a natural disaster.



Fig. 3. Goat shelters with different materials constructed by beneficiaries using cash transfers and adopting improved designs. Photo by CRS staff.

Increasingly in emergencies, development aid organizations across the globe are considering cash transfers an effective strategy to meet people's relief and recovery needs (Gardner & et al., 2011). In cases where markets are functional, cash is found to be more cost-effective, efficient and have a positive effect on local economies in addition to the beneficiaries themselves (WFP Experience Report, 2006). CRS has strong experience in cash and market-based programming across the globe and it leveraged this expertise to support the most vulnerable households rebuild their goat shelters and adopt improved design principles. A small minority of households (around 5%) reported losing all their goats, including sheep was around



Fig. 4. Beneficiaries receiving cash through remittance agency. Photo by CRS staff.

15% (ALIA Report [1]) due to damage of goat shelter. Furthermore, it is a fact that the major fixed cost consumed by goat shelter construction. This fixed cost of goat shelter construction matters a lot for especially smallholder, landless marginalized farmers for restoring their goat-based livelihoods. Considering economic loss for smallholder farmers and CRS supported conditional cash transfers to restore the goat shelter of most vulnerable households under the Recovery and Response Project. A cash transfer to restore the goat shelter of larger numbers of smallholders, marginalized, vulnerable communities was itself new pilot interventions. Although, cash transfer is a widely accepted means during the emergency to support vulnerable communities. In addition, as per livestock emergency guidelines standard [7], suggested livestock shelter construction can be done through CIT program as an emergency need to restore communities' livelihoods. Thus, CRS designed and implemented a Conditional Cash Transfer (CCT) programming and embedded it with an extension to help households rebuild their goat shelters.

1.1.1. Project design and implementation

CRS conducted series of consultations with communities, government extension workers (including Goat Research Station of Government of Nepal), local administration, and vendors dealing with hardware components (roofing sheets, iron nails etc) to assess the feasibility of cash-based programming, value of cash to be transferred and locally appropriate improved shelter design principles which can be promoted in the project.



Fig. 5. Ansisha Shrestha holds baby goats at her newly constructed goat shelter; Photo by Jen Hardy/CRS.

Table 1

Tool and sampling details.

Name of the Tool	Sample Size and Location
FGD with goat shelter beneficiaries	Two FGDs (one each with male and female beneficiaries) each in Taple and Tandrang; total four FGDs
FGD with non-beneficiaries	2 FGDs (one each with male and female respondents) each in Taple and Tandrang; total four FGDs
KII with local government representative	1 KII in Tandrang
KII with livestock extension officer	1 KII each in Taple and Tandrang
Transect walk check-in	5 HHs each in Taple and Tandrang

Based on an analysis of the inputs received, CRS decided to, promote following two simple and low-cost design principles (Handbook for farmers: Goat husbandry, 2010),

- A platform raised to about 2.5 ft (~0.75m) from the ground,
- Adequate ventilation to address hygiene and respiratory disease issues.

To minimize reconstruction costs and encourage the use of locally available material like stones, bamboo, wood, beneficiaries were encouraged to use materials of their choice including salvaged material from their homes and choose a shelter size based on their needs. In addition to orientation programs aided by illustrated educational materials, CRS constructed demonstration goat shelters to help communities visualize the new design.

CRS's analysis of the existing goat shelters showed that the average cost of these shelters is about \$120–140. Based on this CRS decided on a transfer value of \$100 as this amount nudge households to start their goat shelter reconstruction and at the same time secure some co-investment of funds which is often critical for ownership and sustainability. CRS adopted two different modalities for the cash transfer,

Modality 1: \$100 cash in two tranches of \$50 each. The first tranche was provided upon selection of the beneficiary and attending an orientation programs on improved shelter design, and the second tranche upon completion of the shelter and its verification by project staff. The verification process sought to ensure that the participating household had adopted the improved goat shelter design.

Modality 2: A one-off payment of \$100 upon completion of the shelter and its verification by project staff. This modality was adopted in remote locations where multiple payments were operationally challenging.

Based on the topographic conditions, existing infrastructure like roads, transportation, bank networks etc., CRS adopted two different cash delivery mechanisms. One, through a remittance agency where such services were available and second, through project partner organizations, for locations which are not served by remittance agencies or other financial service providers. In both cases, cash-in-hand was provide to the beneficiaries saving them the drudgery of travelling and other expenses which they would have otherwise incurred to withdraw money from a bank.

Beneficiary selection was carried out through participatory process involving communities, local leaders and elected representatives and facilitated by project staff to ensure transparency and accountability. This intervention was implemented by CRS in Gorkha district with the help of three local implementing partners, namely, Caritas Nepal, System Development Service Center (SDSC), Shree Swanra Integrated Community Development Center (SSICDC).

Table 2

Overall goat shelter reconstruction status (Source: Project Database).

Total Beneficiaries Identified	Gender		Total Beneficiaries who Reconstructed	Gender		Percentage of Beneficiaries Who Reconstructed
	Male	Female		Male	Female	
3882	2558	1324	3849	2548	1301	99%

1.2. Rationale of study

Following the completion of this intervention, CRS wanted to conduct a detailed study to assess the effectiveness of conditional cash transfers combined with targeted extension on adoption of improved goat shelter principles and document key lessons learned. This participatory process and insights coming out of the study would help CRS and other agencies using cash transfer modalities better design and implement such projects in future.

1.3. Objectives/research questions

The following were the key objectives of the study,

- To what extent the project strategies and activities were able to achieve the intended outputs and outcomes with specific focus on,
 - o Impact on vulnerable households
 - o Contribution to strengthening goat-based livelihoods.
- To what extent the outcomes are sustainable and what additional results need to be achieved, if any, to make the outcomes more sustainable?
- What were the key enabling and inhibiting factors that influenced the quality of implementation of the activities and achievement of the outcomes?
- What key design changes, if any, need to be integrated to make such interventions more successful in future?

2. Methodology

2.1. Survey design and study sample

The intervention was implemented in nine Village Development Committees (VDCs)² and one municipality covering 3882 households. Study areas were designed carefully to ensure that they represent the diverse operating environment in terms of socio-economic profile of farmers, access to markets, topography (altitude), concentration of beneficiaries and damage caused by earthquake to the goat shelters. Based on these parameters two VDCs Taple and Tandrang were selected for the study.

The study adopted various participatory approaches and tools (Practical Guide, 2018) which were qualitative in nature. Additionally, quantitative data from project database was also used which was collected since the inception of the project. Data collected using the following specific tools were used for the study,

- Post distribution monitoring tool (PDM)³
- Focus Group Discussion (FGDs) with goat shelter cash transfer beneficiaries.
- FGDs with non-beneficiaries, i.e., households which did not receive cash support but observed the improved goat shelters.
- Key Information Interviews (KII) with local government representatives
- KII with Livestock Extension Officers at the targeted rural municipalities

2.2. Nature and sources of data

The study used a combination of qualitative and quantitative data with more reliance on the former. All the data sources were primary in nature wherein study teams collected data from the field. As is evident from the tools mentioned above, data was collected from various stakeholders who were closely involved in the project activities.

² VDC represents the geographic unit before the federalization of Nepal took place and administrative units were redrawn and renamed. After federalization this Nine VDCs were part of three ruler municipalities (Bhimsen thapa, Arughat and Dharche) and one municipalities (Gorkha).

³ Post Distribution Monitoring (PDM) is a part of Monitoring & Evaluation tool which aims at systematic collection and analysis of information of the project as it progresses.

2.3. Analysis of the information

To analyze the data and interpret findings, a two days reflection workshop was organized to assess the effectiveness of conditional cash transfers combined with targeted extension on adoption of improved goat shelter principles by earthquake-affected households.

There was no need for a high level of statistical analysis as these are presented in simple frequency tables and were made ready in the word processor. Further, the analysis was made different headings according to study inquiry were created and related information from the spreadsheet was put under the appropriate headings. All the information related to and document key lessons learned, and recommendations related to sustainability, implementation approach, and design principles reviewed critically and findings are presented in the report systematically.

3. Results and discussion

3.1. Results

3.1.1. Goat shelter construction results

A total of 3849 households reconstructed goat shelters out of 3882 households which were targeted in the whole project.⁴ The 3849 households (99%) adopted the hygienic shelter principles promoted by the project based on the conditionality. The total 33.80% female beneficiaries built their goat shelter. Participating families co-invested an average of \$80 to \$100 (in material and labor) in addition to the \$100 received from the project to rebuild their goat shelter. Strong ownership of the goat shelters was evident in the regular maintenance observed over the subsequent 18 months.

Community members not involved in the project have begun adopting the improved shelter design principles after witnessing a reduction in respiratory disease due to the improved design in their neighborhoods.

3.1.2. Herd size

The herd size in participating families increased by 20 to 30% over a period of 12 to 15 months following the reconstruction goat shelters adopting improved design principles. This result was attributed by the beneficiaries to the availability of safe shelter, a reduction in morbidity and a decrease in distress sales of animals.

3.2. Modality preference

A large majority of the beneficiaries (79.1%) preferred the double tranche modality while the rest (20.9%) preferred single tranche modality. Getting cash in two tranches helped beneficiaries, especially the poor, invest upfront in buying material and paying for labor for which cash is needed and this factor came across a strong reason for preferring twin tranche modality. The second modality of receiving cash in a single tranche, upon completion of the goat shelter, was found to be more operationally convenient for project staff and helped them serve beneficiaries in remote locations. In terms of effectiveness, almost 100% goat shelter reconstruction completion was observed among beneficiaries receiving cash through either of the modalities. So, the modality of cash transfer did not have any impact on the effectiveness of the reconstruction process.

3.3. Discussion

The overall results, feedback from communities, and the study team pointed to the following factors as key for success. The pre-project needs assessment conducted by CRS was able to rightly identify the large-scale damage to goat shelters as a key impact of the earthquake on the livelihoods of poor households. The shelter interventions and cash transfers were grounded in community needs and context and hence garnered

⁴ This includes the study area as well as other VDCs in the project locations.

strong support from local government and leadership as well which further translated into strong ownership of the intervention by communities. All the goat shelters that were reconstructed using project support are being used for rearing goats and not put into any alternative, unproductive use.

The feasibility assessment conducted prior to intervention designing proved to be crucial in getting community feedback on their preference between cash and in-kind support. The feasibility assessment which included studying the costing of different types of goat shelters in communities also helped in fixing the transfer amount which was appropriate to the local context. Finally, the feasibility assessment provided key insights into the different types of cash delivery mechanisms which are appropriate for the target households and based on which CRS decided on two modalities - cash-in-hand and cash through remittance agencies, to the beneficiaries. The assessment results conclusively showed that participating households preferred cash to in-kind support as it provided the flexibility of choice for quantity and quality of material. Cash also enabled the families to pay for skilled labor for the construction.

A cash transfer or the promise of cash, in the case of the second modality—nudged participants to prioritize goat shelters and catalyzed faster reconstruction (40 to 50 days on average for each shelter). In the absence of cash support, the participating families would likely have taken two to three years to rebuild the shelters by saving slowly and constructing incrementally. During this period of 2–3 years, most of the beneficiaries would have reduced their herd size, thus impacting their income as well. Beneficiaries cited loans with interest rate of 20% and above from relatives and friends as a fallback option to construct the goat shelters.

The cash support provided by project motivated and nudged households to co-invest (about \$80–\$100) and build better by using quality materials and skilled labor. Ratna Gyan Thapa, age 43, of Taple VDC # 3 Co invested additional \$100 to keep breeding buck. He said which resulted in inbreeding previously due to reared all types of goat in one shelter. Now due to separate chamber he was able to reduce loss from inbreeding on his farm as well as whole helmet. A good number of beneficiaries built shelters larger than their damaged ones to address future needs. Most of the beneficiaries reported that the cash was spent on materials like wood, nails and skilled labor which were available in the local markets. Cash was preferred to material due to reasons like flexibility in buying material of their choice and quality; and enabling payment for skilled construction labor. It also gave recipients the option to use scrap or salvaged materials, thus saving on construction costs.

Results from FGD and KII show that providing cash in two tranches was preferred by beneficiaries as it helped more vulnerable households to use the first tranche for buying material and pay for labor. As payment of the second tranche was done on a cluster basis (households in a particular geographic area could only receive their second payment once everyone in that area had completed construction), it contributed to peer support to expedite the construction process, especially for the most vulnerable households, such as the elderly and women-headed households. The one-time payment was generally effective, but in some cases led to a delay in construction completion as families struggled to make the initial investment on their own.

The promotion of improved shelter focused on design principles and did not call for specific materials or shelter size. Providing this flexibility empowered participants to choose materials that were locally appropriate, promoting use of salvaged material, and reducing cost. In most cases, households have chosen locally available materials like wood, stone, and bamboo for construction, thus making future maintenance easier and cheaper.

CRS strategy of constructing demonstration goat shelters using different varieties of raw material prior to cash distribution yielded positive results. The demonstration goat shelters combined with regular and short-duration trainings using simple IEC material (Annexure 1) in the project areas helped community members understand and better adapt the design principles to their specific needs.

Project participants reported reduction in respiratory diseases and diarrhea and an overall improvement in goat health after the construction of improved shelters. Behavior change in terms of more frequent cleaning of goat shelters (once in 2–3 months compared to once in six months earlier) was also observed in field as the raised platform made cleaning convenient. Beneficiaries also reported the project promoted goat shelter design principles were easy to understand and implement. They attributed improvements in goat health to the improved goat shelter design, especially the raised platform as it helped them to clean the faeces easily.

The cash assistance covered about 20% of the total households in the project area. This large-scale coverage created momentum within the community, which facilitated wider awareness on the improved design. It was observed that community members who were not involved in the project started (especially households making new goat shelters) to adopt the improved design after 6 or 7 months, based on their observation of positive results, largely in terms of disease reduction in goats. Adoption was also reported to be easy owing to the simplicity of the design.

Through the cash assistance of \$100 and accompanied extension messaging, 3849 households adopted improved goat shelter designs to reconstruct their goat shelters and there has also been adoption by non-beneficiaries. This pump priming also helped beneficiaries to co-invest. These outcomes strongly point towards to cost-effectiveness of the intervention.

4. Lessons learned

Key learnings from the study are listed below:

- Inputs and/or cash when embedded with extension services are likely to increase the chances of behavior change among communities and lead to sustainable adoption of improved livelihood practices.
- Cash transfers empowered the beneficiaries and enabled them to take decisions on the nature of the goat shelter they want to rebuild. It also provided flexibility to beneficiaries to use locally available raw materials like stones, bamboo, wood, salvaged materials etc. based on their preference.
- Focus on promotion of few but high impact goat management practices meant that the interventions were kept simple which ultimately contributed to the effectiveness and high adoption.
- This intervention was not found to be appropriate for the ultra-poor household who generally reared very few animals and kept animals inside their homes rather than having a separate goat shelter. They were also constrained by their inability to co-invest in the reconstruction of goat shelter. To successfully benefit such households, a higher transfer value should be explored.

5. Conclusion and recommendations

Based on the project results and insights from the study, following conclusion and recommendations are suggested to inform design of similar interventions in future,

5.1. Conclusion

Earthquake recovery provided CRS with an inroad to strengthen the livelihoods of poor households through goat shelter reconstruction using

hygienic design principles. Use of cash assistance for goat shelters is a relatively new and innovative in Nepal and provided a comprehensive learning opportunity to identify factors that can influence the success of such interventions in future. The cash assistance met the twin objectives of restoring the livelihoods of participants and improving the health of their animals through adoption of improved shelter design. Along with cash support, the project's approach, of promoting simple design and locally available raw materials, proved to be crucial in adoption and replication by community members who were not a part of the project, thus extending its impact. Key lessons learned are that cash distribution in two tranches, promotion of improved shelter design features and demonstration goat shelters can be applied in other contexts with necessary adaptations. In summary, when combined with extension and mentoring support, cash assistance can be a strong nudging tool to promote adoption of proven technologies or best practices.

5.2. Recommendation

- Thorough and participatory needs and feasibility assessment helps in identifying the right modality (cash transfer in this case and not material) and nature of mentoring support required to help beneficiaries reconstruct their goat shelters adopting improved design principles. The shelter interventions were grounded in community needs and hence helped in mobilizing strong support from local government and communities.
- Focus on simple, low-cost, relevant to specific problems, and fewer behavior changes helps in effective messaging and wider adoption of project promoted goat shelter design principles. Non-beneficiaries who adopted shelter design principles reported that simplicity of design as one of the key factors for adoption.
- Adoption of improved design principles by non-beneficiaries was not immediate. Non-beneficiaries started to adopt improved design principles only after observing the changes in goat health for six to seven months. Hence, it is important to schedule core implementation activities in a way that there is adequate time available in project to support non-beneficiaries in adoption and replication.
- Providing flexibility, rather than a one-size-fits-all approach, on construction material, size of the shelters etc. empowers the beneficiaries to make their own choices based on their requirements and context. Such approaches contribute to ownership and post-project sustainability of the results.
- Providing cash in minimum two tranches with one advance payment helps beneficiaries make upfront investment in materials and skilled labor. This is particularly crucial for poor households who are short on cash and have limited or no access to credit from formal and informal sources. The balance payment serves as an incentive for beneficiary households to complete the construction in time. Cash transfer supports like this indicate a strong cost-effectiveness compared to other modes of interventions.
- Well-designed and targeted cash support helps create household level infrastructure without directly provisioning for any hardware support which can sometimes be cost intensive and time consuming. Wherever feasible, cash transfer programs should be explored instead of hardware provisioning.
- Demonstration goat shelters built by using a wide range of materials in the same geographic area plays a key role in increasing awareness and skills of the households on improved and hygienic design principles before households start their own goat shelters construction. It also provides an opportunity for the households in terms of shelter design and choosing raw material of their choice. Hence, organizing demonstrations and awareness programs prior to cash transfer is recommended.
- Possibility of separate cash transfer modalities like higher cash limits, higher first tranche etc. should be explored to provide additional assistance to ultra-poor households to reconstruct their goat shelters.
- Disbursement of second/final tranche in groups or batches helped in expediting construction process due to peer encouragement and support. In many cases beneficiaries were found to be opting for collective planning specially to address skilled labor scarcity and complete construction in short time.
- Cash transfer for goat shelter activities were implemented at scale with about 20% of the total households covered. Large-scale coverage creates a momentum and buzz within the community which further facilitates wider awareness on the improved design principles and subsequently contributes to adoption by non-beneficiaries.
- Short duration and regular orientation trainings particularly helped women to adopt improved goat shelter features. Short duration trainings help in participation from poor households who are otherwise busy in regular chores and repeat trainings help in stronger retention of key messages.

Credit author statement

Conceptualization, Methodology, data curation, writing, original draft preparation and Validation: Krishna Mohan and Prachanda Kattel. Data collection, Review and feedback given by CRS team.

Declaration of Competing Interest

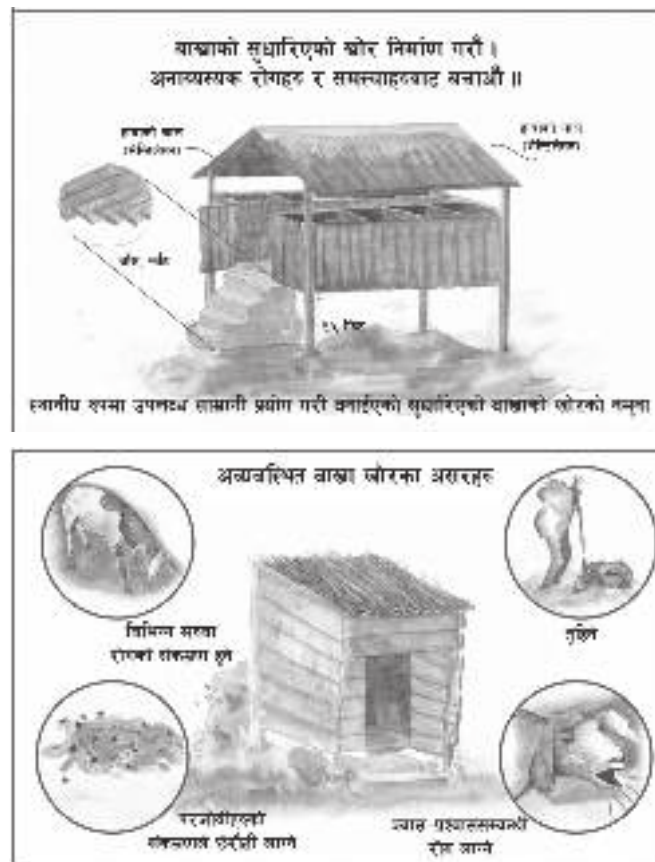
None.

Acknowledgement

Authors would like thanks CRS Nepal.

Annexure I

IEC Material Used for Awareness Generation



Map of Study Area

Index

- IEC Working Area
- CRS Study Area
- Gorkha District
- District Boundary
- Province Boundary

0 10 20 km



Annexure II

List of participants for KIIs

SN	Name	Position	Organization	Address	Contact No
1	Sanukaji onta	Veterinary officer	Veterinary Hospital and expert center, Gorkha	Gorkha Municipality # 9	9,851,013,195
2	Sabin Baram	Junior technician	Aarughat Ruler Municipality	Arughat Bazzar	9,845,634,396
3	Narayan Doj Khadka	Ward president# 5	Arughat Ruler Municipality	Arughat Ruler Municipality # 5	9,840,045,065
4	Dil Prasad bhatta	Lead Farmer	Self-employ	Bhimsen Thapa Ruler Municipality (Previous Tandrang VDC)	9,849,962,167
5	Gyan Bahadur Rana	Lead farmer	Self-employ	Gorkha Municipality#2, (Previous Taple VDC)	

Annexure III

Tool 1: FGD with Goat Shelter Beneficiaries

1. Objective

- Assess the effectiveness and relevance of GRRP cash transfer support to vulnerable households for goat shelter reconstruction.
- Assess the efficiency and effectiveness of project cash transfer strategies.
- Understand the impact of goat shelter support on beneficiaries.

2. Guidelines:

- Group size of should be within 6–9 with 50% male and females.
- As these are mixed group FGDs, please ensure a female facilitator.
- Ensure that respondent him/herself was directly associated with project activities on goat shelter reconstruction.
- Identify a place (preferably a common place like school, Panchayat office etc) which is convenient for the participants
- Have enough space where all participants can sit and move comfortably
- Place should be well ventilated where it is easy to maintain eye contact

3. Introduction

Namaste! My name is _____ and with me are _____ (introduce other members of the team). We are from *Partner Name* and CRS. Today, we have come here to discuss and understand from you about the effectiveness and relevance of cash support and training on improved goat shelter that you received from the project. Your inputs will help us in developing appropriate project interventions for this area. While participating in the discussion, please be open about your views. There are no right or wrong answers. We expect that every participant will share his/her thoughts freely. Participation in this discussion is purely voluntary and we don't promise or commit anything in return for your participation in the meeting. This discussion might take about 45–60 min. We can start if you are ready.

4. Key Questions and Probes:

- Can you please tell me what was the impact of earthquake on your goat shelters? Ask separately to men and women. Probe for:
 - Was the goat shelter damaged fully or partially?
 - Were the damaged goat shelter usable or unsafe for use?
 - Did the respondents reduce the number of goats through distress sale?
- What kind of support did you receive from project to repair/reconstruct your goat shelters? Ask separately to men and women.
- What did you think about the process for the goat shelter cash support? Ask separately to men and women. Probe for:
 - What do you think about the beneficiary selection process for goat shelter support? Did the selection process led to selection of right beneficiaries like landless, women headed HHs and other vulnerable groups for whom goat rearing was the main livelihood option? If not, what were the challenges?
 - What do you think about the timeliness of the cash support?
 - What is your feedback on the mode (cash in envelope) of cash transfer? Would you have preferred any other options like bank deposits, remittance etc? If yes, why?
- What did you think about the package of cash support to reconstruct your goat shelter? Ask separately to men and women. Probe for:
 - What do you think about the amount provided to repair the goat shelter? Did you invest additional funds for the construction? If yes, how much? What type of material (new and scrap) used for the construction?
 - What do you think about the conditions (two tranches, mandatory participation in training on improved shelter design and adoption of two design features) for receiving the cash support?
 - Was cash the right medium or would you have preferred material support instead? If yes, why?
 - Did you face any challenges in timely receipt of tranches? If yes, what are they?
- What did you think about the utilization of the cash received? Ask separately to men and women. Probe for:
 - Did you face any challenges in utilizing cash grant for goat shelter, especially given that there could have multiple priorities for cash expenses? Probe for both yes and no response.
 - Was there enough material and skilled labor available in the market to reconstruct goat shelter? On which items (material or labor) you spent the maximum money?
- What do you think about the improved shelter design promoted in the project through cash transfer? Ask separately to men and women. Probe for:
 - What were the main benefits you observed in your goats, if any, due to the improved design?
 - Do you think the project should have allowed beneficiaries to construct goat shelters as per their own design preference instead of prescribing improved one? If yes, why do you think so?

- Do you think the orientations provided by project staff on the improved design features was adequate to help you in construction? If no, what else could have been done to help you adopt project promoted goat shelter design?
- How long did it take to construct the goat shelter? Did you face any challenges in constructing goat shelter with improved design features? If yes, what are they?
- During the last 18 months, did other households construct/repair goat shelters without project support. If yes, have you observed them adopting the improved goat shelter design features? If yes, what do you think motivated them to adopt new design? If no, why do you think they did not adopt the improved design? Ask separately to men and women.
- How would you have managed to reconstruct your goat shelter had there been no support (technical and financial) from project? Ask separately to men and women. Probe for:
 - Coping mechanisms like taking loan, borrowing money from friends/relatives etc
 - How long would it have taken for you to completely reconstruct your goat shelter without project support?
- What has been the key impact/s of project support on your goat shelter reconstruction? Ask separately to men and women.
- Do you have any suggestions for CRS if it were to implement a similar intervention in future? Ask separately to men and women. Probe for: *beneficiary selection process, amount of cash, tranches, restricted/unrestricted etc.*

End the FGD by checking with participants if they have any questions or clarifications and respond to the same.

Tool 2: KII with Rural Municipality Representative and Livestock Official

1. Objective

- Get feedback on the effectiveness, relevance, and efficiency of the PSP model for goat breed improvement.
- Assess Government's willingness to support and/or promote such models.

2. Introduction

Namaste! My name is _____ and with me are _____ (introduce other members of the team). We are from *Partner Name* and CRS. Today, we have come here to discuss and understand from you about your feedback on the goat breed improvement program implemented in GRRP. While participating in the discussion, please be open about your views. There are no right or wrong answers. Participation in this discussion is purely voluntary and we don't promise or commit anything in return for your participation in the meeting. This discussion might take about 20–30 min. We can start if you are ready.

3. Key Questions and Probes:

- Are you aware of the goat breed improvement services being promoted in GRRP/CRS/ (partner name) project? If yes, can you please give you please share your feedback on the following?
 - Do you see breed improvement as a key need for communities who depend on goats for their livelihoods and income? Probe for both yes and no response.
 - What do you think about the fee-based model for breed improvement? What are some of the advantages and disadvantages of this model?
 - Do you think there are other ways in which goat breeds can be improved? If yes, what are they?
 - Have you observed any improvements in herds based on the service provided? If yes, what specific improvements have you observed?
 - Do you think the PSP selection process adopted by the project was able to identify the right kind of PSPs? Probe for both yes and no response.
 - Do you think the services were open to all groups including socially excluded ones like Dalits, Janjati, single women etc? Do you remember any example on top of your mind of such groups availing benefits of the service?
- Does the Rural Municipality have any plans to promote this model in other wards and villages? If yes, what kind of support will be provided to entrepreneurs? If not, why?
- Are there ways in which the Rural Municipality can support the existing PSPs in expanding their operations, increasing their profitability and strengthening their technical skills? If yes, what are they?
- Do you have any suggestions for CRS if it were to implement a similar intervention in future? Probe for: *beneficiary selection process, amount of cash, tranches, restricted/unrestricted etc.*

End the FGD by checking with participants if they have any questions or clarifications and respond to the same.

Tool 3: FGD with Non-Beneficiaries

1. Objective

- Assess feedback from non-beneficiaries on the perceived effectiveness of improved goat shelter features promoted in the project.
- Assess willingness and ability of non-beneficiaries to adopt improved goat shelter features.
- Understand non-beneficiaries' feedback on effectiveness and efficiency of the goat practices training content, delivery methods and approaches.

2. Guidelines:

- Non-beneficiaries mean households who have not received cash support from GRRP but have been part of goat trainings and might have received breeding support from buck entrepreneur.
- Group size of should be within 6–9 with 50% male and females.
- As these are mixed group FGDs, please ensure a female facilitator.
- Ensure that respondent him/herself was directly associated with project activities on goat trainings.
- Identify a place (preferably a common place like school, Panchayat office etc) which is convenient for the participants.
- Have enough space where all participants can sit and move comfortably.
- Place should be well ventilated where it is easy to maintain eye contact.

3. Introduction

Namaste! My name is _____ and with me are _____ (introduce other members of the team). We are from *Partner Name* and CRS. Today, we have come here to discuss and understand from you about the effectiveness and relevance of trainings on improved goat management practices that you received from the project. Your inputs will help us in developing appropriate project interventions for this area. While participating in the discussion, please be open about your views. There are no right or wrong answers. We expect that every participant will share his/her thoughts freely. Participation in this discussion is purely voluntary and we don't promise or commit anything in return for your participation in the meeting. This discussion might take about 30 min. We can start if you are ready.

4. Key Questions and Probes:

- Can you please tell me what kind of trainings have you received on goat rearing practices in the project? Ask separately to men and women.
 - Out of these trainings, which trainings or topics you found to be most useful and why? Which trainings or topics you found to be least useful and why? Ask separately to men and women.
 - Have you adopted (especially the shelter practices) any of the improved goat rearing practices that were promoted in the project? If yes, which practices have you adopted? If no, what were the challenges in adoption? Ask separately to men and women.
 - Have you observed any benefits of adopting the improved practices? If yes, what are they? Ask separately to men and women.
 - What do you think about the method and timing of trainings? Ask separately to men and women. Probe for,
 - Was it easy to understand the key messages and concepts? If not, what were the challenges?
 - What is the feedback on duration and timing of the trainings?
 - What is the feedback on frequency of the trainings?
 - Did you get adequate advance information about the training?
 - What is your feedback on the location/venue of the trainings?
 - What is the feedback on IEC material used in the training?
 - What do you think about the beneficiary selection process for the cash transfers on goat shelter reconstruction? Ask separately to men and women. Probe for,
 - Were you aware of the selection process including HH criteria for selection?
 - Do you think the process helped in identification of most needy and vulnerable HHs for the cash transfer? If not, what were the challenges or gaps?
 - What do you think about the buck entrepreneurship model promoted in the project? Ask separately to men and women. Probe for,
 - What is your feedback on the PSP identified in your community? Do you think the selection process was transparent and helped in identifying the right person? If not, what were the gaps?
 - Have you used the services offered by the PSP on breed improvement? If not, why? Probe for any social exclusion issues like caste etc.
 - If yes, what have been the key results so far? Would you want to use the services again?
 - What is your feedback on the fee charged by the PSP? Do you think very poor HHs are able to access this service by paying fee or is fee a deterrent?
 - Do you have any suggestions for CRS if it were to implement a similar intervention in future? Ask separately to men and women.
- End the FGD by checking with participants if they have any questions or clarifications and respond to the same.

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Regular Article

Community led post-earthquake heritage reconstruction in Patan—issues and lessons learned

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ABSTRACT

Earthquake of 7.8 magnitude hit Nepal on April 25, 2015 leading to severe damage to its heritage buildings. Cultural heritage is an expression of the ways of living, developed by a community and passed on from generation to generation including customs, practices, places, tangible objects, artistic expressions, and values. In addition to the reconstruction of monuments within Patan Durbar Area, Kathmandu Valley Preservation Trust (KVPT) is working with communities of Patan and providing technical support to the reconstruction of their community buildings such as *Phalcha / Pati*, *Chaapa*, *Sattal*, *Guthighar* and *Aganchhen*. Communities in collaboration with local government and lead agencies for heritage conservation are addressing heritage reconstruction. Community-led reconstruction is recognised by both Government of Nepal (GoN) and public as an important approach. The purpose of this paper is to examine community-led reconstruction approach undertaken by communities of Patan and share issues, success stories and lessons learnt where KVPT provided technical support. A literature review of documents related to the reconstruction and heritage buildings were conducted. Following a case study method and using qualitative method, data is captured from community members and technical personnel involved in reconstruction. A comparative chart with case studies is created to depict the issues hindering community-led heritage reconstruction. From this study it is found that people of Patan have sense of belonging to their heritage. They are interested in taking part and leading the reconstruction process. However, challenges exist in terms of budget, awareness on traditional methods and construction management, technical, social process and bureaucratic procedures. For successful project completion, there is a need of knowledge sharing and capacity building of communities who want to lead heritage reconstruction. The result from this paper can be used by communities as key points to frame their own reconstruction plans and by GoN to devise strategies to support communities who want to lead heritage reconstruction.

1. Introduction

On April 25 and May 12, 2015, earthquakes of 7.8 and 7.4 magnitude struck Nepal with epicentre at Gorkha district,¹ north-west of the capital Kathmandu (April), and between Sindhupalchok and Dolakha districts north-east of the capital (May). Immediately after earthquake, Post-Disaster Needs Assessment was prepared by the National Planning Commission. The total estimated damage to tangible cultural heritage was predicted to be NPR 16.9 billion (US\$ 169 million) [25]. In May 2016, Nepal Government launched a Post Disaster Recovery Framework [26] to provide vision and the strategic objectives to fulfil reconstruction goals. In [26], GoN stated principles of recovery and “build back better” as the key element of reconstruction and rehabilitation policy. Strategic recovery objective of [26] states “Restore and improve disaster resilient housing,

government buildings and cultural heritage, in rural areas and cities”. It recognised Community-led reconstruction as an important approach and emphasizes to engage Community Based Organizations (CBOs) to ensure community participation and ownership of reconstruction and recovery. And at the same time it enhances social cohesion to build resilient communities. It also emphasizes on preservation of both tangible and intangible heritage along with physically resilient reconstruction [10].

In many neighbourhoods of Kathmandu valley, community-led organizations strongly associate themselves with heritage and want more responsibility in heritage reconstruction [2,3]; A study of this approach together with the issues faced and lessons learnt is necessary. By assessing the implementation challenges and understanding successful cases in community-led reconstruction projects, suitable policies can be developed to upscale and increase the quality and speed of heritage reconstruction.

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¹ Nepal is divided administratively into three level of government – federal, state and local. State government is divided into provinces. Local government units includes rural municipalities, urban municipalities, sub-metropolitan cities and metropolitan cities at the bottom level. These local government units were further divided into Wards. Similarly, district level local governments are formed which can include the various municipalities.

The objective of this paper is to:

1. Examine community-led reconstruction approach undertaken by communities of Patan towards cultural heritage reconstruction and share issues, success stories and lessons learnt.
2. Share procedures that were followed during heritage reconstruction projects and community engagement.

1.1. Literature review

Cultural heritage is an expression of the ways of living, developed by community and passed on from generation to generation, including customs, practices, places, tangible objects, artistic expressions and values [12]. [1] through examples of African American context mentions that through heritage, people communicate the stories of their past in the present. When heritage is missing it impacts personal and group identity. He further states that there is a fundamental link between cultural heritage and identity. Heritage plays a central role in the formation of collective memory, sense of place and establishing a link to the history.

Different definition of community exists in literature. For this research, framework suggested by [14,21] is used to describe community as their definition closely relates with communities studied in this research. [14] explains community as spatial and economic unit and a web of kinship, in which there is a direct involvement of community in managing and developing local areas. [21] have identified four characteristics which a community possess. First is sense of belonging or membership to a group. The second is influence or a sense of mattering and making a difference to a group matter. The third characteristics is reinforcement, integration and fulfilment of needs. The last characteristics is shared emotional connection, the commitment and belief that members have shared and will share history, common places, time together and similar experiences.

Sendai Framework 2015 specifically states that the community can play an active role in the protection of its cultural heritage and in enhancement of resilience of socio-urban system because it is the repository of the local culture. This is elaborated in the Burra charter of 1979 that conservation, interpretation and management of a place should provide opportunity for the participation of people for whom the place has significant associations and meanings, or who have social, spiritual or other cultural responsibilities for that place. [7] presents an interesting case of Irpinia, a town in Italy where in the course of few years many community-led practices have developed, which have reinforced the networking of local actors and their "awareness of place". They link the cultural heritage and social capital as enabler of sustainable and resilient human settlements.

An idea proposed by [24] is that values-based methodology (community participation) needs to be complimented with scientific approaches (technical) and wider collaboration involving academia, local government and upper-tier government bodies. An interesting example is the *Rekompak* approach from Indonesia where disaster-affected communities were given the opportunity to rebuild their traditional buildings with funding channelled directly through the government's budget as block grants. These infrastructures were developed based on Community Settlement Plan (CSP). *Rekompak* provided facilitators to increase capacity of the community and government related to the organizational, managerial, economic and technical aspects of preservation and heritage management. [22,27] explains interesting Japanese approach of *machizukuri* which relates to how the residents engage in the planning and management of their living environments at the neighbourhood level. It also played a role in the reconstruction of a shared sense of place and community. [27] explains that after disaster of 2011 Yamamoto town -initiated *machizukuri* councils aiming at involving residents as active stakeholders in community building and in creating a dialogue between the town administration and the residents. It is interesting that *machizukuri* councils in Yamamoto were supported by researchers from Miyagi University, Japan. Another principle for reconstruction is that the main actors should be the municipalities or local government, as it is the municipalities who are closest to their communities and understand local characteristics better. [17] through their

case in Talca, Chile also propose that community-based initiative allow a place to redevelop in more sustainable and equitable ways. They also highlighted that in Talca's case, this realisation came much late - after many urban poor residents faced gentrification and relocated to remote areas where employment, public transportation, and basic services were limited. There is not much publication on Nepal's model of community-led heritage reconstruction and its comparison with global example. Therefore, a study is necessary.

However, concerns are raised for community-led heritage recovery programs. [24] has rightfully stated that growing role of well-intentioned community members who are often amateurs and emotionally driven devalues the scientific and technical aspects of conservation. In addition, [18] through their study in Dohani of Greater Lumbini raises concerns that persuading local communities to engage in heritage protection is difficult when there is initially no immediate social, spiritual or economic benefit. Community-led processes take time and need long-term commitment to develop in depth. Scholars of *machizukuri* found a deadlock in bottom-up community development approaches where [31] argues that a shift is needed from *machizukuri* to a more comprehensive regional management mechanism together with urban planning tools and administrative policies.

1.2. Introduction of Patan

Patan is also known as Lalitpur or "City of Beauty". It lies in Kathmandu valley and considered to be the oldest among three cities in the valley. It is believed to be existing since 7th century BCE during Kirat period [35]. Kathmandu Valley is inscribed in the UNESCO World Heritage List. The inscription in World Heritage List is an exceptional testimony to the architecturally explicit, traditional civilization of coexistence of Hinduism and Buddhism. Patan represents the legacy of Newar people who are renowned artisans and craftsmen who shaped the city to a distinct identity. The core area of Patan city takes a compact and dense form still prevalent. Private houses, community centres and business centres are in the core area. Core area also boasts of ancient Hindu and Buddhist temples, monasteries, shrines, *chaityas*, *Pati* or *Phalcha* (resthouses) and waterspouts. Uniformity exists in use of building materials where outstanding craftsmanship exists in brick, stone, timber and bronze [15,36].

1.3. Cultural heritage conservation principles

When dealing with reconstruction of heritage conservation - principles, practices and norms must be considered as they provide a framework for project initiation, planning, execution, monitoring and controlling. As per Nepal's Ancient Monument Preservation Act 1956, the Nara Document on Authenticity and many other international charters- heritage reconstruction recommends use of traditional materials. It further elucidates that reconstruction should have no impact on its value, authenticity, or integrity of a building and its immediate environment. Furthermore, the Nara document on authenticity stemmed from the spirit of the Venice Charter, proposes not just authenticity of material but conservation methods that could substitute the physical carrier of monuments but preserve their essence through survival of the traditional building/conservation techniques and communities that sustain them [11]. In scenarios where this is not possible, the impact should be minimal and the work should correspond to practices of heritage conservation [13,29].

1.4. Community led reconstruction in literature

Community led reconstruction in this paper refers to an approach which actively includes beneficiaries or earthquake affected communities in design, construction, and management of their heritage. Community led reconstruction would mean that financial and/or material assistance is channelled through community organizations that are actively involved in decision making and in managing reconstruction [13]. This approach closely relates to Community Driven Development (CDD) that is termed by the World Bank in which communities have direct control over

important project decisions as well as the management of finances [19]. There needs to be a structured community engagement to identify concerns, goals, and abilities, but there is a possibility that there might not be consensus on these items [13].

1.5. Heritage reconstruction through community based organization - then and now

The case of Kathmandu Valley provides an interesting insight into a non-western model of heritage governance. When discussing about community-led management, it is noteworthy to discuss about Newar *Guthi* system which is believed to have existed since Lichhavi era (400 to 750 CE) [16,32,33]. *Guthi* is a core feature of Newar socio-cultural setup. It is a community institution created within specific caste or groups within Newar society. *Guthis* can have objectives such as organizing festivals, workshops, teaching specific skills, maintaining and conserving heritage buildings [6,9,16]. It can be said that almost all temples and monasteries had some forms of a *Guthi* for its protection, preservation, and maintenance. However, this type of decentralised model of heritage management was nationalised after establishment of “*Guthi Sansthan Act*” of 1964 and further amendments in 1976. A state or market solution was envisaged through *Guthi Sansthan Act* which superseded the powers of community that would manage the heritage buildings. Many Newar *Guthis* and their functions were merged into the state-owned *Guthi Sansthan Corporation* to institutionalise modern public administration system.

For reconstruction of heritage after 2015, there is a growing practice of forming *Upabhokta Samiti* (literal translation - User's Committee or Group). It is a group of people formally registered in local bodies who directly benefit from the implementation and operation of a project. The committee or group is then legally mandated to build, operate,

manage and maintain the project. *Upabhokta Samiti* model intends to increase cost-effectiveness, ensure better quality and sustainability of the project. The main objective of *Upabhokta Samiti* is to create employment and involve the beneficiary community. A democratic and consensus-based process is followed for the formation of *Upabhokta Samiti* and maximum of 11 members can be included with mandatory 33% female participation. For applying to any government funds for a project, *Upabhokta Samiti* is expected to contribute certain cash or labour contribution for the project. The committee must have a President, Secretary and Treasurer as leading members.

Department of Archaeology (DoA) is responsible government organization for conservation, maintenance and renovation of public ancient monuments [8]. A six-year recovery period which would require an average of US\$ 34 million per year was proposed for the restoration and reconstruction of all damaged and collapsed historic buildings. To meet the associated challenges, GoN announced establishment of a public body, the National Reconstruction Authority (NRA) which has a mandate to oversee the reconstruction and distribution of aid to the affected. The heritage reconstruction processes are planned and monitored by a committee that involves the NRA, DoA and local municipalities. One of the famous temple in Lalitpur district named Rato Machhindranath temple in Bungamati is being reconstructed through the *Upabhokta Samiti* model. It is interesting that GoN initially had contracted responsibility of reconstruction this temple to a private construction company with financial assistance from the Government of Sri Lanka [23]. However, the private construction company failed to deliver the project on-time and could not fully abide by the cultural heritage conservation principles. As a plausible solution *Upabhokta Samiti* was formed by the community and they are undertaking reconstruction works. *Upabhokta Samiti* of Rato Machhindranath temple reconstruction



Fig. 1. Location map of the case studies located in Patan City.



Fig. 2. Muchhen Aganchhen before earthquake, Picture courtesy: - Dr. R. Ranjitkar.

have coordinated with skilled traditional Newar craftsmen who work with wood, clay, metal and stone. The role of skilled traditional craftsmen for heritage conservation works is immense both from a practical point of view as well as in safeguarding their skills through knowledge transfer to next generation of craftsmen.

1.6. Role of Kathmandu Valley Preservation Trust (KVPT) in this research

Four communities in Patan proactively requested KVPT (an organization working to safeguard the extraordinary and threatened architectural heritage of the Kathmandu Valley) for providing technical support for reconstructing their heritage buildings. Fig. 1 shows the location map of case studies located in Patan city. These heritage buildings together with respective communities are taken as case studies. The goal of this support was to reconstruct the damaged heritage through community-based approach and preserve the Newar architecture and cultural heritage. Finances for construction had to be managed by communities themselves. KVPT had no decision-making power and the projects are entirely community led. Researcher worked as Conservation Architect and part of technical team inside KVPT that supported the communities.

1.7. Case studies

1.7.1. Muchhen Aganchhen, Ward no. 12, Patan

Muchhen Aganchhen (See Figs. 2–6) is located at the north of Bahadur Shah building at Patan Darbar Square. It is a 3 storey rectangular shaped building. This was built during Malla-era in early 15th century. Muchhen Aganchhen resembles vernacular Newar house from outside, but with difference in purpose. A typical Newar residential house, locally termed as *Chhen* is rectangular in plan, divided into three floors plus an attic. The walls are pierced by timber door and windows and house has pitched jhingati tiled roof. Aganchhen is different because it is dedicated to tantric practices as “house of god”. It is located inside a courtyard. Muchhen Aganchhen does not have a circumambulatory path like a temple or stupa. The façade has an ornately carved window called *Pasuka Jhya* with 5 bays placed at first floor and second floor level. The building is used for



Fig. 3. Muchhen Aganchhen after 2015 earthquake Picture courtesy:- Mr. A. Joshi.

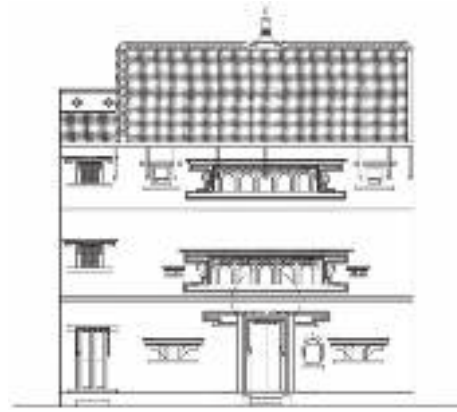


Fig. 4. Front facade of Muchhen Aganchhen (Proposed), KVPT 2017.



Fig. 5. Ongoing reconstruction of Muchhen Aganchhen, Feb 2021.

purposes such as storage of chariot of goddess *Manamaneswari*, worship, community hall for meeting and feast. Building materials used for its construction includes brick and mud mortar, wooden windows, and doors, jhingati roof tiles and telia floor tiles. According to the community members, the previous purpose of this building was storage of Swords of Malla kings' after their deaths. The building was heavily damaged in the 2015 earthquake. Only the front wall of the ground floor remained. The main deity has been relocated to a neighbouring house.

1.7.2. Bhagavati Phalcha – Kobahal, Ward no. 9, Patan

The building under-construction resembles a *Sattal* (See Figs. 7– 11), with an open ground floor plan and wooden pillars supporting the upper

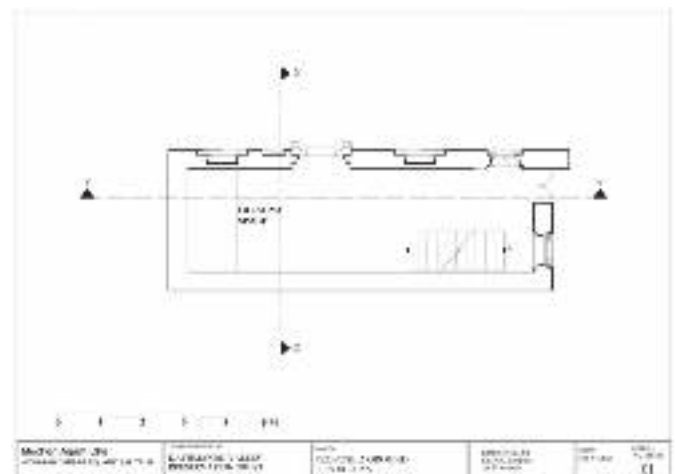


Fig. 6. Master plan of Muchhen Aganchhen (Proposed), KVPT 2017.



Fig. 7. Bhagavati Phalcha – Kobahal with modern RCC building, Year:- 2017.

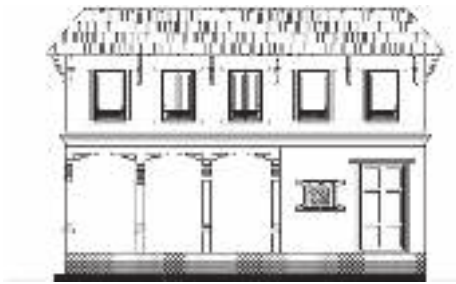


Fig. 8. Initial design prepared by an engineer, Year: 2017.

floor. In ancient times, such buildings were originally built as rest house for longer sojourns of Sadhus, Gurus and other pilgrims. It was reported verbally by locals that a five-bayed half-roofed traditional *phalcha* was standing in the place. Due to lack of evidence, an exact replacement or re-building was not possible. Hence based on contemporary exigencies or evolving local needs of the community new architectural design based on conjecture was proposed which would respect the overall spatial and volumetric composition of the place. The new design proposes a two-storey rest house together with a hall for community meetings. The ground floor has *Phalcha* or rest house together with a shop which can be rented to generate income for building maintenance. A community meeting area is planned on the first floor. On the day of Indraajatra, the community from Kobahal perform special worship of goddess *Bhagawati*. The responsibility for organizing Krishna worship on the day of *Krishnastami* and *Matya* procession (an annual procession conducted in Patan) passes down in turn through different *tole* of Patan. During design process, lesson was learnt that a certain level of flexibility must be adopted while working with communities. It takes time for community to decide on functional and spatial use and there can be several modifications before reaching a consensus. KVPT's initial proposal presented had an open plan for ground floor, later on there was a request by community to create a room for youth club in ground floor. But eventually during construction, community decided for an open plan. These requests from community for design changes were acknowledged by architects.

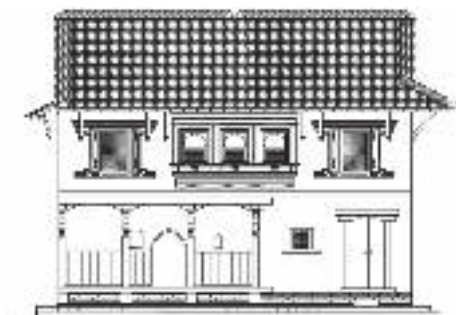


Fig. 9. Design refined by KVPT in consultation with community. Year:- 2018.



Fig. 10. Fund-raising feast (Newar *Bhoje*) organised by User committee, Date:- Nov 2018.

1.7.3. Om Bahal Seto Ganesh Chapa Chhen (*Guthighar*), Ward no. 9, Patan

This is community building constructed primarily for gatherings *Guthi* members of Om Bahal Seto Ganesh *Guthi* (See Figs. 12-15). The photographic documentation of the building before 2015 clearly shows a 5-bay *Phalcha* (rest house) attached as portico to a 2 storey Newar style brick building. This building has no direct connection with any deity but an image of Shiva is found on one of its wooden pillar visible from its front



Fig. 11. Construction completion of new Bhagavati Phalcha, Date: Feb 2021.



Fig. 12. Historical picture of Om Bahal Seto Ganesh *Guthi* ghar, Year:- 2005.



Fig. 13. Om Bahal Seto Ganesh *Guthi* ghar after 2015 earthquake.



Fig. 14. Community members leading reconstruction of Om Bahal Seto Ganesh Guthi ghar, Year:- May 2019.



Fig. 15. On-going construction of Om Bahal Seto Ganesh Guthi ghar, Year:- Feb 2021.

façade. Before rebuilding, it was used to store salvaged wood and bricks. On the first floor, a large slanted wooden window is placed also known as *Biman Jhya*. The ground floor which is enclosed by traditional bricks is still used when a sacred fire is made on *Yahmarhipunhi* festival. The *Phalcha* is used by community members of Om Bahal as a place to socialize and gatherings. 2015 earthquake caused a heavy damage to this building. Demolition and reconstruction were the only option. Reconstruction is ongoing using traditional materials, technology and salvage materials which could be reused in construction. The principles of conservation which are preservation of original appearance, size, type and composition of the structure are followed as far as possible.

1.7.4. Mu Bahal monastery, Kwapadyo shrine, Ward no. 20, Patan

Mu Bahal is one of the branch of Hiranyavarṇa Mahabiihar or commonly known as Golden Temple. It is located near the Ashok stupa at PimBahal tole. Bahals are monasteries for practising Vajrayana Buddhism which is a form of tantric Buddhism mostly practiced in Kathmandu valley. The Kwapadyo shrine is the central shrine inside a quadrangle shaped courtyard. The shrine is placed right opposite of entrance gate to the courtyard. It is three-storied shrine building facing east. The front façade of the building is plastered with traditional plaster and white-washed with lime.



Fig. 16. Front facade of Mu Bahal monastery, Kwapa dyo shrine, Year:- 2019.

The ground floor has central carved door, small lattice window called *tikijhya*. The first floor has a three bayed ornate window called *Pasukajhya* and latticed window on other side. The second floor has a large three-bayed window typical of a Newar house. The building is made with brick and mud mortar, wooden windows, and doors, jhingati roof tiles and telia tiles. The building was heavily damaged due to 2015 earthquake. The southern end wall is in critical condition. Fig 16

2. Methodology

The research was carried out following the “Case study method”. [37] has stated that a case study is an empirical study which examines a contemporary phenomenon within its real-life context, notably when the boundaries between phenomenon and context are not obvious. Understanding the local context is necessary and has helped in contextual analysis of events, conditions, and their relations. Previous studies in the field of urban and disaster research in Nepal have applied qualitative methods to understand context and analysis of events [4,20,31]. Subba [34] asserts to understand the contextual, reality and dynamic interplay between human actions and human needs, a qualitative method is required.

Researcher is also an Architect and had direct interactions with the affected community members during the support program to the community from 2017 to 2020. Procedures adopted while supporting the community includes: -

1. Identification of damage
2. Assessment for rescuing and reusing of salvage materials
3. Identification of community needs and scope of assistance
4. Site survey, field observation and documentation of existing condition
5. Historical documents research, data collection on tangible and intangible values of building
6. Develop a conservation / reconstruction plan with various options
7. Discuss various pros and cons of reconstruction plans with community leaders
8. Agree on an option of the future use or adaptive reuse plan of the building
9. Prepare architectural drawings, detailing and cost estimate based on the agreed option
10. Handover technical documents to community for further funding application
11. Construction monitoring / quality control as per request from community

Salvage materials were used as much as possible during the reconstruction. A philosophy of “Minimal intervention” was adopted involving repairs and localized reconstruction using the original materials and methods to avoid unnecessary cost. [29].

Documentation related to GoN's reconstruction plans, NRA framework, guidelines from DoA, historical documents about the heritage buildings, and agreements between Community Based Organization and government bodies financing the reconstruction were studied. Semi-structured questionnaire was prepared for interviewing the community members in the four case study sites. Formal semi-structured and informal interview technique were chosen for interviews with community members. Formal semi-structured interview technique were chosen for key informants including conservation architect and engineer supporting the communities, municipal- and ward-level civil servants and officials from NRA. Appointments were taken for formal interview and a set of questions relating to the issues in reconstruction were put forth to the interviewee. Informal interviews were carried out without a structured question and in a casual setting during field-visits and consultation meetings. Semi-structured interviews were conducted to acquire qualitative data about perceptions, meanings and definitions. It also opened new leads to current research [5,28]. Data was gathered at the time of community visits, technical consultation meeting and site visits.

Upabhokta Samiti members comprising of President, Secretary and Treasurer of Kobahal, Om Bahal and Muchhen ($n = 9$) were interviewed before

the start of construction and during the actual construction works. One formal interview and one informal interview were conducted with them before the start of construction to understand the challenges while initiating and planning for the project. During actual construction phase, two residents were added for the interview ($n = 15$). After the start of physical reconstruction, two informal interviews and one formal interview were conducted to understand the challenges while executing the project. Researcher also interviewed conservation architect and engineer from KVPT supporting the community in field level execution.

The process of understanding issues has four major steps: identifying the challenges; working out the major factors involved; identifying possible causes and analysing the cause and effect. During the case study and construction monitoring field visits, community drivers and challenges of reconstruction were documented. A comparative chart was used to document the distribution of the multiple issues (causes) and sub-issues which produce them. The sub-causes were grouped in five main-issues: financial aspects; awareness on traditional methods of construction & construction management; technical and skilled human resource constraints; social process; bureaucracy and administrative requirements.

3. Results

The Table 1: *Comparative analysis of four case studies – Challenges in community led heritage reconstruction* shows the results of the analysis highlighting five main issues faced by community in Patan during community-led heritage reconstruction. Under one main issue several other sub-issues are illustrated and the explanation of each sub-issue in relation to the case study is illustrated. This shows issues and success stories in each case study. Three of the communities formed *Upabhokta Samiti* whereas one community has not formed *Upabhokta Samiti*.

Table 2 *Comparison of reconstruction cost of different buildings* shows that a traditional heritage building can cost approximately twice as much as a modern minimalist reinforced concrete building in Kathmandu valley (assuming that there are no salvage materials available and all building elements are new). This is a constraint or a project feature that must be addressed while formulating any reconstruction plans.

Table 3 *Comparison of per day cost of wages (NRs.)* shows that GoN has a fixed rate for materials and labor services which is also called District rate created under Public Procurement Act 2064, clause 148. However, User Committee objected on the rate of certain items that it does not match with prevailing market rate due to rising cost of building materials and higher remuneration rate of skilled craftsman. The incongruence in rates causes adverse effect on quality of works.

4. Discussion

The examined case studies reveals that the local community can be activator and leader of the heritage reconstruction projects in Patan. [1] through examples of African American context explained that heritage has been considered as a medium for people to communicate the stories of their past in the present. The same notion is experienced in reconstruction of heritage buildings in Patan because they are its identity and related to social, economic, and cultural aspects of city.

Upabhokta Samiti model which is Community-led reconstruction model of Nepal is found to ensure local participation, inclusive decision-making and a sense of ownership for heritage reconstruction projects in Patan. Reconstruction of buildings studied in this research would not have started if the community had not taken the lead. This reaffirms with [7] case study of Irpinia town, Italy which concludes that community-led practices reinforce communities “awareness of place”. *Upabhokta Samiti* model is also in concurrence with the spirit of Sendai Framework 2015 and Burra charter of 1979. This model for heritage reconstruction has resulted in greater community participation, social cohesion and in long run - resilience and productive community which would also be prepared for further development projects. Moreover, examples such as handing over the responsibility

of reconstruction of Rato Machhindranath temple in Bungamati from a private contractor to *Upabhokta Samiti* shows that GoN acknowledges potential of *Upabhokta Samiti* model.

KVPT's engagement has bridged challenges faced by *Upabhokta Samiti* such as - lack of trained engineers and architects in heritage conservation; quality control process in construction; and technical support. These challenges were reported as significant deterrent while initiating and executing their project. This practice of combining technical support with *Upabhokta Samiti* has increased awareness level of community and their confidence in carrying out heritage reconstruction projects. KVPT's intention for the community building is not only restoring them but is also to “adapt them to present-day expectations and community needs” on basis of creative and scientific activity. It also raises a need that professionals or institutions must make themselves aware of heritage norms and devise extra training programs which produces field-ready human resources.

Nepal's *Upabhokta Samiti* model has certain similarities with *Machizukuru* approach of Japan and *Rekompak* approach from Indonesia. But the political strength and the wide-spread application that the later two approaches carried is not the same for Nepal's *Upabhokta Samiti*. It can be perhaps due to the challenges and limitation within the *Upabhokta Samiti* model for its large-scale implementation. *Upabhokta Samiti* model differs from *Machizukuru* concept of Japan and *Rekompak* concept from Indonesia in few ways. First there is an absence of the integrated neighbourhood scale planning or Community Settlement Plan (CSP) like in *Rekompak* approach. A *Upabhokta Samiti* is working for reconstruction of only a single building or building complex rather than in neighbourhood scale. Second, *Upabhokta Samiti* has reduced scope in terms of funds they can mobilise and geographic coverage. Third, there is absence of dedicated “facilitators” who provide organizational, managerial, economic and technical assistance to *Upabhokta Samiti*. This can be a potential area where INGOs / NGOs can engage. Fourth, it was observed that there is a lack of engagement of academia or universities with *Upabhokta Samiti*. It is interesting that *Machizukuri* councils in Yamamoto were supported by researchers from Japanese University.

One of the lessons learnt from *Machizukuru* concept is that a major stakeholder should be the municipalities, as it is the municipalities who are closest to their communities and understand local characteristics best. This phenomenon links with idea proposed by [24] which advocates for wider collaboration involving technicians, academia, local government and upper-tier government bodies. One positive aspect noticed was that a large-scale gentrification has been prevented in heritage areas of Patan. One factor can also be the sense of ownership of the place by the community. The community-based initiatives have also allowed reaffirming the community's ownership in an equitable way. However, in Talca, Chile this realisation came much late - after many urban poor residents faced gentrification and relocated to remote areas with limited basic services were limited.

While Nepal's *Upabhokta Samiti* model is promising, the challenges found during the research inhibit scaling it up and producing quality results. Capacity and knowledge of a community was, by the present study, identified as an important factor to determine success. Several dimensions of knowledge and capacity have been identified as desirable which are- skills, knowledge of norms, leadership, communication, conflict management and a culture of cooperation and learning. Lewer et al. [18] findings from Dohani, Lumbini that community-led processes take time and need long-term commitment to develop in depth is also strengthened by the current study. Other challenges include lack of adequate funding allocation and deadlines for completion of specific milestone of the construction project which does not match with community's work schedule. It was found that *Guthi* members of Kobahal and Om Bahal are active and contributed in formation of *Upabhokta Samiti*. So it was a symbiotic relationship. This kind of symbiotic approach can be an inspiration for other heritage area awaiting reconstruction.

Table 1
Comparative analysis of four case studies – Challenges in community led heritage reconstruction.

Case study name		Muchhen Agan Chhen – central shrine	Bhagavati Phalcha – Kobahal	Om BahalSeto Ganesh Chapa Chhen	Mu Bahal -central shrine / KwapaDyo Chhen
Issue	Sub-issue				
Financial aspect	Lack of funds for reconstruction	-Primary challenge, – received partial funds from Lalitpur Metropolitan City (LMC) -had applied to NRA but were unsuccessful in receiving funding	-Primary challenge, -had organised a fund-raising feast, – received partial funds from Lalitpur Metropolitan City	-Primary challenge, -received partial funds from Sansad Bikash Kosh (Province no. 3 government) & other from Lalitpur Metropolitan City	-Primary challenge, no funding source identified
	High cost of materials & labour compared to modern concrete buildings	-Traditional material costlier than modern concrete building, -want to retain authenticity in design and construction, -KVPT recommended to complete the construction within one-year for smooth flow of project management aspect however if it's not possible suggested incremental approach	- Traditional material costlier than modern concrete building, -want to retain authenticity in design and construction, decided for incremental approach due to tranche-based funding method of Lalitpur Metropolitan City	- Traditional material costlier than modern concrete building, -want to retain authenticity in design and construction, decided for incremental approach due to tranche-based funding of Lalitpur Metropolitan City	- Yet to tackle the issue of lack of funding, -want to retain authenticity in design and construction,
	Market rate of labour / materials does not match with district rates	<i>upabhokta Samiti</i> carrying out demolition works	<i>upabhokta Samiti</i> reported district rates does not match with market rate	<i>upabhokta Samiti</i> reported district rates does not match with market rate	Have not started reconstruction
	Unavailability of construction materials on time	Gathering information construction materials	Faced delays due to unavailability of good quality timber, bricks	Faced delays due to unavailability of good quality timber, bricks	Have not started reconstruction
Awareness on traditional methods of construction & construction management	Balance between “build back better” & heritage conservation norms	-Unclear on what a resilient heritage building means, -unclear about national and international norms on heritage preservation, -wants reduction of seismic risk	-Unclear on what a resilient heritage building means, -wants combination of traditional construction materials with modern steel reinforcement and concrete, -prioritizes reduction of seismic risk	-Unclear on what a resilient heritage building -intends to follow traditional construction materials and technology -prioritizes reduction of seismic risk	-Wants a resilient heritage building,
	Conceptual unclarity about heritage conservation (New element = not history, Old element = real history)	-Community members have confusion on traditional architectural design, proportions -building materials that should be used, and materials that should not be used. -requested KVPT's support for clearing the concepts on heritage conservation	-Community members had confusion on traditional architectural design, proportions, building materials that should be used, and materials that should not be used. -community reported that after KVPT's support their level of awareness on heritage conservation increased	-Community members had confusion on traditional architectural design, proportions -building materials that should be used, and materials that should not be used -community reported that after KVPT's support their level of awareness on heritage conservation improved	-Community members have confusion on traditional architectural design, proportions, building materials
	Construction management	Reconstruction has commenced and KVPT supporting construction management	Faced difficulty with: - -calculations of expenses -construction scheduling -site monitoring -material inventory management	Faced difficulty with: - -calculations of expenses -construction scheduling -site monitoring -material inventory management	Yet to start reconstruction
	Lack of skilled craftsmen	- Requested support from KVPT to source skilled artisans and craftsmen	-Reported delay due to facing shortage of skilled artisans and craftsmen	-Reported delay due to facing shortage of skilled artisans and craftsmen	Yet to start reconstruction
Technical and skilled human resource constraints	Lack of training to engineers and architects	-Reported technical personnel working in heritage conservation require training on Newar architecture and construction methods	-Community members were not satisfied with an initial design proposed by an engineer trained in modern concrete construction. -reported necessity of training to technicians to construct Newar buildings, cost estimation	-Faced lack of engineers and architects who can design, provide cost estimate and construct Newar buildings with the features and quality set by national and international norms.	-Faced lack of engineers and architects who can design, provide cost estimate and construct Newar buildings with the features and quality set by national and international norms.
	Technical support	- <i>Upabhokta Samiti</i> approached KVPT for technical support directly. KVPT provided technical documentation, planning and design support	- <i>Upabhokta Samiti</i> approached KVPT for architecture drawings and cost estimation support	- <i>Upabhokta Samiti</i> approached KVPT for most of technical support and documentation.	Locals approached KVPT for technical and fund-raising support
	Lack of quality control process during reconstruction	For quality control in construction, <i>Upabhokta Samiti</i> requested KVPT for construction monitoring.	-Executed project on basis of their own resources and experience. -found lack of checklist for quality control of resilient heritage building	-Found lack of checklist for quality control of resilient heritage building -requested occasional construction monitoring support from KVPT	Yet to decide
	Consensus building takes long time	Formed <i>Upabhokta Samiti</i> with members from Patan Durbar Square	- <i>Guthi</i> members are active and helped in formation of	- <i>Guthi</i> members are active and helped in formation of	<i>Guthi</i> members are active but have not formed <i>Upabhokta Samiti</i> .

Table 1 (continued)

Case study name		Muchhen Agan Chhen – central shrine	Bhagavati Phalcha – Kobahal	Om BahalSeto Ganesh Chapa Chhen	Mu Bahal -central shrine / KwapaDyo
Issue	Sub-issue				
		area and relevant stakeholders, <i>Upabhokta Samiti</i> reported that managing community's perceptions and coming to an agreement is time-consuming convincing	<i>Upabhokta Samiti</i> -reported that managing community's perceptions and coming to an agreement is time-consuming -are unclear on the logic for not using cheaper and modern construction material like reinforced cement concrete	<i>Upabhokta Samiti</i> , -reported that managing community's perceptions and coming to an agreement is time-consuming -were unclear on the logic for not using cheaper and modern construction material like reinforced cement concrete	Community members reported that they still have to reach on consensus of how to start reconstruction or who should lead
	Lack of appreciation for voluntary effort by government & other community members	- <i>Upabhokta Samiti</i> expressed grievances over the lack of appreciation they get from other community members and local government.	- <i>Upabhokta Samiti</i> expressed grievances over the lack of appreciation they get from other community members and local government. -craftsmen felt that their skills are less valued by the society.	- <i>Upabhokta Samiti</i> expressed grievances over the lack of appreciation they get from other community members and local government. -craftsmen felt that their skills are less valued by the society.	community members anticipated that if they get engaged in reconstruction their voluntary efforts might not get appreciated
Bureaucracy and administrative requirements	Long government process / bureaucracy	Faced difficulty in:- -paperwork for formation of <i>Upabhokta Samiti</i> -understanding of project agreement papers -documents to present in government office for fund release -lack of understanding of bureaucratic procedures	Faced difficulty in:- -paperwork for formation of <i>Upabhokta Samiti</i> -understanding of project agreement papers -documents to present for fund release for fund release and settlement of grant amount -lack of understanding of bureaucratic procedures	-Paperwork for formation of <i>Upabhokta Samiti</i> -construction cost calculations using traditional building materials -lack of understanding of bureaucratic procedures	Community informed about a lack of knowledge on funding application or bureaucratic procedures
	Lack of knowledge about project documentation needs during various stages	-Preparing project proposals -taking building measurement -photographic documentation of building	-Preparing project proposals -taking building measurement -photographic documentation which would show regular progress -lack of knowledge on progress reporting	-Preparing project proposals -taking building measurement -photographic documentation which would show regular progress -lack of knowledge on progress reporting	-Taking building measurement -preparing project proposals -photographic documentation
	Knowledge on book keeping / accounting practice	-Recently started reconstruction. - have approached KVPT for training on book-keeping / accounting	Faced difficulty in:- -maintaining ledger book (expenses tracking) -payroll accounting -tax deduction calculation	Faced difficulty in:- -Knowledge on ledger book (expenses tracking) -payroll accounting -tax deduction calculation	Yet to started reconstruction
	Financial deadlines doesn't match with community's work schedule	LMC could not allocate all the requested funds in one work package and a tranche-based model is used as in a multi-year project with specific deadline for a milestone. However a milestone's completion deadline doesn't match with community's work schedule	-Government financial deadline July 1st week was not met. - <i>Upabhokta Samiti</i> had to return remaining amount without completion of work package	-Government financial deadline July 1st week was not met. - <i>Upabhokta Samiti</i> had to return remaining amount without completion of work package	Yet to started reconstruction

Lalitpur Metropolitan City (LMC) is local body that governs the city of Patan city and surrounding urban areas.

Table 2

Comparison of reconstruction cost of different buildings.

S.N.	Particular	Muchhen AganChhen – central shrine	Bhagavati Phalcha – Kobahal	Om Bahal Seto Ganesh Chapa Chhen	Mu Bahal - central shrine / KwapaDyo
A	Cost of Newar heritage building as per detailed estimate (Rs.)	7,497,475.13	6,594,881.28	7,388,623.81	14,094,425.24
B	Total floor area (sq. ft)	955.32	761.02	906.61	1618.85
C	Per sq. ft. cost based on detailed estimate (Rs.)	7848.13	8665.84	8149.73	8706.44
D	Cost Per sq. ft. @ Rs. 4500 of same sized modern RCC building (Rs.)	4,298,940.00	3,424,590.00	4,079,745.00	7,284,825.00
E	Cost Difference in constructing a heritage building vs modern RCC building (A-D)	3,198,535.13	3,170,291.28	3,308,878.81	6,809,600.24
F	Ratio (A divided by D)	1.74	1.93	1.81	1.93

Table 3
Comparison of per day cost of wages (NRs.)

S.N	Description	Unskilled labour	Skilled labour and craftsman	Jhingati roof tile layer
A	Government rate (as per DoA material rate 2075–76)	700	1300	1450
B	Market rate (2075–76)	900	2000	3500
C	variation (A-B)	– 200	– 700	– 2050

5. Conclusions and recommendation

Community-led reconstruction is an important approach in post-disaster heritage reconstruction in Kathmandu valley. It is necessary to support such initiative and understand the issues faced by communities. Adequate tools, techniques and policies must be developed for smooth implementation of community projects.

This research leads to several preliminary recommendations that could help in the continued heritage building reconstruction in Kathmandu where community have a strong connection with the heritage building:-

1. Government as well as donor agencies must step in to support such bottom-up initiatives. However, “one size fits all” approach is not suitable as communities in heritage zone have varied capacity and needs. Only a handful of INGOs / NGOs are working in this sector to support communities to rebuild their heritage buildings. They can step in to support communities.
2. Most of the heritage buildings exist within urban areas where municipal and local governments are active. The capacity of government technicians, engineers and architects must be proportionally increased.
3. Bureaucracy and administrative requirements must be communicated properly to the community with clear flows of information to avoid hurdles in later phase of the project. If capacity does not exist within communities, donors can step in to support the community. There are already international and national personnel who have experience to carryout field assessments, administer funding and process paperwork.
4. Municipalities can be authorized for reconciling the district rates especially for heritage reconstruction works which demands higher quality of material and craftsmanship as they are closest to their communities and understand local context.
5. It is important to balance ‘building back better’ with heritage conservation norms. Communities must understand that heritage buildings have different set of values than a modern concrete building. And reconstruction projects must endorse these values. As much as possible traditional materials and technology should be used. If it cannot reduce seismic risk from a technical perspective, then only non-traditional construction materials should be used.
6. Public awareness regarding heritage conservation norms and values of heritage buildings is essential.
7. Skilled technical personnel must be consulted while preparing reconstruction proposals so that User groups of the reconstruction work become fully aware of what should be done during field implementation and vice versa. GoN can create a roster of experts who have specific skills in heritage conservation and share the roster with community for consulting services or advices.
8. As far as possible municipalities should allocate the requested funds for heritage conservation in one work package which would facilitate in smooth construction management. In a tranche-based funding model one fiscal year duration might be inadequate for heritage conservation works led by community. In such case reconstruction projects should be multi-year projects or encouraged to be incremental type. Milestone deadlines should be set considering community's working schedule.
9. Community members and craftsmen working in heritage reconstruction must be appreciated for their effort. Community members

provide time and effort in voluntary or pro-bono basis. Society must also appreciate and respect craftsmen who continue to protect and promote our heritage. Job security and financial sustainability for them can be few options as appreciation.

5.1. Knowledge and capacity of user groups which influences success of community-led heritage reconstruction

While engaging with communities, following key points ensures effective community-led heritage reconstruction: -

- A well-structured initial project proposal where justification is well thought.
- Clarity in monuments current use, future use and adaptive reuse plans
- Clarity in local contribution in the form of funds or labor
- Technical resource person in the steering committee or user committee, or technical partner with a person skilled in heritage conservation
- Community having knowledge about bureaucracy and government requirements
- Harmony between stakeholders so that consensus can be reached sooner
- Communication and coordination skills of user committee
- Conflict management skills of user committee
- An institutional setup that would manage the heritage after its built. Beneficiary community should be able to devise a resource management strategy.
- Effective leaders within community

Identification and correction of weaknesses is necessary to fully benefit from community-led reconstruction approach. This study was conducted only in Patan and highlighted few User Committee. A study of other cases inside Kathmandu valley and comparing them can give new ideas on how issues can be resolved in a practical manner and ideas on upscaling the *Upabhokta Samiti* model further where communities are still waiting for their heritage reconstruction.

Declaration of Competing Interest

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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Regular Article

An analysis of use and effectiveness of communication channels, media and tools in post-earthquake private housing reconstruction in Nepal

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 Owner driven reconstruction

ABSTRACT

In the wake of any disaster, communication plays a significant role in attaining the objective of Build Back Better; to provide accurate and timely information to the affected communities, enhance awareness and extend outreach of authorities. Although communication channels, media and tools pave the way to eliminate information gaps at different levels of the process, not all of them work effectively. This paper explores the channels, media and tools used for communication during the reconstruction of private houses after the 2015 Gorkha earthquake in Nepal, their effectiveness in providing quality information to the beneficiaries and its correlation with reconstruction outcome of construction time period. With aid of both qualitative and quantitative methodological approaches, three target groups (beneficiary, implementation and policy levels) were surveyed. Convenience sampling method was used to collect the data of beneficiary level survey where structured telephone interview was conducted among 274 earthquake reconstruction program beneficiaries of four earthquake affected districts; Kathmandu, Dhading, Nuwakot and Dolakha. Purposive sampling method was used to collect data from implementation and policy level respondents using web based survey. Results revealed that communication channels varied differently among different target groups, based on their role in reconstruction, level of education and accessibility. Where beneficiaries perceived to have received information regarding reconstruction on time and clearly, the time taken to complete construction had significantly decreased. Thus, to increase communication and outreach, understanding the diversity of target groups at different levels and usage of multiple media tools and channels is important. Comprehensive communication strategies and programs with ample resources, especially at the local and community levels for local mass media and person-to-person information sharing is crucial to disseminate information to end-users on time. This, followed by adequate monitoring for quality assurance and credibility aids the post-disaster reconstruction of private households in an owner driven reconstruction approach.

1. Background

The twenty-first century is widely referred to as the age of communication. With the advent of new technologies and digital communication channels, advancement and transformation of traditional media, the dependency of people on mass media for information has been significantly increased [1]. Although there are divergent views among the communication experts regarding the influence of media in the society and complexity to measure it, nonetheless role of mass media in disseminating information, educating people and triggering behavioral change cannot be ruled out. Communication technology has been recognized as integral to disaster management for a long time [1].

In disaster risk management too, role of mass media has been widely appreciated. Especially during and immediately after a disaster, various communication medium such as radio, television, phone communication, print

and even social media are primary sources of information and messages for victims and general people. The well-established fact is that mass media has tremendously contributed during various past disaster events especially in the disaster response related activities [1]. However, its role is not limited to this.

The role of effective communication is paramount in all cycles of disaster management, preparedness, response, relief and recovery [8]). It helps communicate important messages or information about preparedness, impact of disaster, rescue and relief efforts, vital reconstruction messages and more. Reconstruction of destroyed and damaged infrastructures is one of the key phases of disaster management cycle [6]. Post-disaster reconstruction consist of rebuilding flattened houses, as well as increasing local capacity and knowledge on disaster risk reduction measures [6]. Earlier studies have identified 'information sharing' as a major component that fuels a post-disaster recovery program [4]. Communication, especially,

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supports a disaster recovery process not just as a tool for sharing information on policy, but also to increase public discourse, support the roles of authorities and advocates for risk reduction [5].

The task of rebuilding homes and communities is complex, challenging and apprehensive with potential pitfalls. In post-disaster situations the status quo shifts constantly, a challenge that makes strategic communication a crucial element in the response and reconstruction environment. Effective communication in a reconstruction is not about what governments and projects “say” but what beneficiaries “hear” [7]. An effective communication means target group gets the information and messages as per expectation which was conveyed to them and it was able to change their mindset, attitudes, behavior and views on particular issue [8]. For effective or strategic communication, it is needed to identify the four W's, namely; **who** is the audience, **what** is the message, **how** to disseminate, and **what** is the medium [8].

While past studies highlight the importance of communication and mass media in disaster management and post-disaster recovery, the array of channels, tools and media available have not been discussed in depth. Apart from mass media, various other channels such as person-to-person communication, awareness and training activities, demonstration construction are also available, and perhaps more prominent. In the post 2015 Gorkha earthquake housing reconstruction in Nepal, especially, a large amount of investment was done by the government as well as partner organizations in providing technical assistance and counselling through field engineers and social mobilizers deployed in the earthquake affected communities. Similarly, local governments also played significant role in information sharing. Thus, a study on new avenues of communication and their impacts on post-disaster recovery, especially in an owner driven reconstruction approach for private houses must be undertaken.

2. Introduction

The 2015 Gorkha earthquake was the largest disaster recorded in Nepal in terms of losses; over 9000 lives were lost and USD 7bn in economic losses was incurred [2]. To repair and reconstruct more than 825,000 houses damaged by the Gorkha Earthquake, the Government of Nepal led a process of reconstruction through the National Reconstruction Authority (NRA) with the mandate to plan and implement reconstruction activities (National Reconstruction [3]). To achieve the objectives of disaster resilient and sustainable reconstruction as highlighted in the recovery framework, the National Reconstruction Authority along with several development partners utilized different channels, tools, media to disseminate information to the beneficiaries and other stakeholders of the reconstruction program.

Organizationally three tiers can be visualized in communication during the reconstruction process. The National Reconstruction Authority as the governing body for reconstruction, its Project Implementation Units (PIUs) and national level partner organizations can be depicted as the first tier and the main source of information. These organizations, depicted as policy level actors in this study generate information and provide resource for various channels to disseminate them. The second tier in the process were implementation actors; field engineers and officials deployed by NRA and partner organizations and local government representatives, who directly engaged with and disseminated information to the beneficiaries on a community or household level. Inevitably, the earthquake reconstruction program beneficiaries were the end-users and the third tier of the communication process. Communication between these different tiers were facilitated by a wide array of channels; ranging from mass media such as television, radio and newspapers, digital and social media, print media such as IEC materials and notices to person-to-person communication via training, orientations and door-to-door campaigns.

This paper studies the effectiveness of communication channels, media and tools used by the policy and implementation actors in disseminating information regarding reconstruction by examining the perception of different target groups. The study also examines the correlation between beneficiary perception on quality of information received and their

reconstruction outcome in terms of time taken for completion of construction. With these information, the paper derives crucial recommendations for developing and implementing effective communication efforts in future post-disaster recovery of private houses through an owner driven approach.

3. Research questions

The purpose of the study is to analyze how communication initiatives and use of different channels and media impacted the quality of information and reconstruction of houses of earthquake affected beneficiaries. As such the study encompasses four major questions:

1. What channels, media and tools of communication were mostly used during reconstruction?
2. What is the perception of different beneficiary groups towards the information received through different channels? What challenges were faced to provide adequate information on time?
3. What is the relationship between quality of information received by beneficiaries and their reconstruction outcome of construction time period?
4. What can be done to develop better communication strategies in future post-disaster recovery process?

4. Methodology and procedure

In order to attain the objectives of the study, both quantitative and qualitative research was conducted. The survey was administered at three target groups; **(1) Beneficiary Level Survey** targeted towards earthquake reconstruction beneficiaries who had or had not completed construction, **(2) Implementation Level Survey**, targeted towards major actors at national, district and local levels provided with authority and responsibility to disseminate information to beneficiaries and **(3) Policy Level Survey**, targeted to national level decision makers who were involved in designing and implementing different communication policies and tools. Primary data were collected either through telephone interview or internet survey during 5–15 August 2020 using Kobo Toolbox application. The collected data was downloaded, refined and analyzed using SPSS and excel software tools.

For the first target group, structured telephone interview was done among 274 house-owners of four most affected districts namely; Kathmandu, Dhading, Nuwakot and Dolakha. The convenience sampling method was used. The respondents were selected from the database of reconstruction beneficiaries collected through district authorities and partner organizations working in the area. The respondents were notified about the purpose of survey beforehand. For the second group, purposive sampling method was used. Respondents were identified from three categories, a) government officials (NRA district level officials and field engineers), b) partner organizations (I/NGO officials and field staff) working in reconstruction and c) local government representatives (elected and government officials at local levels). These respondents had direct involvement in implementation level of reconstruction i.e. providing information to earthquake beneficiaries. For the purpose of uniformity, 30 respondents from each category were identified and selected. Since the target group had access to internet, web based survey was done. Among the 90 selected respondents who had been contacted for the survey, 70 respondents filled up the survey forms.

Similarly, for policy level survey, reconstruction actors (NRA officials, partner organizations, and national level media) were purposively selected based on their direct involvement in reconstruction process, especially in the promulgation and dissemination of communication and information policies and materials. 20 professionals in this target group were selected for the survey where six of them responded. Different set of questions for three levels of respondents with multiple choice questionnaire were developed for the structured interview and internet survey.

Some typical questions asked to beneficiary level respondents are as follows:

- Have you completed construction of your earthquake damaged house? If yes, how much time did it take? If not, why haven't you constructed yet?
- What mass media platforms did you use for getting information on reconstruction? Apart from mass media, what other source of information did you have?
- To what extent do you agree that you received information regarding reconstruction on time? To what extent do you agree that you have received and understood all information regarding reconstruction? If you disagree, what information was mostly not very clearly received?
- If you had a technical challenge during construction, whom did you generally ask and receive required information? From where did you generally receive information regarding (change in) reconstruction policies and programs?
- Where did you place your queries, questions and issues of reconstruction? What mode of communication do you think is more suitable to share information regarding reconstruction in your community?

Additionally, some typical questions asked to the implementation level and policy level were as follows:

- To what extent do you agree that you have received relevant information on reconstruction from central/district level on time and clearly?
- To what extent do you agree that information regarding reconstruction policies and decisions has reached the affected beneficiaries in time? In your opinion, what were the major challenges in disseminating quality and credible information to beneficiaries in time?
- In your opinion, what strategy should be changed in future disaster reconstruction programs to make communication more effective?

5. Results and discussions

5.1. Distribution of respondents

In the beneficiary level respondents, altogether 274 house-owners responded the telephone survey. The distribution of the respondents according to district, construction status and level of education is presented in Table 1. Among them, 255 reconstruction beneficiaries had already completed the construction while 3 beneficiaries had not started. Among the respondents, majority (82%) were literate with varying levels of education whereas 18% were illiterate. Likewise, among a total of 70 participants who responded the implementation level survey, 27 (39%) were local government representatives, 25 (36%) were partner organization (PO) officials and 18 (26%) were government officials from NRA. Likewise six policy level respondents filled up the policy level survey forms.

Similarly, data in Table 2 highlights the distribution of the beneficiary level respondents based on the average time taken for completion of reconstruction.

Of the 255 beneficiary level respondents who stated completion of construction as in Table 1, highest proportion (28%) stated that they completed their construction within 1–2 months period. Similarly, 18% of respondents completed within the first month of initiation of construction while 17% started they took 2–3 months for completion. Evidently, 63% of all respondents completed their construction within 3 months, whereas 2% beneficiaries took more than 12 months period for completion.

5.2. Source of information and communication

5.2.1. Use of communication channels

Table 3 shows the distribution of the different communication challenges that respondents used in order to get the information regarding reconstruction. It can be seen that all four respondent groups had a wide range of media, tools and channels for receiving information on reconstruction, however, some tools were much more prominent than others. Additionally, the prominent source varies according to the group as well.

In case of implementation level respondents, social media and official websites were the most prominently used source of information for government (89%) and partner organization officials (88%) whereas local government representatives relied more on training/orientation events (89%) and local radio (78%) for information. Similarly, government officials used other sources sparingly while partner organizations used other sources as well, primarily training/orientations, television programs and newspapers/portals.

In case of reconstruction beneficiaries, among all communication sources, local radios were the most prominently used source of information by 73% of the respondents. Second to local radios, local government representatives were the primary source of information for beneficiaries. Other forms of information were also used, however, data suggest that person-to-person communication through government and partner organization officials and training or orientation activities were much more profound than telecommunication such as websites and phone communication, printed media such as IEC materials and newspapers or national level mass media channels such as national radio or television programs.

The bar chart in Fig. 1 illustrates the distribution of means of communication as per the level of education of beneficiary level respondents. It can be seen that medium of communication is vastly different among different groups, especially based on education. While 73% illiterate and 86% semi-literate respondents used local radios, the proportion decreased significantly among secondary (69%) and university level (22%) respondents.

Respondents with higher level of education chose to follow TV programs and social media/websites much more than lower education level respondents. 78% of the participants with university level of education use newspapers as source of information, very high compared to lower education levels. In all cases, very few of the participants use the phone inquiries or messaging to be informed on the issues of reconstruction.

5.2.2. Type of information vs sources

The data in Table 4 elaborates the distribution of sources from where beneficiaries specifically received three major types of information on reconstruction; policies, financial (inspection and tranches) and technical (construction technology). Respondents relied more on PO officials (75%) and government officials (60%) for earthquake resistant construction techniques, while for information on reconstruction policies and tranche disbursement, local representatives (68%) were widely sought after.

5.2.3. Channels for two-way communication

A key component of communication is the ability and mechanism of two-way communication, primarily in addressing queries and issues from

Table 1
Distribution of beneficiary level survey respondents.

District	Construction status			Level of education					Total
	Complete	Under const.	Not Started	Illiterate	No formal education	Primary	Secondary	University	
Dhading	71	3	1	19	11	21	22	2	75
Dolakha	114	2	2	15	51	19	28	5	118
Kathmandu	21	9	–	3	7	5	13	2	30
Nuwakot	49	2	–	11	12	17	11		51
Total	255	16	3	48	81	62	74	9	274

Table 2

Distribution of time taken by beneficiary respondents for completion of construction [N = 255].

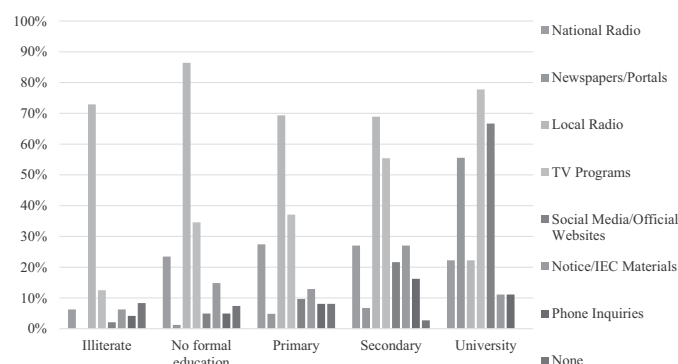
Months	0–1	1–2	2–3	3–4	4–5	5–6	6–7	7–8	8–9	9–10	11–12	>12	Total
f	47	72	43	22	9	21	7	4	1	1	22	6	255
%	18%	28%	17%	9%	4%	8%	3%	2%	0%	0%	9%	2%	100%

Table 3

Distribution of frequencies of different media of mass communication used by different respondent groups.

Communication channels	Reconstruction beneficiaries	Government officials	Local representatives	PO officials
A. Mass media				
i. Local radio	201 (73%)	4 (22%)	21 (78%)	9 (36%)
ii. National radio	61 (22%)	2 (11%)	14 (52%)	8 (32%)
iii. Television programs	105 (38%)	6 (33%)	20 (74%)	17 (68%)
B. Printed media				
i. IEC materials/Notices	44 (16%)	6 (33%)	15 (56%)	18 (72%)
ii. Newspapers/Portals	14 (5%)	8 (44%)	11 (41%)	18 (72%)
C. Telecommunication				
i. Phone Inquiry/messaging	24 (9%)	6 (33%)	14 (52%)	14 (56%)
ii. Social media/Websites	33 (12%)	16 (89%)	18 (67%)	22 (88%)
B. Person-to-person communication				
i. Local representatives	194 (71%)	–	–	–
ii. Community people/Masons	59 (22%)	–	–	–
iii. Government officials	121 (44%)	–	–	–
iv. PO/NGO officials	193 (70%)	–	–	–
e. Training/Orientation activities	106 (39%)	10 (56%)	24 (89%)	19 (76%)

The bold signifies highest values.

**Fig 1.** Distribution of means of communication among different level of education of beneficiaries.**Table 4**

Distribution of major source of information according to type of information [N = 274].

	Govt. officials	Mass media	PO officials	Local representatives	Social media/Websites	Notice/IEC materials	Awareness activities
Reconstruction policies	147 (54%)	31 (11%)	146 (53%)	189 (69%)	15 (5%)	19 (7%)	52 (19%)
Inspection and tranches	159 (58%)	33 (12%)	152 (55%)	185 (68%)	9 (3%)	20 (7%)	58 (21%)
Construction technology	165 (60%)	34 (12%)	207 (76%)	159 (58%)	17 (6%)	26 (9%)	91 (33%)

The bold signifies highest values.

the information recipient. Table 5 below presents the distribution of different focal points where beneficiary respondents placed their queries and issues regarding reconstruction for solutions.

The distribution clearly indicates that among the various available options, local government representatives and social leaders were the most sought after when beneficiaries had any queries regarding reconstruction (89%). This was followed by government officials (54%), partner organization officials (47%) and community people (11%). Much of the beneficiaries stated that they did not quite directly correspond to mass media to place queries or issues.

Additionally, when asked if they had used the toll free number activated by NRA to ease people in asking the confusions and collect grievances, 217 (79%) of all respondents stated that they did not know about it at all, 18% stated that they had heard of it but not used while only about 3% of the respondents stated that they had used it multiple times.

The results in sections above clearly outline the variation in communication media and channels used by different target groups during the post-earthquake reconstruction campaign in Nepal. At the beneficiary household or community level, localized sources of information were highly used whereas implementation level groups used other variety of

Table 5

Frequency distribution of major focal points for placement of issues (N = 274).

	Government officials	mass media	PO officials	Local representatives/Social leaders	Family	Community people	None
f	149	2	128	243	12	29	5
%	54%	1%	47%	89%	4%	11%	2%

sources as well. This is particularly true as the earthquake affected communities, especially in the rural areas with lack of transportation access or cable television, are highly dependent on local sources for all sorts of information and daily updates. Additionally, earthquake affected communities across the country also varied largely in socio-economic, cultural and topographical status as well as in capacity, advantages and problems (for example, an earthquake affected house owner in the heart of Kathmandu City would have issues of land management, and thus would require specialized information on resolving land issues whereas a house-owner in a rural village would have issues with understanding technical details, and thus would seek information on construction). This variation, especially in an owner driven reconstruction approach, results in unique challenges and issues, which require micro-level coverage that national level information channels cannot undertake adequately. Similarly, it is also seen that beneficiaries are not adequately informed the different channels of communication available (such as the toll free number) and how to access them.

Among various types of communication sources, local media and person to person communication involving government and partner organization officials, local representatives or awareness activities was more prominent source of information than national mass media, telecommunication and online sources. It can also be seen that earthquake affected beneficiaries with different education levels prioritized different communication channels and beneficiaries with higher level of education received information from multiple sources, as opposed to that with lower education levels. This points to the need to prominently invest in and capacitate local information sources in scrutinizing, handling and disseminating information. Similarly, person-to-person communication must be included as a major component of communication channels. Furthermore, with different groups of organization and people having more or less equal weightage on information sharing to beneficiaries, any misunderstanding of information or biasness in any of these sources could create conflicts and confusion among beneficiaries. This is especially true in a large scale reconstruction activity, where changing political and social environments, updated information and emerging issues creates a dynamic environment, with frequent changes in policies.

5.3. Perception of information quality

To understand the perception of different target groups towards the quality of information received during the reconstruction process, respondents were asked to rate their level of satisfaction on two aspects of communication, (i) timely reception of information and (ii) clarity in the information received. The Table 6 below highlights the results from the data analysis.

Table 6

Respondent satisfaction to two major aspects of communication in reconstruction.

Respondents	Parameter	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Government officials (n = 18)	Time	0 (0%)	0 (0%)	0 (0%)	14 (78%)	4 (22%)
	Clarity	0 (0%)	2 (11%)	2 (11%)	9 (50%)	5 (28%)
Local representatives (n = 27)	Time	0 (0%)	6 (22%)	8 (30%)	6 (22%)	7 (26%)
	Clarity	0 (0%)	2 (7%)	8 (30%)	12 (44%)	5 (19%)
PO officials (n = 25)	Time	0 (0%)	2 (8%)	3 (12%)	17 (68%)	3 (12%)
	Clarity	0 (0%)	3 (12%)	5 (20%)	13 (52%)	4 (16%)
Beneficiaries (n = 274)	Time	21 (8%)	62 (23%)	56 (20%)	88 (32%)	47 (17%)
	Clarity	29 (11%)	54 (20%)	61 (22%)	51 (18%)	79 (29%)

Results show that the perception regarding quality of information received varies widely among the respondent groups. While all of the government officials said they either agree (78%) or strongly agree (22%) on receiving timely information, in case of local representatives, 22% disagreed on having received information on time while another 30% remained neutral. Equal proportion of local representatives strongly agree on receiving timely information. This shows the disparity in timely dissemination of information among the local government units. Among the partner organization officials however, majority of the respondents (80%) agree or strongly agree on having received timely information. Likewise, half of the beneficiary respondents agreed to having received information regarding reconstruction on time (17% strongly agree and 32% agree). 23% of them disagree that they have received reconstruction information and messages on time whereas 8% strongly disagree on the same. In summary, it is seen that half of the respondents were satisfied with timely information sharing while the other half were not.

Similarly, the respondents were also surveyed regarding their perception on the clarity of information received from various sources whereby only 29, 16, 19 and 28 percentages of beneficiaries, partner organizations, local representatives and government officials respectively strongly agreed that they were able to receive and clearly understand all information regarding reconstruction. Among beneficiary respondents, 31% disagreed to having received clear information on reconstruction. Across all four respondent groups however, it is seen that the respondent satisfaction towards clarity of information is much lower than the timely reception of information.

To ascertain the gaps between these perceptions, policy and implementation actors were also asked to state their level of satisfaction in disseminating timely and clear information to beneficiaries. More than 75% of the policy level actors and 65% of the implementation level actors agreed or strongly agreed that the communication initiatives undertaken during reconstruction was able to provide timely and clear information to beneficiaries. On the other hand, less than half of the beneficiary level respondents agreed to have received clear information on time as shown in Table 6.

Furthermore, the data in Table 7 depicts the perception of quality of information received by beneficiary level respondents against the number of communication channels that they had access to. The results are based on the number of channels out of the twelve that beneficiary level respondents stated to have access to in Table 3 above. In general, it is seen that with an increase in the number of channels that beneficiaries used for information, the perception of beneficiaries regarding the quality of information improved.

Most significantly, among the 52 beneficiary respondents who had access to only up to two channels, a majority of respondents were either

Table 7

Perception regarding timely reception and clarity of information based on the number of communication channels that beneficiaries had access to [N = 274].

No. of channels	Parameter	Strongly agree		Agree		Neutral		Disagree		Strongly disagree	
		f	%	f	%	f	%	f	%	f	%
1–2 [n = 52]	Time	5	10%	15	29%	7	13%	21	40%	4	8%
	Clarity	8	15%	11	21%	11	21%	15	29%	7	13%
3–4 [n = 117]	Time	13	11%	37	32%	32	27%	28	24%	7	6%
	Clarity	25	21%	24	21%	32	27%	23	20%	13	11%
5–6 [n = 72]	Time	15	21%	24	33%	14	19%	11	15%	8	11%
	Clarity	29	40%	12	17%	11	15%	14	19%	6	8%
7–8 [n = 23]	Time	8	35%	9	39%	3	13%	2	9%	1	4%
	Clarity	11	48%	2	9%	7	30%			3	13%
9–10 [n = 8]	Time	4	50%	3	38%					1	13%
	Clarity	4	50%	2	25%			2	25%		
11–12 [n = 2]	Time	2	100%								
	Clarity	2	100%								

neutral or stated that they did not think they received information on time (61%) or clearly (63%). At up to four communication channels, 59% of the 117 respondents remained neutral or agreed on having received information on time and clearly. With the increasing number of communication channels used, the proportion of beneficiaries who strongly agree on receiving quality information increases. At the apex, while only two beneficiary level respondents state to have been using all twelve channels of communication, both of them strongly agree on having received information on time and clearly.

While information may be disseminated through various channels, communication cannot be deemed effective unless the end-users for whom the information in developed and disseminated adequately gather, process and use the information for their benefits.

Results obtained from the data analysis above clearly state that different target groups perceived information differently. This variation resulted from two major reasons, (i) the communication channel that the respondents used did not adequately disseminate information and (ii) the information that was disseminated did not adequately correspond to the target group. For example, as most of the government and partner organization officials were adequately oriented and trained on regular basis regarding reconstruction policies and updates, they had a higher degree of satisfaction on quality of information. On the other hand, local government representatives were largely left out of such engagements. Similarly, information pertaining to beneficiaries such as technical standards was more widely and better propagated than information pertaining to local government representatives such as grievance handling, land management, tranche distribution or financing. Hence, while beneficiaries were satisfied to a degree on having received quality information, local representatives were significantly unsatisfied.

Additionally, a clear disparity can be seen between the source (policy level actors) and medium (implementation actors) with the destination (beneficiary level) in terms of the perception of quality of information disseminated. A reason this has resulted is the lack of a proper feedback mechanism, which would enable beneficiaries to report on any dissonance in communication to be collected and analyzed by policy and implementation actors to revise and strengthen their communication approaches.

Furthermore, the availability and use of multiple channels of communication is also crucial in obtaining clear information. Especially in the propagation of complex information, use of multiple sources is also required to increase credibility of the information. Results show that where beneficiaries were able to access reconstruction information from multiple communication channels, their perception of timely information and clarity increased. Hence, although local information sources are to be prioritized as stated above, these results points to the need of investing in and utilizing an assortment of communication channels for disseminating information, perhaps in a varying degree of prioritization.

5.4. Influence of communication on reconstruction

To ascertain the relationship between quality of communication and reconstruction, an analysis of the time taken for completion of reconstruction (no. of months) taken by beneficiary respondent was done against their perception regarding timely reception and clarity of information through media was done. The analysis was done using the data of 255 out of the 274 beneficiary respondents who had completed the construction of their houses at the time of this study.

Two individual models were developed for the study. Model 1 included analysis of satisfaction level on the timely reception of information and the Model 2 included satisfaction level on the clarity in information reception with the time taken for reconstruction completion respectively.

Responses were collected on a 5 point scale rated 1 as Strongly Disagree to 5 as Strongly agree for measuring the satisfaction level on timely reception of information & the clarity in information reception. Also for the time taken for construction completion, the responses were categorized into four categories; 1 month, 2 months, 3 months and more than 3 months. An ordinal logistic model was utilized for the analysis.

For the calculation of model fit, both the models have statistically significant chi-square statistics ($p < 0.050$); 31.324 for model 1 & 28.476 for model 2 with degree of freedom 2, which indicates that the final model gives a statistically significant improvement over the baseline intercept-only model.

Additionally, from the goodness of fit test, the null hypothesis is that model fit are good for both models. Here, $p = 0.79 > 0.05$ for model 1 and $p = 0.355 > 0.05$ for model 2, hence we accept the null hypothesis and conclude that the both model does fit the data well.

Also, from the pseudo R^2 Statistics, the values of Nagelkerke are 12.1% for Model 1 and 11.1% for Model 2 indicates that explanatory variables (timely reception of information and clarity in information reception) explain about 12% and 11% of the variation between the construction time period. This is just as we would expect because there are numerous others factors such as economic condition, availability of materials and labor etc. that impact on construction time period, many of which will be much more important predictors of attainment than any simple association with timely reception of information and clarity in information reception.

Table 8 presents the parameter estimates for the Model 1. There appears to be a relationship between the construction time period and the satisfaction on the timely reception of information through media. We can see the significant and positive coefficients for the months taken on completing the houses. When compared to responses of the time taken for the completion of the respondents, completion time taken in a month had Odds Ratio (OR) = $\text{Exp}(\text{Estimates}) = \text{Exp}(1.483) = 4.404$ (95% CI 0.857 to 2.109), $p = 0.00$ and in 2 months had Odds Ratio (OR) = $\text{Exp}(\text{Estimates}) = \text{Exp}(1.157) = 3.18$ (95% CI 0.625 to 1.689), $p = 0.00$ as compared to the time taken for completing the houses more than 3 months.

This implies that the respondents reconstructing their houses in one and two months were 4.4 and 3.18 times simultaneously more likely to satisfy on the timely reception of the information than those who were unsatisfied. This result was found to be statistically significant. For any rating level, people constructing houses in a month or 2 months have positive satisfaction (i.e. agree) about the timely reception of information than those who completed their houses taking more than 3 months.

Table 9 presents the parameter estimates of Model 2 corresponding to clarity of information received. There appears to be a relationship between the construction time period and the satisfaction on the clarity of the information used by media. We can see the significant and positive coefficients for the months taken on completing the houses. When compared to responses of the time taken for the completion of the respondents, completion time taken in a month had Odds Ratio (OR) = $\text{Exp}(\text{Estimates}) = \text{Exp}(1.755) = 5.783$ (95% CI 1.099 to 2.411), $p = 0.00$ as compared to the time taken for completing the houses more than 3 months.

This implies that the respondents reconstructing their houses in a month had 5.78 times more likely to satisfy on the clarity in the information reception than unsatisfied. This result was found to be statistically significant.

Table 8

Parameter estimates of the Model 1.

		Estimate	Std. error	Wald	df	Sig.	95% Confidence interval (CI)	
							Lower bound	Upper bound
Satisfaction level on the Timely Reception of Information	[time_score = 1]	−2.133	0.255	70.158	1	0.000	−2.633	−1.634
	[time_score = 2]	−0.432	0.168	6.652	1	0.010	−0.761	−0.104
	[time_score = 3]	0.510	0.168	9.162	1	0.002	0.180	0.840
	[time_score = 4]	2.235	0.221	102.369	1	0.000	1.802	2.669
Construction Time Period Taken	[months_for_completion_4cat = 1.00]	1.483	0.319	21.552	1	0.000	0.857	2.109
	[months_for_completion_4cat = 2.00]	1.157	0.271	18.192	1	0.000	0.625	1.689
	[months_for_completion_4cat = 3.00]	0 ^a	.	.	0	.	.	.

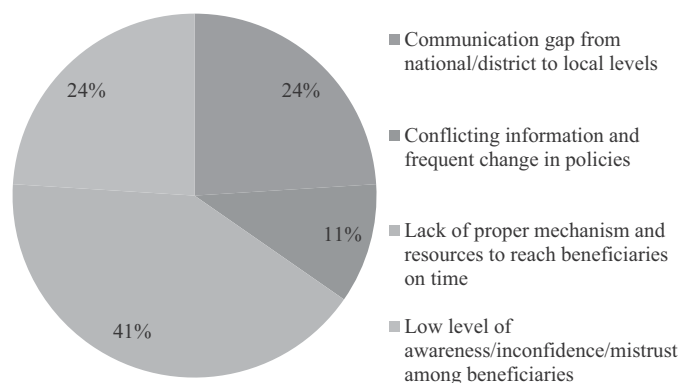
Link function: Logit.

^a This parameter is set to zero because it is redundant.**Table 9**

Parameter estimates of the Model 2.a

		Estimate	Std. error	Wald	df	Sig.	95% CI	
							Lower bound	Upper bound
Satisfaction level on the clarity of the information	[clarity_score = 1]	−1.992	0.234	72.237	1	0.000	−2.451	−1.533
	[clarity_score = 2]	−0.556	0.168	10.889	1	0.001	−0.886	−0.226
	[clarity_score = 3]	0.450	0.167	7.276	1	0.007	0.123	0.777
	[clarity_score = 4]	1.329	0.186	51.152	1	0.000	0.965	1.693
Construction Time Period Taken	[months_for_completion_4cat = 1.00]	1.755	0.335	27.501	1	0.000	1.099	2.411
	[months_for_completion_4cat = 2.00]	0.467	0.260	3.217	1	0.073	−0.043	0.978
	[months_for_completion_4cat = 3.00]	0 ^a	.	.	0	.	.	.

Link function: Logit.

^a This parameter is set to zero because it is redundant.**Fig 2.** Top Challenges faced by implementation level respondents to provide credible and timely information to beneficiaries (N = 70).

For any rating level, people constructing houses in a month have positive satisfaction (i.e. agree) about the clarity of the information received than those who completed their houses taking more than 3 months.

Results above elaborate the relation between effective communication and reconstruction outcome. Where beneficiaries presented higher levels of satisfaction towards having received information on time and clearly, the time taken for the construction of their house significantly decreased.

5.5. Challenges in communication and information dissemination

Different channels, media and tools were designed and implemented by policy and implementation actors in disseminating information on reconstruction. However, owing to the disparity in the level of clarity and timely reception of information at the beneficiary as well as implementation level respondents, Fig. 2 depicts the key challenges faced by implementation level actors in effectively providing information to the beneficiaries.

As evident in Fig. 2, 41% of implementation level respondents stated that lack of proper mechanism and adequate resources was the major challenge in providing information to beneficiaries in time. 24% of respondent stated low level of awareness among beneficiaries. Another 24% of respondents stated communication gap between national, district and local levels whereas 11% stated conflicting information and frequent changes in policies.

Implementation actors primarily pointed out to the disparity in the source of information available and used and the accessibility of beneficiaries as the major hindrance in communication. Primarily, administrative information on reconstruction policies and grants were largely propagated through official notice boards, which were limited to the administrative center. Similarly, discrepancy in information shared, especially between the major stakeholders at the local level also created challenges. Implementation actors largely opined that they themselves received several information late, and lacking clarity due to communication gap between the different levels. This was especially highlighted by local government

representatives, who were unable to provide clear information to beneficiaries on issues such as grievance resolution and tranche disbursements. Furthermore, the level of education and awareness of beneficiaries also hindered information sharing, especially pointing to the diversity in language, culture and community perception towards the reconstruction program, policies and actors.

On the other hand, policy level target group opined that communication materials and contents were not developed as proficiently and easy way to understand. Lack of funding in communication was a major setback, as very few organizations had intensive and comprehensive communication programs, especially through mass media. This lack of funding also hindered in the coverage of local issues at the national levels. Similarly, uncoordinated efforts by different stakeholders at different levels created an un-uniform flow of information, resulting in confusion and conflicts. Use of audio-visual medium of communication, such as television, was not as widespread as needed. Results shows that the information regarding changes in policies and norms were not propagated in the communities in time concurrently with implementation level actors stating that they themselves did not receive clear information on time. Confusion among beneficiary level respondents regarding reconstruction policies also stemmed from biased statements from political and social leaders about the reconstruction process. It indicates that proper information sharing and awareness activities are needed so that they could deliver right message without any political and personal bias.

6. Conclusion and recommendations

Results obtained from this study show that where beneficiaries perceived information on reconstruction to be available timely and clearly, the time taken for construction was significantly less. Although, such a perception is dependent on a number of factors, its correlation and impact on the reconstruction time period cannot be undermined, especially in an owner driven reconstruction approach, where successful reconstruction is largely dependent on the beneficiaries' ability to gather, process and utilize several forms of information towards construction of their houses. In a complex and dynamic process like post-disaster recovery, the integration of multiple communication channels through a comprehensive communication program would be the most suitable medium to increase outreach to a wide range of target groups. The following conclusions have been derived based on the results and discussions above.

- (i) Communication strategy and programs are vital components of post-disaster recovery campaigns: Significant correlation can be seen between the reconstruction rate (time to completion) of earthquake reconstruction beneficiaries with respect to the effectiveness of communication and information shared and received at the community level. Thus, it is of paramount importance that communication and information dissemination is acknowledged as a major component of post-disaster recovery, especially where multiple stakeholders are involved. Considering the effect of timeliness of information dissemination, the study also points out to the need of developing communication strategies and programs immediately after, if not prior to, a disaster, with roles and responsibilities delineated to different stakeholders. However, strategies alone cannot fulfill objectives, adequate resources must be allocated for developing and implementing comprehensive communication programs using suitable tools as discussed above in conjunction with such strategies. The government and partner organizations must allocate sufficient resources in communication.
- (ii) Communication channels must be appropriate and wide: Effective communication in post-disaster recovery can be attained by complimenting large scale information dissemination through mass media with localized and specific information sharing through local radios, local governments and socio-technical assistance groups. Similarly, specific information must be propagated owing to the level of education, access to facilities and the needs and necessities of the target communities. The study comes with the conclusion that multiple

sources and media of communication must be appropriately used to disseminate information, owing to the diversity of the end-users. Similarly, as interpersonal communication through local authorities and social leaders are the major source of information, they themselves need to be well informed on different aspects and facades of reconstruction. While national level policy actors have a greater reliance on national level mass media or social media as it provides better control on content, and appears to have a wider geographical coverage. However, it is far from sufficient. Localized media of information including local radios, community and social leaders, social mobilizers, field engineers and local governments bear the major role in disseminating information, hence enhancing capacities and as well as resources at these levels will inevitably increase the outreach of any reconstruction program.

However, considering the availability of resources, it might not be always practical to use variety of communication channels. Thus, a thorough study of the accessibility and suitability of channels and the socio-economic, demographic, cultural and linguistic status of the target group must also be examined properly to identify and use the most effective communication channel.

- (iii) Monitoring, evaluation and feedback mechanism for quality control: Dissemination of credible information is another major aspect to be considered during a post-disaster recovery campaign. With multiple stakeholders involved, the risk of disparity of information shared arises. As effective communication strategy does not only include the effectiveness of the medium but also the final outcome, a responsive monitoring and evaluation plan is utmost necessary to identify gaps and challenges such as misinformation, biasness and confusion and formulate necessary strategies to overcome them. To achieve this, a strong monitoring and evaluation mechanism must be put in place. This mechanism must be implemented by the national governing authority, preferably with the use of third party monitors. Additionally, all information flowing out to the beneficiaries must be adequately reviewed by an authority, to provide credibility, most suitably through a one-door policy. However, this mechanism of control must not delay the process of dissemination of such information, as timeliness of information is as important as the quality. For this, the different levels of governments, at central, provincial and local, must be involved in the quality control mechanism.

Additionally, to avoid gaps in communication between the different tiers and stakeholders, an appropriate feedback mechanism, either in form of periodic satisfaction surveys and feedback collection, or through ground study of process and outcome will be necessary. A good initiative of this was the toll free number that was activated by the NRA, however, in lack of adequate information regarding this, beneficiaries were not able to use it to their full advantage. Such initiatives by the policy and implementation actors will provide much needed feedback for strengthening communication channels, and inevitably, the outcome of quality communication.

7. Limitations and further study

While this study evaluates the effectiveness of communication with respect to the perception of the end-users and its impact on reconstruction time period, it only covers the aspects of communication media and channels. Further study of organizational communication through the different tiers can be done to better evaluate the overall communication mechanism that the NRA and different partner organizations utilized during the reconstruction process. Similarly, in this study, time taken for completion of reconstruction is taken as a measure of reconstruction outcome, as it is one of the prime factors in determining success of a reconstruction program, and directly corresponds with the beneficiaries' ability to gather, process and utilize information in their rebuilding efforts. However, further study will also be required to understand the effectiveness of communication channels on other aspects of reconstruction, such enhancement of

awareness and capacity of communities, outreach of the implementation agencies and its impact on enhancing disaster resilience.

Declaration of Competing Interest

None.

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Regular Article

The 2015 Nepal earthquakes and psychosocial impact among Nepali speaking population in the United States of America

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1. Introduction

The earthquake of 7.8 Richter scale magnitude that hit Nepal on April 25th 2015 killed close to 9000 and injured more than 22,300. Aftershocks of 6.7 M_w on 26th April 2015 and 7.3 magnitude on 12th May 2015 further traumatized the nation paralyzing life and activity in severely impacted cities and region. There was resultant property destruction of close to 500,000 private houses and 2700 government buildings; and partial damage to 256,697 private houses and 3622 government buildings; disadvantaged social groups in the poorer districts suffered the largest damage and loss [1]. The earthquake destroyed many UNESCO (United Nations Educational, Scientific and Cultural Organization) heritage sites and entirely flattened some villages. It may take years or even decades to heal from this natural disaster of such a devastating magnitude. A post-disaster recovery analysis estimated the need for about US\$6.7 billion to reconstruct damaged properties and infrastructure and to support recovery in affected sectors of the economy [2]. Four months after the earthquakes in Nepal, one out of three adults were found to have experienced symptoms of depression and distressing levels of anger, one out of five engaged in hazardous drinking, and one out of ten had suicidal thoughts [3]. There is previous research in Nepal which found quake-associated wide mental health and psychosocial problems, such as post-traumatic stress disorder (PTSD) symptoms among children [4], adolescents [5], mothers [6], families [6], adult survivors [7,8], older people [9,10], and persons with disabilities [10].

As per single ethnicity report from American Community Survey, close to 172,000 Nepalese were living in the United States of America (USA) in 2017 [11]. The two large earthquakes in 2015 also had far-reaching ramifications on Nepalese living abroad. A recent study undertook an online survey in 2015 via Facebook Messenger to examine the post-earthquake communication behavior of Nepali immigrants and how the exposure to information about damage and destruction affected their mental well-being [12]. Given the potential impact of the earthquake on Nepali communities in the USA, federal behavioral health agency Substance Abuse and Mental Health Administration (SAMHSA) at the behest of the then White House initiative on Asian American and Pacific Islanders (WHIAAPI) mobilized a volunteer team of public health experts of Nepal nativity in the USA.

These experts, following a Community Based Participatory Research (CBPR) approach, launched the 2015 Community Behavioral Health Needs Assessment (CBHNA), a unique and first of its kind real time assessment of the earthquake's Psychosocial impact on Nepali family members, relatives, and friends living in the USA. There is no previous study that investigated the psychosocial impact of the earthquakes on Nepalese living abroad. The purpose of our study was to: (a) gather data on psychosocial impact of the earthquake among Nepali speaking population living in the USA and whose family members or relatives are living in Nepal; and (b) assess the coping mechanism that impacted individuals utilized to address the quake associated psychosocial problems.

2. Methods

2.1. Study population

We conducted a cross-sectional study in the USA between September 2015 and February 2016 using web-based smartphone-enabled Survey Monkey. The study inclusion criteria were as follows: Nepali speaking population 18 years and older residing in the USA who had some family members or friends and relatives in Nepal, willing to participate in the study, and had no physical impairment. Purposive sampling technique was applied to sample the respondents. We calculated sample size based on proportion = 0.50 with the assumption that the Nepal earthquakes potentially had psychosocial impact among 50% of Nepali speaking population living in the USA, confidence limit 95% (i.e., $\alpha = 0.05$, z score = 1.96) and margin of error = 0.05. Of 389 participants who met the inclusion criteria, 310 responded online and 79, on-site. To control for potential response bias, trained bi-lingual community volunteers administered the on-site surveys in a culturally and linguistically competent manner and with questions presented together in both English and Nepali.

No incentives were provided to the participants or the interviewers. The study was pursued in the USA with the request and approval of Substance Abuse and Mental Health Administration and followed the agency's approved human subjects and ethical standards.

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2.2. Measures

The survey instrument included key questions on symptoms of anxiety, depression, and post-traumatic stress disorder (PTSD) with a view to assess behavioral health impact of the severe earthquake on Nepalese living in the USA. To allow for comparability and consistency, the study selected questions from psychometric instruments used in previous literature to assess immediate trauma exposure, post-quake associated behavior changes, current trauma experience, coping mechanism, perceptions of support from family, friends and others, and help-seeking behavior. We adapted five indicators from Hopkins System Checklist (HSCL), a standardized tool that has 25 items—10 statements to measure anxiety symptoms and 15 statements to measure depression symptoms [13]. These indicators were: difficulty falling asleep or staying asleep, feeling tense or keyed up, feeling no interest in things, and feeling sad. HSCL was modified to a four Point Likert scale (not at all, a little, quite a bit, and extremely) in alignment with cultural nuances [14]. Two additional indicators were adapted from 16 Item-Harvard Trauma Questionnaire (HTQ) [15]. These were: trouble (difficulty) concentrating (an “arousal” symptom) and remembering past traumatic event (“recurring or re-experiencing” symptom). This study is in alignment with DSM-IV Criteria for Post-Traumatic Stress Disorder (PTSD) [16]. We especially were drawn to one study that succinctly discussed how DSM-IV, as compared to DSM-5, is more suitable to look at traumatic experiences in subjective terms, first, by defining the range of qualifying stressors and second, by requiring that the person's response involved intense fear, helplessness, or horror [17]. Prior to the data collection, we utilized two subject experts to perform face validation of both the English and Nepali version tools.

We calculated total score of Psychosocial impact (PSI) within last week (minimum 14, maximum 1005, mean 50, Cronbach's Alpha = 0.784) and total score of PSI after 6–10 months (minimum 14, maximum 1386, mean 52, Cronbach's Alpha = 0.972). Total score of PSI were coded as “Yes” (above the mean score) or “No” (below the mean score). We asked same questions to the same respondents at same time for both responses (within first week and after 6–10 months).

2.3. Analysis

Bi-lingual (English and Nepali) research assistants entered survey data utilizing Microsoft Excel 2010. We verified the Excel data for consistency, corrected for resultant errors and imported into SPSS 22.0 for Windows. Next, we merged the cleaned data with data imported from Survey Monkey and which was verified further for accuracy to ensure data was uncompromised in the data integration. Descriptive and inferential statistics were analyzed. Frequencies and percentages were calculated for descriptive outcomes. Bivariate technique was applied to identify the significant differences between PSI and background variable; a p -value ≤ 0.05 was considered statistically significant.

3. Results

Sample respondents' nationality was Nepali, 340 (87.4%); Nepali speaking Bhutanese, 27 (6.9%); other, 22 (bi-cultural nationality speaking Nepali: Nepali/Indian; Nepali/White, 5.7%). More than three-fifth respondents were male; more than 50% were between 25 and 44 years of age; close to 88% were native of Nepal; 7% were Nepali speaking Bhutanese; most respondents arrived in the USA when they were between 18 and 24 years older; an overwhelming majority (92.3%) spoke English with close to 58% reporting excellent English proficiency (Table 1).

Table 2 (left side) shows immediate PSI which was measured across 14 domains. Concerning behavioral symptoms (immediate trauma) experienced within the first week of the April 25th earthquake in 2015, 67% were extremely and 17% quite a bit worried about family in Nepal. A notable finding is that the respondents were extremely (15%) and quite a bit (30%) worried also about family in the United States. Respondents reported worrying about friends extremely (53%) and quite a bit (27%), feeling

Table 1

Select Demographic Description of Study Population ($n = 389$).

Variable	N	%
Age	378	
18 to 24	37	9.8
25 to 34	76	20.1
35 to 44	129	34.1
45 to 54	73	19.3
55 to 64	43	11.4
65 and Older	20	5.3
Nationality	389	
Nepali	340	87.4
Nepali speaking Bhutanese	27	6.9
Others	22	5.7
Gender	387	
Male	247	63.8
Female	140	36.2
Age of Arrival (U.S.)	378	
17 and Younger	58	15.4
18 to 24	115	30.6
35 to 44	66	17.6
45 to 54	17	4.5
55 to 64	8	2.1
65 and Older	2	0.5
Speak English	389	
Yes	359	92.3
No	30	7.7
English Proficiency (%)	378	
Fair	88	23.3
Excellent	217	57.4
Native Level	73	19.3
Speak Nepali (%)	389	
Yes	382	98.2
No	7	1.8

helpless extremely (35%) and quite a bit (26%). As regards the PTSD “arousal symptom” measures, one interesting finding was that 18% experienced extremely and 24% quite a bit difficulty (or had trouble) in concentrating. As for recurring or re-experiencing PTSD symptoms, 18% extremely and 19% quite a bit remembered the traumatic event. One fifth (18%) experienced extreme and 24% experienced quite a bit difficulty in the HSC-25 measure “falling asleep or staying asleep.” High percentages of anxiety and depression systems were found for HSC-25 measures of “feeling tensed or keyed up” (extremely, 22%; quite a bit, 27%) and “feeling sad” (extremely, 39%, quite a bit, 24%).

Table 2 (right side) presents the PSI after 6–10 months of earthquake. Respondents reported that they were extremely (15%) and quite a bit (24%) worried about family in Nepal; extremely (12%) and quite a bit (26%) worried about friends in Nepal; and extremely (11%) and quite a bit (14%) remembering past traumatic events.

People who were Nepali national had higher PSI within the first week of earthquake. PSI had slightly decreased after 6–10 months of earthquake compared to first week of earthquake (Table 3). PSI was higher for female gender, older current age, and age at USA arrival (over 35 years).

PSI is statistically different between “within the first week” and “after 6–10 months of earthquake” (Table 4).

Concerning coping mechanisms or resources that helped to cope with the problems, findings were encouraging as they reflected a good degree of social support. When asked about what coping resources were utilized, help from the following were among the most prominent: family/close relatives (86.1%, $n = 322$, $N = 374$); close friends (80.5%, $n = 285$, $N = 354$); social groups (61.8%, $n = 214$, $N = 346$); and community leaders (44%, $n = 147$, $N = 334$); and temples/churches (32.6%; $n = 106$, $N = 325$). The findings, that only 21.9% ($N = 320$) found health clinics helpful and 18% ($N = 320$) found mental health agencies helpful, are insightful from a policy intervention standpoint. The reasons could be unmet behavioral health need, low help-seeking behavior or lack of awareness about available resources (data not shown).

The findings on what other type of health would the participants like to see provides additional perspectives into the unmet need for behavioral

Table 2
Psychosocial impact (PSI) domains within one week and after 6–10 months of earthquake.

Variables/Items	Within one week (n = 360)				After 6–10 months (n = 358)			
	1	2	3	4	1	2	3	4
Worrying about family in Nepal	14 (3.9)	39 (10.8)	63 (17.5)	244 (67.5)	64 (17.8)	150 (41.8)	87 (24.2)	53 (14.8)
Worrying about family in US	108 (30.0)	118 (32.8)	68 (18.9)	54 (15.0)	192 (53.8)	97 (27.2)	40 (11.2)	20 (5.6)
Worrying about friends in Nepal	20 (5.6)	52 (14.4)	96 (26.7)	192 (53.3)	79 (22.0)	138 (38.4)	93 (25.9)	42 (11.7)
Feeling anxious	38 (10.6)	63 (17.5)	109 (30.3)	145 (40.3)	140 (39.1)	116 (32.4)	59 (16.5)	36 (10.1)
Feeling helpless	54 (15.0)	80 (22.2)	96 (26.7)	125 (34.7)	167 (46.8)	102 (28.6)	43 (12.0)	38 (10.6)
Difficulty falling asleep or staying asleep	91 (25.3)	113 (31.4)	88 (24.4)	65 (18.1)	234 (65.4)	77 (21.5)	24 (6.7)	17 (4.7)
Sleeping too much	226 (62.8)	77 (21.4)	38 (10.6)	15 (4.2)	261 (72.9)	54 (15.1)	21 (5.9)	12 (3.4)
Feeling tensed or keyed up	77 (21.4)	102 (28.3)	97 (26.9)	80 (22.2)	183 (51.1)	110 (30.7)	37 (10.3)	21 (5.9)
Feeling no interest in things	148 (41.1)	109 (30.3)	53 (14.7)	44 (12.2)	239 (66.6)	74 (20.6)	30 (8.4)	11 (3.1)
Trouble concentrating	96 (26.7)	108 (30.0)	86 (23.9)	64 (17.8)	211 (58.8)	96 (26.7)	25 (7.0)	18 (5.0)
Difficulty eating	187 (51.9)	95 (26.4)	43 (11.9)	33 (9.2)	266 (74.5)	52 (14.6)	21 (5.9)	10 (2.8)
Feeling sad	43 (11.9)	87 (24.2)	85 (23.6)	142 (39.4)	159 (44.4)	106 (29.6)	56 (15.6)	31 (8.7)
Remembering past traumatic event	116 (32.2)	106 (29.4)	68 (18.9)	66 (18.3)	165 (46.0)	99 (27.6)	50 (13.9)	38 (10.6)
Feeling unsafe	139 (38.6)	92 (25.6)	61 (16.9)	64 (17.8)	208 (58.1)	75 (20.9)	34 (9.5)	33 (9.2)

1 = Not at all, 2 = A little, 3 = Quite a bit, 4 = Extremely.

health. The needs were: enabled communication with hard-to-reach family members in Nepal (74.4%, N: 355); general disaster crisis counseling in the community (73.5%, N: 344); information on handling distress or grief (70.1%, N:355); training community members in the Mental Health First Aid (69.5%, N:347); culturally sensitive mental health outreach (66.6%, N: 344); specific mental health wellbeing programs for women (65.7%, N:338); and mind-body health counseling (61.3%, N:344) (data not shown).

4. Discussion

Most of the respondents felt elevated psychosocial impact within the first week of the earthquake. Common problems were worrying about their family and friends, feeling helpless, developed arousal symptom,

and difficulty in concentrating. Most respondents remembered the traumatic event, had difficulty in falling asleep, and felt tensed and sad. Even after 6–10 months of the earthquake these symptoms remained prevalent though at a slightly lower level for most respondents. The study results suggest interesting opportunities for future program or policy concerning immigrants and their psychosocial problems in physically detached locations or community diaspora. A study conducted among Nepali immigrants in different countries had found similar mental health problems associated with the earthquake [12]. Several studies conducted in Nepal have highlighted the impact of earthquake in mental health among children [4], adolescents [5], and adults [6–10].

Our study found that the older respondents reported more psychosocial problems associated with the earthquake. A study conducted among several countries immigrants had found the similar findings [12]. Although, a

Table 3
PSI and demographic variables.

Variables	PSI within first week				PSI after 6–10 months			
	Yes	No	Total	P-value	Yes	No	Total	P-value
Nationality								
Nepali	46 (14.3)	275 (85.7)	321	0.475	40 (12.5)	281 (87.5)	321	0.404
Bhutanese	1 (5.3)	18 (94.7)	19		1 (5.3)	18 (94.7)	19	
Other	2 (10.0)	18 (90.0)	20		1 (5.0)	19 (95.0)	20	
Sex								
Male	24 (10.6)	202 (89.4)	226	0.073	25 (11.1)	201 (88.9)	226	0.228
Female	25 (18.9)	107 (81.1)	132		16 (12.1)	116 (87.9)	132	
Age in years								
18–14	4 (10.8)	33 (89.2)	37	<0.001	2 (5.4)	35 (94.6)	37	0.105
25–34	2 (2.7)	71 (97.3)	73		2 (2.7)	71 (97.3)	73	
35–44	14 (11.7)	106 (88.3)	120		18 (15.0)	102 (85.0)	120	
45–54	11 (15.5)	60 (84.5)	71		13 (18.3)	58 (81.7)	71	
55–64	11 (28.9)	27 (71.1)	38		4 (10.5)	34 (89.5)	38	
>64	5 (38.5)	8 (61.5)	13		2 (15.4)	11 (84.6)	13	
Age at USA arrival								
<18	6 (10.7)	50 (89.3)	56	0.008	5 (8.9)	51 (91.1)	56	0.126
18–14	13 (11.7)	98 (88.3)	111		9 (8.1)	102 (91.9)	111	
25–34	11 (11.3)	86 (88.7)	97		17 (17.5)	80 (82.5)	97	
35–44	11 (17.7)	51 (82.3)	62		8 (12.9)	54 (87.1)	62	
45–54	5 (31.3)	11 (68.8)	16		1 (6.3)	15 (93.8)	16	
55–64	3 (75.0)	1 (25.0)	4		2 (50.0)	2 (50.0)	4	
>64	0 (0)	1 (100)	100		0 (0)	1 (100)	1	
Speak English								
Yes	47 (14.1)	286 (85.9)	333	0.346	34 (10.2)	299 (89.8)	333	0.006
No	0 (0)	13 (100.0)	13		3 (23.1)	10 (76.9)	13	
Speak Nepali								
Yes	47 (13.8)	293 (86.2)	340	0.756	39 (11.5)	301 (88.5)	340	0.882
No	1 (16.7)	5 (83.3)	6		1 (16.7)	5 (83.3)	6	

P-value is from Chi-Square test.

Table 4

PSI within the last week and after 6–10 months of earthquake.

PSI within first week	PSI after 6–10 months		Total	p-value <0.001
	Yes	No		
Yes	32 (51.6)	30 (48.4)	62	
No	23 (7.4)	288 (92.6)	311	
Total	55	318	373	

P-value is from Chi-Square test

systematic review of literature from different countries revealed that youth had higher mental health problems compared to adults [18].

Our study findings were similar to those in a previous study conducted with immigrants [12] which had female respondents self-reporting higher psychosocial problems than male. These findings also resonate those from other earlier studies that highlighted females as compared to males experiencing more mental health problems and being more susceptible to advanced symptoms compared to male [19,20]. Both of these findings were in line with our theoretical predictions. The reported psychosocial responses among females and older respondents specifically attributable to the emotional nature among female and older people, and their long time connection with their family and friends in Nepal were the mechanisms that influenced psychological responses to the earthquake.

That the respondents extensively sought help from family/close relatives, close friends, and social groups were very encouraging as they are reflective of the great role of familial and social support in helping people cope with grief and trauma. This is one reason why counseling and therapy needs to embrace a family-centered approach. A post-quake study in Nepal provides interesting recommendations for mental resilience that are also of unique relevance for USA based Nepali communities: improving preparedness capacity with community-based programs; promoting resilience through religious and spiritual approach; improving leadership and governance of mental health related activities; and effective risk communication through relevant information, before, during, and after disaster [21]. Our study found that one fifth respondents had received help from mental health agencies or health clinics to cope with the problems. There is an important systemic need to step up efforts to provide resources or programming to outreach ethnic minorities more effectively and in a culturally competent manner. This is critical given that many community members are reluctant to seek behavioral healthcare because of high and pervasive levels of stigma in the society.

The highest-level need felt during the disaster were: communication with family members or relatives in Nepal, counseling supports, information on handling distress, and mental health wellbeing programs and activities. Inability of USA based Nepali communities to contact family members and friends in Nepal thus appeared to have a tremendous impact on their psychosocial health. This has important implications for effective disaster response and preparedness and highlights the critical need for improved and sustained or undisrupted telecommunications system. One past study [12] revealed that the importance of communication and information during the disaster. The tremendous unmet need for culturally sensitive behavioral health counseling and gender-specific programming especially for women also warrant further discussion. As policy translational efforts, counseling psychologists and behavioral health administrators of the Nepali diaspora in the USA proactively undertook culturally competent counseling sessions in Nepali, held community conversations, and utilized Mental Health First Aid [22] and Psychology First Aid [23]. U.S. federal agency SAMHSA also sponsored a Nepali translation of the non-diagnostic culturally and linguistically competent behavioral health tool “Five Emotional Signs of Suffering” [24].

This Community Behavioral Health Needs Assessment is a unique and first of its kind scientific attempt to assess the international impact of the 2015 earthquake on Nepalese living in the United States. Assessing traumatic event exposure is usually complex from a measurement standpoint

as it entails a gamut of issues including definition, methodology, consistency and validity [25]. One study attempted to compare the sensitivity surrounding trauma questionnaires with those asked for disaster inventories for assessing the prevalence of exposure to natural disaster or associated risk for post-disaster psychopathology [17]. One research in Nepal also emphasized the importance of key prevention strategies to reduce the risk of distress progressing to disorder within post-disaster mental health systems of care [3]. One recommended actionable item in another study [26] in Nepal is equally germane to Nepali communities in the USA that there is a dire need to run programs to improve awareness about mental health, reduce stigma about mental disorders and promote mentally healthy lifestyles in the community.

The main strength of our study is that it was population-based and included some representation of Nepali diaspora from various cities in the USA. Data was collected by utilizing bi-lingual enumerators that helped to increase the trustworthiness among respondents as they were able to better grasp the nature of the tools and the purpose of the study. We applied face validity to improve reliability and validity of the data collection tools.

This study had several limitations. First, it employed a purposive sampling technique to survey the Nepalese living in the USA; and hence the findings are not generalizable to all Nepali diaspora living abroad. Second, the responses were collected over ten months (between September 2015 and February 2016) and at a single point of time for both responses (within first week and after 6–10 months). As a result of time maturation (history), some degree of response bias may be likely due to loss thereof in accurate recollection or capture of the trauma immediacy, especially among responses that were collected after many months following the earthquakes. As the data were collected only once from self-reported questionnaires following a cross-sectional methodology, a causal relationship could not be established. Our study thus lacks pre-earthquake prevalence estimates for Nepalese to allow a pre- post- comparison, also acknowledged by a similar study in Nepal [3]. Third and last, we did not include all the 25 items in the standardized Hopkins System Checklist (HSCL) to allow for a fuller assessment of symptoms of anxiety, depression, and distress (a combination of anxiety and depression scores) [13].

5. Conclusions

PSI and immediate trauma was prevalent among Nepalese people living in the USA within the first week of earthquake in Nepal and continued at some level even after 6–10 months of the earthquake. PSI was higher among older people than young people. Getting help from relatives and society are the common mechanism of coping of PSI. That respondents received help from family/close relatives, followed by close friends, and social groups is very encouraging. This critical finding is reflective of the pivotal role familial and social support play in helping people cope with grief and trauma and in developing resilience.

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Declaration of Competing Interest

None.

CRediT author statement

Surendra Bir Adhikari: Conceptualization, Methodology, Software, Validation, Formal analysis, Resources, Investigation, Writing - Original draft, Writing - Reviewing and editing, Supervision. **Dharma Nand Bhatta:** Methodology, Software, Validation, Formal analysis, Resources, Investigation, Writing - Reviewing and editing. **Deelasha Rayamajhi:** Investigation, Resources, Writing - Original draft, Project administration. **Ruchi Adhikari:** Writing - Review, Resources, Data curation, Visualization.

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Regular Article

Effects of horizontal seismic band on seismic response in masonry structure: Application of DIC technique

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ABSTRACT

Masonry construction is one of the oldest building systems and practiced since the early stage of human civilization. Even though industrialized nations developed new building practices using steel and concrete materials, most developing countries still use unreinforced masonry buildings. Evidence from past events shows that masonry structures sometimes performed well and survived several earthquake events, particularly in the area where earthquake events struck regularly and enough to show how structures behave. However, an alteration from the traditional cultural building practice is seen due to the lack of proper scientific knowledge about such local construction cultures. Amongst traditional construction techniques, one captured authorities' and scientists' attention as showing excellent properties: seismic bands that can be found in many parts of Nepal. After the 2015 Gorkha earthquake, reconstruction works started adopting the guidelines developed by DUDBC and National Building code that suggest using such seismic bands. The evidence of using such band dates to 2500 BCE, and qualitative studies of those applications have proven to enhance the performance in the masonry structure. However, the experiment's quantitative parameters using various materials are needed to carry out the parametrical analysis to optimize seismic band's use. To provide quantitative results, we have started with two specimens, one without a band and one with a timber seismic band, and incorporate the digital image correlation (DIC) technique to obtain the localized information. The quasi-static cyclic test is carried out for our specimens to compare the behavior concerning the energy dissipation, and the surface area of the crack formed during the loading cyclic. This work clearly shows the seismic band's advantage in limiting the crack propagation and improving masonry structure integrity.

1. Introduction

Masonry structures constitute the oldest buildings constructed by human civilization and their technic evolved with cultural values and way of living. As per the world population statistics, approximately 86% of the world population is present in the underdeveloped and developing nation [1]. According to the United Nations, half of these population live in building constructed using earth materials (rammed earth, kneaded earth, adobe, wattle, and daub, cob, etc.). [2] carried out a basic SWOT (Strengths, Weakness, Opportunities, Threats) analysis for the earthen structures and found several benefits of using such construction material. Such construction practices not only preserve the socio-cultural aspect but also has economic and environmental gain.

With the increasing construction trend using concrete and steel structures, people have started forgetting their traditional construction practices and adopting new materials without proper technique. When we look at the

global seismic hazard map, most densely populated countries with weak financial conditions are located in the seismically active zone [3]. There is evidence showing that some traditional buildings survived several events of an earthquake. At the same time, sometimes modern RC structures collapsed [4]. Despite that, traditional cultural constructions seem to be fading out and being replaced by modern construction techniques. Some questions are emerging- is the current construction practice sustainable, did we miss to understand better and study our traditional building practice?

To better understand the traditional cultural practice, several research works have been carried out. [5] has highlighted that the earthquake-resistant traditional construction is not an oxymoron with the examples of structures that survive during a disaster event in various parts of the world. Many works have been carried out to enhance masonry structures' strength using retrofitting techniques [6–10]. Some of these techniques required skilled labor for an effective benefit from the application and could vary in cost depending upon the availability of materials.

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The use of timber in masonry structure as a seismic band was present from the Minoan Crete 2500 years BC [11], and the finding observed after the 2017 Lesvos Earthquake in Greece by [12] showed that structures with timber reinforcement suffered only localized damage and prevented them from complete collapse. The materials for such a band can be timber, reinforced concrete, bamboo, etc. But there is a lack of quantitative data, which prevent the efficiency comparison of different reinforcement technique [13] and without scientific experimental results, the behavior and performance cannot be assessed.

In this paper, the main idea is to reveal the traditional practice using seismic band placed during construction of building rather than repairing it after the damage as adopted by many countries and observed the crack opening in the masonry wall using the Digital Image Correlation technique. The quantitative pieces of information are obtained through two experimental samples, which can be useful for comparison and validation for the numerical model to carry out a parametrical analysis. This work is a part of a multi-scale experimental campaign to characterize seismic bands' behavior and then validate the numerical model developed at our laboratory.

In the following subsection 1.1, the background about the use of the seismic band, their recommendation as per various guidelines, and codes are included. Subsection 1.2 allows one to understand the major failure modes in masonry and appreciate the advantages of having a seismic band (subsection 1.3) in the masonry structure.

1.1. Seismic band

Seismic bands are a constructive device-specific to traditional masonry constructions in seismic zones. The first traces come from the Minoan period - the bronze age - in Crete [14]. Such a device consists of placing at a level of several horizontal joints from the ground level regularly spaced pieces of wood forming a kind of ladder that is "laid" lengthwise on the

masonry. Such bands may also be referred to as a ring beam in [15–19], but that is not always the case and depends on the connection between insertions. These elements can be continuous (above the openings) and look like a horizontal beam as shown in Table 1 (at lintel, roof, plinth level) or discontinuous (at the level of the openings) as shown in Table 1 (at sill level), even punctual (at the level of the angles). These inclusions are usually made of timber or reinforced concrete in fired or raw bricks (adobes) or stone masonry. Sometimes, one can also find longer stones used as a band in stone masonry. Nepal National Building Code [20] also mentioned using bamboo as a seismic band in NBC 203. Table 1 shows the recommendation for seismic band location and material that can be used for such band by different codes and guidelines for earthquake resistant design for masonry structures. As per our knowledge and finding, the various code's current provisions were prepared by the team of experts at International Association for Earthquake Engineering during 1980s [16] and consequently adopted by different countries.

Table 2 shows that longitudinal timber members' dimension has some variation, which might be due to construction and material restriction in the region. For a reinforced concrete band, all the guidelines and reference have the same recommendation for the dimension.

1.2. Failure modes

Usually, the interface is the weak bond between mortar and units in masonries. This low tensile strength creates a key reason for most of the damage [28]. Damage in the structure is directly influenced by the seismic event, which has its characteristics. Each seismic event is characterized by its horizontal and vertical ground motion components, which are influenced by the nature of fault rupture, the distance between source to site, ground condition, and magnitude [29]. The structures' failure pattern can vary depending on the nature of the material used, bond strength, normal axial loading due to roof and other superstructure on the wall, placement

Table 1

Guidelines with the recommendation for seismic band location and material.

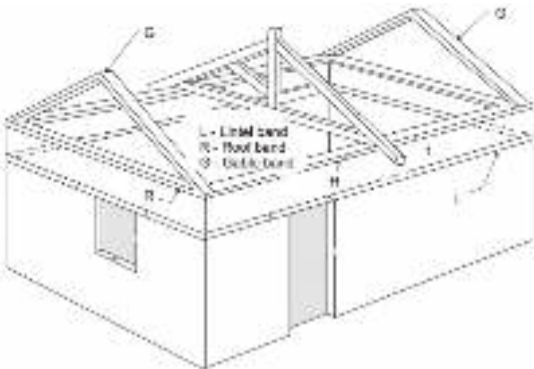
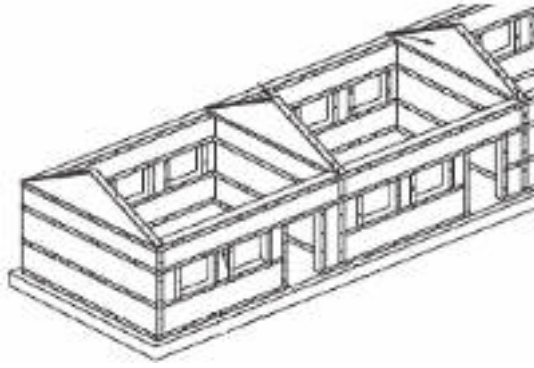
Guidelines and building codes	Seismic band material	Location
Guidelines for earthquake resistant non-engineered construction [16]	Reinforced concrete	 Lintel, Roof, and Gable
Indian standard [21]	Timber	
UNESCO Guideline [15]		
Earthquake resistant Guidelines-Afghanistan [22]		
NBC 203, National Building Code- Nepal [23]	Reinforced concrete	 Plinth, sill, lintel, roof, and gable
Earthquake resistant Guidelines-Pakistan [24]	Timber	
Building reconstruction guidelines for Nepal [25]	Bamboo	

Table 2

Dimension specification for timber and reinforced concrete band.

Timber seismic band	Reinforced concrete seismic band
Longitudinal member	
Dimension:	
75 mm × 38 mm [15,22,24,26]	75 mm thick with two longitudinal rebars 12 mm diameter
75 mm × 45 mm [25]	150 mm thick with four longitudinal rebars at lintel level
100 mm × 50 mm [27] Transverse member spacing = 500 mm	Tie spacing 150 mm c/c using 6 or 8 mm diameter rebar [15,20,22,24–27]

of opening, and seismic loading. Fig. 1 shows the global failure mode in a masonry structure when submitted by seismic loading action. However, these entire failure modes are not necessarily occurring during any event. In the case of an out-of-plane wall, the failure can be due to flexural bending or corner separation or the wall's delamination. For the in-plane wall, it could be due to diagonal shear crack, shear sliding, or flexural bending/rocking. Suppose the crack formation and propagation can be limited by any means. In that case, the structural damage can be minimized and, most importantly, save the people's lives during a seismic disaster event. One such technique is the use of the horizontal seismic band.

1.3. Advantages of seismic band

Several experimental campaigns were conducted by submitting a masonry structure with a seismic band to dynamic loading using a shaking table [31–33]. They highlighted some advantages of inserting seismic bands. Their integration in masonry structures helps to improve integrity and ductility. If regularly spaced, bands prevent crack propagation and are limited within the region separated by the seismic band [34]. Moreover, the creation of a fused interface contributes to dissipating energy with minor damage. The dissipated energy depends on the material used and the connection between elements (as observed with timber band) [35].

Having past evidence from the ancient traditional structure and some of the qualitative performance behavior of the seismic band application highlights the benefit of using it. But, few more question arises, when we check the available guidelines and codes of some nations. What should be the suitable thickness of the band? Does the spacing between the band matter? Is there any major change in the behavior when the material used as a band is changed? Answer to such questions requires rigorous analysis, which becomes difficult with the only experiment, and hence, the need for numerical modeling to carry out parametrical analysis plays a key role. The accuracy of the numerical model depends upon the constitutive laws and validation with the experimental results. Thus, our experimental campaign's objective is to obtain reliable information that addresses the structural behavior in a localized region and can help validate the numerical model in the future.

2. Materials and methodology

As per the reconstruction guidelines of Nepal [25], there are suggested using a vertical reinforcement bar at the corner and opening. However, from the study of [8], internal placement of vertical reinforcement proved

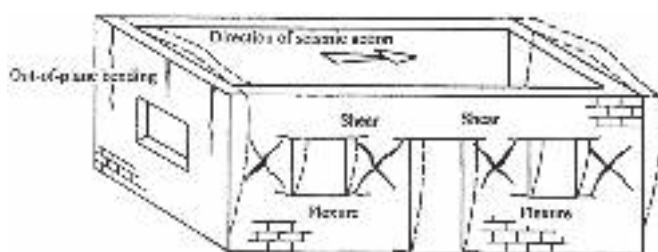


Fig. 1. Various failure mode in a masonry structure [30].

to create stress concentration and make the structure weak. Also, data from the site suggests difficulties in placing the vertical reinforcement bar. Therefore, we have considered a wallet-size sample with and without a band to determine in-plane behavior for this study. A quasi-static cyclic loading test is used to determine the influence of a horizontal seismic band in a masonry wall. The shear resistance of the wall can be obtained by applying the in-plane loading [36], but for this study, we have compared the crack surface area with the corresponding force rather than the classical hysteresis curve. The loading pattern was selected based on the recommendation of [37] for the quasi-static loading cycle. The general experimental setup is shown in Fig. 2, where the loading actuator/jack, camera setup, and specimen location are indicated. With the help of a C-shaped metallic connected to the actuator (graphically indicated in Fig. 3), it is possible to apply cyclic loading by changing the loading direction. Two masonry walls (dimension 0.91 m in length, 0.86 m in height, and thickness of 0.32 m) are built with and without a seismic band. Timber was used as a seismic band with a cross-section dimension of 70 mm × 50 mm and arranged in the form of the ladder as shown in Fig. 4 using nail connection. Earth (adobe) bricks are used to construct the walls using mud mortar with a thickness of 20 mm. A reinforced concrete stud is cast around the first brick bed, and a metallic strip is added to the ends, which is fixed using nuts and bolts. The compressive strength of brick-and-mortar ranges from 1.2 MPa to 1.4 MPa when tested individually, and with the compression test on the wallet, the average compressive strength of about 1 MPa was obtained. These values are necessary for determining the loading conditions for the test. A speckle pattern on the wall surface, which is needed for carrying out digital image correlation (DIC), is created using black and white aerosol spray paint. DIC was quite useful in the past few decades to get information at the local level without the use of any sensor on the specimen. The digital image correlation technique allows for a continuous record of cracks formation all along the displacement cycle.

A dead load of 9.8 kN is added on the top of the wall, representing that of a roof and any other structure supported by the wall. This dead mass is uniformly applied on the wall creating normal axial stress of 0.03 MPa. A cyclic displacement until a maximum amplitude of 80 mm is applied on the wall, as shown in Fig. 5, at a variable rate of displacement (see Fig. 6).

3. Results

Two masonry walls are quasi-statically loaded. The measurement of force recorded from the sensor associated with the jack and displacement recorded using the LVDT sensor at the top of the wall are used to generate a hysteresis curve, as shown in Fig. 7. From this plot, we observe that both walls' behavior is similar until 5 mm horizontal displacement, after which we notice changes in the nature of the curve. For the wall without the seismic band, the peak force value is increased more than the one with a timber band. However, the maximum displacement of the wall with the band is higher due to the wall's sliding behavior at the interface between the seismic band and the adobe brick.



Fig. 2. General experimental set up for the quasi-static test.

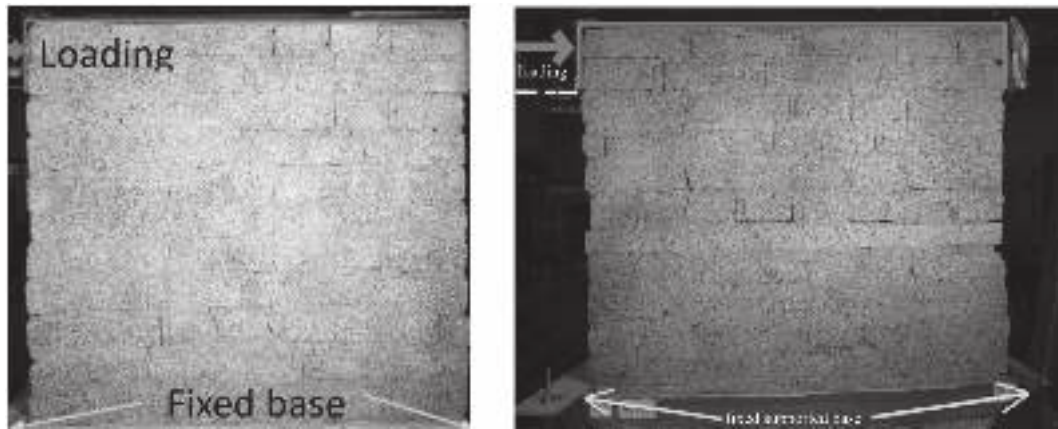


Fig. 3. Masonry wall without a band (left) and with timber seismic band (right).

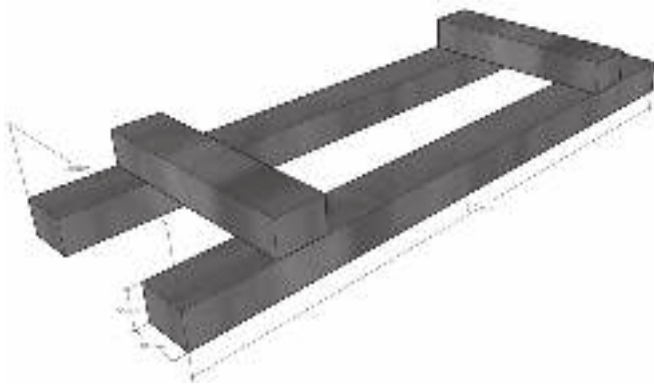


Fig. 4. Dimension of timber seismic band used.

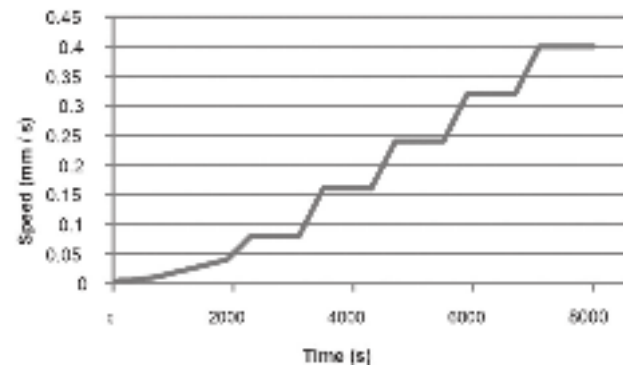


Fig. 6. Displacement loading rate.

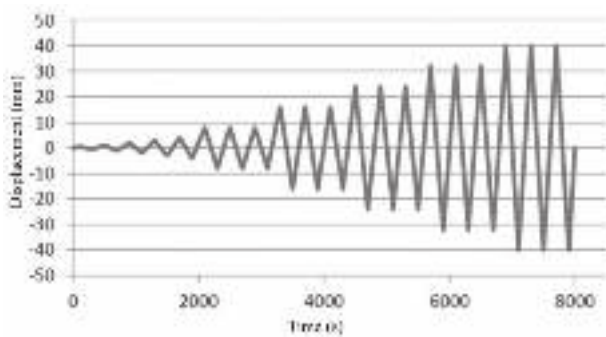


Fig. 5. Displacement sequence for the quasi-static cyclic tests applied to the jack.

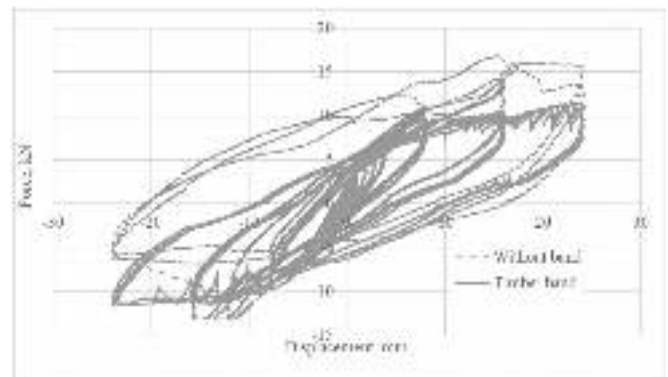


Fig. 7. force-displacement hysteresis curve.

Fig. 8 shows the same tests' envelope curves, which are constructed by taking the ultimate force values during the first cycle of targeted amplitude cycles and their corresponding displacement point. From this plot, we observe that the force value increases in both loading directions for the wall without band because the changing direction develops new crack/fissures in the sample. Whereas, for the wall with timber band, the force is higher during the first cycle with an increasing amplitude indicated by the negative force-displacement part of the curve. This phenomenon could be due to the sliding behavior at the interface of the band and brick joint.

The energy dissipation is calculated from the hysteresis curve, taking the area under the curve for three classified cycles (Fig. 10) and tabulated in Table 3. The values indicated here are the total energy dissipated by the global behavior of the wall. The value of energy dissipation by the

wall without band is more because of the more force required to reach the targeted displacement and more permanent damage on the wall.

The entire experiment is recorded with a high-resolution camera with images captured at an interval of 10 s. These images are later analyzed using the image-correlation software 'Tracker' [38]. The imaging was carried out for the only surface, but the crack propagation on both the surface was verified and observed uniformity regarding crack development. Each brick is associated with four points placed on its corners, forming quadrilateral, and the position of each brick is tracked image by image. The corner of the whole or fragmented brick was manually located by comparing the first image with the last one to avoid the error during DIC due to crack formation

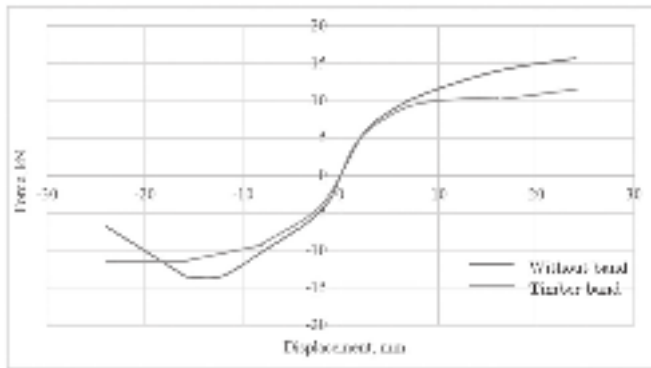


Fig. 8. Envelope curve for two wall samples.

Table 3

Energy dissipation from hysteresis curve.

	Energy dissipation, kN-mm	
	Without band	Timber band
Cycle 1	303	241
Cycle 2	848	605
Cycle 3	1653	1154

or missing part at the measurement point, which is the reason why the shape of the brick looks irregular, as seen in Fig. 9. The horizontal force's value applied on the wall at each stage is associated with the captured image in the analysis. Thus, results obtained with the two walls using DIC can be compared with the corresponding force applied at a particular instant. Fig. 9 shows the DIC output results plotted graphically using MATLAB.

As the loading in the horizontal direction is applied, the crack opening at header joints (vertical fissures) increases significantly. A process is established to evaluate the pattern of vertical cracks. Each crack is viewed as a quadrilateral made of four points, two from each side of adjoining bricks. Coordinates are calculated to enlarge the cracks only when there is a difference in the displacement values between two bricks. This displacement obtained from DIC is multiplied with the head or bed joint's length to calculate the surface area of fissures in a vertical or horizontal direction, respectively. For comparing the results of the two cases, it is important to consider deformation stages. For that, three cycles were chosen with constant displacement amplitudes, as shown in Fig. 10. The following analysis is carried out for each cycle using cracks surface area total variation in square

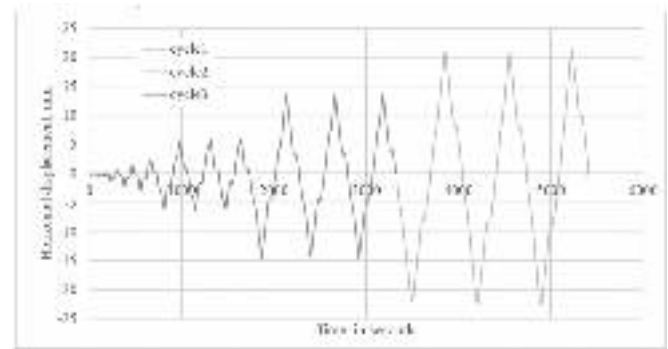


Fig. 10. Classification of displacement cycle for a wall with a band.

millimeters extending upwards in the y-axis direction, dependent on the force value in the x-axis direction. The x-axis consists of the force applied by the loading actuator. The positive part indicates pulling force (represented with positive force and displacement when the wall is moved towards the left), and the negative part indicated the pushing force (represented with negative force and displacement when the wall moves towards the right).

Four main observations can be done throughout the first loading cycle that is shown in Fig. 11. Here, the cycles are classified by the peak horizontal displacement applied to the walls, and each cycle indicated has three periods of oscillation. First, in the beginning, both walls have similar behaviors. Crack opening increases at a slow pace, and deformation is characterized by almost perfect elasticity. Bonding between bricks is still intact, so walls behave like an entire unit. Second, the wall with a horizontal band suffers 8-shaped fluctuations in the crack opening, which is due to cracks below the band that are enlarged and then closed again while slightly ripping and drifting towards permanent deformation. Third, when a force pushes the wall without a seismic band towards the right (force is negative in this case), we can see an obvious increase in the crack opening. It reveals the appearance of the first major diagonal crack in the wall without any band. We can observe sorts of steps, or a stair-like shape, while fissures jump from 100 mm^2 to around 520 mm^2 . These sharp increases are the result of abrupt disconnections between certain bricks. Fourth, at the end of the first cycle, due to the newly formed crack, not much (negative) force is needed to impose displacement in the right direction. Then, the semi-detached block of bricks smoothly glides at every displacement cycle of constant amplitude.

During the second cycle (Fig. 12), a more regular evolution pattern is observed. The phenomena previously described during the first cycle seem to predefine the behavior during the second cycle. The previous

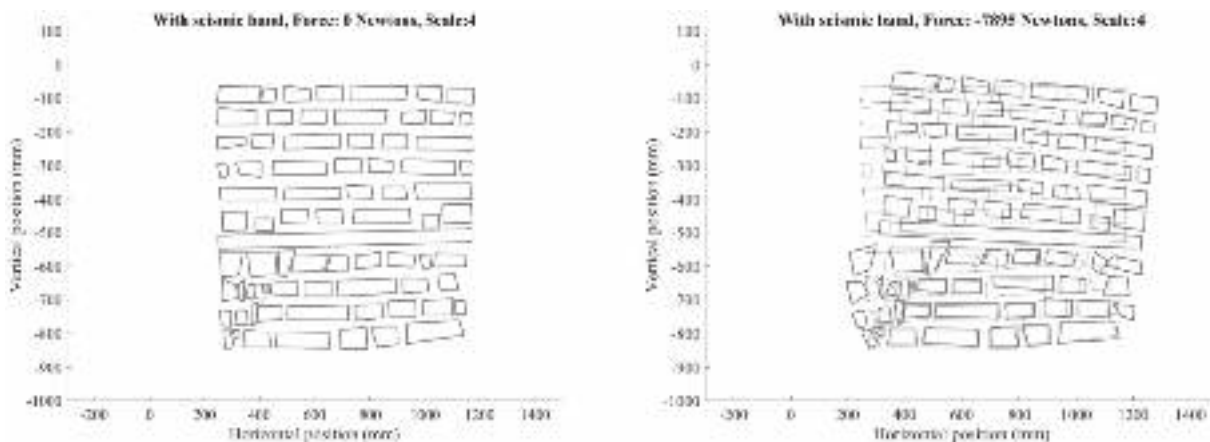


Fig. 9. DIC displacement output field for masonry wall with timber band at zero force (left) and 7.89 kN force (right).

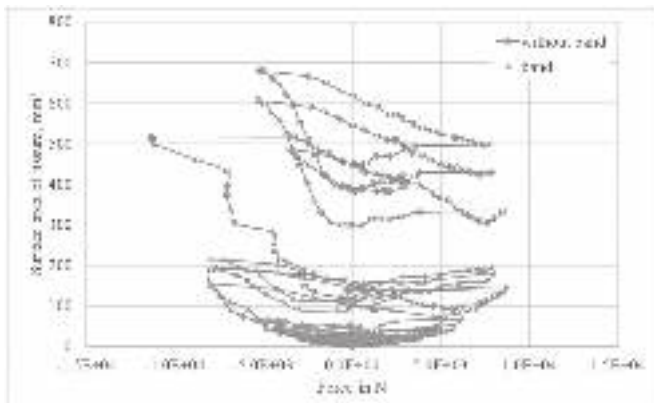


Fig. 11. Vertical fissure area in relation to the applied force during the first cycle.

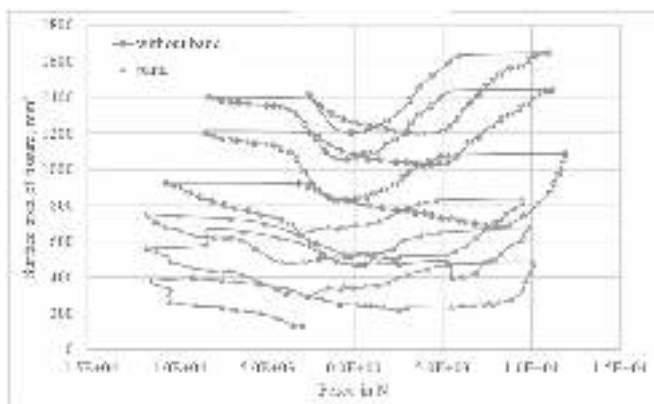


Fig. 12. Vertical fissure area in relation to the applied force during the second cycle.

loading cycle remnants are immediately noted; the surface area is around 200 mm^2 for the wall equipped with a band and around 680 mm^2 for the wall without any band at the beginning of the second cycle. The orange curve is smoother and narrower than the blue one. This shows a very gradual and stable enlargement of cracks between the bricks. On the other hand, the blue curve shows a less stable pattern.

For both the wall, the surface area of cracks increases way faster at every round. Secondly, a steep decline in the surface area of crack is noticed in every direction change of the applied force. That is because separated blocks slide back to their initial positions. Since the first crack was seen on the right side of the wall when the force is negative, both increase and decrease of crack opening follow the same trend. However, when the force is positive, the wall is pushed on the left, the first left-side cracks appear on the wall without any band. Therefore, the blue curve on the top right side of the graph increases a lot more than the orange one. The maximum surface area of fissures obtained during the second cycle is approximately 800 mm^2 and 1620 mm^2 , respectively, for the wall with a band and without a band.

During the third cycle (Fig. 13), the behavior of the wall with the band is still the same, and the orange line follows the same trend as in Figs. 11 and 12. This means that integrity is preserved in a wall with the seismic band until the end of the third cycle of displacements. The same cannot be said about the behavior of the wall without any band. The blue line shows that the crack surface area seldom decreases in value. Older cracks expand, and new cracks in the wall's inner parts are created whenever the imposed force is at its highest. Another interesting thing to notice, in the case of the wall with a band, is that while force switches directions, the crack surface area remains almost constant. This happens because both the upper and

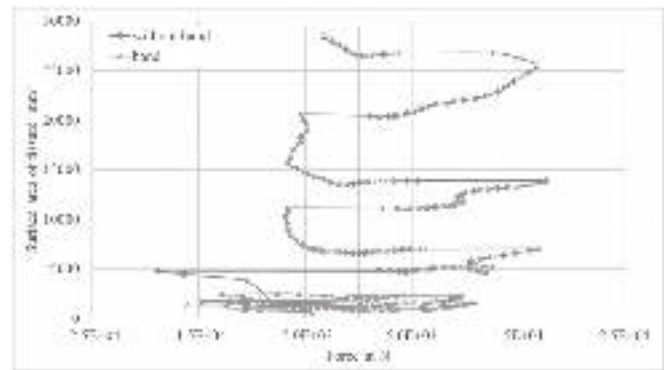


Fig. 13. Vertical fissure area in relation to the applied force during the third cycle.



Fig. 14. Wall with timber band at 4560 s of loading at peak displacement towards left.



Fig. 15. Wall with timber band at 4880 s of loading at peak displacement towards the right.

lower part of the wall has been disconnected at the band level, so instead of expanding, cracks simply shapeshift from rectangles into parallelograms (when pushed or pulled from the initial location) while covering the same surface as shown in Figs. 14 and 15.

4. Discussion

The results presented in this paper show a correlation between the dissipation energy and the amount of crack opening area. Indeed, the wall without a seismic band has both dissipation energy and a quantity of crack opening area much stronger than the wall with the seismic band. This result may seem counter-intuitive but perfectly logical because the seismic band limits the masonry's damage and makes it possible to locate the slip at its interface. Without a seismic band, the slip between the bricks is stronger, leading to both an increase in dissipation energy and a loss of structural stability of the whole. The higher crack area shows more damage to the masonry structural integrity. From this, one could conclude that the wall without the band tends to have several major cracks, which might increase the cost for retrofitting, if possible, in the structure after a seismic event. However, when the fissure surface area is small (as seen with the wall with a seismic band), the occupant's structural integrity and safety are maintained. Such structures can be easily retrofitted at a reasonable cost. The horizontal cracks have also been studied, but results are not conclusive, partly because the opening of horizontal cracks is low due to the axial loading caused by the dead mass on the wall's top. This phenomenon is also seen in the real structure where the gravitational load acting on the wall is high, and the seismic signal has significant horizontal components.

The failure occurred through the mortar joints and propagated along the horizontal and header joint. Some of the bricks were fragmented during the crack propagation, as seen in Figs. 14 and 15.

5. Conclusions

The crack opening size below 50% of ultimate displacement stays similar in both the walls (with or without timber band). After that limit, we have a bigger crack size for the wall without a band. Such cracks are not visible easily, but thanks to the DIC technique, we can capture the small variation in the displacement, which helps understand why there was a drop in the value of force after each cycle's first peak. For a wall sample with a timber band, the cracking opening change is gradual, contrary to that of the wall without a band. In the wall with a horizontal seismic band, the crack was formed in the lower part, which did not propagate to the upper part. This also highlights the benefit of a seismic band in limiting the crack, and once the crack reaches the interface with the band, it propagates horizontally, leading to a sliding mechanism between the interface of the band and the adjacent masonry layer, which helps in energy dissipation. The results of a comparison of two walls with respect to the crack opening and corresponding force are helpful to understand the shear behavior of the wall from a distinct perspective apart from the hysteresis curve, where we cannot have a detailed illustration of behavior and crack formation.

6. Perspectives

We studied the influence of the horizontal loading applied quasi-statically on the wall with and without a timber seismic band on crack opening size during this study. But further studies are needed with the use of the RC band and to figure out how such a band influences the structure's behavior. In design code, mostly horizontal seismic force is only considered, but there are some events where the vertical ground motion becomes significant. Therefore, the study on such band behavior needs to be made for both horizontal and vertical components. It would be interesting to extend the study to other types of interface material such as reinforced concrete and bamboo as per different guidelines. The preliminary study [35] shows that sliding and energy dissipation depends on the material and its surface roughness and connection type. Therefore, it is important to carry out a similar test with other materials to verify the benefits of having such a band. From this study, we saw the crack propagation, and damage in a wall with timber seismic band was limited in the bottom part (see Fig. 9). What will happen when several such sections are separated with multiple layers of the band must be investigated.

Moreover, structural behavior varies during quasi-static and dynamic loading. In the real scenario, the earthquake loading is dynamic where the damping and inertial force play a key role. Therefore, it is also necessary to investigate the seismic band's performance when impacted by dynamic loading using shaking table tests and numerical modeling for parametrical analysis. In our multi-scale experimental campaign, we are going to test the reduced scale house model using seismic band under dynamic shake table test, more quasi-static test using wallet sample, shear behavior at the interface, along with material property characterization. Similarly, we are developing a numerical model developed using a macro element that will use our experimental results and then carry out parametrical analysis of the whole house structure.

Author statement

Florent Vieux-Champagne, Eugénie Crété, and Yannick Sieffert: conceptualization; methodology; writing-review & editing. Yannick: project administration; software Santosh Yadav, Hala Damerji, and Reinold Keco: formal analysis; investigation; validation; visualization. Santosh Yadav: writing-original draft, writing-review & editing. Yannick Sieffert, Philippe Garnier, and Yann Malecot: supervision; funding acquisition; writing-review & editing.

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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Regular Article

Community-based participatory approach in cultural heritage reconstruction: A case study of Kasthamandap

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ABSTRACT

Kasthamandap, a 7th -century structure, a traditional public rest house with social, cultural, and religious significance, completely collapsed during the Gorkha earthquake of 25th April 2015. The initial reconstruction plans of Kasthamandap were not satisfactory, as they contradicted the traditional construction system. Therefore, the public protested against the proposals and insisted on using traditional methods and materials with community involvement for maintaining its value and originality. This paper focuses on challenges and discusses the learning of a community initiative in rebuilding Kasthamandap. The paper presents an exemplary participatory heritage rebuilding process, a learning to heritage reconstructions for the future.

1. Introduction

Kathmandu valley is rich in cultural and natural heritage. Kathmandu valley, one of the World Heritage Sites in Nepal, has seven monument zones and Kathmandu Metropolitan City (KMC) shares a significant portion of them (e.g., Kathmandu Durbar Square, Pashupati, Swayambhu, and Baudha). Kathmandu Durbar Square area has numerous temples, palaces, and monuments, including Kasthamandap. The Gorkha earthquake in 2015 and its aftershocks caused enormous damage to heritage structures. Seven hundred fifty three heritage sites of immense socio-cultural and religious values were destroyed ([7], Bhagat et al. 2019). Major monuments in Kathmandu's World Heritage Monument Zones were severely damaged, and many collapsed, including the Kasthamandap [22]. (See Fig. 1).

Kasthamandap is the oldest public building in Kathmandu Valley, with a traditional tiered-roof style structure reflecting the Newārī¹ Architecture of Kathmandu valley. [8] Kasthamandap carries significant emotional, religious, and cultural values in Kathmandu. (See Fig. 2).

Despite Kasthamandap's high heritage significance, the government disclosed a reconstruction plan for the monument a year after it collapsed. A group of self-motivated locals launched campaigns to motivate the

government agencies to emphasize and prioritise the rebuilding of Kasthamandap. Department of Archaeology (DoA)² publicly displayed the proposed design at Basantapur in March 2016. In April of 2016, KMC opened a call for the contractors for the tender process as per Public Procurement Act, where construction firms placed bids and the lowest bidder would be awarded a turnkey project contract. It was estimated that the construction would take three years and cost about 192 million Nepali rupees. The reconstruction plans raised alarms, as it proposed the use of modern materials such as steel and concrete, which were undesired and against the norms of traditional construction system of timber framework and mud mortar-brickwork joinery. The plans were also in contradiction of the guidelines prepared by the DoA for the conservation and reconstruction of heritage affected by the Gorkha Earthquake 2015. Rebuilding projects, including the historical *Rani Pokhari*, *Trailokya Mohan Temple*, and *Joshi Degal*, were also halted due to local opposition, which were put with similar proposals of using modern materials disregarding the traditional building system. Therefore, the campaigners started to compel the government for the timely reconstruction of heritage, also directing their attention to the ongoing issues of malpractices in heritage rebuilding as a major concern. Furthermore, there were questions regarding transparency and ramming the projects through the lowest-bidder tender system resulting in handing over reconstruction works to contractors without expertise. Hence, a community

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¹ Belonging to the Kathmandu Valley and surrounding territories constituted the former Newar kingdom of the Nepal Mandala.

² Government organization in Nepal for the archaeological research and protection of the cultural heritage of the country



Fig. 1. Damage in Kathmandap due to earthquake on 25 April 2015 (Photo credit: DirghaMan and GaneshManChitrakar Art Foundation). Source: <https://rubinmuseum.org/page/then-and-now-kathmandu-durbar-square>



Fig. 2. Kathmandap (Source: Department of Archaeology).

initiative to rebuild Kathmandap started with a voluntary group of diverse communities demanding community-led construction.

There are many actors in the case of Kathmandap reconstruction, such as the DoA, KMC, National Reconstruction Authority (NRA),³ and community groups. This paper discusses the community-led reconstruction process of Kathmandap in coordination with these institutions. Often community participation in reconstruction work is limited to donations, voluntary labor works, and participation of the community in rituals and events catering to a narrow spectrum of public participation. The process of participation undergoes a challenge to bridge the gap between the professional's vision and the local community's expectations [2]. The reconstruction model of Kathmandap is a unique one with several challenges. The tangible and intangible aspects of Kathmandap, related to the function of *guthis*⁴ and various spaces used by them are mentioned in the paper. This paper aims to deliver this new learning and understanding of participatory heritage reconstruction.⁵

2. Methodology

This paper is ethnographic research based on the author's direct observation during the reconstruction phase of Kathmandap, right after the

³ Entity established with the main objective of rapid reconstruction of the physical damages caused by the massive earthquakes of 25 April and 12 May 2015 and their aftershocks.

⁴ A Guthi is a common interest group with collective responsibilities and privileges devised to enable the individual or group of the society to fulfill his socio-religious obligations.

⁵ Official term used for Newari language.



Fig. 3. Interaction with *guthi* members during Community Interaction and Exhibition from Oct 26–28, 2017 (Source: Rebuild Kathmandap).



Fig. 4. Baakhan Nyane Waa Program at Bhindyo Twa (Source: Rebuild Kathmandap).

devastating earthquake.⁶ Various workshops were conducted during the campaigning phase, where experts from different fields shared their knowledge and experience. Besides reviews of different studies during this phase, websites, social media, news items, and discussions with local community members, government representatives, and other stakeholders were taken into account. The authors have closely worked with different community groups and are part of the technical team in the campaigning and construction phase of the reconstruction process.

Observation and documentation of festivals and traditional ceremonies, oral stories related to the monument, public lectures by heritage experts (on history, traditional architectures, and iconography), walking heritage tours, interviews with community and professional experts, research and documentation during the campaign to rebuild Kathmandap are significant sources of information gathered to prepare this paper. (See Figs. 3–4).

In addition to hands-on experience on-site, close observation of the immediate community and a larger community in the context as a world heritage monument has been explored. The acquired knowledge is based on a bottom-up process and patterns are derived from observations, therefore, follow an inductive approach.

⁶ Name of Hindu deity



Fig. 5. Kasthamandap location.

3. Description of Kasthamandap and its significance

Kasthamandap, also known as *Mārusatah* (in Nepal bhasa) is centrally located in the historic urban settlement of Kathmandu. The name of Kathmandu valley was derived from Kasthamandap. It is an architectural marvel of timber artisanship. Kasthamandap serves as a palimpsest to the history of millennia. The large wooden pavilion, used as a rest house for traders, is located at the crossroads of two ancient Trans Himalayan trade routes that connect China and Tibet to India, and intersects two ancient towns of *Yambu* and *Yangal*. [15]. Kasthamandap has served both religious and secular functions. The foundation of Kasthamandap was built in a mandala form as suggested by its name Mandap [19]. The sanctum which was revealed during the excavations done in 2015 and 2016 [3] proved the existence of the nine-pit *Navakunda* foundation.⁷

Kasthamandap gained religious significance after the establishment of the Guru Gorakhnath Statue in 1465 CE. It also housed Ganesh idols representing major Ganesh of Kathmandu including Jal Binayak, Karyabinayak, Suryabinayak, and Ashok Binayak. Kasthamandap might have been a royal council hall and coronation pavilion [17]. It also functioned as a marketplace as seen in the old paintings by Rajman Singh Chitrakar 1844 CE and H.A Oldfield 1880 CE. Therefore, Kasthamandap stands as a witness to the ever-changing society of Kathmandu to date.

Intangible heritage such as festivals and Jatra that takes place in Kathmandu played a significant role in helping people cope and adapt to disasters after the earthquake [6]. The practice of different social and cultural activities around Kasthamandap has been continued throughout the phase of its reconstruction that includes the celebration of Indra Jatra festival (*Yenyaa* in Nepal bhasa), the annual chariot procession of *Seto Machhindranath*, a procession of *Māru Ganesh*, *Gai Jatra* and most major festivals. This monument, along with other historic urban landscapes, encompasses the essence of a traditional settlement amidst the usurping modernity.

3.1. Guthis of Kasthamandap

Guthi is an institution created to accomplish a job collectively. Religious Guthis were created to perform worship rituals [23]. During the

campaigning of the Kasthamandap rebuilding process, eight different *guthis* or community groups in direct association with Kasthamandap, were identified. Among them, three major *guthis* of Kasthamandap are required for diligent upkeep of the structure and the traditions. *Ta: Chatan guthi* and *Sa guthi* are currently active, and the third one, *Manandhar guthi* is not much active [7].

Interviews, workshops, and interaction with community groups were undertaken at different phases to collect information and for further verifications. The collected data were discussed in closed workshops with community members held on 26th and 28th October 2017. The output of the workshop was displayed for public reviews for the further development of reconstruction and management plan of Kasthamandap on 29th October 2017 at the open square premises of Maru area.

Members of *Ta: Chatan guthi* are the people of the Tamrakars community of Piganani. They carry out a special two-day ritual of cooking sacred rice inside Kasthamandap and store it overnight in the northwest room on the ground floor of Kasthamandap. The Newar Buddhist community of Kathmandu celebrates *Panchadaan*⁸ on this day. *Bajracharyas* and *Shakyas* from different places come and gather around the wooden mandap⁹ and wait for the blessed rice and other offerings. These activities would be held inside Kasthamandap, but after the earthquake, they were held outside. Kasthamandap acts as a center for several religious and cultural activities of local communities.¹⁰ (See Fig. 6).

Another important Guthi in Kasthamandap is *Sa Guthi*. On the occasion of *Magha Sankranti* or *GhyaChakuSanlu* (in Nepal bhasa), this Guthi carries out the ritual of feeding grains to cow in front of Kasthamandap. On the day, the *guthi* members climb up to the top of the Kasthamandap to hoist a flag (*dhvāy*) and distribute/ spread food items like *chatamari*, *yomari*, and *lochamari* in four directions of Kasthamandap. The ritual of hoisting the flag is the reminder of the monitoring of the price of the two commodities, salt and oil [12] (See Fig. 7). The collapse of Kasthamandap did not stop the locals from performing the ritual, which was carried out on the roof of the temporary covering in the center. The *Manandhar guthi* were the original members responsible for the flag hoisting ritual on *Maghe Sankranti*. They also used to pour mustard oil from the pinnacle on the

⁸ alms giving five types of offerings

⁹ raised platform made from four planks of wood

¹⁰ first day of the Nepali month of Magh

⁷ A religious and cultural procession



Fig. 6. Ta: Chatan Guthi Preparing for Panchadaan (Source: Rebuild Kasthamandap).

same day, which was associated with the maintenance work of the Kasthamandap by *Guthi*. However, they no longer perform these rituals.

The other defunct *guthis* identified are the *Gorakhnath community*, *Kapali Guthi*, *Mahabali Guthi*, *Manandhar Guthi*, *Maru Kisan Guthi*, and *Pachali Bhairab Guthi*.

4. Overview of community-based participatory approach

Community is conceptualized as involving a social group of any size whose members reside in a specific locality sharing a common heritage or set of values, such as with a shared cultural identity or with political bonds or often referred to as a community of interest. Participation is the



Fig. 7. Sa Guthi Members performing rituals on Maghe Sankranti (Source: Rebuild Kasthamandap).

act of engaging in and contributing to the activities, processes, and outcomes. [10].

Different community-led reconstruction initiatives for various monuments were witnessed right after the earthquake. The user's committee led the Community-led reconstruction. One of the examples is from Ashok *caitya*¹¹ in Thamel, the restoration was attempted before the earthquake and was restarted after the earthquake. Since the old *Guthi*, which took care of the stupa was defunct, a new committee was formed and registered at the municipality office with some members from the old *guthi* involved and commenced the restoration with a permit from the municipality. It had partial funding from the municipality and other donations from the committee. A few from many community-led initiatives are restoration works at *Bauddha Stupa*, *Maitripur Mahavihara*, *Taranidevi temple*, and *Ashok Binayak dyochhen*.

The importance of community participation in heritage reconstruction has been highlighted in various papers and articles, [20,4,11]. There has been a wide coverage of issues of Kasthamandap in national media, research papers on identity and heritage [15], the importance of cultural heritage in Post-disaster settling [7], Post-Disaster Reconstruction challenges, and Influencing factors [16]. All of these suggest that public participation should encourage the public to have meaningful input in the decision-making process.

Nepal is highly susceptible to earthquakes [13] and experiences major earthquakes every 50 to 70 years [1]. Our ancestors had realized the possibility of damage to heritage due to earthquake. They had commissioned *guthis* for conservation and maintenance of heritage resources along with other activities such as organizing festivals, handing over artisanship, teaching traditional dances and music [11]. The fund for up keeping of such tradition was entirely based upon revenues from farmlands, entrusted upon the *guthis*. However, with the establishment of Guthi Sansthan, all the land under *guthis* came under the authorities of the Nepalese government [14]. This took a massive toll on the revenues generated by the *guthi* lands, which meant less or no money, but the responsibilities were still intact to upkeep the traditions guided by the communal *guthis*. Community participation, which is often in conversation about heritage conservation practices, was already being implemented in the *guthi* system. Newari *guthi* are incredibly important to the structure of society and for the cultural heritage in the Kathmandu Valley (Toffin, 292). The new generation of the *guthi* members gradually lost interest in such voluntary jobs, benefitting the government organizations solely. The role of such *guthi* is considerably reduced in the state's administrative structure. As a result, several monuments were left without their traditional custodians before the 2015 earthquake; the structures were often neglected for their periodical upkeep, which caused irreplaceable damage to those monuments during the earthquake. Therefore, available social capital and revival of traditional patterns of heritage conservation through community participation is essential in Kathmandu [11].

4.1. Post-earthquake community-led activities in Kasthamandap

On 25 April 2015, the day of the earthquake, a blood donation program was being held in Kasthamandap like any other Saturday. As the disaster struck, ten people lost their lives under the debris of Kasthamandap. As soon as the earthquake struck, people were busy with rescue and relief operations. Armies and local people rescued and cleared the rubbles from Kasthamandap (See Fig. 9). For a brief time, some locals set up camps on the top of the Kasthamandap ruins.¹²

Excavators used to remove debris from Kasthamandap during the rescue and relief activities could have caused irreparable damage to the foundation (See Fig. 8). Few months after the earthquake, the Government of Nepal set up the autonomous body-National Reconstruction Authority for the reconstruction and rehabilitation process in different sectors. Some foreign reliefs put particular interest in reconstructing important heritage sites

¹¹ a shrine, sanctuary, temple or prayer hall in Buddhism

¹² Worshipping ritual



Fig. 8. Volunteers carrying the body of a victim from the debris in front of Kasthamandap and excavators clearing site for rescue operation (Source: AP Photo/ Niranjan Shrestha).



Fig. 9. Rescue work at Kasthamandap right after the earthquake (Source: <http://ecs.com.np/features/why-kasthamandap-matters>).

where Kathmandu durbar square is primarily taken care of by the Chinese and US Aid. Patan Durbar Square is receiving funds from the Japanese Government and is coordinated by KVPT (Kathmandu Valley Preservation Trust), while reconstruction drive had started in Bhaktapur as well [5]. However, Kasthamandap was not the priority of the government, and received no media attention. [15]

Self-motivated individuals and groups then launched campaigns to push the government and drive attention towards Kasthamandap. They showed immense solidarity towards Kasthamandap reconstruction with full justice by recognizing the vernacular techniques and construction methodology native to Kathmandu Valley.¹³ A small-scale model of Kasthamandap was prepared by artist Hira Ratna Brahmacharya and was handed over to KMC. Meanwhile, Ar. Wolfgang Korn also gave his measured architectural drawings of Kasthamandap on 7th November 2015, a part of his book, [9] asserting its importance to the national identity [15]. In December 2015, a UNESCO-funded archaeological team

from Durham University excavated the Kasthamandap site, which further helped understand the construction, cause of the collapse, and additional history of Kasthamandap [3].

On 19th December 2016, locals organized a Saptabidhanottar Puja with 185 Bajracharya priests, and called the community to join forces in rebuilding Kasthamandap. The momentum to rebuild Kasthamandap in public participation increased after the puja with the involvement of volunteers from different fields. After the discussions with National Reconstruction Authority (NRA) and DoA, the need for a formal organization to carry out the reconstruction work more efficiently and transparently was realized. Therefore, as a requirement to work with DoA, a formal non-profit organization was registered in the name “Campaign to Rebuild Kasthamandap” (hereafter referred as CRK synonymously) for proper procedures with the government entity.

Marking two years from the day of the Gorkha earthquake on Baisakh 12th, 2074 (25 April 2017) the campaign-conducted mega event, starting from *Kumari* House declaring the commencement of rebuilding. Before the event, a series of workshops had been organized to bring in volunteers from all over Nepal and the world to form a community equipped to rebuild Kasthamandap, retaining its integral values. There was a huge support, and people pledged for community-led reconstruction. After a series of discussions with the NRA, KMC, and DoA officials, a four-party agreement was signed. The agreement designated CRK responsible for construction work, and DoA and KMC as supervisory bodies. The signing event was held in NRA Hall, in the presence of the Minister for Industry, government officials, and dignitaries from different fields on 12th May 2017. The event was two days before local elections, and political dynamics changed, which later led to unpredicted disturbances in rebuilding of Kasthamandap.¹⁴

After the local elections of 13th May 2017, the working modality again had to be reconsidered as there was a new political dimension. Series of dialogues were conducted with KMC and the CRK. There were claims from both sides for the opportunity to rebuild Kasthamandap. CRK had already proceeded with the research works and drawings were prepared in coordination with experts and local communities. The CRK team, made up of part-time volunteers, had prepared the complete set of architectural drawings of each floor, and the foundation, taking reference from photographs of the building elements and in consultation with senior architects, master artisans, archeologists and historians. The team worked on the detailed drawings, and the computational and modeling aspects to assess the structural integrity using traditional construction materials and methods. However, KMC declared that the rebuilding process should be under their direct involvement. There were disagreements from the CRK side regarding this decision. However, the assurance of rebuilding the monument with community involvement, and with use of traditional materials and techniques, and no contract-based reconstruction made the campaigners agree upon the decision and stepped back for KMC to proceed further. (See Figs. 10–11).

Therefore, the campaign's role was limited to documentation and research on intangible heritage related to Kasthamandap and oversaw the activities of the newly formed committee Kasthamandap Reconstruction Committee (mentioned as KRC hereafter). KRC was formed on 1st May 2018, led by Hon. Rajesh Shakya, member of the provincial parliament. A new agreement was signed by KMC and KRC on 12th June 2018 to proceed with the reconstruction work. KRC, including local community members, *guthi* members, and experts, continued their support towards the reconstruction procedure.

The transition from CRK to KRC saw the change of working mechanism with the community, but the overall sentiment of rebuilding the monuments using traditional materials, artisans, and communities were ensured. The rebuilding process so far has seen the community-based model of KRC, which includes more than 55 members from 4 wards that share the boundary of Kasthamandap. The various sub-committees consist of those members overseeing the day-to-day rebuilding process of Kasthamandap. The KRC committee is overarched by a steering committee chaired by the Mayor of

¹³ A young girl worshipped as goddess

¹⁴ Smallest administrative division of the local government



Fig. 10. Saptabidhanottar puja on 19th December 2016 (Source: Rebuild Kasthamandap).

Kathmandu Municipality. The progress and process of reconstruction of Kasthamandap are open to all those who wish to visit. The annual progress report is publicly presented on the premises of Kasthamandap, thus trying to achieve progress transparency of the project. (See Figs. 14–15).

Heritage and conservation experts who had been involved with the CRK, continued to support the newly formed KRC. Similarly, KRC continued to involve social actors from various occupations, by addressing them into various formal sub-committees according to their preferences. The technical experts in the conservation field are consulted in every aspect of construction. The students' groups, mostly from architecture schools, volunteered the measurement and inventory of the salvaged wooden members. The army personnel helped sort and recover the wooden members from Kasthamandap, among other debris. Various social clubs, local clubs, interested individuals, organizations joined forces. Although the reconstruction modality became an issue of contention, every heritage lover wanted to see Kasthamandap being rebuilt with its original values.

Community participation has been observed in Kasthamandap throughout various programs. One of the events was the hoisting of four central posts and four central beams. The humongous task of hoisting the central four pillars and beams could have been done using modern means and technology. However, the idea was to bring the community together, therefore these four important central columns of Kasthamandap were raised amidst a large public function. Various rituals have been performed at different



Fig. 11. Oath taking and public declaration 25th April 2017 (Source: Rebuild Kasthamandap).



Fig. 12. Four Party agreement-12 May 2017 (Source: Rebuild Kasthamandap).



Fig. 13. Bamboo scaffold being assembled to cover the foundation of Kasthamandap from monsoon rain (Source: Rebuild Kasthamandap).

events during the construction period. These efforts have meaningfully contributed towards the actual concept of heritage making and safeguarding intangible heritage as well. The KRC intends to have continued efforts as such so that all the social actors retain their activities and connectivity with Kasthamandap.¹⁵

5. Issues of community-led reconstruction

Community-led reconstruction ensures the community's pride in heritage and belongingness. The objective of the community-led reconstruction is to re-establish the heritage ownership to the community, to engage the new generation in reconstruction work, and transfer traditional knowledge. and, to ensure quality in heritage reconstruction against the low bidding procurement system. It should focus on transparency and accountability.

¹⁵ Amanat system is also one of the prevalent procuring, construction systems where the government party itself procures the raw materials, hires all the technicians, and human resources for the intended construction; this system assures quality control over the tender awarding to the lowest bidder.



Fig. 14. Documentation of salvaged wooden members of Kasthamandap (Source: Rebuild Kasthamandap).

However, various issues were faced during the community-led reconstruction and are discussed here.

5.1. Conflicting roles and responsibilities

Different agencies are responsible for heritage and monuments conservation and preservation in Nepal. In Hanuman Dhokha Durbar Square, there are several government agencies within the premises i.e. Hanuman Dhokha Conservation Project, under KMC, DoA, Hanuman Dhokha Museum directly working under cultural and heritage preservation works, Nepal Army, Nepal Police, and Department of Tourism.

There had been confusion regarding the jurisdiction area at the initial stage of the rebuilding process of Kasthamandap. The path that goes from Maru to Ason divided the monuments' responsibility; the eastern part was under DoA's jurisdiction, and the western part under KMC's jurisdiction. Therefore, Kasthamandap was within KMC's jurisdiction. Further, there were claims from different wards regarding Kasthamandap, as it lies in the boundaries of four wards 19, 20, 23, and 24, though it lies in Ward 20. As the community-led initiative started, coordination among these agencies was essential. Hanuman Dhoka Durbar Square is also one of the seven monument zones in Kathmandu valley World Heritage sites;



Fig. 15. Rituals performed in a public ceremony before installation of main four pillars of Kasthamandap (Source: Authors).

UNESCO is also one of the stakeholders. Further, Hanuman Dhoka Durbar Square had different donor countries and international organizations already working on reconstructing world heritage sites. Repeatedly there was conflict regarding who should be given the authority regarding the rebuilding process. Though a four-party agreement was reached, as mentioned in the previous section, as the reconstruction work was not able to proceed smoothly due to lack of coordination and miscommunication among the agencies and community organizations.¹⁶

5.2. Defining community

The definition of community for Kasthamandap is broad. Usually, temples and shrines belong to specific local communities; they perform daily and occasional puja rituals, and have different guthis to look after these temples. Two main guthis of Kasthamandap *Ta: Chatan Guthi* and *Sa Guthi* were still actively involved in the regular maintenance, restoration, and cultural activities. The residents of Maru Tole, a historical neighborhood, represent the immediate community for Kasthamandap after the *Guthis*. Kasthamandap is centrally located in one of the busiest areas of Kathmandu, people associate with Kasthamandap as they visit the premises for shopping, morning worshipping rituals, and observing jatras and festivals. Therefore, overall residents of Kathmandu valley belong to the community of Kasthamandap along with the heritage conservation group. Many people from diverse professional backgrounds, various age groups and caste gathered during the rebuilding process of Kasthamandap via. CRK, to contribute in whatever way they can. However, there were misunderstandings and conflicts between the immediate locals and heritage enthusiasts regarding the community associated with Kasthamandap. Later, KRC published the *Adhar Patra* (Guidelines), which recommends each person and entity who wants to work in the reconstruction to be a part of the cause, thus explaining its larger community. As Kasthamandap falls under the world heritage zone, not one specific community can own it. It is a world heritage citing to its Outstanding Universal Value (OUV). During the reconstruction process, the committee launched the work inviting all the stakeholders and people from various organizations as well as the local communities.

5.3. Level of community participation

The rebuilding journey started with the direct involvement of the community where the community itself was a decision-maker; citizens had control of power in the form of the campaigning phase. People governed the program as an institution and tried to take full charge of managerial aspects. They even planned for public funding directly flowing to the community organization, maintaining transparency and accountability. Power had to be delegated for the actual implementation of the rebuilding process from a government institution. Many problems were raised during this stage. Later, a partnership model was followed where the government entity and committee agreed to share planning and decision-making responsibilities through committees, and mechanisms for resolving impasses. This is an achievement in the heritage reconstruction process as the power is still with the citizens.

5.4. Funding

Different donor countries and international organizations pledged for heritage reconstruction in Nepal. However, fund management and procedural hassles delayed the start of the reconstruction [18]. In the case of Kasthamandap, no foreign funding was proposed. The foreign-funded projects usually have limited involvement of local experts and artisans with little or no communication with the community. Therefore, the use of foreign funding had become a major concern in the case of rebuilding Kasthamandap. Since the usage of foreign investment would lead to limited

¹⁶ Title of Centenary figure given by Government of Nepal

public participation and detach them from heritage, foreign investment was not accepted. While most of the monuments in Kathmandu Durbar Square were being built with foreign aids, e.g., Gaddhi Baithak by US Support, *Nau Tale* (9 storey palace) by China, Shree Krishna, and Maha Bishnu Temples by Japan. Kasthamandap was envisioned to be reconstructed with local resources and it was expected to meet the funding collection by crowdsourcing within the Nepalese community from home and abroad. However, this was not taken ahead as KMC provided funding for Kasthamandap.

5.5. Technology and technical guidelines

Conflicting guidelines make reconstruction a complicated affair. Experts, academicians, archeologists, and bureaucrats debate whether the damaged structures should be retrofitted or completely reconstructed. UNESCO has its guidelines regarding World Heritage sites [21], NRA has its policies, and there is the Ancient Monument Act and Regulations [18]. The proposal for the use of modern material in Kasthamandap was highly debated as Kasthamandap had already withstood several major earthquakes in the past, and this earthquake damage had occurred purely due to negligence in the previous renovation where a main wooden pillar was not connected to the foundation. Therefore, the argument in Kasthamandap was regarding justification on the use of modern materials, an urgency to research the cause of the collapse, and rational usage of new interventions if the traditional methods were proved insufficient for structural safety.

5.6. Supply of construction materials and involvement of traditional artisans

The supply of construction materials such as seasoned timber, special bricks (the original size of the bricks used were found to be (245x165x50 mm big bricks *mā apā* and 220x15x50 mm small bricks *mā apā*) were not commercially produced. It was challenging to procure such bricks as the manufacturers were very limited, and the prices of the manufacturing itself soared. Stones are usually a major issue in heritage reconstruction projects as the available stock is never adequate. Forest Act and other conservation Acts of forests and protected areas prohibit obtaining timber for construction. Also, after the new federal system, the laws of each state are different. Hence, the legal and administrative task for timber procurement was a big hassle.

Traditional artisans work individually and are not affiliated with a registered company, whereas for government projects, only formal organizations are allowed in the bidding system. Therefore, skilled artisans were never going to get a chance to be involved in the reconstruction process as per the existing provisions. Therefore, *Amanat* system of reconstruction had been proposed forward for the reconstruction. The rebuilding process is currently practicing reconstruction through KRC, which partly resembles the user's committee system in which the restoration works that need to be done are discussed in an open meeting with all the stakeholders and the public. Then the estimation of the budget is presented after a detailed survey of works to be done. The working procedure for Kasthamandap is unique among heritage reconstruction practices to date. For a grant of up to six million rupees, a share of 20% has to be maintained by the user's committee, and the rest of the 80% is borne by the government entity. However, in the case of Kasthamandap budget is approximately 200 million, which is currently funded by KMC. At present, KRC is guided by the "*Adhar Patra*" that has been unanimously agreed by every committee member.

5.7. Governance

The debate on modality to rebuild Kasthamandap came with the governance challenge. Various forms of community participation, the idea of community involvement, and the very question of who is a community raised many challenges. The initiation for the project was from CRK later, the rebuilding process was taken by KRC, chaired by Member of Parliament Mr. Rajesh Shakya, with 55 members from the community in the working committee. The honorable mayor of KMC, Mr. Bidya Sundar Shakya leads

the "*Nirdesak Samiti*" – steering committee –, which includes 11 ward representatives, NRA, and DoA.

The steering committee is responsible for the overall policy setting and ensures that the working committee is adhering to the reconstruction, accountability, and transparency guidelines. The "*Samrakshyak Samuha*" – protection committee – consists of key personalities in Nepal to whom we look up to ensure that the entire organization, including the steering committee, is working as per the norms of reconstruction and inclusion. The "*Satabdi Purush*" – Mr. Satya Mohan Joshi – a veteran in culture conservation chairs it. The "*Bigya Samuha*" – expert committee – consists of veteran heritage conservationists and technical experts who guide all the technical aspects of the structure reconstruction. Within the 55 member working committee, there are 13 sub-committees chaired by members from the working committee to ensure proper work division.

6. Achievements of community participation

As the community took the initiative of pressurizing the government, regarding the traditional construction methodology to be embraced for Kasthamandap, further scientific research was carried out regarding the strength and stability of traditional building construction, which was otherwise thought to be inappropriate for construction at the present scenario. The construction method was changed, as the tender system was scrapped and construction work is ongoing through KRC. Opinions for the necessity of reconstruction using traditional methods and materials and community involvement were realized to maintain identity, increase community belongingness, and connect the new generation with the heritage. Research and Documentation of both tangible and intangible aspects were considered at each step of the reconstruction process, which also revealed various unknown aspects of Kasthamandap.

Guthi associated hold a close relationship with Kasthamandap. *Guthi* members voluntarily participated during the initial planning phase of reconstruction work in Kasthamandap. They have been consulted with during the rebuilding phase as well. Their valuable inputs were a source of primary data and photo collections, helping with much-needed details in design and construction. Examples of such incidence were the details of the corner pavilion on the ground floor, also the opening on the third roof tier at the north side for the *guthi* members to access to the topmost finial part to attach the flag and the design of the base of the pinnacle.

In addition, at the construction site, community monitoring is allowed and site is accessible to all. Other community from other such monuments visit the Kasthamandap reconstruction site for their reference. The transition of the rebuilding process from the community-led organization to the formation of a new committee for effective and larger representation of community and institutions were lessons to be learnt from the Kasthamandap rebuilding process.

7. Conclusions and recommendations

Community participation in heritage reconstruction is essential, yet it is challenging due to conflicting roles and responsibilities, and political influence. Creating a platform for community-led reconstruction is a challenge as the present provision only allows construction companies to participate in the government procurement process. Such construction companies rarely consider heritage value. Public participation is limited to rituals and donations and involvement in the decision-making process is limited. Community-led initiative in Kasthamandap is unique as people from different communities and professional background came together. The notion of heritage reconstruction as the sole responsibility of the government, has been broken. Discussions and meetings, along with awareness, are required for creating enthusiasm in the community. Sense of belongingness, attachment towards heritage, and community bonding increases with collective efforts of the community.

In Kasthamandap, the local community within the monument's vicinity, educated with conservation facts and procedures, were the first ones to approach and raise questions to the authorities about the correct procedures

for conservation. The voice raised in favor of community engagement and awareness, quality of work, transparency in the process and against the unhealthy procurement Act boosted the fight for change in the modality of the reconstruction process. Exploration and documentation of past knowledge can be utilized for progress in the future. Comprehensive heritage management with research on both tangible and intangible aspects should be prioritized along with the rebuilding process.

The project of rebuilding Kasthamandap has become a pioneering one. It has inspired the community to lead ahead towards heritage conservation and be informed in every step of the rebuilding process. The perspective of community participation, which was limited to donations and labor contributions in most of the cases, was changed. The community became actively involved in the decision-making process and it has contributed remarkably in the design and construction phase. The community effort prevented the lowest bidding practice on a contract basis. Therefore, policy supporting such construction is required for heritage reconstruction in the future. Reconstruction of cultural heritage and monuments should not be made on a monetary basis. Retaining values and integrity is necessary. Kasthamandap is the perfect example of the resilience of the community who stepped forward to retain the values and not serve to public amnesia and blame game towards the government institutions only.

Research and documentation of both tangible and intangibles during heritage reconstruction have to be prioritized. Learning from the experience of Kasthamandap, similar platform should be created for other heritage where people can participate to the fullest. Institutional setup guidelines should be prepared based on the experience of Kasthamandap, with improvements from its learnings. The handing over of Kasthamandap back to the community or future use should have a detailed management plan of keeping up with the spirit of the place. Multiple values of such urban heritages as Kasthamandap are to be explored in the upcoming years. Coordinated government interventions, institutions, and structures of authority to restore and retain the values of Kasthamandap is always required.

Credit author statement

Rija Joshi: Conceptualization, Methodology, Data curation, Resources, Writing- Original Draft, Reviewing and Editing, Project administration
Binita Magaiya: Writing- Original Draft, Validation, Resources, Reviewing and Editing.
Alina Tamrakar: Writing-Original draft, validation, Resources.

Declaration of Competing Interest

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