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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-LAxpTW9mGJgIRz25rUWNDHdbkYk#:~:text=Highly%20Affected%20Districts,%2CDhading%2CGorkha%2CMakwanpur.>)

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

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.

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.

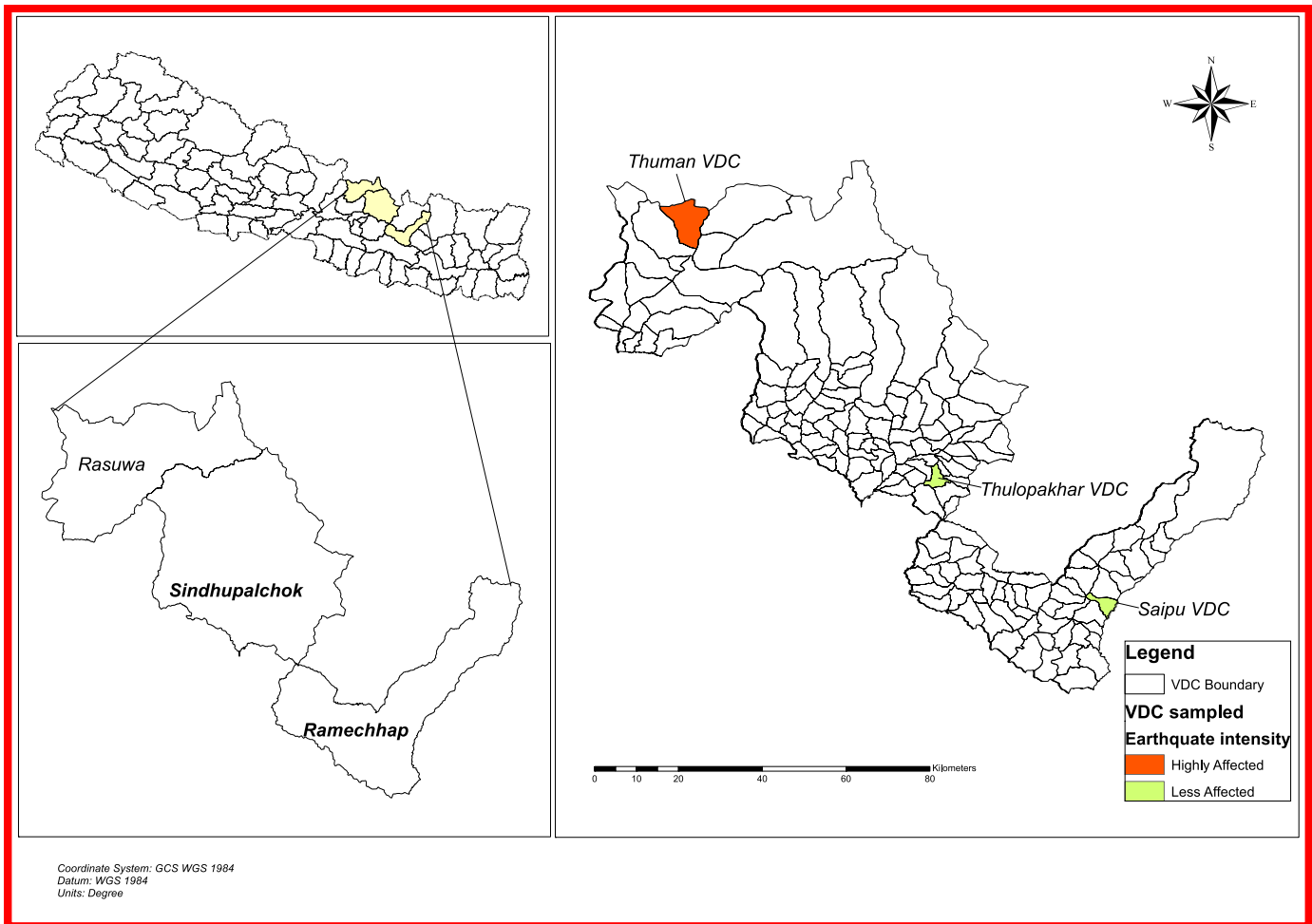


Fig. 1. Earthquake affected and non-affected VDCs selected for study. Source: Calculated from PoSHAN Survey 2013 and 2016

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

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]

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

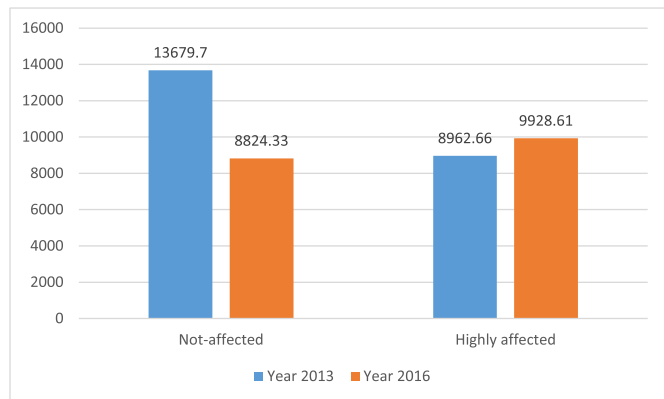


Fig. 2. Effect of earthquake on consumption expenditure by year and earthquake intensity (in NPR). Source: Calculated from PoSHAN Survey 2013 and 2016

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 δ₅ 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.

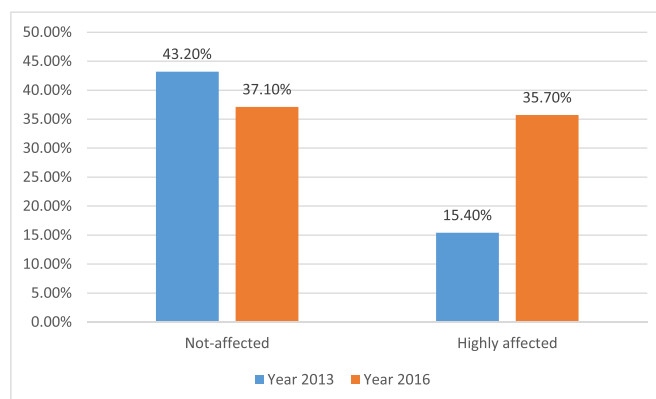


Fig. 3. Remittance as a coping strategy. Source: Calculated from PoSHAN survey 2013 and 2016.

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.

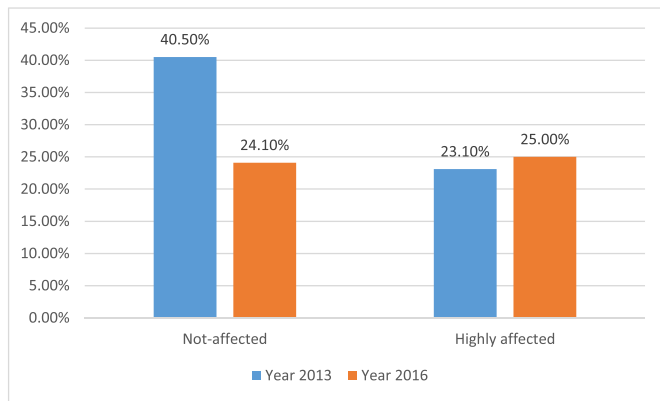


Fig. 4. Loan as a coping strategy. Source: Calculated from PoSHAN survey 2013 and 2016.

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 not-affected areas. It can thus be inferred that borrowing was also another important coping strategies the households adopted.

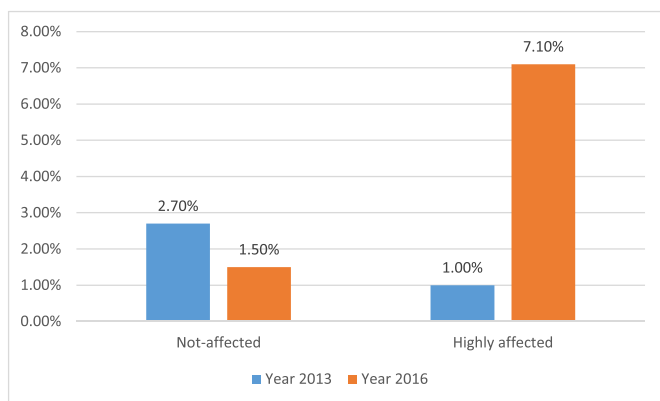


Fig. 5. Sale of assets as a coping strategy. Source: Calculated from PoSHAN survey 2013 and 2016.

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

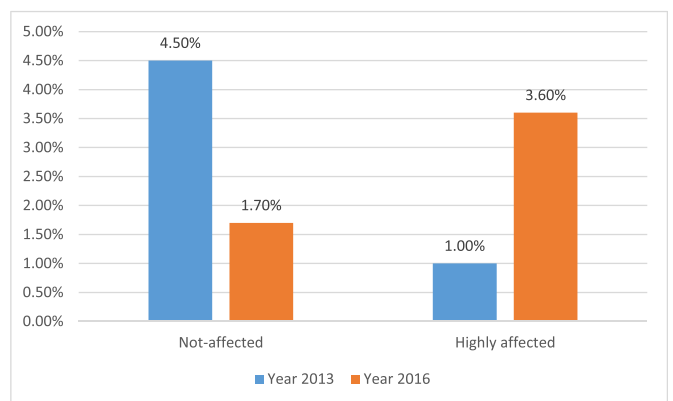


Fig. 6. Sale of livestock as a coping strategy. Source: Calculated from PoSHAN survey 2013 and 2016.

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.

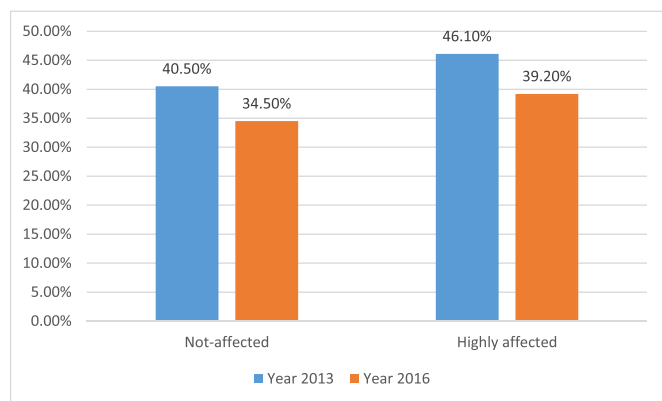


Fig. 7. Paid wage work as coping strategy. Source: Calculated from PoSHAN survey 2013 and 2016.

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.

VARIABLES	(1)	(2)
	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)	(2)	(3)
	Log of consumption expenditure		
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 vil- lage, sale of assets, and survey year 2016 is not reported because of the lack of suf- ficient observations for its estimation.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

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