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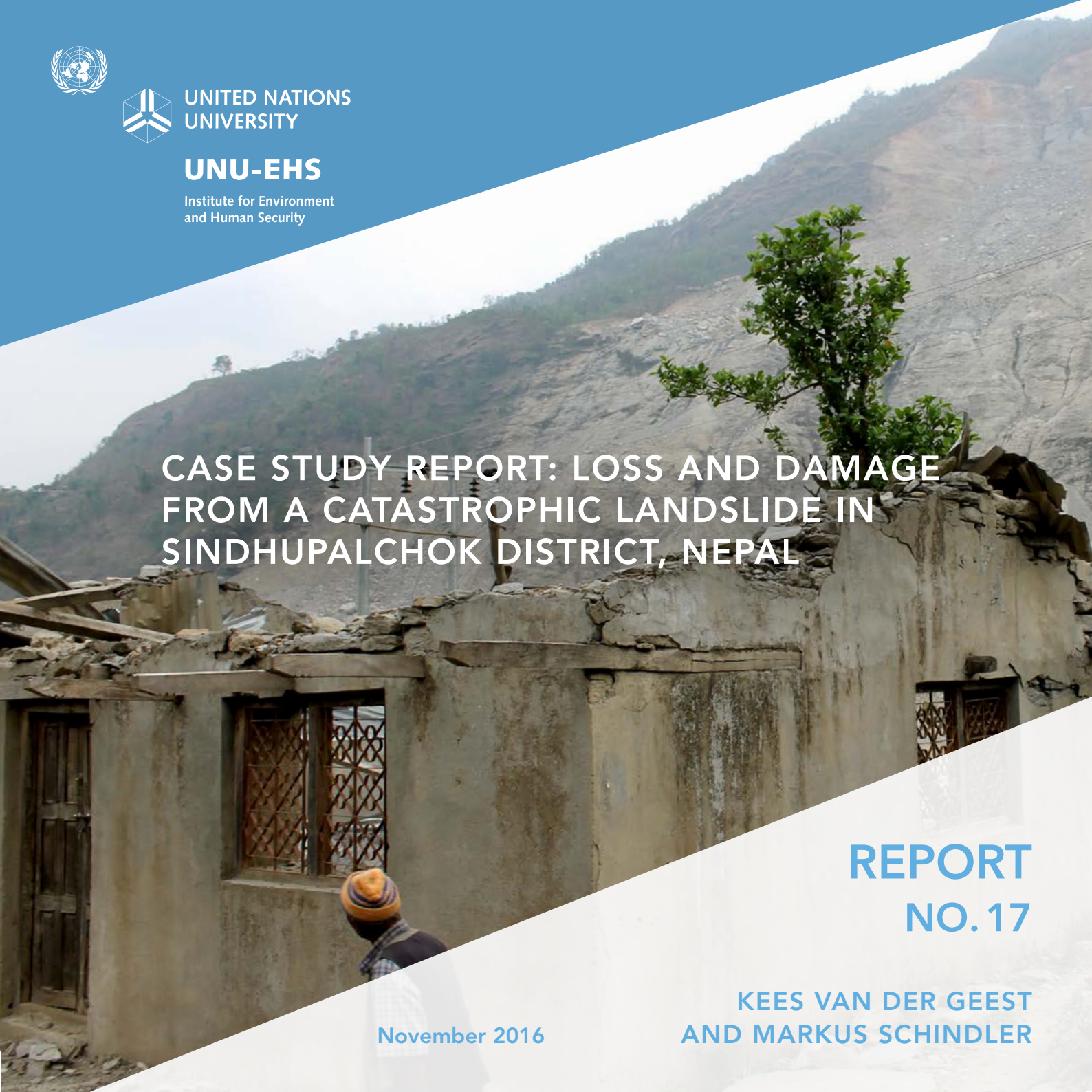

CASE STUDY REPORT: LOSS AND DAMAGE FROM A CATASTROPHIC LANDSLIDE IN SINDHUPALCHOK DISTRICT, NEPAL

REPORT
NO. 17

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Executive summary

On 2 August 2014 a major landslide struck in a densely populated area 80 km northeast of Kathmandu, the capital of Nepal. With a death toll of 156, it was one of the deadliest landslides in Nepalese history. This report presents the findings of a case study that investigated the loss and damage resulting from this catastrophic landslide. The central research question of this project is: what losses and damages did the 2014 landslide in Sindhupalchok District cause to households in the area; how effective were their preventive and coping measures; and what were the major constraints?

This research applied a mixed-methods approach, consisting of a household survey, focus group discussions, expert interviews and secondary sources. The survey was conducted in Nepal's mountainous Sindhupalchok District, about 80 km northeast of Kathmandu, where the landslide caused major destruction of houses, infrastructure and the Araniko Highway, Nepal's only road connection to China. Landslide debris created a 55-metre-high dam in the Sunkoshi river, which blocked the river flow and created a three-kilometre-long lake that inundated houses and farms further upstream.

The 234 respondents interviewed for the survey constituted all households in eight clusters around the landslide area. The typical survey respondent was a married, Hindu, farmer, born in the same village he or she lives in today, with little or no school education. Primarily, the respondents' livelihood sources were crops (96%) and also livestock (89%). However, these sources mainly provided food, and not much monetary income. By contrast, non-farm income (84%) provided most cash income. The average annual cash income from this source amounted to 855 United States dollars per household, followed by remittances (45%) that yielded $480 per year on average.

The research showed that households experienced significant losses and damages to houses and land. With 80 per cent of the sample affected, impact on crops was the most common, but led to limited losses and damages in monetary terms. Loss of soil or land was experienced by almost as many respondents (79%), and led to the most severe losses and damages in monetary terms. The mean cost amounted to more than $26,000 per affected household. The second most severe impact type, sustained by 53 per cent of respondents, was impact on housing, which led to around $7,200 in losses and damages per affected household. It was also found that the severity of impacts in monetary terms was generally greatest for the richest households in the sample (defined as households with an annual income of more than $2,000), who experienced median losses of more than $10,000. However, when viewing monetary losses relative to annual income, the poorest households (with less than $1,000 annual income) were affected most severely, as their losses amounted to up to 14 times their annual income.

The research also looked at the efforts taken by households and organizations to prevent landslide impacts and to cope with the consequences when landslide impacts cannot be avoided. For preventive measures, it was found that around 68 per cent of households that took preventive measures predominantly attempted to diversify their livelihoods in order to pre-empt the impact of idiosyncratic shocks in general. This mostly involved having household members work in areas other than sustenance farming. The majority of households who adopted this strategy perceived it to be quite effective at reducing the harm the landslide caused. However, the most effective preventive measure was house adjustments, adopted by around 21 per cent of respondents. This measure involved moving the house to locations that were deemed safer, and using stronger building materials. Other measures taken were the erection of physical barriers (adopted by around 38%), land use adaptation (by around 29%) and proactive migration (by around 5%). Among these, house adjustments and proactive migration were the only ones that were exclusively seen as effective preventive measures by respondents.

Around 86 per cent of respondents identified constraints to adopting more effective preventive measures. Respondents mostly felt that there was nothing else they could do (54%), although more than a third (35%) also gave a lack of financial means as the reason why they did not adopt more effective preventive measures. A major reoccurring theme was that respondents simply did not expect an event of such severity to occur.

Coping measures were adopted by more than 91 per cent of the sample. The most common measures taken were to make use of support or relief from an organization (73%), make use of buffers (63%) and to migrate (58%). However, selling assets and utilizing social networks, done by 7 and 40 per cent respectively, were seen as the most successful measures to cope with losses and damages from the landslide. Despite the measures taken, 55 per cent of respondents said they will never fully recover from the landslide. This was often due to the scarring loss of family members caused by the landslide, which cost the lives of 156 people. Beyond the loss of lives, many respondents suffered permanent trauma through the event. In addition, respondents who lost their house and most of their land had little hope of full recovery.

Although most respondents took up coping measures, 80 per cent identified constraints to adopting more effective coping measures. Many respondents mentioned there was nothing else they could do (54%), a lack of financial means (50%) or a lack of knowledge and other resources (20%) as a coping constraint. Only 12 per cent did not see it as a priority to adopt coping measures and 5 per cent said it was not their task to adopt coping measures.

Almost 80 per cent of respondents stated that the government or NGOs had not taken any measures to prevent landslides. Most of them thought that this was simply because no one had expected such a large-scale landslide to occur. In contrast, the government and NGOs implemented a wide range of relief efforts, mostly consisting of monetary compensation, in-kind aid and engineering work to repair the damage caused by the landslide and prevent a debris dam outburst flood. While there was the call for further measures among respondents, especially for the prevention of future disasters, most viewed the engineering work and the relief provided in a positive light. However, some respondents felt that measures lacked a long-term perspective and were not egalitarian.

This report ends with a set of policy recommendations to address loss and damage from landslides. The policy measures are classified into three types: measures that aim at avoiding landslides, measures that minimize impacts, and policy to deal with landslide impacts that cannot be or have not been avoided.

1. Introduction

1.1 What happened?

On 2 August 2014 a major landslide struck in a densely populated area 80 km northeast of Kathmandu, capital of Nepal. With a death toll of 156, it was one of the deadliest landslides in Nepalese history. The landslide had a length of 1.26 km and was 0.81 km wide at the bottom. It destroyed all land, houses, properties and infrastructure in its path and created a 55-metre-high dam in the Sunkoshi river (see Image 1). Behind the debris dam, a three-kilometre-long lake inundated houses, farms and a hydropower plant. The Araniko Highway – Nepal's only road connection to China – was severely damaged (see Image 2), which had nationwide impacts. For nine hours after the landslide, the river flow stopped entirely. Downstream, people had to be evacuated due to the risk of an outburst flood. In the days after the landslide, army engineers forced openings in the dam through digging and controlled blasting. This limited the size of the landslide dam lake and prevented more extensive damage upstream, where the town of Bahrabise was at risk. The objective of the controlled blasts was also to prevent a dangerous outburst flood, which could have wreaked havoc in hundreds of settlements downstream, all the way to Bihar State in Northern India, affecting an estimated 400,000 people. On 7 September 2014, after 36 days, part of the dam breached, reducing the water level in the lake by 18 metres. Just like the landslide, this happened in the middle of the night, at 2.30 a.m. Thanks to preventive evacuations there were no casualties, but riverside farmland and houses downstream were damaged by the outburst flood.

A more anecdotal perspective on the events is offered in a poem written about the event by a poet from the region (Textbox 1: Poem about the Jure landslide, p.10), which tries to encapsulate the prevalent perceptions and emotions during the landslide and in the aftermath of the event and helps with understanding how severely people were impacted by the landslide.

POEM
THE NIGHT MANKHA WEPT

(Author: Jagdiswor, Translater: Ram Krishna Kunwar)

1. Giant landslides tunnelled down like death in the lap of Sunkoshi
   Ramche cried at night, along with Dhuskum, Tekapur Mankha.
   All the people buried under the debris with their loved ones.
   The month of Shrawan (August) equals to Death in Sindhupalchok.
2. Mother, father, sister, grandma, niece and maternal aunt
   Uncle, brother, nephew, big brother, cousin and sister-in-law
   fields of terraced land and livestock all swept into the Koshi
   weeping all night before the daybreak died on the River.
3. Sunkoshi was stopped, houses drowned in Ramche, Jure and Dhuskun
   Those higher up were still seeing the sun
   Many lived because they ran, and others were abroad
   alive, but poor now and without a home.
4. Blocked its path, Koshi welled over, immerging settlements in water
   There was no escaping from it
   Buried by the landslides were all the industries and schools
   Where do those poor infants study now?
5. Worse was the condition due to lack of food, clothes and shelter.
   How cruel was the God! Oh what a blow!
   Three villages turned into a single cemetery
   Human tears flowed like the water of the Koshi.
6. When the giant igneous rocks dropped in its core,
   Even the mighty Koshi could not steer ahead on its path,
   Koshi became a lake so deep unknown, immersing the settlements there.
   Koshi will burst one day, may a man not stay where she runs on her way.
7. Before the mountain came down, people thought that they were safe
   Neither did the government resettle the people, no good response.
   Hearing this, the heart throbbed for all that was lost.
   The speed of the Koshi ceased before the daybreak, the Jure had spoken.
8. Neither utensils nor food, clothes or a roof at night.
   Families drowning in their grief, a lake of sorrow
   Billions of drops formed an ocean that covered their world
   Oh! Nepalese whoever able let's help with fund

Textbox 1: Poem about the Jure landslide

Image 1: The landslide debris dam

Image 2: The extent of the landslide

1.2 How could this happen?

Landslides are a common phenomenon in the Hindu Kush Himalayan Region and in the Sunkoshi valley in particular due to weak geological formations and steep topology. One informant in the study site expressed it like this: "Just like living creatures, the rocks also have an age. One day they get old and crumble."

> "Just like living creatures, the rocks also have an age. One day they get old and crumble."
>
> – A respondent –

Images 3 to 6 are historic satellite images of the landslide area. The images until 2013 are from before the landslide and the 2014 image was taken two months after the event. The light spots on the pre-landslide images depict degraded land and small landslides. These could have been warning signs that a major slope failure could occur. However, the process that leads to a landslide is non-linear – some degraded areas recover, while others eventually collapse, which complicates predicting landslide events considerably.

The Jure landslide occurred after two days of torrential rainfall (141 mm) that seeped through cracks and gullies in the mountain surface and built up pressure inside the mountain. The average annual rainfall in the study area amounts to 3,000 mm, 80 per cent of which is registered during the monsoon season.[1] July and August are the wettest months, with approximately 780 mm of rain falling during each month. The maximum amount of rain within 24 hours ever registered in the area was 166 mm on 29 July 1982. In the immediate prelude to the 2014 landslide, the torrential rainfall nearly reached this historical benchmark. This raises the question of whether global warming influences the frequency and severity of extreme rainfall events.

Extreme rainfall is a prime trigger of landslides in the Himalayas (e.g. Dahal and Hasegawa, 2008), although evidence of a link between changing precipitation rates and climate change remains inconclusive (Huggel et al., 2013). Nevertheless, "climate change effects are likely to occur faster and be more pronounced than the global average" in the Himalayan region (Sharma et al., 2009). The effects of climate change are primarily visible in an increase in the region's average temperature by 0.01°C per year (ibid), and a greater variability of precipitation (Mirza, 2010). The region's increasing temperatures lead to a rising snowline, which increases the amount of meltwater in the short term and leads to a higher risk of inundation and floods. In the long term, the amount of meltwater will be reduced once a new snowline has stabilized (Sharma et al., 2009). In the short term an increase in meltwater can cause hillside lubrication, leading to a higher probability of landslides. However, the subsequent decrease in meltwater may lower the probability of landslides in the long term.

An increasing variability in rainfall patterns complicates predictability and targeted adaptation to changing climatic conditions, as discernible seasons with regular rainfall variations are gradually replaced by random, and often more extreme, rainfall events (ibid).

However, geological preconditions and extreme rainfall are not the only factors that increase landslide risk. Unsustainable land use, the absence of effective water-channelling mechanisms and a general lack of alternatives for the local population also significantly contributed to the occurrence and severity of the Jure landslide. Satellite and ground pictures of the area show that the slope was already heavily degraded (NASA Earth Observatory, 2014) before the landslide occurred and informants reported that they had warned local authorities of high landslide risks on several occasions. Nothing was done to

1 Rainfall data come from the meteorological station in Bahrabise, a small town in Sindhupalchok District of central Nepal, 5 km from the landslide area.

Image 3: Landslide area, 2004

Source: Google Earth

Image 4: Landslide area, 2009

Source: Google Earth

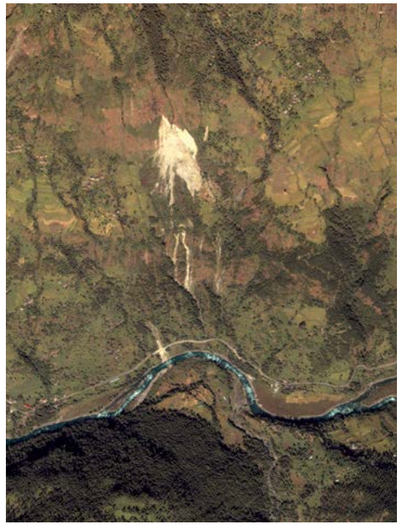


Image 5: Landslide area, 2013

Source: Google Earth

Image 6: Landslide area, 2014

Source: Google Earth

Attribution to climate change

There is no evidence of a direct causal relationship between climate change and the Jure landslide. While attribution science studies how climate change increases the likelihood of extreme wveather events (James et al., 2014), there is very little research on attribution of landslides (Huggel et al., 2012).

However, changes in precipitation and increases in the region's average temperature do have the potential to increase the risk of landslides in the Himalayan region:

1. Precipitation that was formerly stored as snow increasingly flows into the valleys.
2. Higher variability of precipitation complicates the prediction of and adaptation to extreme rain fall events.

The resulting lubrication of hillsides increases landslide probability, and exacerbates the riskiness of living in the region at large. Climate change likely increased the probability of the Jure landslide, but the event was equally the result of several other causal factors pertaining to the physical environment and human influences.

Textbox 2: Attribution to climate change

follow up on their warnings they said. Opposing this, the local authorities reported to the field team that they had warned villagers on several occasions that the area was unsafe. Poverty and scarcity of land, however, prevented them from moving to safer areas despite the known risk of landslides.

In sum, while it is certain that landslides are often triggered by extreme rainfall events, there is less certainty about whether climate change has altered the frequency and severity of such events. Climate change affects precipitation patterns globally, but the extent to which it affects regional and local rainfall patterns is unclear. Another uncertainty is the extent to which changing precipitation influences landslide risks. Moreover, the Jure landslide was caused by numerous other factors. Although climate change may increase the likelihood of landslides and other extreme events, it cannot be pinpointed as its definitive cause (also see Textbox 2, p.15).

Beyond scientific explanations, local informants offered alternative explanations why the landslide had occurred (Textbox 3, p.16). They suspect interventions of a deity and, in hindsight, some recognized foreshadowing warnings or other signs of the Gods, which many say should have made evident what was to come, or what was to be done. A selection of three alternative explanations are outlined in Textbox 3 (p.16).

1.3 Loss and damage: Conceptual framework

"Loss and damage" is an emerging topic in climate change negotiations, research, policy and implementation of climate change action (Roberts & Pelling, 2016), connecting the fields of climate change adaptation and disaster risk reduction. Building on an earlier definition by Warner and van der Geest (2013), in this case study report we define loss and damage as:

Adverse effects of climate-related stressors resulting from insufficient capacity to reduce the risks associated with climatic stressors, to cope with impacts of climatic events and to adapt to climatic changes.

Though there is much overlap between impacts of climate change and loss and damage from climate change, the two terms are not exactly the same. The concept of loss and damage emphasizes that currently, many avoidable impacts are not being avoided, while some impacts cannot be avoided even with large improvements in mitigation and adaptation policy – and hence need to be addressed retroactively (Roberts et al., 2014; Zommers et al., 2016).

Folk explanations

Sacrilege

Nagraj, the Hindu Serpent God of rain, appeared in the area that was hit by the landslide when people were butchering cows. Eating beef is against Hindu tradition and not heeding the snake's warning led the perpetrators to their untimely death by the disaster. Other accounts describe how a tyre-sized snake was killed with hits on its head, which split into five heads shortly before it died, spelling doom for the killers of cows and snakes.

The Children

A different event was reported by the Nepalese Army, which, while working to open the dam, spotted some children walking across the river in the landslide area. When they embarked on the river to save the children, they had disappeared. Following this event, a Mataji (a 'God-driven') lady declared that the water would not flow out of the blocked lake until the children were found, and trying to release the water will provoke painful repercussions. Finally, the Serpent God was seen flying eastwards at lightning speed, before water burst out of the landslide dam in early September.

Acts of the Creator

People told of the God of all Gods (Mahader), who visited the valley and blocked the river because he wanted to take a bath, which caused the creation of the dam lake. Other explanations have it that Mahader, the Creator, Ruler and Destroyer of the world, sought to liberate people who died in the landslide.

Textbox 3: Folk explanations for landslide occurrence, reconstructed by Ram Krishna Kunwar

The conceptual framework of this report is outlined in diagram 1 (p.17). It builds on earlier findings from empirical work on loss and damage from climatic stressors in rural Africa and Asia (van der Geest & Warner, 2014, 2015).

Starting with "Normal opportunities, risks and constraints of the environment", households can adopt specific livelihood strategies and preventive measures to brace themselves for disasters (Ayeb-Karlsson et al., 2016). After a sudden-onset event like a landslide, the first instance of losses and damages incurred (LD1) are those that could not be prevented by preventive measures taken. Following the first-order impacts, those affected may employ coping strategies to mitigate impacts (Warner et al., 2012, 2013). These potentially entail second-order impacts (LD2), as coping strategies can involve costs and/or adverse effects, such inability to repay a loan (Opondo, 2013;). The chain is concluded with the post-event household vulnerability, which then determines a household's capability to adopt adequate livelihood strategies and preventive measures, as the cycle begins anew.

Loss and damage:

Adverse effects of climate-related stressors resulting from insufficient capacity to reduce the risks associated with climatic stressors, to cope with impacts of climatic events and to adapt to climatic changes.

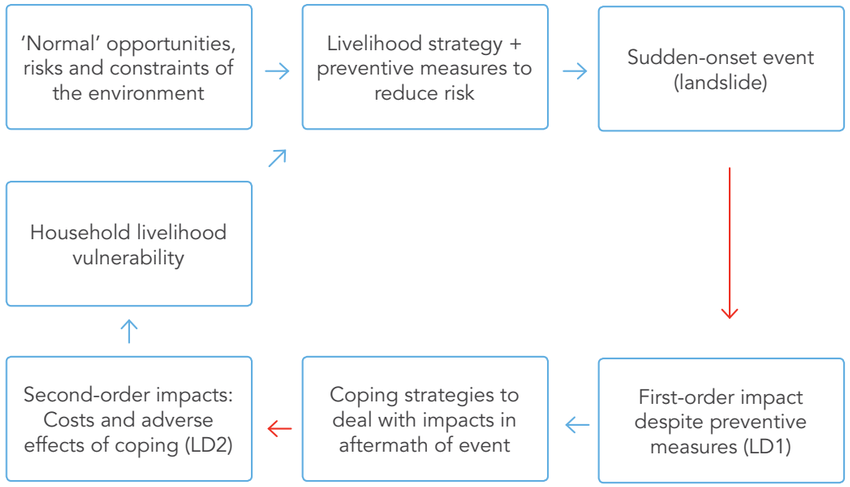


Diagram 1: Conceptual Framework on Loss and Damage

Source: Authors' own

1.4 Research questions

The central research question addressed by this study is the following: What losses and damages did the 2014 landslide in Sindhupalchok District cause to households in the area; how effective were their preventive and coping measures; and what were the major constraints? To answer this question, sub-questions were formulated, organized in five domains: prevention, impacts, coping, vulnerability and policy.

→ Prevention:

- What measures did households and organizations adopt to prevent landslides and minimize impacts?
- How effective were these measures?
- What were the major constraints to adopting effective measures?

→ Impacts, loss and damage

- How did the landslide affect households in the area; what types of impacts did they incur?
- How were landslide impacts distributed spatially?
- What was the monetary value of the losses and damages households incurred?

→ Coping

- What measures did households and organizations adopt to cope with landslide impacts?
- How effective were these measures?
- What were the major constraints to adopting effective measures?

→ Vulnerability

- Can household vulnerability indicators predict the incidence and depth of landslide impacts at household level?
- Can household vulnerability indicators predict the uptake and effectiveness of preventive and coping measures?

→ What can government agencies and NGOs do to help improve landslide prevention, minimize impacts and address residual loss and damage?

1.5 Outline of the report

The structure of this case study report broadly follows the conceptual framework and research questions. After introducing the study area and the methods used for this research, we describe the livelihoods of people in the area and analyse their vulnerability to landslides. The next section is about the preventive measures that households and organizations adopted to avoid landslides or to minimize impacts of landslides. We look at the types of measures that were adopted, how effective these were, and what constraints people and organizations faced in adopting more effective measures. The following section is about the impacts of the catastrophic 2 August 2014 landslide and outlines how the landslide affected different aspects of people's livelihoods in general and by looking at the spatial distribution of impacts. Further, monetary losses and damages are analysed spatially and in relation to wealth groups. This is followed by a section on coping and relief measures, with sub-sections on effectiveness and constraints. We conclude the report with a set of policy recommendations and suggestions for future research.

Findings are structured according to chronological order, starting with preventive measures, followed by the impacts of the landslide, and ending with coping strategies and relief.

Image 7: Enumerator conducting an interview

2. Methods

Results are primarily based on a household survey with quantitative and qualitative assessments by 234 respondents. The fieldwork team further conducted expert interviews and focus group discussions and consulted secondary sources to encapsulate the complexity of the situation as adequately as possible. The methods are explained in more detail in this section.

2.1 Household questionnaire

The household surveys were conducted after a three-day training session by the principal investigator, when a team of five enumerators interviewed 234 respondents between 26 March and 6 April 2015. The questionnaire encompassed 13 pages and took 45 to 60 minutes to complete. Design and structure of the questionnaire were informed by the conceptual framework and research domains for this study. Throughout the questionnaire, the intention was to strike a balance between enabling quantitative measurements and facilitating qualitative understanding of loss and damage. For key topics such as landslide impacts and the effectiveness of preventive and coping measures, we started with open-ended questions, in order to better capture the respondents' perspective on the events. These were followed by more detailed closed-ended questions aimed at quantifying loss and damage and the effectiveness of household risk management.

The questionnaire for this fieldwork was based on a template questionnaire that was developed by the principal investigator

for the overall project, aimed at designing a handbook for assessing loss and damage in vulnerable communities. The questionnaire has two parts. Part one starts with basic socio-demographic data and then continues with questions that feed into ten vulnerability indicators, which are aggregated into the multidimensional vulnerability index (MDVI). Part two assesses loss and damage from climate-related events, with regards to preventive and coping measures, their effectiveness and constraints. The third and last part of the survey has open questions about respondents' perceptions of vulnerability and recommendations for future actions that could be taken by organizations or the governments to protect people against landslide impacts.

The methods intend to strike a balance between enabling quantitative measurements and facilitating qualitative understanding of loss and damage.

2.2 Survey sample

The expert interviews in Kathmandu and informal interviews upon arrival of the researchers revealed that the impacts of the landslide varied greatly by location. The consequences downstream were different from upstream, and around the area that was covered by the landslide and its debris. Hence, the team decided to select survey areas in a purposive way, based on which areas were generally affected by the landslide. Within those designated areas all households were interviewed, so as to maintain randomness in the overall sample. The location of survey households is shown in Image 8 (p.23). Expert interviews were also used to cross-check information gained from the field survey. For example, the estimated average value of lost land seemed exceedingly high relative to incomes in the area, but were confirmed as accurate by the consulted experts.

Locations are divided into eight different clusters (see Table 1, p. 22) for number of interviewed households per cluster). Image 8 (p. 23) shows the clusters and the legend provides the number of households we interviewed in each cluster. As said, all households in the clusters were interviewed. The only exception was the "Upstream" cluster, as the first eight interviews showed that people had hardly been affected by the landslide and hence could not provide input relevant to the research.

The cluster called "Camp" consisted of two sub-locations, which were both on the premises of a closed magnetite factory. The dots on the left are households which were relocated to the old barracks of the factory workers and the dots on the right are households who were living in tents.

"Damsite" as a cluster was formed in the analysis phase when we found out that households living near the road and river, left and right of the landslide area, had experienced similar impacts that were different and more severe than for adjacent households higher up on the slope.

In each household we interviewed the household head (67%) or the spouse (27%). In exceptional cases (6%), a son or a daughter of the household head was interviewed. Selecting respondents that were not considered the head of the household was deliberate, and aimed at avoiding a male bias in our research results. If we had interviewed only household heads, 80 per cent of our respondents would have been male. By contrast, in our sample, 47 per cent of the respondents were women.

CLUSTER	NUMBER OF INTERVIEWED HOUSEHOLDS
Downstream	31
Camp	35
West	38
Damsite + Damsite Lake	23
Opposite Bank	30
Opposite Lakeside	48
Crown	21
Upstream	8

Table 1: Number of interviewed households per cluster

Source: Authors' own

2.3 Other methods

Other methods employed were focus group discussions, expert interviews and the use of secondary sources. The focus group discussions provided input to the participatory evaluation of adaptation (PEA) analysis. This research tool was developed by the authors, but based on earlier work of the Participatory Assessment of Development (PADev) Project (Dietz et al., 2013; Pouw et al., 2016). The PEA analysis aimed at assessing the ability (and constraints) of existing adaptation and disaster risk reduction projects to protect people in the study areas from loss and damage. This work stream complements the household questionnaire, which focuses more on autonomous adaptation and risk reduction measures by households themselves. Moreover, the exercise can inform possible solutions/actions for each research site, and local practitioners can learn a lot from the analysis as it sheds light on what works, what does not, and why, from the point of view of intended beneficiaries.

The PEA exercise also helped gain insight into the efforts of the government or organizations in terms of prevention and relief. We applied this research tool by separately asking groups of 10–15 male and female respondents which projects were implemented in the area, by whom and how effective they were. This qualitative data helped enhance the findings on organizations' and government actions from the survey.

Expert interviews were conducted to obtain information that would not easily be obtained from focus group discussions and the questionnaire survey or to cross-check information from these research tools. For example, questionnaire respondents and participants in focus group discussions were able to compile a list of projects by government agencies and NGOs, as was done in the participatory evaluation exercise. However, certain information about these interventions (such as the year it started and ended, the back donor, etc.) was unknown to them, but could be supplemented by experts.

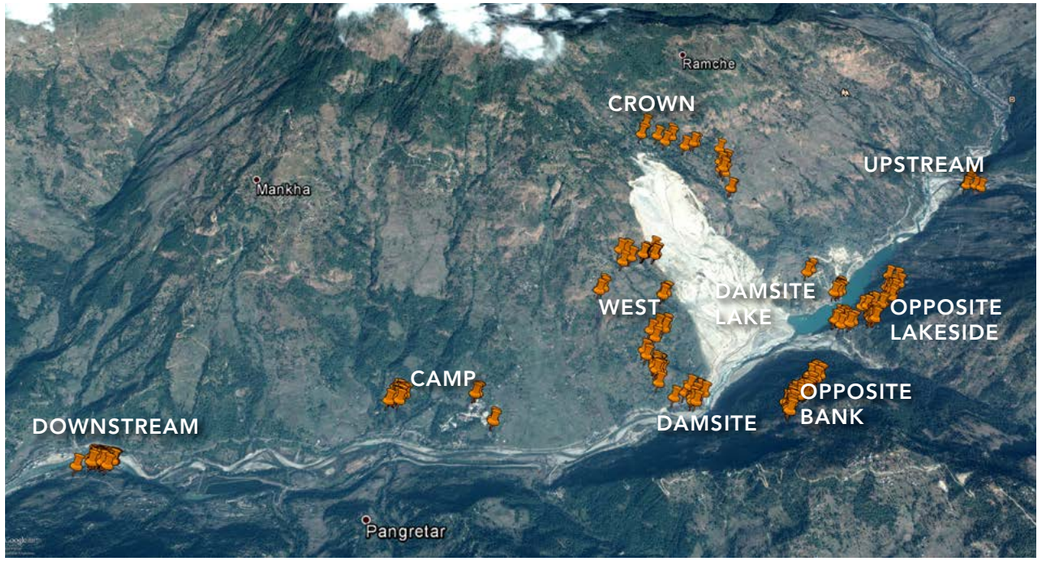


Image 8: Spatial distribution of the respondent households

Source: Google Earth

Finally, secondary sources including government documents and information from international organizations, as well as eyewitness videos on YouTube, were used to better understand the situation. News coverage and reports by other organizations were also consulted. Information from these sources could help triangulate the validity of results from the methods mentioned above, and provide input for valid interpretations of the data.

Image 9: The landslide area

Image 10: School yard on the eroded river bank

3. Study area

The study area lies in the district of Sindhupalchok in the Central Development Region of Nepal (Map 1), which spans an area of 2,542 km² and contains 79 Village Development Committees (VDCs). The district headquarters is Chautara, the only settlement in Sindhupalchok that officially constitutes a municipality. It is located to the northeast of Kathmandu and borders on Tibet, China to the north. The Araniko Highway that runs through the district is the only road connection between Nepal and China.

Sindhupalchok is generally classified as a "mountain district" (Lillesø et al., 2005), where elevations of more than 3,500 m are reached (OSOCC, 2015). However, most of the population lives in the lower-lying, hilly areas (ibid).

The 2011 census counted a total population of 287,798 (138,351 males and 149,447 females). Projections for the year 2016 estimated a population of 292,370 overall and an increasing gap between males and females (Government of Nepal, 2014). The 66,688 Sindhupalchok households in 2011 had an average size of 4.32 persons and were predominantly headed by males (50,651 male household heads and 16,037 female household heads).

Labour migration to foreign destinations is a common and growing phenomenon in Sindhupalchok District. During the 2008–2014 period, 27,807 labour permits were issued for persons from the District. This amounts to almost one tenth (10%) of the 2011 district population, and is substantially higher than the figure at national level (6%). The district level figures include only labour permits that were issued through a recruitment agency, and exclude application made by

individual applicants. These individual applications amounted to 22 per cent of the total at national level. The annual number of international labour permits increased from less than 3,000 in 2008–2010 to more than 8,000 in 2013. Of the 27,807 permits issued to migrants from Sindhupalchok, 23,704 (85%) were for male migrants and 4,103 (15%) for female migrants. With 9 per cent of all female migrants, Sindhupalchok had the largest share of female international labour migrants in Nepal (Government of Nepal, 2014). While the precise share of labour migrants per destination from Sindhupalchok is unknown, the most popular destination of Nepalese migrants overall is Malaysia (41%). This is followed by Saudi Arabia (23%), Qatar (20%) and the United Arab Emirates (11%). A minority of migrants also travel to Kuwait for work (2%). Migration to Malaysia, Qatar and Kuwait is male-dominated; the proportion of female migrants to these destinations never exceeds 3 per cent.

Hinduism is the most common religion both in Nepal at large and in Sindhupalchok District, with 169,740 followers counted in 2011. Buddhism is the second most common religion, with 109,238 members. The third most common religion in the district was Christianity, with 5,280 members.

In terms of education 2011 census data revealed, the majority of the population aged 5 years and above (264,274) could read and write (157,469). On the other hand, 98,960 respondents could neither read nor write, while 7,635 could only read but not write and 210 did not state their literacy. The most common level of educational attainment was primary school (73,000), followed by lower secondary (31,480) and non-formal education (15,266). Secondary education was attained by 14,957 respondents (Government of Nepal, 2011).

The Araniko Highway that runs through the district is the only road connection of Nepal to Tibet, and with it to China. After the landslide in 2014, this highway was severely damaged and submerged by water due to the 55-metre high river-blocking dam created by the landslide, which posed a dilemma between economic and humanitarian interests for the authorities. On the one hand, the dam had to be removed as quickly as possible in order to allow traffic on the highway to continue. On the other hand, removing the dam too quickly and carelessly posed the risk of causing severe damage to local people's livelihoods due to the ensuing outburst flood. The district's dependency on the highway and the growing risk of an uncontrolled outburst flood lead authorities to a compromise which consisted of carefully forcing an opening of part of the dam through controlled blasting.

In Nepal at large, hydropower is an important source of energy. With the first hydropower plant built in 1911, a multitude of projects have emerged since then. One of the three hydropower plants in Sindhupalchok, the Sunkoshi Hydropower Plant (capacity: 10,050 kW), was damaged in the landslide, which left a large proportion of people in our study area and beyond without electricity (Boss Nepal, 2016).

Map 1: Location of Sindhupalchok District in Nepal

Source: Authors' own

Image 11: Family that lost its house in the landslide; in the back is their temporary shelter

4. Survey population

This section outlines sociodemographic characteristics of the households surveyed for this study, in order to give the reader a better idea about the composition of the sample.

Household heads in the sample are 80 per cent male and 20 per cent female. Nearly 90 per cent of respondents are married; only a minority is either widowed (around 8%), single (around 2.5%) or separated (less than 1%). The vast majority of surveyed households are Hindu (around 87%). Approximately 9 per cent are Buddhist, and less than 1 per cent is Christian. Around 70 per cent of respondents indicated they were born in the place they currently reside in. A little less than 25 per cent originally came from elsewhere in the district, 2.5 per cent said they came from elsewhere in the zone and around 3 per cent were born elsewhere in the country. No respondent originally came from outside of Nepal.

The typical respondent is a married, Hindu farmer, born in the same village he lives in today, with little or no school education.

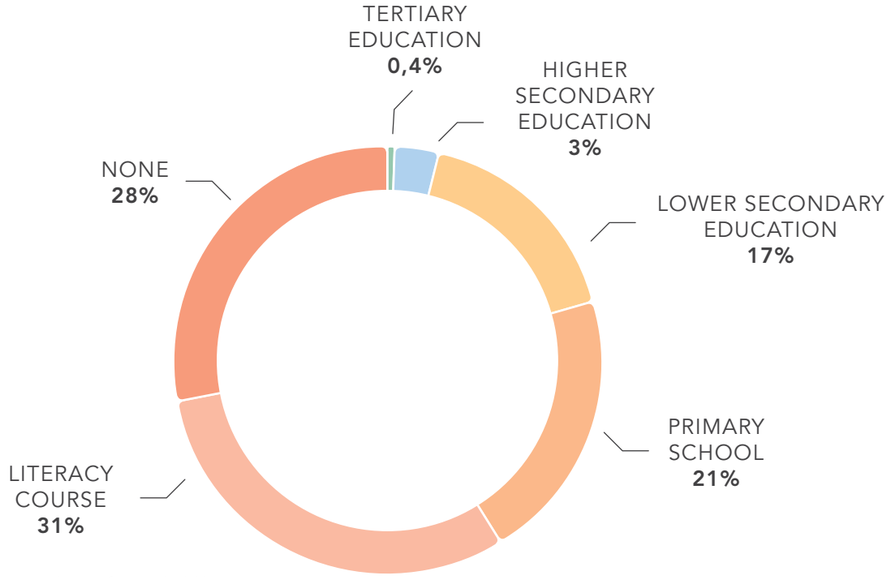


Figure 1: Education level of household heads

Source: Authors' own

Figure 1 shows that the most common level of education among respondents is completing a literacy course (31%), or no formal education at all (28%). This is followed by having attained primary (21%) and lower secondary education (17%). Higher education was attained by around 3 per cent of the sample, and tertiary education by only one respondent, who stated to have finished a bachelor's degree.

Hence, the typical respondent is a married, Hindu farmer, born in the same village he lives in today, with little or no school education.

More than 95 per cent of the households in the sample own the house they live in. Iron sheets are the most common construction material for roofs (75%), followed by natural materials such as earth or thatch (33%). The walls of respondents' houses are mostly constructed from stone and mud (50%), wood (23%) or iron sheet (15%). Most floors consist of earth (82%).

A majority of respondents think that their house is of average quality (53%), with 34 per cent thinking that their house is of better quality and 13 per cent think that the quality is worse. We also asked respondents to rate the riskiness of the location of their house compared to other houses in the area. Three quarters (75%) felt that their house was in a much riskier place than the houses of others – usually because of its location close to the landslide area, the river or a cliff, whereas 19 per cent saw themselves in a safer position than others and 6 per cent believed themselves to be in a position of average safety.

Image 12: Enumerator interviewing a household head in Majhi Gaun village

Image 13: A woman at a water fountain in Majhi Gaun village

Around 95 per cent of households have access to electricity from the power grid. Only one respondent stated to receive electricity from a solar source.

As with electricity, access to sanitation was relatively widespread. Most respondents reported having access to a latrine or a WC and water from either a pump or pipe (87.18%). The roughly 10 per cent without reliable water access have no latrine or WC at their disposal and have to drink surface water, well water or water from other sources.

A majority of households owns at least one television (58%) and almost all households (90%) own at least one phone. Bikes, motorbikes, cars and fridges are a rare possession among respondents, with less than 5 per cent of households owning any of these assets. None of the respondents owns a tractor.

Image 14: Kitchen of an abandoned factory barrack in which landslide victims found shelter

5. Livelihood and vulnerability

This section outlines the livelihood circumstances and multidimensional vulnerability of households, based on household-level data from the survey. It aims to showcase the living conditions in the research area by shedding light on several aspects of the people's daily lives. To this end, this section discusses households' sources of food and income, possession and usage of land, poverty and food security. Furthermore, the conceptual composition of multidimensional vulnerability, as well as its representation and distribution in the sample, is shown. The respondents' subjective impressions of vulnerability are used to put the statistical findings into perspective, by outlining how respondents feel about their vulnerability and which demographic of the population they feel is the most vulnerable.

5.1 Sources of livelihood (food and income)

Figure 2 displays the proportion of households who engage in different livelihood activities, and the mean annual income in US dollars that the households gain from each activity. Almost all households (94%) engage in three or more activities simultaneously, generally combining subsistence-oriented farming with non-farming activities and sometimes remittances as sources of cash income.

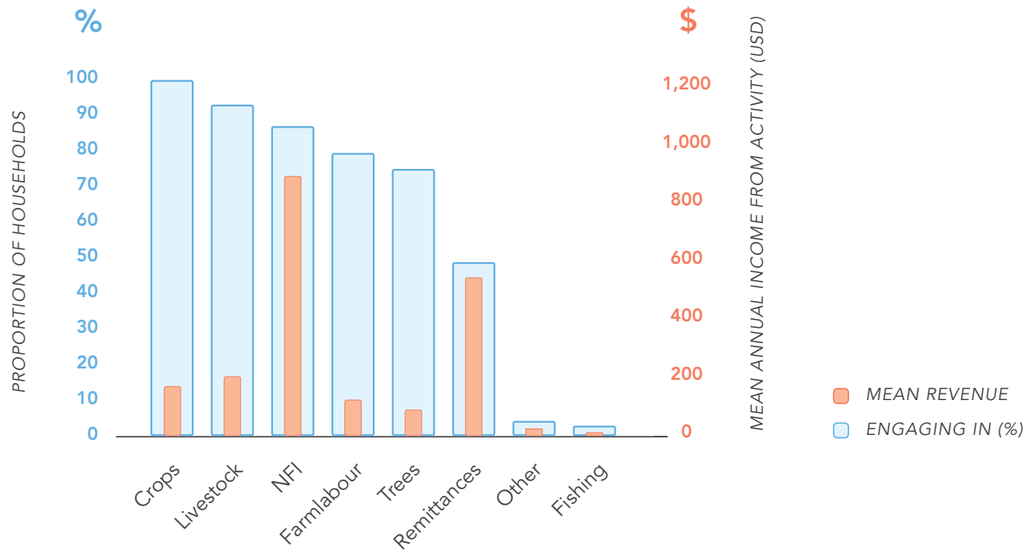


Figure 2: Livelihood sources and cash income

Source: Authors' own

Crop cultivation and livestock herding are the two most common livelihood activities. However, the revenue derived from these activities is relatively low. The same applies to farm labour and trees used for commercial purposes. Non-farm income and remittances, on the other hand, generate the largest cash income. Other income-generating activities such as pensions and rent, as well as fishing, are least common and generate little income.

The most commonly cultivated crops are paddy, maize, mustard and millet. Farming is generally subsistence oriented;

It is likely that households who engage in sustenance farming as well as income-generating activities are least vulnerable to idiosyncratic shocks.

few respondents reported selling their produce. Goats and sheep are the most commonly kept domestic animals (78% of households), followed by fowls (62%). Cows are owned by 54 per cent of households, while pigs are the rarest type of livestock with only 4 per cent of households keeping at least one pig.

Three quarters of the respondent households have members who engage in farm labour. Around a third (32%) have one household member who works on other people's farms, while 29 per cent have two household members working on other people's farms. In a minority of cases, households have between three and five household members working on other farms. Some people engage in farm labour as an income-generating activity while others participate in communal labour arrangements that do not involve payouts.

The great difference in mean annual income among livelihood activities is due to their differing purposes: while activities such as farming and livestock are primarily used for sustenance, non-farm income and remittances are targeted at generating income. It is likely that households who engage in sustenance farming as well as income-generating activities are least vulnerable to idiosyncratic shocks. For example, when cash income sources fail or in the event of hyperinflation, people can fall back on subsistence production, and when harvests fail or livestock dies, they will have some cash to put food on the table.

5.2 Land

Land is one of the most important resources for the people in the study area. It is the primary means by which most respondents sustain their livelihoods, via farming, livestock keeping and tree products. Where land is not cultivated, locals usually use it for shelter. As we will see in the section on landslide impacts, loss of land was one of the most severe consequences of the landslide for the majority of respondents.

Looking at land ownership (Figure 3, blue bars), almost half of the households (47%) own between 2 and 10 ropani[2] of land (around 1,052–5,220 m²), and the fewest own more than 20 ropani (10,521 m²). The mean amount of land owned by respondents is 10.13 ropani (5,301 m²), and the median is 6.13 ropani (3,197 m²), indicating that respondents tend to own less land than the mean: a few households own a disproportionally larger share of land than others, which leads to a higher mean value.

As with land owned, the orange bars in Figure 3 show that 49 per cent of households cultivate between 2 and 10 ropani (1052–5,220 m²) of land, and fewest cultivate more than 20 ropani (10,521 m²). The mean amount of land cultivated is 9.43 ropani (4,937 m²), and the median is 6 ropani (3,116 m²). As above, the distribution of cultivated land speaks for some inequality in the distribution of land, as the majority of people cultivate less than 9.43 ropani. However, the distribution is slightly more equal than that of land owned. A possible explanation for this is that land-abundant households may rent out land to land-scarce households. This assumption is supported by the fact that many land-scarce households in the sample cultivated more land than they owned.

5.3 Poverty

Based on a poverty line of $1.25 per capita per day, nearly 77 per cent of respondent households from the sample live below the poverty line. Non-monetary activities such as sustenance farming are not included in this estimation, which only covers cash income. On average, households in the sample earned

2"Ropani" is a traditional Nepalese unit of measurement. 1 ropani equals 508.74 m² or 0.1289 acres.

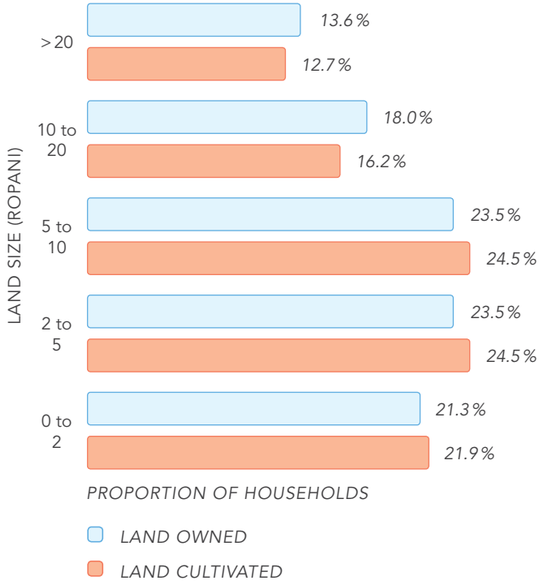


Figure 3: Land owned and land cultivated (ropani)

Source: Authors' own

35,754 rupees ($365) per capita in the year before the survey[3], which translates into one dollar per day. The median income was found to be considerably lower, with $0.60 per capita daily[4], or $219 per capita per year.

Non-monetary income is an important aspect of the local population's livelihood. While the respondents in the sample are mostly poor judged by their monetary income, their situation is ameliorated by the fact that they can meet part of their needs with subsistence production.

3 Annual household income was calculated as the sum of revenues from crop cultivation, livestock production, fishing, trees, farm labour, non-farm activities, remittances, pensions and rent over the past 12 months.

4 Source for exchange rate: http://www.oanda.com/currency/converter/.

Nearly 77 per cent of respondent households live below the poverty line.

5.4 Food security

People living in the area generally eat three meals per day. However, 37 per cent of respondent households said that there had been months in the past year in which they had to eat less because they lacked food or money to buy food. The months with the most food shortages were Nepali months four and five in 2014, when more than a fifth of respondent households had to eat less (Figure 4). Most respondents reported that the lack of food was due to the landslide, which led to land and lives being lost. Others gave lack of income as a reason.

Within the past ten years, just over one third of households experienced food shortages (36%). For most households, this happened in one (12%) or two (10%) years, while a few households lacked food every year (2%). Giving a reason for this, some referred to a drought or lack of irrigation water. Others said that cultivating "only one crop" or their "fishing occupation" did not provide enough food, and that they simply lacked money to ensure sufficient food supply.

This confirms that households seem to be able to provide for their livelihoods even without substantial monetary income, but only for as long as the environment they depend on is not disrupted. In the case of disruption, many households are unable to rely on buffers and cannot cope with unexpected shocks to their livelihoods as a result.

The orange bars in Figure 5 show that only 11 per cent of households are fully self-sufficient in food production and only 6 per cent buy all the food they consume. Thirty-two per cent of the respondent households buy more than half of their food

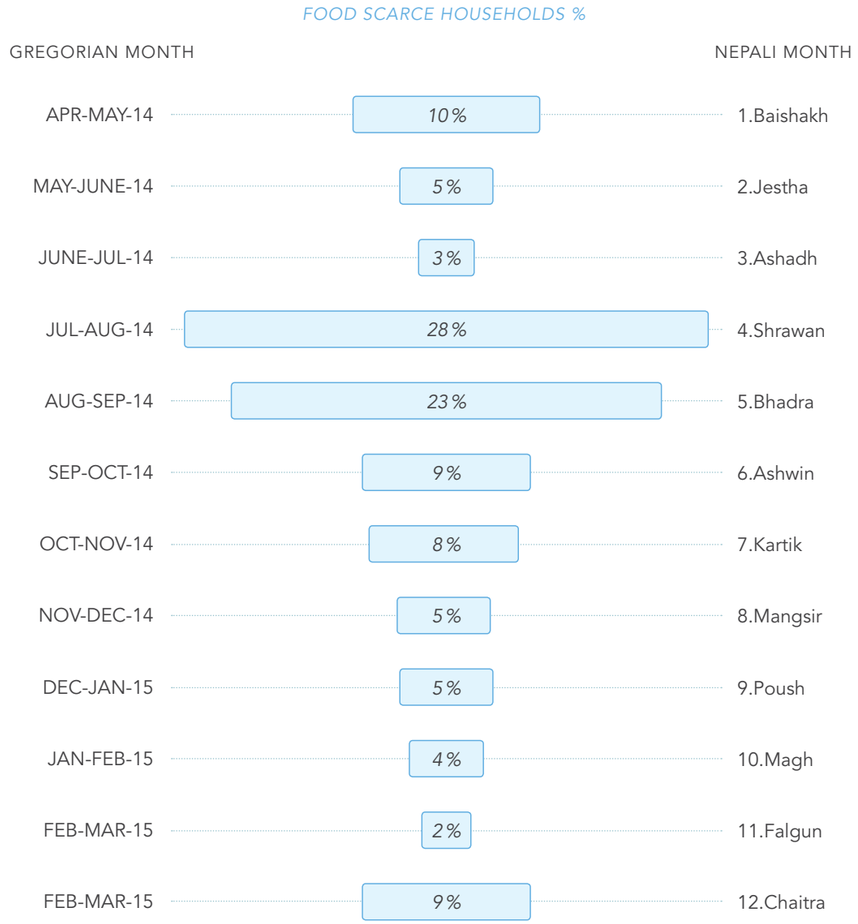


Figure 4: Food shortage by month

Source: Authors' own

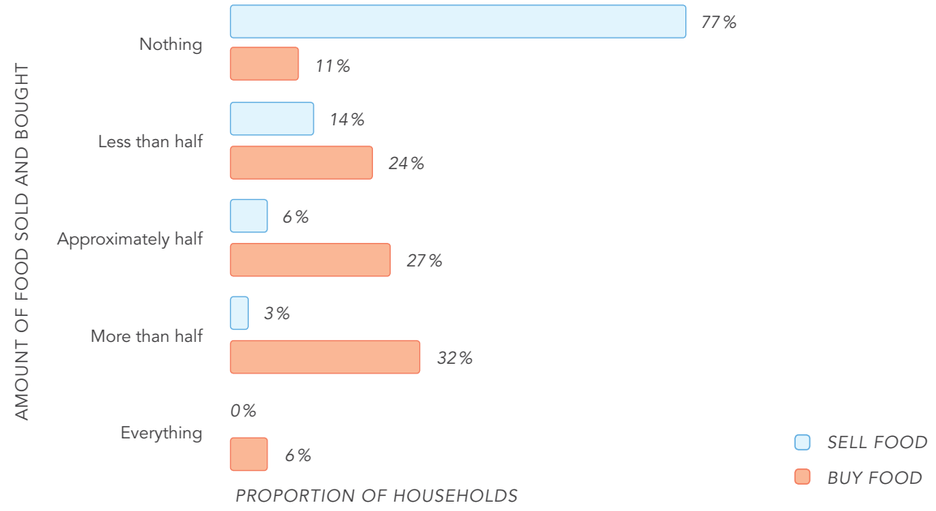


Figure 5: Amount of food sold and bought by household

Source: Authors' own

Many households do not have buffers to rely on and cannot cope with unexpected shocks to their livelihoods.

consumption, and 27 per cent buy approximately half. A little more than a fifth (24%) of households buy less than half (Figure 5). The blue bars show that most households sell none of the food they produce and no households sell all of their food. This indicates that the usual purpose of farming is sustenance. Together, the orange and blue bars show that while most households farm for subsistence, the level of self-sufficiency is quite low. There are two possible explanations for this – one more positive and one more negative. On the negative side, it could be an indication that local agriculture is in crisis and it is not productive enough to feed the population. The positive explanation would be that the area is experiencing a process of "de-agrarianization" (Bryceson & Jamal, 1997). Most households nowadays have diversified their livelihoods with non-farm activities. The data in this sample suggest that both explanations are valid, but for different types of households. The fact that a majority of households have not experienced food shortages in the past ten years indicates that the de-agrarianization explanation is most powerful. However, for the most vulnerable households, this might not be the case.

5.5 Multidimensional vulnerability index

Understanding people's vulnerability to climate-related stressors is key to minimizing loss and damage. If one discovers, for example, that households with low levels of education tend to be more affected by landslides or other hazards than households with higher education levels, then it might be worth investing resources in understanding why that is the case and seek solutions.

To assess household vulnerability, we used an index that builds on the Alkire Foster method for measuring the multiple dimensions of poverty (Alkire & Foster, 2011). Based on the household survey data, ten vulnerability indicators were defined, namely education level, land and livestock ownership, livelihood diversity, total income, dependency ratio, house quality and exposure, food security and level of preparedness. These indicators represent the three dimensions of vulnerability:

Exposure, sensitivity and (lack of) adaptive capacity.[5] For each indicator, four thresholds were chosen, dividing the sample population into five groups. For example, for education the groups are "no formal education", "attended literacy classes", "primary school", "lower secondary school" and "higher secondary or tertiary education". For quantitative indicators (e.g. land size, livestock ownership and total income), the sample population is divided into quintiles, and household scores are assigned accordingly.[6] The vulnerability indicators selected for the analyses in this paper are listed and described in Table 2, and thresholds are provided in **Annex 1**.

Each household in the sample has a score of 1 to 5 on each indicator. The multidimensional vulnerability index (MDVI) is calculated as the average of the scores on the ten indicators, and ranged from 1.7 to 4.3 in this sample. A higher score on the index indicates higher vulnerability to landslides and other stressors. For the whole sample, the average score was 3.06 with a standard deviation of 0.54. The scores are normally distributed (see Figure 6).

There were 40 female-headed households in the surveyed population. With an average MDVI score of 3.29, they were slightly more vulnerable than the 190 male-headed households, which had an average MDVI score of 3.02. The difference in MDVI score between the two groups was statistically significant ($p<0.01$, calculated with ANOVA).

Using the MDVI as a predictor for the principal research domains of this study proved less effective. The MDVI and the landslide losses and damages were found to be unrelated. Likewise, no significant relations were found between MDVI and household coping and adaptation measures. This is likely due to several factors. First, landslides as environmental hazards are localized events. Hence, the question of whether or not a household was affected by the landslide included a large degree of luck, independent from possible preventive measures. Similarly, the fact that landslides are difficult to predict meant that many households abstained from taking precautionary measures, not necessarily because they lacked the means, but because they did not see a need to do so.

5.6 Perceptions of vulnerability

Most households perceive themselves to be much more vulnerable than other households in the area (Figure 7). This results from the purposive selection of study sites in this research; most places we selected were affected by the landslide. When asked to specify why, respondents tended to answer that their house, their land, or both was destroyed by the landslide, or that their property is close to either the river or the landslide area. Similar sentiments could be found among respondents who deemed themselves "a bit more"

5 The three dimensions of vulnerability originate from the IPCC definition of vulnerability that was used in the Third and Fourth Assessment Report. Füssel & Klein (2006) discuss this definition in more detail.

6 The upper and lower bounds of quintiles for each country are listed in the annex.

1. Education	Level of education of household head: none=5; literacy training=4; primary=3; lower secondary=2; higher secondary or tertiary=1.
2. Dependency ratio	Dependent household members (aged <18 and >65) / adult household members (18-65) * 100 (score based on quintiles, see **Annex 1** for threshold values).
3. Land ownership	Size of land owned by the household (score based on quintiles).
4. Livestock ownership	Expressed in Tropical Livestock Units (score based on quintiles). See **Annex 1** for conversion factors.
5. Livelihood diversity	Number of the following livelihood sources: crop cultivation, livestock keeping, fishing, trees, farm labour, non-farm income, remittances, other (mostly pension, rent).
6. Total cash income	Total amount of cash income from all sources (score based on quintiles).
7. House quality	Based on floor material (more vulnerable if earth, mud, cow dung) and own perception of house quality. See **Annex 1**.
8. Location	Based on respondents' own perceptions of how risky the location of their house is; how exposed it is to landslides.
9. Food security	Based on months of food shortage in the past year and years of food shortage in the past decade.
10. Preparedness	Based on the number of different preventive measures the household adopted to reduce likelihood and impact of a landslide (e.g. gabion walls, tree planting, and house adaptations)
MDVI	Average score on the 10 indicators, allowing for 2 missing values.

Table 2: The 10 indicators of vulnerability

Source: Authors' own

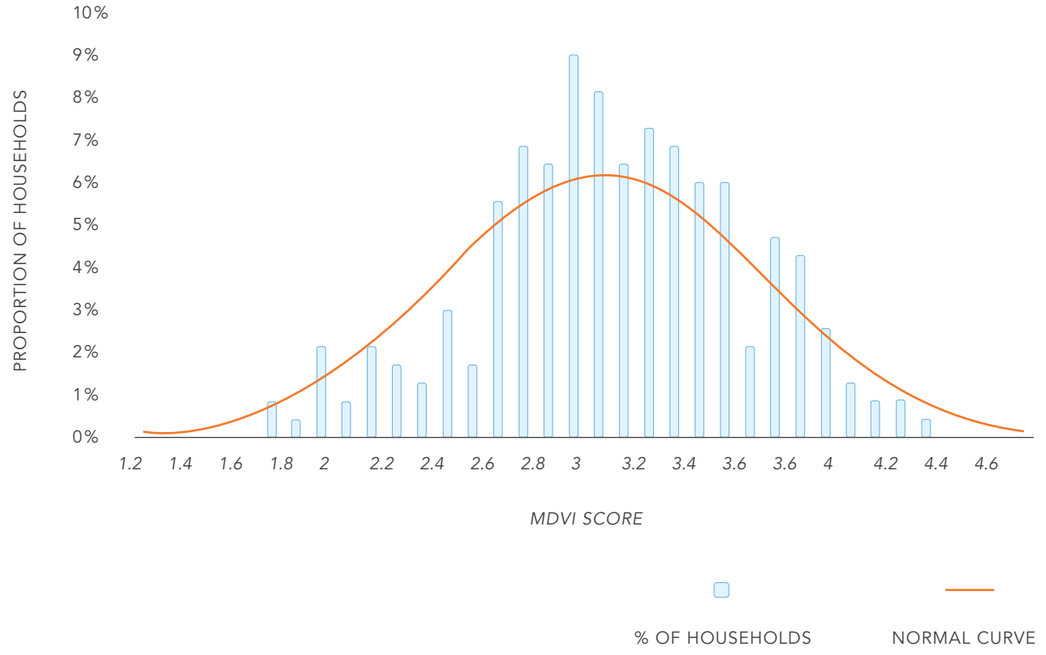


Figure 6: Normal curve - distribution of MDVI scores

Source: Authors' own

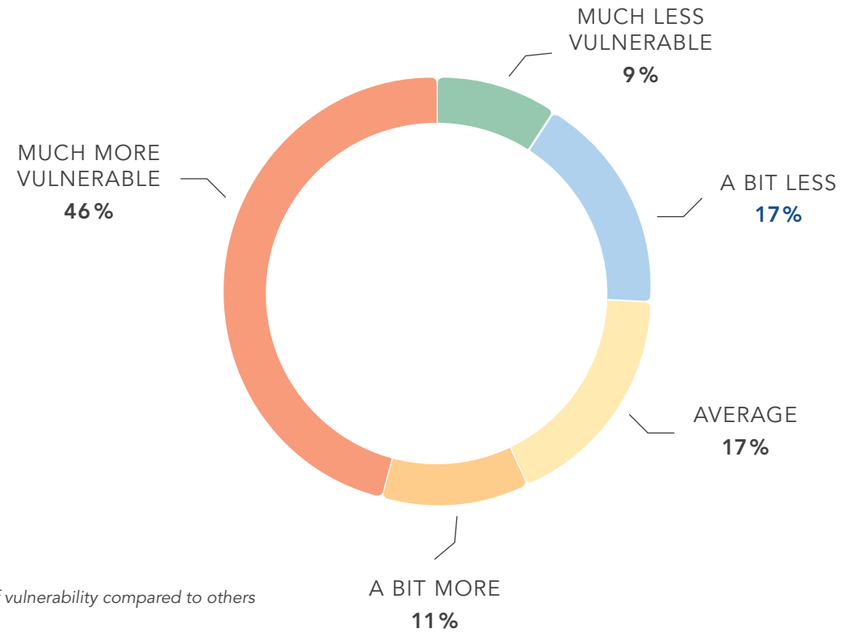


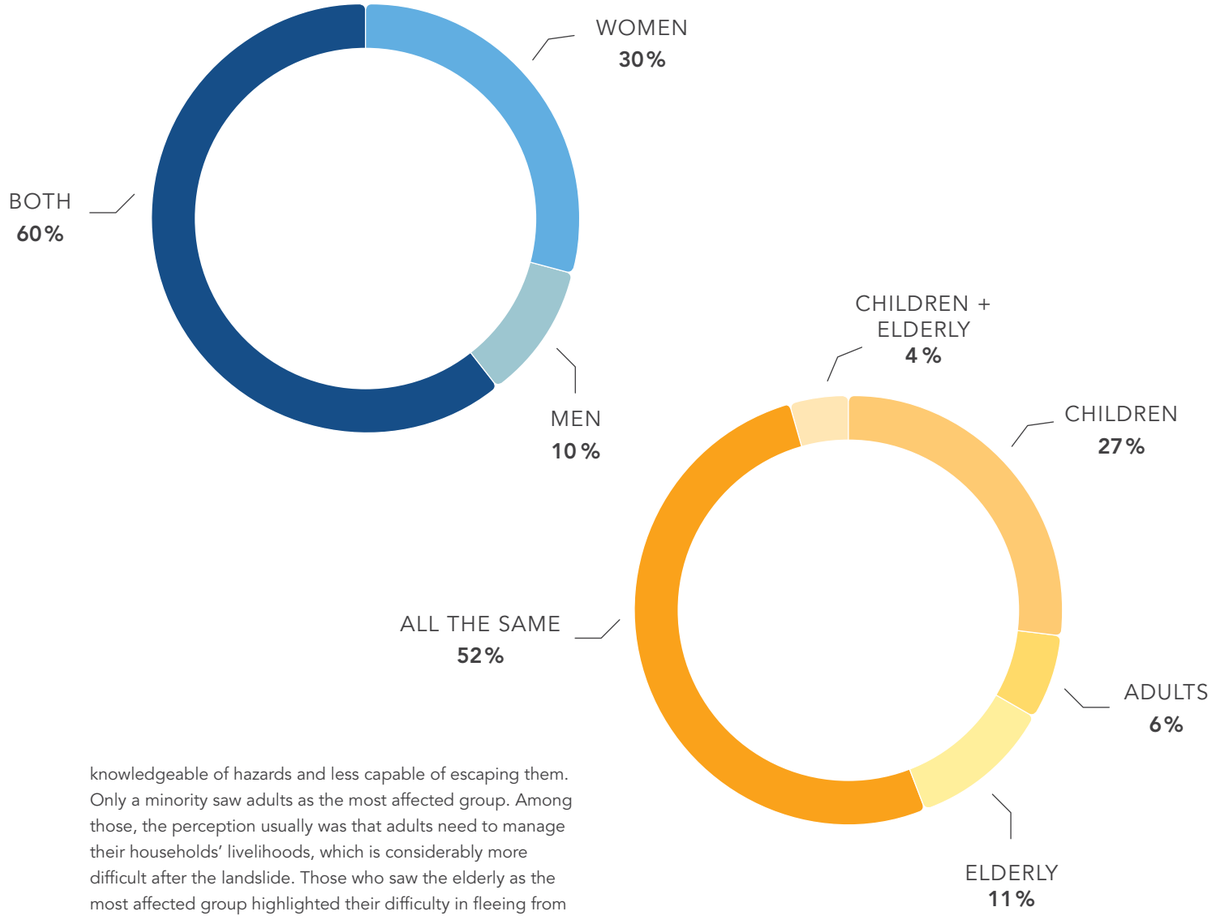
Figure 7: Perceptions of vulnerability compared to others

Source: Authors' own

vulnerable, whereas those who claimed to have average vulnerability tended to state that "all are affected" by the landslide, and that they had lost their land, but not their house. Respondents who felt less vulnerable indicated that they were less affected because they live further away from the landslide. Others stated they did not feel as vulnerable because they had fenced their property.

Around 60 per cent of respondents stated that women and men were equally affected by the landslide, reasoning that the fear, mental stress and losses are the same for both (Figure 8). Those who claimed women were more affected based this on the custom that women stay at home and cannot run as fast as men. Respondents who saw men as the most affected group based this on the male responsibility to provide for their family, which the landslide has complicated considerably.

When asked who was most affected by the landslide among different age groups, the majority said that everyone was affected similarly – generally pointing out that everyone suffered, everyone is in fear, and everyone has to cope with the impacts of the landslide. Others pointed out that children were mostly affected, because they could no longer, or only with great difficulty, go to school, and that children are less



knowledgeable of hazards and less capable of escaping them. Only a minority saw adults as the most affected group. Among those, the perception usually was that adults need to manage their households' livelihoods, which is considerably more difficult after the landslide. Those who saw the elderly as the most affected group highlighted their difficulty in fleeing from hazards and relocating to a safer place. Also, the elderly's lower capability to work was seen as an issue. Similar issues were pointed out by those who viewed children and the elderly combined as the most affected, adding that children and the elderly are more affected by mental stress than adults.

Figure 8: Perceptions of vulnerability by gender (blue) and age group (yellow)

Source: Authors' own

Image 15: Gabion boxes near the river

6. Preventive measures

This section describes and analyses efforts by households and organizations to either prevent or minimize potential landslide impacts. While we distinguish different types of measures, all measures are referred to as preventive measures for convenience purposes. We distinguish three types of measures. The first type involves direct preventive measures that aim to prevent the occurrence of landslides. The second type consists of measures that minimize loss and damage if landslides occur. The third type involves measures that enhance people's capacity to cope with impacts that the other measures could not avoid. One household can adopt all or several such measures. For example, it can plant trees to prevent landslides; it can build its house in a safe place in case a landslide does occur; and it can take out insurance or put money aside to be better prepared against loss and damage from natural hazards, such as landslides.

In this section we first discuss the uptake of different types of measures by households. After that we analyse the effectiveness of the measures and the constraints to taking (more effective) measures. The analysis uses qualitative as well as quantitative methods. In the last part of the section, the focus shifts from household measures to the things government agencies and NGOs did to prevent landslide impacts.

6.1 Uptake

About two thirds (65%) of households in the study area adopted preventive measures to minimize future impacts of

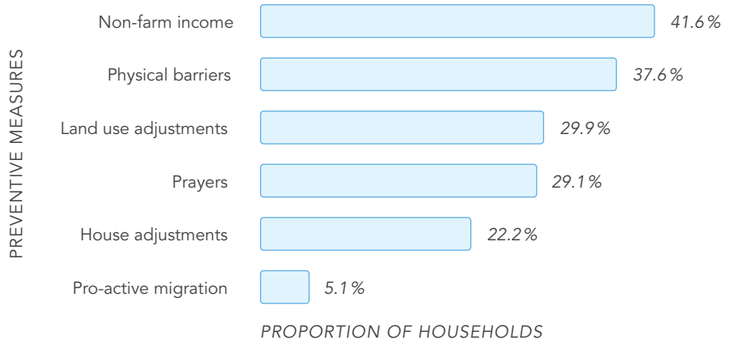


Figure 9: Uptake of preventive measures

Source: Authors' own

landslides and other natural hazards. This included adjustment to houses, the construction of physical barriers around houses and at other strategic places, adjustments in land use and tree planting, livelihood diversification into non-farm activities and proactive migration.

Figure 9 shows the uptake of these measures, with the different types of prevention combined in one figure. Livelihood diversification into non-farm income activities was the measure that was adopted most frequently and is an example of a preventive measure aimed at enhancing a person's capacity to cope with impacts that cannot be avoided. The study area is located close to the main road connection to China and several small towns or bazaars in the direct vicinity provide opportunities to make additional income besides the farm work. Many find work as drivers, porters, construction labourers and petty traders. This livelihood diversification makes people less vulnerable in the face of landslide risks.

The construction of physical barriers mostly involved gabion boxes that were either placed on hillsides to keep soil in place or along rivers to protect against flooding, including outburst floods from the debris dam (see image 16, p. 48). Other physical barriers around houses and in fields were stone, wood or bamboo fences. House adjustments usually involved moving the house to locations that were deemed safer, and the use of stronger building materials. In-field adjustments included tree planting and changes in cropping patterns to keep soil in place. Some respondents also mentioned the repair of gullies and cracks.

Image 16: Gabion boxes next to the river and on the hillside

Migration as a preventive measure often refers to seasonal migration during the rainy season, as torrential downpours increase landslide risk. In order to minimize the risk of severe impact, some households opt to relocate rather than stay in landslide-prone areas. Besides that, the historic satellite images of the landslide area, displayed in the introduction of this report, show that the area is much less densely populated than the surrounding areas, with no new houses appearing since 2004. This is an indication that people avoid the area – possibly because of its steep topology, and because of the perceived risk of landslides. There is also some evidence that households who lived in the landslide area moved away before the landslide occurred. For example, 15 per cent of the households we interviewed mentioned that they moved their house to a safer location (captured under house adjustments in Figure 9). However, only some of them had their house within the perimeter of the landslide.

About a third of the households in the study area did not adopt any preventive measures against landslides and their impacts (Figure 10), with prayers and rituals excluded from the count. The main reason these households gave for not taking preventive measures was that they never expected such a destructive landslide to occur. As we will see in Figure 13, many respondents also doubted whether they could do much against them.

Two thirds of respondent households did take preventive measures before the landslide. Often, these measures went beyond protection against landslide impacts, by serving to secure the economic position of the household generally.

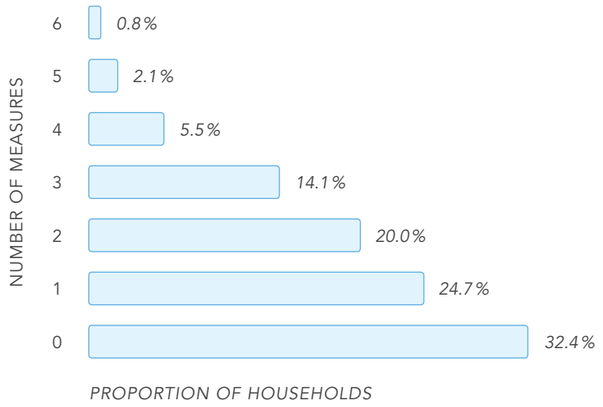


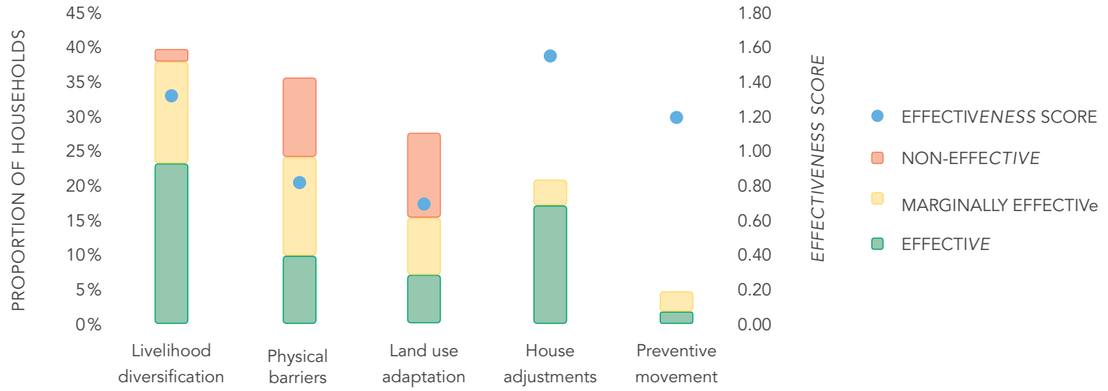
Figure 10: Number of preventive measures by households

Source: Authors' own

Around 25 per cent adopted one preventive measure, and about 20 per cent implemented two. The maximum number of preventive measures taken by households in the sample was six. The mean was 1.62 measures and the median 1 measure. This suggests that the mean was increased by a minority of households who used substantially more measures than most other households, which is confirmed in Figure 10.

Figure 11 shows respondents' assessments of how effective they regarded the preventive measures they took, ranging from "fully effective" to "negative effects". The latter case describes measures that left the household in a worse state than before adopting the measure. The most positive evaluations ("fully effective") are dark green and the most negative ones ("negative effects") are red. The horizontal black lines depict the aggregate effectiveness score (see note below Figure 11). House adjustments were evaluated most positively by respondents. Many of them had managed to avoid the worst impacts of the landslide by moving their house to a safer place in time. The least effective measures, which sometimes entailed adverse effects, were the construction of barriers and farm adjustments, such as tree planting. While they could have been successful in mitigating the impacts of smaller landslides, the sheer force of the landslide rendered efforts to protect land and properties useless. In addition to losing their land, many respondents highlighted the loss of time and resources used to implement these measures.

Expert interviews and informal conversations in the study area gave deeper insight into the role of trees. While most people



*Note: Effectiveness scores were calculated as 'fully effective'*5 + 'quite effective'*3 + 'marginally effective'*1 + 'not effective' *0 + 'negative effects'*-2.*

Figure 11: Effectiveness of households' preventive measures

Souce: Authors' own

regard trees as a natural barrier against landslides, some think that tree planting on steep slopes can actually be harmful and cause landslides. This is because such trees can easily fall down and slide down the slope, loosening up soil. In addition, we were told that prior to the landslide people had opted to cut trees down. The reasoning was that it would make more sense to 'harvest' the trees before a landslide would destroy them. This unsustainable land use may have been one of the drivers of the catastrophic August 2014 landslide.

Besides inquiring about the effectiveness of individual preventive measures, the questionnaire also asked how successful the mix of methods had been at avoiding impacts. Figure 12 shows that most households who adopted measures still experienced severe or moderate adverse effects of the landslide despite the measures taken. Only 15 per cent indicated that they were able to avoid adverse effects or even improve their situation. Of those, 95 per cent had diversified their livelihood with non-farm income to be better prepared for natural hazards, against 42 per cent for the whole sample. Livelihood diversification decreased their vulnerability by facilitating coping efforts. No significant differences were found between adopters and non-adopters of other measures.

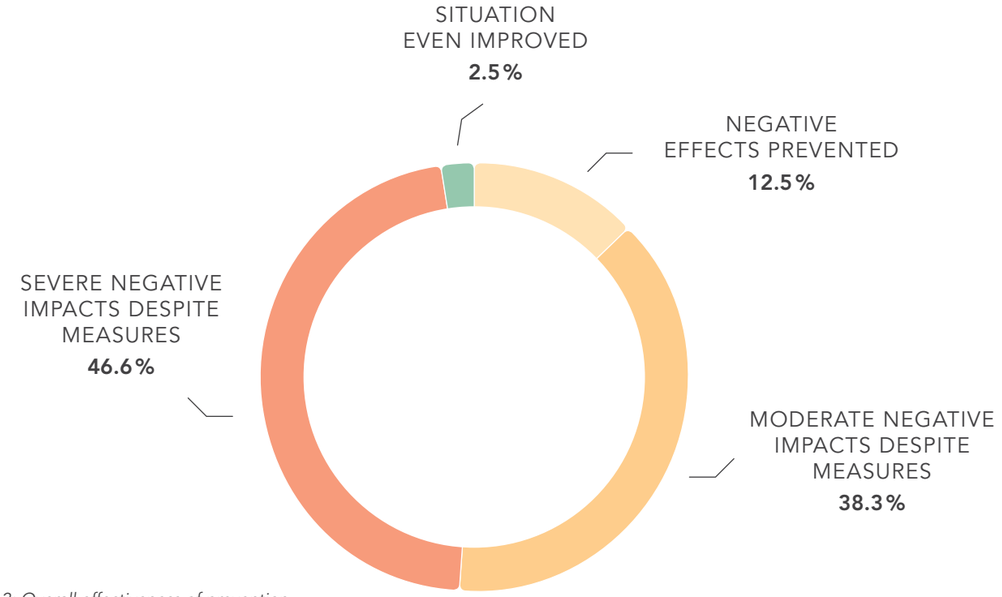


Figure 12: Overall effectiveness of prevention

Source: Authors' own

6.2 Constraints

Assessing loss and damage is not just about measuring what is lost or damaged. It is also about understanding how and why people incur loss and damage. Of particular importance is people's perceptions of which preventive or adaptive measures work under which circumstances, which do not, and why (not). One major cause of losses and damages is that people and their local or national governments face adaptation constraints. Figure 13 shows that 54 per cent of the surveyed households thought that there was nothing else they could have done. Common constraints were also a lack of financial means (35%), skills and knowledge (22%) and other resources (21%). Most respondents who mentioned an "other reason" (36%) explained that they had never experienced such a landslide and did not imagine it could happen, which is why they did not think to prepare for one. Only a minority felt that it was not a priority (9%) or their task (7%) to prepare for a landslide.

6.3 Prevention by organizations

Alongside the measures people took to prevent landslide impacts, this case study also looked at preventive measures by organizations. This involves measures in the policy domain of disaster risk reduction. While Nepal has a national centre for disaster management, such preventive measures can be implemented by a varied set of organizations, including

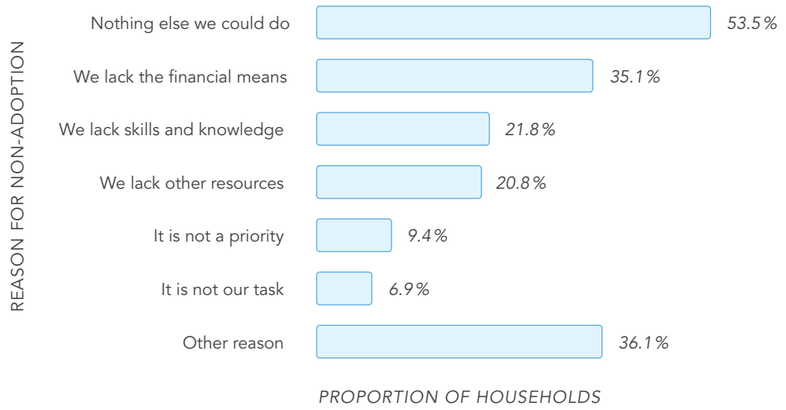


Figure 13: Reasons for not adopting more (effective) preventive measures

Souce: Authors' own

PEA: Prevention

This textbox outlines the participatory evaluation of adaptation (PEA) results for preventive measures.

The evaluation was done through two focus group discussions with 10–15 participants each. They listed projects, activities or interventions by government agencies and NGOs and then discussed how successful these were and why they might not have been.

WOMEN	MEN
According to the women group no preventive measures were taken, except the placement of some gabions along the river banks. They thought that prevention of landslides was not a priority of the government. The women group suggested that afforestation and placing gabion walls on the slopes as possible prevention measures, but they wonder how effective these would be in the event of a large-scale landslide.	The men mentioned two interventions that were implemented approximately 20 years ago. The first was a long gabion wall along the roadside and the second was an engineering project by Chinese contractors who drained the mountain to reduce the buildup of water pressure. No more recent efforts were reported but participants conceded that there was not much that could have been done to avoid a landslide of this magnitude.

Textbox 4: Participatory Evaluation of Adaptation for preventive measures

Souce: Authors' own

non-governmental ones. The results in this section are based on responses from the questionnaire, and the information from the participatory evaluation of adaptation (PEA), as outlined in the methods section.

Among respondents, only 21 per cent stated that organizations did something to avoid landslides or reduce the impacts of landslides. Mostly, this involved government organizations which supported the placement of gabions by either providing materials for their construction or placing them directly. To a much lesser extent, organizations were reported to have planted trees as a preventive measure. Ten per cent of respondents also said that the Armed Police Force and the VDC operated an early warning system (EWS). However, this system was established after the landslide, to warn settlements downstream about an expected outburst flood. No early warning against landslides was reported. Ten respondents reported that organizations had provided resettlement opportunities. None of the respondents had heard of organizations providing insurance against landslide impacts. The impressions from the survey are confirmed by the PEA (Textbox 4, p. 52), showing how respondents saw only scarce attempts at prevention by organizations. On the other hand, respondents conceded the likely ineffectiveness of measures in the face of large-scale landslides, such as the one that wreaked havoc in August 2014.

Almost 80 per cent of respondents could not think of any measures that the government or NGOs had taken to prevent landslide impacts. According to many of them, the main reason why organizations generally did little to prevent landslide impacts was the same reason why households themselves did not do much: they never expected such an event to occur. However, some respondents also thought that organizations or the government had been negligent. Still, the question remains what exactly governments and NGOs could have done to avoid impacts. We will get back to this question in the last section of this case study report, where we provide policy recommendations.

6.4 Main findings on preventive measures

Most households or organizations did not implement many preventive measures. Evidently, neither households nor organizations knew how to effectively prevent landslides. A common measure by households was to build gabion walls, the materials for which were often supplied by organizations and/or the state, but this proved ineffective. The results of this section indicate that most of the measures taken were unsuccessful in preventing the impact of the landslide. Only house adjustments and livelihood diversification were evaluated as more successful by respondents. Effective house adjustments included moving their houses to safer places. Diversifying livelihoods with non-farm income as a preventive measure proved beneficial because non-farm activities are less sensitive to landslide impact than farming and provided a monetary buffer. Generally, the findings highlight that measures facilitating coping with the event after it happened were more successful than attempts to directly prevent the landslide.

> Neither households nor organizations knew how to effectively prevent landslides.

Image 17:The interior of a house that was severely damaged and abandoned after the landslide

Image 18: Destroyed house near the river

7. Impacts

This section analyses the impacts of the landslide in a more granular way – outlining which aspects of life and livelihoods were affected and how severely, as well as visualizing the intensity of impacts. Specifically, it shows impacts by type, by number, in monetary terms and by location. Special attention is given to land losses, which arguably constituted the severest and most lasting landslide impact on people's livelihoods. Loss and damage to infrastructure and mental stress are also described in separate sub-sections. The spatial distribution of landslide impacts is analysed with the help of an impact map showing eight clusters of households at different locations relative to the landslide area and the dam lake. Lastly, we compare the losses and damages sustained by poor and non-poor households to test the hypothesis that poor households are more severely affected by natural hazards.

7.1 Type, extent and depth of impacts

The landslide caused severe impacts on both household assets and the natural environment of the area. Figure 14 shows the proportion of households (blue bars) that incurred different types of losses and damages, and the value of these losses and damages in monetary terms (orange bars). The highest proportion of households reported loss and damage to crops, soil or land. Soil or land was by far the costliest impact type, followed by housing and properties. Impact on soil or land is extremely costly because rather than having lost one year's harvest, as is the case with an impact on crops, an impact on the soil or land itself renders it useless indefinitely. Households

Figure 14: Proportion of affected households and mean cost by impact type

Souce: Authors' own

who lost land reported an equivalent to more than $25,000. This is a large amount considering average earnings in the study area. We will examine land losses in more detail below.

Loss of life and mental stress could not be evaluated monetarily. Typically, respondents would declare that no money could bring back their loved ones. The fact that one out of every ten households we interviewed had lost a member shows how deeply these communities were hit by the landslide. The high prevalence of mental stress is largely caused by the fear of new landslides.

Most households (99%) experienced at least one kind of impact (Figure 15), and around 11 per cent experienced ten or more types of impacts. The mean number of impacts sustained by households was 5.8, and the median was 5. As the mean and the median are relatively similar, it appears that the number of impacts are evenly distributed across respondents and only slightly biased towards having experienced more than five impacts, which is confirmed in Figure 15.

Figures 16 and 17 show how severely households were impacted by the landslide in monetary terms, first for the total survey population and second by location. The categories used to classify severity of impact range from moderate (<$1,000), to substantial ($1,000–$10,000), severe ($10,000–$100,000) and extreme (>$100,000).

Figure 16 shows that almost half the households suffered severe or extreme losses, with the largest proportion of households incurring losses worth between $10,000 and $100,000. The research locations in Figure 17 are sorted in order of severity of losses in monetary terms. Hence, the most severely affected area was around the damsite, followed by the area opposite the slope of the landslide. Households in the Camp cluster were also severely affected, which is not surprising because most of the households we interviewed here had lost their house in the landslide and had been displaced. The Upstream and Downstream clusters were the least affected areas of the study area.

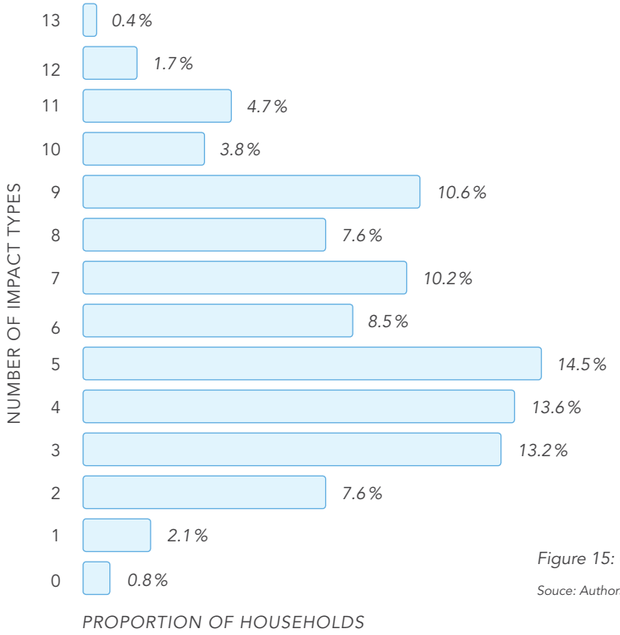


Figure 15: Number of impact types experienced by households

Souce: Authors' own

7.2 Loss and damage to land

Impact on land, together with impact on crops, was by far the most severe in monetary terms and the number of people affected, and thus requires closer inspection. Damages reported ranged from no damages at all and 500 rupees ($5.10) as the lowest reported amount of damage, to more than 25 million rupees ($255,000). The sample mean of the 180 households who reported damages is 2,665,588 rupees ($27,189), and the median is 775,000 rupees ($7,905). This indicates that the majority of losses were below $7,905, but the significantly larger losses of some households resulted in a mean loss that was much higher than the median loss.

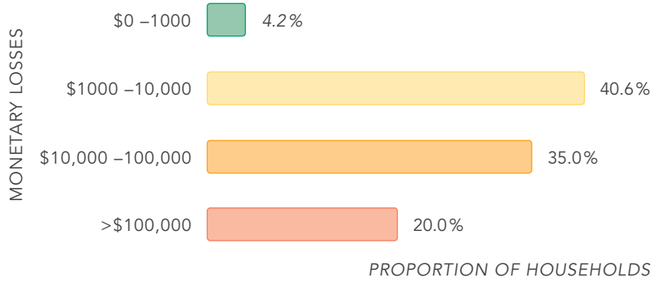


Figure 16: Monetary losses incurred by households

Souce: Authors' own

Due to the surprisingly high estimations of losses, we decided to consult local experts to evaluate the estimations' validity. The experts highlighted that prices in the area differ depending on geographical location and type of price scale used[7]. The price of land is directly related to its distance from the highway: the closer to the highway, the more expensive it becomes, as it gets converted to urban land use due to the shops, apartment blocks and enhanced means of transportation that living close to the highway entails.

In addition, land can be evaluated by the market price, or the government price. Generally, the government price is below market price. Close to the highway, the market price ranges roughly from 30 to 40 lakhs[8] per ropani ($30,600–40,800),

The price of land is directly related to its distance from the highway.

7 Source : Mr Madhusudhna Sapkot – Administrative Director (CDECF: Community Development and Environment Conservation Forum) & Mr Netra Karki – Hotel Owner (Prateek Hotel)

8 **1 lakh** = 100,000 rupees = $1,020 at the time of the landslide.

Value of land in Sindhupalchok

A great determinant for land value is its distance from the Araniko Highway. Land directly adjacent has the highest value, as it is the most urbanized and used for house construction. It grants easy access to the highway, shops and businesses. The price for land decreases with increasing distance.

The value also differs significantly depending on the price applied: government or market price. The price is generally estimated in lakhs (100,000 rupees).

	GOVERNMENT PRICE/ ROPANI	MARKET PRICE/ ROPANI
ADJACENT TO HIGHWAY	8-10 Lakh	30-40 Lakh
MEDIUM DISTANCE FROM HIGHWAY	2/3 Lakh	5/6 Lakh
HIGHER UP THE HILLS	Less than 2 lakhs	Less than 5 lakhs

Textbox 5: Value of land in Sindhupalchok

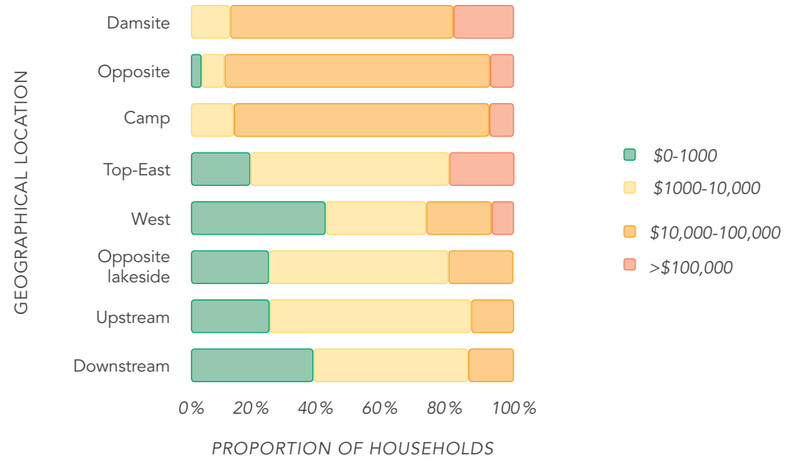


Figure 17: Monetary losses incurred by households per location

Souce: Authors' own

while the government estimates between eight and ten lakhs per ropani ($8,160–10,200). For land further away from the highway, the market estimates around five or six lakhs per ropani ($5,100–6,120), while the government price is around two or three lakhs per ropani ($2,040–3,060). While losses and damages are based on estimations reported by households and thus may not be completely objective, the attempts to verify their credibility via secondary literature and the consultation of experts have indicated that the losses reported are conceivable.

The landslide brought rampant destruction and led to the submersion of large chunks of land. Land that was not submerged after the landslide was often rendered infertile as the landslide washed away the soil and only left barren ground.

Other respondents reported debris covering their land, siltation, or just generally stated that their land was permanently lost. Beyond this, the landslide also triggered a 3.3 magnitude earthquake (Nepal Government, Ministry of Irrigation, 2014), which further exacerbated impacts, especially on the opposite hillside.

Figure 18 shows the land losses and damages in US dollars. The figure shows that around 80 per cent of households have incurred land loss because of the landslide. Most of those who lost land estimated damages to be in the $1,000 to $10,000 bracket, although nearly 12 per cent reported to have lost land valued at more than $50,000.

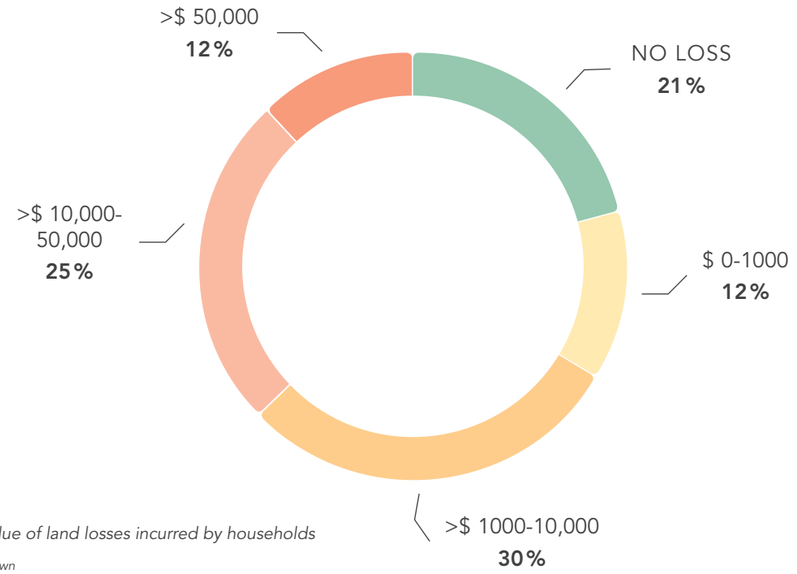


Figure 18: Value of land losses incurred by households

Souce: Authors' own

7.3 Damage to infrastructure, public places and the natural environment

Most respondents (94%) reported damage to infrastructure or important places in their community. In the study sites directly adjacent to the landslide, all households reported such impacts. Damage to roads, bridges, temples, cremation sites, schools, the market and irrigation canals were reported most frequently. Damage to roads and bridges complicated transportation, which had indirect effects on food prices, trade and health throughout the region. Damage to or destruction of places of worship and burial grounds was reported by 85 per cent of respondents.

Alongside this damage at village level with mostly local effects, a few households mentioned damage to a hydropower plant, reducing the generating capacity for electricity by 10 per cent beyond the region, including in the country's capital, Kathmandu, and causing power outages. Furthermore, the damage to and blockage of the Araniko Highway disrupted the only road connection between Nepal and China, with severe consequences for cross-border trade, causing estimated losses of nearly $400,000 per day (ICIMOD, 2014a). Beyond the household level, the landslide also caused loss and damage to the natural environment. The two most visual effects were the loss of tree cover along the valley slopes and the fact that the course of the river was shifted.

Nirjala Adhikari (18 years old)

"It was a very scary moment, and I couldn't think of anything else than grabbing my mobile phone and my school certificate before I ran out of the house", said Nirjala, a secondary-school graduate. "I secured my certificate because only this will help me establish a bright future."

Nirjala and her family, along with nine other affected households, are currently residing in tents at an abandoned magnetite factory (picture). The landslide made her homeless and destroyed her school. Her family also lost its paddy field, which was the mainstay of their livelihood. It also killed some of her close friends.

She feels especially lucky to have survived, as her house was only 30 m away from the landslide. While she sometimes visits her former home to salvage belongings, the house has become uninhabitable. Fear of future disasters has kept her family from attempting to rebuild the ruins. She reports that organizations provided in-kind relief, some following up on recipients every two to three months. The government provided Rs. 3,000.

Her mother is the key breadwinner, working at a small restaurant nearby. Her father sends remittances from Kuwait every three months, to finance her and her siblings' education.

Textbox 6: Nirjala's story

7.4 Psychological impacts

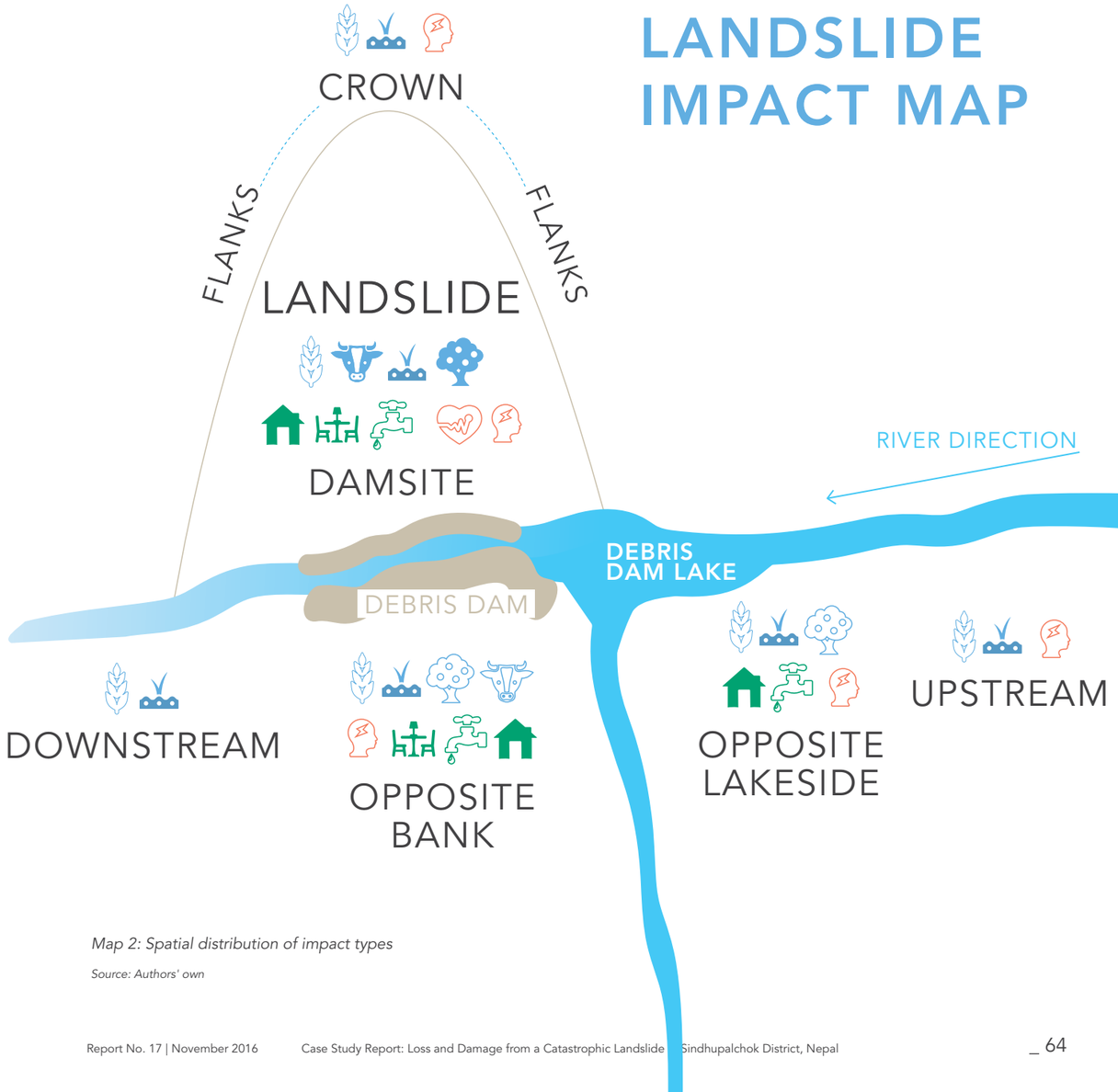
Most respondents (86%) also reported "other ways" in which they were affected by the landslide. A closer look at the qualitative information revealed that almost all "other impacts" respondents mentioned can be classified as non-economic loss and damage (NELD), meaning loss and damage to items that are not commonly traded in markets (Fankhauser et al., 2014). Such losses and damages are difficult to quantify, but can have severe effects on a population (Serdeczny et al., 2016). In our study area, mental stress and fear of flooding or another landslide are among the most commonly reported problems. More than 60 per cent of the respective respondents in every geographical cluster reported to be affected. The landslide caused severe emotional trauma and displacement of households. In total, 115 houses were completely destroyed (ICIMOD, 2014b). These are strong factors that people still struggled with at the time of the survey. High reporting of mental stress may have also resulted from the fact that the household interviews were conducted on the eve of the monsoon season (March–April 2015). Respondents fear the heavy rains as they significantly increase landslide risk.

Nirjala, an 18-year-old secondary-school graduate from the study area, tells her story in Textbox 6 (p.62). The only items she saved from her house when the landslide came were her mobile phone and her secondary school certificate. The certificate, she said, is essential for establishing a bright future. She also gives a vivid account of how she experienced the landslide, describing her grievances at the loss of some of her close friends and material assets that used to ensure her household's livelihood before the landslide.

The difference between colour icons and white icons is based on the average impact costs.

Solid: More than $1000

White: Less than $1000



Map 2: Spatial distribution of impact types

Source: Authors' own

7.5 Spatial analysis of impacts

Map 2 is based on satellite images of the landslide area, and sketches impact types by location as represented by icon symbols (see legend). The types of impacts are divided into livelihood impacts (blue), impacts on household assets (green) and non-economic impacts (orange). We define a location as having been affected by a certain type of impact (represented by an icon) based on the percentage of households affected per cluster. An impact type was included for a location if more than 50 per cent of local households were affected by it. We also differentiated between high- and low-intensity impacts for each impact type. To do this, we defined impacts that caused costs of more than $1,000 as high-intensity impacts (solid icons), and impacts that caused less than $1,000 in damages as low-intensity impacts (white icons).

Evidently, especially the area surrounding the debris dam (the Damsite, Opposite Bank and Opposite Lakeside clusters) was most affected by the landslide.

Over fifty per cent of households in all the study sites experienced impacts on crops. However, crops were affected in diverse ways in the different locations. While crops upstream and along the lake were inundated by the rising water, crops downstream were washed away by the outburst flood that followed a month after the landslide. Again different, crops on the opposite bank were covered by landslide debris. Lastly, households around the crown of the landslide mostly lost crops because they owned farmland in the area where the slope failure occurred.

Damage to houses was very common in areas around the landslide area, while households around the crown of the landslide are left with a daily fear of a recurring disaster, as the land they lived on was destabilized in the Jure landslide. Similar fears predominate in the areas surrounding the debris dam, where the landslide caused rampant destruction.

Relief was based on a categorization of victims in three categories, organized by the District Disaster Relief Committee. The deciding factors for categorization were loss of house and land. A red card was issued for complete destruction of house and land and the need for complete relief. Yellow cards indicated the need for supplementary relief on the basis of severe damage to house and land, and green cards showed slight to almost no damage. The categorization was summarized in a "list of affected people", which was the basis for the provision of relief.

Despite the application of this system, our findings show that the actual number of affected households far exceeded those who were mentioned on the "list of affected people". The list used a narrow definition of who was a victim and/or affected by the landslide that was solely based around losses of life within a household, or the destruction of a household's homestead. However, as our research shows, people were affected in many different ways.

7.6 Loss and damage by income group

While vulnerability is not the same as poverty (Chambers, 1989), poor people do tend to be more vulnerable to natural disasters (Blaikie et al., 2014). The survey data for the present research allow us to investigate whether poor households also incur more losses and damages than non-poor households. In Figure 19 the household sample is divided into three groups: those earning less than $1,000, those earning more than $2,000 and those in between. The green bars show the median losses and damages per household in monetary terms. The analysis shows that non-poor households actually lost more than poor households. While this seems at odds with the expectation that poor people would lose more, it has a straightforward explanation: non-poor people simply had more to lose.

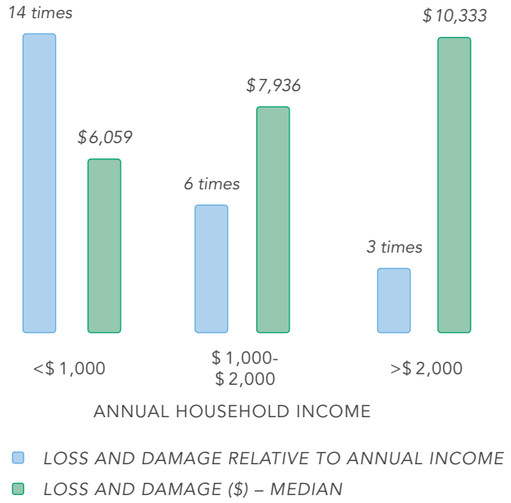


Figure 19: Loss and Damage in USD and as proportion of annual income

Source: Authors' own

By contrast, when losses and damages are expressed relative to the annual household income (the blue bars), we get a glimpse of what the real impact is on poor households and how long it might take them to recover from these losses. The value of losses among households in the lowest income group amounted to a median of 14 times their annual earnings. It seems reasonable to believe that many of these households will never return to the level of assets, livelihood security and well-being as they had prior to the landslide. For the highest income group, the value of losses was much less (three times their annual earnings), but the landslide was nevertheless a heavy blow for them as well, one from which it could take them years to recover.

Poor households are most affected by the landslide, despite lower losses and damages in absolute terms.

7.7 Main findings on impacts

The majority of households experienced three or four different impacts, mostly on crops, soil and land, and trees. Geographically, the areas surrounding the debris lake and dam were most severely affected, as they have been hit by direct as well as indirect impacts. Mental stress and loss of life were difficult to quantify, and mostly occurred around the landslide area. The analysis by income group shows that losses and damages, when expressed in absolute monetary terms, are lower among the poorest households. This is because they simply had less to lose. However, the relative losses for this group are almost five times higher than for non-poor households and this groupwill be in direst need of support to help the recoveryprocess.

Image 19: Life goes on; man working on his farm at a stone's throw from the landslide

8. Coping strategies and relief efforts

This section outlines coping measures taken by respondents in our sample, as well as their effectiveness and reasons for not taking additional or more effective measures.

Literally, to cope means "to deal successfully with something difficult" (Oxford Learner's Dictionary, 5th edition). The glossary of the IPCC Fifth Assessment Report defines coping as "the use of available skills, resources, and opportunities to address, manage, and overcome adverse conditions, with the aim of achieving basic functioning of people, institutions, organizations, and systems in the short to medium term". In livelihood research and development studies, the term is reserved for the things people do to survive or recuperate in the aftermath of adverse events such as the landslide that is the subject of this report.

While coping measures are aimed at recovering from detrimental impacts, they can also be erosive. Coping strategies are erosive when they undermine future livelihood security (van der Geest & Dietz, 2004). For example, when seed stocks are eaten, productive assets are sold, a child is taken out of school to beg or work in the informal sector, or when productive members of farm households are absent (e.g. due to migration) when the fields need to be prepared for the next harvest, long-term livelihood security is sacrificed for short-term benefits, leaving the household in a more vulnerable situation.

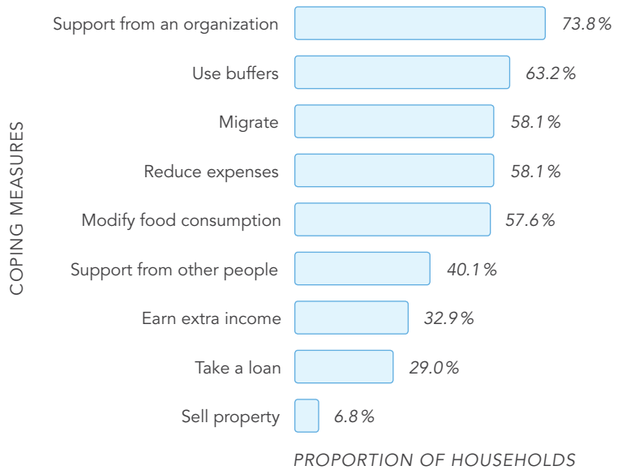


Figure 20: Uptake of coping measures by households

Source: Authors' own

8.1 Uptake

The section about coping in the household questionnaire started with an open question that inquired about how people coped with the impacts of the landslide. The answers showed that people seemed to base their response on their experiences during the event. Most households who lived in low-lying places, for example, answered that they went to higher and drier land in order to escape from flooding and inundation. Many of those who resided close to the site of the landslide reported that they went to safer places to be less at risk of new landslides while the slope was still unstable.

After the open question, respondents were asked about the uptake of specific coping measures. Figure 20 shows the frequency with which different coping measures were adopted by households. The largest proportion of households coped with the impacts of the landslide by receiving support from an organization, often specifying the Red Cross or the Srijansil children welfare organization as those who supported them. Using buffers (63%, mostly stored food or savings), migrating, reducing expenses and modifying food consumption (around 58% each) were also adopted by more than half of the respondents. Selling property, on the other hand, was rarely reported by households (6.8%), possibly because only a small proportion of households had property available to sell.

Generally, households engaged in several different measures to cope with landslide impacts, as shown in Figure 21. Seventy-eight per cent of the respondent households adopted three or more coping measures.

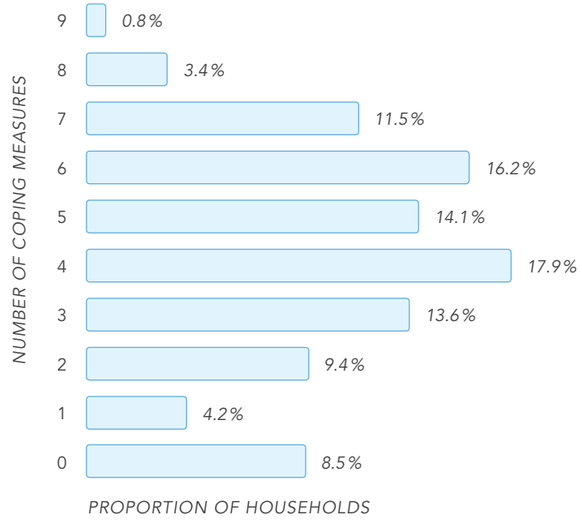


Figure 21: Number of coping measures by households

Source: Authors' own

8.2 Effectiveness

Figure 22 depicts the effectiveness of different coping measures, based on respondent evaluations. Reliance on buffers or receiving support from one's social network of family and friends emerged as the most effective measures to cope with the landslide impacts. Both these measures depend on the preventive measures people took before the event, and are thus different from the next most effective measure, relying on loans. To rely on loans was an effective way to cope for many, although it also has the highest proportion of households who stated that it had negative effects after adoption (4%).

Coping measures that entailed negative effects, as was the case for some respondents who took up loans, engaged in migration or relied on other income, fall in the category of "second-order impacts" (see conceptual framework in the introduction). Also referred to as "erosive coping", this type of impact involves measures that may help people survive or mitigate impacts in the short term, but undermine livelihoods in the longer term (van der Geest & Dietz, 2004), meaning that the household will ultimately be worse off than it would have been had it not adopted the measure. In the case of relying on loans, this involved the inability to repay the loan, which often entailed social disgrace, fines and the inability to rely on loans in the future. Migrating to cope with landslide impacts was often a strategy of last resort. Being away from home, and from local livelihood tasks such as land preparation and

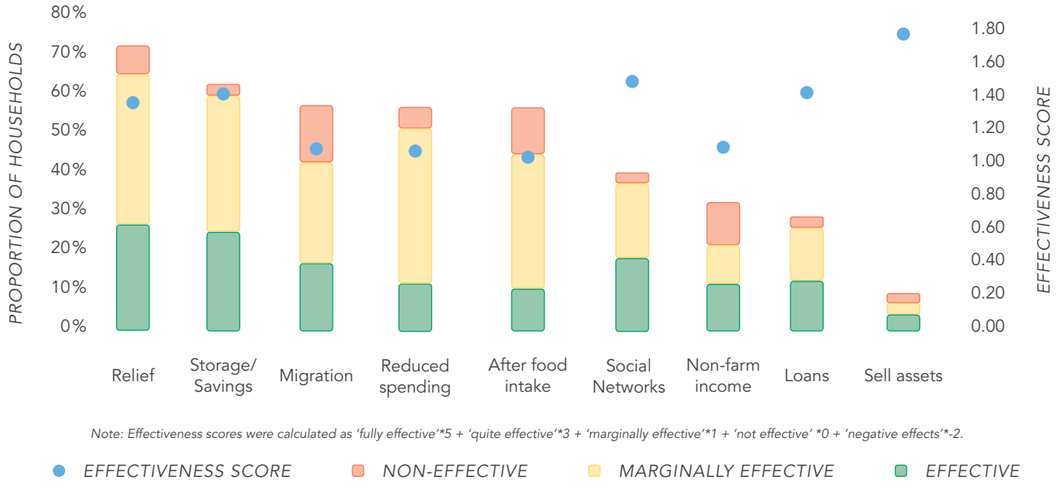


Figure 22: Effectiveness of households' coping measures

Source: Authors' own

sowing, led some to view migration as an erosive coping measure. Respondents who pointed to adverse effects of relying on non-farm income as a coping strategy usually did so because they lost their land and regarded the alternative livelihood activity as less sustainable. This emphasizes that, while efforts to diversify livelihoods may be increasing, land is still the most important source of livelihood for respondents.

Besides inquiring about the success of specific coping measures, respondents were asked how effective the whole portfolio of measures they took had been at helping to recover from landslide impacts (Figure 23). More than half the respondents said they will never fully recover from the impacts of the landslide despite the measures taken (55%). Many of them mentioned the loss of loved ones or irrecoverable loss of land. Less than 20 per cent had a positive view in the aftermath of the landslide (16% had recovered and 3% reported a situation that was better than before the landslide), while 26 per cent said they still have not recovered from the landslide impacts.

People's ability to recover is primarily related to how badly they were affected by the landslide. Those who reported to have already recovered had experienced an average of three impact types, while those who had not yet recovered had experienced six impact types on average.

We conducted a stepwise binary logistic regression to study the effect of ten different coping measures on recovery. In line with the findings presented in Figure 22 (Effectiveness of individual coping measures), the model results show that

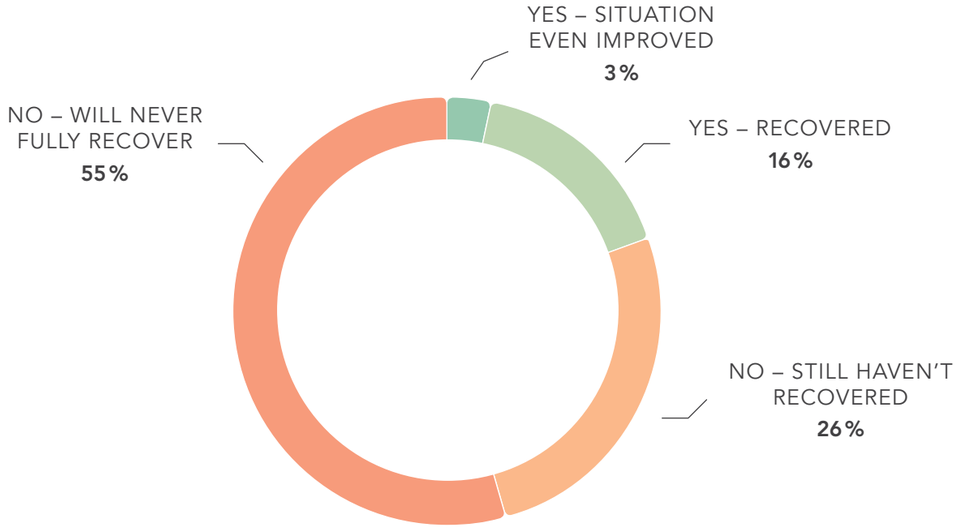


Figure 23: Effectiveness of coping measures at facilitating recovery

Source: Authors' own

households who coped with landslide impacts by relying on buffers and by seeking support from their social network were significantly more successful at recovering. In contrast, four types of coping measures were negatively associated with recovery success: modifying food consumption, help from organizations, taking loans and reliance on extra income. Annex 2 has more detailed model results that support these findings.

8.3 Constraints

As a reason why respondents did not adopt more efficient coping measures, around 54 per cent said there was nothing else they could do and 50 per cent lacked the financial means to take any measures (Figure 24). Around 20 per cent of respondents said they either lacked the skills or the resources to adopt additional measures, while 12 per cent did not see coping measures as a priority and 5 per cent claimed it was not their task to adopt coping measures.

Fifteen per cent of respondents gave other reasons for not adopting more coping measures. For example, one respondent said that whatever he does will not matter, as he cannot return his lost wife, son or land. Among these 15 per cent of respondents, this attitude of resignation in the face of previously unimaginable losses was confirmed by many. Some referred to the lack of work, the destruction of their field that leaves them without means to feed their children, or the

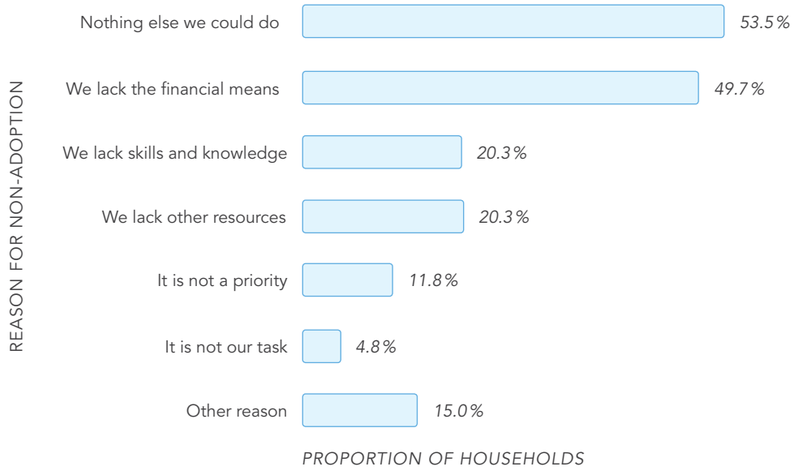


Figure 24: Reasons for not adopting more (effective) coping measures

Source: Authors' own

lingering fear of additional landslides. Others said that relief efforts were insufficient, or that the government and organizations were negligent – either by not providing enough relief, or by failing to ensure that measures were effective and targeted at the neediest.

8.4 Relief

While the government and NGOs had done little to prevent landslide impacts, they did implement a wide range of measures for relief purposes. Respondents said that these efforts usually pertained to monetary compensation, in-kind aid and engineering work, such as the removal of debris and forcing openings in the dam that blocked the river after the landslide. Relief was provided by the government and the District Development Commission (DDC), Village Development Committees (VDCs), NGOs (e.g. the Red Cross, the Federation of Nepalese Chambers of Commerce and Industry and the Srijansil children welfare organization), political parties, Banijya Bank, the army and the police. Religious organizations, such as the church, the Tamang society and the Gumba, also provided support.

> *One respondent said that whatever he does will not matter, as he cannot return his lost wife, son or land.*

Concerning monetary relief, 40,000 rupees (around $400) was regarded as the "going rate" that the government paid per deceased household member. Several respondents mentioned that the compensation money was just enough to cover funeral expenses.

The VDC coordinated a relief fund that was created for the support of landslide victims. It was funded by donations from organizations on the one hand and individuals, such as business people and international migrants, on the other. NGOs often helped via in-kind donations and support. The Red Cross erected a camp to harbour displaced people, who continued to receive support at the time of the fieldwork for this study. A government report specified that 384 persons received relief material, including food aid, shelter, cooking utensils, drinking water and blankets in the aftermath of the disaster (Government of Nepal, 2014).

The participatory evaluation of adaptation (PEA) results shown in Textbox 7 (p. 75) highlight three different elements of post-landslide measures that were adopted by organizations: engineering, emergency relief and compensation. Engineering work was generally viewed as well-executed, although some respondents highlighted the need for further measures to aid effective prevention of future impacts. Emergency relief was largely seen as good. However, some respondents felt that they lacked a long-term component and were not egalitarian. Further, successful measures in emergency relief were mostly attributed to NGOs rather than the government. This impression was largely matched by opinions on compensation.

Much of the relief was organized and dispatched according to a list of "affected people". However, as the previous section on landslide impacts shows, the true number of affected people far exceeded the number of people on this list. About a quarter of the respondents (26%) reported that they did not receive any support from organizations to cope with landslide impacts. Some said that this was simply because they had not been as severely affected as other households. Others claimed that organizations did not care about them, or that nobody informed the organizations of the situation. One respondent said that the Nepali government lacked "capital, resources and capacity" to handle the problem. Complaints about corruption and unfair distribution of relief funds were also raised among respondents. Lastly, there seemed to be the strong perception that money spent on research was more than what people received in relief efforts, which was cause for some resentment.

Based on the results of the survey and the PEA, relief efforts by organizations and the government compare favourably to the preventive measures that had been taken before the landslide. However, despite the measures taken, many of the losses and damages could not be addressed. Especially the poorest and least influential victims seem to have had difficulties in securing compensation for their losses.

8.5 Main findings on coping and relief

Most households attempted to cope with the landslide with a diverse set of measures (median: 4). Resorting to buffers and seeking support from one's social network were considered the most effective coping measures. Loans were also seen as effective, although the analysis showed that it led to negative effects for some. Migration and other income were also reported to have entailed negative effects in some cases. Despite adopting a wide range of coping measures, the vast majority of households had not yet recovered from the landslide impacts and over half feared that they would never recover.

The coping measures that prevailed in the sample mirrored the diversity of impacts that households incurred. Those who were displaced sought shelter with relatives or relocated to the camp location in the area. Households living downstream, who

PEA: Post-landslide measures

This textbox outlines the participatory evaluation of adaptation (PEA) results for measures taken after the landslide.

The evaluation was done through two focus group discussions with 10–15 participants each. They listed projects, activities or interventions by government agencies and NGOs and then discussed how successful these were and why (not).

Engineering refers to post-landslide reparation efforts, such as controlled blasting to force an opening in the debris dam. Emergency relief and compensation describe efforts by NGOs or the government to improve the situation for households in the landslide area, mostly by providing money to those affected (e.g. going government rate per deceased family member: 40,000 rupees).

Most of the 23 interventions mentioned by women involved emergency relief measures, such as food aid, blankets, tents, cooking utensils and money.

Men mentioned 16 interventions, and referred mainly to compensation, engineering and recovery measures (four times each). Relief and preventive measures were only mentioned twice.

WOMEN	MEN
Engineering: Divided opinions on the lake that formed after the landslide blocked the river – some would have preferred leaving the lake for tourism, others are grateful that the debris dam was opened due to fear of an outbursts flood.	**Engineering:** The work done was seen as good, but respondents highlighted the need for further efforts aimed at preventing future impacts.
Emergency relief: Viewed as good and helpful in the short term.	**Emergency relief:** Adequate and fast, but mostly thanks to NGOs and not the government. Also, richer and more powerful people were able to access more support than the poor.
Compensation: Same as emergency relief, although everyone lost more than they gained.	**Compensation:** Fair for lives lost, but lacking for other damages.

Textbox 7: Participatory Evaluation of Adaptation for post-landslide measures

faced risks of an outburst flood, did not move. They only spent the nights on higher ground in case an outburst flood caught them sleeping. This looming threat and the uncertainty caused considerable mental stress. For more than a month they lived with the fear of an outburst flood while there was also a chance that they would not be affected at all. This is illustrated by the actions reported by one respondent, who said: "After the landslide, I did nothing. I went home and finished a pack of cigarettes."

The relief provided to respondents was usually recognized and highly appreciated. However, people also expressed concerns about a lack of organization and transparency on the side of the providers of the efforts. Reports about relief supplied to the best-connected rather than the neediest is indicative of this and was further cause for complaint.

Resorting to buffers and to a personal social network were deemed the most effective coping measures.

Relief efforts by organizations were largely seen as insufficient.

Image 20: Green terraces adjacent to the landslide debris

9. Conclusions

This study looked at the losses and damages caused by a catastrophic landslide in Sindhupalchok District in Nepal. It took a people-centred perspective on the landslide by focusing on how households were affected and how they tried to prevent landslides, minimize impacts and cope with impacts that could not be avoided. The principal data source for this study were questionnaire interviews with 234 households. In addition, the field team conducted expert interviews, focus group discussions and in-depth interviews with landslide victims. This was done to triangulate survey findings and to allow for respondent input that goes beyond the limits of survey questions.

One of the most severe impacts of the landslide was damage to or loss of land. Two thirds of the respondents (68%) estimated the losses and damages to land for their households at more than $1,000 and for over half of this group, the losses were more than $10,000. Beyond the significance in monetary terms, households rely on land for their livelihood. Although most households have diversified their livelihood with non-farm income and remittances, land-based activities such as crop cultivation and livestock keeping are essential for attaining food and livelihood security. The landslide severely diminished people's ability to sustain their livelihoods. Geographically, the most severe and diverse impacts were reported in the area surrounding the debris dam, including on the opposite bank of the Sunkosi river. At least ten different types of impacts were recorded in these locations.

Richer respondents were shown to have sustained larger absolute impacts, while the poorer were more heavily affected from a relative standpoint. In other words, the value lost to

richer households was higher but the poorer lost more in relation to their income. Specifically, respondents with an annual income of less than $1,000 incurred median losses of around $6,000, which on average represented 14 times their annual income, whereas respondents with an annual income of more than $2,000 had median losses of more than $10,000, which was roughly three times their annual income on average. This has implications for discussions about loss and damage compensation. Should scarce resources go to those who lost most (wealthier households) or those who are in most dire need of support for survival and recovery after a disaster (poorer households)?

The analysis of household vulnerability, using the multidimensional vulnerability index (MDVI), found that impacts sustained by households were largely independent from their vulnerability levels as measured by the MDVI. The main explanation is the scale of the landslide, which nobody had expected. Even the most robust house, for example, would not have withstood this landslide.

About a third of the respondents failed to take any preventive measures against landslides. As a reason, many of them indicated that they never expected a landslide of this scale to occur. Those who did take measures mostly only took one. Around 40 per cent did so by diversifying their sources of income and around 35 per cent by placing physical barriers, such as gabions, on their land and around their dwellings. This study analysed people's perceptions about the effectiveness of the preventive measures they took. House adjustments, livelihood diversification and proactive migration were evaluated most positively by respondents, and land use adjustments and physical barriers were considered least effective.

The study also found that the government and non-governmental organizations did little to prevent landslide impacts in the area. Many respondents expressed resentment, while others thought that organizations could not have done much to prevent the landslide or minimize its impacts. A visual analysis of satellite images from recent years shows that simple visual patterns were insufficient to reliably predict if a landslide was imminent or not. The hard-to-predict nature of landslides makes preventing damage a complex task. There is a strong need for better techniques to identify high-risk areas and to respond to risk appropriately, for example through the design and implementation of an efficient early warning system against landslides.

The study did not only look at what people and organizations did to prevent landslide impacts; it also investigated how they dealt with the impacts, and to what extent coping strategies helped people recover from landslide impacts. Many households were to some extent successful in mitigating damage by adopting coping measures. Nearly 80 per cent of respondents adopted three or more coping measures. While receiving support from organizations was the most common measure (73%), buffers and social networks turned out to be most effective at mitigating losses and damages. These measures were evaluated as at least marginally effective by the majority of respondents who relied on them and had the highest overall effectiveness scores. Migration was also engaged in by a majority of respondents (58%). Although it did not rank among the most successful coping mechanisms, it was seen as at least marginally effective by three quarters of adopters. Despite the adopted measures, the losses incurred proved too severe for coping measures to help recovery up to the pre-landslide levels of livelihood security and well-being for the majority of households.

This report about the 2014 Jure landslide in Sindhupalchok District, Nepal, applied a people-centred approach towards post-disaster loss and damage assessment. The methods were part of a new toolbox that was tested in similar case studies in India and Pakistan (for more info, see Van der Geest & Zeb, 2015). The approach yielded a more thorough understanding of loss and damage than the disaster loss "stocktaking exercises" that are usually conducted in the aftermath of extreme events. It expanded the focus from what was lost to how and why people incur loss and damage. In particular, the people-centred evaluation of preventive and coping measures by households and organizations in the area provided invaluable information about adaptation constraints. This information is crucial for identifying entry points for effective policy to address loss and damage.

9.1 Policy recommendations

Nepal is located in an area that is exceptionally susceptible to natural disasters. The collision of the Indian and Eurasian Plates continues to expand the Himalayan mountain range, and leaves its mark on the terrain and soil by causing tremors or general instability. In combination with heavy and frequent rains and human activity, this makes Nepal "one of the world's landslide hotspots" (Witze, 2015).

Policy to address landslide loss and damage can be classified into three types of measures: those that aim at avoiding landslides, measures that minimize impacts, and policy to deal with residual impacts that cannot be or have not been avoided. In the household interviews respondents were asked what the government and other organizations should do to address landslide loss and damage. We classified the answers into the three categories.

First, to avoid landslides, respondents mostly suggested placing more gabions in landslide-prone places, planting trees and raising awareness of landslide risks. They also highlighted the need for more scientific research on landslides. This could encompass identifying high-risk areas via regular geological surveys and monitoring the areas identified using scientific methods such as the landslide susceptibility index (LSI) (e.g. Poudyal, 2013; Rao & Ho, 2015; Shahabi & Hashim, 2015). While respondents saw the need for more landslide research, some also displayed resentment concerning money invested in research while many people did not receive adequate relief to deal with the consequences of the landslide and were still suffering. In addition to the respondents' views, expert interviews suggested that supporting and promoting sustainable land use, better water management and fortifying high-risk areas could considerably reduce landslide risks.

Second, to minimize landslide impacts respondents primarily thought of government-initiated resettlement schemes that take people out of harm's way. Similarly, assisted migration from high-risk areas could help reduce impacts when landslides do occur. To reduce impacts of dam lake outburst floods, respondents suggested the creation of river embankments in the lowlands. Other suggestions by respondents were the promotion and support of more resilient building methods and conducting risk assessments for infrastructure projects.

Independent from respondent suggestions, others have highlighted the need to address health concerns in the aftermath of the disaster. Especially the provision of sanitary facilities and equipment is imperative, as decaying bodies of victims and livestock, as well as open defecation in the absence of sanitary establishments, can contribute to quickly spreading diseases (OSOCC, 2015). Also, lives could be saved by setting up early warning systems (EWSs) against landslides and designing adequate escape routes. While a good EWS against landslides may save lives it is unlikely to save property due to short lead times. Scholars on landslide EWSs emphasize the need for an adequate choice of warning levels, dependent on context-specific thresholds (Intrieri et al., 2012).

The third set of policy measures to address loss and damage involves dealing with residual impacts. The most prominent suggestion by respondents was for the government to provide compensation for lives, properties and income lost. However,

Early warning systems (EWSs)

Intrieri et al. (2013) understand EWSs as a balanced combination of design, monitoring, forecasting and education (Illustration 1). Arguably, design and forecasting can be directly administered by research. Monitoring and education, on the other hand, can be informed by research, but need to be administered by policymakers.

DESIGN

- → Geological knowledge
- → Risk scenarios
- → Design criteria
- → Choice of geo-indicators

MONITORING

- → Instruments installation
- → Data collection
- → Data transmission
- → Data elaboration

FORECASTING

- → Data interpretation
- → Comparison with thresholds
- → Forecasting methods
- → Warning

EDUCATION

- → Risk perception
- → Safe behaviors
- → Response to warning
- → Population involvement

Diagram 2: Four components of an EWS

Source: Adjusted from Intrieri et al. (2013).

potential measures beyond direct financial aid could include providing access to affordable loans to help the recovery process and establishing alternative livelihood options for households that previously depended on farming. Also migration could be a successful remedy, as it leaves households with considerable agency in terms of who they send to migrate, and where to. Lastly, providing subsidized insurance against landslide damage could be an effective way to deal with impacts that have not been avoided with other measures.

9.2 Future research – The April 2015 earthquake

The earthquake that hit Nepal on 25 May 2015 led to an estimated death toll of more than 8,600 people (UNISDR & PreventionWeb, 2015). Even though the epicentre was west of Kathmandu, Sindhupalchok was the worst-affected district in the country with more than 3,500 casualties and 63,885 houses severely damaged (UNOCHA, 2015). In the months following the earthquake, Sindhupalchok was the most food-insecure district in Nepal according to the Nepal Food Security Monitoring System (NeKSAP, 2015).

The severe impacts of the April 2015 earthquake in Sindhupalchok were partly due to 7.3 magnitude aftershocks that hit the district. However, a so-called "vulnerability cascade" may have been an aggravating factor: people were still recovering from the landslide when the earthquake hit, which made them more vulnerable than people elsewhere in Nepal, and this might have exacerbated losses and damages. A national newspaper reporting on the post-earthquake situation in the district wrote: "two disasters have collapsed into one" (Nepali Times, 2015).

The household data for the landslide impact study were gathered just three weeks before the April 2015 earthquake. As such they can provide a unique baseline for studying the functioning of vulnerability cascades.

Image 21: Street vendor and child; petty trade is an important non-farm activity in Khadichaur

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Annex 1: Thresholds for vulnerability indicators

1. Education

Education level of the household head.

		FREQUENCY	PER CENT
1.	Higher secondary and tertiary	9	3.9%
2.	Lower secondary	39	16.7%
3.	Primary	48	20.5%
4.	Literacy classes	72	30.8%
5.	None	66	28.2%
	Total	234	100.0%

2. Dependency ratio

Dependent household members, calculated as:

(Dependent household members (aged <18 and >65) / adult household members (aged 18–65)) × 100. The higher the dependency ratio, the more vulnerable the household.

		FREQUENCY	PER CENT
1.	0–16.67	39	16.7%
2.	20–37.5	48	20.5%
3.	40–66.67	52	22.2%
4.	75–100	47	20.1%
5.	>116.67	48	20.5%
	Total	234	100.0%

3. Land ownership

Size of land owned by household (hectares), based on quintiles.

		FREQUENCY	PER CENT
1.	>0–85	45	19.2%
2.	0.45–0.81	44	18.8%
3.	0.28–0.43	40	17.1%
4.	0.13–0.25	54	23.1%
5.	0.01–0.11	46	19.7%
	Total	234	100.0%

4. Livestock ownership

Livestock owned, expressed in Tropical Livestock Units and based on quintiles. Conversion factors:

Horse – 0.8; cow – 0.7; donkey – 0.5; pig – 0.2; sheep/goat – 0.1; poultry – 0.01.

		FREQUENCY	PER CENT
1.	>2.54	46	19.7%
2.	1.61–2.54	46	19.7%
3.	1–1.6	48	20.5%
4.	0.31–0.99	46	19.7%
5.	0–0.3	48	20.5%
	Total	234	100.0%

5. Livelihood diversity

Number of livelihood sources out of the following list: farm/garden cultivation, farm labour, livestock, fish, trees, non-farm activities, remittances, other sources of income (mostly old age allowance)

		FREQUENCY	PER CENT
1.	6 or 7 sources	52	22.2%
2.	5 sources	104	44.4%
3.	4 sources	51	21.8%
4.	3 sources	14	6.0%
5.	0 to 2 sources	13	5.6%
	Total	234	100.0%

6. Total cash income

Total cash income over the past 12 months, expressed in rupees and based on quintiles. Calculated as the sum of income from all sources mentioned under livelihood diversity.

		FREQUENCY	PER CENT
1.	>254,000	45	19.2%
2.	150,500–254,000	45	19.2%
3.	91,500–150,000	43	18.4%
4.	41,000–90,000	46	19.7%
5.	0–40,000	46	19.7%
	Not available	9	3.9%
	Total	234	100.0%

7. House quality

Based on floor material (vulnerable if earth or tent materials) and personal perception of house quality (better, average, worse).

	IS FLOOR OF THE HOUSE MADE OF EARTH OR TENT MATERIALS?	
Personal perception of house quality	No	Yes
Better	Vulnerability = 1	Vulnerability = 3
Average	Vulnerability = 2	Vulnerability = 4
Worse	Vulnerability = 3	Vulnerability = 5

		FREQUENCY	PER CENT
1.	Vulnerability=1	35	15.0%
2.	Vulnerability=2	46	19.7%
3.	Vulnerability=3	56	23.9%
4.	Vulnerability=4	70	29.9%
5.	Vulnerability=5	13	5.6%
	Not available	14	6.0%
	Total	234	100.0%

8. Location

Based on respondents' personal perceptions of how risky the location of their house is; how exposed it is to landslides.

		FREQUENCY	PER CENT
1.	Much safer	107	45.7%
2.	A bit safer	66	28.2%
3.	Average	14	6.0%
4.	A bit riskier	25	10.7%
5.	Much riskier	19	8.1%
	Not available	3	1.3%
	Total	234	100.0%

9. Food security

Based on months of food shortage in the past year and years of food shortage in the past decade.

	YEARS OF FOOD SHORTAGE IN PAST DECADE		
Months of food shortage in past year	0	1–3	4–10
0	Vulnerability = 1	Vulnerability = 2	Vulnerability = 3
1-3	Vulnerability = 2	Vulnerability = 3	Vulnerability = 4
4-12	Vulnerability = 3	Vulnerability = 4	Vulnerability = 5

		FREQUENCY	PER CENT
1.	Vulnerability=1	99	42.3%
2.	Vulnerability=2	58	24.8%
3.	Vulnerability=3	34	14.5%
4.	Vulnerability=4	21	9.0%
5.	Vulnerability=5	1	0.4%
	Not available	21	9.0%
	Total	234	100.0%

10. Preventive measures

Based on the number of different preventive measures the household adopted to reduce the likelihood and impact of a landslide (e.g. gabion walls, tree planting and house adaptations)

		FREQUENCY	PER CENT
1.	4 or 5 measures	15	6.4%
2.	3 measures	34	14.5%
3.	2 measures	47	20.1%
4.	1 measure	58	24.8%
5.	0 measures	80	34.2%
	Not available	21	9.0%
	Total	234	100.0%

Annex: Effectiveness of coping strategies (model results)

This annex gives model results for a stepwise binary logistic regression of the effectiveness of coping strategies at facilitating recovery from landslide impacts. An advantage of binary regression is that it allows for multiple independent variables, which can be dichotomous, ordinal or continuous. Also, it quantifies the explanatory power of the model.

In the model, the coping measures are the independent variables, and the dependent variable is coping effectiveness. One additional variable was included in the model, namely the number of impact types. The dependent variable is coded as follows: 0 = No, coping measures were not effective enough to recover from landslide impacts; 1 = Yes, coping measures were effective enough to recover from landslide impacts.

The independent variables are added to the model stepwise in order of statistical significance. The threshold for inclusion was a statistical significance ("sig") of less than 0.05, which corresponds to a 95 per cent confidence level. Three coping measures did not enter the model as they were not significantly related to the dependent variable (coping effectiveness). These were selling assets, reducing expenditure and migration.

"Number of impact types" was added first as it was most significantly related to coping effectiveness. Households that incurred less different impact types were more likely to have recovered. The last variable to enter the model was "Reliance on help from other people". The model as a whole has a Nagelkerke Pseudo R^2 of 0.466, meaning that it is able to explain 46.6 per cent of the variation in the dependent variable, successful recovery from landslide impact.

The signs for "B" indicate how the independent variable influences the dependent variable, meaning that households that coped with the landslide using measures with a negative "B" tended to be less successful at recovering from the landslide's impacts. For example, households that relied on help from organizations to cope with landslide impacts were less likely to have recovered at the time of the interview. The opposite is the case for a positive "B". Thus, those households who relied on help from people or buffers tended to recover better from landslide impacts than households that did not engage in these coping measures.

Step	Coping measure	B	S.E.	Wald	Df	Sig.	Exp(B)/ Odds ratio
1	Number of impact types (0-12)	-.374	.114	10.757	1	.001	.688
2	Engage in extra income activities (0=no, 1=yes)	-1.692	.581	8.472	1	.004	.184
3	Take a loan (0=no, 1=yes)	-1.291	.654	3.895	1	.048	.275
4	Modifying food consumption (0=no, 1=yes)	-1.093	.449	5.911	1	.015	.335
5	Rely on buffers (0=no, 1=yes)	1.452	.647	5.036	1	.025	4.272
6	Rely on help from organization (0=no, 1=yes)	-.979	.472	4.308	1	.038	.376
7	Rely on help from people (0=no, 1=yes)	.913	.462	3.906	1	.048	2.491
	Constant	.876	.833	1.105	1	.293	2.401

Model x^2 = 70.297 p. < .0001
Nagelkerke Pseudo R^2 = 0.46
N = 204

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