Examining Determinants of Household Vulnerability in Nepal: Descriptive Statistics Analysis of Flood Disasters

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Abstract

This study examines determinants of household vulnerability at the community level based on primary data by descriptive statistics. As a result, multiple variables that are awareness, traditional knowledge, and preparedness, nature of asset, income & information are its determinants. These variables are themselves vulnerable. In the correlation result, agro loss, family size and income of household are significant. Agro-loss is a major determinant one. About 70 percent households are vulnerable in which 23.75 percent households are extremely vulnerable. Therefore, adaptation capacity should be improved to reduce vulnerability. This study is expected to contribute in the execution of disaster risk reduction management (DRRM) in the study area of Nepal.

Introduction

A vulnerability issue is deepening widely in the world. World Bank (2016) reckons $520 billion economic loss per year from natural disasters and finds about 26 million people into poverty per year. Relatively, the vulnerable population heavily pays more than non-vulnerable population because of a limited adaptation capacity of the poor. It is 60 percent of annual consumption. In 2022, 29 major disasters are recorded in the world (www. yaleclimateconnections.org/2022/….). In Europe, heat waves killed more than 16000 people. In Germany, flooding in 2021 damaged 43 billion USD and killed 236 peoples. Likewise, in Pakistan, flooding in 2022 killed 1700 people. Bangladesh is 7th vulnerable country. One in every seven people will be displaced due to climate change impacts resulting in 18 million climate migrants by 2050. Adverse effect of increasing salinity in the agriculture is projected. (www.icccad.net) IEDRO, (2010) accounts 219 natural disasters with $ 16 billion losses in Bangladesh. In 2009, tropical cyclone alia displaced half a million people and destroyed hundreds of thousands of acres of cropland. In 2004, flooding affected 30 million people (IEDRO, 2010). Similarly, Nepal is 4th vulnerable country, where more than 80 percent population is at risk of multiple disasters (MoH, 2017). Thus, a vulnerability is being a big threat in the world.

This threat is understood as poverty (Porter, et al., 2022 and World Bank, 2016). UNISDR, (2009b) explains it more than poverty. It means helpless people. Wisner et al. (2004) argues the vulnerable people living in unsafe locations. Twigg (2004) explains the people having 'fragility', 'weaknesses, 'deficiency' or 'lack of capacity'. In another

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words, it is "susceptibility to harm" or "exposure to natural hazards". Similarly, Birkmann, (2006) and IPCC (2012) illustrate it unsafe and dangerous conditions.

Besides, it is the inability of people to prepare for and withstand disaster (Alexander, 2000, Clark, Cash, Corell, Dickson, Hall and Parson, 2000 and UNDP, 2004). Hodinott and Quisumbing (2003) and Turner II et al. (2003) mention it as the inability to withstand the effects of a hostile environment.

Similarly, Cardonna (2003) and Porter, et al (2022) explain it to refer to risk by explaining the relationship between shock and vulnerability towards risk. Explicitly, Chambers (1989) mentions it external side (risks, shocks and stress to individual) and internal side (defenseless of individual (physically weaker, economically improvised, socially dependent and psychologically humiliated)-no means to cope without damaging loss). Brooks, (2003), and Adger, et al. (2004) argue similar.

Differently, Adger, (2006) argue it in terms of exposure and susceptibility to, and can be associated with the capacity to cope with the existing disaster. Similarly, the United Nations Environment Program (UNEP) (2003) argues it as shock's consequences including loss of human lives, malnutrition, income losses, water stress, and environmental degradation. In simple, vulnerability and individual defenseless have positive correlation and vulnerability and no defenseless of individual have negative correlation (Bista, 2011a, Bista, 2011b, Bista, 2011c, Bista, 2013, Bista, 2018, Bista, 2019, & Bista, 2019). Theoretically, such a relationship can be observed at the individual level or the household level.

Despite a large empirical works in developing countries in the world, these literatures concern different contexts across different developing countries. In Nepal, few literatures (Bista, 2007, Bista, 2011a, Bista, 2011b, Bista, 2011c, Bista, 2013, Bista, 2018, Bista, 2019, & Bista, 2019) deal on this issue from different perceptions and analytical methods. Therefore, this study is highly relevant to fill out the research gap on the relationship between vulnerability and natural disasters and socio economic determinants of household vulnerability.

In this context, this study examines whether the relationship between vulnerability and natural disasters and socio economic determinants of household vulnerability is positive, whether there are determinants of vulnerability and whether there are issues related to vulnerability at the community level. Its output and outcomes would be valuable to the policy makers to understand socio-economic variables, vulnerability issues and climate disaster's concern to formulate development modules and disaster risk reduction management (DRRM) and their linkages across the country for improving resilience level at the community and reducing climate led disaster vulnerable population in the future.

The objective of the study has been to examine determinants of household vulnerability at the community level. Its specific objectives are as follows: a) to identify factors influencing household vulnerability, b) to measure household vulnerability level, and c) to find out policy issues.

The paper is presented in six sections: Section 1: Introduction, Section 2: Materials and Method, Section 3: Results and Discussion, Section 4: Conclusion, and Section 5 Reference.

Materials and Method

Conceptual Framework

A theoretical and empirical literature (Shen et al. 2011) on vulnerability mentions income loss of household as measurement of vulnerability. This is a theoretical framework of this study, on which this study has made an analytical framework of different variables (socio economic and natural shocks) in Nepal. Scientifically, vulnerability depends on socio economic condition of households and natural shocks. In a better socio-economic condition, households will be less vulnerable. Reversely, if not, households will be higher vulnerable. Thus, the relationship between vulnerability and socio-economic condition is inverse and the relationship between vulnerability and natural disasters is positive. Its theoretical function is an equation (i) below.

$$Y_{Til} = f(X_{h,}, \varepsilon)\dots\dots\dots\dots\dots\dots\dots(i)$$

Where

Y_{Til} = household's total income loss,

X_h = socio economic bundle (income, literacy, asset, family size, land holding etc),

ε = error term

Study Area

To understand how socio economic variables affecting household vulnerability level during natural shocks in Nepal, UNDP's household survey is undertaken in the Sotkhola water basin and its catchment areas (Figure 1) in the northern part of Surkhet, the western Nepal. The water basin is a tributary of a big river, Bheri (Figure 1). Its length is about 30 km originated from Chandane, Gadhi VDC and ends to Rakseni, Kunathari VDC (Figure 1) (DDC, 2015). Its water level seems to be permanent character but its fluctuation occurs in the different seasons from monsoon to winter. In winter, its water level is unexpectedly lower. Thus, the river is a monsoon lover.

Geomorphologic of the water basin has mainly three catchment areas having 28 square spread from sea level to Mahabharata range: Gadhi VDC (Upper stream), Lekhagaon VDC (middle stream) and Kunathari VDC (downstream) (DDC, 2015). Such hilly and mountainous landscape is rich for heterogeneity and diversity in wildlife and ecosystem. Demographically, population size is about 3369, out of which main castes are Magar (37.7 percent), Brahmin (30.6 percent), Cheetri (17.1 percent), Sunwar (5.7 percent) and others (22.6 percent). Others include Kami, Sarki, Thakuri, Gurung, Damai, Sherpa, etc (VDC, 2015). b) Lekhgaon village spreads 110 km length and 30 km breadth of 2451 square km (249016 hectare) from 198 meter (Tata pani) to 2369-meter (Matela gurase) altitude (Figure 1). Hill with 84 percent dominates to 16 percent valley. Population size is 3999 (651 households) (DDC, 2015). c) Kunathari is another study village lying between 600 meter and 1200 meter (Figure 1). It is 20 km far from district headquarter). Population

size is 3413 (CBS, 1991) and (DDC, 2015). This water basin is a source of clean drinking water, irrigation water and water and terrestrial ecosystems to the catchment households. This study area is purposively selected by i) its climatic variation and disasters event as flooding and landslides in 2014, ii) its huge vulnerability at the catchment areas, iii) its morphological structural change, iv) its aquatic and terrestrial ecosystem and biodiversity and v) its agricultural lifeline and its risk.

In the study area, socio economic information, household vulnerability and natural disasters are essentials. Secondary data relates to natural disasters and household vulnerability is collected from District Development Committee (DDC) office as well as from Ministry of Home Affairs. Primary data related to household socio economic information are collected from UNDP's Household Survey conducted in the post natural disasters in 2014 during from

Figure 1: Sotkhola and its catchment study Area
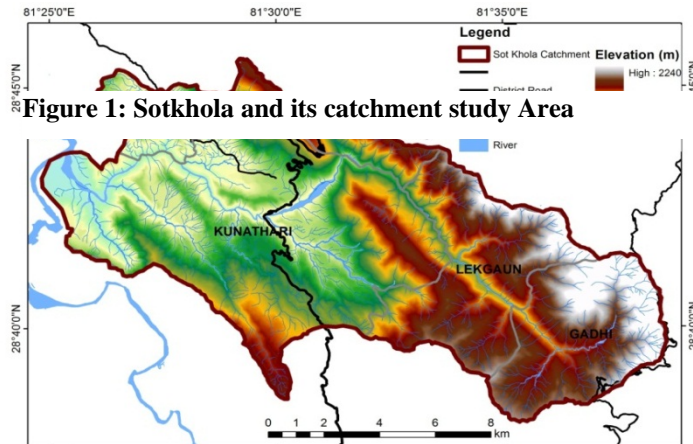
Source: GIS map of Study area based on field survey, 2015

September 2015 to October 2015 to collect reliable and accurate data and information about climatic events and disasters and its vulnerability to install hydrological monitoring system, alert system, infrastructure and building adaptation capacity.

Methods

Independent variable's coefficients

The theoretical framework includes three types of variables, in which household's income loss (Y_{TIL}) is dependent variable and Socio economic bundle and natural disaster are independent variables. Their relationship is a curiosity with two questions.

- What is contribution of socio economic condition and natural disasters on household's total income loss (vulnerability)?
- What is independent variables share producing household vulnerability?

Nature of Data Sets

Data sets of the study were of socio-economic characteristics of households, disasters, and adaptation behavior. Household survey to assess the vulnerability level was a major tool to collect these three segments from the catchment areas of Sot Khola (Gadhi VDC, Lekhagaon VDC, and Kunathari VDC) of the water basin. The supplementary data and information was secondary nature.

Sample Size and Sample Selection Procedure

The two stage sample selection method was employed. In the first stage, the catchment areas of Sotkhola River Basin: Gadhi, Lekhagaon and Kunathari are sample areas of this study in the first level. Its rationales are heavy and erratic rainfall, extreme flood disaster in Sotkhola River in 2014, and a huge economic loss (vulnerability).

In the second stage, household sample size was 642 (19.3%). Out of 3310 total populations, the size of samples was selected into two stages: dividing clusters to each catchments area into nine ward units and applying a random sampling method to select the sample households.

Data collection method

In the study, data collection methods are household survey, Focused Group Discussion (FGD) and Key Informant Interview (KII). Household survey was administered to collect quantitative data and information. In the survey, a structural questionnaire was a tool to collect about socio economic information about household (land holding, income level, source of income, size of family, gender, age, caste etc.), climatic events and vulnerability. Similarly, climatic events and vulnerability set of questionnaire provides information, experience and perspective about climatic events, its types, natures, patterns and vulnerability level. Lastly, adaptation capacity, behavior and decisions set provides data set related to income, information, technology, experience, indigenous skills, application and loss reduction. Further, the effects of disasters on household income loss are analyzed and identified. The survey was conducted from September 2 to October 15, 2018 in the catchment households after its pretest.

As complement to household survey, focused group discussion (FGD) and key informant interview (KII) were employed to validate the collected quantitative data and information and to collect qualitative information about vulnerability, disaster and socio-economic condition, and cross cutting issues for in detail case analysis and understanding.

Data Analysis Method in which descriptive statistics and correlation method were employed to understand the influence of control variables on dependent variable (income loss). In the correlation method, Pearson Correlation test was used to understand whether the independent factors influence on household vulnerability.

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}} \qquad\qquad 2$$

Where r= correlation coefficient
      X= values of X variable in a sample
      ẍ= mean values of X variable in a sample
      y= values of y variable in a sample
      ŷ= mean values of y variable in a sample

The correlation coefficient (r) is the measurement of correlation. This coefficient measures the linear dependency between the data sets. The value of the Pearson correlation coefficient product (r) is between -1 to +1. Its values lie in three points and results as follows.

- If r is zero, it implies no correlation. In this analysis, it means no influence on household vulnerability.
- If r is +1, it implies positively correlated. In this analysis, it means higher influence on household vulnerability.
- If r is -1, it implies negatively correlated. In this analysis, it means negatively influence on household vulnerability.

Results and Discussion

Household Vulnerability in terms of Income loss

Climatic vulnerability index (CVI) results 69 percent vulnerable households in the study area due to climate change induced disaster. Further, it is determined by sensitivity and adaptive capacity (IPCC, 1996). This section presents two curiosities: whether a large household is affected from these hazards and whether these hazards damage heavily at household and the community level. This section presents nature, size and number and degree of the affected households at the community level . Table 1, illustrates losses of three household property: asset (house & asset), crop/product (crops & livestock) and income (business income, wages and agricultural income) as follows.

- Household Property Damages and Loss in which table 1 shows that 6.7 percent two

Table 1: Damages and Loss of Household Asset and Income from Hazards

| Items		Affected Household		Total Damage (Rs)	Mean (Rs)	Max (Rs)
		No	%			
Household Property	Houses	43	6.7	3,344,000	167,000	500,000
	Asset	20	3.1	10,000,000	293,000	3,120,000
Crops/product	Crops	152	23.75	798,777	5,255	100,000
	Livestock	11	1.7	410,000	37,272	60,000
Lost income	Salary	9	1.4	88,650	9,850	30,000
	Business income	10	1.5	266,200	4,840	115,000
	wages	55	8.5	101,000	10,100	100,000
	agriculture	138	21.5	3,455,800	25,000	500,000
Total				18,464,427		

Source: Field Survey, 2018

story's houses (Rs.3.344,000) dominates to 3.1 percent fully and partially damaged asset (Rs. 10,000,000). Since HDI and HPI ranks Surkhet district vulnerable district with massive poverty, this loss increases the magnitude of vulnerability.

- Damages to Household production and products in which table 2 displays damages Rs. 798,777 of crop and fertile land (64 Ropani). Similarly, it shows the loss of 41 livestock (cow, buffalo and goat) with the worth of Rs. 410, 000. In total, crop loss (23.75%) is greater than livestock loss (1.7%). Figure 2 reveals that 66 % crop loss dominates to 34 % livestock loss. Since these are livelihood assets, their loss makes critical livelihood led vulnerability.

Source: Field Survey, 2018

- Income loss in which table 2 illustrates shows Rs. 3,911,650 farm and off-farm income losses due to disaster. Figure 3 displays 88 % farm income loss, 7% business income loss, 3 % wage loss and 2% salary loss. Thus, it increases directly the degree of household vulnerability.

- Injury and loss of life: this is important dimension of vulnerability. In the disasters, human injury and loss are not recorded, despite no early warning system, preparedness, and sufficient time and place to family evacuation. Its reason is indigenous knowledge and skill and collective action. When rain falls in the upstream, the downstream households evacuate themselves. Similarly, in 2014, an old villager in the midnight who saw increasing water level in house rang plate as siren. As early warning, the villagers immediately moved at the safe place.

Figure 2: Income Loss of Household
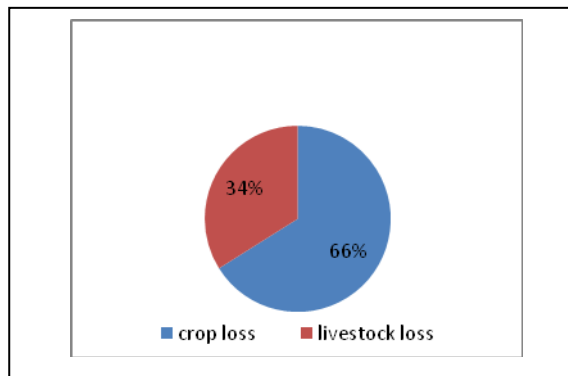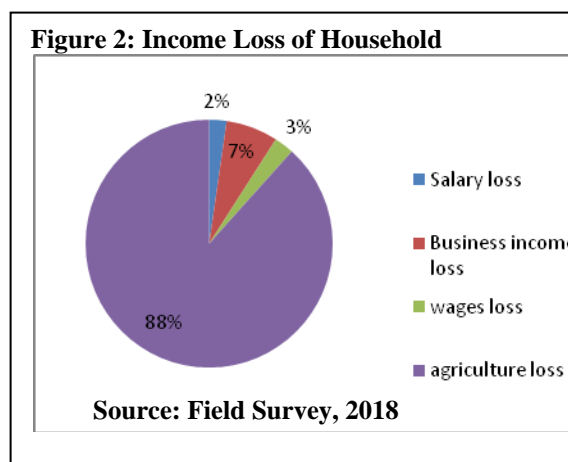
Source: Field Survey, 2018

Characteristics of Household Vulnerability

Household vulnerability relates with weak characteristic houses. This study employs three variables such as a) geographical setting, b) type of house, and c) income structure to characteristics of house as follows: Geographical setting that is an important determinant to household vulnerability. is a curiosity. Table 2 displays

Table 2: Geographical Setting of Households

Distance (Meter)	No of HHs	Vulnerable level
0-50	21	Higher
50-100	18	Moderate
Above 100	17	lower

Source: *Field Survey, 2018*

heterogeneous landscapes such as slop and plain land. The slop land is scientifically considered vulnerable relative to plain land. Therefore, the slop land is not preferred for constructing resilient house. Almost houses are constructed in the slop land in Lekhagaon, and Gadhi. These houses are mud and stone made two story small houses by traditional

method and local mason. These houses are exposure to landslide but not to flood. However, houses in Kunathari that are constructed in the low land are exposure to flood. Table-2 shows that 38 percent (21 houses) are higher vulnerable. It is followed by 32 percent (18 houses) lying moderate vulnerable and 30 percent (17 houses) having lower vulnerable. All houses are vulnerable. It complements to household vulnerability.

Types of houses in which table 3 shows temporary (vulnerable) and permanent (resilient). Temporary house is constructed with mud and stone or mud and brick, meanwhile permanent house is constructed by cement made. Table 3 reveals 95 percent mud made house in Gadhi, Lekhagaon and Kunathari. These houses are themselves vulnerable to flood and

Table 3: Types of Houses

Construction Materials	%
Mud made	95
Cement made	5
Total	100

Source: *Field Survey, 2018*

landslides. Table 3 shows only 5 percent cement and brick made houses. Therefore, these houses are resilient to flood and landslides.

a) Income structure in which figure 2 shows a divergent income loss. Feudal land is main structure of income. Since disaster damages land, larger land holder are vulnerable more than lower land holder. It implies that the landlord may be more vulnerable than the poor. In case of landslide, the poor is more vulnerable than the rich.

The factors influencing household vulnerability

The tangible and non-tangible divergent factors influence household vulnerability as follows: Awareness about disaster and vulnerable place in which figure 4 shows 35 percent households having a knowledge about disaster in Kunathari, 25 percent in Lekhagaon, and 13 percent in Gadhi. Similarly, figure 4 reveals 15 percent households having no knowledge about disaster in Kunathari, 8 percent in Gadhi and 3 percent in Kunathari. Its reason may be a higher illiteracy. In this under-rated awareness level about disaster, Kunathari is more vulnerable and risk from the potential risk than Gadhi and Kunathari.

Figure 3: Knowledge about Natural Hazards
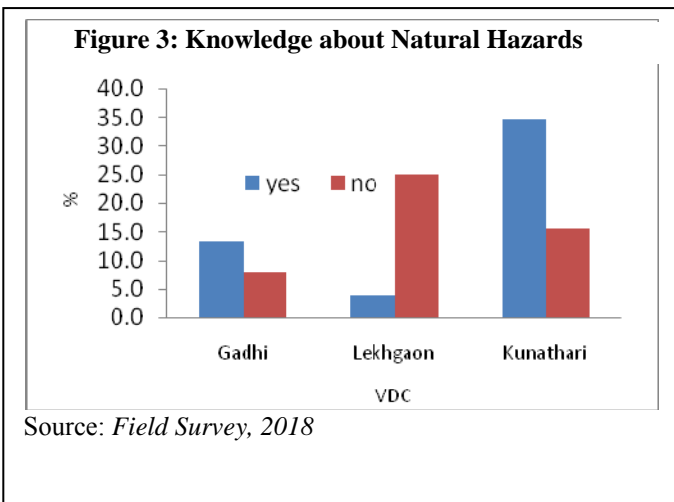
Source: *Field Survey, 2018*

- Traditional knowledge in which 98 percent households holds such knowledge. such as canalling rainfall water, switching seeds into rainfall resilient or drought resilient, bamboo wall construction in the bank of river, small stone dam construction, ringing plate, watching water level of river, rainfall in the upstream areas, making a bag for essential and valuable items, discussing in the community, etc. For example, 65 years old person rang plate to alert

the community at the mid-night in 2014, when he saw flood in his house in Kunathari. This warning system was traditional. It reduced vulnerability by saving life and asset.

- <u>Willingness to evacuate to a safe place</u> that is 98 percent households are positive on it but only 2 percent are not. If it is on time before disaster, the vulnerable household could reduce vulnerability by evacuating to safe place.
- <u>Preparedness</u> improves household's adaptation capacity to reduce vulnerability. Only 15 percent households participates in the preparedness program but 85 percent households have not. It implies weak preparedness of household. It means high risk of household.
- <u>Physical Assets (house & land)</u> reveals economic capacity of a household including <u>ownership</u> and <u>quality of assets</u>. About 98 percent vulnerable people own house and land. In quality of assets, there are 54 percent wood-made houses and 46 percent mud-made. It is supplemented by 88 percent one-story house and 12 percent two-story house. Almost houses are vulnerable.
  Similarly, like house ownership, almost all households (97 percent) own land. Only 3 percent has no land. The average landholding was 15 Katta. Almost all lands are a terrace and inferior land. The land is also sensitive to natural shock. Such land does not make 12 months food sufficiency.
- <u>Household income</u> in which almost vulnerable population (80 percent) earns income from agricultural activities. It is followed by 10 percent wage income, livestock activities (5%), entrepreneurs (3%), and service (2%). The income is not sufficient to allocate more on non-food items. About 95 percent of food items is self-produced and about 5 percent items is purchased from markets. It indicates households living below the poverty line. This contributes household vulnerability.
- <u>Access to information and news in which</u> there are 65 percent of using radio as a source of information and news, about 10 percent households using neighbor's information, like paper (10%), VDC (10%), and NGO (5%). It indicates the household's socio-economic vulnerability complement to vulnerability and the lack of alternatives.

Descriptive Statistics

It is assumed that above socio-economic variables influence household's vulnerability level as per their behavior and intensity. This assumption is observed but not tested yet. To test such relationship, Pearson's Correlation method was used to test the relationship between independent variable and control variables, considering income loss of household as an independent variable and above socio-economic variables (agricultural loss (agro loss), labor loss, early warning, traditional knowledge, types of house, family size, education and income level of house as control variables. Nature and pattern of variables are important to run correlation with as query whether these socio-economic variables contribute to household's vulnerability. Mean and Standard deviation are used to understand descriptive statistics. Its result is presented in table 4.

Table 4: Descriptive Statistics

Descriptive Statistics		
Description	Mean	Std. Deviation
Total loss of HH from natural disasters (Rs)	202435.49	681615.20
Agro loss (Rs)	58998.77	193928.42

Labor loss (Rs)	4915.79	15544.08
Early warning (Yes/No)	0.01	0.14
Traditional knowledge (Yes/No)	0.95	0.80
Types of house (Yes/No)	0.96	0.20
Family Size (No)	4.79	1.56
Education (Level)	0.85	0.36
Income of family member (Rs)	10401.03	13545.54

Source: *Field Survey, 2018*

A query whether these socio-economic variables contribute to household's vulnerability was captured to test in above given independent and control variables in the Pearson Correlation Test. SPSS were employed. Its result is presented in table 5 below.

Table 5: Result of Pearson Correlation Test

Descriptive	Correlation coefficient	total loss of HH	Agro loss	Labor loss	Early warning	Traditional knowledge	Types of house	Family Size	Education	Income of family member
Total loss of HH	Pearson Correlation	1.00								
	Sig. (1-tailed)									
Agro loss	Pearson Correlation	0.18	1.00							
	Sig. (1-tailed)	0.01**								
Labor loss	Pearson Correlation	0.21	0.14	1.00						
	Sig. (1-tailed)	0.06	0.16							
Early warning	Pearson Correlation	-0.02	0.03	0.17	1.00					
	Sig. (1-tailed)	0.38	0.35	0.11						
Traditional knowledge	Pearson Correlation	-0.03	-0.31	-1.00	-0.39	1.00				
	Sig. (1-tailed)	0.45	0.23	0.00*	0.04*					
Types of house	Pearson Correlation	0.05	0.02	0.04	-0.06	0.32	1.00			
	Sig. (1-tailed)	0.15	0.39	0.40	0.08	0.08				
Family	Pearson	0.09	0.02	-0.22	-0.02	-0.17	0.04	1.00		

Size	Correlation									
	Sig. (1-tailed)	0.05*	0.42	0.05*	0.36	0.23	0.17			
Education	Pearson Correlation	0.07	-0.03	0.02	-0.08	0.10	-0.04	-0.01	1.00	
	Sig. (1-tailed)	0.11	0.35	0.44	0.03*	0.34	0.14	0.44		
Income of HH	Pearson Correlation	0.10	-0.02	-0.17	-0.01	-0.03	-0.09	0.16	0.13	1.00
	Sig. (1-tailed)	0.03*	0.38	0.11	0.45	0.45	0.02*	0.00*	0.00*	

Source: *Field survey, 2018*
*. Correlation is significant at the 0.05 level (1-tailed).
**. Correlation is significant at the 0.01 level (1-tailed).

Let's consider value of coefficient (r) <30 small correlation, 30-50 medium correlation 50-70 moderate correlation, and >70 strong correlations and two significances of correlation: 0.01 level and 0.05 level.

The table 5 presents only three variables (agro loss, family size and income of household) are significant at 0.05 and 0.01 level but their correlation coefficients (r) of agro loss, family size and income of household are found less than 30 percent. It implies small correlation. Thus, agro-loss, family size, and income of household are major determinants of vulnerability of household among which agro-loss is a major one. Reversely, all remaining variables (labor loss, early warning, traditional knowledge, types of house and education) are not significant but correlation coefficients of these variables are found less than 30 percent. It implies small correlation. Besides, early warning and traditional knowledge have negatively small correlation with household vulnerability.

Natural Shock, Adaptive Capacity, and Vulnerability

The above results show the situation of higher intensity and wide coverage natural shock but vulnerable household (poor adaptive capacity). Despite the occurrence of traditional knowledge to be safe from natural shocks (flood and landslides), all indicators are negative and socio-economic vulnerable due to poverty, vulnerable geography, and poor infrastructure. The poor households have the poor adaptive capacity in which the households were excessive exposure and still had higher sensitivity. It means almost all households were in higher vulnerability due to natural shock.

The table 6 shows four different levels: extremely higher vulnerability (23.75%), higher vulnerability (7.3%), moderate vulnerability (38.2%), and lower vulnerability (30.7%).

Table 6: Vulnerability Level and Distribution

Vulnerability	Ward	VDC	Altitude	Cluster HH (%)
Extremely higher vulnerable	1,2,3	Lekhagaon and Kunathari	Middle and Lower	23.75

Higher Vulnerable	4,5,6	Gadhi	Higher	7.3
Moderate Vulnerable	4,5,6,7,8,9	Kunathari	Lower	38.2
Lower vulnerable	1,2,3, 4,5,6,7,8,9	Gadhi Lekhgaon	Higher & moderate	30.7

Source: *Field Survey, 2018*

The vulnerable population that is 70 percent is large and significant. They need urgent adaptive support from the government agency. Otherwise, they will become poorer than before. Thus, the vulnerability will be more complicated than before because negative relationship between natural shock and adaptive capacity and positive relationship between natural hazard and vulnerability.

Conclusion

This study examines determinants of household vulnerability at the community level by using primary data sets and descriptive statistics. As a result, household vulnerability is extremely higher in the study area. This vulnerability is determined by the divergent factors such as awareness about disaster and vulnerable place, household's perception and its potential impacts, traditional knowledge, technique and method, willingness to evacuate to a safe place, preparedness, physical asset, household income and access to information and news. Almost factors are themselves vulnerable to contribute household vulnerability. Similarly, the result of Pearson correlation test of labor loss, early warning, and traditional knowledge, types of house, family size, education and income level of house with income loss of household. The result shows three variables (agro loss, family size and income of household) are significant but correlations are less than 30 percent. Thus, agro-loss, family size, and income of household are major determinants of vulnerability of household among which agro-loss is a major one. The remaining variables (labor loss, early warning, traditional knowledge, types of house and education) are not significant. Finally, about 70 percent households are vulnerable in which 23.75 percent households are extremely vulnerable.

Therefore, household vulnerability is made complex by above these factors. Therefore, the poor household should be urgently responded to improve their socio-economic level and adaptive capacity to avoid natural shock and reduce vulnerability.

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