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Determinants of Poverty, Self-Reported Shocks, and Coping Strategies: Evidence from Rural Nepal

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Abstract: This paper assesses the interrelationship between poverty, climatic and non-climatic shocks, and shock coping strategies adopted by farm-based rural households in Nepal. An analysis is based on a comprehensive data set collected from 300 randomly selected households from three purposively chosen villages of Gandaki province. The study utilizes binary and ordered probit regression models to analyze the determinants of poverty, shocks, and coping strategies. Findings reveal that the Dalit (ethnic group), large-sized, and agricultural households are more likely to be characterized as poor. The study further shows that majority of the households are exposed to the severe shock of climatic types. Patterns of shock exposure vary with the household's characteristics. In particular, poor households in the hills primarily dependent on forest for livelihood are more likely to experience severe shocks. Further analyses indicate that the households ex-post choose dissaving, borrowing, shifting occupation, and migration to cope with severe climatic shocks. The analyses also reveal that the nature of shocks, socio-economic, demographic, geographic contexts, and factor endowments effect adopting a particular coping strategy. Findings suggest household level-specific support should be provided to mitigate the effects of shock, and appropriate measures are taken to protect their means of living.

Keywords: climatic shocks; forest-dependent households; determinants of poverty; coping strategies; rural Nepal

Citation: Gautam, N.P.; Raut, N.K.; Chhetri, B.B.K.; Raut, N.; Rashid, M.H.U.; Ma, X.; Wu, P. Determinants of Poverty, Self-Reported Shocks, and Coping Strategies: Evidence from Rural Nepal. *Sustainability* **2021**, *13*, 1790. https://doi.org/10.3390/su13041790

Academic Editor: Bradley Hiller
Received: 5 January 2021
Accepted: 4 February 2021
Published: 7 February 2021

1. Introduction

Reducing poverty and addressing climate change impacts are two major global challenges in the present context. These ensure adequate efforts are made towards sustainable development. Studies have indicated that people from developing countries are highly susceptible to disasters [1]. For example, global warming, erratic rainfall, floods, drought, and other extreme events create immense challenges, particularly to rural people in developing economies [2]. Likewise, non-climatic shocks caused by illness, wildlife damage, accident, theft, and fraud also befall mostly on vulnerable sections of the society. So far as the climatic hazards are concerned, Himalayan regions are now experiencing extreme events more frequently than other regions [3]. Consequently, thousands of marginalized people are killed and many more displaced, causing losses worth billions of dollars in lives and property [4]. Few of the most disastrous natural events in the recent past were the Indonesian tsunami (2004), Katrina hurricane (2005), Haiti earthquake (2010), India heatwave (2011), Queensland flood (2011), Great East Japan earthquake (2011), and Nepal earthquake (2015). These natural disasters have caused immense economic damages, thus retarding and in some cases reversing nations' growth and development activities [5]. More

vulnerable to the disasters are rural poor, relying on subsistence agriculture and forest for fulfilling their household needs [6–10].

In developing countries, marginal communities are excluded from access to natural, social, and economic opportunities that are further aggravated through deforestation and forest degradation [7]. Similarly, climatic hazards affect the rural population disproportionately, in particular, because their livelihood is mostly dependent on subsistence agriculture; such hazards would potentially destroy the agricultural supply system such as arable lands, irrigation facilities, and rural roads, and also agricultural inputs and output such as stored seeds, field crops, and farm equipment [11,12]. These households' adaptive capacity to cope with such shocks is also limited by particular socio-economic, demographic, technological, and ecological constraints it faces [13,14]. For example, poorer households have limited alternatives available as coping strategies; hence, an adequate and efficient adaptation mechanism is not only a matter of choice to them but a necessity [15]. Therefore, it is important to assess the adaptive capacity of these households by understanding the type of coping strategies adopted by them.

Nepal is a Himalayan country in South Asia's developing region. It has delicate geography, primarily with subsistence farming and natural resource-centered livelihood. Nepal is also ranked as one of the most vulnerable countries to climate change [16]; it ranks 11th and 30th country in terms of risk associated with earthquakes and floods respectively [17]; fourth in terms of climatic hazard [18]; and 20th among multi-hazard country in the world [19]. Gandaki Province is one of the country's highly sensitive regions where forest fires [20], landslides, floods, and droughts [21] are frequent. Overall, about 80% of the population is threatened by natural hazards such as earthquakes, extreme temperatures, droughts, floods, landslides, and glacier lake outburst floods in Nepal [22]. Further, World Risk Index 2019 identifies the inadequacy of Nepal's assets to cope with the shock, even lower than the riskiest countries such as Vanuatu [23]. This means that Nepal is in a very precarious position, both in terms of its susceptibility to disasters and its ability to select appropriate coping strategies to the effects of climate change. Hence, understanding the factors affecting the household's susceptibility to climatic shocks and their capacity to adopt particular types of coping strategies becomes imperative.

There is scant literature that considers multiple shocks and adaptation strategies simultaneously; most of them analyze a single type of shock without considering other types, which may have equal or a greater bearing on the household's well-being [24–26]. Likewise, the households may resort to multiple or a mix of strategies to adapt to these multiple shocks. Further, it is also worth studying separately whether and how the shock dynamics affect poor households who primarily live on subsistence farming and forest resources. Hence, in this study, we first assess determinants of poverty, then study the determinants of self-reported shocks: climatic and non-climatic, and then understand the strategies adopted by the households to cope with the shocks. This particular sequencing is important since it helps to select appropriate coping strategies for ensuring the livelihoods of marginal communities. This study will thus add value to the literature in three aspects. One, it will provide a detailed account of the type, frequency, and determinants of shocks experienced by households in the rural setting of developing countries. Second, it will demonstrate the type, set, and determinants of coping strategies selected by households in response to the climatic shocks. Lastly, in addition to the disparate observations between the shock and adaptation dynamics, as is usually done in the literature, this study will bring about an integrated and robust perspective to understand the nature of shocks and recommend effective and efficient strategies to deal with them. This will further help the poor and forest-dependent communities in formulating livelihood policies that enhance their resilience capacity.

2. Materials and Methods

2.1. Study Area

The study was conducted in three rural villages of Gandaki province of Nepal. Although Nepal underwent a historical transformation toward a secular federal democratic republic that pursued socio-economic change as one of the prime agendas, it still faces a significant risk of severe poverty. The country's population is 28.3 million, of which 39% are poor, and about 31% earn less than US$3.2 per day [27]. The severity of poverty and associated risks are higher in rural communities of mountains and hills than in Terai (a lowland physiological region of southern Nepal adjoining with India border) areas [28]. More than 65% of households collect firewood for cooking and heating purposes, where 44% of the collection is from the community-managed forest [29]. About 37% of the national forest was provided to the community for conservation and utilization of forest products as community forest (CF) (a popular participatory approach of forest management in conserving natural resources by fulfilling the daily forestry needs of the user groups living within the forest and contributing towards local community development through the direct use of community forest user groups (CFUGs) income [30]), where more than 2.9 million households are engaged and are benefiting from forest management [31]. The contribution of forest income to the household economy is about 16% in rural areas of Nepal [32]. The selected province extends from mountains and hills in the north to the low lands of the south, where 28% of the national forests are managed under CF [21]. Most of the districts in the province fall under highly sensitive areas in terms of climatic shocks [20], where about 18% of the population experience agricultural loss. This province is ranked as the fourth most vulnerable region in human causality due to natural disasters [33]. In the hills, people usually face landslides, and in the southern plains, non-climatic shocks such as encroachment and attacks by wild animals are the major threats [34].

The study was concentrated in three CFUGs, viz., Nandan, Gahate Durakorukh, and Ludhi Damgade from Nawalpur, Kaski, and Gorkha districts in Gandaki province, respectively. Study area map is given in Figure 1. Nandan CFUG of Nawalpur district falls in the Terai region, and the other two, i.e., Gahate Durakorukh (Gahate in short) and Ludhi Damgade (Ludhi in short) CFUGs of Kaski and Gorkha districts, respectively, are situated in the hills.

After consultation with respective Provincial Ministries and Divisional Forest Offices, the CFUGs list was prepared following the predetermined study area selection criteria. General criteria for selection of the study area were (i) densely populated nearby forest community; (ii) areas dominated by marginalized and poor people; (iii) geographically at least from two ecological zones of Terai and hills; and (iv) community forests with the management history of more than 20 years, both formally and on an ad-hoc basis. Using these criteria, the three CFUGs were chosen purposively to ensure that the selected CFUGs consist of the poor and marginalized households interacting differently with the forest. Then after, the selected CFUG households' list was prepared, and the sample households for the study were selected randomly. Separate randomizations were carried out in each selected CFUG to capture the socio-economic and demographic variation across these households. Variation across the households is important to understand the determinants of severe shocks and identify the household's coping strategies using econometric analysis which is discussed later. The description of the study areas is given in Table 1.

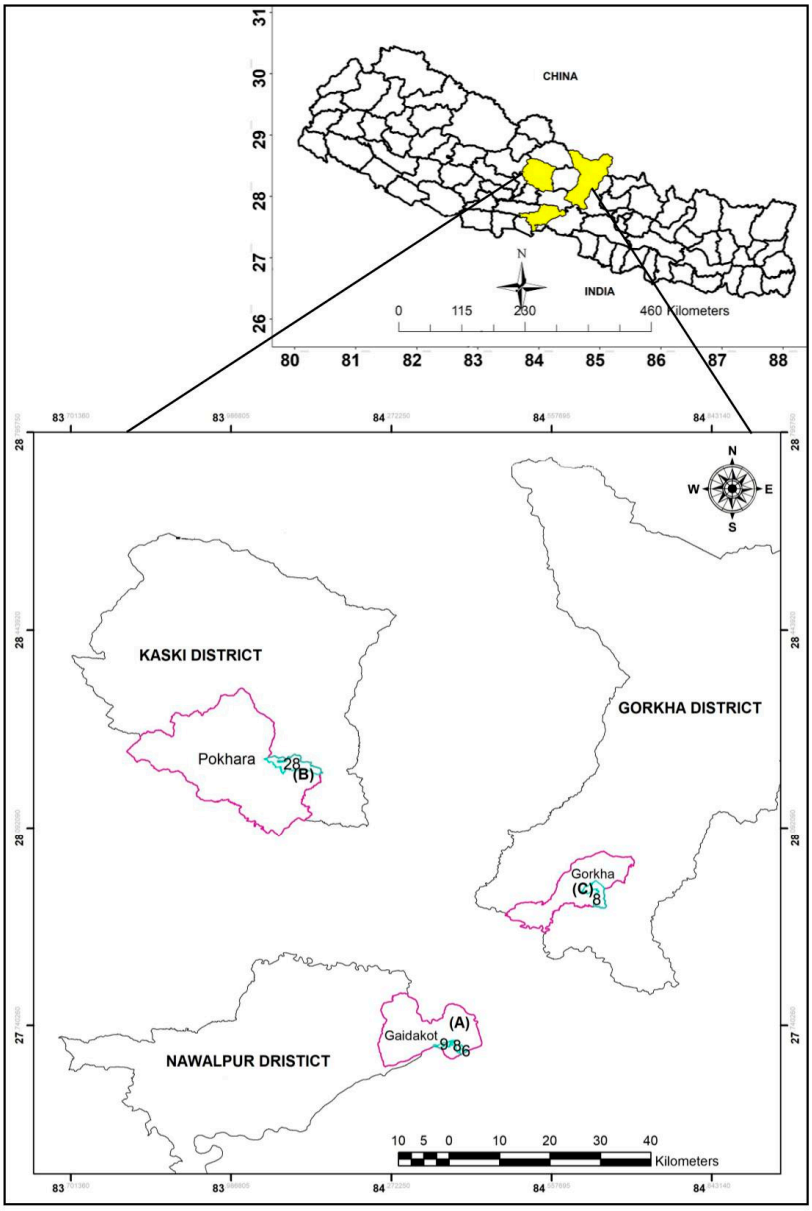

Figure 1. Study area map showing the selected CFUGs: Nandan CFUG of Nawalpur (A), Gahate Durakorukh of Kaski (B), and Ludhi Damgade of Gorkha district (C).

Table 1. Study area description.

Study Area Characteristics	Nandan CFUG	Gahate Durarukha CFUG	Ludhi Damgade CFUG
Address	Gaidakot-6,8,9	Pokhara-28 (Kalika VDC-1, 2,4-Kaski)	Gorkha-8
Geo-location (UTM)	X: 242,180, Y: 3,067,081	X: 213,339; Y: 3,123,503	X: 267,996; Y: 3,094,619
Geographical region	Low land (Terai)	Mid-hills	Mid-hills
Area (ha)	444.80	34.73	305.78
Year of handover	2007	1997	1992
Household (hh)	1059	254	522
Population	5630 (male 2887, female 2743)	1270 (male 615, female 655)	3551 (male 1805, female 1746)

Table 1. *Cont.*

Study Area Characteristics	Nandan CFUG	Gahate Durarukha CFUG	Ludhi Damgade CFUG
Dalit * hh	124	53	75
Hh according to wealth strata	Poor 117, medium 905, rich 37	Poor 4, medium 229, rich 16	Poor 92, medium 405, rich 25
Members in committee	15 (male 10, female 5); dalit 1; poor 1, medium 12, rich 2	11 (male 8, female 3); dalit 2; poor 0, medium 8, rich 3	21 (male 14, female 7); dalit 1; poor 0, medium 20, rich 1
CC program or REED^{+} activities	No	No	REED plus was in Ludhi river watershed (2009–2011)
Conflict situation	No	Encroachment	No
Regular climatic hazards	Yes (flood, fire)	Yes (landslide, fire, hailstone)	Yes (flood, landslide, fire)
Major tree species	*Shorea robusta, Terminalia alata, Adina cordifolia, Semecarpus anacardium, Ougeinia oojeinense*	*Schima wallichii, Pinus roxburghii, Castanopsis indica, Prunus cerasoides, Fraxinus floribunda*	*Shorea robusta, Schima wallichii, Anogeissus latifolia, Castanopsis indica, Terminalia alata*

* Dalit is one of the caste group of Nepal which is also called the lower-caste and untouchable, mostly involved in traditional occupation.

2.2. Data Collection and Analysis

The household survey (face to face interview) focus group discussion (FGD), and key informant survey (KIS), were used to collect primary data for the study. However, some essential qualitative data were also collected using village meetings. Village-level meetings in each selected CFUG were organized, and the participants were asked about the history of disasters in their villages, forest management practices, as well as success, progress, and challenges experienced by the communities. Likewise, shocks experienced by villagers in the last ten years due to climatic and non-climatic hazards were also discussed, synthesized and listed in the meetings. Old-aged residents (older than 50 years), local school teachers, and the poor who had been regularly collecting forest products also participated in the meetings. The average number of participants in the meetings was 21. The information recorded during the meetings was summarized, and the checklist was developed to be used later to design the interview schedule. The checklist helped the respondents recall the types and extent of historical hazards, shock levels, and adopted coping strategies. Altogether 300 households were surveyed, where a neutral semi-structured schedule (questionnaire) was used as a study material. During the household interview sessions, information relating to household characteristics, climate change, its impact (ex-post), and coping strategies was gathered. The eldest members of the household were requested for the interview.

Likewise, in the FGD, the impacts of the events and coping strategies with institutional support in each timeline were discussed. First, we started with the earliest hazard events to make participants recall the timeline of the last ten years, which was used to identify sizeable climatic hazard events. Participants of the discussion were asked questions by allowing them to stand in line at the appropriate time frame, describe the event, show the meteorological trend, and discuss frequencies of shock and their impacts. The checklist prepared during village meetings was also used to facilitate discussion during the FGD [35,36]. Various shocks, adaptive capacity, a trend of the seasonal calendar of farming system, and forest product collection were also discussed and recorded. One FGD was organized in each wealth class in each CFUG. Altogether nine FGDs were conducted, where ten to fifteen old-aged people participated in each FGD. People who have been involved in forest management activities for 30 years were purposively selected for KIS. Old-aged farmers, forest dwellers, teachers, researchers, local leaders, and governmental and non-governmental personnel also participated in the survey. Altogether, ten KISs were conducted to explore the climate change pattern, the extent of climatic events, and their shock to the villagers.

For the purpose of analysis, households were defined and categorized according to the household income, income from the forest, the extent of shock, major household occupation, and distance to the forest area. Total annual household income was split into three equal parts to construct a wealth tertile, viz. poor, medium, and rich household.

Forest income was computed by valuing the collected forest products; then, the forest-dependent households were defined based on whether the income from the forest was below or above Nepalese Rupees one lakh (USD 1 equals Nepalese Rupees (NPR) 114). The households were grouped into three classes based on the severity of shock: low/no shock households, moderate shock households, and severe shock households. Later, during the regression analysis, only severely affected households were considered for simplicity in the analysis. The households were also further categorized based on the causes of the shock: climatic and non-climatic. Similarly, the household's principal occupation (source of livelihood) was grouped into two classes, i.e., agricultural or non-agricultural households (e.g., service, business, or remittance). Lastly, the households were classified according to the proximity to the forest area; the households within 30 min walking distance to the nearest forest area were categorized as proximate households while other households were categorized as distant households. The threshold was decided on the basis of the average response reported by the participants in the village meetings. In order to analyze the data, descriptive statistics, probit, and ordered probit regression were used.

2.2.1. Empirical Strategy

We employed two empirical frameworks in this study: the probit and an ordered probit model. The probit model was applied to understand the determinants of being poor and assess various coping strategies adopted by households in response to the climatic shocks. An ordered probit model was applied to analyze the factors affecting self-reported severe shocks, both climatic and non-climatic (There is not much difference between the two models; in probit model, the response variable is binary, which takes values either 1 or zero, while in ordered probit model, the response variable is categorical and measured in an ordinal scale. In this respect, ordered probit model is essentially an extension of binary probit model [37]). Descriptive statistics of model variables are given in Table 2.

Table 2. Description of model variables (n = 300).

Types of Variable	Model Variable	Mean	SD
Dependent	All severe shock (=1)	0.48	0.500
	Severe climatic shock (=0, 1, 2)	0.44	0.669
	Severe non-climatic shock (=0, 1, 2)	0.28	0.546
	Poor (=1)	0.33	0.472
	Strategy: dissaving (=1)	0.31	0.465
	Strategy: wage (=1)	0.07	0.266
	Strategy: loan (=1)	0.14	0.354
	Strategy: occupation shift (=1)	0.86	0.281
	Strategy: migration (=1)	0.31	0.465
Independent	Severe climatic shock (=1)	0.34	0.474
	Log of forest income (NPR)	10.56	1.058
	Household head education (years)	5.47	5.208
	Log of land (Ropani *)	1.91	0.991
	Distance to forest (>30 min = 1)	0.23	0.423
	Dalit	0.19	0.398
	Janjati	0.13	0.344
	Poor (=1)	0.33	0.472
	Female headed household (=1)	0.47	0.499
	Major household occupation (agriculture = 1)	0.11	0.321
	Kaski district (Gahate)	0.33	0.472
	Gorkha district (Ludhi)	0.33	0.472

* Ropani is unit of area calculation in Nepal, where one Ropani of land equals 508.74 sq. m.

Shocks are predicted to decline with income and well-being [32,38,39]; hence, we expect a negative relationship between the level of income and the risk of vulnerability to the climatic shocks. For example, households from low socio-economic strata (e.g.,

poor, marginal forest dwellers, Dalit) are more likely to experience severe climatic shocks. Underemployment due to subsistence agriculture is prevalent in rural areas of Nepal; in such a situation, any additional family member would add nothing to the household production. Hence, an increase in family size may slow down the pace of the restoration of livelihood affected by natural disasters [32]. Hence, it is expected that households with larger family size are more likely to experience climatic shocks. Geographically, mountains and hilly areas are more sensitive to natural disasters [40]. Selected CFUGs, i.e., Gahate and Ludhi from Kaski and Gorkha districts, are hilly areas. Hence, we expect that these two hilly sites are more vulnerable to climatic shocks than that of Terai. Previous research indicates that highly educated households are more likely to get better jobs and earn higher incomes; hence schooling is expected to have a positive impact on the probability of adopting various coping strategies [41–43] and negative impact on the probability of becoming poor and experiencing severe shocks [44]. Therefore, it is expected that household head's education is positively linked to deciding climate change adaptation and negatively to poverty and shock. Female-headed households are usually information constrained, and the economic opportunities available to them are also limited [45]. So, we expect that female-headed household is less likely to decide on climate change adaptation. Likewise, Dalits are racially discriminated and have even fewer fundamental rights and privileges [46], which ultimately influence their income level, whereas Janajatis are mostly in Armed services and out-migrate for getting regular remittances [47]. Thus, we assume that Dalits are more likely to be vulnerable and less likely to adopt income-based coping strategies and vice versa in the case of Janajati. There is an ambiguous relationship between the effect of landholding and climate change adaptation. Gbetibouo [48] identified that land is a property like cash that can be instrumental in reducing poverty; hence he observed a favorable relationship between land size and selecting adaptation decision to climate change while Deressa et al. [41] observed a negative relationship.

2.2.2. Probit Model

Let us first start with the exposition of the probit model. In this study, the household h would adopt a particular coping strategy if it expects that the utility derived from the adoption is greater than non-adoption expressed as a latent variable ($Strategy_h^*$). This can be expressed as

$$Strategy_h^* = \beta_0 + \beta_1 X_h + d_h + \varepsilon_h \quad (1)$$

Since latent variable in Equation (1) is not directly observable, the expression in Equation (2) below is rewritten in terms of the observable dependent variable $Strategy_h$ as follows:

$$Strategy_h = 1[\, Strategy_h^* > 0] \quad (2)$$

where $Strategy_h$ takes the value one if the utility derived from adopting a particular coping strategy is positive ($Strategy_h^* > 0$) and zero if the utility is zero or negative ($Strategy_h^* \leq 0$).

So far as other variables on the right-hand side of Equation (1) are concerned, X_h is a bunch/vector of independent variables that include both shock and non-shock variables. Shock variable is a dummy for a severe climatic shock that the household may have faced in the last ten years. Non-shock variables represent the household's socio-economic, demographic, and forest-related characteristics such as an area of land owned, poverty status, caste, household head's years of schooling, gender, major occupation, forest income, and distance to the nearest forest. d_h is district fixed effects. This takes into account any unobserved heterogeneity existing at district level such as infrastructure, and culture that normally do not change over time. ε_h is a random error term clustered at district level. We run a probit model and report marginal effects for each type of coping strategy adopted by the households. Suppose the coefficient estimate of the shock variable is positive and significant for a particular coping strategy. In that case, we conclude that the household's probability of adopting that strategy is higher vis-à-vis the households that do not report such severe shock. We also use probit model to analyze the determinants of poverty [49–51].

2.2.3. Ordered Probit Model

We exploit an ordered probit model in order to assess the determinants of self-reported severe shocks, both climatic and non-climatic. We develop three categories/orders for each type of shock: households reporting no shocks as "0"; one shock as "1"; and at least two shocks as "2". In this model, like in the probit model, the ordered response can also be expressed as a latent continuous random variable $Shock_h^*$ which is a linear combination of some predictors plus a disturbance term that has a standard normal distribution.

$$Shock_h^{*k} = \delta_0 + \delta_1 Z_h + d_h + \epsilon_h, \;\; \epsilon_{h\sim}(0,1), \; \forall h = 1 \ldots . N \tag{3}$$

and

$$Shock_h^k = k \Leftrightarrow \mu_{k-1} < Shock_h^{*k} \leq \mu_k \tag{4}$$

In Equation (4), $Shock_h^k$ is the observed ordinal variable and k = 0, 1, 2. The equation exhibits the relationship between the observed changes $Shock_h^k$ and the latent continuous variable $Shock_h^{*k}$. Where, Z_h are the explanatory variables as reported in Equation (1) except shock variable. d_h is district fixed effects. ϵ_h is a random error term clustered at district level. We run an ordered probit model and report the marginal effects of each response category.

3. Results

3.1. Distribution of Shocks in the Last Ten Years

The result shows that around half of the sampled households (=144) experienced a number of climatic and non-climatic severe shocks in the last ten year. Some of the households were exposed to both climatic and non-climatic shocks, whereas some others were exposed to only one types of shock. Out of the total households, 35.67% (=107) reported the climatic and 33% (=99) reported the non-climatic types. Distribution of the climatic and non-climatic shocks and their types is presented in Table 3.

Table 3. Distribution of severe climatic and non-climatic shock.

Types of Severe Shock	Causes	Shock Frequencies	Shock Percentage	Total Shock Households
Climatic	Increase in temperature	48	36.64	34
	Heavy rainfall	40	30.53	34
	Frost/hailstone/thundering	16	12.21	16
	Drought	15	11.45	12
	Erratic rainfall	12	9.16	11
	Total	131	100	107
Non-climatic	Pest/diseases	32	29.09	30
	Damage by animals	30	27.27	30
	Lack of resources	29	26.36	20
	Accident	17	15.45	17
	Fraud	2	1.82	2
	Total	110	100	99

Table 4 shows severe climatic, non-climatic, and total severe shocks over the last ten years. In terms of family size, households with an average family size above the national average faced a higher number of both climatic and non-climatic shocks; however, they experienced more climatic than non-climatic shocks. Similarly, households residing closer to the forest areas usually depend on forest products for livelihood and hence face more severe shocks. Households with a literate head reported experiencing more severe climatic shocks vis-à-vis households with an illiterate head. So far as ethnicity is concerned, Dalits reported facing more severe shocks as compared to the Janajatis. Nevertheless, Brahmin or Chhetri, who more possibly dependent on subsistence farming for their livelihood, faced

more severe climatic shocks. In contrast, wealthier households faced less severe shock than poor and medium households.

Table 4. Frequency distribution of severe shocks (n = 300).

Household Characteristics	Severe Climatic Shocks	Severe Non-Climatic Shocks	Total Severe Shocks
Family size			
Under national average [1] (<4.6)	36	26	62
Above national average (>4.6)	95	84	179
Forest income class			
<100,000 NPR per annum	118	102	220
>100,000 NPR per annum	13	8	21
Household head education			
Illiterate	48	55	103
Literate	72	55	127
Distance to forest class			
Close users (<30 min)	67	69	136
Distant users (>30 min)	64	41	105
Household ethnicity			
Brahmin/Chhetri [2]	90	70	160
Dalit	34	29	63
Janjati (or indigenous caste)	7	11	18
Wealth strata			
Poor	57	37	94
Medium	53	49	102
Rich	21	24	45
Household head sex			
Female	51	50	101
Male	80	60	140
Major occupation			
Non-agriculture	90	85	175
Agriculture	41	25	66
Studied districts and CFUGs			
Nawalparasi (Nandan)	18	31	49
Kaski (Gahate)	33	43	76
Gorkha (Ludhi)	80	36	116

[1] Mean family size of the country is 4.6 [52]. [2] Brahmin/Chhetri is another caste group of Nepal which is called the higher caste, mostly they are Hindus.

Similarly, female-headed and agricultural-based households faced fewer climatic shocks than male-headed and non-agricultural households, respectively. Accordingly, the number of severe climatic shocks increase by altitudes; study areas in hills experience more shocks than the low-land areas. In other words, hilly sites in Gorkha (Ludhi CFUG) and Kaski (Gahate CFUG) districts faced more severe shocks than that of a low-land site in Nawalpur (Nandan CFUG) district.

3.2. Determinants of Being Poor

Table 5 presents the determinants of being poor using probit model. We report two different results: one that includes severe climatic shock as an explanatory variable (column 1) while the other does not (column 2).

Table 5. Probit estimates of determinants of being poor (Marginal effects).

Variables	(1)	(2)
	With Shock as a Control	Without Shock as a Control
Severe Climatic Shock (=1)	0.0371	
	(0.0293)	
Family size	0.0296 **	0.0302 **
	(0.0138)	(0.0130)
Log of forest income	−0.0240	−0.0223
	(0.0171)	(0.0182)
Log of land (in Ropani)	−0.0272	−0.0289
	(0.0240)	(0.0227)
Forest more than 30 min (=1)	0.00392	0.00332
	(0.0278)	(0.0276)
Years of head schooling	−0.00580	−0.00595 *
	(0.00372)	(0.00359)
Dalit [a]	0.142 ***	0.143 ***
	(0.0156)	(0.0138)
Janajati	0.0247	0.0190
	(0.0458)	(0.0478)
Female (=1)	−0.0261	−0.0298
	(0.0341)	(0.0358)
Agriculture (=1)	0.366 ***	0.363 ***
	(0.00797)	(0.00904)
Kaski-Gahate CFUG [b]	0.240 ***	0.242 ***
	(0.0489)	(0.0474)
Gorkha-Ludhi CFUG	0.132 **	0.145 ***
	(0.0541)	(0.0465)
Observations	300	300

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Note: [a] Reference category is Brahmin and Chhetri. [b] Reference category is Nawalpur-Nandan CFUG.

The result shows the family size, castes, education, and occupation as the major determinants of poverty. While an increase in family size, being in a low caste, and agricultural-based households increase the probability of being poor, education decreases it. A one-unit increase in family members would increase the probability of being poor by about three percentage points. Likewise, one additional year of schooling by household head would decrease this probability by 0.06 percentage points. A probability of Dalit households becoming poor is about 14 percentage points higher vis-à-vis Brahmin and Chhetri households. Likewise, the probability of households with agriculture as the main occupation becoming poor is by far the largest; this probability increases by about 36 percentage points. Finally, the households both in Gahate CFUG of Kaski and Ludhi CFUG of Gorkha are more likely to be poor than the households in Nandan CFUG of Nawalpur. However, Gahate CFUG of Kaski is poorer than Ludhi CFUG of Gorkha.

3.3. Factors Affecting Self-Reported Severe Shocks

Table 6 reports regression results of the ordered probit model separately for all severe shocks, climatic severe shocks only, and non-climatic severe shocks only. In order to simplify interpretation, marginal effects for each ordered response are reported. Table 6 shows that the determinants of different types of shocks are heterogeneous; only family size matters in explaining all these types of shocks. While Janajati caste explains all severe shocks and non-climatic shocks, being in a poor, female-headed, and agricultural household determines all severe shocks and severe climatic shocks. One additional increase in family size increases the probability of experiencing at least one severe shock by 0.7 to 1.5 percentage points. Janajati households are less likely to experience severe shocks, vis-à-vis Brahmin-Chhetri households. However, this is mostly true in the case of non-climatic than severe climatic shocks. Poor households are more likely to experience severe

climatic shocks; the probability of experiencing at least one severe climatic shock is higher by 7.3 percentage points while that of at least two severe shocks is higher by 5.3 percentage points. On the other hand, female-headed and agricultural households have a lower probability of experiencing severe climatic shocks. In the case of a female-headed household, the probability of experiencing severe climatic stocks decreases by 2.3 (at least two shocks) to 3.6 (one shock) percentage points. Likewise, agricultural households' probability of experiencing severe climatic shocks decreases by 4.1 (at least two shocks) to 7.9 (one shock) percentage points.

Table 6. Ordered probit estimates of the determinants of severe shocks (Marginal effects).

Variables	All Severe Shocks			Climatic Severe Shocks			Non-Climatic Severe Shocks		
	No Shocks = 0	One Shock = 1	At Least Two Shocks = 2	No Shocks = 0	One Shock = 1	At Least Two Shocks = 2	No Shocks = 0	One Shock = 1	At Least Two Shocks = 2
Family size	−0.024 ***	0.008 **	0.015 **	−0.021 **	0.013 **	0.008 **	−0.009 *	0.007 **	0.003
	−0.01	−0.04	−0.006	−0.01	−0.006	−0.004	−0.005	−0.002	−0.003
Log of forest income	−0.055	0.019	0.035	−0.093 ***	0.056 ***	0.036 ***	0.01	−0.007	−0.003
	−0.07	−0.027	−0.043	−0.035	−0.021	−0.013	−0.05	−0.036	−0.015
Years of head schooling	0.007	−0.002	−0.004	0.004	−0.003	−0.002	0.007	−0.005	−0.002 *
	−0.005	−0.002	−0.003	−0.003	−0.001	−0.001	−0.006	−0.005	−0.001
Log of land (in Ropani)	0.08	−0.029	−0.051	0.073 ***	−0.045 ***	−0.029 ***	0.015	−0.011	−0.004
	−0.05	−0.019	−0.031	−0.019	−0.012	−0.007	−0.048	−0.034	−0.013
Forest more than 30 min (=1)	−0.002	0.0006	0.001	0.014	−0.008	−0.005	−0.032	0.023	0.009
	−0.025	−0.009	−0.015	−0.02	−0.012	−0.008	−0.049	−0.033	−0.017
Dalit [a]	−0.029	0.01	0.193	0.044	−0.027	−0.016	−0.059	0.042	0.017
	−0.035	−11	−0.023	−0.037	−0.023	−0.013	−0.096	−0.068	−0.028
Janajati	0.157 ***	−0.067 ***	−0.089 ***	0.138	−0.091	−0.047	0.097 *	−0.073	−0.024 *
	−0.039	−0.023	−0.018	−0.096	−0.067	−0.029	−0.056	−0.046	−0.014
Poor (=1)	−0.099 **	0.033 *	0.065 **	−0.126 *	0.073 **	0.053 *	0.016	−0.012	−0.004
	−0.045	−0.018	−0.027	−0.066	−0.035	−0.03	−0.084	−0.062	−0.022
Female (=1)	0.087 *	−0.031 ***	−0.055 *	0.059 ***	−0.036 ***	−0.023 ***	0.038	−0.027	−0.010
	−0.044	−0.012	−0.032	−0.022	−0.138	−0.008	−0.037	−0.235	−0.013
Agriculture (=1)	0.192 ***	−0.087 ***	−0.105 ***	0.120 ***	−0.079 ***	−0.041 ***	0.079	−0.059	−0.019
	−0.034	−0.012	−0.023	−0.029	−0.024	−0.008	−0.076	−0.052	−0.024
Kaski-Gahate CFUG [b]	−0.141 ***	0.045 ***	0.096 ***	−0.031	0.019	0.012	−0.170 ***	0.117 ***	0.053 ***
	−0.032	−0.01	−0.025	−0.039	−0.024	−0.016	−0.005	−0.02	−0.016
Gorkha-Ludhi CFUG	−0.261 ***	0.074 ***	0.187 ***	−0.028 ***	0.151 ***	0.129 ***	−0.084 ***	0.059 ***	0.025 ***
	−0.023	−0.012	−0.021	−0.031	−0.016	−0.015	−0.01	−0.014	−0.007
Observations					300				

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Note: [a] Reference category is Brahmin and Chhetri. [b] Reference category is Nawalpur-Nandan CFUG.

There are a couple of other determinants of severe climatic shocks: forest income and landholding size. The probability of forest-dependent households, as measured by the amount of forest income, experiencing one severe climatic shock increases by 5.6 percentage points, and at least two severe shocks increase by 3.6 percentage points. Similarly, a one per cent increase in landholding size decreases the probability of experiencing one severe climatic shock by 4.5 percentage points and at least two severe shocks by 2.9 percentage points.

3.4. Adoption of Coping Strategies

In the study area, most of the households practiced various adaptation strategies to cope with the impact of shocks on agricultural production, livestock, human resources, and properties. Households reported experiencing more climatic than non-climatic shocks during the last ten years. So far as adaptation is concerned (Figure 2), about 42% of the households experiencing climatic shocks adopted dissaving (spend materials or cash saving in emergencies) as a coping strategy, while this was 37% for the households experiencing non-climatic shocks. Likewise, 23% of households facing climatic shocks resorted to borrowing while only 15% of households borrowed in case of non-climatic shocks. Households also reported migration as an important coping strategy, both for climatic and non-climatic shocks. Nearly 18% of households reported migration as a coping strategy in case of climatic shocks while 17% in the case of non-climatic shocks.

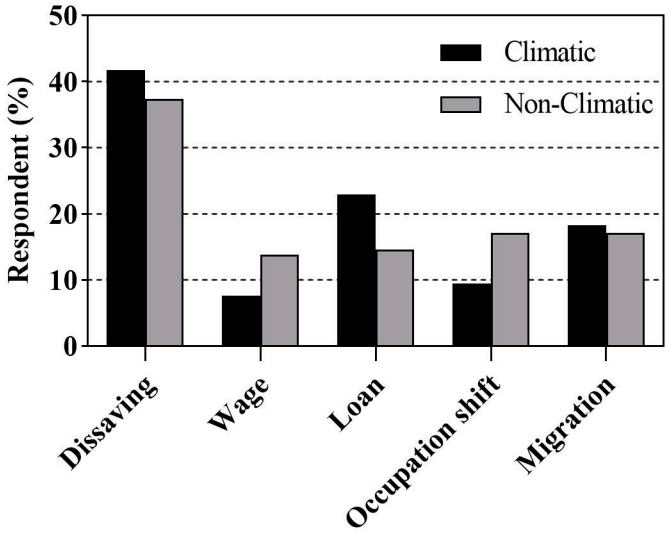

Figure 2. Adaptation strategy to cope with the severe climatic and non-climatic shock.

Few households also reported resorting to wage jobs and occupational shifts as coping strategies. However, these strategies were mostly taken by households experiencing non-climatic than climatic shocks. Only about 8% of households affected with climatic shocks resorted to wage jobs, while this was 15% in case of non-climatic shocks. Likewise, nearly 10% and 17% of the households affected with climatic and non-climatic shocks respectively reported shifting their traditional occupation for livelihood diversification. These indicate that most households facing severe climatic shocks adopted dissaving, borrowing, and migration as important coping strategies. In the regression analysis below, we further estimate the probability of the households facing severe climatic shocks to adopt these coping strategies.

As mentioned earlier, probit model is used to assess various coping strategies adopted by the households as a response to the severe climatic shocks: dissaving, wage jobs, borrowing, a shift in occupation, and migration (Table 7). Marginal effects are reported. We utilize a dummy variable for a severe climatic shock experienced by the household, i.e., if the household experienced at least one severe climatic shock, it is equal to one otherwise zero.

Table 7 shows that households experiencing severe climatic shocks resorted to various coping strategies to enhance their livelihood, more importantly, dissaving followed by borrowing, a shift in occupation, and migration. The probability of dissaving increased by 65.8 percentage points while borrowing by 25.5, shift in occupation by 7.7, and migration by 3.17 percentage points. This indicates that households resorted to multiple coping strategies, dissaving and borrowing in particular, in order to restore their livelihood.

So far as other explanatory variables are concerned, households with larger family size are less likely to borrow and migrate; forest-dependent households are more likely to borrow while less likely to migrate; households with larger landholding are less likely to do wage work but more likely to shift their occupation; households with the educated head are less likely to borrow; Dalit and Janajati households are more likely to borrow; besides, Dalit households are more likely to shift occupation, and Janajati households are less likely to resort to dissaving; poor households are less likely to shift occupation; female-headed households are less likely to borrow and migrate but more likely to shift occupation, and agricultural households are less likely to borrow. Finally, households in Gahate CFUG of Kaski are more likely to resort to dissaving while they are less likely to do wage work and shift occupation as compared to households in Nandan CFUG of Nawalpur. Households in Ludhi CFUG of Gorkha are less likely to migrate.

Table 7. Probit estimates of the adoption of the coping strategies (Marginal effects).

Variables	(1)	(2)	(3)	(4)	(5)
	Dissaving	**Wage**	**Loan**	**Occupation Shift**	**Migration**
Severe climatic shock (=1)	0.658 ***	0.0423	0.255 ***	0.0772 ***	0.0317 *
	(0.0664)	(0.0454)	(0.0667)	(0.0284)	(0.0182)
Family size	0.00491	0.00864	−0.00415 ***	0.000230	−0.0235 ***
	(0.0129)	(0.00618)	(0.000127)	(0.00220)	(0.00835)
Log of forest income	−0.0457	0.0149	0.0201 **	−0.00358	−0.0470 ***
	(0.0517)	(0.0168)	(0.00970)	(0.00615)	(0.0146)
Log of land (in Ropani)	0.0101	−0.0397 ***	−0.0279	0.0348 ***	−0.0410
	(0.0566)	(0.00721)	(0.0232)	(0.00348)	(0.0297)
Forest more than 30 min (=1)	−0.0284	0.0269	0.0109	−0.0153	0.0136
	(0.0739)	(0.0329)	(0.0198)	(0.0246)	(0.0578)
Years of head schooling	−0.00795	0.00274	−0.00520 *	−0.00135	−0.00690
	(0.00854)	(0.00208)	(0.00300)	(0.00271)	(0.00651)
Dalit [a]	−0.0861	0.00368	0.130 **	0.120 *	0.0142
	(0.0587)	(0.0356)	(0.0584)	(0.0625)	(0.0897)
Janajati	−0.188 ***	0.00456	0.0218 **	−0.00569	−0.0451
	(0.0272)	(0.0323)	(0.00971)	(0.0346)	(0.0834)
Poor (=1)	0.000118	0.0553	0.00835	−0.0586 ***	−0.0660
	(0.0197)	(0.0580)	(0.0227)	(0.0203)	(0.0535)
Female (=1)	−0.0174	−0.0216	−0.0286 **	0.0196 **	−0.132 **
	(0.0138)	(0.0367)	(0.0121)	(0.00859)	(0.0626)
Agriculture (=1)	−0.112	−0.00176	−0.0401 **	−0.00397	−0.0513
	(0.0723)	(0.0696)	(0.0198)	(0.0497)	(0.0529)
Kaski-Gahate CFUG [b]	0.268 ***	−0.0243 ***	0.0230	−0.0195 **	−0.00180
	(0.0108)	(0.00869)	(0.0322)	(0.00938)	(0.0217)
Gorkha-Ludhi CFUG	−0.0365	−0.0229	0.0685	0.0490	−0.160 ***
	(0.0560)	(0.0172)	(0.0817)	(0.0342)	(0.0313)
Observations	300	300	300	300	300

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Note: [a] Reference category is Brahmin and Chhetri. [b] Reference category is Nawalpur-Nandan CFUG district.

4. Discussion

The study finds that family size, ethnicity, education, and principal occupation of the households are major determinants of poverty in rural areas of Nepal. Table 5 shows that households with agriculture as the main occupation, those with larger family size, and Dalit households have a higher probability of being poor. It is evident that only about two per cent of agricultural households in Nepal are engaged in commercial farming [29]. This indicates that the majority are engaged in subsistence farming with limited access to modern skills, technology, improved seeds, and other inputs; this has an effect on poor agricultural productivity, hence adding to their poverty status. This finding is consistent with Shrestha and Nepal [53], who have also concluded that the agriculture sector is highly influenced by climatic shocks, which has dropped agricultural production rapidly affecting rural households more severely. Other studies also report that agriculture in rural Nepal is mostly subsistence, which further intensifies poverty in such areas [54,55]. Likewise, Dalit households are mostly poor; one reason for this is the discrimination they still face in socio-economic, political, and administrative affairs [56]. People in hilly areas (Kaski and Gorkha) are more likely to be poor than in Terai areas (Nawalpur). This finding is in line with the results reported by Thorlakson and Neufeldt [9]; they argued that the poor prefer to live in rural hills because they can only afford to reside in such areas. Rural hills are underdeveloped and prone to climatic shocks, where limited alternatives are available for income diversification; hence people living in these areas have limited livelihood options than those in Terai areas, pulling them gradually into the poverty trap [57].

On the other hand, education is a significant predictor of poverty; households with the heads having more years of schooling are less likely to be poor. Hence, education of family head or decision-maker in a family has been considered as an essential benchmark of household well-being; see, e.g., [58–60]. These studies further argue that education assists households to make informed decisions by, for example, investing in assets such as human, physical, and financial, by carefully analyzing risk-return trade-offs. This has an effect on reducing poverty.

In the second leg of empirical analysis, where we analyze the determinants of the severe shocks, we find poverty, family size, forest dependency, geography (sites), gender of the household head, landholding size, and principal occupation as the significant determinants of experiencing climate-induced shocks (Table 6). While family size explains all types of shocks considered, the effects of other explanatory variables on these shocks are heterogeneous. In the third leg of empirical analysis, we see that households resorted to diverse adaptation strategies in order to cope with the adverse effects of climatic shocks on livelihood. More importantly, households resorted to dissaving, followed by borrowing and migration (Table 7).

An increase in family size increases the probability of experiencing all types of severe shocks. On similar lines, Chhetri [32] also concluded that rural people in Nepal are unemployed, unproductive in terms of income generation, and hence pose an additional burden to sustain household well-being. Therefore, households with bigger family size are vulnerable to these shocks. Few papers suggest otherwise. For example, Bista [61] argues that larger household size plays a supportive role in farming; any addition of the member to the family would therefore yield higher incomes that they can invest in ex-ante adaptation strategies which may reduce the probability of experiencing severe shocks. However, studies in Nepal have shown that the marginal productivity of both labor and fertilizer, although positive, are very close to zero. This is because of the increased congestion on given farmland without a corresponding use of technology; this has forced farmers to use their farm more and more intensively such that the marginal products approach zero [62]. In terms of coping options, larger family size decreases the probability of borrowing and migration. One argument as to the negative relationship between borrowing and family size is that if the per-capita assets holding is lower, it dilutes the rural household's capacity to use fragmented assets as collateral, in case of both formal and informal loans. Chen and Chivakul [63] indicate that the high dependency due to few economically active household members also diminishes the household's credibility to borrow. Likewise, Thapa and Acharya [64] inferred that larger household size decreases the probability of remittance received. The sign of the family size coefficient in the case of migration equation (Table 7) in column (5) is counter-intuitive. There may be two possible explanations for the inverse relationship between the decision to migrate and family size. One, it may be related to borrowing; as already discussed, a larger family may have restricted access to borrowing that further worsens the household's ability to finance migration. Two, large family households in rural areas of Nepal are relatively poorer, get low wage because of lower education, and may accumulate very low yearly remittance demotivating to out-migrate. Devkota [65] also concluded on similar lines.

Similarly, our finding that low-income household is more likely to experience severe climatic shocks and less likely to non-climatic shocks is also supported by past literature. This is because the poor people generally reside in hazardous locations such as the edge of the forest [1], riverbank, and landslide-prone areas and spend less on risk-reduction measures [66], which makes them more vulnerable to the climatic shock, pulling them into further poverty [67]. Hence, a vicious cycle of poverty persists [68]. Any sort of external relief, aid, and support extended to these households are also captured by few influential people, usually wealthier and elites [69,70]. Hence, these households have fewer options to support their livelihood, as also shown by our study, i.e., the poor households are less likely to shift their traditional occupation.

Households that are dependent on forest, proxied by increased forest income are more likely to face severe climatic shocks. This finding meets our expectations; Gautam et al. [71] also concluded that people living in proximity to the forests are more likely to be affected by natural disasters; as a consequence, their use of forest resources, firewood, in particular, increases as an immediate relief to restore livelihood. The findings from other studies, such as by Cavendish [72], Chhetri [32], and Dercon [69], also support this notion. So far as coping strategies are concerned, forest-dependent households are more likely to borrow but less likely to migrate. Nepal's government recognizes CFUGs as an enterprise unit and motivates forest-dependent households to initiate small-scale forest-based enterprises [73]. This cause is also supported by various donor agencies and local cooperatives [74]. Hence, it may be the case that forest-dependent households borrow to run such enterprises as a strategy to livelihood recovery. The availability of this livelihood option also explains why such households are less likely to migrate.

The study further finds that female-headed households and Janajati households have a lower probability of experiencing severe climatic shocks. Chhetri [32] shows that female-headed households in one of the study districts considered in this study are usually less dependent on forest and mostly receive regular remittances from her spouse or son. He also shows that female-headed Janajati households receive remittances more regularly than others to support household well-being. These findings are also consistent with our findings, since female-headed and Janajati households are comparatively wealthier in our study areas. Hence, although these households may be exposed to similar shocks as others, they may be experiencing less severe shocks, either because they have different livelihood options or have a regular and stable source of income. This also explains why female-headed households are less likely to borrow and migrate and are more likely to shift their occupation. In the study areas, most of the Janajati households, especially Gurungs, have regular income from armed service and pensions and can easily borrow during crisis periods. Lenders also trust them more than other castes due to their regular income and larger assets holding. Our findings also explain these phenomena.

Similarly, households with larger landholdings have a lower probability of experiencing severe climatic shocks. Although agriculture-based households are mostly poor, the probability of these households experiencing the climatic shock is lower than the non-agriculture-based households. This suggests that these households can put their larger landholdings into multiple commercial uses (such as renting out land, use it as collateral, and put it in non-farm uses) so that they can absorb the risk of vulnerability. In our study area, people with sufficient land also use it as collateral for borrowing money from the bank or money lender. It was also the case that the landowners sell some land for starting a new business. These findings are consistent with the findings by Apata et al., 2010. They concluded that more landholding increases household's access to credit, which further increases their prospects of investing in income-generating activities. This will thus help these households absorb the shock. Thus, the involvement of households in agriculture practices with relatively larger landholdings minimizes their chances of experiencing severe climatic shocks. In terms of coping options, larger landholdings support the households to practice several occupations without having to resort to wage labor during periods of crisis. Khanal and Wilson [75] also concluded that Nepalese farmers have limited farming knowledge on modern farming practices due to limited access to information and large dependency on improved seed and fertilizers, which demotivates them to continue with the traditional occupation; hence they are more likely to change occupations.

The recurring shocks, in the absence of appropriate shock control mechanisms in the rural areas, push households to poverty. The elite capture of the resources (e.g., relief, aid) and access to opportunities have to be adequately monitored. Although forest resources provide a safety net to the rural households in the time of severe shocks, strong monitoring, as well as a fair product distribution mechanism, should be devised to control the illegal forest activities during the times of emergency. It helps to reduce the chances of forest deterioration and to provide prompt relief to the victims. Limited access, as well as poor

knowledge on the part of poor households about the selection and use of proper mitigation and adaption strategies further, retards their prospects of coming out of poverty. This requires that an integrated approach to alleviating poverty be used. It helps in reducing poverty by discouraging migration so that poor household can effectively manage climatic problems. This will not only help to protect their assets but also help in diversification of livelihood such that they become resilient to shocks. Hence, in order to avoid poverty from rural areas, integrated farm-forestry measures are needed to address the challenges posed by climatic and other types of shocks and prevent them from falling into further poverty.

5. Conclusions

Using detailed household survey data from randomly selected 300 households of three different locations in Nepal, this paper assesses the determinants of being poor, provides empirical evidence of the factors affecting varying degree of climatic and non-climatic shocks faced by rural households, and the factors affecting their choice of coping strategies. The study shows that the less-educated, low landholding and larger-sized Dalit households, whose livelihood is based on agriculture and who are residing in the hilly areas are more likely to be poorer than others. An agriculture-based household is 36 percentage points more likely to be poor than the households pursuing other occupations. Similarly, the probability of Dalit household being poor is about 14 percentage points higher vis-à-vis Brahmin and Chhetri households. Findings show that in the last ten years, about half of the households were exposed to severe shocks and that the majority of them were of climatic type. In particular, three of the highly reported climatic shocks were increasing temperature, heavy rainfall, and frost/hailstone. On the other hand, so far as non-climatic shocks are concerned, most of them reported pest/disease infliction, animal damage, and lack of resources as the three important shocks. Larger-sized poor, and forest-dependent households in the hills were found to be significantly associated with exposure to severe shocks. One additional increase in family-size increases the probability of experiencing at least one severe shock by 0.7 to 1.5 percentage points. Findings also clearly indicate that the severity of shocks faced by the poor is relatively high compared to the wealthier households. Poor households are more likely to experience severe climatic shocks; the probability of experiencing at least one severe climatic shock is higher by 7.3 percentage points while experiencing at least two severe shocks is higher by 5.3 percentage points. The major shock coping strategies reported by the households were dissaving (39%), borrowing (18%), migration (18%), occupation shift (14%), and extra wage work (11%). Households use multiple coping strategies; dissaving and borrowing are more frequently used to cope with climatic shocks, while occupation shift and extra wage work are mostly used for non-climatic shocks. More importantly, shock coping choices vary by socio-economic characteristics of the households such as sex of the household head, family size, occupation, landholding, and forest dependence. Our findings also indicate that the choices of coping strategies are context-specific and therefore affected by several factors. In addition to the nature of the shocks, household's decision to adopt a particular strategy depends on socio-economic, demographic, and geographic contexts along with the factor endowments. The results suggest that frequent exposure to various climatic and non-climatic shocks inhibits resource-constrained, particularly Dalit and poor forest-based households move out of poverty. Therefore, the policies that support investments in sustainable intensification of agricultural production may help them in coping with severe shocks. Similarly, providing information on climate change is another important factor that allows them to prepare and/or modify their livelihood strategy, especially when the types and severity of shocks are uncertain. At the same time, it is also important to provide household level-specific support to the vulnerable households so that appropriate measures to protect their means of living can be taken in a timely manner.

Author Contributions: Conceptualization, N.P.G.; methodology, N.P.G., N.K.R., and B.B.K.C.; formal analysis, N.P.G. and N.K.R.; writing—original draft preparation, N.P.G.; writing—review and editing, N.K.R., B.B.K.C., N.R., M.H.U.R., and P.W.; supervision, X.M. and P.W. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the Science and Technology Promotion Project of Fujian Forestry Bureau (2020TG19), the Co-Innovation Center for Soil and Water Conservation in Red Soil Region of the Cross-Straits, China (KP80ND80304) and the Project of Fujian Provincial Colleges and University Engineering Research Center of Plantation Sustainable management (PTJH18009).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: This paper and the research behind it would not have been possible without the exceptional hospitality and support of Nandan, Gahate Durakorukh, and Ludhi Damgade CFUGs of Gandaki Province. We extend our deep sense of gratitude to them for allowing us to access their documents and answering numerous questions with unfailing patience. We would also like to express our sincere gratitude to Melina, Samjhana, Anjila, Ashok, Shambu, Nirajan for collecting data for the research. Further, we sincerely acknowledge Abadhesh Singh for generously editing the language of this paper.

Conflicts of Interest: The authors declare no conflict of interest.

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