HOUSEHOLD VULNERABILITY AND ENVIRONMENTAL DEPENDENCE IN RURAL NEPAL

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DECLARATION

This thesis entitled, "HOUSEHOLD VULNERABILITY AND ENVIRONMENTAL DEPENDENCE IN RURAL NEPAL", was conducted under the supervision of Associate Professor Resham B. Thapa, PhD of Central Department of Economics, Tribhuvan University. I declare that the results and analysis reported in this thesis is the result of my own study, except where due reference has been made. The thesis has not been accepted for any degree nor has been submitted for candidature in other degree granting programs.

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LETTER OF RECOMMENDATION

This thesis entitled,"HOUSEHOLD VULNERABILITY AND ENVIRONMENTAL DEPENDENCE IN RURAL NEPAL", is submitted by Mr. Sanjeev Nhemhafuki under my supervision for partial fulfillment of the requirements for the degree of Master of Arts in Economics. I forward it with a recommendation for approval.

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Thesis Supervisor

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Date: February 08, 2024

APPROVAL LETTER

We certify that this thesis entitled, "HOUSEHOLD VULNERABILITY AND ENVIRONMENTAL DEPENDENCE IN RURAL NEPAL" submitted by Mr. Sanjeev Nhemhafuki to the Central Department of Economics, Faculty of Humanities and Social Sciences, Tribhuvan University, in the partial fulfillment of the requirement for the Master of Arts in Economics has been found satisfactory in scope and quality. Therefore, we accept this thesis as a part of the said degree.

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ABSTRACT

This thesis examines whether the households dependent on environmental income are vulnerable in rural setting of three distinct geographic region of Nepal. For this purpose, the study develops a composite household vulnerability index based on the various capitals owned by the households and relates the latter with the share of environmental income to total income. The study uses the environmental augmented household-level livelihood longitudinal data-set of Nepal, known as PEN (Poverty Environment Network) dateset. It covers the period of 2006, 2009 and 2012. Further, we assess the relationship between the household vulnerability and environmental dependence. The results suggests that Environmental dependence and Household Vulnerability are positively associated. The level of vulnerability is different in different ecological zone. Mountainous region seems more vulnerable as compared to Lowland and Mid-hill region. Rural households are confined to rural activities which are related to environment. Therefore, more environmental dependence has to do with more vulnerability. A serious policy debate in the society which claims global illustration of Community Forest Management and Conservation Areas Management.

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LIST OF ACRONYMS

BPLM	Breusch and Pagan Lagrange Multiplier
ComForM	Community Based Forest Management in the Himalaya
CBS	Central Bureau of Statistics
DFID	Department for International Development, UK
DFRS	Department of Forest Research and Survey
FAO	Food and Agriculture Organization
FE	Fixed Effect
HH	Household
HHH	Household Head
HKH	Hindu Kush Himalayas
HVI	Household Vulnerability Index
IOF	Institute of Forestry
IFRO	Department of Food and Resource Economics, University of Copenhagen
LVI	Livelihood Vulnerability Index
MLVI	Multi-dimensional Livelihood Vulnerability Index
OLS	Ordinary Least Squares
PEN	Poverty and Environment Network
POLS	Pooled Ordinary Least Squares
RE	Random Effect
SD	Standard Deviation
SLA	Sustainable Livelihood Approach
SLF	Sustainable Livelihood Framework
SoVI	Social Vulnerability Index
TU	Tribhuvan University
UNDP	United Nations Development Programme
VDC	Village District Committee

CHAPTER I
INTRODUCTION

This chapter's content presents the study's background, statement of the problem, research question, and thesis objectives. In addition, it highlights the significance and limitations of the study.

1.1 Background of the Study

According to The World World Bank (2021) the global rural population constituted 43.5% of the global population. The prevailing trend indicates a decline in the rural population is declining attributed to the Social, Economic, Technological, Infrastructure and services, Environmental influences as discussed by (Jaszczak et al., 2018). The United Nations (2018) projects that by 2050, sixty-eight percent of the world's population will be urban by 2050. While scholars and institutions project a decline in the share of the rural population, the number of people living in rural areas remains significant.

The population residing in rural areas faces considerable vulnerability, as highlighted by Acharya (2008). The global rural population is estimated to be 3.4 billion, according to The World Bank (2022). In terms of poverty, a striking 80 percent of those living in extreme poverty are found in rural areas (FAO et al., 2021). Additionally, the escalating risks of climate change disproportionately affect rural populations (Gemenne, 2022), posing a significant threat to their livelihoods, especially given the heavy dependence of many rural households on the natural environment. This phenomenon poses a massive threat to the poor rural livelihoods (Pelser & Chimukuche, 2022). Angelsen et al. (2014) contends that the natural environment such as forests and other natural areas, are crucial for sustaining rural livelihoods. So environmental reasons, along with political and economic, stands amongst the drivers of migration (McNamara et al., 2016).

The rural population is increasingly falling into poverty, and those left behind are becoming more challenging to reach (United Nations, 2019). This trend has contributed to a rise in migration from rural areas (Lazarte-Hoyle, 2017). In some instances, migrants are unfairly blamed for urban poverty (Tacoli & Mcgranahan, 2015). Consequently, this imbalance in rural-urban resource distribution results in

the mismanagement of opportunities and resources in rural areas. Simultaneously, it fuels heightened competition for urban resources, leading to their scarcity (Artuso, 2011).

Against this backdrop, it becomes imperative to investigate rural areas, their inhabitants, and their means of sustaining themselves to develop a more comprehensive understanding of rural economies. The residents of these areas predominantly rely on their surrounding environment, with natural resources assuming a pivotal role in their livelihoods (Nawrotzki et al., 2012). Frequently, income generated from nature serves as a crucial safety net during periods of deficiencies in other livelihood activities, supporting immediate consumption needs and offering a potential pathway out of poverty (Angelsen & Wunder, 2003). However, relying on environment also may contribute to the vulnerability of the households. Therefore, a thorough examination of the sources of livelihood in rural regions and the extent to which households are reliant on the environment becomes crucial.

The most frequently employed frameworks for rural livelihood and vulnerability analysis are Anani (1999), DfID (1999), and Ellis (1999). These frameworks serve as foundational tools for scrutinizing rural households within specific contexts and their livelihood resources. The Sustainable Livelihood Approach, incorporating key elements such as livelihood resources, vulnerability contexts, institutional processes, livelihood strategies, and outcomes, provides a comprehensive structure for rural livelihood analysis (Walelign & Jiao, 2017). Numerous studies have utilized frameworks like the Sustainable Livelihood Framework, Livelihood Assets Framework, Vulnerability Framework, and others to conduct in-depth analyses.

Nawrotzki et al. (2012) underscores the central importance of natural resources in rural livelihoods through a thorough analysis. Building on this, Díaz-Montenegro (2019) establishes that capital assets play a crucial role in determining the livelihood strategies adopted by small-scale farmers. In addressing poverty in rural areas, Mukotami (2014) advocates for the promotion of non-farm activities, emphasizing that the poorest rural groups face limited opportunities for diversification, hindering the accumulation of resources for investment purposes. Furthermore, Cavendish & Campbell (2008), in exploring the link between environmental income and inequality, identifies access to non-environmental cash income as the most significant

contributor to rural inequality.

Charlery & Walelign (2015) employs a decomposition method to distinguish between stochastic and structural poverty within households, utilizing both income data and assets index. The study reveals that those classified as income poor exhibit a higher dependence on environmental resources. In a related vein, Walelign & Jiao (2017) employs clustering to identify various remunerative strategy groups, highlighting a higher reliance on environmental resources within the cluster employing the least remunerative strategies. The author suggests, based on this finding, that households in an upward transition phase show a reduction in environmental dependency, emphasizing the importance of enhancing poverty reduction strategies.

In the study conducted by Walelign et al. (2020), it is observed that households with high reliance on environmental resources exhibit lower income and asset endowments. Conversely, households with lower environmental reliance fare better in terms of both income and assets. Adding to this perspective, Walelign et al. (2021) highlights the impact of poor infrastructures in mountainous areas of Nepal, resulting in households having fewer assets and lower income compared to their counterparts in mid-hills and lowlands. Furthermore, Chhetri et al. (2022) concludes that forest and environmental income remain the primary source of income and livelihoods for poor and marginalized households, with a notable decrease in forest and environmental incomes as household income increases.

A substantial body of scholarly literature, spanning both international and national contexts, has delved into the exploration of factors influencing the livelihood strategies adopted by rural households across diverse countries. For instance, Angelsen et al. (2014) scrutinizes the determinants of household income across 8,000 households in 24 developing nations. The econometric model employed in the analysis incorporates factors such as household characteristics, assets, shocks, institutions, location, and site-level economic factors. In a related study, Emeru et al. (2022) identifies determinants of livelihood diversification strategies, including the age of the household, education status, family size, access to credit, market access, and positive impacts from training and extension services. Similarly, Amevenku et al. (2019) underscores the significance of marital status of the household head, the duration of food shortages experienced per year, access to credit and extension

services, distance to regular markets and district capitals, as well as experience in fishery, as major determinants influencing livelihood strategies.

In the specific context of rural Nepal, there is a noticeable scarcity of literature assessment of the household vulnerability and environmental dependence. Furthermore, a critical gap exists in the identification and analysis of households that are vulnerable which is a crucial step to help policymakers foresee prospective routes for different segments, and thus frame out interventions more effectively. To address these gaps, this study endeavors to provide a comprehensive analysis, aiming to contribute valuable insights and enhance our understanding household vulnerability and its relationship with the environmental dependence in the rural landscapes of Nepal.

1.2 Statement of the Problem

Many communities in developing countries heavily rely on natural resources and the environment for their rural livelihood strategies (Adger, 2000; Ahmadpour et al., 2020; Chambers & Conway, 1992; Ellis, 1999). However, past literature has not thoroughly studied environmental dependency and its influence on household vulnerability. This could hinder the provision of a more accurate representation of environmental dependency, potentially limiting our understanding of the true impact of environmental changes on rural household vulnerability. Consequently, this gap in the literature may impede the development of effective policies to mitigate these effects.

Moreover, although (Mao et al., 2020; Shan & Ahmed, 2020; Lorato, 2019) have conducted some analysis on the determinants of rural livelihood strategies, there is a compelling need for more in-depth examination to gain a comprehensive understanding of the relationship with household vulnerability of these strategies, particularly those related with environment and nature. This entails a thorough investigation into the social, economic, and environmental factors that shape the decisions and choices of rural households and communities. Such a nuanced analysis is crucial for developing a holistic perspective on the intricate dynamics that influence policy and decision making.

In summary, the absence of a comprehensive understanding of environmental

dependency and the household vulnerability determinants presents a substantial challenge to sustainable development and poverty reduction efforts in numerous rural areas. Further, there is a very limited studies that have assessed the transition of households to new state from old state of vulnerability. The panel structure of the dateset allows this study to assess the time-varying vulnerability transition from one state to another and assess how have the factors played role in the transience and persistence. It is imperative to address these knowledge gaps to formulate effective policies and interventions that can support rural communities and enhance their resilience in response to environmental changes. This proactive approach is essential for fostering sustainable development and improving the well-being of rural populations.

1.3 Research Questions

The research question centers around the necessity for a more comprehensive understanding of the vulnerability of impoverished rural households and the factors influencing it. Notably, there is a gap in the assessment of household vulnerability based on the various components that contribute to the household's vulnerability, restricting a nuanced comprehension of the actual impact of the factors. Further, there is a gap of studies which studies the vulnerability positions of the households relative to the earlier positions. Moreover, a deeper analysis is warranted to scrutinize the social, economic, and environmental factors shaping the decisions of rural households and communities. Addressing these knowledge gaps is pivotal for developing policies and interventions that foster the resilience of rural communities in the face of environmental change, thereby supporting sustainable development and poverty reduction efforts in rural areas.

Research Questions:

(i) What are the differences in household vulnerability across households in rural Nepal?

(ii) What are the factors that play a role in determining the vulnerability of rural households Nepal?

1.4 Objectives of the Study

General Objectives

The study aims to assess the household vulnerability and its determinants of the households in rural Nepal. To achieve the objective, two broad objectives has been set:

(i) Provide an overview of rural household vulnerability across households.

(ii) Determine the factors that affect the household vulnerability with a focus on rural household's reliance on environmental resources.

Specific Objectives

To achieve the broad objective, two specific objective has been set:

(i) Compare the extent of rural household vulnerability within and across the households in selected villages from rural Nepal. Analyze the differences in the degree of vulnerability among these strategies.

(ii) Identify and analyze the primary determinants influencing the rural household vulnerability in Nepal, with a particular emphasis on the environmental reliance.

1.5 Significance of the Study

In the realm of environmental dependency across household strategy categories, the agricultural environment-based strategy group demonstrates the highest levels for both poverty incidence and environmental dependency, as noted by Walelign (2016). Despite this, there is a notable dearth of research on how this dependence could be a factor that contribute to vulnerability in rural communities within the context of Nepal. Furthermore, no study has specifically addressed the relationship between the household vulnerability and environmental dependence. The present study capitalizes on the panel characterstics of the dataset. By utilizing established econometric tools, this thesis aims to fulfill its objectives. The findings of this study are anticipated to provide insights into the household vulnerability and environmental

reliance in Nepal's rural communities. This information holds significance for policymakers as they assess which strategy policies to prioritize in efforts to enhance the well-being of rural communities.

1.6 Scope and Limitations of the Study

Scope:

This study aims to examine the determinants of rural household vulnerability based on various assets of the hosueholds in the Chitwan (lowlands), Kaski (mid-hills), and Mustang (mountains) of Nepal. The study will use a 3-wave panel data set collected in 2006, 2009, and 2012, and will analyze the relationships between household demographics, assets, income, and their impact on rural household vulnerability. The study will focus on the following research questions:

(i) What are the different assets that households in the study area have at their disposal?

(ii) How do households vary in terms of their vulnerability relative to their counterparts?

(iii) What are the key determinants of household vulnerability?

(iv) How do these determinants vary across different regions and over time?

This study aims at assessing the household vulnerability and environmental dependence of the rural households in Nepal.

Limitations:

(i) The study is limited to three districts in Nepal and may not be representative of other regions or countries.

(ii) The analysis will rely on secondary data.

(iii) The study will focus on a limited set of variables and may and may leave out consideration of other equally important factors that affect the household vulnerability.

1.7 Organizations of the Study

The following chapter provides an overview of the literature, encompassing theoretical and empirical reviews and addressing the existing research gaps. Moving on to Chapter 3, the research plan is delved into, encompassing aspects such as research design, philosophical considerations, variable operationalization, conceptual framework, empirical model, and data sources. Likewise, Chapter Four is dedicated to the presentation of data analysis and subsequent discussions. Concluding the report, the final chapter outlines the conclusions drawn, recommendations, and potential avenues for future extensions.

CHAPTER II
REVIEW OF LITERATURE

This chapter reviews empirical and theoretical literature, encompassing theoretical issues and empirical evidence. The scientific literature available in credible sources and references is examined. Such as the Journals and Google Scholar.

2.1 Theoritical Review

The main economic theory to study the sustainable livelihoods was developed by Robert Chambers and Gordon Conway in mid 1980s. Chambers & Conway (1992) contends that a sustainable livelihood is one that can withstand stress and shock, maintain or improve its assets and capabilities, and create opportunities for future generations to live sustainably. It also generates benefits for other livelihoods both locally and globally as well as over the long term. The author created the Sustainable Livelihood Approach (SLA) for the purpose of evaluating various vulnerability contexts to improve the effectiveness of development cooperation.

Based on the Sustainable Livelihood Approach (SLA), the Sustainable Livelihood Framework (SLF) was proposed with a particular emphasis on the institutional processes which mediate the ability to carry out combination of livelihood strategies with the given livelihood resources in a particular context to achieve an outcome. Some of the well-known livelihood frameworks are those proposed by Department of International Department DfID (1999), Ellis (1999) and Scoones (2013).

DfID defines livelihoods broadly and systematically, considering the various assets that individuals or communities can draw upon for sustainable living. It emphasizes the inter-linkage of various capitals (Human, Social, Financial, Physical, and Natural Capital) the households possess with the livelihood outcomes. The framework provides a holistic viewpoint by taking into consideration the dynamic exchange of the capitals and how they influence the result of livelihood.

Ellis builds on the DFID model by introducing the idea of vulnerability and emphasizes the importance of understanding the factors that makes certain people or groups more vulnerable to shocks and stresses. The author highlights the significance of understanding the elements that make people or communities more vulnerable to shocks and pressures and presents the idea of vulnerability as a major predictor of

livelihood strategies and results.

Scoones contributed to SLF issue by emphasizing the importance of social relations and political economy in determining the livelihoods. The author's work highlights the need for critical analysis of social relations and political context and how they impact the household's ability to secure more sustainable livelihoods. The framework stress the need for a comprehensive understanding of livelihoods, taking into consideration not only the assets and vulnerability but also the the social, economic and political dimension.

In a nutshell, DFID framework provides a comprehensive overview of various capitals that impact livelihoods. It acknowledges the concept of vulnerability but doesn't make it a central focus. Also, it does not explicitly delve into social and political dimension of livelihoods. Ellis on the other side of the spectrum, introduces the concept of vulnerability and places a strong emphasis on understanding the elements that increase the likelihood of failure. The framework includes some consideration of political and institutional factors but is centered more on vulnerability. Scoone highlights the critical role of political economy and power structures in shaping the livelihoods. Each framework brings unique perspectives to the understanding of sustainable livelihoods, with varying levels of focus on capitals, vulnerability, political economy, and power dynamics.

2.2 Household Vulnerability

Vulnerability is a concept that is applied in various disciplines, including engineering, ecology, economics, psychology and sociology (Fang et al., 2016). Vulnerability refers to a state in which a person feels insecure when something harmful occurs. "Vulnerable" refers to something that is likely to be harmed or wounded in everyday language. The term "Vulnerable", which means "wound", is dervied from the Latin word "vulnerare," (Calvo & Dercon, 2005). On a similar note, Chambers (1989) states that vulnerability "refers to exposure to contingencies and stress, which is defenselessness, meaning a lack of means to cope without damaging loss".

The concept of household vulnerability is both controversial and multifaceted Zhang et al. (2020). So, household vulnerability analysis requires identification of not only the threat, but also the 'resilience', or responsiveness, in exploiting

opportunities, and in resisting, or recovering from, the negative consequences of a changing environment (Moser, 1998). In this perspective, Bernier & Meinzen-Dick (2014) defines the resilience as the ability of a person, household, community, or system to adapt over time to shocks and proactively lower the risk of future shocks is what we refer to as resilience; these efforts promote growth and development as opposed to stability.

Many scholars conceptualise resilience as capacities that are driven by a set of capitals to produce outcomes such as influencing preparedness, mitigating impacts, and enhancing recovery against some risks. Gaisie et al. (2021) reveals complex relationship between household capitals and disaster outcomes in Ghana. The study finds that household capitals indicating higher economic status were linked to worse impacts from flooding but were essential for facilitating household recovery over time. Zhang et al. (2020) in the similar study conducted in China suggests that all forms of capital (financial, human, natural, physical, and social capital) of a household were important determinants of household vulnerability. The term "resilience" and "vulnerability" has been used in the literature as antonyms of one another. The basic concept is that the more resilient a system, the less vulnerable it is.

Fang et al. (2016), by constructing a composite vulnerability index, assessed the household vulnerability of the households in Shigatze Prefecture in Tibet Autonomous Region (TAR) in China. The index has been constructed by taking into account the factors such as food variability, literacy rate of labor force, cash income and expenditure, precipitation vulnerability and drought area. The study finds that the factors under consideration reflects the close relationship between the basic requirement of th rural households in te harsh plataeu environment, less developed regions and vulnerability.

Antwi-Agyei et al. (2013) assessed the vulnerability to drought across six communities in Ghana. The study reveals varying vulnerability degrees influenced by socioeconomic factors. Authors find that less vulnerable households depict the resilience through alternative livelihoods and social connections. On a similar study, Rahman et al. (2023) quantifies cyclone vulnerability in rural Bangladesh, emphasizing the multidimensional nature of vulnerability encompassing social, economic, physical, institutional, environmental, and attitudinal factors. The research, focus-

ing on Kalmegha and Patharghata regions, reveals distinct vulnerability patterns, particularly in environmental and composite aspects. Notenbaert et al. (2013) constructed the household vulnerability index and explores the vulnerability and coping capacity related to current variability conditions with focus on the adaptive capacity of the households. The study suggests that distance to paved road, income diversification and savings of the households significantly influences the household vulnerability.

2.3 Review of National Studies

Numerous studies have been conducted with respect to the assessment of vulnerability across Nepal. The following study uses the country-level data to investigate the vulnerability. Aksha et al. (2019) investigated the social vulnerability in Nepal by adapting Social Vulnerability Index (SoVI) methods to Nepalese context using the full data set of 2011 census provided by the Central Bureau of Statistics (CBS). The study employs the Principal Component Analysis (PCA) to generate the independent set of factors to calculate the SoVI score. The SoVI for Nepal was calculated for each spatial unit (3918 village development committee and 53 municipalities). The components used in the study are Renters and Occupation, Poverty and Poor Infrastructure, Favorable social conditions, Migration and gender, Ethnicity, Medical services, Education. The study finds that social vulnerability is particularly high in areas that have concentrations of Dalit and Minority populations.

Shahi & Shreezal (2020) estimates the vulnerability score for Nepal using a three-stage feasible generalized least square technique to assess the vulnerability to poverty. Using the third round of Nepal Living Standard Survey data , the study's finding reveals that the overall vulnerability of Nepal is 33 percent implying that they have the probability of falling into poverty for household-level shocks. The shocks include death, illness, unemployment and other idiosyncratic shocks. Vulnerability Score is invariably high for minority population. The authors find that Karnali and Sudurpaschhim have a higher proportion of highly vulnerable households.

On a household level, Bista (2019) examines the relationship between the magnitude of climate variability and household vulnerability in the catchment areas of Sot Khola sub water basin in the western mountainous Surkhet, Nepal. The author

constructs theoritical climate vulnerability index based on household level data collected from 642 Household covering adaptive, sensitive and exposure. The findings reveal that majority 52.7% households are sensitive to Climate induced disasters: landslide and flood due to their socio-economic status and food insufficiency. The study suggest finds that in total, 67 percent household is vulnerable at different level from moderate to extremely higher vulnerable. The remaining (33 percent) is least vulnerable.

Another household survey study by Mainali & Pricope (2019) employs a mixed-method approach, utilizing the Livelihood Vulnerability Index (LVI) at the community level. By integrating data from over 900 household surveys and national-level databases, the authors map the climate vulnerability of ten drought-prone villages in the central-east mid-hill region of Nepal. The findings reveal significant spatial variation in vulnerability, even within the lowest administrative units. Livelihood strategies, water availability, and topographic factors were among the key determinants of vulnerability, with strong interconnections among these components.

A study by Gerlitz et al. (2017) based on Hindu Kush Himalayas (HKH) collects data from 2311 households from six districts (Khotang, Udaypur, Siraha, Dolakha, Sunsari, Kavrepalanchok) in Koshi sub-basin in Nepal and computes the Multidimensional Livelihood Index (MLVI). The MLVI was constructed using AF method (Alkire & Foster, 2011). Several variables as an indicator of Adaptive capacity, Sensitivity and Exposure has been employed to form a composite MLVI. The author finds, among the six districts, Khotang showed the highest multidimensional livelihood vulnerability with 96% of the population were multidimensionally vulnerable to change and on average vulnerable in regard to 52% of the 25 vulnerability indicators, resulting in an index value of 0.50. Udayapur district showed the highest absolute contribution of lack of adaptive capacity to livelihood vulnerability 0.16.

2.4 Research Gap

Theoretical literature suggests that household vulnerability is influenced by a variety of factors, including income, assets, idiosyncratic and co-variate shocks. However, there has been limited research conducted in Nepal that has examined this issue using both cross-sectional and panel datasets.

Several studies in Nepal have examined the household vulnerability on a national level by employing census data from Central Bureau of Statistics (CBS). Aksha et al. (2019); Shahi & Shreezal (2020) are the studies done on a national level. Household level analysis also have been done employing household surveys. Bista (2019); Mainali & Pricope (2019); Gerlitz et al. (2017) carried out the vulnerability analysis using cross-sectional surveys. Household vulnerability analysis in Nepal's rural areas play a pivotal role in understanding the socio-economic dynamics of the population, particularly in the face of various shocks and stressors. However, it is essential comprehending the inter-temporal dynamics of vulnerability. This gap is particularly pronounced in the context of rural households across the diverse physiographic regions of Nepal.

Existing studies on household vulnerability in Nepal predominantly rely on cross-sectional data, providing a snapshot of vulnerability at a specific point in time. The temporal dimension is crucial in unraveling the nuanced changes in vulnerability over time. A dearth of studies employing panel data sets hinders our ability to capture the trajectory of vulnerability and identify patterns of persistence. Employing panel data sets is imperative to unravel the inter-temporal dynamics of household vulnerability. Such datasets allow for the tracking of individual households over time, enabling researchers to discern patterns of vulnerability persistence, identify key determinants, and assess the effectiveness of interventions.

Nepal's diverse physio-graphic regions contribute to significant variations in socioeconomic and environmental conditions. Yet, a substantial literature gap exists in incorporating a comprehensive geographic perspective into household vulnerability analysis. The absence of studies encompassing survey data from rural households across different physio-graphic regions impedes our understanding of regional disparities and specific vulnerabilities unique to each area. The physio-graphic diversity in Nepal implies that vulnerabilities and coping mechanisms may differ across regions. A comprehensive understanding of household vulnerability necessitates survey data from rural households in each physio-graphic region. This approach would unveil region-specific challenges, enabling targeted policy recommendations.

In conclusion, addressing the identified literature gap requires a twofold approach: the utilization of panel data sets to capture the inter-temporal dynamics

of household vulnerability and the collection of survey data from rural households in the diverse physio-graphic regions of Nepal. Bridging these gaps is crucial for advancing our understanding of household vulnerability, informing evidence-based policies, and ultimately enhancing the resilience of rural communities in Nepal.

CHAPTER III
RESEARCH METHODOLOGY

This section discusses the theoretical and conceptual framework of the study. Sustainable rural livelihood framework proposed by DfID (1999) and Household Vulnerability assessment framework approach is used to examine the Household vulnerability. The following sections describes the sample design, conceptual frame work , sources of data and techniques for data analysis.

3.1 Philosophical Issues

This study adopts a research paradigm influenced by radical structuralism, which assumes that household vulnerability and coping capacity is objectively determined by factors such as Social Asset, Human Asset, Natural Asset, Financial Asset, and Physical Asset. The ontological position of this study is objectivism, as it aims to produce objective and value-free knowledge about reality as a part of economics research. The epistemological position is positivism, as it relies on empirical methods and data to develop and test theories of Household Vulnerability. The axiological position is value-free, as the researcher endeavors to not be influenced by or influence the subject or results of the study. The philosophical tradition that guides this study is the Neo-classical framework.

3.2 Research Design

The research is based on descriptive and analytical research design. The objective of the research is to assess the household-level vulnerability and coping capacity. The variables related to Social Asset, Human Asset, Natural Asset, Financial Asset, and Physical Asset were included at the time of Household-level vulnerability index. The variables are: Household head age, Hosuehold head educational attainment, Highest educational attainment of the household, Number of male adults, Number of childrens, Number of female adults, Number of Elders, Debt of the household, Land owned by the household, Saving of the household, Jewellery of the household. The index were then employed to assess the household's vulnerability and variability in relation to other households in the same village of the districts of concern.

3.3 Conceptual Framework

The conceptual framework for the first research objective is shown in figure 3.1 on the following page. In the figure, we present the sources of household vulnerability. Total of five components comprise of this conceptual framework. They are: Human

Capital; Physical Capital; Livelihood; Social Capital; Financial Capital. Using the variables, we construct the Household vulnerability index.

Similarly, figure 3.2 represents the conceptual framework for the second objective of the thesis. The figure shows that Household vulnerability as an dependent variable. Meanwhile, Environmental dependence is considered the main explanatory variable. We used both year control and time-invariant controls such as districts and VDCs.

3.3.1. Household Vulnerability Index

A household confronted with a difficult situation is at risk of potential future declines in welfare. Vulnerability, which is the probability of encountering future loss of welfare, typically takes into account the severity of anticipated losses. The level of vulnerability is influenced by both the nature of the risk and the household's capacity to address risk using the capitals they possess. Households face numerous uncertain events. A household is said to be vulnerable, if it doesn't have adequate resources or capitals, particularly when exposed to risky situations where the household needs to use the resources at their disposal. Those resources are capital or assets of the households. Having these resources not only helps the houeholds deal with uncertain events but also improve their livelihoods and lifestyles.

To identify the different levels of vulnerability amongst the households in rural households, we construct the Household Vulnerability Index. Taking into the capitals that households possess, we construct an aggregated index which helps to identify the vulnerable households within the community. The capitals we use to construct the index are: Human; Physical; Social; Financial; and livelihood strategies.

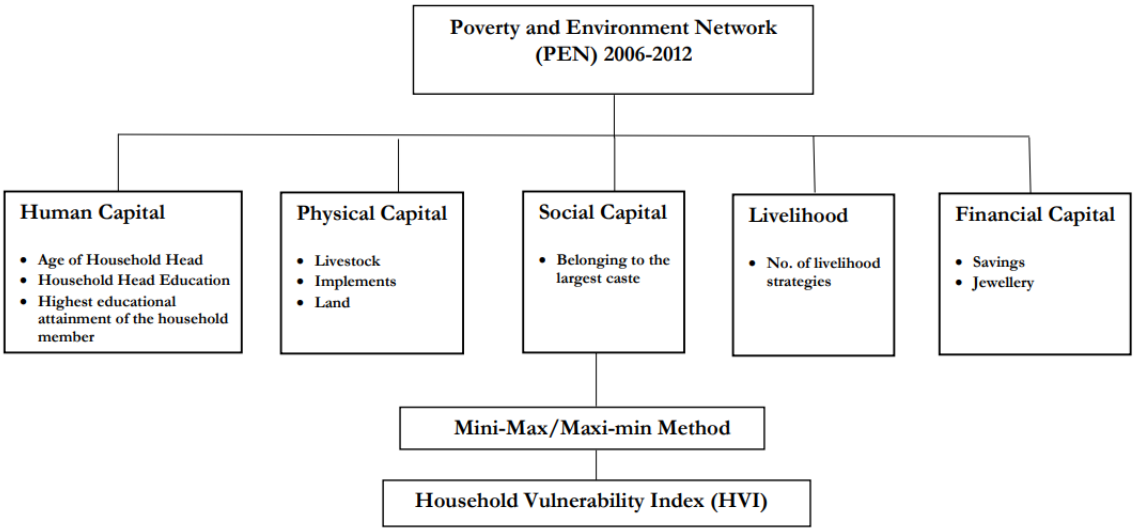

Figure 3.1: Schematic of objective one

3.3.2. Household Vulnerability and Environmental Dependence

After we construct the index and identify the most and least vulnerable, we attempt to understand the effects of the factors that weren't included in the index construction. These variables represent the liability to a household. Environmental income is a semi-capital/semi-liability characteristics variable. Because the income from the Environment is a predominant source of income for livelihoods of rural households, it can be a source of capital for those households who do not have adequate resources. But, on the other hand, it can also be a liability when depending solely on these sources. Particularly, in the context of climate change and environmental degradation, it can be a source of liability of households. So, we investigate the influence of Environmental dependence on the household vulnerability.

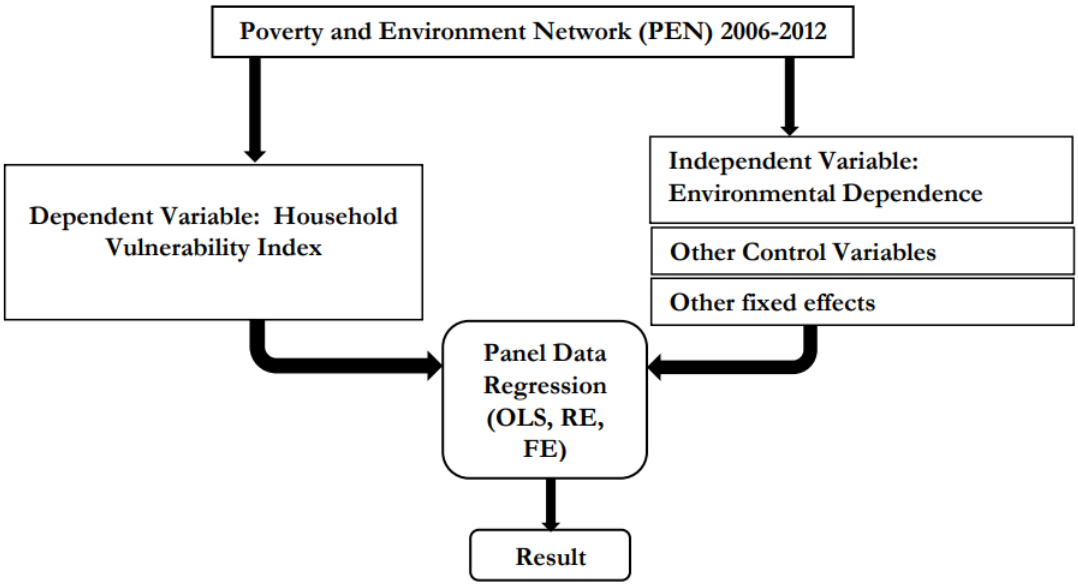

Figure 3.2: Schematic of objective two

3.4 Sources and Nature of the Data

The sources and nature of the data are explained in this section. Further, the operationalization of the is also discussed in this section.

This study employs the A unique environmental augmented household-level livelihood panel dateset (Walelign et al., 2022) from Nepal, Full Panel 2006-2012, produced by Tribhuvan University's Institute of Forestry and the University of Copenhagen's Department of Food and Resource Economics . It is a geographically representative survey spanning three main physio-graphic regions of Nepal. Data was collected in the districts of Chitwan (lowland), Kaski (mid-hills), and Mustang (mountains). Total of 507, 446 and 428 randomly sampled households were surveyed in the year 2006, 2009 and 2012 respectively. For the questionnaire see (Larsen et al., 2014).

The three primary physio-graphic regions of Nepal—the lowlands, mid-hills, and mountains—are covered by the study sites. The selection factors included the following: (i) Nepal's changes in elevation and vegetation; (ii) the environmental reliance of households; (iii) the attitudes of communities toward long-term research; and (iv) village accessibility and researcher safety (because of the ongoing civil conflict in Nepal at the time of site selection in 2005).

The data was collected through the Community Based Forest Management in the

Himalaya (ComForM) phases I - III collaborative project conducted by the Institute of Forestry (IOF) at Tribhuvan University and the Department of Food and Resource Economics (IFRO) at the University of Copenhagen, with support from the Department of Forest Research and Survey (DFRS) at the Ministry of Forests and Soil Conservation, Nepal. The questionnaire design was developed together with the Poverty Environment Network (PEN).

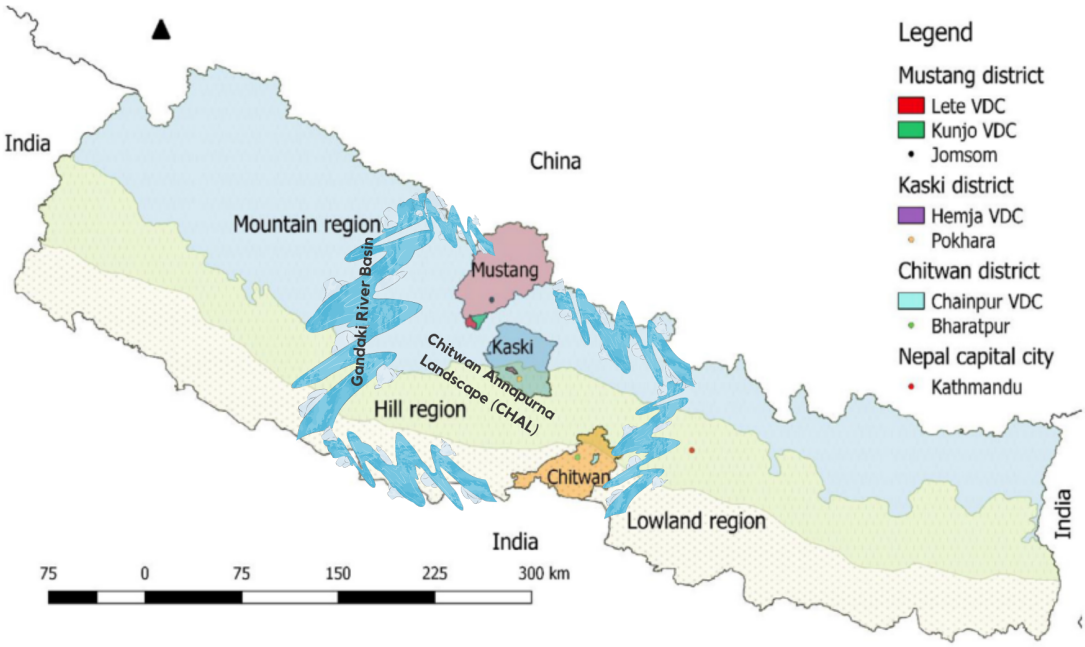

Figure 3.3: Map of the survey districts and VDCs

We construct the HVI as a barometer to evaluate the level of household vulnerability at the micro level. We constructed HVIs whose values are expressed on an interval scale of 0-1, where the value of 0 indicates that the household is at the minimum level of vulnerability (least vulnerable) and the value 1 indicates that the household is at the maximum vulnerability (most vulnerable). In order to construct the HVI, we first normalize the variables using the equations (3.5) and (3.6). The variables used are in Table 3.1. After the normalization, we grouped the variables into the group of capitals the variables belongs using equation (3.7). The we find the HVI for each household using (3.8).

Table 3.1: Definition of Variables used for HVI Construction

Variables	Construct
hhh_age	Household head age in years
hhh_edu	Education attainment of household head
max_hh_edu	Highest educational attainment by a household member
implements	Total value of implements such as: Car; Trucks; Motorbike; Plough etc. owned by the household in Rs.
livestock	Total value of livestock (of all types) in Rs.
land	Total area of land owned by the household in sq. m
hh_caste	Household belonging to the biggest caste in the village (=1)
bank_saving	Households savings kept in banks or other recognized financial institutions
jewellery	Households' saving in the form of non-productive assets, such as Jewellery.
n_livelihoods	Count of livelihoods of the households

Source: PEN Dataset

HVI is then considered the outcome variable in the model (3.9) whereas Environmental dependence, as measured by ratio of Environmental Income to Total income of the households, is the the independent variables. Using the model, we investigate the effect of the Environmental dependence on the Household vulnerability.

Table 3.2: Definition of Variables affecting HVI

Variables	Construct
env_dependence	Measured by the ratio of Environmental Income to Total income of the household
dependency_ratio	Measured by the ratio of dependent and working adult members of the household
debt	Debt of the household in Rs. household member
n_shocks	Count of the shocks experienced by the households

Source: PEN Dataset

3.5 Techniques of Data Analysis

Household vulnerability indicators were selected after thoroughly reviewing the available literature.All indicators and their descriptions and sources are summarized

in Table 3.1. The techniques of data analysis are elaborated upon in the following sections.

3.5.1. Household Vulnerability Index

To ensure the comparability of indicators that were used in the construction of the household vulnerability index, all indicators were standardised following the (UNDP, 2007) procedure of standardising indicators for life expectancy index. This ensures that all indicators were normalised to have a relative position between 0 and 1.
All variables with different scales are normalized with the following Min-Max standardization (Equations 3.5 and 3.6). Min-Max normalization helps to resize/rescale all variables analogously (i.e., into one scale). Here, all values are scaled between 0 and 1. Equation (3.5) applies to variables positively associated with vulnerability, while equation (3.6) applies to variables negatively associated with vulnerability. This method has been widely used in the literature related to vulnerability assessment. Fang et al. (2016); Antwi-Agyei et al. (2013); Karunarathne & Lee (2020); Huynh & Stringer (2018); Dumenu & Takam Tiamgne (2020) are some of the literature that have employed mini-max/maxi-min normalization technique to construct the vulnerability index.

When the variable has upward functional relationship with vulnerability, normalization was done using (3.5) and when the variable has downward functional relationship with vulnerability, normalization was done using equation (3.6):

$$\mathrm{X_{ij}} = \frac{X_{\mathrm{i}} - X_{\mathrm{Minj}}}{X_{\mathrm{Maxj}} - X_{\mathrm{Minj}}} \tag{3.5}$$

$$\mathrm{X_{ij}} = \frac{X_{\mathrm{Maxj}} - X_{\mathrm{i}}}{X_{\mathrm{Maxj}} - X_{\mathrm{Minj}}} \tag{3.6}$$

where X is the observed value of the variable related to household i in district j, and Xmax and Xmin are maximum and minimum values of each variable, respectively. After normalizing all variables, we used equation (3.7) to calculate the final

normalized index for each key component.

$$\mathrm{HVI_{Cij}} = \frac{1}{n}\sum_{i=1}^{n} \mathrm{X_{ij}} \tag{3.7}$$

where $\mathrm{HVI_{Cij}}$ is one of the five key components for HH. The main elements include human capital (C1), physical capital (C2), social capital (C3), livelihood (C4) and financial capital (C5). $\mathrm{index_{Hvi}}$ depicts the variables of the key component indexed by C for i household in j district (while n represents the number of variables for each component). We used equation (3.8) to calculate the overall Hvi for the HH.

$$\mathrm{HVI_{ij}} = \sum_{i=1}^{n} \mathrm{HVI_{Cij}} \tag{3.8}$$

where HVI is the Multi-facet Composite Household Vulnerability Index for HH x. C represents the numbers of key components, indicates the weighting schemes used for the composite index, and n ensures the number of key components. Table 3 illustrates the weighting schemes used for the composite index calculated.

3.5.2. Household Vulnerability and Environmental Dependence

To examine the effect of Environmental dependence on Household vulnerability, this study employs panel estimation techniques, including pooled-OLS, fixed effects (FE), and random effects (RE) models. While simple pooled-OLS doesn't account for the time-specific or hosuehold-specific effects, the fixed effects and random effects models are designed to address such endogenity issues. Pooled-OLS is essentially a statistical regression analysis method that visually represents the relationship between data points and determines the best-fit line for a dataset. However, the fixed effects model is theoretically more suitable for cases involving unobservable individual or household effects that may be correlated with the variables included in the model. Conversely, if individual effects are strictly uncorrelated with explanatory variables, the random effects model is a preferable choice (Hsiao, 2022). Effect of Environmental dependence on household vulnerability is modeled using following regression,

$$HVI_{i,t} = \beta_0 + \delta \mathbf{ED}_{i,t} + \mathbf{X}_{i,t}\beta + \mathbf{Z}_i\lambda + \mathbf{T}_t\delta_t + \boldsymbol{\epsilon} \tag{3.9}$$

where, *HVIi,t* is Household Vulnerability of i^{th} household in t year, *EDi,t* is Environmental dependence, T is year control variable, *Xi,t* is the variables controlled for, which includes Dependency ratio, log of debt, count of shock experienced and *Zi,t* represents control for time invariant fixed effect such as district and VDCs and $\beta_0, \delta, \beta, \lambda, \delta_t$ are the parameter of the model.

3.5.3. Diagnostic Tests

For each techniques of the Panel data analysis, we'll run few diagnostic tests to check for the effects to be included in the model such as Individual and Time effects. Also, we run the efficiency test for choosing between the models.

3.5.3.1 Individual Effects Test

We run the Pooled Ordinary Least Squares (OLS) regression model without considering individual effects. After obtaining the results from Pooled OLS regression, we conduct F-test to determine if there are significant individual effects (fixed effects) present in the model. We'll refer to the F-statistic and associated P-value to determine the presence of significant individual effects. A low p-value suggests the presence of significant individual effects.

3.5.3.2 Time Fixed Effects Test

We also test for if there are time effects in the model. For this, we run the Pooled Ordinary Least Squares (OLS) regression model without considering individual effects. After obtaining the results from Pooled OLS regression, we conduct the Lagrange Multiplier Test - Honda (1988). It will allow us to determine if there are significant time effects (fixed effects) present in the model. We'll refer to the t-statistic and associated P-value to determine the presence of significant individual effects. A low p-value suggests the presence of significant time effects.

3.5.3.3 Breusch-Pagan Lagrange Multiplier (BPLM) Test

This test is commonly referred to as Pool-ability test conducted for confirming if the cross-sectional unit in the panel has the same intercept or a different intercept. Breusch & Pagan (1980) assesses the pool-ability of the data after incorporating the time and individual fixed effects. We'll analyze the test-statistic and associated p-value. A low p-value suggests that the data is not poolable, indicating the inadequacy of Pooled OLS regression. We'll go for Random effects (RE) regression if the p-value is low.

3.5.3.4 Hausman Specification Test

If the BP-LM test suggests that the data is not pool-able and suggests to go for Random Effects (RE) model, we'll run the RE regression. We'll also run the Fixed effects (FE) model to compare the result. After running both Random Effects (RE) and Fixed Effects (FE) models, conduct the Hausman Specification test Hausman (1978) to determine the efficient model. The test is to check whether the coefficients estimated by the two models are significantly different. We'll analyze the test statistic, typically a chi-square value, and assesses the associated p-value.

CHAPTER IV
RESULTS AND DISCUSSION

This chapter shows the results obtained by using the methodology described in the previous section. It also provides evidence and explanation of affecting factors of Household Vulnerability index and how the components contribute to the household vulnerability across the years.

4.1 Descriptive Analysis

This study employed A unique environmental augmented household-level livelihood panel dataset from Nepal for the years 2006, 20009, and 2012. The sample encompasses 428 households from the districts: Chitwan; Kaski; and Mustang, across the survey years 2006-2012 respectively.The study uses household characteristics and other information from the survey, which is more suitable for calculating the household vulnerability of the surveyed households. Table 4.1 presents various variables used for constructing the households vulnerability index district-wise. Appendix Table 1 presents the VDC-level variables.

In the year 2006, the Household Vulnerability Index (HVI) ranged from 0.61 to 0.65 across the survey districts. By 2012, minimal changes were observed, with certain VDCs in the study districts experiencing a improvement. For instance, Chainpur VDC in Chitwan improved its vulnerability position from 0.62 in 2006 to 0.61 in 2009 but remained stagnant at 0.61 in 2012. Similarly, Kunjo VDC in Mustang district reduced its vulnerability from 0.65 in 2006 to 0.64 in 2009, but remained stagnant at 0.64 in 2012. Lete VDC in Mustang district exhibited no change in vulnerability from 2006 to 2009 but saw a decrease from 0.63 in 2006 to 0.62 in 2012. Conversely, Hemja VDC in Kaski district maintained the same vulnerability position over the six-year span. The observed phenomenon of households improving little to not improving its positions aligns with the findings of Acharya (2008) that households in rural areas face significant vulnerability.

Table 4.1: Variables used to construct the Vulnerability Index

Year	**2006**			**2009**			**2012**		
District	**Chitwan**	**Kaski**	**Mustang**	**Chitwan**	**Kaski**	**Mustang**	**Chitwan**	**Kaski**	**Mustang**
Human Capital									
hhh_age	50.36	50.14	52.89	52.13	52.00	54.12	52.24	53.52	55.24
	(14.15)	(14.57)	(13.52)	(13.75)	(13.39)	(13.78)	(17.20)	(13.71)	(14.17)
hhh_edu	3.08	6.29	3.05	2.93	6.07	2.94	2.91	6.91	2.90
	(4.06)	(4.97)	(3.98)	(4.06)	(5.23)	(3.78)	(4.33)	(5.07)	(4.08)
max_hh_edu	8.44	10.76	7.64	9.70	11.18	8.04	9.89	11.91	8.22
	(3.91)	(2.90)	(3.32)	(3.63)	(3.94)	(3.93)	(4.44)	(4.03)	(3.87)
Physical Capital									
implements	4660.32	14057.03	10360.32	10153.80	30700.04	15135.16	22165.29	48959.03	21466.58
	(11275.51)	(16860.40)	(19629.35)	(23970.96)	(46128.42)	(25508.99)	(38089.26)	(70582.61)	(27566.06)
livestock	18532.68	26573.08	80387.77	43936.83	35690.11	56165.26	38993.71	34635.85	34114.52
	(15428.31)	(20411.58)	(224589.10)	(39679.86)	(35760.04)	(178639.73)	(34330.39)	(39306.64)	(39335.73)
land	2027.47	1187.00	2940.39	915.91	1491.41	2235.09	1041.46	1374.96	1921.22
	(6367.27)	(1013.02)	(2789.36)	(765.38)	(2060.26)	(3738.40)	(1136.88)	(2253.95)	(1892.77)
Social Capital									
hh_caste	0.58	0.89	0.49	0.66	0.98	0.58	0.50	0.86	0.59
	(0.50)	(0.32)	(0.50)	(0.48)	(0.14)	(0.50)	(0.50)	(0.50)	(0.42)
Financial Capital									
bank_saving	879.58	9663.83	31897.65	1911.63	11937.72	24536.06	11953.55	25410.64	48051.24
	(2661.50)	(26812.59)	(79933.66)	(6126.69)	(31025.90)	(59338.85)	(31763.88)	(66932.36)	(104495.00)
jewellery	0.00	0.00	31662.91	4396.88	20485.87	38598.35	21477.20	51605.95	54132.35
	(0.00)	(0.00)	(67846.57)	(6965.54)	(16594.27)	(79440.96)	(23620.48)	(48463.66)	(112328.06)
Livelihood									
n_livelihoods	4.81	4.72	4.56	4.93	4.74	5.11	4.60	4.78	4.60
	(0.97)	(0.91)	(0.93)	(1.02)	(0.91)	(0.84)	(0.98)	(0.90)	(0.98)
Household Vulnerability									
HVI	0.62	0.62	0.64	0.61	0.62	0.63	0.61	0.62	0.63
	(0.05)	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)

Note:SD in the parenthesis
Source: Author's Calculation

4.1.1 Human Capital

Household Head Age, Education and Maximum educational attainment by the household member were taken as the Human Capital of the households. Household head age as a measure of experience and knowledge has been taken as a contributing factor in Human Capital of the households. The average age of the household head was 52 years in 2006, 53 in year 2009 and 54 in year 2012. This progression in the household head age positively affects human capital.

On household head education, Hemja VDC of Kaski district has made a jump of 6 to 7 mean years of schooling from 2006 to 2012. Similarly, Lete VDC of Mustang district has made a negligible progress of 3.25 to 3.3 mean years of schooling. Chainpur VDC of Chitwan district and Kunjo VDC of Mustang district has made negative progress. This mixed progression of household head educational attainment will have mixed effect on human capital.

All VDCs have made positive improvement in part of maximum educational attainment by the household members. Hemja VDC has the highest mean years of schooling of the household members. It has made a remarkable progress from 10 mean years of schooling to 12 from 2006 to 2012. Chainpur VDC also has followed the similar trajectory. It had mean of 8 years of schooling in 2006 and it improved to 10 by the end of 2012. Lete VDC had 8.14 mean years of schooling in the year 2006 which only slightly improved to 8.7 in the year 2012. Kunjo VDC has the least mean years of educational attainment by the household member with 7.1 years in 2006 to 7.72 in 2012. The improvement in the schooling years would affect the human capital positively.

4.1.2 Physical Capital

Chainpur VDC had the least implements in the year 2006 whereas Hemja had the highest level of implements in the same year. But, chainpur made remarkable progress by increasing its implements by 118% by the end of 2009 and exactly the same increase by the end of the year 2012. Hemja also experience the same rate of growth of implements in the year 2009 but the rate declined to 59% in the year 2012. Kunjo and Lete, both VDC of Mustang could improve its implements position in the year 2009 by 77% and 32% respectively. However, both VDC had a decline

in the growth of the implements in the last wave of the survey. Kunjo's increase of the implements was 69% and Lete's was only 25%.

In part of Livestock holdings, Lete VDC had the highest holding in the year 2006 whereas Chainpur had the least holding of the livestock. However, Chainpur managed to increase its livestock-holding by 137% at the end of year 2009. But Chainpur VDC's livestock holding declined by 11% by the end of 2012. Kunjo was the second place after Lete in the livestock holding in year 2006. But, its livestock-holding declined continuously in the following years 2009 and 2012 by 25% and 11% respectively. Lete VDC despite holding the most livestock in the year 2006 had a severe decline in its livestock holding placing itself as the least livestock-holding VDC by the end of year 2012. It experienced the decrease of 33% in the year 2009 and almost 60% in the year 2012.

Lete VDC had the highest land holding followed by Kunjo VDC in the year 2006. Kaski had the least land holdings in the same year. Chainpur then followed Kaski. In year 2009, Chainpur had a decline of 55% whereas Kunjo and Lete had a decline of 14% and 33% respectively. Hemja, however, increased its land-holding by 26% by the end of 2009. Chainpur, despite experiencing decrease in land-holding, managed to increase the land-holding by 14% by the end of 2012. In the same period, all 3 VDCs': Hemja; Kunjo; and Lete experienced decline in the land-holding by 8%, 13% and 15% respectively.

All of these fluctuations in the physical capital holding is going to alter the household vulnerability.

4.1.3 Social Capital

Following Alha (2018); Vanneman et al. (2006), the caste was considered as a social capital. Belonging to the largest caste improves the household's network within the community as well as across the community. Thus it helps the households to negate the effects of uncertain events. So, belonging to largest caste have a negative influence on the household vulnerability. In the year 2006 Hemja had the highest percentage of Household head i.e. 89% belonging to largest caste. Whereas Kunjo had the least percentage of the household heads belonging to the largest caste in the village. The trend followed with increase in the percentage of the household heads

belonging to the largest caste in the year 2009. Chainpur, Hemja, Kunjo and Lete had the percentage change of household heads belonging to largest caste increase by 13%, 10%, 19% and 17% respectively.

However, the percentage change declined by 23% and 48% for Chainpur and Hemja respectively in the year 2012. Kunjo and Lete, however experience an increase of the percentage of household heads belonging to caste by 65% and 8% in the year 2012 respectively.

4.1.4 Financial Capital

Bank savings and Jewellery are considered as the financial capitals. The financial capital play a huge part in the welfare of the households.

Lete VDC had the highest bank savings in the year 2006 and the trend continued until the final wave of the survey year 2012. It experienced decline of the saving in the year 2009 relative to 2006 by 11% but it managed to increase its saving by 114% by the end of 2012. Chainpur had a opposite experience than that of Lete. It had the least bank saving among all VDCs in the year 2006 and it persisted to have least of it in the final wave of the survey year 2012. However, it managed to increase its own saving by 117% in the year 2009 and 525% by the end of 2012.

Kunjo had a fairly fluctuating trend with respect to bank saving. It followed Lete to have the second highest possession of bank saving in the year 2006. Though it managed to maintain the position in terms of ranking it had a decline of 41% in the second of wave of survey year 2009. In the following wave of the survey it experienced an increase of savings by 54%. But, it fell below the previous ranking. Hemja had a moderate growth of its saving in the year 2009 of 24%. The rate leaped to 113% by the end of 2012.

The data for jewellery possession were not available for Chainpur and Hemja VDC for the year 2006. So comparing between Kunjo and Lete, Lete had the highest possession of jewellery. It continued to have the highest jewellery possession in the following wave of surveys. The rate of increase remained moderate of 13% and 22% in the year 2009 and 2012 respectively. Kunjo, on the other hand, have aggressively increased its jewellery possession by 45% in the year 2009 and 80% in the year 2012.

Data for jewellery possession were available for Chainpur and Hemja for 2009 and 2012. Chainpur had the least possession in the year 2009. But, it managed to increased its possession by 388% in the year 2012 which is the highest rate of increase among all VDCs. Nonetheless, it persisted in the VDC having the least possession of jewellery in the final wave of survey year 2012.

4.1.5 Livelihood Options

This includes the diversity of livelihood options that the households in the particular area in the particular period of time. The livelihood is considered a capital because having diversified income can raise household income, reduce risk, and improve their livelihoods (Scoones, 2013). All of the VDCs have a relatively similar livelihood counts. In the year 2006, the number of livelihood strategies that the households adopted ranged from 4.32 to 4.81. Kunjo had the least number of livelihood strategies while Chainpur had a relatively more number of strategies. The average number of livelihood strategies have increased in the year 2009. But, the rate of increase is fairly mild for Chainpur with only 2% increase and Hemja with only 0.4%. As for Kunjo, it had an increase of 11% in their livelihood counts. Lete had an increase of 12% in the year 2009. In the year 2012, all VDCs except for Hemja experienced downward sloping livelihood counts. Hemja observed a growth of 0.84% in livelihood strategies, while Chainpur, Kunjo, and Lete exhibited reduced growth rates of 7%, 11%, and 8%, respectively.

4.2 Environmental Dependence and Household Vulnerability

Table 4.2 presents the factors that are likely to affect Household vulnerability with central emphasis on Environmental dependence. The table consists of four critical variables which are assumed to affect the household vulnerability. The definition of the variables are in Table 3.2. The variables are: Environmental dependence; Dependency ratio; and Shock.

Table 4.2: Household Vulnerability and Environmental Dependence

Year		**2006**		
District	**Chitwan**	**Kaski**	**Mustang**	**Mustang**
VDC	**Chainpur**	**Hemja**	**Kunjo**	**Lete**
env_dependence	0.13	0.16	0.40	0.29
	(0.19)	(0.20)	(0.23)	(0.23)
dependency_ratio	0.66	0.73	0.88	0.69
	(0.62)	(0.76)	(0.85)	(0.63)
debt	12234.42	25896.24	17792.57	31217.37
	(19246.56)	(47371.72)	(19055.29)	(69576.58)
shock	1.75	0.55	2.48	1.97
	(1.66)	(1.07)	(1.24)	(1.2)
Year		**2009**		
env_dependence	0.14	0.13	0.19	0.21
	(0.23)	(0.15)	(0.30)	(0.59)
dependency_ratio	0.58	0.63	0.77	0.68
	(0.56)	(0.63)	(0.64)	(0.69)
debt	18249.69	46654.49	14887.21	20616.94
	(36642.37)	(72705.08)	(16156.9)	(41324.71)
shock	0.24	0.59	0.65	1.16
	(0.65)	(0.96)	(1.00)	(1.14)
Year		**2012**		
env_dependence	0.15	0.14	0.78	0.27
	(0.20)	(0.25)	(3.16)	(0.25)
dependency_ratio	0.51	0.53	0.77	0.49
	(0.60)	(0.57)	(0.82)	(0.56)
debt	37221.48	64572.68	24507.84	19864.55
	(87094.30)	(133587.15)	(33242.18)	(27238.68)
shock	0.77	0.31	0.35	0.24
	(1.01)	(0.66)	(0.72)	(0.59)

Note: Standard deviation in the parenthesis

Source: Author's Calculation

4.2.1 Environmental Dependence

From the table, Kunjo VDC had a highest dependence on environment for its livelihood in the year 2006 and 2012. Lete VDC followed Kunjo in the dependence on environment. Both of the VDC continued to persist on a higher level of environmental dependence across all waves of survey years. Kunjo and Lete VDC's dependency decreased in the year 2009 by 27% and 52% respectively. However, the dependency increased by a notably significant 78% for Kunjo and only 28% for Lete in the year 2012.

Chainpur had the least dependency on environment in the year 2006. Hemja had only slightly higher dependence on environment in the same year. Chainpur had a mild increase of 8% in dependency in the year 2009 whereas Hemja had a decline of 18% in the dependency. However, in the year 2012, both of the VDCs had similar mild rate of increase in dependence of 7% and 8% respectively.

Chainpur and Hemja VDC's environmental dependence in relatively lower in comparison to Kunjo and Lete. Kunjo, in particular had a relatively higher environmental dependence. This evident difference of environmental dependence in the physio-graphic regions implies that communities in the upper belt are more environmentally dependent. This tendency can be credited to the availability the livelihood options to these communities (Rayamajhi et al., 2012; Larsen et al., 2014). The environmental dependence is expected to contribute to household vulnerability positively.

4.2.2 Dependency Ratio

In the year 2006, the dependency ratio for Kunjo VDC is the highest and lowest for Chainpur. The dependency ratio has declined continuously in all of the VDCs across all 3 waves of the survey period. Only Kunjo VDC had a consistent level of dependency ratio in the year 2009 and 2012.The dependency ratio is expected to affect the household vulnerability positively.

4.2.3 Debt

Lete VDC is the highest indebted VDC in the year 2006 with average of Rs. 31,217.40 debt. However, the debt declined to Rs. 20,616.94 in the year 2009

and Rs. 19,864.55 in the year 2012. Chainpur VDC had the lowest debt in the year 2006. But, the debt increased to Rs. 18,249.69 in the year 2009 and Rs. 37,221.48 in the year 2012. Hemja also had its debt increase from Rs. 25,896.24 in year 2006 to Rs. 46,654.49 in year 2009 and to Rs. 64,572.68 in the year 2012. Kunjo, however had a mixed trend of indebtedness. It had a declining trend from the debt of Rs. 17,792.57 in the year 2006 to Rs.14,887.21 in the year 2009. But, the debt increased to Rs. 24,507.84 by the end of 2012.

Although being indebted is not a ideal position to be in rural setting, particularly when the household doesn't have regular flow of income to service the debt. However, households in rural setting resort to acquiring debts to stay away from the situation that could worsen the vulnerability. In the short run, the debt could reduce the vulnerability when exposed to shocks. In this regard, debt is expected to reduce the vulnerability of the household.

4.2.4 Shock

Shocks like Crop failure, Serious Illness, Death of an adult member of family, Land loss, Livestock loss, Other assets loss, Wage employment loss, Costly Social Events are included in the count of the shocks. This includes all forms of severity from less severe to more severe shock. When a shock occurs in the community or household, they lose their assets that might be in the form of saving or other form of assets which increases their vulnerability (Dercon, 2006).

Counting the number of shocks experienced by the household across the survey years, Kunjo VDC of Mustang district had experienced relatively higher number of shocks with an average of 2.48 as compared to its counterparts in the year 2006. Lete VDC of the same district followed it with the average of 1.97 number of shocks in the same year. Both of the VDCs had lower number of shocks in the following wave of survey in the year 2009. Kunjo had a significantly lower drop of 74% in the number of shock experienced. It only had an average of 0.65 in the year 2009. Lete also had an decrease of 41% in the number of shocks experienced in the year 2009. Both of the VDCs had a significant drop in the number of shocks experienced in the final wave of survey year 2012. Lete was the VDC with the least number of shocks experienced by the end of the year 2012.

Chainpur had a fairly fluctuating average of shocks experienced. Its count of shocks was 1.75, 0.24 and 0.77 in the respective waves of 2006, 2009 and 2012. It experienced a lower number of shocks in 2009 relative to 2006. However, the shocks increased in 2012 relative to 2009. But, the count is lower relative to 2006. Hemja had a different trend. The number of shocks increased to 0.59 from 0.55 from 2006 to 2009. Nonetheless, the number decreased to 2012.

The expected effect of shock on household vulnerability is positive. As the number of shock increases, the households become more vulnerable and vice-versa.

4.3 District and Village level Household Vulnerability

Table 4.3 presents data on the average household vulnerability Index for different districts across three distinct years: 2006, 2009, and 2012. The districts include Chitwan, Kaski, and Mustang.

In 2006, the mean HVI in Chitwan, Kaski, and Mustang were 0.61, 0.62, and 0.64, respectively. Similarly, in 2009, the mean HVI for the mentioned districts were 0.61, 0.61, and 0.63. The trend continues in 2012, with mean of 0.61, 0.62, and 0.63 for Chitwan, Kaski, and Mustang, respectively.

This allows for an analysis of the variability in the household vulnerability Index within each district across the specified years, providing insights into the distribution of household vulnerability levels over time.

Table 4.3: District level mean and SD HVI for all waves

Year/	**2006**			**2009**			**2012**		
District	**Chitwan**	**Kaski**	**Mustang**	**Chitwan**	**Kaski**	**Mustang**	**Chitwan**	**Kaski**	**Mustang**
HVI	0.61	0.62	0.64	0.61	0.61	0.63	0.61	0.62	0.63
	(0.05)	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)

Note: Standard deviation in the parenthesis
Source: Author's Calculation

Figure 4.1 is a radar chart, also known as a spider chart or web chart, is a graphical method of displaying multivariate data in the form of two-dimensional chart. In our analysis, the radar chart represents the District level mean HVI values across the 3-waves of survey from 2006-2012 with 3 years gap in each interval.

Each axis in the radar chart represents wave of survey (2006, 2009 and 2012). The data points on each axis correspond to the mean HVI values for the respective

districts (Chitwan, Kaski and Mustang). The lines connect the data points for each district, forming a polygon or shape in the chart. The area enclosed by the lines represents the range or variability of the mean HVI values for each district.

Chitwan district had a relatively stable vulnerability level across all waves of survey with mean HVI of 0.61. The polygon enclosed by the lines from the HVI data points indicates that the variability of HVI is consistent across the points.

Kaski district had a mildly variable HVI. In 2006 it had mean HVI of 0.62 which decreased to 0.61 transitioning to year 2009. Then again in the year 2012, the mean HVI increased back to its original level mean HVI of 2006. This exhibits a mild variability over the years for Kaski district.

Mustang district had mean HVI of 0.64 in the year 2006, indicating relatively higher household vulnerability in other survey districts. Moving to 2009 the HVI slightly decreased to 0.63. In 2012, the HVI remained stable completing the polygon with HVI of 0.63. This demonstrates the slight variability in the HVI in the first transition from 2006 to 2009. However, the polygon stabilized from 2009 to 2012 with a consistent HVI.

The examination of Chitwan's, Kaski's, and Mustang's polygons reveals distinct characteristics in variability. A stable polygon for Chitwan implies consistent mean HVI, while subtle shifts in Kaski's polygon suggest a potential decrease in variability. Mustang's polygon, displaying variability followed by stabilization, hints at fluctuations.

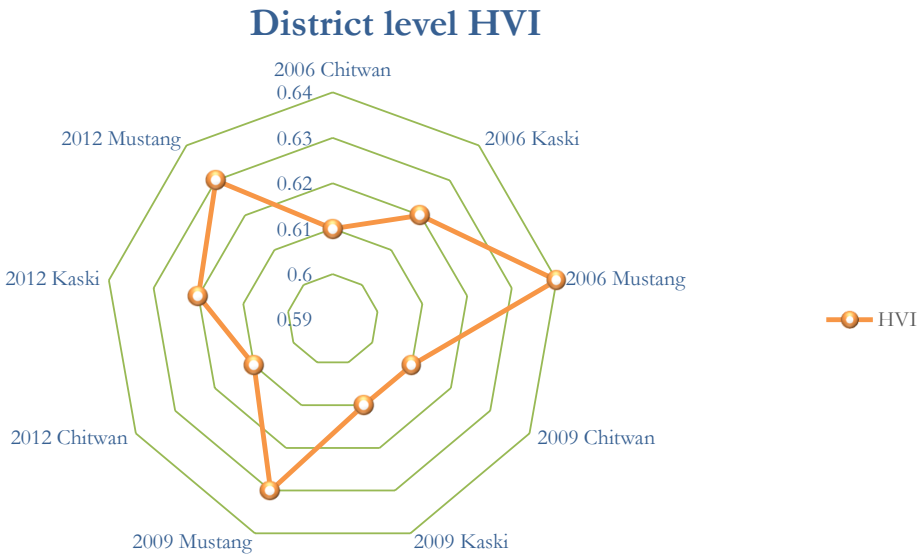

Figure 4.1: District level HVI for all waves

Table 4.4 represents household vulnerability Index (HVI) values for different Village Development Committees (VDC) across three districts (Chitwan, Kaski and MUstang) for three distinct years: 2006, 2009, and 2012. The VDCs within each district are Chainpur, Hemja, Kunjo, and Lete. The HVI values are provided for each combination of VDC and year.

Table 4.4: Village level mean and SD HVI for all waves

Year/	**2006**				**2009**				**2012**			
District	**Chainpur**	**Hemja**	**Kunjo**	**Lete**	**Chainpur**	**Hemja**	**Kunjo**	**Lete**	**Chainpur**	**Hemja**	**Kunjo**	**Lete**
HVI	0.61	0.62	0.65	0.63	0.61	0.61	0.64	0.63	0.61	0.62	0.63	0.61
	(0.05)	(0.04)	(0.04)	(0.05)	(0.05)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)

Note: Standard deviation in the parenthesis
Source: Author's Calculation

In 2006, the mean HVI in Chainpur, Hemja, Kunjo and Lete were 0.61, 0.62, 0.65 and 0.64, respectively. Similarly, in 2009, the mean HVI for the mentioned VDCs were 0.61, 0.61, 0.64 and 0.63. The trend continued in 2012, with mean HVI of 0.61, 0.62, 0.63 and 0.61 for the above-mentioned VDCs respectively.

We present the radar chart for the Village level mean HVI for all the VDCs

across the survey years.

The radar chart for Chainpur shows a polygon with points relatively close to each other, suggesting a stable pattern in HVI across the years. The HVI for the VDC has remained stable at 0.61 across all waves of survey. Similarly, Hemja's radar chart exhibit a slight variation with 0.01 decline in vulnerabiity from the year 2006 to 2009. Nevertheless, the vulnerability rose to the original level of 2006 in the year 2012. Both of the VDC's data points have remained relatively stable as compared to Kunjo and Lete.

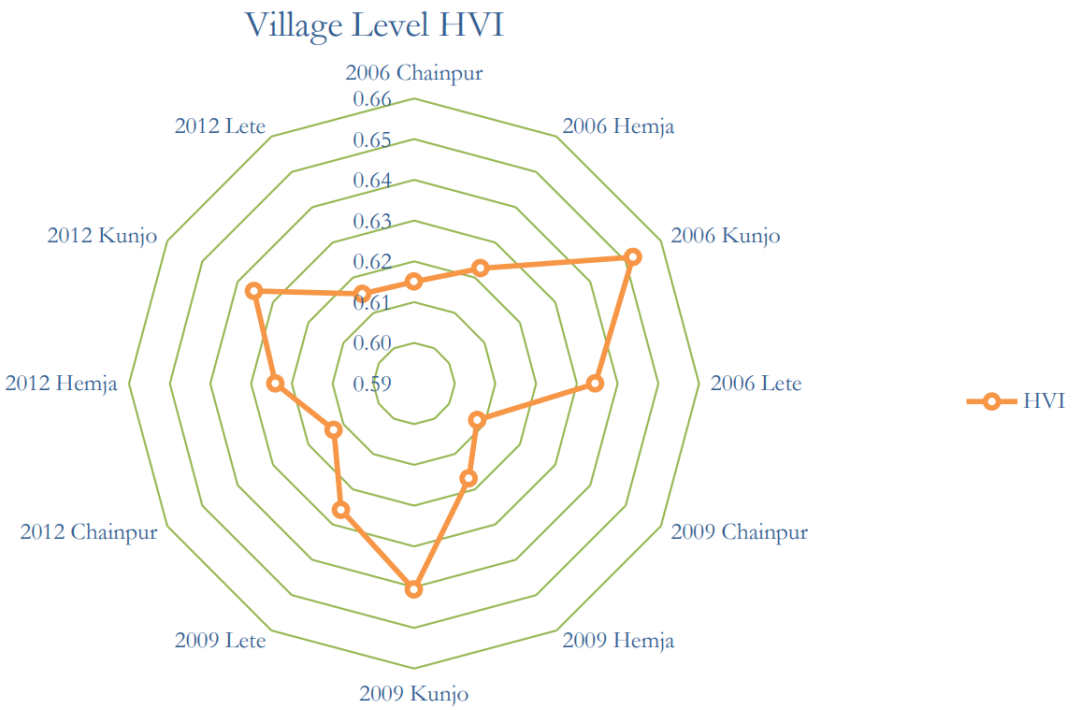

Figure 4.2: Village level HVI for all waves

Kunjo was the highest vulnerable VDC among all the VDC. Lete followed it in terms of the vulnerability. Kunjo had a consistently declining HVI forming a mildly varying polygon. The HVI declined by 0.01 in 2009 from 2006. The fall in HVI is by the same level of 0.01 in 2012 from 2009. The VDC had 0.65, 0.64 and 0.63 HVI in the year 2006, 2009 and 2012 respectively. This steady variation has formed a fluctuating polygon. Lete's HVI was 0.63 in the 2006 which remained consistent in the year 2009. However, it declined to 0.61 in the year 2012.

Table 4.5: Mean of the HVI components for Chainpur VDC, Chitwan

Year	Human Capital (C1)	Physical Capital (C2)	Social Capital (C3)	Livelihoods (C4)	Financial Capital (C5)
2006	0.63	0.98	0.68	0.31	0.99
2009	0.60	0.98	0.72	0.30	0.99
2012	0.60	0.97	0.63	0.34	0.98

Source: Author's Calculation

4.4 Components of the Household Vulnerability

4.4.1 Chainpur VDC, Chitwan

Table 4.5 represents Chainpur VDC data for different years (2006, 2009, 2012) and various components of vulnerability, categorized into five types of capital: Human Capital (C1), Physical Capital (C2), Social Capital (C3), Livelihoods (C4), and Financial Capital (C5). The variables used in each component is in the Table 3.1. The value for the capital has been derived from equation 3.7.

Fig 4.3 exhibits how each component has contributed to the vulnerability level of the households in Chainpur, Chitwan. Having higher Human capital reduces vulnerability. Human Capital is exhibited to have slight decrease from 0.63 in 2006 to 0.60 in 2009 and 2012 in Chainpur. This implies that the decline in the Human capital had a negative effect on household vulnerable. Physical capital remained relatively stable around 0.98 across all rounds of survey years, suggesting a consistent level of vulnerability related to physical assets. Social Capital is demonstrated to have some variation, increasing from 0.68 in 2006 to 0.72 in 2009 and then decline to 0.63 in the year 2012. This suggests that this variation could potentially have some effect on the overall vulnerability of the household. In the livelihood component, depicts a slight dip to 0.30 in the year 2009 fro 0.31 in the year 2006. However, livelihood component have increased to 0.34 in the year 2012. Financial capital have remained stable at around 0.99 across 2006 and 2009 and only slightly decreasing to 0.98 in the year 2012.

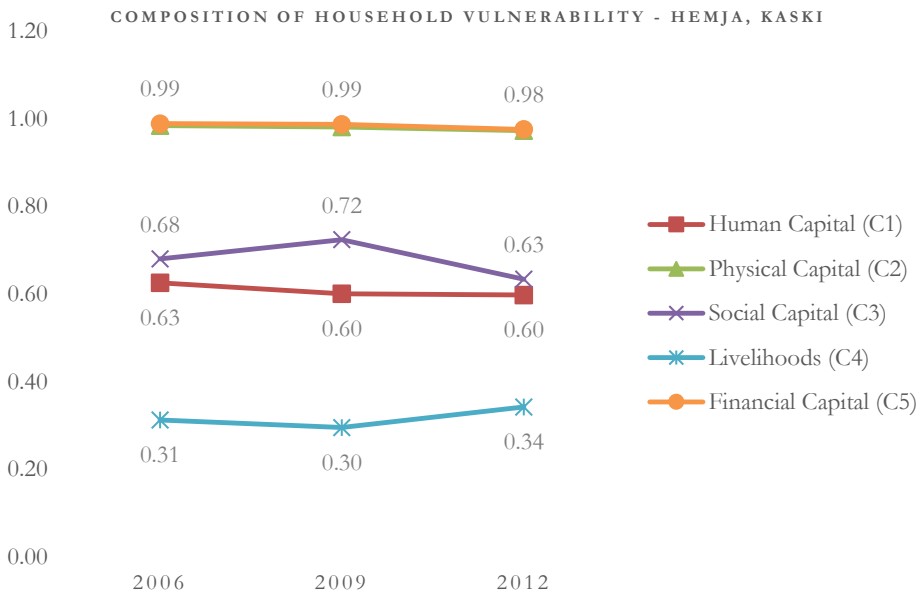

Figure 4.3: Component of HVI - Chainpur VDC, Chitwan

4.4.2 Hemja VDC, Kaski

Table 4.6 represents data for Hemja Village Development Committee (VDC) in Kaski district across the years 2006, 2009, and 2012.

Table 4.6: Mean of the HVI components for Hemja VDC, Kaski

Year	Human Capital (C1)	Physical Capital (C2)	Social Capital (C3)	Livelihoods (C4)	Financial Capital (C5)
2006	0.53	0.98	0.84	0.33	0.99
2009	0.52	0.97	0.87	0.32	0.98
2012	0.49	0.95	0.62	0.32	0.96

Source: Author's calculation

Figure 4.4 shows the representation of different components of vulnerability. Human Capital decreases steadily from 0.53 in 2006 to 0.52 in 2009 and further to 0.49 in 2012 in Hemja VDC over the specified years. Physical capital is exhibited a gradual decrease from 0.98 in 2006 to 0.97 in 2009 to 0.95 in 2012. Social capital also have experienced an increase from 0.84 in 2006 to 0.87 in 2009 and declined to 0.62 in 2012.Livelihoods Remains relatively stable, ranging from 0.32 to 0.33 across the three years. Financial Capital also remained relatively stable with a slight decrease from 0.99 in 2006 to 0.96 in 2012.

Hemja VDC in Kaski district exhibits a vulnerability profile characterized by a decline in human and physical capital over the years. Social capital shows variability, with a decline from 2006 to 2012. Livelihoods and financial capital remain relatively stable.

Figure 4.4: Component of HVI - Hemja VDC, Kaski

4.4.3 Kunjo VDC, Mustang

Table 4.7 represents data for Kunjo Village Development Committee (VDC) in Mustang district across the years 2006, 2009, and 2012. Each row corresponds to a specific year, and the columns represent different components of vulnerability. Human

Table 4.7: Mean of the HVI components for Kunjo VDC, Mustang

Year	Human Capital (C1)	Physical Capital (C2)	Social Capital (C3)	Livelihoods (C4)	Financial Capital (C5)
2006	0.65	0.97	0.59	0.31	0.97
2009	0.63	0.97	0.63	0.24	0.97
2012	0.64	0.97	0.82	0.32	0.96

Source: Author's calculation

capital component was 0.65 in 2006, decreases to 0.63 in 2009, and slightly increases to 0.64 in 2012. Physical capital remains constant at 0.97 across all three years. Social capital component 0.59 in 2006, increases to 0.63 in 2009, and further in-

creases to 0.82 in 2012. Livelihood components exhibits variability across the years. The average value decreased to 0.24 in 2009 from 0.31 in 2006 and then increasing to 0.32 in 2012. Financial capital remained relatively stable at around 0.97 across three years.

Overall, Human capital and financial capital exhibited slight fluctuations. Physical capital remained stable. Social capital experienced a significant increase. Livelihood show variability with a dip in 2009 and subsequent increase in 2012.

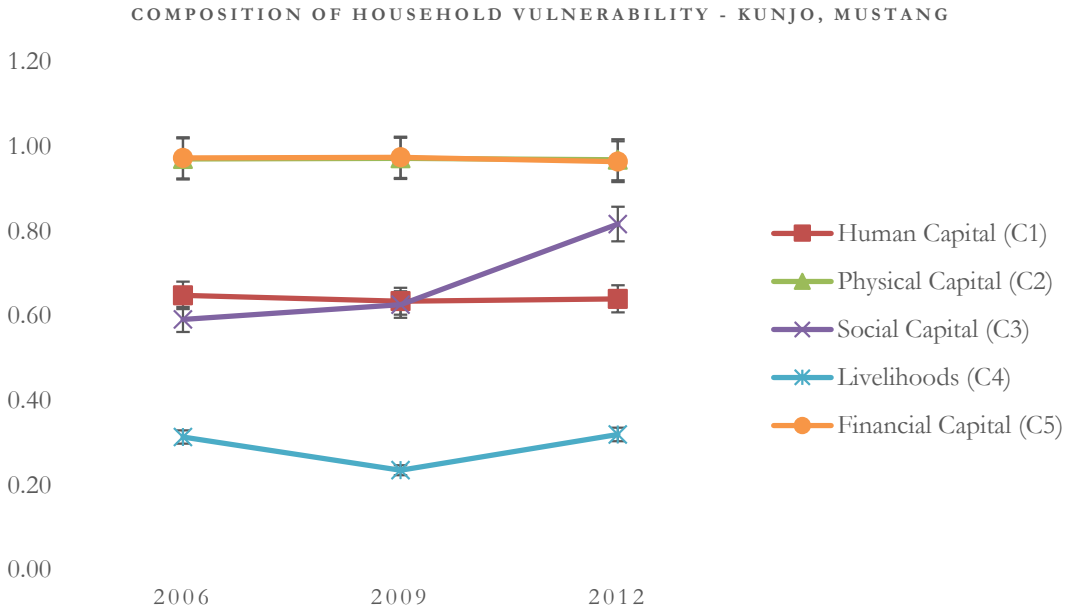

Figure 4.5: Component of HVI - Kunjo VDC, Mustang

4.4.4 Lete VDC, Mustang

The table represents data for Lete Village Development Committee (VDC) in Mustang district across the years 2006, 2009, and 2012. Each row corresponds to a specific year, and the columns represent different components of vulnerability. Human

Table 4.8: Mean of the HVI components for Lete VDC, Mustang

Year	Human Capital (C1)	Physical Capital (C2)	Social Capital (C3)	Livelihoods (C4)	Financial Capital (C5)
2006	0.61	0.96	0.66	0.38	0.96
2009	0.61	0.97	0.69	0.31	0.96
2012	0.59	0.97	0.70	0.36	0.94

Source: Author's calculation

Capital indicates stability with a minor decline in. The human capital component was 0.61 in 2006, remains constant in the following year, and slightly decreases to 0.59 in the year 2012. Physical Capital suggests stability and a slight improvement. The physical capital increases from 0.96 in 2006 to 0.97 in the year 2009 and remains constant in 2012. Social Capital is exhibited to have consistent rise across the years. It was 0.66 in the year 2006, increases to 0.69 in the year 2009, and further increases to 0.70 in the year 2012. Livelihoods component is fluctuating across the years. Livelihood decrease from 0.38 in 2006 to 0.31 in 2009, and then increasing to 0.36 in 2012. Financial capital indicates generally stable but slightly declining level of vulnerability related to financial resources. Financial Capital component was 0.96 in 2006, remained constant in 2009, and decreased slightly to 0.94 in 2012.

We could observe stability in physical capital and social capital with minor fluctuations. human capital and financial capital exhibited a minor decline. Livelihood showed variability with a dip in one wave and increase in another wave.

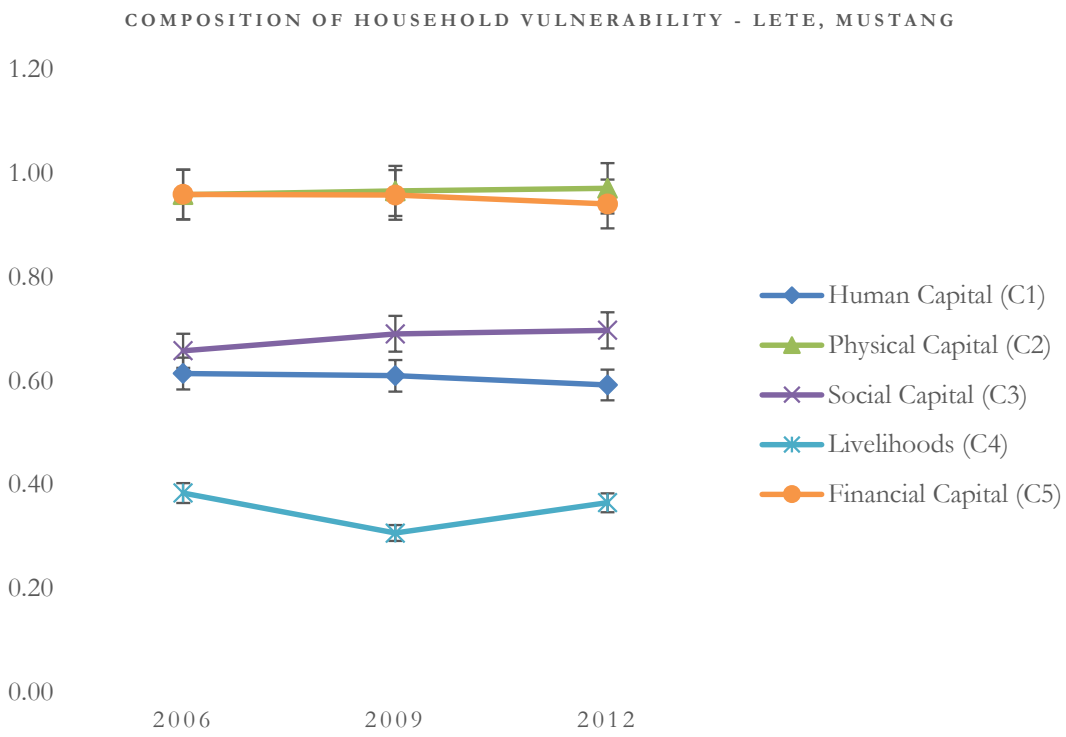

Figure 4.6: Component of HVI - Lete VDC, Mustang

A panel summary of the components of the HVI is presented in Appendix Table 2. Further a composed stacked line with markers is presented in Appendix Fig 1.

4.5 Persistence and Transience of Household Vulnerability

Figure 4.7 is a Sankey diagram presenting the persistence and transitions of the household vulnerability level across the waves of survey. The value labels represent the number of households that are in the corresponding vulnerability.

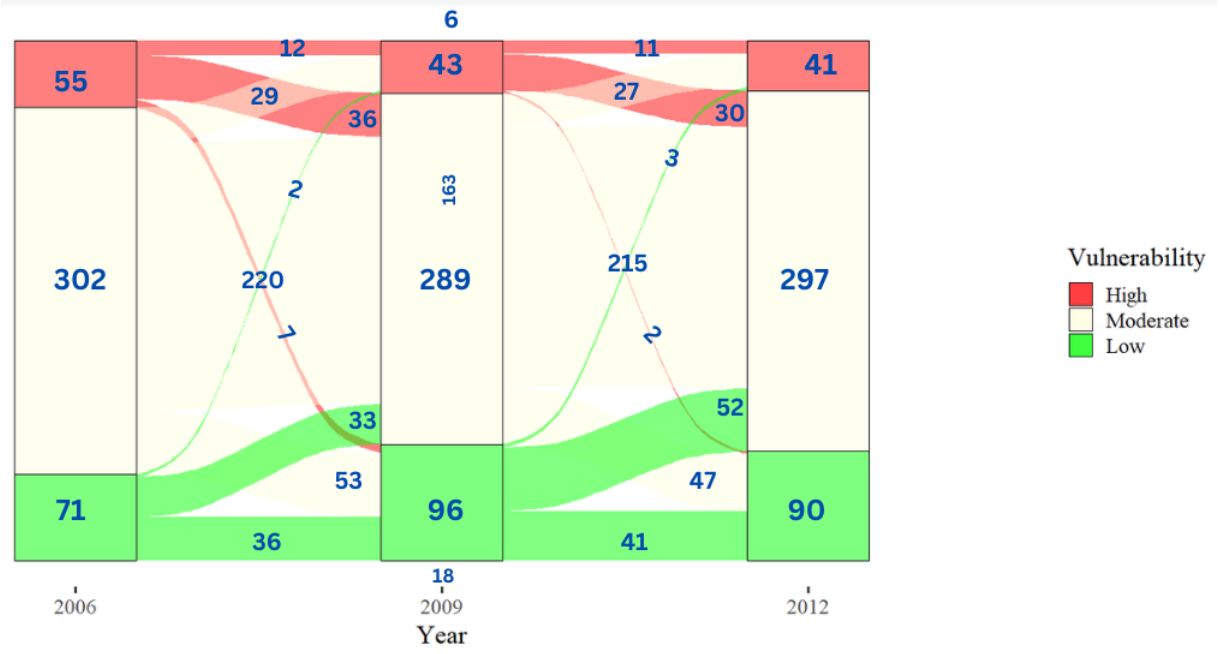

Figure 4.7: Persistence and Transience of Household Vulnerability

The details of the Vulnerability level across the survey waves (2006, 2009, 2012) is presented in Table 4.9. In the table, in 2006 there are 55 households categorised as "High", 302 as "Moderate" and 71 as "Low" vulnerability level. In 2009, the number of households classified as "High" vulnerability decreased to 43, "Moderate" vulnerability decreased to 289, and "Low" vulnerability increased to 96. In 2012, the number of households classified as "High" vulnerability further decreased to 41, "Moderate" vulnerability increased slightly to 297, and "Low" vulnerability decreased to 90.

Table 4.9: Vulnerability level across the waves of survey

Vulnerability level	**2006**	**2009**	**2012**
High	55	43	41
Moderate	302	289	297
Low	71	96	90

Source:Author's calculation

Table 4.10 presents the transition of the vulnerability levels of the households. This table shows the household transitioning from one vulnerability level to another between each pair of survey years. For example, from 2006 to 2009, there were 12 households that were "High" vulnerability in 2006 and remained "High" vulnerability in 2009. Similarly, there were 36 households that were "High" vulnerability in 2006 and transitioned to "Moderate" vulnerability in 2009.

Table 4.10: Transition matrix of the household vulnerability

Vulnerability Level	**2006-2009**	**2009-2012**
High to High	12	11
High to low	7	2
High to Moderate	36	30
Low to High	2	3
Low to Low	36	41
Low to moderate	33	52
Moderate to High	29	27
Moderate to low	53	47
Moderate to Moderate	220	215

Source:Author's calculation

Table 4.11 presents the persistence of vulnerability across the survey waves. It highlights the number of households that remained in the same vulnerability level throughout the entire period of 2006 to 2012. There were 6 households that remained in the "High" vulnerability category from 2006 to 2012. Similarly, there were 18 households that remained in the "Low" vulnerability category throughout the same period.

Table 4.11: Persistence of vulnerability the household 2006-2009-2012

Vulnerability level	**No. of Households**
High to High	6
Low to Low	18
Moderate to Moderate	163

Source:Author's calculation

4.6 Results from Empirical Analysis

This section presents the results for the household vulnerability regression estimates. We report the marginal effects, standard errors for all the models included in the regression. We included household vulnerability index as an dependent variable which we calculated using equation 3.8. For the independent variable, we used Environmental dependence, Debt, Dependency ratio and Shock as the independent variable. While Environmental income could be an important source of smoothing consumption but could be considered a liability rather than a capital for the vulnerable households. Our results find that household's vulnerability increases as environmental dependence increases.

Other factors influencing household vulnerability included Debt. Our results, though insignificant, confirms that debt could reduce the household vulnerability. Also, Dependency ratio was a liability factor of the household's resilience. Our regression results is similar with the findings of the prior literature. The other control we include in the model is the shock as measured by the number of shocks experienced by the households. This study finds that as the the number of shocks increases the household vulnerability increases. Fixed effects controls have also been introduced in the regression models to account for the variation caused by the time-invariant variables such as district and VDC.

Table 4.12 presents the results of the Panel Data regression employed in the analysis. 3 methods of Panel data namely: Pooled OLS; Random Effects; and Fixed Effects have been employed to investigate the factors that affect household vulnerability. The first model is a simple Pooled OLS model where the dependent variable household vulnerability has been regressed by Environmental dependence. The result on the regression is that Environmental dependence increases the household vulnerability. The significance level is on 1%. This simple regression has been the landmark of this analysis. Following the result, we extend the regression in the following models for Pooled OLS by adding control variables Debt, Dependency ratio and Shock. Further, we add Fixed effects of Year, District and VDC. The result of the step-wise regression is on the Appendix Table 2. The final result of a full specification model of the POLS regression in the Table 4.9 suggests a significantly positive association between household vulnerability and environmental dependence.

Table 4.12: Panel Data Regression

	Dependent variable: Household Vulnerability			
	POLS (1)	POLS (2)	RE	FE
Env. Dependence	0.068***	0.045***	0.024**	−0.004
	(0.012)	(0.012)	(0.011)	(0.013)
Debt		−0.0005	−0.0004	−0.0003
		(0.0003)	(0.0003)	(0.0003)
Dependency ratio		0.020***	0.018***	0.014***
		(0.002)	(0.002)	(0.002)
Shock		0.001	0.001	0.001
		(0.001)	(0.001)	(0.001)
Constant	0.557***	0.562***	0.583***	–
	(0.012)	(0.012)	(0.011)	–
Fixed Effects				
Year	No	Yes	Yes	Yes
District	No	Yes	Yes	Yes
VDC	No	Yes	Yes	Yes
Fit statistics				
Observations	1,284	1,284	1,284	1,284
R^2	0.024	0.131	0.095	0.042
Adjusted R^2	0.023	0.125	0.089	-0.446

Note: Standard errors in the parenthesis: *p<0.1; **p<0.05; ***p<0.01
Env. = Environmental

After running the Pooled OLS regression we ran the Lagrange Multiplier Test - Honda (1988) to test if there are time effects in our model. The Null hypothesis is that there are no time effects in the model. The result indicate that there are significant time effects in the model. The test statistic is 10.822 and the p-value is extremely small (0.000) which suggests that there is a strong evidence to reject null hypothesis. The result of the test is in the Appendix B1.

Similarly, we also tested for the individual effects in the Pooled OLS model. We conducted F-test and found that there are individual effects (fixed effects) in the model. The results suggests strong evidence to reject the null hypothesis. The F-statistics is 2.4874 with degree of freedom df1=472 and df2=852. The p-value is

extremely small (0.000). This implies that there are significant individual effects in the model. The results of the tests are in Appendix B2.

Referring to the results of the test, we included the time factor (Year) as well as time-invariant factors District and VDC. Since, the result suggested that there is strong evidence that there are time as well as individual effects. So, we controlled the Year, District and VDC fixed effects.

After obtaining the results from the Pooled OLS regression, we tested for the pool-ability to confirm if the cross-sectional unit in the panel has the same intercept or a different intercept. Also, whether or not it had different slopes. For this purpose, we employed Breusch and Pagan Lagrangian multiplier test (Breusch & Pagan, 1980) to test the poolability of the data. It was confirmed that the panel data was not pool-able. So, Pooled OLS is not appropriate for the model. The result of the Breusch and Pagan Lagrange Multiplier test is in Appendix B3.

Since the result indicate that p-value = 0.000, we conclude that the Pooled OLS model is not efficient estimator for our data. So, we run Random Effects (RE) model. The result of the RE regression is in the Table 4.9 which suggests that there is a positively significant relationship between the household vulnerability and environmental dependence which implies that as the environmental dependency increases the household becomes more vulnerable. The result is similar with Pooled OLS model but the coefficient and significance is different between the two. The step-wise regression results for the Random effects (RE) is on the Appendix Table 3. The model progression is similar to Pooled OLS model. The first model is simple Random effects model with dependent variable household vulnerability and only on independent variable environmental dependence. Then in the subsequent models, control variables Debt, Dependency ratio, Shock is added gradually. Furthermore, Fixed effects for Year, District and VDC were considered in the model in the similar fashion.

We also run the fixed effects (FE) regression. The result of the full specification FE model is in the Table 4.12. It suggests that there is a negative but non-significant relationship between Environmental dependence and household vulnerability. However, for other control variables, the results are similar to those of Pooled OLS and RE. The step-wise regression for FE is in the appendix Table 4. The model

progression is similar to Pooled OLS and RE model. The first model is simple Random effects model with dependent variable household vulnerability and only on independent variable environmental dependence. Then in the subsequent models, control variables Debt, Dependency ratio, Shock is added gradually. Furthermore, Fixed effects for Year, District and VDC were considered in the model in the similar fashion.

After the FE regression, we conduct Hausman Specification test (Hausman, 1978). The test assesses whether the coefficients estimated by the two models are significantly different. The test for our model suggest that fixed effect model is preferred over random effect model. The corresponding chi-square value is 25.48 which is realtively large with 6 degrees of freedom, and the adjoint probability was much less than 0.05. The result obtained for Hausman Specification test is in the Appendix B4.

However, we take the inference of RE as efficient estimates because we have a very small T (3) and large N (428). RE estimator is efficient, consistent and unbiased estimator when T is small and N is large (Hsiao, 2022).

4.6.1.1 Environmental Dependence and Vulnerability (OLS)

Appendix Table 3 presents the results of the Pooled OLS Regression results. The model specification is in equation 3.9. Model 1 of the equation is a bi-variate regression with household vulnerability as an dependent variable and only Environmental dependence as an dependent variable. The result suggest that there is a significantly positive association between the household vulnerability and environmentally dependence. It suggest that as environmental dependence increases for a household, the household vulnerability increases.

In model 2, we introduce Debt, one of the variables controlled for in our regression model. Debt has a significantly negative effect on household vulnerability. The regression coefficient of Environmental dependence didn't change after the introduction of the control variable debt.

In the following models 3, 4 we further introduce the control variables Dependency ratio and Shock respectively. The addition of the variables in our model only slightly changed the coefficient of the Environmental dependence. Dependency ratio

is shown to have positive effect on household vulnerability in both the models. In the model 4, shock also is exhibited to have a positive and significant influence on household's vulnerability. For the remaining models (5, 6, and 7), Year, District, and VDC fixed effects were introduced consecutively. Even after the Fixed effects were applied, significance and direction of our main independent variable Environmental dependence remained same as the model 1. However, the coefficient were on a declining trend as the control variables were added in the model. The shock variable lost its significant but the direction remained the same, implying that shock has a positive effect on household vulnerability.

The Pooled OLS regression results indicates that that environmental dependence increases the household's vulnerability. Similarly, the increase in the Dependency ratio also increases the household vulnerability. Shock variable also has a positive effect on household vulnerability. However, debt has a negative influence on household vulnerability.

4.6.1.2 Environmental Dependence and Vulnerability (RE)

Appendix Table 4 presents the Random Effects Regression results of our estimates. The model specification is same as of Pooled OLS Model. Result from Model 1 suggest that there is a significantly positive association between the household vulnerability and environmentally dependence. Here, no control variables have been included.

Controls such as: Debt; Dependency; and Shock have been included in the following models 2, 3 and 4 respectively. Debt, in the model 2 had a significantly negative effect on household's vulnerability, indicating that the debt reduces the household vulnerability. However, it lost its significance with the addition of dependency ratio in the model 3. The direction remained unchanged nonetheless. In model 4, dependency ratio and shock had a positive effect on household vulnerability.

Similarly, in the models 5 , 6 and 7, random effects regression were run with Year, District and VDC fixed effects in the consecutive models. In model 5, with the Year fixed effects, Debt had a negative but insignificant effect on household vulnerability. Dependency ratio had a positive and significant effect on household vulnerability. Shock variable had a positive but insignificant effect on the dependent variable in

the model. The same trend is observed across the following models.

Importantly, our major variable of interest Environmental dependence continued to have a positive effect across all the models. Up to model 5, Environmental dependence displayed to have a positive effect on household vulnerability at 1% significance level. However, the significance level reduced to 5% in the following models. The loss in the significance is the effect of introduction of the time invariant fixed effects: District and VDC.

4.6.1.3 Environmental Dependence and Vulnerability (FE)

Appendix Table 5 presents the regression estimates of Fixed effects model. The model specification is same as of Pooled OLS Model and Random Effects Model. Result from Model 1 suggest that there is a negative association between the household vulnerability and environmentally dependence. However, there is no significance of the effect. Here, no control variables have been included.

Controls such as: Debt; Dependency; and Shock have been included in the following models 2, 3 and 4 respectively. Debt, in the model 2 also had a negative effect on household's vulnerability, indicating that the debt reduces the household vulnerability. The effect is not significance nevertheless. The direction has remained unchanged. In model 3 and 4, dependency ratio had a significantly positive effect on household vulnerability. The coefficient and significance is consistent in model 5. Shock in the model 4 had a positive and significant effect on household vulnerability.

In models 5, 6, and 7, Fixed Effects Regression was employed, incorporating Year, District, and VDC fixed effects in successive iterations. In model 5, the inclusion of Year fixed effects revealed a negative but statistically insignificant impact of Debt on household vulnerability. Conversely, the Dependency ratio exhibited a positive and statistically significant association with household vulnerability. The Shock variable displayed a positive yet statistically insignificant effect on the dependent variable in this model. This pattern persisted consistently in the subsequent models.

Environmental dependence, consistently demonstrated a negative and insignificant effect upto model 6. However, in the model 7, the effect was positive and significant. This implies that the best fit of the model is when all the relevant and necessary variables are included in the model.

4.7 Discussion

4.7.1 Household Vulnerability Index

With the objective of assessment of household vulnerability in the three distinct physio-graphical region: Mountain; Mid-hill; and Lowland region of Nepal, we constructed household vulnerability index for the Kunjo and Lete VDC of Mustang, Hemja VDC of Kaski and Chainpur VDC of Chitwan. We employed the Min-Max standardization in 3.5 and 3.6 for standardizing the values of the variables in order to ensure the comparability of indicators used in the HVI construction. After standardization of the values, we assigned the variables to the respective capital categories to calculate the final normalized index in 3.7 for each key component, namely: Human Capital; Physical Capital; Social Capital; Livelihood; and Financial Capital. After the component calculation, we get the combined household vulnerability index using 3.8 which we assign to each household and assess the vulnerability.

From the HVI, we find that HVI ranged from 0.61 to 0.65 across the survey districts in the year 2006. Kunjo and Lete of Mustang district had the highest vulnerability in the year 2006. These VDCs persisted to be the most vulnerable across all waves of the survey years. Hemja VDC of Kaski persisted on a same level of vulnerability with 0.62. By 2012, mild changes were observed, with certain VDCs experienced lowered Vulnerability across the waves of survey. Chainpur VDC of Chitwan experienced a slight decrease in vulnerability from 2006 to 2009 but the level persisted in the year 2012. Kunjo VDC of Mustang followed a similar trend.

We presented the persistence and transitions of the vulnerability positions of each districts across the survey years from 2006 to 2012 in a Radar chart in Figure 4.1. We also presented the village level Radar chart in Fig 4.2. Similarly, we also present the Component of household vulnerability index in a stacked line with markers for each VDCs across all rounds of survey years in Figure 4.3, 4.4, 4.5 and 4.6.

4.7.2 Household Vulnerability and Environmental Dependence

After the assessment of the vulnerability positions of the VDCs and Districts across the survey years, we carry out the empirical estimation to find the relationship between the household vulnerability and environmental dependence. For that purpose, we carry out Panel data regression employing Pooled OLS, Random Effects (RE)

and Fixed Effects (FE) regression techniques. The dependent variable is household vulnerability as measured by HVI and the independent variables include Debt, Dependency ratio, Shock. Other controls are Year, District and VDC fixed effects. The results are presented in 4.5.1.

Angelsen & Dokken (2015); Abbas et al. (2018); Gentle et al. (2014) contests that environmental resource dependence had a positive effect on household vulnerability, particularly in the context of changing climate and climatic hazards. Our result confirms the findings of the literatures. Table 4.9 presents the results of the Pooled OLS Regression. A total of 7 models have been included in the regression. based on the literature. Model 1 is a bi-variate regression whose result show that there is a significant positive relationship between Environmental dependence and household vulnerability. Model 2 to model 4 are multi-variate regression models where additional controls are added in the model consecutively. The addition of the controls in the model didn't alter the significance and direction of the effect of the Environmental dependence on household vulnerability. Debt as a coping mechanism, particularly when faced with some sort of shock (Rabbani & Hasan, 2021). Debt exhibited negative effect on household vulnerability, implying that Debt reduces the vulnerability. However, its significance was only evident in model 2. Having more dependent in the household increases the vulnerability of the household (Rabbani & Hasan, 2021; Sun et al., 2020). The results suggest that dependency ratio had a significantly positive influence on household vulnerability which suggests that having more dependent meant that household are more vulnerable. The effect of dependency ratio is consistent throughout the models with only slight change in the coefficients. Number of studies including Bühler & Cunningham (2018); Barua & Banerjee (2020); Völker & Waibel (2010) show that the shocks can push the household to be vulnerable. The results also suggest that shock had a positive influence in all of the models. However, the significance was only observed in model 4.

Yeas as a time fixed effects and District and VDC as time-invariant fixed effects were added in the model 5-7. It had its effect in changing the coefficients of the variables. Overall, the Pooled OLS regression results suggests that Environmental dependence is able to positively influence household vulnerability. Similarly dependency ratio and shock variables are able also had a positive effect on household

vulnerability. Debt had a negative effect.

Table 4.10 presents the result of the Random effects regression. The effect of Environmental dependence is shown to be positive, just like in Pooled OLS regression. However, the coefficient have changed. Also, the significance level has been decreased. The change can be attributed to the Random Effect regression technique which corrects for the serial auto-correlation. The Random effects estimator is more consistent and efficient than Pooled OLS because it corrects for endogenous partially. The model controls for unobserved individual-specific characteristics because it assumes that individual characteristics are constant over time (time-invariant).

Fixed effects regression result is presented in Table 4.11. The effect of Environmental dependence is shown to be negative from model 1 to 6. However, the effect is not significant. The effect is positive and significant in model 7 where all the control variables and time fixed effects Year and time-invariant fixed effects District and VDC fixed effects have been included in the model. The change in the results can be attributed to the Fixed effects regression techniques which assumes that the idiosyncratic errors are uncorrelated and also the strict exogeneity assumption on the explanatory variables.

CHAPTER V
SUMMARY AND CONCLUSIONS

In this chapter, the summary of the study is presented in the first section. The conclusion, recommendations, and potential extensions are shown in the subsequent section.

5.1 Summary of the Findings

The central focus of this thesis is the comprehensive analysis of household vulnerability in rural Nepal. The research aims to delve into the inter-temporal dynamics of vulnerability and conduct a physiographic analysis by constructing a household vulnerability index (HVI). The HVI is developed by integrating various capitals, including Human capital, Physical capital, Financial capital, Livelihood strategies, and Social capital. Additionally, the study explores the factors influencing household vulnerability in the context of rural Nepalese households.

The research employs a unique and environmental augmented household-level livelihood panel data-set, as outlined in (Walelign et al., 2022). This data-set spans the period from 2006 to 2012 and is sourced from Tribhuvan University's Institute of Forestry and the University of Copenhagen's Department of Food and Resource Economics. The data-set serves as a valuable resource for capturing the nuances of household livelihoods over time.

The construction of the household vulnerability Index is a pivotal aspect of the research methodology, accomplished through the application of Mini-max and Maximin methods. These methods enable a comprehensive assessment of vulnerability by considering multiple dimensions. The analysis of the household vulnerability reveals distinct patterns. Chitwan exhibits a stable vulnerability level with a mean household vulnerability index (HVI) of 0.61 across 2006, 2009, and 2012. Kaski shows mild variability, decreasing from 0.62 in 2006 to 0.61 in 2009 and increasing back to 0.62 in 2012. Mustang indicates higher vulnerability in 2006 (0.64), a slight decrease in 2009 (0.63), and stability in 2012. Radar charts further depict the variability within districts, with Chitwan's polygon suggesting consistent vulnerability, Kaski's indicating at potential decrease, and Mustang's showing fluctuations followed by stabilization.

Furthermore, the study employs Panel Data Regression techniques, including Pooled Ordinary Least Squares (OLS), Fixed Effects (FE), and Random Effects (RE) regression, to identify and quantify the factors influencing household vulnerability. Notably, environmental dependence emerges as a key contributor to increased household vulnerability in the rural households. The study reveals a positive correlation between dependency ratios and the household vulnerability Index (HVI), indicating that a higher dependency ratio exacerbates vulnerability. Additionally, the analysis suggests that shocks to households also play a substantial role in elevating vulnerability levels. Surprisingly, the research finds a mitigating effect of debt on household vulnerability, suggesting that indebted households exhibit lower levels of vulnerability.

5.2 Conclusion

The research examines the relationship between the household vulnerability and environmental dependence in the rural households across the physio-graphic regions utilizing various capital such as Human Capital, Physical Capital, Social Capital, Financial Capital and Livelihood. A composite index was developed using the minimax normalization method. The index allowed the analysis of the vulnerability on a household, village and district level.

From the analysis, we found that Chitwan district had a stable vulnerability across all waves of the survey (2006, 2009, 2012) with a mean HVI of 0.61. Kaski district exhibited mild variability, with a decrease in mean HVI from 2006 to 2009 and an increase back to the original level in 2012. Mustang district showed relatively higher household vulnerability in 2006, a slight decrease in 2009, and stability in 2012.

After the household vulnerability analysis, we investigated its relationship with Environmental Dependence. The household vulnerability index, calculated based on established equations, served as the dependent variable. Environmental dependence as a major determinant, consistently exhibited a significantly positive association with vulnerability. Additionally, the study attempted to study the association of Debt, Dependency Ratio, and Shock on vulnerability. Debt, as a coping mechanism, displayed a negative relationship with vulnerability, though statistically insignifi-

cant. In contrast, Dependency Ratio, and Shock demonstrated significant positive associations with vulnerability. These insights contribute to a comprehensive understanding of the multifaceted nature of household vulnerability and factors affecting it.

5.3 Recommendations and Possible Extensions

This thesis builds national and sub-national level vulnerability assessment Antwi-Agyei et al. (2013); Aksha et al. (2019); Shahi & Shreezal (2020) by developing and applying a household vulnerability index to characterize the nature and inter-temporal dynamics of the household vulnerability across the distinct geographic regions of Nepal. This study targets an important gap in the literature, improving understanding of the processes and factors that affect vulnerability, with a view to guiding the development of effective policies. The findings and result has shown that across the distinct geographical setting, different communities and households may experience differential vulnerability that may be attributed to differences in capitals possessed by the households. The analysis showed that across the rural setting communities, Mountainous village of Mustang district had a relatively higher household vulnerability. However, when we look at the inter-temporal dynamics, the vulnerability has declined consistently across the 3 waves of the survey in the district. Lowland and Mid-hills depicted lower vulnerability as compared to Mountains. However, there is a certain vulnerability in all households in these communities. Notably, Chitwan district representing lowland region had a stagnant vulnerability of 0.61 across all waves of survey. Kaski, a representative of mid-hill rural region had slightly improved its vulnerability position from the year 2006 to 2009 but remained stagnant at 0.61 in the year 2009 and 2012.

This contrast between the Nepal's diverse geographic landscape, significantly influences rural livelihoods and prevalence of subsistence economies. These differences must be taken into account when drafting the interventions to address specific vulnerabilities in areas exhibiting different patterns. Further, it is important to prioritize the environmental factors and household's dependency on environment. This thesis finds that there is a positive relationship between Environmental dependency and household vulnerability. So, policies that attempt to lower the dependency on

the environment must be designed and implemented in rural setting. Additionally, community-level resilience programs, educational initiatives, and cross-sectoral collaboration could be proposed to address the multifaceted nature of household vulnerability. These programs and policies may help to foster sustainable development, resilience, and improved livelihoods in rural Nepalese communities while accounting for the specific geographical and economic characteristics of each region.

Moreover, there is a possibility for this version of the study to be expanded. Due to time and resource constraints, we used the equal weighting approach at the time of computing the household vulnerability index. In future studies, consultation with stakeholders regarding the weight of the the components of the household vulnerability could be discussed and apply the weights.

Similarly, this study estimates the association between the household vulnerability and environmental dependence with the explanatory variables in the publicly available data-set. However, there is a possibility to identify the instrumental variable to detect the potential confounding effects on the variables of interest. This will enable causal inference to be drawn from the study.

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APPENDICES

Appendix Table 1: VDC-wise variables used for the construction of Household Vulnerability Index

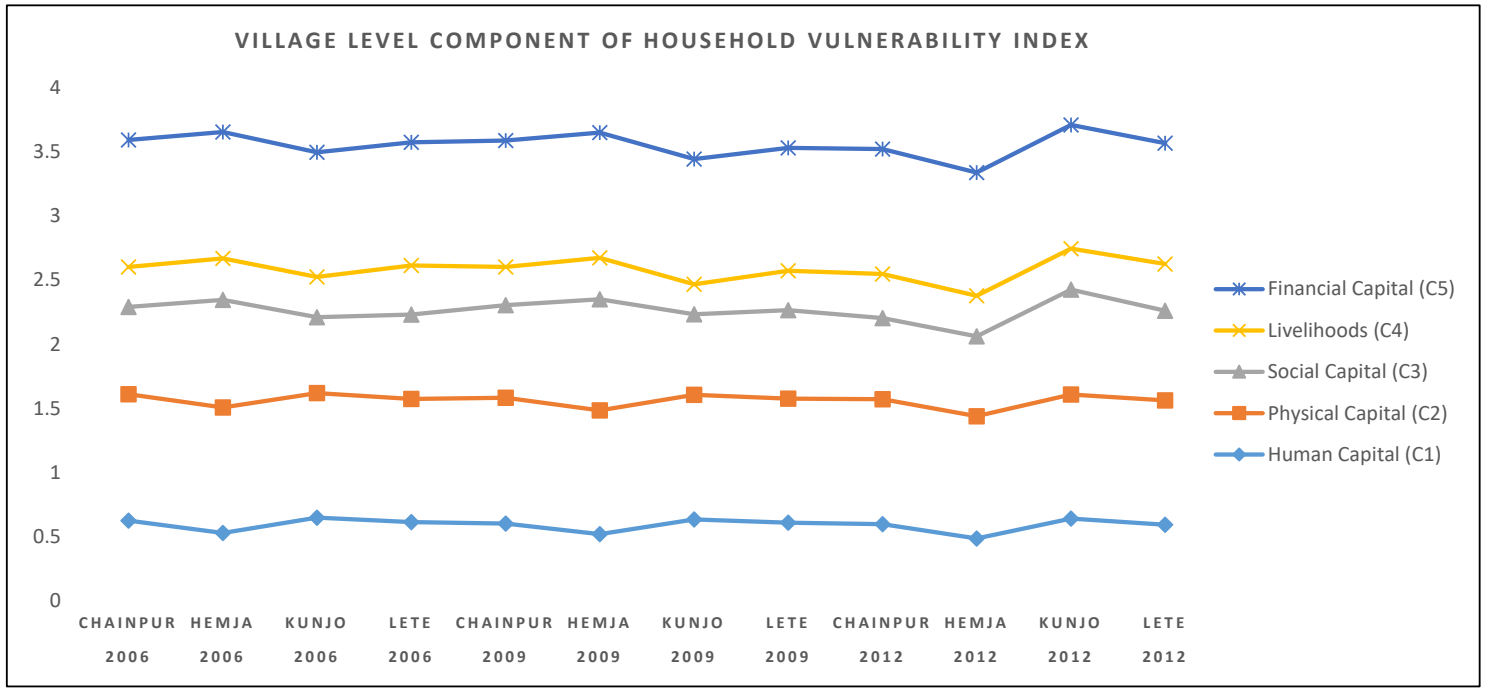
Year/	**2006**				**2009**				**2012**			
District/	**Chitwan**	**Kaski**	**Mustang**		**Chitwan**	**Kaski**	**Mustang**		**Chitwan**	**Kaski**	**Mustang**	
VDC	**Chainpur**	**Hemja**	**Kunjo**	**Lete**	**Chainpur**	**Hemja**	**Kunjo**	**Lete**	**Chainpur**	**Hemja**	**Kunjo**	**Lete**
Human Capital												
HHH Age	50.36	50.14	51.54	54.16	52.13	52.00	52.63	55.50	52.24	53.52	52.77	57.54
	(14.15)	(14.57)	(14.66)	(12.32)	(13.75)	(13.39)	(14.57)	(12.95)	(17.20)	(13.71)	(15.92)	(11.98)
HH head Education	3.08	6.29	2.83	3.25	2.93	6.07	2.79	3.08	2.91	6.91	2.48	3.30
	(4.06)	(4.97)	(3.42)	(4.46)	(4.06)	(5.23)	(3.28)	(4.21)	(4.33)	(5.07)	(3.39)	(4.62)
Max HH Education	8.44	10.76	7.10	8.14	9.70	11.18	7.75	8.32	9.89	11.91	7.72	8.70
	(3.91)	(2.90)	(2.92)	(3.60)	(3.63)	(3.94)	(3.47)	(4.33)	(4.44)	(4.03)	(3.71)	(3.97)
Physical Capital												
Total Implements	4660.32	14057.03	6579.07	13892.80	10153.80	30700.02	11694.79	18349.19	22165.29	48959.02	19824.44	23000.68
	(11275.49)	(16860.42)	(11240.12)	(24616.53)	(23970.94)	(46128.36)	(16393.21)	(31531.21)	(38089.25)	(70582.56)	(30068.34)	(25109.33)
Total Livestock	18532.68	26573.08	64484.18	95156.95	43936.83	35690.11	48328.19	63305.51	38993.71	34635.84	43044.51	25772.02
	(15428.31)	(20411.58)	(217769.73)	(230659.93)	(39679.84)	(35760.07)	(157785.27)	(196365.44)	(34330.40)	(39306.60)	(40803.87)	(36222.90)
Total Land owned												
(in sq. m)	2027.47	1187.00	2851.25	3023.66	915.91	1491.41	2443.77	2040.13	1041.46	1374.96	2120.03	1734.96
	(6367.27)	(1013.02)	(2588.66)	(2979.45)	(765.38)	(2060.25)	(4381.85)	(3034.05)	(1136.88)	(2253.95)	(1955.97)	(1825.09)
Social Capital												
HH belong to												
biggest caste	0.58	0.89	0.44	0.54	0.66	0.98	0.52	0.63	0.50	0.86	0.50	0.68
	(0.50)	(0.32)	(0.50)	(0.50)	(0.48)	(0.14)	(0.50)	(0.49)	(0.50)	(0.50)	(0.35)	(0.47)
Financial Capital												
Bank Saving	879.58	9663.83	26550.42	36893.08	1911.63	11937.72	15583.53	32899.60	11953.55	25410.64	24116.56	70411.25
	(2661.50)	(26812.62)	(49925.24)	(100295.99)	(6126.69)	(31025.90)	(33746.90)	(75131.34)	(31763.88)	(66932.34)	(64770.84)	(127638.23)
Jewellery	0.00	0.00	17329.52	45053.31	4396.88	20485.87	25209.19	51106.62	21477.20	51605.94	45374.61	62313.92
	(0.00)	(0.00)	(31072.47)	(87655.54)	(6965.53)	(16594.26)	(56538.65)	(94727.93)	(23620.47)	(48463.62)	(120899.24)	(103824.98)
Livelihood												
No. of livelihood strategies	4.81	4.72	4.80	4.32	4.93	4.74	5.35	4.86	4.60	4.78	4.76	4.45
	(0.97)	(0.91)	(0.92)	(0.93)	(1.02)	(0.91)	(0.83)	(0.86)	(0.98)	(0.90)	(0.87)	(1.10)
Household Vulnerability												
HVI	0.62	0.62	0.65	0.63	0.61	0.62	0.64	0.63	0.61	0.62	0.64	0.62
	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)

Note: Standard deviation in the parenthesis
Source: Author's calculation

Appendix Table 2: Mean and SD of the Components used in HVI Construction

Year/	**2006**				**2009**				**2012**			
District/	**Chitwan**	**Kaski**	**Mustang**		**Chitwan**	**Kaski**	**Mustang**		**Chitwan**	**Kaski**	**Mustang**	
VDC	**Chainpur**	**Hemja**	**Kunjo**	**Lete**	**Chainpur**	**Hemja**	**Kunjo**	**Lete**	**Chainpur**	**Hemja**	**Kunjo**	**Lete**
Human Capital (C1)	0.48	0.49	0.48	0.47	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.45
	(0.11)	(0.11)	(0.09)	(0.09)	(0.11)	(0.12)	(0.09)	(0.11)	(0.10)	(0.12)	(0.10)	(0.11)
Physical Capital (C2)	0.98	0.98	0.97	0.96	0.98	0.97	0.97	0.97	0.97	0.95	0.97	0.95
	(0.03)	(0.01)	(0.05)	(0.05)	(0.02)	(0.04)	(0.05)	(0.05)	(0.03)	(0.05)	(0.03)	(0.02)
Social Capital (C3)	0.68	0.84	0.59	0.66	0.72	0.87	0.63	0.69	0.63	0.62	0.82	0.70
	(0.33)	(0.26)	(0.35)	(0.32)	(0.32)	(0.23)	(0.32)	(0.33)	(0.33)	(0.35)	(0.27)	(0.32)
Livelihood (C4)	0.99	0.99	0.97	0.96	0.99	0.98	0.97	0.96	0.98	0.96	0.96	0.94
	(0.00)	(0.01)	(0.03)	(0.06)	(0.00)	(0.01)	(0.03)	(0.05)	(0.03)	(0.03)	(0.06)	(0.06)
Financial Capital (C4)	0.31	0.33	0.31	0.38	0.30	0.32	0.24	0.31	0.34	0.32	0.32	0.32
	(0.14)	(0.13)	(0.13)	(0.13)	(0.15)	(0.13)	(0.12)	(0.12)	(0.14)	(0.13)	(0.13)	(0.15)

Note : The values are scaled using the mini-max and maxi-min method.



Appendix Fig 1: Village level HVI Components

Appendix Table 3 : Pooled OLS Regression

	Dependent variable:Household Vulnerability						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Env Dependence	0.068***	0.068***	0.064***	0.062***	0.062***	0.049***	0.045***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Debt		−0.001*	−0.0004	−0.0004	−0.0004	−0.0004	−0.0005
		(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Depndency ratio			0.022***	0.021***	0.021***	0.021***	0.020***
			(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Shock				0.002*	0.002	0.001	0.001
				(0.001)	(0.001)	(0.001)	(0.001)
Constant	0.557***	0.561***	0.550***	0.550***	0.552***	0.558***	0.562***
	(0.012)	(0.012)	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)
Fixed effects							
Year	No	No	No	No	Yes	Yes	Yes
District	No	No	No	No	No	Yes	Yes
VDC	No	No	No	No	No	No	Yes
Fit statistics							
Observations	1,284	1,284	1,284	1,284	1,284	1,284	1,284
R^2	0.024	0.027	0.105	0.107	0.108	0.126	0.131
Adjusted R^2	0.023	0.025	0.103	0.105	0.104	0.121	0.125

Note: Standard errors in the parenthesis *p<0.1; **p<0.05; ***p<0.01
Env. = Environmental

Appendix Table 4: Random Effects Regression

	Dependent variable:Household Vulnerability						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Env. Dependence	0.035***	0.035***	0.037***	0.035***	0.034***	0.026**	0.024**
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Debt		−0.001*	−0.0003	−0.0004	−0.0004	−0.0004	−0.0004
		(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Dependency ratio			0.020***	0.019***	0.019***	0.019***	0.018***
			(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Shock				0.002**	0.001	0.001	0.001
				(0.001)	(0.001)	(0.001)	(0.001)
Constant	0.588***	0.592***	0.576***	0.576***	0.580***	0.581***	0.583***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Fixed effects							
Year	No	No	No	No	Yes	Yes	Yes
District	No	No	No	No	No	Yes	Yes
VDC	No	No	No	No	No	No	Yes
Fit statistics							
Observations	1,284	1,284	1,284	1,284	1,284	1,284	1,284
R^2	0.007	0.010	0.072	0.075	0.076	0.091	0.095
Adjusted R^2	0.007	0.008	0.070	0.072	0.072	0.085	0.089

Note: Standard errors in the parenthesis *p<0.1; **p<0.05; ***p<0.01
Env. = Environmental

Appendix Table 5: Fixed Effects Regression

	Dependent variable: Household Vulnerability						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Env. Dependence	−0.003	−0.003	−0.001	−0.001	−0.004	−0.004	−0.004
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Debt		−0.0004	−0.0003	−0.0003	−0.0003	−0.0003	−0.0003
		(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0003)
Dependency ratio			0.015***	0.015***	0.014***	0.014***	0.014***
			(0.003)	(0.003)	(0.003)	(0.003)	(0.002)
Shock				0.002*	0.001	0.001	0.001
				(0.001)	(0.001)	(0.001)	(0.001)
Fixed Effexts							
Year	No	No	No	No	Yes	Yes	Yes
District	No	No	No	No	No	Yes	Yes
VDC	No	No	No	No	No	No	Yes
Fit statistics							
Observations	1,284	1,284	1,284	1,284	1,284	1,284	1,284
R^2	0.00005	0.002	0.034	0.037	0.042	0.042	0.042
Adjusted R^2	-0.501	-0.500	-0.453	-0.450	-0.446	-0.446	-0.446

Note: Standard errors in the parenthesis *p<0.1; **p<0.05; ***p<0.01
Env. = Environmental

Appendix on Diagnostic Test Results

Appendix B1: Lagrange Multiplier Test - (Honda) Time effects test

data: HVI $\sim$ Environmental Dependency + Debt + Dependency ratio + Shock + ...

$normal = 10.822$, $p - value < 2.2e - 16$

alternative hypothesis: significant effects

Appendix B2: F test for individual effects

data: HVI $\sim$ Environmental Dependency + Debt + Dependency ratio + shock+...

$F = 2.4874$, $df1 = 427$, $df2 = 852$, $p - value < 2.2e - 16$

alternative hypothesis: significant effects

Appendix B3: Lagrange Multiplier Test - (Breusch-Pagan)

data: HVI $\sim$ Environmental Dependency + Debt + Dependency ratio + shock+...

$chisq = 117.12$, $df = 1$, $p - value < 2.2e - 16$

alternative hypothesis: significant effects

Appendix B4: Hausman Test data: HVI $\sim$ Environmental Dependency + Debt + Dependency ratio + shock+...

$chisq = 25.48$, $df = 6$, $p - value = 0.0002782$

alternative hypothesis: one model is inconsistent