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Climate Change Vulnerability and Agriculture in Nepal

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Abstract

This study was conducted during the period of January 2014 to December 2015. Its main objective was to investigate the status of climate change vulnerability in the water basin and its catchment areas. Its method was the survey of relevant literatures. Climate change is emerging issue induced vulnerability at the household level of developing countries more critical than of developed countries because of lower adaptive capacity of household. Its distribution is horizontal across the different income groups but its magnitude is vertically different across the different income groups. Its magnitude is less in the high-income group but higher in the low-income group. Therefore, the low-income group is more vulnerable from climate change than the high-income group in developing countries, like in Nepal. In addition, climate change induced disasters have negative correlation with altitudes in Nepal.

Keywords: Vulnerability; Climate change vulnerability; Disaster; Altitude; Adaptive capacity

Introduction

So far, concerning climate change vulnerability, the recent studies conceptualize it new form of vulnerability. Considers it as the unmanageable adverse impacts of climate change. In the scientific assessment reports, explain it as the degree to which a system is vulnerable to or unable to manage with the adverse impacts of climate change including climate variability and extremes. Further, argues it as some extent of damage to climate change depending on a system's sensitivity and on their capacities to adapt to new climatic conditions [2]. Specifically, have similar conclusion as a function of the character, magnitude, and rate of climate change and of system's exposure, sensitivity and adaptive capacity. It is followed by with similar observation on the features of the vulnerable system, their types, stressors, main reasons and effects on the system, and the time period of the assessment. Horizontal and vertical effects of vulnerability occur when climate change emerges [3]. Concerning the effects of vulnerability, explain vulnerability of social systems into different variables such as the threat, the region, the sector, the population group, the consequence and time. Similar observation is found in the study of Metzger specifies the vulnerability of ecosystems to global change with respect to a particular ecosystem service, a location, a scenario of stressors, and a time slice [4]. Furthermore, argues climate change vulnerability having technological and economic challenges to societies. In order to minimize its negative implication at farm level, adaptation method is effective. Proclaimed that future livelihoods might be in the risk of the change in global climate variables such as change in temperature and precipitation [5]. These variables are considered significant estimators in the agrarian societies in south-western Cameroon regions where agriculture is main source of livelihood. However, differently, in his socio-economic development studies finds the connection of vulnerability of individual and community with climate variability as socio-economic vulnerability [6,7]. He argues that it is the key aspect in the structure of vulnerability. In the structure, the aspects of individual and collective vulnerability are different. At the individual level, this type of vulnerability embraces relative poverty and deprivation as well as unrecognized social security. Similarly, at the collective level, it encompasses infrastructure, the role of the state and policy intervention. Both the levels of vulnerability reflect on vulnerability to climate change with the changing incidence of extreme events. Studies of WHO in health sector find such

vulnerability of climate change as severe risk of defensible public health [8]. Further, there is expected a rise in climate-related diseases, such as heat strokes and the growing events of vector borne diseases, such as malaria during tremendously rainy and arid years. In addition, studies have worried and alerted about the consequences of growing drought on food and fiber production. Still, its effect is mysterious in depth.

Factors of Climate Change Vulnerability

Climate Change Vulnerability has different factors. IPCC Third Assessment Report and found vulnerability as an element of the character, extent, and rate of climate variation to which a framework is uncovered, its affectability, and its versatile limit. In this IPCC theoretical literature, three components: exposure, sensitivity and adaptive capacity are mentioned as follows:

- Exposure is the immediate risk (i.e. the stressor), and the nature and extent of changes of a province's climate variables (e.g., temperature, precipitation, extraordinary weather events).
- Sensitivity is the human–environmental conditions that can intensify the threat, enhance the risk, or activate an effect.
- Adaptive capacity refers the capacity of household to cope

Structurally, advocate two sides of vulnerability to environmental hazard: internal and external sides which are used to distinguish the external stressors that a system is exposed from the internal factors that determine their impacts on that system [10-14]. External is used for socio-economic factor. In this regard, considers its similar two sides. The external side of risks relates to Individual to climate change and internal side is defencelessness i.e. a shortage of resources to handle without destructive damage. Differently, Moss, identify three dimensions of vulnerability to climate change: physical-environmental, socio economic and external assistance. The physical-environmental dimension mentions to the climatic conditions in area and to the biophysical effects of climate change, such as changes in agricultural output or the distribution of malady vectors [15]. The socioeconomic dimension refers to area's capability to recuperate from risky occasions and adjust to alter over the longer term. The third dimension, external assistance, is defined as the level to which area may be assisted in its attempts to adjust to alter through its partners and transaction associates, diaspora communities in other regions, and international arrangements to provide aid. In contrast to United Nations, this conceptualization of vulnerability includes factors outside the vulnerable system, such as characteristics of the stressor and the expected level of external assistance [16]. Furthermore, differently, in the study of vulnerability factors, United Nations distinguished the four groups of vulnerability factors: physical factors, economic factors, non-economic factors (social factors) and environmental factors. Physical factors describe the exposure to vulnerable elements within a region. Economic factors, which describe the economic resources of individuals, populations groups, and communities; social factors, which describe non-economic factors that determine the well-being of individuals, population groups, and communities, such as the level of education, security, access to basic human rights, and good governance; and environmental factors, which describe the state of the environment within a region. All of these factors describe properties of the vulnerable system or community rather than of the external stressors. Just mentioned four dimensions like as United Nations, but differently to explain a vulnerable situation in his conceptual framework of vulnerability: a) System refers to a coupled human–environment system, a population group, an economic sector, a geographical region, or a natural system. b) Attribute of concern: The valued attribute of the vulnerable system that is threatened by its exposure to a hazard. c) Hazard: it is a potentially damaging influence on the system of analysis. United Nations defines hazard largely as a possibly destructive physical event, phenomenon or human movement leading towards the loss of life or wound, assets loss, social and economic disturbance or environmental ruin. Hence, a hazard is understood as some influence that may adversely affect a valued attribute of a system. A hazard is generally but not always external to the system under consideration. For instance, a community may also be threatened by hazardous business activity or by unsustainable land management practices within this community. Hazard are often distinguished from discrete hazard, denoted as perturbations, and continuous hazard, denoted as stress or stressor. Developed his climate change vulnerability assessment framework based on the features of the defenceless structure, the category and quantity of stressors and their root reasons, their impacts on the structure, and the time period of the valuation to assess climate-related vulnerability [17,18]. In the framework, he included four fundamental dimensions related variables specifically (i) the system is mentioned in the framework of region and/or population group and/or sector of concern. In simple, it may be applicable to natural systems. Downing and simplified to three dimensions into single one as natural systems. (ii) The hazard is the external stressor (or set of stressors) such as climate change, flooding etc. United Nations as a potentially critical physical event, phenomenon or human action causing the damage of life or wound, assets loss, social and economic disturbance or environmental deprivation broadly explains hazard. Hence, a hazard is understood as some external influence that may adversely affect a valued attribute of a system. (iii) The consequences are physical valuable matters, biological life and biological life related assets. Its examples are human lives and health, the existence, income and cultural identity of a community, the biodiversity, and forest ecosystems and (iv) a temporal reference provides reference to assess climate related

vulnerability and its extremity and also comparative study. If the vulnerability of a system or its exposure to the hazard is expected to change significantly into the time period considered in an assessment, statements about vulnerability should specify a temporal reference, i.e. the period that they refer to. This is particularly relevant to vulnerability assessments addressing anthropogenic climate change, which may have a time horizon of several decades or longer.

Distribution and Magnitude of Climate change vulnerability

Climate change vulnerability is the result of climate change. Its distribution is all over the world where adaptation capacity of each country determines its magnitude. In developed countries, its magnitude is lower meanwhile its magnitude level is higher in developing countries.

Climate change vulnerability at global level

Climate change vulnerability is a big issue at Global level. On this issue, there are many empirical literatures, out of which this study has surveyed to most relevant empirical literatures for understanding its distribution and magnitude. Climate change is a driver of vulnerability. Found rain falls variability as shock behind growing vulnerability i.e., the likelihood of charming deprived of the future and further the household have a 39 per cent chance to be deprived of the future [19]. This is the result of their study on the relationship between rainfall variability in arid areas and vulnerability at the rural household in Kenya by using pseudo panel data. Similarly, found highly delicate to those people below 2USD earning poverty line and the poor remains poor because of climate overindulgence in their study on the farmer's vulnerability to climate extremes in Ethiopia by using econometric approach to identifying vulnerable farmers and probability of their loss of income. The magnitude of climate change vulnerability is due to lower adaptive capacity. The positive relationship between higher magnitude of climate change vulnerability and lower adaptive capacity in their study to construct a picture of socioeconomic context of vulnerability by focusing on indicators that measure both the state of development of the region and its capacity to progress further through vulnerability index based on primary data sets. The absolute poor household has lower adaptive capacity. Therefore, they are more vulnerable. Similarly, have found similar results in their analysis of vulnerability to climate change at household level in South Africa in 2010 by using the frequency of past and predicted changes in rainfall and temperature by 2050 [22]. Its distribution to the largest exposure to climate change is not almost the most vulnerable condition because the vulnerability is intertwined with social and economic development. In this regards, found the most vulnerable countries are those arranged in sub-Saharan Africa and those that has as of late experienced clash. Versatile limit—one component of vulnerability—is related overwhelmingly to administration, common and political rights, and proficiency in their determinants of vulnerability and adaptive capacity at the national level and the suggestions for adjustment in sub-Saharan Africa by creating calculated structure with an arrangement of markers of vulnerability and ability to adjust to atmosphere changeability, and by augmentation climate change. Identified climate change induced landslide disaster affecting adversely effects more on the lower socio economic household than the higher socio economic household in the study the extent and nature of the increasing adverse effects of landslide on housing in Murree City by dividing three clusters: inner city, urban fringe and rural fringe. Furthermore, he found that the weak and poor communities are more vulnerable to the landslide effects on housing than rich, educated and powerful houses. Adaptive capacity of Household and Institutions to floods in Chiang Mai, Thailand based on primary data collected by field survey by using theoretical method. The study found at the institutional level issues of jurisdiction and confusion between local authorities and development planning. At some extent, the local authorities worked on the flood mitigation plans, particularly on structural measures. The study argued its negative externality such as worsening floods of downstream areas. The early warning system in Chiang Mai Province was well-developed to the flood. In addition, the flood risk map was very effective. The study found autonomous and individual adaptation behaviour in nature at household levels in which the rural household had adaptive behavior more than the urban household did. Such difference depended on frequency of flood. In rural areas, frequency of flood per annum was more than in urban areas. The study argued to need of increasing public awareness and knowledge about flood preparedness. The climate change vulnerability of household in 12 Municipalities in the province of Laguna, Philippines by using a quantitative approach such as the Vulnerability Index (VI) and Vulnerability as Expected Poverty (VEP). The study found about 29 percent (VI) and 36 percent (VEP) of the household at least moderately and highly vulnerable respectively. The high incidence of vulnerability occurred in the case of the employee of the commercial and services sector and the livelihood dependent on agriculture. In addition, female-headed household had also higher vulnerability. Two results showed VEP and VI vulnerability categorization matched for only about 53 percent of the observations. In Laguna, typhoons and floods were the most significant natural hazard in terms of frequency and proportion of household affected. These hazards damaged to houses, psychological and emotional distress, and loss of income. There were occurrence of autonomous adaptation adopted by majority household such as strengthening the structure of their houses,

moving belongings to higher ground, and temporarily evacuating. Household had preferred top five interventions such as financial assistance, provision of relief goods, information dissemination, medical assistance, construction of flood mitigation infrastructure, and livelihood assistance. The result would be a good basis for economic analysis for identifying adaptation options. The distribution of climate change vulnerability in the world is much more on agriculture sector [26]. Impact on agriculture in the study to measure climate vulnerability and economic globalization by using data base of different indicators such as exposure to import trade, adaptive capacity, such as soil quality, water availability, foreign employment, infrastructure, human capital and physical capital with a Climate Sensitivity Indicator (CSI) (dryness and monsoon). Higher agriculture cost due to climate change in his study evaluating impacts on harvest yields with general harmony model to consider the effects of product yield changes in costs, free market activity, and on whatever remains of the economy [27]. At the farm level of agriculture sector, found climate change vulnerability having technological and economic challenges to societies in his study on climate variability, vulnerability and effectiveness of farm-level adaptation options: the challenges and implications for food security in South-western Cameroon. He focused the need of adaptation and its effectiveness for minimizing its negative implication at farm level. Similarly, found climate change vulnerability on maize crop production in his study on Measuring Vulnerability to Climate Change has empirically examined how climate variability affects household in developing countries by employing disaggregated and adjusted to computable general equilibrium (CGE) models on Malawi.. Simultaneously, its large land holding rural household may be in fact beneficial due to the increased maize prices. However, urban poor and small-scale farmers are vulnerable to climate change because of their food intensives. Estimated 6 per cent downfalls of farm level net revenues with the marginal effect of enlarged temperature in his study whether it is the impact of mean climate changes or climate variability that is assessed, whether farms are irrigated and geographic locations and in which season climate variability occurs. He used Ricardian Method based on cross-sectional farm level data onto eleven African countries. Further, on dry land farms, its effect on net revenue is estimated at -8 percent. On the irrigated land farms, its effect on net revenue is positive and estimated 3 percent growths of warming. The impact of declined precipitation also shows large variations, although both irrigated and rain-fed farming is expected to lose. Assessed the impacts of climate variability on Malawi, specifically economy wide impacts of droughts and floods on Malawi as well as adaptation through adoption of drought resistant maize variety. The study employed the CGE model at farm household level based on the simulation of production losses in agriculture estimated in a stochastic drought and flood model. The study estimates average loss with 1.7 per cent of GDP annually due to droughts and floods with Malawi. The CGE model divided farm household based on land holding size and region, as well as urban and rural non-farm household. Land size was used to categorize Farmland meanwhile skill level was used to categorized labor [29]. Found drought affected significantly agriculture and food production by reducing crop yields and then food production in the country in their study on the relationship between climate change and food security in Zimbabwe based on the assumption that climate change is a severe risk on food security in developing countries, like in Africa. Further, they observed a shift in the country's agro-ecological regions and its attribution to climate change. In this context, found negative effect of climate change on crops as dropping yields of plantain, cocoyam, maize and cocoa and deteriorating livelihood and expanded poverty, hunger and deterioration of living standards in their study on the impact of climate change on crop production and development of Muyuka subdivision [30]. During increasing sunshine, the drought climatic event caused drying of plants and ripening of cocoa pods before maturity.The negative productivity of the two main crops, corn and soy in US to multi-decade changes in exposure to extreme heat in the study of the potential impacts on economic outcomes and adaptation to climate change in US agriculture by using global climate models using data of temperature and precipitation changes across US counties. Further, they projected substantial losses under future climate change in the absence of efforts to help farmers better adapt to extreme heat [31].

Climate change vulnerability at national

Climate change vulnerability is emerging a big issue at local level too. On this issue, there are few empirical literatures. Few most relevant empirical literatures are surveyed for understanding its distribution and magnitude in agriculture. In Nepal, climate change vulnerability lies more in hills and high hills. Examined impact of climate change on agriculture in Nepal by using time series data by using econometric model. The study found temperature rising with 2.00 C averages in the western Nepal. It is relatively 3 times higher than lower temperature within the country and significantly higher in the comparison of global trend of temperature variation. Over the last 36 years (1975-2010) in western Nepal, rising average temperature is 1.2°C that is twice more of the global average. He indicated more vulnerability to climate change in hills and high hills. Like as in the world, its vulnerability is higher in agriculture in Nepal. Found more vulnerable the agriculture system from the flood in the study on flood hazard, their impacts, and the resilience of communities at the watershed level of Kankai River in Nepal [32,33]. Further, they found that the hazard prone area would increase from 25 year-returns period flood to 50 year-returns period flood. More

than 10 sq. km. of the agriculture land was in high hazard zone. The flood hazard was due to change in precipitation pattern and human intervention. Changes in climate and monsoon pattern made these areas more vulnerable. Special attention to the concerned body of this disaster should be drawn for the mitigation and to minimize loss from damage. Found heavy costs of climate change higher than the benefits of the farmers in the study on the potential economic impacts of the climate change on smallholder farming communities in Nepal by using theoretical and empirical papers published in different Journals [34,35]. In direct cost, there was higher cost of decreasing crops and livestock and increasing cost of production, along with cost from the increased risks of natural hazard and indirect cost as cost of change in socio-economic conditions, lost opportunities for the improvement in living conditions and adaptation costs. In the benefit, there were shortening crop life cycle, increasing to growing seasons and carbon fertilization increasing the crop production. The impacts of climate change on food security in the country in the context of policies of commercialization of farm production of his paper on Climate change and Food Security in Nepal based on literature review and analysis of secondary data. Time series secondary data onto agriculture, rainfall and temperature collected from publications of the Ministry of Agriculture and Cooperatives (MOAC) and Department of Hydrology and Meteorology (DHM). Similarly, food production data was collected from MOAC. In the method of analysis, statistical and econometric techniques were applied. The results were discoursed empirically and qualitatively on global, national, household and individual levels. The climate change affected the food security adversely at all four levels—global, national, household and individual. It was realized that among the climate estimators, the rise in minimum temperature reduces the yield of rainy season crops affecting the national self-sufficiency of food grains. The climate change affected the entire food system from production, processing, distribution, consumption and utilization. Food security in Nepal was particularly vulnerable to climate change due to low level of human control over the water and the temperature and fragile ecosystems that got easily affected from the climate change and related extreme weather events. The study noted a rise in minimum temperature pulls down the productivity of rice and push up risk of food insecurity. In this context, it pointed out the need of policy measures for improving food security and some areas for further research. Adaptation measures can reduce climate change vulnerability cost in Nepal. Policy measures for reducing the costs of the climate change the farmers bear in the study on the potential economic impacts of the climate change on smallholder farming communities in Nepal by using theoretical and empirical papers published in different Journals. He argued the importance of interventions such as variety, drought tolerant livestock, irrigation infrastructure and suitable farming technology to the farmers. In addition, it emphasized on the creation of the off farm employment opportunities as less affected by climate change than the agricultural source of income. It mentioned the need of farming system researches for the identification of location and endowment specific management trade-off suitable for the poor farmers. It gave the importance of national and international policy measures for the compensating the farmers for the costs due to the climate change, the need of public sector investment in agricultural production to safeguards the farmers from the vagaries of the climate change and the need of agricultural research program to develop technologies necessary for climate change adaptation. At end, the study opened up new research areas of quantification of the costs and benefits of the climate change in relation to the farmers and also to the food security of the nation. The study found the poor suffered from the floods more than the rich. Its evidence was flood damage costs accounted for 54.2 percent of the household income of the poor, but only 9.7 percent of the rich household in the urban area. Tested community level education's effect on the vulnerability to floods and landslide in Nepal by using the secondary data on losses at the village level due to flood and landslide published by the government of Nepal and micro data at the individual level from the 2001 census. In addition, primary information was collected from in depth interviews for various stakeholders in the study areas. Regression analysis method was employed to analyse such issue. The study found statistically significant explanatory variable to the mean years of schooling of young people aged 15-39 explaining losses caused by floods and landslide in all parts of Nepal. Rising mean years of schooling had higher effectiveness in the Terai than in the rest of the Nepal to reduce the numbers of lives lost and numbers of families affected. Its effectiveness level was almost 50 percent to reduce vulnerability higher in the Terai than in the rest of Nepal. A one year increased in educational attainment pulled down 59 percent in the Terai and 37 percent in Hill and Mountain Regions. The study argued that the effect of education falling vulnerability was more prevalent than income/wealth in floods and landslide in the study area [36,37].

Conclusion

Climate change vulnerability is more in the developing countries than in the developed countries. Its distribution is horizontal across the different income groups but its magnitude is vertically different across the different income groups. Its magnitude is less in the high-income group but higher in the low-income group. Therefore, the low-income group is more vulnerable from climate change than the high-income group in developing countries, like in Nepal. In addition, climate change induced disasters have negative correlation with altitudes in Nepal. Its intensity is higher in agriculture where the farmers have higher cost of climate change vulnerability than revenue from agricultural production.

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