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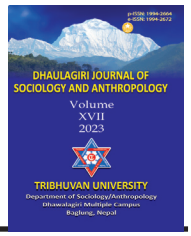

Climate Change and Social-ecological Vulnerability in the Himalaya: A Study of the Kaligandaki Basin, Nepal[1]

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Abstract

This research examines the implications and opportunities for climate change adaptation in the Kaligandaki Basin, Nepali Himalaya. The study adopts a holistic approach to explain human-environmental interrelationships. The Sustainable Livelihood Approach and the system approach of analyzing Change-Impact-Response are integrated to construct a dynamic framework that assesses household and sub-regional social-ecological vulnerability. Findings suggest that climate-sensitive social-ecological systems of the Himalayas are highly exposed to both climate change and non-climatic stressors. Households are trying to adapt to rapid change; however, their adaptation knowledge is not sufficiently translated into actions. Consequently, food and livelihood systems are insecure, and social ecosystems in the Basin are highly vulnerable to change.

Keywords : climate change, human environmental interaction, social-ecological vulnerability, system approach

Introduction

Climatic warming is higher in the mountains and in the Himalaya in particular (Lemke et al., 2007; Shrestha et al., 2012). The consequences in the Himalaya are wide, ranging from fast melting of glacier (Prasad et al., 2009), shift in monsoon characteristics (Turner, & Annamalai, (2012), and alteration in social ecological regime of the region (Nepal & Shrestha, 2015; Moiwo et.al., 2011).

The problems created by climate change differ from any other problems that contemporary human communities have been facing because its impacts pose risks to ecological, social, cultural, economic, and political systems (Barnett & Adger, 2003; Barnett & Adger, 2007). This study, thus, investigates the dimensions of human-environmental interactions in the Nepali Himalaya about climate change. The research has created interdisciplinary dialogue in understanding climate change and investigated its implications in the social ecosystem, adaptation measures the communities developed, barriers faced, and assessed the social-ecological vulnerability in the Kaligandaki Basin. The research developed and adopted an interactive framework of the system approach to study human-environmental interactions through integrating the Driver-Pressure-Stage of Change-Impact-Response (DPSIR) and the Sustainable Livelihood Approach (SLA). The findings provided important information for a climate change adaptation framework for South Asia in general and for Nepal in particular. The study contributed to the

1. This is a short communication of the PhD thesis of the author. The thesis is entitled: Human Ecological Implications of Climate Change in the Himalaya: Investigating Opportunities for Adaptation in the Kaligandaki Basin, Nepal. It was accepted for the PhD in the discipline ofGeography and Environment at the University of Adelaide, Australia, in 2016. It is available digitally, for general public at: http://hdl.handle.net/2440/99095.

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holistic approach to understanding human-environmental relationships and suggested an innovative methodology to study complex social-ecological systems under the disciplines of human geography, environmental sociology, and cultural anthropology.

Methodology

The use of the triangulation methodologies to create interdisciplinary dialogue in research findings, the adoption of a social learning approach to enhance policy implications of research, and measuring the multi-dimensional social-ecological vulnerability of micro-level social-ecosystem are the key methodological innovations of this work. Data and information have been collected through intensive fieldwork in three ecological zones of the Kaligandaki Basin. Primary data were collected through face-to-face interviews with the heads of 360 households, focus group discussion was conducted in 24 locations, historical timeline calendars were created in 7 sites, and crop calendars in 9 micro-ecological zones were constructed. Social perception of climate change (under 14 variables), impacts (under 15 variables), and adaptation response (under 35 variables), as well as adaptation barriers (under 10 variables), have been collected using the uni-polar Likert Scale. In addition, 40 year's meteorological data from three different meteorological locations have been analyzed to understand the physical changes in the climate system. The household food security has been assessed using the Household Food Insecurity Access Scale (FHIAS), livelihood sustainability has been assessed through five livelihood capital indices, while the multi-dimensional social-ecological vulnerability index (SVI) has been calculated from the exposure (23 variables), sensitivity (36 variables) and adaptive capacity (59 variables) indices using the IPCC Vulnerability Framework: Social-Ecological Vulnerability Index (SVI) = (Exposure Index –Adaptive Capacity Index)* Sensitivity Index. The SVI lies between '1' profound vulnerable to '-1' least vulnerable (Hahn et al., 2009; Mohan & Sinha, 2010). The results have been presented in reference to ecological zones, different classes of vulnerability level, and for individual households.

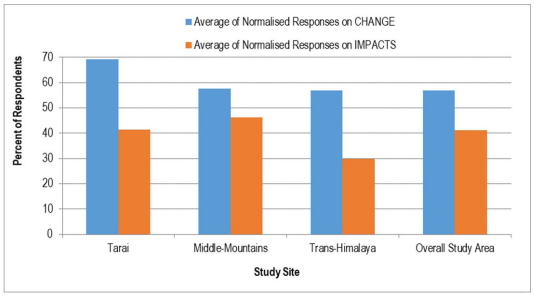
Results and Discussion

Climate Change and Corresponding Impacts

The changes in the Himalayan climate system are real, and so are the impacts. Yet, there exist spatial variations (Figure 1). The comparison between perceived and observed climate change shows both consistencies and contradictions. Rising summer temperatures are similar except in the case of extreme maximum and maximum temperatures at Jomsom, where the opposing results were found in the variability of winter temperatures, with no significant decrease in empirical assessment, but the majority of the respondents perceived a decline in winter temperature extremes.

Figure 1

Perceived Climate Change and corresponding Impacts on the Social-Ecological Systems of the Kaligandaki Basin, Nepal



Source: Pandey (2016).

The expansion of rainfall in the Trans-Himalaya is analogous to the observed change. However, this is not the case in the Middle Mountains and the Tarai. In general, community opinions regarding increased extreme rainfall events and floods agree with the scientific observations. Most of the respondents agreed that the monsoon has been coming later and withdrawing earlier in recent years, which is true only for the last few years in the case of meteorological data. The communities are often referring inter-annual variability as change. The experienced and desired outcomes of meteorological events play a role in the construction of community opinion. Nevertheless, these changes have produced many environmental challenges for the social-ecological systems of the Himalaya. Most of the reported impacts are increased soil erosion, landslides, floods, erratic rainfall events, drought, thunderstorms, and hailstones, as well as changes in plant phenology, shifts in habitat, and increased crop and livestock diseases and pathogens. All of these impacts are adding livelihood burdens to the communities.

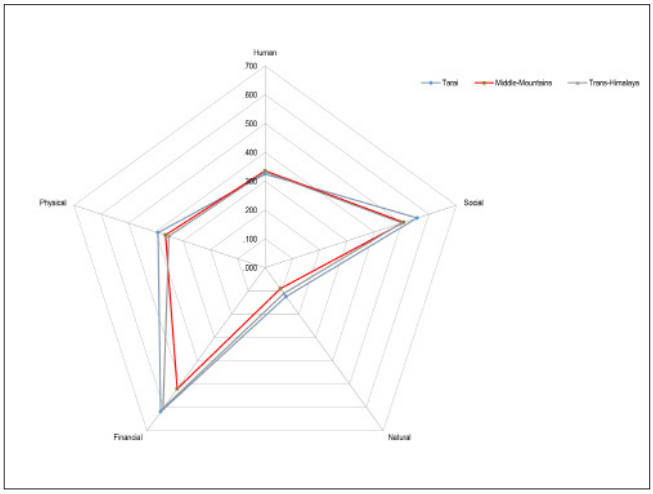
Livelihood system

The livelihood system of the studied households contains most of the components of the social-ecological system of the basin, which is stressed due to endogenous and exogenous factors. The index-based assessment of livelihood assets showed poor human capital but relatively rich social capital. However, the richness of social capital is seemingly irrelevant to climate change adaptation because all communities suffer from the impacts at once. The status of natural capital is also markedly poor because of access to only marginal size of land, which also lacks irrigation. Financial capital is at low level while public infrastructure to compensate for

the lack of private capital is inadequate. All these have detrimental implications for the livelihood sustainability of the studied communities (Figure 2).

Figure 2

The Mean of Livelihood Capital Indices across the Ecological Zones



Source: Pandey (2016)

Adaptation

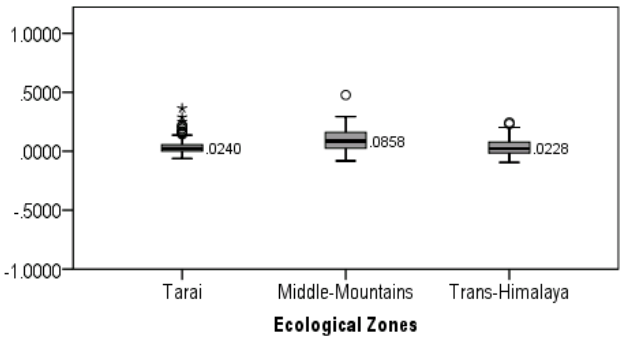
The studied communities demonstrated poor levels of adoption of adaptation strategies despite many of them holding relatively rich knowledge of the options. This has indicated the fact that knowing is not sufficient for doing. Among others, bio-physical adaptation strategies are found to be effective and relevant for most of the households, however, the small size of farm holdings, poor access to forest resources, and insufficient irrigation led to poor levels of adoption of such strategies. Some of the informants reported that the lack of knowledge transfer to younger generations - poor social learning, because of the lack of interest among young people in agriculture, has resulted in poor agricultural adaptation while some of the strategies adopted by the communities cannot be justified by climate change alone. Rather, they are the strategies for adapting to routine or severe pressures in the livelihood system.

Social-ecological Vulnerability

The results of the vulnerability assessment show that the social-ecological systems of the studied households are vulnerable (Figure 3). As the SVI ranges between -1 to 1, the households are categorized into four groups - very high, high, medium, and low levels of vulnerability[2]. The majority of households fall into the 'highly vulnerable' group, with 84.4 percent of households in the Middle Mountains, 75.2 percent in the Tarai, and 63.6 percent in the Trans-Himalaya. Only a few households (10.6 percent in the Trans-Himalaya, 3.9 percent in the Tarai, and 3.5 percent in the Middle Mountains) are 'less vulnerable.'

Figure 3

The Social-Ecological Vulnerability Index by Households and Ecological Zone in the Kaligandaki Basin, Nepal



Source: Pandey (2016); (also appears in Pandey, & Bardsley, 2015)

Conclusions

Implications of Study

This study has explained that human-environmental interactions in relation to climate change cannot be understood comprehensively through orthodox human ecology and neo-environmental determinism approaches but requires a lens of 'social-ecology' that integrates societal and natural processes and their dynamics. Similarly, no single approach to system analysis is sufficient to deal with the complex issues of human-environmental systems so a holistic analytical methodology that integrates multiple approaches and frameworks becomes imperative. In addition, considering household as a key unit of vulnerability analysis instead of the spatial cluster is more appropriate for effective policy practice within marginal contexts because such practice informs vulnerability 'hot spots' warranting interventions. Based on the theoretical contributions of this research, an integrated and dynamic adaptation framework has been proposed to make the research findings applicable to adaptation policy.

Conclusions

This study comprehensively analysed human-environmental interactions in the Himalaya in relation to climate change using an integrated framework and methodology. The systematic and integrated assessment of climate change and associated impacts, a broad description of livelihood capital of the communities, and careful mapping of adaptation responses provide important information on the exposure, sensitivity and adaptive capacity of the social-ecological systems of the Kaligandaki Basin, Nepal. Because of the higher level of exposure to the change and sensitivity of the social ecosystem in the

2. Very high (>=0.3), High (>=0 and <0.3), Medium (>=-0.3) and (<0), and Low (<-0.3)

context of poor adaptive capacity the micro-level social-ecological systems of the basin are highly vulnerable, and the Middle-Mountains being the more so. However, it is difficult to distinguish vulnerability from poverty and multidimensional deprivation in the basin since the studied households are generally poor and marginalized already, lacking basic necessities or a voice in policy decision-making, so they are vulnerable irrespective of climatic factors. In this context, an integrated adaptation policy to increase the broader resilience of social-ecological systems is proposed, and such a proposition will require to be supported externally, including the state of Nepal.

Declarations

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Conflict of Interest:

No conlfict of interest regarding to this publication.

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