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Contribution of geographical information system on livelihood adaptation in Nepal

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Abstract

The issue of livelihood adaptation along with the change in climate has been a matter of discussion in the academic arena to address the climate change and geographical diversities in Nepal. The utility of GIS (geographical information system) has been considered as one of the effective tools adapted from ICT. This paper discusses the contribution as of GIS on livelihood adaptation and challenges to overcome the situation for effective management of environmental changes in Nepal. The virtual nature of the interne and novice users to its considerable capacity may contribute for the effective and efficient livelihood adaptation. The study has concluded that GIS is essential for forecasting and redeployment of resource through geographical mapping. Managing future risk requires insight into current and future vulnerabilities and how to prevent or reduce them, the probabilities of a threat, and the costs associated with potential outcomes and how to mitigate them. Some of the issues for consideration related to sustainable development and management can be regulatory measures of GIS, legal measure, technical and procedural measures and public awareness and capacity building.

Keywords: livelihood, poverty

1. Introduction

Sustainable livelihood of any household depends on effective security measures i.e. ownership, resources and income earning activities, including resources and assets to offset risk, ease shocks and meet contingencies; ownership of land and livestock; rights to grazing, fishing, hunting or gathering; and stable employment with adequate remuneration.

Livelihood is determined by a number of factors and there is diversity in livelihood strategies that exist at every level within geographic areas, across sectors, within households and over time which are mainly determined by environmental, socio-economic and cultural factors. The major socio-economic and cultural factors include tradition, caste and other identity also it is determined by the people's evaluation of the possibilities offered by these physical as well as socio-economic environment. (Knowles and Wareing, 1996). Livelihood is also shaped by political system within which they operate (van der Hoeck, 2001). Many livelihood patterns are largely predetermined by accident of birth and their parents occupation and some are less predetermined and improvised through education and migration (Chambers and Conway, 1991).

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In general adaptations refer to responses or actions of individuals that have survival value for the individual and the group that constitute the plan of actions carried over a specific time by a specific group of people to allow them to adjust or to cope with their local environment. During the latter parts of the 1990's Nepalese began to migrate to the Gulf countries for work, particularly to Saudi Arabia, the United Arab Emirates (USE), Kuwait and Qatar within a short period .

The livelihood pattern implications of this situation are far-reaching for Nepal as a whole, for the structure and dynamics of regional and local economy and society. Livelihood strategy varies from place to place. Particularly two characteristics of physical environments of the existing resources together with the socio-economic/culture factors control human activities (Young, 1973).

Livelihoods comprise the capabilities and material and social assets necessary for a means of living (Chambers and Conway, 1991). A sustainable livelihood includes the idea of coping with and recovery from external stresses so as to maintain or enhance existing capabilities and assets - a notion central to the definitions of resilience being discussed in relation to climate change.

2. Objectives of the study

The main objective of the study was to evaluate the effects of sustained livelihood adaptation and use of remote sensing using GIS (geographical information system). It was also aimed to determine the influence of mitigation towards climate change and to assess the problems and prospects of the hazard mitigation.

3. Research methodology

An analytical mixed method research design was used in this study as it helped to explore the pattern of adaptation strategies in the village including rural and urban settings. The research tools supported to identify the reasons for the purpose of study. It looked for causes and reasons of the current status of the subject in the study. Analytical research design explained the effects of livelihood adaptation strategies over the development interventions and intervening variables on the selected areas of western mid hills of Nepal.

The data was obtained secondary sources mostly. The technique of primary data was limited to be clarify what were found in secondary, so no structure questions were developed. Secondary sources of data were mainly through a review of previous works in the subject matter with a view to finding out any existing gaps that the research study tried to fill. These secondary sources included information sought from journals, articles, books and government reports.

4. Study location

Arghakhanchi district, the study area is located in Lumbini Zone, Western Development Region of Nepal. It is located in the hilly side. Geographically, the district extends from 27045' to 2806' north in latitude and 80045' to 83023' in longitude and its total area is 1,193 square kilometers. In case of geographical division, the Mid-hill covers 68% and the Siwalik hill covers 32% of the total land areas. In case of political division there are 37 VDCs (Village Development Committees), one municipality and 11 Ilakas (Thapa, 2014).

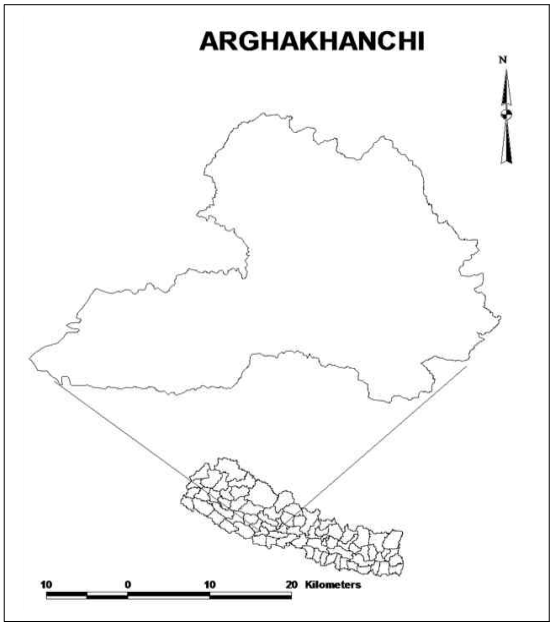
The topographic elevation of Arghakhanchi begins from 305 meters above sea level in the south to 2,575

meters to the north. Almost 40% of the district is covered with the bushes and jungle. There are many rivers and lakes, namely Kharkabesi, Mathurakhola, Durgakhola, Waglekhola, Sitakhola, Jhimruk as well as Thadadaha, Senlengdaha and Khanadaha. In general, Arghakhanchi has a steep slope (Thapa, 2014).

A greater part of Argahkhanchi, which borders on the plain Tarai in the south, consists of low hills, river banks, low land ravine and open and wide cultivated land. About 18% of total cultivated land makes slope of 300. In terms of slope cultivated district, Arghakhanchi is in the first rank (Singh, 1995), geological feature and fertility of land.

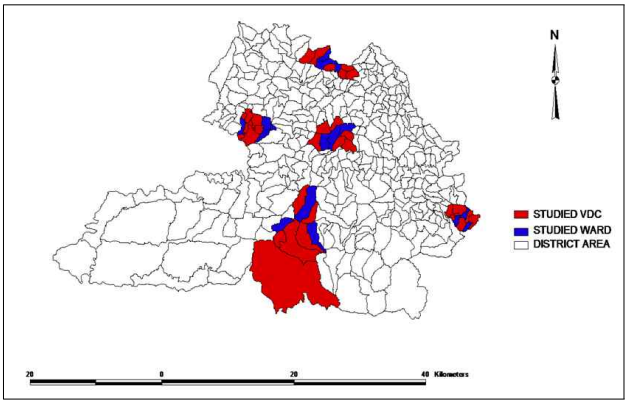
In the map of Nepal, it is surrounded by many districts: Palpa to the east, Gulmi to the North, Kapilvastu and Rupandehi to the South and Dang and Pyuthan to the West. Majority of land (68%) falls in the Mahabharat range and the rest in the Siwalik Hills.

Figure 1. Map of Nepal showing sample district



Regarding the significance of its naming, there is a traditional hearsay –while offering 'Argha' (libatia) in the Bhagavati Temple, Goddess Durgaa appeared. Hence 'argha' came into existence; and 'khanchi' is the term derived from 'khajanchi' (the treasurer), who collects land revenue. Thus in course of time, Arghakhanchi was possible (Argakhanchi DDC Profile, 2011).

Figure 2. Map of Arghakhanchi showing the sample VDCs



Source: Nepal Map House, 2014

The population pressure varies according to the link existing human resource development system of the society. The finding and conclusions have been derived on the basis of functional analysis in terms of human resource variables such as demographic, economic and social aspects.

The geological structure of Arghakhanchi covers recent structure, Siwalik, Jarbuta, Neta, and Meta sedimentary structures. The soil in Arghakhanchi is found to have been categorized into grey, dry, damp, black and red, respectively. The majority of the district is constructed with low hills, gorges and river basins. The chance of soil erosion is high due to naked pastureland, haphazard construction work and deformation. The farmland is likely to be converted into deserted land due to the soil erosion, heavy landslide and avalanche of concrete. What is more, the southern part of the district is in the vulnerable position from the soil erosion perspective since there is a heavy deforestation due to human encroachment in this area.

5. Theoretical discourse and conceptual framework

It has been mentioned that there are several ways of analyzing the issue of poverty which can be categorized broadly into two schools of thought: one school of thought considers poverty from the point of view of employment, whereas another considers livelihood as crucial, especially in the context of rural poor people. The employment school of thought views income at the center of analyzing poverty and ponders over the concepts of urban areas, industries, and other formal sector of economy where an individual can hold a job and get regular payment as daily, weekly or monthly pay and perks. It is perhaps true in an urban setting.

The second school of thought considers livelihood as a complex phenomenon, primarily in a rural setting. The rural poor reside very far from the formal sector of economy with timetable, employment, salary, and market economy. Thus, they can think of the ways to seek livelihood by exploiting a whole range of activities in different seasons. Poverty is one of the components interlocking the entire dimension of deprivation which has five clusters of disadvantages: physical weakness, isolation, poverty, vulnerability and powerlessness (Chambers, Saxena and Shah, 1991). Poverty has no single component; understanding it requires complex and exhaustive efforts.

Professionals, planners, and policymakers strongly believe that poverty can be reduced by creating off-season employment for the rural poor. Following such idea, *Jawahae Rozagar Yojana* has initiated in India to

provide employment to the poorest in the slack seasons and build infrastructures. But outcomes do not support the set assumptions (Singh, 1995). Similarly, in Nepal (late 1999s), the Nepali Congress government initiated a special program Garib sanga Bisheshwar (Bisheshwor Amount the Poor) which was designed to serve 100 families from each of the 205 parliamentary electoral constituencies every year. In order to implement the program and address the problem of the people, it developed criteria of the poor people who could benefit from the program, e.g. landless state, nutrition level, social deprivation, marginalization, gender, and age but no remarkable achievement has been noticed due to such program so far. In Nawalparasi district, both the programs *Garib Sanga Bisheshwor* and West Tarai Poverty Alleviation have been implemented. Despite the fact that the relevant VDCs have met all the criteria to implement the anti-poverty programs, 42 percent of the households are yet without land (www.cbs.gov.np). Due to their varied and conflicting interests, the central and district level policy makers never implemented the anti- poverty programs in the concerned VDCs.

In order to measure the programs in society, the modern world has developed several indicators, viz. Gross Domestic Product (GDP). Gross National Product (GNP), Physical Quality of life Index (PQLI), Human Development Index (HDI), Human Empowerment Index (HEP), and Gender Empowerment Index (GDI), etc. Similarly, a number of approaches for rural development have been used, viz. top-down approach, bottom-up approach, integrated rural development approach, etc (Devkota, 1999).

Almost all of development approaches so far have been devised and advocated by the economists and their relevance in terms of ground realities is being increasingly questioned. UN has become one of the vanguards for development. At the end, past development efforts have either left behind, or in the same way even created, large areas of poverty, stagnation, marginality and exclusion (quoted in Esteva, 1999: 18). The role of anthropology as a discipline and that of anthropologists as experts have only recently recognized in the form of development anthropology or anthropology (Grillo, 2002). In Nepal, there are some distinguished anthropologists who have contributed in the field of development.

Since the failure of anti-poverty agenda of the US in 1960, the issue of poverty has gradually been taken away from the economists and it now falls under the modernization paradigm and due importance is given to the social aspects. It is noteworthy to mention that there are several theories in sociology and anthropology which explain the status of poverty. For example 1) Social Theory of Povety; 2) Culture of Poverty; 3), Situational Theory of Poverty; and 4) Structural Theory of Poverty. Before going into the conceptual framework of this study, let us consider the above stated theories briefly.

Social Theory of Poverty was propounded by Charles Darwin. Vigorous proponents of this view have been found in the US recently as a 'new right ' which includes George Gilder, Murry and Richard Hernstein. They hold an extreme belief that the poor are genetically blueprinted to be at the bottom of the social hierarchy; to invest for them is a sheer wastage of resources.

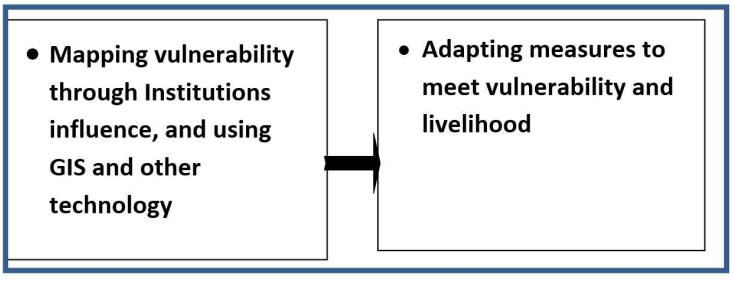
The theory of Culture of Poverty was developed by Oscar Lewis (2007) which was based on his observations and experiences in Mexico. The Situational Theory of Poverty gives importance to the condition of society that contributes toward magnifying poverty. The Structural Theory of Poverty is caused by the structure of large scale socio-economic order. It is the macro and holistic structure of the society that produces inequality and as a result poverty emerges which becomes widespread. Various theories have been used to describe the issue related with poverty but their perspectives are different. However, the examples of the Third World countries, especially from the neighboring country, are relevant.

The word 'livelihood' can be used in many ways on the basis of context and culture which comprises the capabilities, assets (material as well as social resources), and activities that are required for a means of living. CARE Nepal has pursued livelihood security at the household level, which can only be achieved by integrating the needs and opportunities related to individual security components like economic security, food security,

potable water, health services, educational opportunities and time for community participation (CARE Nepal, 1997). But it has undermined the decision-making component, which is one of the crucial factors, at all levels in policy framework. Oxfam and UNDP have also used the livelihood approach in their programs to analyze the poverty issue.

6. Conceptual framework for result and discussion

Figure 3. Conceptual framework for mapping and mitigating vulnerability



7. Discussion

7.1 Existing institutions influence on vulnerability

Institutions influence the livelihoods and adaptation of rural households in three important ways.

1. They structure the distribution of climate risk impacts. How particular social groups and populations will be affected by climate hazards is in part a function of the physical and structural characteristics of the hazard. It is also in part a function of the way macro- and micro-level institutions in a variety of domains affect distribution of risks related to climate hazards.
2. They constitute and organize the incentive structures for household and community level adaptation responses which shape the nature of these responses. Institutional incentives are key factors in determining whether adaptation responses will be organized individually or collectively because institutions affect the emergence of leadership in different contexts, costs of collective action, and the extent of transactions costs.
3. They mediate external interventions into local contexts, and articulate between local and extra-local social and political processes through which adaptation efforts unfold. External interventions in the shape of finances, knowledge and information, skills training, new institutional inputs, and technological support can assume many different forms. Local institutions shape the acquisition and distribution of these interventions in fundamental ways, thereby affecting the degree of success of such interventions.

7.2 Problems faced by livelihoods

The concept of static equilibrium envisaged in eco-system analysis of man-environment relation has attracted the scholars in recent days. Humans are capable of modifying the rate of such changes or even to reverse it. In fact, man modifies the natural environment for the production of both plants and animals for subsistence and exchange. The sustainability of livelihood depends on different factors. Among them, the climate condition plays a significant role. In recent years, the global climate has changed due to various human induced causes. In this research, climate and socio-economic change varies from local to regional, country and global level and in cases the spatial unit of enquiry is the administrative region. This is formal, which is not necessarily characterized by natural process and associated system in which ecological and physical factors, infra-structural provision, population, ethnicity and social cultural tradition differ markedly within a short spatial distance. This factor shapes livelihood directly and indirectly as these factors provide opportunities as well as constraints for people's livelihood. Thus there is need of study at rural level.

7.3 Vulnerability mapping using GIS

In the context of hazard management, GIS can be used to create interactive map overlays, which clearly and quickly illustrate which areas of a community are in danger of disaster. Such maps can then be used to coordinate mitigation efforts before an event and recovery after. GIS, thus, provides a powerful and versatile tool to facilitate a fast and transparent decision-making. In addition, a digital elevation model (DEM) is prepared from the contour and spot heights and used for preparing a slope map, cross-section profile of the terrain, and river profile; and delineating potential sites for river-bank cutting, disaster-prone areas, assuming a dam of a certain height at a given river reach. A DEM is also used to calculate the damaged area by incorporating it into the U.S Army Corps' Hydrological Engineering River System Analysis (HEC-RAS) flood modeling software.

7.4 Collaborative mapping and mobile GIS

Elements-at-risk information is collected from a wide variety of sources, some of which are discussed in the section below. There are also many areas in the world for which no detailed digital data is available on elements-at-risk. In such situations data should be digitized from analogue maps or in case these also don't exist, be mapped in the field, for instance using mobile GIS. With the use of mobile GIS it is possible to directly collect the spatial information, based on a high resolution image that can be uploaded into a palmtop computer, or smart phone and link it with attribute information that is collected in the field. Some of the most used tools for mobile GIS in urban elements-at-risk mapping are ArcPad and Cybertracker. Several initiatives have come up for collaborative mapping of topographic features. For example Open Street Map is a free editable map of the whole world, which is made using collaborative mapping by volunteers. It allows users to collect, view, edit and use geographical data in a collaborative way from anywhere on Earth.

7.5 Remote sensing and GIS for natural hazards

The use of earth observation products and GIS has become an integrated, well developed and successful tool in disaster risk management. Hazard and risk assessments are carried out at different scales of analysis, ranging from a global scale to a community level. Each of these levels has its own objectives and spatial data requirements for hazard inventories, environmental data, triggering factors, and elements-at-risk. An overview is given of the use of spatial data with emphasis on remote sensing data, and of the approaches used for hazard

assessment. This is illustrated with examples from different types of hazards, such as earthquakes, windstorms, drought, floods, volcanic eruptions,

7.6 Approaches to livelihood

The livelihood concept is a recent one. This concept dates back to the work of Robert Chambers in the mid-1980s and was further developed by Chambers and Conway and others in the early 1900s (DFID, 1999). The sustainable livelihood approach as a development concept is legitimized through several international forums.

With regard to sustainable livelihoods DFID (1999) published a set of guidance sheets' with a view to attempting to summarize and share on the sustainable livelihoods approach. The guidance sheets are the outcomes of the White paper on International Development issued by Government of the UK in 1997. Following the approach of Chambers and Conway, DFID defines livelihoods with some modifications but it is exactly the same as defined by Carney (1998). The guidance sheet presents origin, core concepts and framework of sustainable livelihoods. The framework presents the main factors that affect people's livelihoods and interrelationship between these factors. It begins with simultaneous of people's assets, their objective and the livelihood strategies, which they adapt to achieve their objectives. The framework shows five capital assets-human, social, natural, physical, and financial in a shape of pentagon, which lies at the core the framework and it is connected to the other components which vulnerability context, transforming structure and processes, livelihood strategies and livelihood outcomes. The capital assets are defined as:

1. Human capital represents the skills, knowledge, ability to labor and good health that together enable people to propose different livelihood strategies and achieve their livelihood objectives.
2. Social capital includes networks and connectedness, membership of more formalized groups and relationships of trust, reciprocity and exchanges.
3. Natural capitals are the natural resources stock from which resources flow and service useful for livelihoods are derived. These include land, forest, marine/wild resources, water, air quality, erosion protection, waste assimilation, storm protection, biodiversity degree and rate of change.
4. Physical capital comprises the basic infrastructure and produce goods needed to support livelihoods.
5. Financial capital denotes the financial resources that people use to achieve their livelihood objectives. There are two main sources of financial capital- available stocks (cash, bank deposits, livestock, and jewelry) and regular inflow of the money such as pension or remittances.

7.6.1 Adaptive strategies towards sustainable development

The households of different communities situated in mid western hills of Nepal pursue many activities in response to the changing environment. There was no unique coping as well as adaptive strategy of a particular community. Depending on the access to different strategies, the households of the area are adopting all the possible coping and adaptive strategies for their survival.

Storage of food, fodder and fuel wood, taking loan, selling jewelries and domesticated animals, mortgaging land and wage laboring are the common coping strategies of the households of all the communities. Taking loan is the major coping strategy for the different ethnic groups including Brahmin/ Kshetri, Ethnic groups, Dalits, Indigenous groups owing to market integration of the local produces - cash crops, vegetables and dairy.

But working as wage labor is the principal strategy of the poorer households, particularly the Dalit,

Indigenous group and Ethnic communities of Arghakhanchi. Wage labor as the coping strategy is adopted by Dalit community.

It is not because of the fact that the money lenders do not believe the poor households who possess enough assets or have access to cash crops or vegetables or dairy. The Dalits and several poor households of other communities have the least amount of jewelries on average. Therefore, such households have limited option for selling jewelries as an immediate alternative, in case risk arises.

7.6.2 Technology for adaptation

The wise use of technology and techniques are best factors that mitigate the worse impacts of climate change induced risk not only of disasters but also of agricultural production, water scarcity, drought and erosion. Most of the villagers are unknown about cost effective and simple techniques and technologies such as rainwater harvesting, sprinkle irrigation etc. Availability of technical assistance such as heavy equipments may help to reduce flood and debris flow through land reclamation. As temperature increases the chances of increasing pest is also increasing. Proper pest control technology may minimize its worse impacts.

8. Conclusion

While studying the different researches and studies made by many other organizations, it can be concluded that still there are a number of challenges despite of some progress and advancement in the livelihood adaptation. The majority of the population of Nepal resides in the rural areas so that the livelihood in general is critical in such areas. While studying for twenty years there have been changes and progresses in the livelihood pattern and adaptation strategies. The study and analysis of the documents have revealed that there has been a tremendous efforts carried out for the implementation of the programmes of interventions in future. The sustainable programmes have been demanded for the accumulation of the climatic change effects as well as the environmental factors for poverty alleviation.

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