CHAPTER I

INTRODUCTION

1.1 Background

Livelihoods are the means people used to support themselves, to survive, and to prosper. It is an outcome of how and why people organize to transform the environment to meet their needs through technology, labor, power, knowledge and social relations (Hoeck, 2001). It comprises a complex and diverse set of economic, social and physical strategies. These strategies are realized through the activities, assets, and entitlements by which individuals make a living (UNDP, 1999a). Rural livelihoods comprise one or more often several activities, which variously provide food, cash, and other goods to satisfy a wide variety of human needs (Chambers and Conway, 1991).

Livelihood is defined by a number of individuals and organizations (Chambers and Conway, 1991; Scoones, 1998; UNDP 1999a) including Department for International Development (DFID, 1999). DFID has presented a slightly modified version of the definition originally developed by Robert Chambers and Gordon Conway as:

> A livelihood comprises the capabilities, assets and activities for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (p. 4).

Livelihood is determined by a number of factors. People's access to different levels and combination of assets has probably the major influence on their choice of livelihood options. Enormous diversity of livelihood strategies exist at every level within geographic areas, across sectors, within households and over time. Therefore, specific livelihood outcomes are mainly determined by environmental, socio-economic and cultural factors. The environmental factors like climate, soil and relief not only impose certain constraints and limitations but also provide opportunities upon the range of livelihood activities. For example, crops that may be successfully cultivated and the type of livestock that may be profitably reared in an area depend on

environmental conditions. Socio-economic and cultural environs influence peoples' choices of livelihood options. The major socio-economic and cultural factors include tradition, caste and cultural identity. However, within any particular environment many choices and options are normally open to the people, the actual livelihood pattern is determined by the peoples' evaluation of the possibilities offered by these physical as well as socio-economic and cultural environments (Knowled and Wareing, 1996). Livelihoods are also shaped by political system within which they operate (Hoeck, 2001). Many livelihoods are largely predetermined by accident of birth by their parent's occupation and some are less predetermined and improvise through education and migration (Chambers and Conway, 1991).

The role of assets in livelihoods is enormous (Chambers and Conway, 1991; Scoones, 1998; DFID, 1999). Both tangible (resources and stores), and intangible (claims and access) assets provide material and social means. There are five different categories of livelihood assets (DFID, 1999)- these are natural, physical, human, social and financial. The role of each asset is important however; the importance of individual asset differs greatly by places and time due to variation in physical and socio-economic and cultural environments.

Of the five assets, natural assets are quite important for livelihood of backward and poor communities in developing countries. Water is one of the natural assets, which is fundamental to livelihoods. Of all the earth’s resources, none is more fundamental to life than water. The earliest stirrings of life began in water (Sharma, 1985). The uses of water in human life are varied. We drink it, bathe in it, travel on it or see beauty in its different forms, procure different occupation with its use (Critchfield, 1987).

Water security can play a wider role in improving livelihoods. Water is also valued for environmental and ecosystem and ecosystem is valued for regulating water quality and quantity (Rosegrant et al., 2002). On an average the quantity of water required for drinking and cooking purposes is estimated to be about 5 liters per person per day. About 2,500 kg of water is required to produce one loaf of bread and the flour that goes into that loaf, 17,000 kg of water is required to produce half kg of beef and 29,000 kg of water is needed to make one ton of steel (Khadka, 1998). The potential positive impacts of better domestic water supply as identified by International Water and Sanitation Center (2003) are: improvement in health, reduction in time and effort

spent for collecting water, reduction in expenditures on water, availability of time for education, improvement in environmental sanitation, ensuring women empowerment, increase in the capacity of local community, provide more opportunities for home-based activities which lead to improved employment, increase in productivity and income, and enhanced level of food security and nutrition. Since the demand of water for domestic use and irrigation purposes depends on the size of the population, an increase in population would result in a greater demand of water for other purposes too. Similarly, advancement in industrialization increases the demand of water for industrial purposes and enhances the use of water for navigation as the cheapest means of transport, in some areas. The intensity of water use depends on the availability of water resources, demand of water for different purposes, and technological advancement to augment water.

Water is one of the most important constituents of the environment, but limited in supply. Planet Earth constitutes nearly 1,400 million cubic km of water (Khan, 1994; Subba, 2001). Most of it (97 percent) is salt water, and is of little direct use to mankind. Out of the 3 percent balance, 77 percent is virtually unavailable for human use as it is locked in permafrost, icecaps and glaciers, 22 percent of global fresh water can not be exploited as it lies at the depth of the more than 800 meters. Lakes and rivers contain hardly 0.4 percent (136,000 cubic kilometer) of the world's fresh water available to human use (Rashid, 2000). The spatial distribution of water is uneven as a result of a number of factors. These factors include the amount and pattern of rainfall, ground water stock, and storage of water in the form of snow and glacier. The availability of and demand for water are closely linked to climate factors. Water availability determines spatial variation in livelihoods.

Nepal is rich in water resources; it has a dense network of more than 6,000 rivers and rivulets (Banstola, 1994; Yogacharya and Sharma 1998; Gyawali, 2001) with a total run-off of about 224 billion cubic meters (Yogacharya, and Sharma, 1998, Ahmad et al., 2001). Annual water availability in Nepal is 11,82,000 cubic meters per square kilometer while the corresponding figure for the world is 2,69,000 cubic meters. The availability of water per head in Nepal is estimated at 7,800 cubic meter per year while the corresponding global figure is estimated at 7,400 cubic meters per capita per year (Ahmad et al., 2001).

Though the potentiality of water use in Nepal is huge, its actual use is limited. The per capita consumption of fresh water in Nepal is 154 cubic meters (Subba, 2001: 14). According to government estimate, in the year 2000, 67 percent of the population had access to domestic water from piped system, protected streams or hand pumps (Dixit, 2002). Out of the total 1.766 million hectares of irrigable land in Nepal, in 2002, 1,126,601 hectares (64 percent) are irrigated. Of these only 461,041 hectares of land are estimated under irrigation throughout the year (HMG/N, 2003). Though, Nepal has an enormous theoretical potentiality of generating 83,000 MW hydropower, only a fraction has been harnessed and only a small fraction of the population has access to hydroelectricity. The total production of hydropower was 535.20 MW in 2001 and 39.4 percent of total population had electricity facility in 2001 (HMG/N, 2003). The use of water for transportation though widespread, is not commercially well developed. The rafting activity is a new development towards this direction. The use of water for religious and cultural purposes is common in Nepal.

The available water is not harnessed adequately on the one hand and demand for water has been increasing due to rapid growth in population and changes in lifestyle due to rapid urbanization and globalization on the other. Warming is a global phenomenon, changes in temperature and alteration in pattern and intensity of rainfall is reportedly common. Deglaciation is a worldwide phenomenon as a result of increase in temperature. These changes have altered the temporal and spatial pattern of water availability. In some places these changes exacerbate the frequency and magnitude of draughts while too much water and floods in the others. These changes have greater implications on people's livelihood.

1.2 Statement of the problem

There are a number of studies on livelihoods (Debner, 1995; Ham, 1995; Bhole and Adhikari, 1998; Ellis-Jones 1999; Blakie, 2000; James 2001; Wyss, 2004). These studies focus on livelihood relating to different capital assets with a sectoral approach focusing one of the components of any one of the five assets. Though the importance of any particular asset in livelihood could not be undermined, the livelihoods of any community of any place do not rely fully on any particular asset. However, the importance of particular asset varies by places depending on situation. The availability of assets differs by places and time as a result livelihood varies depending

on physical, socio-economic and cultural environs of the area. The livelihood strategies of the people are the outcomes of the availability of and access to the assets and peoples' choices. The studies on livelihoods in Nepal are limited and none of the studies analyze livelihoods combining all these assets in an integrated way. In such cases there is a need of study on livelihoods combining different capital assets.

A number of studies deal with water resources and their uses (Joshi, 1981; Mainali, 1987; Bhandari 1994, 1996; Khadka, 1998; Allan, 1999; Banskota, 2000). The studies, which focused on water uses, are also in sectoral approach focusing some of the aspects of water uses. Water is the most fundamental of all the resources to livelihoods and its uses are varied for life and livelihoods. The development of different livelihood activities such as agriculture, industry, livestock, navigation and transport, and energy/hydro-electricity all depends on water availability and its uses. Safe water and sanitation shape peoples' health through potable water supply, safe food preparation, hygiene, better nutrition, and relaxation. Water also provides a means for the diversification of livelihoods. All human activities are directly or indirectly related to water. In this context there is a dearth of studies focusing different water uses relating livelihoods in an integrated way. This is the focus of the present study.

The availability and use of water depends on different factors. Among these, climatic condition plays a significant role. The global climate has been changing due to various human induced causes. Alteration to the seasonal distribution of precipitation with the likelihood of more rain, less snow, and higher evaporation resulting from temperature increase are reportedly common, however the same scenarios are not experienced everywhere. According to Choudhary et al. (2002) the South Asian region is likely to be one of the worst hit regions around the world due to its high susceptibility to extreme weather events as a consequence of high temporal, spatial and inter-annual climate variability. Since Nepal lies within this region, the impact of climate change on water resources and water related livelihoods is certain. Thus, there is a need of study focusing on this aspect.

The scale of the present research varies from local (VDC and district level) to regional, country and global level and in such cases the spatial unit of inquiry is the administrative area. The administrative area is a formal region, which is not

necessarily characterized by natural processes and associated systems. In a mountain watershed, ecological and physical feature, infrastructure provision, population, ethnicity and socio-cultural traditions differ markedly within short spatial distances. These factors shape livelihood directly or indirectly in many ways as these factors provide opportunities as well as constraints for peoples' livelihood. Thus, there is a need of study at watershed level.

With the background mentioned above the pertinent research questions of the study are given below.

- How are the livelihoods structured/influenced by resources/assets?
- What are the present livelihoods strategies of the mountain people?
- How is water utilized and managed?
- What is the role of water resource in livelihood security?
- What are the constraints and opportunities in water uses and how do local people perceive the likely changes in water use due to recent change in climatic elements as caused by global warming?

1.3 Objectives

The general objective of the study is to examine livelihoods of the people living in mountain watershed based on a case study of the Modi Khola watershed. The specific objectives are to:

- analyse different livelihood assets and their implications in livelihoods.
- assess the present livelihood strategies adopted by the people.
- assess the role of water in livelihoods, its utilization and management.

1.4 Hypothesis

Livelihoods of the people are determined by a number of factors. The availability of assets, socio-economic and ecological environments and people's choice are the primary determinants for livelihood outcomes. The following hypotheses are formulated in this regard.

- There is a positive relationship between household assets and the level of household income.

- Multiple income sources of the household lead to higher household income.
- Cropping intensity is directly related to irrigation facility.

1.5 Rationale of the study

This is a micro level study, which tries to compare the results from different communities selected from different altitudinal zones. It provides a picture of the similarities and differences in livelihood options developed by the local people in different circumstances. On the basis of this information possible scenarios of livelihood options and coping strategies could be identified which would be helpful for policy makers to develop appropriate measures for the sustainable development of the mountain area. This study would also be a research base for further investigation along this line.

1.6 Working definitions

A number of different terms used in this study are not common. Therefore, the working definitions of these terms are given below.

- **Livelihood** comprises the capabilities, assets and activities required for a means of living.
- **Capital/asset** refers to resources and stores (tangible assets) and claims and access (intangible assets), which a person and household commands and can use towards a livelihood.
- **Natural capital** refers to natural resource stock from which resource flows and services are derived for livelihoods. The natural capital includes land, forest, water, aquatic resources etc.
- **Physical capital** is defined as basic infrastructures (transport, shelter, water supply, energy and communication) and producer goods used to support livelihoods.
- **Social capital** refers to social resources upon which people depend in pursuit of their livelihood objective. Membership of groups, networks and social institutions and trust are considered as social resources.
- **Human capital** refers to the skills, ability to labor and good health, which together enable people to pursue different livelihood strategies and achieve their livelihood objectives.

- **Financial capital** refers to the available stocks and regular inflow of money.
- **Livelihood strategies** refer to the range and combination of activities and choices that people make/undertake in order to achieve their livelihoods.
- **Adaptive strategies** refer to a permanent change in the mix of productive activities required to meet livelihood needs.
- **Coping strategies** refer to short-term responses of people in abnormal seasons or years to cope with that situation for livelihoods.
- **Livelihood outcome** refers to the achievements or output of livelihood strategies.
- **Access** means opportunity in practice to use a resource, store or service or to obtain information on materials, technology, employment, food or income.
- **Mountain** here refers to terminology adopted by LRMP and FAO/HMG/UNDP in their pysiographic and ecological division, and it does not necessarily follow the native term and geographical zone adopted on the basis of administrative boundary of the district. The term mountain is applicable to the study area in terms of elevation and land use characteristics as developed by Gurung (2005).

1.7 Review of literature

There are a number of studies related directly or indirectly to the present one. Available studies are divided into three groups such as theories on livelihoods, conceptual studies or frameworks, and case studies. In the first section various theoretical approaches and models developed in the field of livelihood have been briefly discussed. The second section deals with the concepts and frameworks developed with regard to livelihoods. The conceptual studies are varied in nature and deal with livelihoods to different capital assets such as water, forest and others. The third section includes the previous studies either dealing with specific areas or specific locations under different sub-sections. These sub-sections include livelihood strategies in general, forest and livelihoods, agriculture and livelihoods, tourism and livelihoods, remittance and livelihoods, water and livelihoods and climate and livelihoods.

1.7.1 Relevant theories on livelihoods

Different postulations have been sought upon to form the theoretical basis of the present study. Though the livelihood concept is a recent development, its application in different fields is tremendous over the years. There is no single theory, which

covers the scope of the present study. Therefore, a brief review of the theories and approaches dealing with different aspects of livelihood is discussed below.

a) Theories on relationship between man and environment

A number of theories/models deal with relationship between man and environment. The livelihoods of the people directly or indirectly depend on different environmental factors. However, the role of different environmental factors differs by places and time. In this regard, there are three distinctly different theories/thoughts on relationship between man and environment.

The view on relationship between man and environment was in existence since the age of exploration. However, the origins of the environmental determinism lie in the works of Charles Darwin (Dixit, 1999). Since then, a number of advocates have highlighted this view. Friedrich Ratzel formalized this view in the early 19th century and later it was further developed by others. Scholars related to this thought believe that man is a passive creature of the environment and all his activities are directly controlled by natural environment. Not only human activities and behavior but also his physical structure and mental abilities are determined by the environmental factors. Environmental factors like climate, soil, water and others play significant role to determine human activities. The importance of different environmental factors varies by places; as a result the variation in human activities does exist. Though, people can modify and use the nature in their favor with advanced knowledge and technology they cannot have full control over them. The influence of these natural factors in peoples' livelihoods can commonly be seen. For example the pattern of agriculture, population distribution, housing and industrial activities are mostly determined by these factors. More precisely, those who depend mostly on natural resource base for their livelihoods are guided by these factors rather than their wishes.

The opponents of the deterministic theory have developed a possibilistic theory or possibilism. This concept was developed in the beginning of the 20th century. Vidal de la Blache was the propounder of the theory. Lucier Febvre, Semple, Jean Brunches, Bowmen and Karl Sauer are the main advocates and further developed the theory (see Dixit, 1999). In contrary to the determinist the advocates of the possibilism believe that man is not a passive creator of the nature; but considers supreme. Man has free

will and participates in the development of each landscape in a unique historical process. Man perceives a range of alternative uses to which he could put an environment and selecting that which best fitted with cultural disposition. Thus, the same environment has different meanings for the people with different heritage and objectives. The physical environment provides a range of possibilities, which man turns to his use according to his needs, wishes, and capacities, in creating his habitat. As described in the theory one of the important factors in selecting livelihoods of the individual or household level is people's choice. For example, in the same physical environment people adapt different livelihood options. However, we cannot ignore the influence of nature on human activities.

Both the theories are heavily criticized and a new thought has been advocated as Neo-determinism. It is a theory in between the extreme theories of determinism and possibilism developed recently by Griffith Taylor (Dixit, 1999) and is widely accepted. According to this theory the relationship between man and environment is two-way, the environment influences man and man also influences environment. Nature provides opportunities for man and man uses these opportunities according to his/her wishes using advance knowledge and technology. Man is not completely free as described by possibilist and nor is he a passive creator as described by determinist. Man acts and reacts with each other in a very complex manner. The balance between man's freedom and nature's control varies by place and time. As a result, the variation occurs naturally in man's livelihood activities.

b) Models on dynamic livelihoods

Braudel (1980) developed a three-fold model, which can help explain how livelihood system changes over time (cited in UNDP, 1999b). His three-fold model differentiates change between the instant (at the level of everyday occurrences), the cyclical (less transitory change, and structural in nature), and the *longue duree* (where change is virtually imperceptible). The individual or household level decision-making or daily coping strategies are dependent on changing situation of daily life. These changes are considered under instant change. Seasonal shift of capabilities of different livelihood groups is considered under cyclical change. The *longue duree* change, for example, the change in the governance structure does not happen often.

Stephen Jay Gould's (1980 and 1990) "Punctuated–equilibrium" model (cited in UNDP, 1999b) purports that stages of relative tranquility are interrupted by sudden and dramatic changes. Such broad exogenous change that is punctuation, will lead to a flurry of radical new forms. In the long run, some of these forms may die out and a period of relative tranquility will ensue. For example, wars, revolution, economic change such as emergence of capitalism and post-industrial economies are the "punctuations" that trigger innovation. What follows is dramatic change in organization, culture, or economics, which changes the constraints and opportunities for social sectors. Such broad based external change has a variety of internal repercussions. Gould's theory of biological evolution can be extended to social evolution by i) considering livelihood groups as internal agents as they perform livelihoods, and ii) outcomes (adaptive strategies) are not necessarily efficient responses to environmental changes.

c) Exchange, and rational choice theories

The exchange theory was developed during 1950s. George Casper Homans was the founder of this theory and later others developed it further (Ritzer, 2000). Homans derived the exchange theory from both behavioral psychology and elementary economics. Regarding people's action he states that people examine and make calculations about the various alternative actions open to them. They compare the amount of rewards associated with each course of action. Thus, there is an interaction between the value of the reward and the likelihood of attainment. The most desirable rewards are those that are both very valuable and highly attainable.

Peter Blau further strengthens the exchange theory emphasizing the role of norms and values on social associations (Ritzer, 2000: 418). The social association plays significant roles on livelihoods and its role depends on situation. People are attracted for a variety of reasons that induce them to establish social associations. Once initial ties are forged the rewards that they provide to each other serve to maintain and enhance the bonds. Rewards that are exchanged can be either intrinsic or extrinsic (for instance, money, physical labor). The mechanisms that mediate among the complex social structure are the norms and values that exist within society.

As noted in Ritzer (2000) James S. Coleman pointed out that persons act purposively toward a goal, with the goal (and thus the actions) shaped by values or preferences.

He argued that the actors choosing the actions that will maximize utility, or the satisfaction of their needs and wants. Actors and resources are two key elements in the theory.

Friedman and Hechter developed a rational choice theory deriving basic principles from neoclassical economics (Ritzer, 2000: 432). The focus in rational choice theory is on actors. Actors have goals toward which their actions are aimed. Regarding actions of the actors this theory emphasizes on two things i.e. the scarcity of resources and social institutions. He states that actors have different resources as well as differential access to other resources. For those with lots of resources, the achievement of ends may be relatively easy. However, for those with few, if any, resources, attainment of ends may be difficult or impossible. The institutional constraints provide either positive or negative sanctions.

1.7.2 Concept and 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 1990s (DFID, 1999). The sustainable livelihood approach as a development concept is legitimized through several international forums. The Brundtland Commission in 1987 introduced sustainable livelihoods in terms of resource ownership and access, basic needs and livelihood security especially in rural areas. Likewise, the 1992 UN Conference on Environment and Development legitimized and adapted the concept referring "sustainable livelihoods for all" in its Agenda 21. The Copenhagen Social Summit linked sustainable livelihoods explicitly to full employment and the Beijing Platform reemphasized the importance of women's livelihoods to successful development (UNDP, 1999a). Department for International Development (DFID) adopted sustainable livelihoods approaches from its 1997 White Paper on International Development to its development activities particularly in poverty elimination (DFID, 1999). Besides, international organizations like the European Commission, the World Bank, Food and Agricultural Organization of United Nations (FAO), International Fund for Agricultural Development (IFAD) are further developing this approach (Wyss, 2004). The livelihood approach is a way of thinking about the objectives, scope and priorities for development. DFID has introduced the sustainable livelihood framework with six guiding principles as a tool

to improve understanding of livelihoods particularly of poor. The framework presents the main factors that affect peoples' livelihood and relationship between these. And it also presents the checklist for the information required for the analysis of different components of livelihoods. The details of the framework are provided in the third Chapter.

a) Livelihood concept in general

Chambers and Conway (1991) had made a study on sustainable livelihoods. The objective of the study was to provide discussion on the concept of sustainable livelihoods. They had raised a number of issues on conventional professional analysis highlighting production, employment and thinking on poverty line, and forwarded the concept of sustainable livelihoods combining capabilities, equity and sustainability. They defined livelihood, modifying the earlier definition of World Commission on Environment and Development (WCED) panel as:

> A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term (p. 6).

The study used household as a unit of analysis and the main component of the livelihoods. They defined stores and resources as tangible assets. Stores include food stocks, stores of values such as gold, jewelry and woven textiles, and cash savings in banks of thrift and credit schemes, and resources include land, water, trees and livestock, farm equipment, tools, and domestic utensils. Claims and access are intangible assets of household. Claims are demand and appeals that can be made for material, moral or other practical support or access. Access is the opportunity in practice to use a resource, stores or service or to obtain information, material, technology, employment, food or income. They further stated that out of these tangible and intangible assets people construct and contrive a living using physical labor, skills, knowledge and creativity. Rural livelihoods comprise one or more often several activities. They also focused on sustainability of livelihoods. Sustainability of

a function of how assets and capabilities are utilized, maintained and enhanced so as to preserve livelihoods.

Chambers (1995) made a study with a view to comparing the professional views and poor peoples' views on poverty. He had raised a number of issues regarding poverty line thinking and livelihoods. He had stated that livelihood refers to many activities, which made up living. The livelihood strategies of the household are usually diverse and complex. Even within the same village, different social groups of the landless can have completely different strategies. In line with Chambers and Conway he also listed a number of different activities by which people are making their livelihoods. He presented the same framework of livelihoods showing relationship between different livelihood components.

Carney (1998) made a study on implementing sustainable rural livelihoods approach. The aim of this study was to highlight a framework for analyzing livelihoods. He presented a slightly modified definition of livelihood, which was originally defined by Robert Chambers and Conway. Carney defined it as,

> A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (p. 4).

This study presents a livelihood framework, which provides the analytical basis for livelihood analysis. The framework is holistic and dynamic and recognizes many complex interactions in rural livelihoods. The five capital assets in the shape of pentagon, vulnerability context, transforming structures and processes, livelihood strategies, and livelihood outcomes are presented in the framework and defined their association. The author presents a detail description of different capitals. This approach by Carney appears to be clear and well formulated.

Ellis (1998) developed a concept on livelihood diversification and sustainable livelihood. The concept elaborated that livelihood diversification was widespread and found in all locations as well as across farm size and across ranges of income and wealth. Diversification occurred for many different reasons. These reasons include

underlying trends and processes, rural population growth, farm fragmentation and declining returns to farming compared to other activities. In connection with decentralization he described three types of income sources- farm income (income from crop and livestock), off-farm income (wage and exchange labor, income obtained from local environmental resources such as firewood, charcoal, house building materials, wild plants etc.) and non-farm income (salary employment, self employment, rental income, remittances, pension etc). According to Ellis diversification can play an important role at household level precisely in achieving objectives of reducing vulnerability and raising incomes. This study analyzes the household's livelihood diversification and its importance with its approach to livelihood diversification concept. This study does provide a base for the analysis of livelihoods in the present study.

Likewise, Koziell (1998) developed a biodiversity approach to sustainable livelihoods. According to him the biodiversity represents a part of natural capital. Natural capital provides the material, energy, processes and information that people could combine to produce and accumulate other capital: physical human and financial assets from which positive livelihood outcomes could be derived. According to this concept biodiversity should be seen as a means of contributing to sustainable rural livelihoods, rather than an end in itself. The another argument of this concept that for poor and marginalized groups, protection and maintenance of, and improved access to, biodiversity can often contribute more to sustainable livelihoods than conservation. A number of potential benefits provided by maintenance or sustainable use of biodiversity include food security, greater biomass output, improvement in health providing nutrition and food.

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 UK in 1997. Following the approach of Chambers and Conway, DFID define livelihoods with some modifications but it is exactly the same as define by Carney (1998). The guidance sheet presents origin, core concepts and framework of sustainable livelihoods. The framework presents the main factors that affect the people's livelihoods and

interrelationship between these factors. It begins with simultaneous investigation 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 of the framework and it is connected to the other components which include vulnerability context, transforming structures 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 pursue 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 resource stocks from which resource flows and services 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 producer 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, jewelry) and regular inflows of money such as pension or remittances.

The paper explains the transforming structures and the processes (the institutions, organizations, policies and legislation that shape livelihoods), livelihood strategies and the livelihood outcomes. It mentions about important tools such as environmental checklist, gender analysis, governance assessment, institutional analysis, macro-economic analysis, market analysis, etc and the techniques such as participatory methods and sample surveys. It also lists a set of questions necessary for the investigation of livelihoods relating to all these capital assets. This paper provides detail information regarding the investigation of livelihoods, which is more relevant to the present research.

Likewise, with a view to update readers to DFID's progress in implementing sustainable livelihoods approach to poverty reduction Carney (1999) made a study. The study was based on materials of Natural Resource Advisor's Conference (NRAC '99). The study presents the roots of the concept, and core principles and its early experiences from different countries along with strength and weakness of the approach. The authors stated that sustainable livelihood was a way of thinking about the objectives, scope and priorities for development, in order to enhance progress in poverty elimination. They presented the same framework of livelihoods as given in livelihood Guidance sheets of DFID.

A study on 'Application of CARE's livelihoods approach' was made by Drinkwater and Rusinow (1999). To quote their definition, "A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living". This livelihood definition used by CARE is very similar to that used by DFID, and is derived from the same source (Chambers and Conway). The idea of livelihood embodies three fundamental attributes viz the possession of human capabilities, access to assets and the existence of human activities. The interaction between these attributes defines what livelihood strategy a household pursues. For this CARE has outlined its own livelihood model, which differs from the model developed by DFID. The authors have mentioned that livelihood strategies are not static and household may vary their strategies, as they respond to shocks or gradually they become more secure, thus moving further to the right on the continuum.

In a study Carney et al. (1999) have compared different livelihood frameworks developed by CARE, Oxfam, UNDP and DFID along with their core emphasis and definition, types of activities, operationalization approach and lesson learned so far. They concluded that the four agencies share much in common, notably the focus on assets and on micro-macro links as well as common roots in the work of Chamber and Conway. In the short term and at a conceptual level commonality exceeds variation. All agencies adopt an asset-based approach, and stress on a need to understand and facilitate effective micro-macro links. All stress flexibility in application. However, there is a somewhat different understanding of sustainability between the agencies.

In a concept paper developed with a view to explaining livelihood concept and its evolution UNDP (1999a) stated that livelihood system comprises a complex and

diverse set of economic, social and physical strategies. These strategies are realized through the activities, assets and entitlements by which individuals make a living. The paper highlighted that household livelihood strategies differ from rural to urban settings. Rural strategies often involve a variety of different household members in such activities as home gardening, exploiting common property resources, share-rearing livestock, family splitting etc. And also it differentiates between coping strategies and adaptation strategies. The coping strategies are short-term response to a specific shock while adaptive strategies mean long-term change in behavior patterns as a result of a shock or stress. The paper puts emphasis on sustainability side of the livelihood.

In another paper UNDP (1999c) stated that livelihoods connote the means, activities, entitlements and assets by which people make a living. Assets, in this particular context are defined as not only natural/biological (i.e. land, water, common-property resources, flora, fauna), but also social and political (i.e. community, family, social networks, participation, empowerment), human (i.e. knowledge, creation by skills), and physical (i.e. roads, markets, clinics, schools, bridges). It has mentioned the political assets in the place of financial asset that mentioned by DFID. This study focuses on the sustainability aspects of the livelihood concept and states that the 1992 UN Conference first referred to sustainable livelihoods for all" in its Agenda 21. The approach defined by UNDP is very comprehensive and applicable. But it does not explain the detail procedure. As a result for practical reason it is not easy to apply.

UNDP (1999d) made a note on the sustainable livelihoods approach, infrastructure financing and reduction of poverty and inequality' with a view to illustrating the implications of the approach for the financing of infrastructure. The paper highlights that the basic infrastructure has a key role in helping to establish income-earning activities and employment through:

- development of rural market infrastructure (roads, drains, bridges, market areas), electricity and water transport sectors,
- raising the efficiency of existing infrastructure provision e.g. by enhancing energy efficiency
- improving access to reliable information so that poor people can find out employment and training opportunities and current market conditions.

Later, Ellis (1999) developed livelihood diversification approach in the context of developing countries. He argued that the diversity of livelihoods was an important feature of rural survival but the architects of policy often overlooked it. According to him diversity was closely allied to flexibility, resilience and stability. He further argued that diverse livelihood systems were less vulnerable than un-diversified ones; they were also likely to prove more sustainable over time because they allowed for positive adaptation to changing circumstances. Risk spreading, consumption smoothing, labor allocation smoothing, credit market failures, and coping with shocks could contribute to the adaptation of diverse rural livelihoods. A diverse portfolio of activities contributed to the sustainability of rural livelihoods because it improves its long-run resilience in the face of adverse trends and sudden shocks. The study thus describes livelihood diversity in relation to vulnerability context and also explains the factors contributing to livelihood diversification.

b) Livelihood concept linking with water

Regarding a link between water and livelihoods Chambers (1988) made a study. The main purpose of the study was to define livelihoods and explain the role of irrigation on livelihood. According to the Chambers livelihood refers to income, assets and well-being. An adequate and secure livelihood is a level of assets and stocks and flows of goods and cash, which provide for year round physical and social well being for a household and protection against impoverishment. Highlighting the role of irrigation he has stated that irrigation has different impacts on different people in different conditions with both gainers and losers. According to him the main livelihood gains from irrigation include- increased employment and income, increased security against impoverishment, stops out migration and attracts in migration and improves quality of life- the non-agricultural uses of irrigation water for washing clothes, personal hygiene and drinking. This study provides conceptual ideas about livelihoods and importance of irrigation on livelihoods of the people. Hence, it is relevant to the present study.

Townsley (1998) put forward an important concept on aquatic resources and rural livelihoods. Aquatic resources constitute a reserve of renewal natural capital, which can be drawn on at times of need and integrated into overall livelihood strategies as required, which relatively little forward planning or investment. Aquatic resources in

many parts of the world constitute a resource of last resort. Open-access fisheries and other forms of aquatic resource use are fallback options for the rural poor when loss of land or failure in other rural activities threatens their livelihoods. Aquatic resources are common pool resources. From the point of view of rural livelihoods, it is their frequent de facto open-access nature for local rural people, which make aquatic resources an attractive livelihood option.

Soussan (1998) developed an approach based on water resource in the context of sustainable rural livelihoods. This approach was elaborated on the assumption that water available as surface stock and flows (rivers), as groundwater in aquifers or as soil moisture could be used directly in livelihood activities and all were important to the viability of ecosystems on which livelihoods depend. Water thus provides a means for the diversification of livelihoods. Many households could gather a range of products from common property resources like water. These products include fish, other aquatic animals and plants and other materials such as sand and gravel. These could be used to meet subsistence needs and to provide secondary income sources. Waterpower could be directly harnessed to contribute to livelihood diversification (e.g. for milling, husking and oil extraction, or for rural electrification) in some locations. This study deals with water, one of the important natural assets, which provides bases for the livelihoods of the people in many ways. The approach is directly related to the present study.

Nicol et al. (2001) have developed a concept paper that discusses a further development of sustainable livelihood analysis by bringing it together with the methodologies of the household economy approach in order to provide an analytical and modeling tool for the development of water security in the context of livelihoods. The paper states that household economy approach describes the strategies people use to access food and income and explores how typical better off, middle, poor and very poor households live and interact economically. The paper further states that in order to address water supply holistically it requires an understanding of factors affecting availability, access and use of water as a productive asset, and how it is combined with other assets not only to sustain life directly, but also to bring the financial and non-financial income to sustain livelihoods. This study does not specify procedural details.

In the same way, Hoeck (2001) has made a study on water and rural livelihoods. He has stated that livelihood thinking is developed in the 1980s as an alternative to production thinking. Livelihoods are an outcome of how and why people organize to transform the environment to meet their needs through technology, labour, power, knowledge and social relation. Livelihoods are also shaped by the broader economic and political system within which they operate. Regarding the use of water on livelihoods, he has stated that water is one of the most essential elements in rural livelihoods because of its diverse uses. Improved access to water is a powerful tool to diversify livelihoods and reduce vulnerability for small producers. Thinking about livelihoods from the perspective of water can guide system redesign and allocation that retain local options, generate higher local value and empower local management. The attempt to link water with livelihood in the study is very relevant to the objective of the present study. However, this study does not provide detail procedures.

1.7.3 Case studies

Livelihood strategies are the ways households handle opportunities and limitations or more specifically the ways a family responds to change resulting in the relocation of land, labor and capital assets (Zoomers, 1999). Livelihood strategies of the people are diverse and determined by a number of different factors. These strategies identified by many researchers are mainly of two types- coping strategies and the adaptation strategies. There are a number of studies dealing with livelihood strategies of the people. Some of such major studies are reviewed below.

a) Livelihood strategies

There are a number of studies dealing with livelihood strategies. One such a study was made by Macfarlane (1976) to analyze the socio-economy and resource utilization pattern of Gurung community. The study area was Thak village near Annapurna Himal in Nepal. The study revealed that in the early part of the nineteen-century the high altitude Gurungs were mainly pastoral tribe, grazing huge herds of cows and sheep that was the mainstay of economy. Another important activity in the past was trading, which declined later. The ways in which Gurungs acted as middlemen carrying rice, wheat, lentils and salt across the Himalaya changed. The bartering of salt against grain ended with the Chinese invasion in Tibet. The crops and method of cultivation had also changed considerably during the last hundred years.

Two major changes occurred- i) change from hoe cultivation to hoe and plough in combination, and ii) from slash and burn, rotating agriculture to permanent fields.

Messerschmidt (1976) studied conflict and change in a village society. The study examined the socio-economic activities of the Gurung community. The study area was the Ghaisu village of Lamjung Himal area in Nepal. He stated that the economy of Ghaisu was based primarily on the combination of field agriculture, mercenary soldiery, pastoralism, and trade. The process of gradual ecological and cultural change in the Gurung economy was very old. A number of factors were responsible for this change in Gurung economy. As the Gurung migrated to lower and more southerly locations, they adopted field agriculture and raised paddy, and other grains. Due to steadily rising population, many forest and marginal land had been reclaimed. The situation caused a loss in the amount of pastureland available for keeping sheep and cattle at lower elevation in winter. Transhumance trade declined due to increased availability of Indian salt at a comparative low price. Later many Gurung villagers turned to various forms of migratory wage labor and mercenary soldiery to support them. This study did clearly analyze the adaptive strategies of the people under the influence of social and environmental conditions.

A study was made by Molnar (1981) to analyze the economic strategies of the Kham Magars living in south of the Dhaulagiri and Dolpo ranges in Nepal. The study area consisted four villages namely Thabang, Lubang, Taka, and Maikot. The study revealed that the Kham Magar had a mixed economy based on hill agriculture and animal husbandry. Herding was an important part of Magar livelihood. They raised cattle, sheep and goats. All of these herds were transhumance. The movement of herd far north and far south was not a strategy resulting from inadequate local pastures, but from climatic conditions. Hunting and gathering played an important role in Magar subsistence. This study provides a general view on livelihoods of the mountain people. The study does not provide methodological details.

Furer-Haimendorf (1981) made a study on the economic and social changes of the Thakali. The study area covered Thak Khola region of the Kali Gandaki valley in Mustang district of Nepal. The author stated that the decline of the trans-Himalayan trade, resulting from the Chinese occupation of Tibet, had led to an exodus of the majority of the Thakalis of Tukche. They had moved to Pokhara and other places of

the middle ranges and established themselves there as shopkeepers and merchants. The shrinkage of the trade with Tibet had affected the economy of other villages of Thaksatsae in varying degree. The people of Marpha and other villages of Panchgaon were also active in animal husbandry and owned substantial herds of yak and goats. They were also engaged in transport business. As in other regions of the high altitude a large part of the population had always spent the winter months in areas of milder climate, and this type of transhumance was combined with petty trade.

Pandey (1987) made a study on livelihoods of the landless peasants. The main purpose of the study was to examine the ways in which evicted landless peasants made their living after eviction. Four settlements in and around Kawasoti, Nawalpur were chosen for the study. The study was based on sampling of 60 households. He stated that in the 1950s, HMG/N initiated land reform and resettlement programs. The incapability of land reform and resettlement program to resettle all the land hungry peasants led them to encroach upon the forest developing a number of forest settlements. The land area taken by the resettlers from the forest was too small to support them. Thus, they adopted a number of alternative strategies along with crop farming. These included livestock raising, military service, selling of edible goods to the markets, tailoring and blacksmithing, carpentry and agricultural labour.

Likewise, Bishop (1990) carried out a study on livelihood strategies of the people of Karnali Basin. The researcher identified homeostatic subsistence ystem of livelihoods in the Karnali basin and explained how such system changed due to external forces. The factors which determined the local homeostatic subsistence system were cultural attitudes and training of the people, delicate ecology, stressed state of animal husbandry parallel with agriculture, undeveloped transportation and trade technology (barter trade with Tibet), and poor health. The system changed as a result of new development like Chinese restriction on grazing in Tibetan pastureland and regulation on trade. The restriction on grazing threatened livestock-based livelihoods of Bhotias of upper Humla and Mugu. The regulation on trade changed the trade direction of the whole Karnali basin. As a result subsistence system of this area became more vulnerable and compelled people to alternative strategies. This study gives an idea about changes in livelihoods by external forces over time.

Stevens (1993) studied Sherpas' subsistence and environmental change in the Highest Himalayas. The study examined the contemporary economy of the Sherpa living in the Khumbu area. He studied from a cultural economic perspective and discussed historical change in the economy, environment, and the culture. At the same time he examined the community resource management institutions and their effectiveness along with the increasing role of tourism in the local economy and its impact on land use and environment. The microclimatic differences within a single Himalayan valley could support crops ranging from subtropical suited rice, sugarcane, maize and banana to temperate thriving barley, wheat, buckwheat and potato and sustain livestock such as water buffalo, cattle and yak that are at home in diverse environments. The people of the Himalayas, like those of other highland regions developed a number of different adaptive strategies and practices subsisting in the distinctive conditions of mountain ecosystems. He identified five broad traditional subsistence agricultural strategies and several common sub-strategies in the central and western Himalayas. These were settled mixed farming, swidden agriculture, middle altitude agro-pastoralism, high altitude agro-pastoralism, and pastoral nomadism. This study is highly helpful in understanding the adaptive strategies of mountain people under the influence of environmental changes.

Ham (1995) studied livelihoods of two Himalayan villages of India with a view to investigating livelihood strategies of the people of the upper Beas watershed in Kullu valley. The study was mainly based on group discussions and key informants interviews. While identifying livelihood strategies, the author defined and differentiated between coping strategies and adaptive strategies. According to the author coping strategies are the bundle of poor people's responses to declining food availability and entitlements in abnormal seasons or year, while adaptive strategies constitute a permanent change in the mix of productive activities required for meeting livelihood needs. The researcher has identified a number of adaptive strategies developed by the people of the upper Beas area. These are listed below.

- Diversification of activities and household inputs,
- Crop species and spatial diversity within the traditional agricultural system,
- Increasing integration of the household with the market economy,
- Reliance on agricultural wage labor and employment in the larger urban centers,

- Building up and drawing down of food, fodder and fuel inventories
- Reliance on common property resources, and
- Development of community groups.

The researcher also stated that the caste was often a factor that determined what strategies would be pursued by individuals and households. This study gives an idea to differentiate between two strategies- coping and adaptive strategies and also provides an idea about strategies that were adapted by the people of the mountain area.

Kausik (1998) made a study on livelihoods of rural poor and marginal farmers. The objective of the study was to examine the impact of project intervention on livelihoods. This study was based on a number of case studies and experiences of southern Aravalis of India. The study mentioned that a large proportion of rural household of this area fell in the category of landless, virtually landless and marginal farmers with small and unviable agricultural land holdings, productivity per se did not translate into the well being of the poorest sections of a village. Therefore, the people of this area adopted a number of livelihood strategies such as wage labor, business, collection of forest products etc. for their livelihoods along with share cropping in agriculture. The growth in non-farm employment and wage employment in developmental works and other draught relief works of the government had the single most important factor in poverty reduction in the 1980s. Since agriculture was the predominant source of the rural employment, either an increase in agriculture employment or an increase in the real agricultural wage rate, or both, could indicate improved rural livelihoods of the people. This study presents livelihood strategies of the poor and marginal farmers.

Ahmad et al. (1998) made a study on livelihood security of the Sultanabad area of Pakistan. The main objective of the study was to identify the dynamics of livelihoods and resource management after two major events (abolishment of Raja Tax and construction of roads). The study revealed that in the past people of the Sultanabad area depended on the local economy, growing their own food through agriculture and livestock. Later, basically after the provision of road their livelihood survival pattern has changed due to market influence as well as availability of labor works in the area. The villagers became less dependent on land and forest resources and involved

themselves more in off-farm activities. They were then more dependent on resources obtained from outside the village. The study was mainly based on survey. The other techniques adopted in the research were participant observation, key informant interviews and transect walk. This study provides general ideas on changes brought in the livelihood pattern of the people by the development of physical infrastructures-the road.

Zoomers (1999) made a study on 'linking livelihood strategies to development: experiences from the Bolivian Andes'. This study was based on the findings of the research project conducted during 1998. This study was based on sampling of the selected communities in northern Chuquisaca and northern Potosi. The study shed light on the diversity and dynamics of rural life in the Andes region, and the interaction between farmers' strategies at the micro level. The study has defined livelihood strategies as the way households handle opportunities and limitations or more specifically the way family respond to change, resulting in the reallocation of land, labor and capital resources. The author distinguished adaptation strategies from coping behavior as adaptation is an ex ante income management and coping is ex post consumption management'. She identified heterogeneity (the spatial variety of various farming system, mode of production and types of organization) and diversity (tendency to be involved in various activities at the same time) in the livelihoods of the people in the study area. She has stated that the people of the study area sought to improve their standard of living through accumulation strategies, to consolidate and perpetuate their situation by using stabilization strategies, to promote their survival through compensatory and survival strategies, and finally, to help ensure their future, they adapt security and risk-reduction strategies. This study provides a detail livelihood strategies of the people in mountain areas hence is relevant to the present study.

Likewise, a study on livelihood strategies and assets of small farmers of Bolivia was made by Ellis-Jones and Mason (1999). The main objective of the study was to explore the social and economic factors that influenced household responses to soil and water conservation technologies. Highlighting the livelihood strategies of the farmer they stated that confronted with a variety of constraints, households evolved different cooping strategies. These were risk minimizing strategies, crisis

management strategies, production maximization strategies and strategies to increase agricultural production. They further stated that soil and water conservation technologies were likely to be viable only in the more intensive farming system at low discount rates and were unlikely to be adapted by the resource poorest. In less intensive systems, where irrigation was not available, adaptation was likely to be low. For widespread adaptation, technologies need to be low cost, productivity enhancing, and risk reducing in the short term. They suggested that it was necessary to consider the wider implications of conservation and water management at the catchments level, taking into account sometimes- conflicting requirements of different land uses. This requires strengthening the participation of existing farmer groups with networking arrangements such as inter-community visits to trail sites and innovative farmer experimentation. The different coping strategies as identified are basically applicable to other studies as well. Therefore, this study is relevant to the present study.

Blakie (2000) made a study on livelihood diversification of Likhu Khola catchments in Nepal. The study analyzed livelihoods of the people of the study area in the context of declining environmental resources. He found out that declining environmental resources (decline in soil fertility) combined with alternative labor market opportunities generated a range of different livelihood strategies. These involved the transfer of labor resources from environmental goods collection to wage labor and non-agricultural employment. Farmers spent their income towards purchasing chemical fertilizers and other inputs to maintain soil fertility. A significant proportion of the farm households had non-farm income source such as business, hotels, contracting, crafts and service. The contribution of these sources to livelihood was also significant. This study shows how the declining soil fertility has compelled people for adapting alternative strategies.

Bhurtel (2000) studied the livelihood strategies of the Kumals living in Lekhanath Municipality of Pokahara valley, Kaski district. He made a census of the Kumals in this town. The findings of the study have shown the changes in the livelihood strategies of Kumal had been related to changes in natural, socio-cultural and economic environments. There had been dramatic changes in the overall economy of the Kumals. Agriculture, pottery and fishing were the major activities of the past. Agriculture was the primary economic activity. Later, the mode of farming changed

from food crop farming to horticulture and market gardening. Presently, their way of living is more diversified than in the past as it is influenced by the force of globalization. Wage labor, business, and services are other additional options adopted by the people along with their previous activities. This study provides an idea about changing livelihoods of the people.

Similar study on changing livelihood strategies of the Baramu ethnic group living at Arupokhari VDC of the Gorkha district carried out by Dahal (2001). He made this study taking samples of Baramu people living in two clusters. He found that the changes that occurred in the natural, economic, and socio-cultural environment in the area brought immense changes in the livelihood strategies of the Baramus. The traditional practice of the *dole* system totally collapsed and *bani* system was declining rapidly and was in its final stage of collapse. The collapse of traditional occupations and the insufficient agricultural land compelled the Baramus to find other income earning activities like wage labor, portering, and small business i.e. selling of firewood and liquor etc. Similarly, increased modernization and the expansion of local market centers brought about significant changes in the socio-cultural sphere of the Baramu. This study thus shows the impact of globalization on natural, socio-economic and cultural environment on diversification of livelihoods of the local people.

Mukherjee (2002) made a study with a view to comparing livelihood strategies of the people of two Indian villages namely Varanasi and Faridabad located in vast contrasting economic, agro-ecological and political situation. According to the researcher in both the villages 60-90 percent of the people were dependent upon agriculture. Agriculture was the main source of livelihood, employer and provided endowment entitlement to almost all the households and created effective demand for a whole range of allied ancillary activities. Later, the position of agricultural activity as a means of livelihood, with all its merits and contribution to community life, was on the decline. The principle reasons for this phenomenon were increasing constraints such as rising costs and greater risks involved in farming, availability of alternative employment opportunities in manufacturing sector, and loss of agricultural land due to shift to other uses of non agricultural purposes. People adopted a number of

livelihood security measures to overcome the constraints mentioned above. These livelihood strategies as reported were:

- Substituting or avoiding crops which are vulnerable to pests, diseases and weeds,
- Fencing and guarding of fields from stray animals,
- Poisoning rats,
- Inclination to move out of agriculture,
- Selling agricultural lands and migrating to other areas,
- Hedge against crop failure, and
- Application of pesticides.

With a view to analyzing livelihood strategies of the Rai community living in two different altitudes in Arun valley, eastern Nepal, Subedi and Pandey carried out a study in 2002. They found that the Rais adapted a number of different strategies to earn their livelihoods. Among different options agriculture (both farming and livestock) was the main source of livelihoods in both the locations. In addition, they have internalized several off-farm activities to make up their living over time. These included professional services, wage labor, portering, and tourism. The authors have further stated that the strategies followed a specific sequence, which differed by location. The extent of involvement in different activities depended upon the availability and entrepreneurial ability of the household. Borrowing, crediting, agriculture wage laboring, portering and sale of livestock were the main options utilized at times of stress in both the locations. Hunting and gathering activities were limited to Makalu probably because of long period of food shortage and presence of large forest in proximity. The study was based on survey and identified livelihood strategies of the Rai community of the Mountain area.

b) Forest and livelihoods

Forest is one of the important natural capitals on which people depend directly or indirectly for their livelihood. A study on the contribution of forest resources in the livelihoods of the Chepang community was carried out by Gurung et al. (1995). The objective of the study was to identify the farm and forest products and their contributions to livelihood of the Chepang community living in Shaktikhor Village

Development Committee in Chitawan district of Nepal. The study was based on random sampling of 26 households. The researchers found that the farms and the forest products were used for the livelihood of all categories of Chepang families. But the contribution of trees and forest products was the highest for poor. This study deals with the effect of one natural resource on the livelihoods of the Chepang tribe.

A study on 'forest based socio-economy and livelihood' was made by Kumar and Pandey (1995) with a view to exploring the livelihoods of the tribal people living in different districts of Chotanagpur region in Bihar, India. They stated that the tribals of Chhotanagpur region were dependent on the primitive methods of agriculture and different forest produces supported their livelihood. They earned their livelihoods by selling different forest produces in local markets. The main forest products exploited by the tribal people were fruits, flowers, seeds, leaves, barks, gums and resins, stems and branches, roots and tubers which could be used for different purposes.

Barraclough and Ghimire (1995) carried out a study on forest and livelihood pattern of people. The study was concerned with assessing social causes, impacts, interactions and feedback associated with deforestation in developing countries. The study was based on case studies carried out by covering four countries- Brazil, Central America, Tanzania, and Nepal. In the case of Nepal they found that a large number of poor households from the hills migrated to the plains in the hope of obtaining land and improving livelihoods. Many more small peasants in the hills would migrate if they could get access to good land there. It was reported that especially weaker social groups such as lower occupational castes, the landless and the indigenous people of the plains felt the impact of deforestation.

Dembner (1995) made a study on forestry and food security. This was based on case studies in Tanzania, Thailand and Vietnam. The study examined the links between forest products and household food security along with the extent and manner of local people's dependence on the forests for food. Highlighting the case of Tanzania the author stated that the ability of forest to sustain agricultural production and also to serve as a supplementary source of food or non-agricultural income was increasingly constrained. More forest products were collected for cash income but later the over all availability of forest foods was declined. In Thailand the study compared the dependence on forests for food security of two villages before and after the

enforcement of a major policy change, which included the closing of forest. The study showed that before the forest was closed, people grew upland crops in the forest along with forest product collection. After closing of the forest the cultivation of upland crops in the forest restricted and collection of forest products was controlled. It caused decline in employment opportunities. As a result livelihood of the poor people was adversely affected. The research highlighted the important role of forest and tree products for household food security in Vietnam especially for the poorest sectors of the population.

A study on common resources and sustainable livelihood of mountain environment was carried out by Singh and Pandey (1998). The study area constitutes the upper Beas basin of the Kullu valley, India. The study investigated the common property resources of the local inhabitants. The four major types of common resources identified were community forest, pastureland, river/rivulets and watershed/river bank. The life of mountain environment was very hard and people were absolutely dependent on the natural resource. The common property resources (CPRs) and common resources (CRs) were the substantial sources of livelihood security and economic development, as the economic opportunities were not available throughout the year. Accordingly the people were forced to migrate to outside the region for off-seasonal activities to sustain their livelihoods. There was a close relation between livelihood security and access to common property resources. An over exploitation of commons in the area made environment fragile and vulnerable, thus increasing exposure to risk from natural hazards. This study emphasizes the role of common property resources on peoples' livelihood. Water is one of the common property resources considered in the study.

Arnold (1998) carried out a study on 'forestry and sustainable rural livelihoods' with a view to explaining the role of forest in livelihoods. The study found that the contribution that outputs from forest and tree resources could make to livelihoods were increased income, increased well-being, reduced vulnerability and more sustainable use of natural resource base. People living in forest environments were likely to draw heavily from the forest and its outputs.

A study on the commercialization of natural resources for sustainable livelihoods was made by Karki (2000). The objective of the study was to highlight the importance of

commercialization of forest products especially non-timber forest products. The study was based on two case studies one from Nepal and the other from China. The researcher showed that mountain people earned their living from the forest in many ways- earning cash income; satisfying their needs for fuel, medicine, shelter and supplementary food; using traditional agricultural inputs such as leaf litter, fodder, small tools and water; and cultivating land inside the forest boundaries as forest encroachments. Emphasizing the importance of role of forest the study showed that non-timber forest products played a vital economic role for at least 25 percent (or around 30 million) of the people living in and around forests and rangelands in the Hindu Kush-Himalayan (HKH) region.

c) Agriculture and livelihoods

Agriculture is the main base of the rural livelihoods. Livestock, horticulture and the crop farming are the main components of agriculture on which livelihoods of the overwhelming majority of the rural people depend. In this respect a study on environmental implications of horticulture on sustainable livelihood and food security was carried out by Singh, et al. (1995). The study was conducted during 1994-95 in Kullu valley in India with a view to analyzing the development and environmental implications of horticulture, with special reference to apple. They found that horticulture crops responded very well to input and resulted in high production per unit area causing the upliftment of rural economy. Horticulture provided employment, food and fodder.

Shrestha et al. (1997) made a study on sustainable farming and livelihoods. Based on purposive sampling the study highlighted the micro level experiences of two countries, India and Nepal. The Kullu district of India and Ilam of Nepal were selected for the study. Farm households having less than one hectare of land were selected for the study from two different areas i.e. transformed (accessible) areas and stagnant areas. In Kullu district of India about four-fifth of the total households had adopted three to four production options in both transformed and stagnant areas. The production options included crop production, vegetable cultivation, livestock farming and fruit cultivation in terms of farm activities, whereas non-farm activities included weaving, agricultural labor, non-agricultural labor, selling of wild plant products, service, business and shop keeping. It was also found that the household and per

capita incomes were higher in all categories of farm households in the transformed areas were higher that those of the stagnant areas. This was mainly because the households had adopted high quality options in transformed areas. The contributing factors for high quality options were higher literacy rates and improved access to marketing inputs and services. In the case of Ilam the relationship between the number of options adopted and the level of income in both the transformed and stagnant areas of Ilam were about the same. The households had adopted six or more options in both areas. Production options adopted by farmers included cereal crop production, amliso, cardamom, ginger, fruits and vegetables, and dairy farming in the case of farm enterprises. Non-farm activities included mainly cottage industries, services, business and other. Health and sanitation conditions were far superior and people enjoyed better quality of life in transformed areas. This study clearly shows the impact of accessibility and education on livelihoods of the farm people.

Bhole and Adhikari (1998) made a study on rural livelihoods at risk to see how Nepalese farmers cope with food insecurity. The study is based on case studies of Nawalparasi and Kaski districts. Three to five villages were selected for intensive study concentrating on food deficient village communities in fragile mountain tracts. Different survey techniques such as PRA, household survey, traffic and trade surveys were applied. The research concluded that more than 50 percent of households were not self-sufficient in food even for six months of the year. Despite all efforts, majority of the mountain population, nevertheless, was severely undernourished. Coping with vulnerability was found to be an interaction of very complex, diversified and multiple combined strategies, which revealed highly dynamic activities of the groups at risk. However, Nepalese are highly active, adaptive and dynamic actors but survival strategies, at the present time hardly suffice to cope with risks. This study provides a general idea about livelihoods of the mountain people and their complex and diversified livelihood strategies.

Ellis-Jones (1999) made a study on poverty, land care and sustainable livelihoods in the hills and mountain region of the world. A major question of the study was whether agricultural growth could be compatible with natural resource conservation and at the same time would create the condition for improving livelihoods and reducing poverty. The study showed that hillsides and mountainous areas were particularly vulnerable to

poverty due to their inaccessibility, fragility, marginality and diversity. According to him although many of the world's hot spots for land degradation are found in hillside area, there are also many bright spots where improvements in natural resource management are resulting in increased incomes. Land degradation is a potentially serious threat to food production and rural livelihoods particularly in the more densely populated areas of rural poverty. The policies, institutions and technologies that impact on their lives influence resource-use decisions made by households and local communities in pursuit of today's survival and livelihood security. Such decisions are the main determinants of links between poverty elimination, improved land care and sustainable rural livelihoods.

Tashi and Pratap (2000) made a study on livestock based livelihoods in Tibet. The study analyzed the trends, issues and options of livestock development and livestock-based food security in the Tibetan highlands. The study showed that for most of the highlanders of Tibet livestock was the only means of sustaining their food security and livelihoods because crop farming and forestry were limited to a few areas due to short growing season. For the nomads of the Tibetan plateau, livestock was the only way of ensuring food and livelihood security. Even in the lower valleys where cropping and forestry farming were possible, livestock farming was the main activity and major means of sustaining livelihoods and food security. The livelihoods of nearly half of the population of Tibet were derived from animals and nearly 30 percent depended almost entirely on livestock. However, Tibet had an insufficient supply of livestock-based food products in regions where population was concentrated. Since 1970s, crop production increased very rapidly through the introduction of high-yielding varieties and expansion of cultivated land. Later Tibet had undergone a transformation from a mainly livestock based agro-economy to crop-livestock based agro-economy. This study presents the significance of livestock for livelihoods of the Tibetan people. Livestock is one of the physical assets, which can contribute a lot in the livelihoods of the people in other places too. The major limitation of the study is that it does not present the methodological details.

A study titled 'sustainability concerns of livestock-based livelihoods in the Andes' was carried out by Leon-Velarde, Quiroz, Zorogastua and Tapia (2000) with a view to describing how the challenge of the constraints faced in the Andes could be met by

adopting a holistic approach. The study concluded that the process of degradation of the natural resource base was dynamic and affecting a large part of the Andean region. The population in large urban cities was increasing and demanding more services and foods. Although both the number and productivity were growing, the actual rates were not enough to cover the additional demand for meat and milk. It seems likely that more products would have to be imported, unless the necessary adjustments were made in land tenure, size of operational holdings, use of appropriate technology, and other factors. They further stated that wide range of appropriate methods and procedures need to be used as tools to support decision making in order to improve production and productivity without degrading natural resource base.

d) Tourism and livelihood

Tourism is one of the main sources of income and contributes much in Nepalese economy. It is important as a source of foreign exchange and employment. A remarkable proportion of economically active population is engaged directly or indirectly in tourism and related activities. Thus it is one of the sources of livelihoods of the people.

Industrial Service Center (ISC) made a study on tourism of Khumbu region of Nepal (1979). The study focused on the impact of tourism on livelihoods of the people of the Khumbu region. The study has brought out the fact that the traditional economy of Khumbu was based on the combination of crop cultivation and transhumance animal husbandry supplemented by yak raising and trade. In addition many Sherpas of lower means used to travel to Darjeeling in search of seasonal employment. The growth of trekking and mountaineering tourism in the Khumbu provided a new avenue and changed the economic pattern of the Khumbu people. The employment opportunity for people in the high remunerative tourism sector affected local agriculture negatively. Tourism became the principle source of the income for their livelihood. In addition to direct employment in guiding and portering people also derived income from operation of hotels and lodges, tea stalls, shops and restaurants. The degree of monetization in the local economy increased significantly. The study mentioned that 64 percent of the families (from 25 surveyed villages) were involved in some kind of tourism services in this area. This study provides an idea about transformation of livelihood pattern of the people after the development of tourism.

Banskota and Upadhyay (1991) made a study on tourism of Makalu-Barun area with a view to explaining impact of rural tourism on income and employment of the local people. The study showed that the impact of tourism on people's livelihood is immense. The direct impact of rural tourism on employment was substantial and portering constituted a major source of cash income of the people especially for Sherpa. About one to two thousands porter mostly men were hired annually by trekkers and mountaineers who visited the Makalu-Barun area. But the employment in hotel and lodges was minimal because most trekkers who visit the area came in groups; hence the demand for local service was low. This study does not elaborate methodological part. However, this study provides general clue about the importance of tourism for livelihoods.

Poudel (1996) studied tourist resources of Pokhara region linking environment with people's livelihoods. The study area covered three districts (Kaski, Manang and Mustang) of Western Development Region. Highlighting the case of Mountain tourism of Ghandruk area the study focused on a number of socioeconomic and cultural issues of the area. The study showed that Ghandruk remained the land of subsistence hill farmers, transhumance and agro-pastoralist for centuries. The development of tourism brought immense changes on different socio-economic and cultural aspects of the people's livelihood. The successful climbing of Mt. Annapurna I (8091 m) by Frecnh climber immediately after opening of the country to climbers in 1949 led the foundationstone for tourism and the opening for trekking in mid 1970s accelerated the pace of tourism in this area. After that local people started to orient their economic pursuit directly or indirectly around tourism. Hotels and lodge keeping, retailing, guiding and portering were the main activities related to tourism of this area. As mentioned in the study tourism brought some remarkable changes on people' livelihoods. These changes were- improvement on sanitation, changes in food items, changes in dressing of the youth, changes in people's traditional social and cultural values, changes in size, material and architecture of the building, increasing use of foreign language for communication and land use change from agricultural land to lodges and camping sites. Now the livelihoods of the Gurung society of Ghandruk have increasingly been commercialized and materialistic. Traditional cultural practices have been replaced by western pop music. The study adopted reconnaissance survey, sample survey and case study approach. The study clearly

highlighted the impact of tourism on livelihoods of the people of the Annapurna Conservation Area.

Banskota and Sharma (1997) made a study on tourism of Ghandruk area with a view to explaining the contribution of tourist expenditure to the local economy. The study was based on sample survey in Ghandruk and Ghorepani area during 1994. As reported, the expenditures made by visitors on accommodation, food, and other local expenses and porter wages were the sources of gross income to the lodges and community. The conservation area fee was also the source of community income. Though the number of tourist visiting this area was good but the link between tourism and community development was not very strong. Because most of the food items for tourist were not produced locally. As a result most of the income went outside. Of the total community income from this sector 61 percent was estimated to be retained locally. The employment generated by tourism was about twelve percent of the active population (aged 10 years and above) of Ghandruk. They identified two types of linkages between tourism and community development. The households that operated lodges had direct linkages with tourism. The indirect occupational linkages of household members were through the sale of their agricultural produce or from being occasionally employed in tourist-related activities. The study deals with the nature of tourist expenditures in the Ghandruk area but does not compare the income from tourism to other sectors of the economy and also does not focus on the impact of tourism on socio cultural aspects of the livelihoods of the local people.

Linking tourism to livelihoods of the local people of Langtang National Park area Banskota and Sharma (1998a) carried out another study. This study was based on key informant interviews and highlighted the importance of tourism for livelihoods of the local people. According to them tourism was one of the main sources of livelihood along with agriculture and animal husbandry for the people residing in Langtang National Park and its buffer zone area. Besides, some people earned substantial incomes from commerce and trade by producing handicrafts or household items such as baskets and mats from forest resources. Almost every household in the Langtang valley was directly or indirectly involved in tourism. However, tourism did not provide employment opportunities all year round and to all those who needed employment. Tourism also played a significant role for the development of National

Parks and wildlife conservation by collecting visitors' fee, royalties paid by hotels, lodges and teashops, and use of timber and other resources. For the improvement of income sources of the local people through tourism a variety of program activities were designed and implemented by Partnership for Quality Tourism (PQT) in Syafrubensi.

Banskota and Sharma made another study on mountain tourism (1998b) with a view to explaining impact of tourism in upper Mustang in general and Lomanthang in particular. The study identified a number of natural as well as manmade assets in this area. As reported these assets were:

- **Natural assets**: beautiful natural landscape, Damodar Kunda, flora and fauna (wild yak, Tibetan wild ass, great Tibetan sheep etc), and Mustang gate.
- **Man-made assets**: monasteries, longest prayer wheel wall, Chhoser cave, Lomanthang wall and Fort tower. Festivals of tourist attraction such as Lhosar, Teej, and Yartung.

The study stated that the tourism activity in Upper Mustang was a recent development. The upper Mustang was open for tourism in 1992. The direct employment in lodges and hotels were limited since group tourism was encouraged in this area. Some employment in teahouses was available. Employment in porter was also low because ponies were commonly used as a means of transportation and they were hired in Jomsom. Therefore, employment benefit generated by tourism in upper Mustang did not benefit the local people. This study identified different livelihood assets of the Upper Mustang area.

Sharma (2000) made a study on tourism and livelihood in the Mountains with a view to exploring the impact of tourism on livelihoods. The study presents the experience of mountain tourism in Nepal sharing two experiences from Nepal- Annapurna Conservation Area Project (ACAP) and Sirubari village tourism. The study showed that the economic and social benefits of tourism were limited to settlements that are strategically located and population groups that already have some resources to take advantages of tourism activities. Assessing the ACAP experience the researcher has commented that there had been an improvement in the overall environmental, economic and social tourism carrying capacity of the Ghandruk area though it was not

sustainable. The linkages of tourism with agricultural, horticultural and livestock sector remained weak but this enhanced social capital. On the other hand Sirubari village tourism experience showed that the community had been able to capitalize the different stocks of natural, social, financial and human capitals using an indigenous institutions, and link it up with promotion and market agency. Thus, livelihoods of people of both Ghandruk and Sirubari areas were influenced directly or indirectly by tourism.

Banskota and Sharma (2000) made another study on tourism with a view to explaining impact of tourism on people's livelihood in Sirubari village in Syangja district. The researchers found that people of this village were benefited from tourism both directly and indirectly. The people benefited directly from tourism were Guest room owners. Non-guest room owners were also benefited directly or indirectly from various community development activities initiated as a result of the promotion of tourism in the village. The welcoming ceremony was a source of direct income to a number of households of the occupational groups. General awareness of cleanliness, sanitation and hygiene were other intangible benefits from tourism. The authors identified a number of different capital assets in the community, which contributed a lot in the development of tourism in the village. These capitals assets were

- **Natural**: community forest
- **Physical**: drinking water, good trail and telephone
- **Social**: rich cultural heritage of the Gurung community, strong sense of solidarity and collective will, relatively well-developed social infrastructures and active rural organization
- **Human:** high literacy, dynamic leadership with exposure to the outside world,
- **Financial:** good economic condition

The study is mainly based on survey and gives a broad knowledge to identify different capital assets in local village level, which is of great significance for the present study to identify the different assets and analyze their role on livelihoods.

e) Remittance and livelihoods

Remittance is one of the main sources of people's livelihoods in Nepal. Its contribution is significant in terms of local as well as national economy. In this

context Seddon et al. (1999) made a study with a view to identifying the role of remittance in Nepalese economy. The study was the preliminary result of the DFID funded ongoing project "the remittance economy" of Nepal. The researchers stated that remittance was a significant contribution to Nepalese economy. It was not only the sources of foreign exchange but also a source of income to many households and local communities throughout the country, particularly in the hill areas. The role of remittances in Nepalese economy was in increasing trend. Both the number of foreign labor migrants and the volume of remittances entering into Nepal increased substantially in the last ten years. Based on conservative estimate the total volume of the remittances coming into Nepal legally and illegally estimated to be 69 billions (25 percent of the GDP) in 1997. But its distribution was uneven. The scale and significance of the remittances reaching the rural areas varies by region, social groups, village and even households. Since remittance is one of the important sources of Nepalese economy, changes in international labor migration pattern and flow of remittances may seemingly bring immense changes in livelihoods of the people.

Adhikari (2001) carried out a study entitled 'role of mobility and remittances in diversifying the livelihood opportunities in rural Nepal' with a view to understanding the role of remittances in the economy at the national scale as well as the village level. The study was carried out during 1998 and was the continuation of the earlier study done in 1990 in two villages of Kaski district in central Nepal. The researcher stated that the remittances and labor migration in Siding and Karuwa-Kapuche as well as in other villages had played a catalytic role in diversifying the livelihood strategies of the households. The strategies followed by the households were wage labor, animal husbandry, service in Nepal and abroad, selling bamboo products, weaving nettle fiber clothes, selling potato, forest vegetables and timbers, business, carpentry, temporary migration, loan and barter-exchange. However, migration or remittances earning opportunities were not accessible to the poorest groups. They were benefited from the other indirect impacts of remittances like land sharing opportunities and wage employment created in the household taking part in remittance economy.

f) Water and livelihoods

There are a number of studies dealing with livelihoods relating to water resources. Water is one of the natural assets and has enormous effects on livelihoods of the

people. Water is used for different purposes- irrigation, household use and many others. Irrigation is one of the most common water uses in Nepal. There are a number of studies dealing with irrigation and its impact on food production and livelihoods.

Pageni (1987) carried out a study linking irrigation to livelihoods of the people. The study is related to Narayani Pumping Irrigation Project and its impact on the livelihoods of the people of Narayanpur Village Panchayat in Chitawan district, Nepal. This study was based on survey of 15 percent (out of total 999) households of the study area. The study mentioned that Narayanpur Village Panchayat area was dry or semi-dry until Narayani pumping irrigation was provided and crop production solely depended on the monsoon. As a result its productivity was very low and paddy used to be grown as a second crop. The provision of irrigation brought noticeable changes in livelihoods of the local people. After the supply of irrigation water about 55 percent of the total cultivated land was used for paddy cultivation as against 30 percent of the cultivated land under paddy prior to development of this facility. The irrigation facility not only brought changes in agricultural area, but also in the pattern, intensity and diversity of crops. The increased agricultural production brought immense changes in livelihood pattern of the people as well. Some of the notable changes were increased food security, changes in occupational structure and income level of the family, and increased in level of education.

Mainali made a study relating irrigation to rice production in 1987. The study focused on the impact of irrigation on rice production as well as livelihoods of the rice-producing farmers of Nuwakot district. The study was based on sampling of three representative villages selected purposively. The total sample size of the study was 120 households. The author highlighted the role of irrigation and stated that the irrigation facility brought drastic changes in the economic situation of the people of the study area. The production of rice per unit of land increased tremendously after the provision of irrigation facility. The productions of rice both native and improved variety increased by 39.5 and 73.5 percent respectively. Net return from per hectare of rice cultivation increased by 118.73 percent compared to the net return per hectare before irrigation facility was available. The farmers substantially could increase their farm productivity and family income as a result of the increase in intensity as well as diversification of crops.

Likewise, Bhandari (1994) studied Kankai irrigation project with a view to identifying the impact of irrigation on paddy production as well as livelihoods of the people. The study covered four VDCs- Sivganj, Panchgachi, Mahabhara, and Baigundhura of Jhapa district. This study covered 400 households (8 percent of the total) using multistage sampling technique. The study stated that the development of irrigation in the study area brought immense changes on paddy production. Both area and production of paddy increased tremendously. The cropping intensity and diversity also increased. The area changed into two rice crops from single rice crop a year. According to the study the average production of paddy was 1.7 metric ton before irrigation and reached 9.5 metric ton after the provision of irrigation facility. The increase in the productivity of paddy brought drastic changes in livelihoods of the local people. As reported the remarkable changes were- increase in literacy rate, level of employment, increase in level of income, saving, and increased food security of the households. This study gives an idea about changes in livelihoods of the people due to the provision of irrigation facility.

Bhandari (1996) made another study at Panchgachi VDC in Jhapa district with a view to analyzing the impact of irrigation on livelihoods of the people. The study used stratified sampling (10 percent of the total household) on the basis of land holding size. The study focused on the impact of Kankai Irrigation Project on paddy production. Before irrigation facility was provided, agricultural activity in this area depended on monsoon and maize was the major crop. The production of paddy was low. Daily life of the farmer was hard due to low production, which earned low income, low saving and low investment by the farmers. Both the area and production of paddy increased after the provision of irrigation. On an average the yield of paddy increased by 79 percent in 1995 compared to that of 1980. Using t test the study concluded that there was a positive relationship between production of paddy and irrigation.

A study entitled Water against poverty: livelihood-oriented water resource management was carried out by Shah (1998). The study reviewed a range of issues and policies regarding the theme of water and rural poverty in South Asia. Emphasizing the importance of water, the researcher concluded that in all three of its critical functions- as consumption goods, as a productive resource and as an

environment water is linked to food supply and livelihood security of South Asia's urban and rural poor in a complex ways. The balanced use and appropriate management of water resources were central to achieving food and nutrition security for south Asia's rural and urban poor. If these objectives are not fulfilled, water can create problems that never existed before.

With a view of highlight different aspects of water uses of rural communities of different coutries of the world, Briscoe and Ferranti carried out a study in 1998. They presented past and present scenarios of water uses. They stated that more than 15,000 million people (30 percent of the world's population) did not have access to safe water. The consequences of this with regard to health, productivity and quality of life, as well as its secondary implications for economic development, poverty alleviation, were believed to be enormous. Improved water supply facilities could bring rural people large benefits in terms of more time, improved health, and better opportunities for production and leisure activities. The benefits were especially important for women, who worked long hours and were extremely poor.

Operation of watermill is one of the water uses. This type of water use is generally found in the hills and mountain areas in Nepal where abundant water is used for grinding cereals- maize, millet and wheat. German Technical Cooperation and Center for Rural Technology, Nepal (2000) studied traditional watermills of Nepal and highlighted its role on rural livelihoods. The study reported that the traditional watermills had been the part of villagers' life and used as important source of energy for centuries for grinding their food grains. The study estimated that more than 25,000 watermills were in operation in Nepal basically in high hills. The study emphasized that the watermill brought positive changes in the livelihoods of mill owners and other community members of the village as a whole.

Dixit (2002) made a study on water science with a view to explaining water and its functional uses. He has stated that water is essential for biological functions of human beings, plants and animal. Water also meets industrial needs and is the source of energy for a variety of production purposes. As a solute, water washes away dirt. In addition, water is an important element of cultural practices and religious beliefs. Thus, water, with its myriad social, economic and cultural values is a means to conserve the environment and enhance quality of life. He has compared domestic

water uses of rural households between Tarai and Hills of Nepal. It was concluded that per capita water use was high in Tarai as compared to Hills.

There are a number of Environmental Impact Assessment (EIA) studies of hydropower projects in Nepal. Some of these studies cover water uses and livelihood pattern in a comprehensive way. One such study is the EIA of Modi Khola hydropower project in carried out by Nepal Electricity Authority (1996). This study covers a small portion of the Modi Khola watershed limited within project-affected areas. The study explains about water uses of the Modi Khola area. As reported, the water from Pati Khola was used for irrigation. People use Modi Khola for bathing and washing purposes. Local people mostly used Modi Khola riverbank or confluence to cremate dead bodies. Fishing was another water use of the area. A few families were involved in fishing and it was also seasonal. Thus, the contribution of fishing on people's livelihood was not significant.

In 1998, East Consult conducted a study titled 'Environmental Study of Upper Modi A Hydroelectric Project'. The study covered the upper part of the Modi Khola catchments limiting to two Village Development Committees namely Ghandruk and Lumle. The study was based on PRA. The report showed the livelihoods of the local people along with water uses. The water from the Modi Khola as reported, was not used for irrigation and drinking in the zone to be affected directly by the project. However, other tributaries of the Modi Khola were used for drinking, irrigation and mills. Fishing was another component of water use. But fishing was not professionally practiced in the Modi Khola in and around the project area. Therefore, the project would not adversely affect livelihood of those who were engaged in fishing.

Likewise, EIA of Melamchi Diversion Scheme (the diversion part of Melamchi Water Supply Project to be implemented for the supply of drinking water to Kathmandu valley) carried out by IUCN and METCON in 1999. The study covers three different major water uses namely irrigation, watermills and fishing. Water use for irrigation is very extensive in the Melamchi valley. Before the development of irrigation facility by using water from the perennial Melamchi Khola, one/two crop system was dominant in the valley and rice fields were extremely limited. With the extension of irrigation from the Melamchi Khola intensification of agriculture took place with the development of three-crop system and the rice fields were greatly expanded. The

intensification of agriculture had greatly influenced the livelihoods of the local farmers. Other important water users as reported by the study were watermills and fishing. Both these activities were important in the valley. However, these activities used to discontinue during the rainy season when water flow would become high. The people engaged in these activities had to opt for other jobs during such periods. The EIA report made a comprehensive survey of water uses for these activities in the valley. The study was based on census in the valley. The report also hinted at the likely impacts of the project on different water uses, which would directly affect livelihood pattern in the valley due to diversion of water from the Melamchi Khola.

CEMAT Consultants (2000) made an Environmental Impact Assessment of Upper Modi Hydroelectric Project. A multidisciplinary study team carried out the study applying survey techniques such as household survey, PRA, observation etc. The study covered only upper part of the valley. The study shed lights on livelihood as well as water use pattern of the upper Modi area. As reported water uses in the Modi Khola area included household use, irrigation, milling, fishing and other social purposes (taking bath on religious occasions and the cremation cites or burning ghats). The water in between intake structures (Kimche bensi) and powerhouse site (Birethanti) of the project was not used for drinking purposes. Side streams, which join The Modi Khola, were widely used for this purpose. Similarly, there were some irrigation canals in the area but the water of Modi Khola was not used for irrigation. Instead, the water from tributaries was used for this purpose. The report stated that the main reasons for not using water from the Modi Khola were low temperature and heavy silt content, which would badly affect the plant growth. There were some watermills operated from the Modi Khola. The watermills operated in the Modi valley were seasonal. The uses of water for other purposes included bathing, drinking for animals, and fishing. These uses were also limited due to strong current of the river. The study also predicted the adverse impact of the project on fish, which would affect livelihood of the local people.

Another EIA was carried out by METCON for Alternative ‘B’ Melamchi Diversion Scheme in 2001. This study confirmed the water uses and livelihood pattern as reported by EIA of 1999. However, it covered the new developments that took place during the two years. Particularly important development was the extension of

irrigation canals from the Melamchi Khola. With this, extensive agricultural lands were changed from two-crop system to three-crop system. As a result the valley became the rice exporting area, and a large amount of rice was being exported to Kathmandu valley. This development remarkably commercialized the local agriculture. This EIA report also predicted likely adverse impacts on water use and livelihood pattern in the valley due to diversion of water from the Melamchi Khola.

GEOCE Consultants made another EIA of 'Upper Modi A Hydropower Project' in 2001. The study covered only upper part of the Modi catchments. The study assessed and predicted the impact of the project activities on physical, biological, socio-economic and cultural resources. The study reported livelihoods along with water uses in the study area. The water of Modi Khola was not used for drinking purpose. The low lands along the river were irrigated from the Modi Khola by using traditional irrigation canals. But it was not seen during the field visit and also not reported by the other EIA reports. Another use of water reported in the study was for watermills operated in the Modi valley. The watermills were operated in the Modi Khola during winter. As reported the water of the Modi Khola area was not used for recreation purposes such as rafting or boating. The study also mentioned that the aquatic resources of the river are likely to be affected adversely due to the project.

There are a number of other EIA studies of hydropower projects conducted by different agencies. The EIA of Kaligandaki Hydroelectric Project (East Consult, 1992), Kulekhani III Hydro-electric Project (METCON Consultants in association with INSEEN, 1997; Nepal Engineering Consultancy Center, 2001); Andhi Khola Storage Hydel Project (METCON Consultants, 1997), Upper Karnali Hydropower Project (Canadian International Water and Energy Consultants, 1998); Budi Ganga Hydropower Project (METCON Consultants, 1998); West Seti Hydropower Project (SMEC International, 1999), Nyadi Hydropower Project (LEDCO, 1999) Khudi Hydropower Project (LEDCO, 2001) and Middle Marshyangdi Hydroelectric Project (NEA with TACE Consultants, 2001) discussed different water uses. The main water uses discussed in these studies were drinking water, irrigation, fishing, recreation and cultural uses. All showed the importance of water for local livelihoods in varying degree by location and river.

g) Climate and livelihoods

Climate is one of the important physical factors influencing livelihoods of the people directly or indirectly. The changes in both temperature and rainfall pattern affect people's activities in many ways. Temperature rise, variability in rainfall, increase in extreme events are the common features of the climate change.

A study with a view to explaining impacts of climate change on physical, ecological and economic system of mountain regions was made by Beniston et al. (1996). According to them the scenarios of climate change in mountain regions are highly uncertain. Atmospheric dynamics create locally distinct topographical microclimates that influence a wide range of environmental factors. These changes would affect water storage delivery infrastructure such as irrigation, hydropower projects and mountain land use related to vegetation cover. The changes in water related infrastructures and changes in mountain land use would bring immense changes in livelihoods of the mountain people.

Kirschbaum and Fischlin (1996) made a study on the link between climate and forest at macro level. According to them forests are highly sensitive to climate change. An increase of as little as 1^0 C in mean annual air temperature could cause changes in the growth and regeneration capacity of many tree species. The researchers used three different models to show the changing scenarios of forest as caused by climate change. They stated that 33% of the currently forested area of the earth is likely to be converted from current vegetation class to new one in response to climate change. They forecasted that the temperature increase by 0.1^0 and 0.35^0 C per decade could cause the migration of vegetation species by 1.5-5.5 km towards the pole per year as well as by1.5- 5.5 m. elevation per year. Such changes in vegetation are likely to cause changes in the people's activities affecting livelihoods.

Agriculture is more sensitive to the climate. Temperature and rainfall determine the production of different crops. Focusing on impact of climate on agriculture of the developing countries Mendelsohn and Dinar (1999) made a study. The researcher stated that both welfare of population and economic development of the developing countries in the tropical and sub-tropical areas that heavily depended on agriculture are adversely affected by global warming. The poor soil in large parts of these regions

was unusable for agriculture and agricultural productivity could decline due to warming. The efficient economic adaptation would significantly reduce the effect of climate change, however, in the developing countries due to their low adaptation capacity agricultural productivity could not be maintained. Since agriculture is the main source of livelihoods of the people in developing countries, changes in agricultural production due to global warming would bring immense changes in livelihoods of the people.

Soz (2000) made a study on climate change. The main objective of the study was to analyze the impact of climate change on various aspects of life in Kashmir, India. As reported, Kashmir has experienced a rising temperature since long time and this change brought a number of physical and socio-economic changes in Kashmir. The notable changes were loss of one full season (20-30 days long season 'Tsonth') between snowy winter and spring, decrease in intensity and amount of snow fall, dressing pattern of the residents, decline in volume of water in the Jhelum river and migration pattern of swallows. The change in the volume of river water brought changes in aquatic environment as well as water uses in downstream areas.

In this regard, Cooper (2000) made a study on climate change with a view to addressing the possible socio-economic impacts of global warming. The researcher highlighted several key potential effects of global warming. The most important effect would lie on the food production. It brought changes in the regional food production as well as food balance because food grains production rose higher in the higher latitudes but it decreased in the tropics due to the decline in water availability in the tropical areas. The other effects of the global warming as reported would be the increase in contagious diseases particularly in warm climates, rise in sea level which could affect habitability of coastal areas and changes in species and pattern of vegetation. These changes would bring about changes in livelihood patterns of the people directly or indirectly.

Pratap and Pratap (2001) made a study with a view to analyzing the impact of climate change on agriculture of Hindu Kush-Himalaya region. The study was based on survey in apple growing areas of the Hindu Kush-Himalaya region. As reported, agriculture was the main source of employment and livelihoods of the people living in this area. However, agriculture in this region was in a stage of transition from

traditional cereal crop farming to high value cash crop i.e. apple farming, the farmers of these areas claimed that over the past decades, the apple production had been declining due to inadequate pollination despite agronomic inputs and orchard managements. One of the major factors responsible for inadequate pollination of apple was climate change. Bad weather conditions such as frost, rain and hailstorms, and low temperature during the apple flowering period adversely affected pollination causing low production. Thus, the livelihoods of the farmers dependent on apple farming were adversely affected.

The studies reviewed above clearly spell out different terms and terminologies along with well-defined conceptual model, and also provide some methodological basis for analysis. The theoretical and conceptual studies reviewed above provide a strong conceptual basis. These theoretical studies are also the important sources for the development of relevant models for the present study.

The case studies reviewed are either focused on individual assets or on livelihood strategies in general. Some studies are related to single activity and some are on influences of climate change on livelihoods. The studies show the extent of contribution of individual asset to livelihoods in varied environmental contexts and their effects in shaping strategies to secure livelihoods. The scales of research vary from local to the global level. Most of the case studies are based on empirical investigation, and they adopt both secondary and primary data/information. However, some studies are vague in methodological details. Despite this, most of the reviewed case studies have been very useful in developing methodological details for the present study.

The studies reviewed are basically sectoral in approach. None of the studies analyzes livelihoods combining all five different capital assets within a single framework. Unlike other case studies, the present investigation is an attempt to combine all five capital assets and associated factors that determine livelihoods within a single framework. It is on this ground that the present empirical study differs from other case studies reviewed above.

1.8 Structure of the study

This study is divided into eight chapters. The first Chapter begins with the introduction of the study followed by approaches and methodology discussed in the second Chapter. The third Chapter deals with the profile of the study area. The fourth Chapter focuses on assets and their contribution to livelihoods and the livelihood strategies are analyzed in the fifth chapter. Likewise, the sixth Chapter highlights the role of water on livelihoods. And livelihoods in relation to climate change are analyzed in seventh chapter. Conclusion and findings are presented in the eighth Chapter, which, is followed by references and appendices.

CHAPTER II

APPROACH AND METHODOLOGY

2.1 Selection of the study area

The study area is Modi Khola watershed. Modi Khola is one of the tributaries of the Gandaki river system. It originates from Annapurna Himal and flows southward in Kaski, Parbat and Myagdi districts in the Western Development Region of Nepal. This river drains 676.8 sq. km area and joins with the Kaligandaki river at Majhbeni, downstream from Kusma Bazaar, the headquarters of the Parbat district. The selection of the study area is purposive. This area represents different ecological zones within a short physical distance. It extends from less than 500 meter in the south to above 8000 meter in the north, which represent entire understanding of livelihood scenario of the country as a whole. The area is also composed of different ethnic groups having different socio-cultural environment. It is one of the few important tourist areas of Nepal. Heavy influx of tourist in this area has caused changes in traditional livelihood options and strategies of the people in different ways. Since the use of water is extensive in this area for a number of purposes, the present study focuses on water uses of the area.

2.2 Conceptual framework

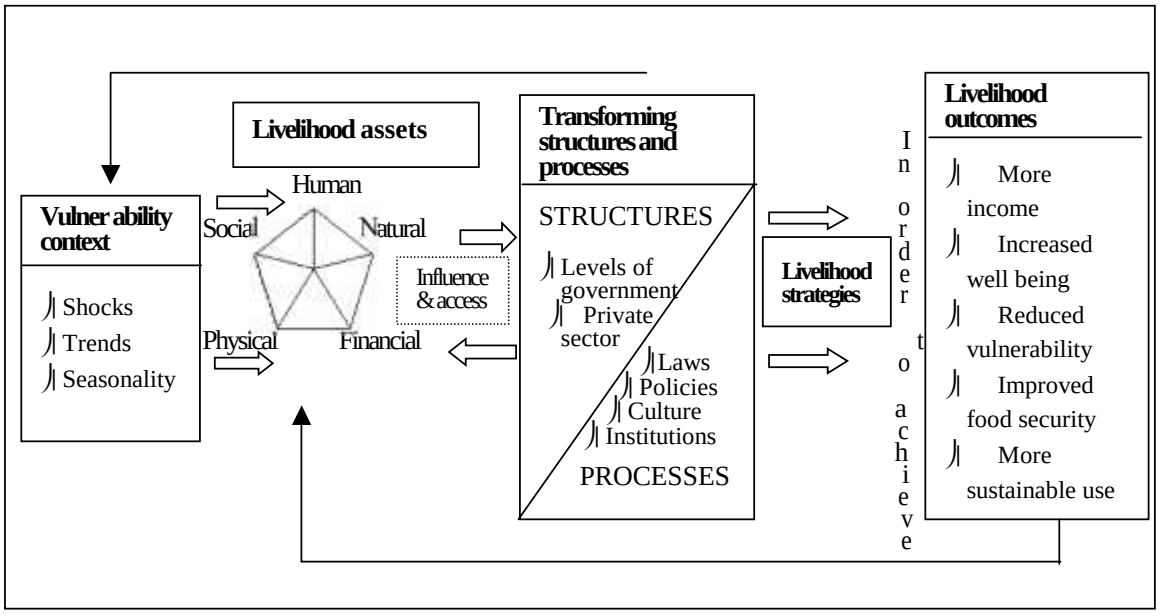
The livelihood study is primarily based on livelihood concept as developed by Robert Chambers in the mid 1980s. Later, Chambers and Conway further expanded this concept in the early 1990s. Based on this, a number of agencies working in the field of development such as Oxfam, CARE International, UNDP and DFID introduced and applied different sustainable livelihood models. Scoones (1998) presented another model for sustainable rural livelihood analysis. Though the structures of the model vary, all these provide an analytical structure for building an understanding of livelihoods and share much in common, notably the focus on assets and on micro-macro linkages as well as common roots in the works of Chambers and Conway (Carney et al., 1999). The concept of sustainable livelihood gained legitimization through several international forums (Wyss, 2004).

The conceptual frameworks constitute two models- livelihood model and water use model. The details of these models are discussed in subsequent sub-sections.

2.2.1 Livelihood model

The model as developed by DFID is directly used for the present study (Figure 2.1). The livelihood approach is concerned first and foremost with people. It seeks to gain an accurate and realistic understanding of people's strengths (assets and capital endowments) and how they endeavor to convert these into positive livelihood outcomes. This model comprises five basic components, which presents the main factors affecting people's livelihoods and the relationship between these components. These components include vulnerability context, livelihood assets, transforming structures and processes, livelihood strategies and livelihood outcomes. The basic components as explained in the model are as follows:

Figure 2.1 Livelihood model adopted for the study



a) Assets

The model is founded on a belief that people require a range of assets to achieve positive livelihood outcomes. These are human, social, natural, physical and financial capitals. A brief description of the livelihood assets as defined by DFID is given below.

- **Human capital**: The skills, knowledge, ability to labor and good health important to the ability to pursue different livelihood strategies are categorised as human capital. At a household level human capital is a factor of the amount and quality of labor available; this varies according to household size, skill levels, leadership potential, health status etc. The human capital is important for gaining access to making use of other assets.

- **Physical capital**: The basic infrastructures (transport, shelter, water, energy and communication) and the production equipment and means are categorized as physical capital. There is a strong relationship between physical capital and other types of capitals. Sufficient and good quality of physical capital helps to improve livelihoods directly or indirectly in many ways, it lowers the cost of access to, and enhances accumulation of and use of other capitals too.

- **Social capital**: Social capital represents the social resources such as networks, membership of groups, relationships of trust and access to wider institutions of society. These are interrelated and intimately connected to transforming structures and processes. The social capital can make important contribution to people's sense of well-being. Mutual trust and reciprocity lower the cost of working together. Social capital helps in improving management of common resources, maintenance of infrastructures, and in increasing people's incomes and saving rates. It has a close relationship with human capital too, it facilitates innovation and development and sharing of knowledge.

- **Natural capital**: Natural capital represents the natural resource stocks from which resource flows and services useful for livelihoods are derived. The natural capital includes land, water, wildlife, biodiversity and environmental resources. Natural capital is important for all however, it is very crucial to those who base their livelihoods on resource-based activities. The relationship between natural capital and vulnerability context is very close. The shocks, for example, floods and conflicts destroy livelihood assets and livelihoods activities.

- **Financial capital**: The financial capital constitutes the resources which are available to people and which provide them with different livelihood options. Available stocks and regular inflows of money are two main sources of financial

capital. The available stock can be held in several forms such as cash, bank deposits or liquid assets such as livestock and jewellery. And pensions or other transfers from the state and remittances are regarded as regular inflows of money. It is the most versatile capital among others and can be converted into other capitals or it can be used for direct achievement of livelihood outcomes.

b) Vulnerability context

The components of the external environment such as trends, shocks and seasonality are known as vulnerability context which influence people's livelihood directly. Shocks such as floods, storms, civil conflicts etc. can destroy assets and force people to abandon them. Trends are more predictable however, they influence on the rates of the return of chosen livelihood strategies. The effects of trend are not always negative. Seasonality i.e. shift in price; employment opportunities and food availability greatly influence the livelihoods of poor people.

c) Transforming structures and processes

Transforming structures and processes within the livelihoods framework are the institutions, organizations, policies and legislation that shape livelihoods (DFID, 1999). Structures make processes function and processes determine the way in which structures operate and interact. The structure and processes can be compared as hardware and software of the computer system and both are important for livelihoods.

d) Livelihood strategies

Livelihood strategies are the range and combination of activities and choices that people make/undertake in order to achieve their livelihood goals. Livelihood strategies vary geographically, across sectors and within household and over time. It is a dynamic process in which people combine different activities to meet their various needs at different times.

e) Livelihood outcomes

The fifth component of the framework is livelihood outcomes. Livelihood outcomes are the achievements or outputs of livelihood strategies. Livelihood outcomes are important because they help us to understand the output of the current configuration of

factors within livelihood framework, motives of people to behave as they do, what their priorities are, how they are likely to respond to new opportunities, and which performance indicators should be used to assess support activities (DFID, 1999). There are different categories of livelihood outcomes but the relevancy of component differs by situation. The major indicators measuring achievements are level of income, level of well-being, food security condition, vulnerability level and use of natural resource base.

2.2.2 Water use model

For the analysis of water and its related aspects, there are a number of schematic diagrams and models developed by different researchers. In this context, Dixit (2002) presents a model of functional water uses, which presents the relationships between different types of water uses, water requirement and sources of water. Since the present study aims to analyze livelihoods of the rural people with more focus on water use, a conceptual model (Figure 2.2) is developed and used. This model is primarily based on Dixit's concept. However, some modifications are made. The model has five basic components and the entire picture endeavors to present water based livelihood system. These components include source of water, the influencing factors, water demand, water use types and livelihood outcomes. A brief description of the individual components of the model is given below:

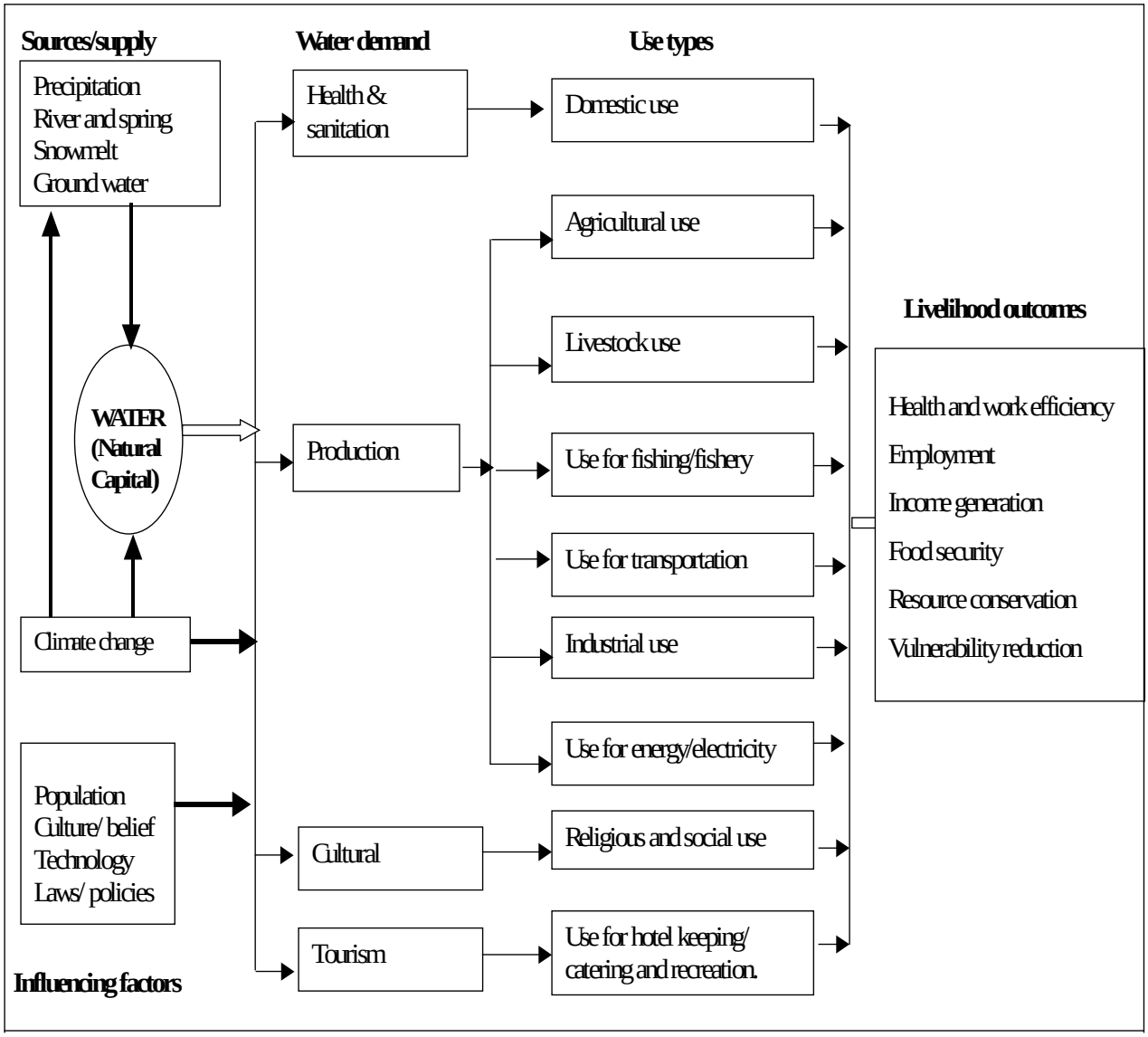
a) Source of water

Water, a natural asset, is present in surface stocks (lakes, ponds) and flows (rivers), as groundwater in aquifers or as soil moisture. In other words, precipitation, river and spring, snowmelt and underground aquifer are the main sources of water. The availability of water varies by time and space and like other assets it provides better opportunities for different livelihood activities.

b) Influencing factors

The influencing factors such as population, cultural tradition and behavior, technology, laws and policies and a number of other factors affect on water demand and its uses. The changes in climatic conditions influence both the availability of as well as demand for water for different purposes.

Figure 2.2 Water use model



c) Water demand

Water requires for a variety of purposes. These include the demand for water for health and sanitation, production (agriculture, livestock, industry, electricity/energy, fishery, transportation), environment, cultural practices and tourism. Though water demand for environment or ecological balance is very important, the demand for water for this purpose is not covered in the present study oweing to apparent difficulty in collecting related data/information. Water is also demanded for cultural and tourism purposes. The increase in population size leads to increase of demand and supply of water for different purposes i.e. for health and sanitation as well as for various production purposes to fulfill increasing requirements. Besides, the technological advancement, laws and policy also have an influence on the demand for water. The climatic change influences both supply of and demand for water.

d) Use types

The model shows the use of water for different purposes. One of the important uses of water is domestic (culinary) purpose, that is, for drinking, bathing, washing, cooking and waste management. This is the most fundamental one among different uses. Agriculture, a major livelihood base of the people of the agrarian country like Nepal, is undoubtedly the largest consumer of water. Therefore, water plays an important role on employment generation, production increase, and rising of income level and food security. Water plays vital role for agricultural intensification, cropland extensification, crop diversification and productivity. Likewise, water use for industrial purposes (production and processing and as a source of raw material) is equally important. In addition, generation of energy (hydro-electricity) and use of water for milling purposes are also important for people's livelihoods. Fishing, transportation and use of water for tourism and pilgrimage purposes are other important aspects of water uses. In this way, water is fundamental for varieties of activities upon which people's livelihoods are based. Therefore, the role of water on livelihood can be evaluated by analyzing the use of water and its performance.

e) Livelihood outcomes

Another important component of the model is livelihood outcome. The livelihood outcomes are the combined output or achievements of water availability (including other assets), influencing factors as well as water using strategies. Livelihood outcomes are of different categories and are not limited to financial nature. These include health and work efficiency of people, employment, income generation, food security, resource conservation and vulnerability reduction. In other words, the model shows the effect of water use on livelihood outcomes. One of the determining factors for the production efficiency of the people is the availability of sufficient quantity and quality of water. It can be measured in terms of human health. Production and employment level, income level and level of food security are also determined by the availability and use of water. Therefore, the importance of water on livelihoods can be measured and evaluated on the basis of factors mentioned above in Figure 2.2.

2.3 Sampling design and techniques

For the purpose of finalizing sampling design, the district maps (scale 1:1,25,000) of the study area have been collected and digitized using GIS software. Three layers of map viz relief, drainage, watershed and VDC boundaries were prepared. A number of socio-economic indicators were chosen for dividing the study area into different clusters or sub regions to determine the sample units. These indicators include the proportion of households having land and livestock, literacy status of 6 years and above population, density of population and family size. The socio-economic indicators mentioned above for the year 2001 were analyzed and relevant thematic maps were also prepared to compare the results. None of the indicators that were tried individually or in combination provided good results. The basis of water regime seems relevant. Hence, this basis is adopted for defining spatial sampling units.

There are altogether 28 Village Development Committees (VDCs) of three districts namely Kaski, Parbat and Myagdi located (partially or fully) in the Modi Khola watershed. For the purpose of sampling, the Modi Khola watershed was divided into two sub-regions- the upstream sub-region and downstream sub-region on the basis of water regime. The dam site of the Lower Modi Hydropower Project was considered as the dividing line. All the Village Development Committees (VDCs) lying below this

limit were considered as part of the downstream sub-region and those lying upstream from this point as part of the upstream sub-region. Altogether five VDCs namely Bhuktangle of Parbat district, Dansing, Ghandruck, and Lumle of Kaski district, and Sikha VDC of Myagdi district are located in the upstream sub-region and 23 VDCs of both Parbat and Kaski district are in the downstream sub-region. An important socio-economic indicator measured in terms of population density further supported this division. Population density in the VDCs of the downstream sub-region is higher than 100 persons per square km and that in the upstream sub-region it is below 100 persons. Each sub-region was further sub-divided into different zones on the basis of altitude at a range of 1000 meters interval. However, a zone without permanent human settlement is not considered as a separate zone, though it lies within the limit of 1000 meters interval. There are three zones in the downstream sub-region i) upper zone (above 2000 meter), ii) middle zone (1000-2000 meter) and lower zone (below 1000 meter) and two zones in the upstream sub region i) upper zone (above 2000 meter), and ii) middle zone (1000-2000 meter).

Altogether 12 settlements were determined for the study after consideration of adequate coverage of settlements. It was also determined that an equal number of community/settlement units would be selected for each sub-region ignoring the numerical strength of settlements. This was done in making the results comparable between the two sub-regions. From each sub-region, six settlements were fixed. For this, all the permanent settlement units of the study area were identified using recent toposheets. These were verified during the scooping stage of fieldwork. Then the total community/settlement units were listed to create a sample frame. Since there are two zones in the upper Modi sub-region, three settlements from each zone were fixed, while in the case of the lower Modi sub-region two settlements from each zone were fixed.

Watershed level population data is not available for Modi Khola watershed. The data are available for 28 VDCs (18 entirely and 10 partially) of the study area. Since VDC boundary does not follow the watershed boundary in many cases, the calculation of exact number of household and population sub-region and zone is difficult. According to the population census of 2001, there were altogether 22,136 households and 1,01,766 population in total 28 VDCs. The population of the watershed was estimated

to be 75,000 (17,000 households) in 2001. A total of 360 households were fixed as sample size for the whole watershed by taking 30 households from each settlement. It constitutes 2.1 percent of the total households of the watershed. The sample size of 30 is statistically considered to be justifiable. Therefore, as a rule of thumbs a total of 30 households from each settlement were fixed.

After finalizing spatial sampling frame, a required number of settlements were selected randomly from the list of settlement units. The settlement units having less than 30 households were replaced considering the sample size of minimum 30 from each settlement. In the case of the absence of settlement having 30 or more households for replacement a desired number of households were taken from the nearby settlement selecting randomly. The settlement units selected for survey are given in the Table 2.1

Table 2.1 Settlements selected for survey by sub-region and zones

Sub-region	**Zones (m)**	**Name of the selected settlements**
Downstream	Lower (below 1000)	Katuwa Chaupari and Chuwa (2)
	Middle (1000-2000)	Bajung and Jobang (2)
	Upper (above 20000)	Halzure/Rele and Halhale (2)
Upstream	Middle (1000-2000)	Syaulibazar, Landruk and Mohariya (3)
	Upper (above 2000)	Ghandruk, Melache/Taulun and Chhomrong (3)
Total	**5**	**12**

Source: Field survey, 2002

For the selection of individual household recent voter lists were used as the sample frame. A list of the household heads was prepared for each selected settlement, and the individual household was selected randomly. The total number of households selected by settlement and ethnicity is given in Table 2.2. Brahmin/Chhetri represents almost 50 percent of the total sampled households followed by Gurung (23.6 percent), Magar (17.5 percent), and others (10 percent).

Table 2.2 Distribution of sample households by settlement and ethnicity

Settlements	Brahmin/Chhetri	Gurung	Magar	Others	Total
A. Downstream	**109 (30.3)**	**2 (0.5)**	**55 (15.3)**	**14 (3.8)**	**180 (50.0)**
⁾ Halzure/Rele	-	-	29	1	30
⁾ Halhale	2	-	26	2	30
⁾ Bajung	27	2	-	1	30
⁾ Jhobang	29	-	-	1	30
⁾ Chuwa	24	-	-	6	30
⁾ Katuwa Chaupari	27	-	-	3	30
B. Upstream	**67 (18.6)**	**83 (23.1)**	**8 (2.2)**	**22 (6.1)**	**180 (50.0)**
⁾ Chhomrong	-	28	1	1	30
⁾ Melache/Taulun	18	10	1	1	30
⁾ Ghandruk	1	25	1	3	30
⁾ Landruk	19	8	-	3	30
⁾ Syaulibazar	10	4	5	11	30
⁾ Moharia	19	8	-	3	30
Total (A and B)	**176 (48.9)**	**85 (23.6)**	**63 (17.5)**	**36 (9.9)**	**360 (100.0)**

Source: Field survey, 2002

2.4 Database

The study is based on both primary and secondary data. The secondary data were acquired from different sources such as published books and journals, unpublished or historical records/documents, professional technical reports, maps and Internet web sites. The study is largely based on primary data/information.

2.5 Methods of data collection

2.5.1 Primary data

An eight members' team for fieldwork including researcher himself was organized. Six field assistants having qualification of Master's degree in Geography were hired in Kathmandu and one local person was hired as guide cum enumerator. A three-day training for these field assistants hired in Kathmandu was organized at Central Department of Geography, Tribhuvan University, Kirtipur before field visit. The local enumerator was trained in the field.

The fieldwork was carried out in two phases- one before Dasain festival and another after this. The first phase of fieldwork was carried out during September-October, 2002 and second phase was completed during March 2003. Three types of survey were carried out. These were household survey, participatory group discussions/PRA, mapping of water related infrastructures and services. Household Survey and Group Discussions were completed in the first phase but mapping and completion of survey of water use was done in the second phase.

a) Household survey

A total of 360 households (30 households from each selected settlement) were selected randomly from the list of the household heads of the 12 selected settlements for the collection of household level information. For this, the selected household heads were interviewed and responses were recorded in the schedule/questionnaire. In the case of absence of household heads other senior members of the households were interviewed. The detail information of the household on different livelihood assets, livelihood strategies and livelihood outcomes and other related aspects were collected. The details include different aspects of population such as age and sex composition, literacy status, household facilities and health, occupation and migration; land distribution, different aspects of agriculture and livestock including food security; income and expenditure pattern of the household; water use and contribution of household on its managements; perception on different aspects of environment such as changes in temperature, precipitation and impact of these changes on livelihoods.

b) Group discussion

Community level information about different resources/assets, distributions and present utilization pattern of these resources, perception regarding climate change and its relation to livelihoods of the local people was collected through participatory discussion approach. For this purpose a group consisting 5-10 persons representing different occupational groups, elected persons, social workers and farmers, where available, was formed at each community selected for group discussion. A total of 12 communities were covered for group discussion, one per each community/ settlement. In addition, a number of informal discussions were also made. Details of group composition are given in Table 2.3.

Table 2.3 Composition of participants for group discussion

Communities	Participants	Group composition
Chhomrong	9	Ward chairperson and chairperson of mother's group, businessman, farmer and chairperson and secretary of electricity users committee
Melache	5	Teacher, and farmer (1 female)
Ghandruk	7	Ward chairperson, chairperson and member of mother's group, teacher, and farmer
Landruk	9	Ward chairperson, teacher, businessman, and farmer
Syaulibazar	5	Teacher, farmer and businessman
Moharia	6	Ward chairperson and farmer
Rele/Halzure	6	Farmer (1 female)
Halhale	10	Social worker, VDC secretary, and farmer
Bajung	5	Vice chairperson of VDC, teacher, farmer
Jhorbang	5	Teacher, social worker and farmer
Chuwa	5	VDC chairperson, and farmer
Katuwa Chapari	7	Social worker, teacher, farmer

Source: Field survey, 2002/03

c) Mapping of water use infrastructures

An inventory of different water uses was made through consultation with local people. These were mapped using Global Positioning System (GPS) receiver and recent topographic maps. The information on different aspects of water use infrastructures and services such as ownership, operation system, household benefited, water sufficiency status, and conflicts on water use and its management etc. were collected. The water uses include watermills, irrigation canals, power plants, woodcarving workshops, piped water supply, hot springs, and religious and culturally important places.

d) Field observation

An extensive field observation was made as a supplementary method to techniques mentioned above. The community level assets (availability and present condition of natural capital such as water, forest, aquatic resources etc.; physical capital such as condition of transport and communication, water use infrastructures etc.) were observed and recorded. The snow-covered area that was reportedly shrinking was also observed. The area affected by natural hazards such as landslides, avalanches and

bank cutting by the river were also recorded. The socio-cultural aspects of the study area such as settlement pattern, housing and construction materials, dressing pattern and different aspects of the cultural tradition were also observed and recorded. In the same time spatial data were checked and updated using maps. A number of photographs related to different aspects mentioned above were also taken during field observation.

Different types of survey tools were prepared and used in the survey. These include structured questionnaire for household survey, checklist for group discussin (Appendix 1) and recording schedule for water use survey and observation sheets. Guidelines for using instruments and conducting field survey were also prepared. The survey tools were finalized after a pilot survey in Ghandruk VDC with necessary corrections.

2.5.2 Secondary data

The spatial database of the study area is prepared. For this, district maps (scale 1: 1,25,000) and topographic maps of the study area (scale 1:25,000 and 1:50,000) published by Department of Survey, HMG/N are collected and digitized using GIS software and a number of different layers are prepared. These include: administrative and watershed boundaries, contour, spot height, drainage, land use, settlements, transportation network, and service centers. Based on these layers a number of thematic maps were prepared. Different characteristics of the population by VDC were collected from census records. These include age and sex characteristics, literacy status, economic activity of population and household having land and livestock etc. VDC or district level information on drinking water, irrigation, hydroelectricity, was collected from the concerned district/VDC level offices during the field survey periods. Information related to tourism such as number of tourist arrival, number of hotels/lodges and other related aspects was collected from the official records and publication of Annapurna Conservation Area Project (ACAP) office.

2.6 Data processing

After the collection of data from the field, they were processed and edited. All the information was recorded in different local units of measurements (land categories in *ropani* and *hal*, grains in *muri* and *pathi*; liquids in *mana* or *pathi* etc.) whatever the

respondents replied during interview considering time constraints of the respondents. All the information/data recorded in the local units were standardized before entering the same into the computer. The data on land categories are converted into hectares, grains and other solid things onto kilograms and liquid into liters. For this the standard conversion factors were used. After editing all the questions of the questionnaire/checklist were coded and entered into the computer in Excel format and a master table was prepared. Individual frequency tables were prepared for all the variables from the Master table and printed and necessary corrections have done to remove the mistakes during data entry. The master sheet was converted into SPSS format also for a convenient analysis. The necessary tables for the analysis were extracted from the master table using the software programs. The spatial database was prepared by digitizing recent topo-sheets of the study area (scales1: 25,000 and 1:50,000). Geographical Information System (GIS) was used to prepare spatial database.

2.7 Data analysis

The study is based on both the quantitative and qualitative data; both statistical and non-statistical tools are applied for data analysis. Altogether three sets of hypotheses are tested statistically. The relationships between variables were tested using different parametric and non-parametric statistical tools such as multiple regression, Analysis of Variance (ANOVA) and Chi square test. Multiple regression model is applied to evaluate the relationship between level of income and household assets. ANOVA is used for the analysis of relationship between combination of sources and level of household income. And relationship between irrigation and productivity is tested with the help of Chi square test. Along with various maps and diagrams are used as non-statistical tools to draw a clear picture of the study.

Different characteristics of district as well as VDC level population are analyzed based on census data. The discussions on distribution pattern of different livelihood assets and livelihood strategies of the people are analyzed using household survey data. The discussions on different aspects of environment including climate change and its impact on livelihood are based on people's perception. The analysis of land use is based on data generated from topographical maps using GIS software.

2.8 Limitations of the study

The study is limited within the boundary of the Modi Khola watershed. The household level information on different aspects of livelihood is derived from the sample survey of a total of 360 households and the information is based on interview with household heads. Its reliability depends on the reliability of the information provided by the household heads. Every effort is made to obtain reliable information. However, in some cases errors due to recall are not unlikely. Necessary verifications are made to correct these errors through group discussion.

The present study is a case study of a watershed. Therefore, a valid generalization at regional and national levels cannot be expected.

CHAPTER III

PROFILE OF THE STUDY AREA

3.1 Physical setting

3.1.1 Location

Modi Khola watershed, the study area lies in Western Development Region of Nepal (Figure 3.1). The watershed is bordered in the east by Mardi and Seti river basins, in the north by Marshyangdi basin and in the west and south by Kaligandaki basin. Altogether 28 VDCs (18 entirely and 10 partially) of Myagdi, Parbat and Kaski districts lie in the Modi Khola watershed. The geographical location of the Modi Khola basin extends from 28^0 10' north to 28^0 40' north latitude and 83^0 32' east to 84^0 21' 30'' east longitudes. This watershed covers an area of 676.8 square kilometers of Myagdi, Parbat and Kaski districts. The watershed is elongated northeast to southwest direction with rectangular shape as Modi Khola flows from northeast to the southwest direction. The north-south expansion (51.2 km) is nearly three-times as compared to the east-west expansion (maximum width of 19 km).

3.1.2 Physical features

The pysiography of the Modi Khola watershed is very complex. The elevation raises from south to the north ranging from 442 meters at Modibeni, the Modi-Kaligandaki confluence to 8,091 meters at the peak of Annapurna 1^{st}. Thus, the altitude variation is very high i.e. 5,549 meters within a short span of 51.2 kilometers. Nearly 18 percent of the area lies above 5,000 meter. The area below 1,000 meters altitude constitutes only 3.5 percent (Table 3.1, Figure 3.2). Nearly 54 percent of the area lies in between 1,000 to 3,000 meter altitude.

Table 3.1 Area by elevation zone

Elevation (meter)	Area (sq km)	Percentage
Below 1000	23.9	3.5
1000-2000	211.3	31.2
2000-3000	151.3	22.3
3000-4000	74.3	11.0
4000-5000	96.8	14.3
Above 5000	119.2	17.6
Total	676.8	100.0

Source: Calculated from topographical maps.

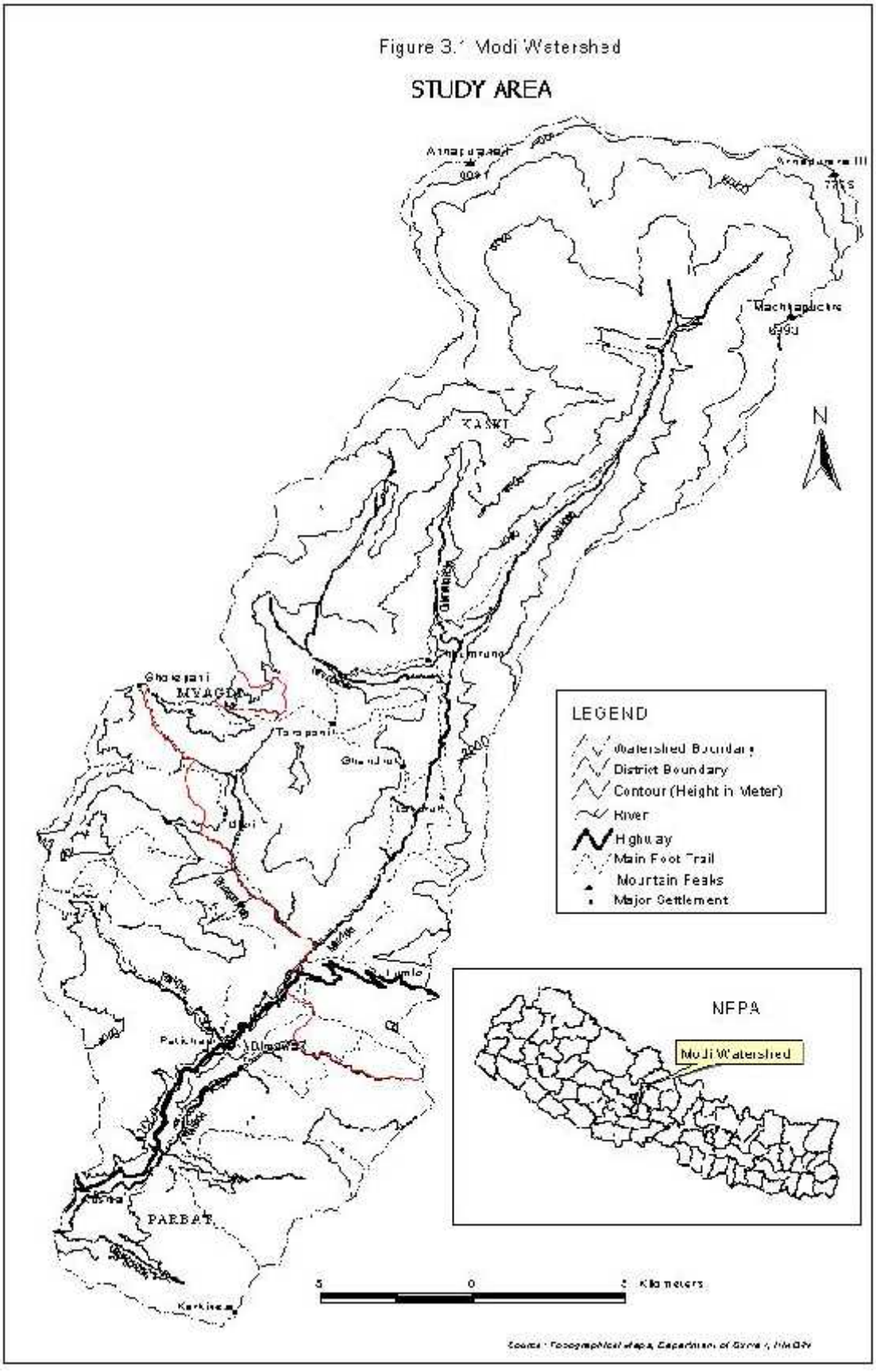
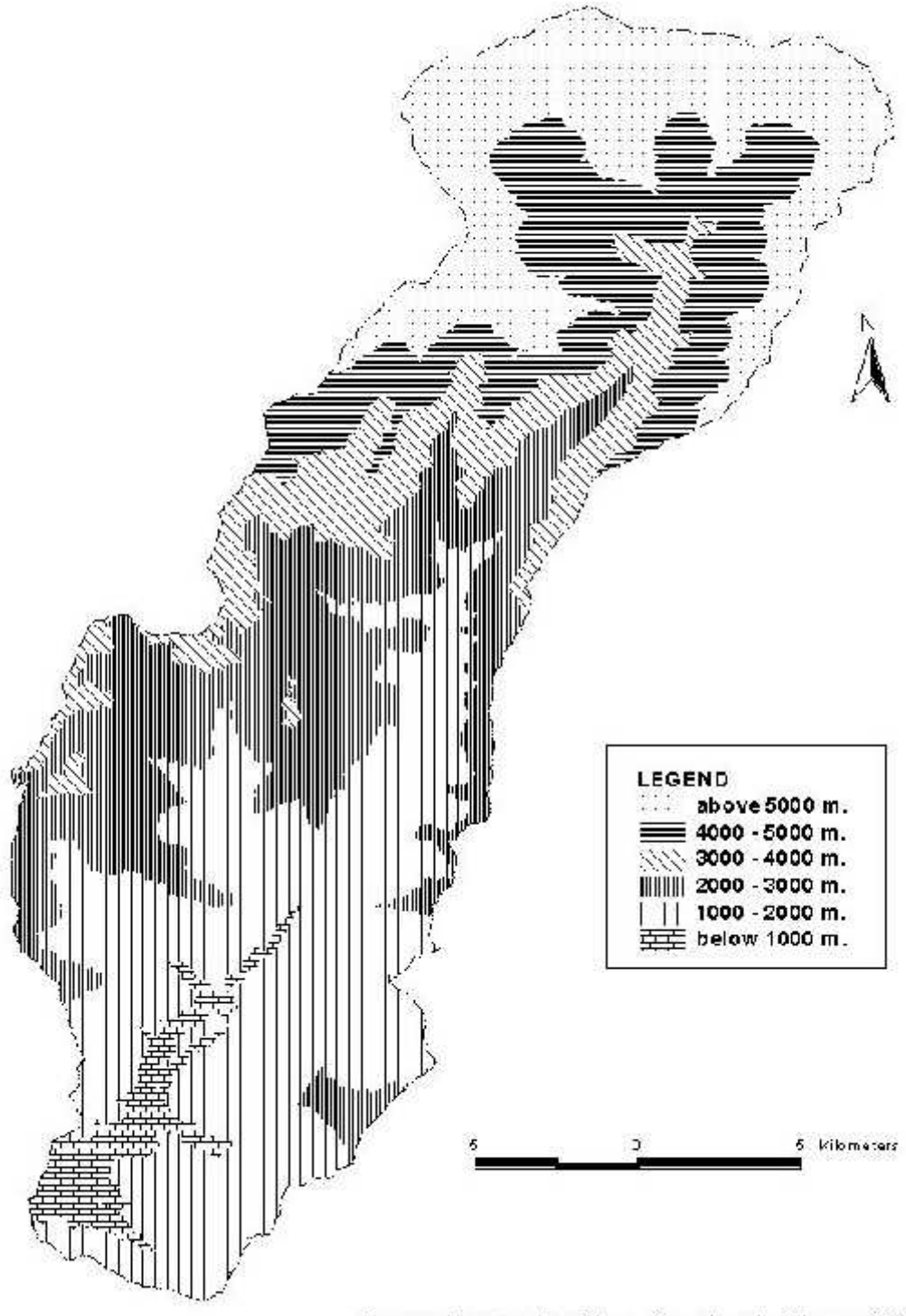


Figure 3.1 Modi Watershed
STUDY AREA
Annapurna I
Annapurna III
Machhapuchre
KASKI
N
Ghandruk
Chhomrung
Ghorepani
MYAGDI
Tadapani
Ghandruk
Landruk
Dhampus
Phedi
Lumle
Pokhara
Dhampus
Kusma
PARBAT
Kushma
LEGEND
Watershed Boundary
District Boundary
Contour (Height in Meter)
River
Highway
Main Foot Trail
Mountain Peaks
Major Settlement
NEPA
Modi Watershed
5
0
5 Kilometers
Source : Topographical maps, Department of Survey, HMG/N

Figure 3.2 Modi Watershed

ELIVATION ZONES



Source: Topographical Maps, Department of Survey, HMG/N

The watershed presents two distinct geographical environments. The northern most part i.e. high Himalayas has glacial and periglacial environments and southern low elevated lands have fluvial environments. Thus, the upper parts of the watershed have landforms associated with glacial and periglacial environments while the southern lower parts have landforms related to fluvial actions. No permanent settlements are found above 3,000 meters in this region.

The northernmost part of the watershed is characterized by lofty serrated ridges, cirque-indented slope and sharp peaks produced as a result of tectonic and glacial actions. South spurs of Annapurna 1st and Machhapuchre enclose an amphitheater known as Annapurna Sanctuary. The pinnacles encircling the sanctuary clockwise are Hiunchuli (6,441 m), Annapurna South (7,219 m), Varah Sikhar (6,501 m), Tharpu Chuli (5,663 m), Tarke Kang (7,193 m), Gangapurna (7,455 m), Annapurna III (7,555 m), and Macchapuchre (7,997 m) (HMG/DOT, 1998 cited in East Consult, 1998).

The northern part of the watershed belongs to young folding mountain system and is geologically active and structurally complicated. Various kinds of high-grade gneisses occupy the southern faces of the Great Himalayas, forming the basement of the Tethys meta-sediments. These gneisses are thrust southwards onto the crystalline schist of the lesser Himalayan zone (Ohta et al., 1973). The Main Central Thrust (MCT) lies about 2.2 km north from the Himal Kyu and the lower MCT (Modi Thrust) lies about 2.6 km south of the Kimal Kyu. At the lower altitude the Modi Khola basin presents rejuvenated landscape (East Consult, 1998). Thousands of meters deep river gorges with vertical river cliffs are found. Low elevated hills and valley floor topography are found below 1500 meter from the mean sea level. Gentle to steep slope are found in the middle altitude and also dissected by a number of tributaries flowing either side of the main channel. *Tar* that is the flat land, such as Gyadi and Kusma and a number of small river terraces are located in the downstream site.

The dominant rocks in the lower part are gneiss, augen-gneiss, quartzite and meta-sand-stone, and migmite with schist and philite while the upper part is supposed to be covered with dolomite and quartzite (Sharma, 1973 cited in East Consult, 1998). Structurally the watershed is complicated and characterized by folding, faulting and a

number of thrusts. The summits of Mt. Machhapuchre and the Annapurna Himal are composed of well-bedded Tibetan Tethys meta-sediments (East Consult, 1998).

3.1.3 Drainage

The Modi Khola is one of the seven tributaries of the Gandaki River system. It is a perennial snow-fed river, starts its journey from the southern flank of Annapurna Himalaya and joins with Kaligandaki River at Modibeni, downstream from the Kusma bazaar. The direction of the flow is from northeast to southwest. A number of perennial and non-perennial tributaries join this river. Dovan, Chhomrong, and Kimrong are its snow-fed tributaries. Modkyu, Porghiun, Chane, Bhurungdi, and Dhoti Khola are the tributaries joining upstream from Nayapul. The other tributaries joining downstream from Nayapul are Pati, Rati, Jare and Malayangdi (Figure 3.3).

The average annual discharge of the Modi Khola at Himal Kyu, downstream from the confluence of Kimrung Khola is 30.48 m^3/sec and it is 33.592 m^3/sec at Syauli bazaar (East Consult, 1998) and long term average flow is 44.75 m3/sec at Nayapul (Saman Engineering Consultants and Water Resource Consult, 2001). Details of monthly discharge of Modi Khola is analysed in the fourth Chapter.

3.1.4 Climate

Climate is one of the determinants, which sets limits for different activities of the people. The climatic condition of the Modi Khola watershed is primarily guided by altitude. Besides, aspect has vital role in creating microclimates as duration of sunshine greatly varies by aspect. The altitude in the watershed ranges from below 500 meter to above 8,000 meters within a short physical distance of about 50 km and the temperature decreases with the increase in altitude. Though the region broadly falls in monsoon climatic belt, the watershed experiences sub-tropical to tundra climates as a result of variation in altitude. The sub-tropical type of climate is found in the lower altitude belts of the southern parts while tundra type of climate are found in the northern part above 4,500 meter altitude. The permanent snow line is confined at about 4,500 meter altitude in this region. Warm temperate, cool temperate and alpine type of climate is found in between these climatic belts. The temperature and precipitation pattern including number of days with amount of rainfall are discussed below.

Figure 3.3 Modi watershed

DRAINAGE SYSTEM

Temperature is one of the important elements of the climate, which is determined by a number of factors such as duration of sunshine, altitude, windiness etc. There are altogether two meteorologival stations namely Lumle and Kusma in the Modi Khola watershed for maintaining temperature records. The average maximum, minimum and daily temperatures of Lumle (20 years') and Kusma (15 years') are shown in Table 3.2.

Table 3.2 Average maximum, minimum and daily temperature (^{0}C)

	Lumle (1740 m)			Kusma (891 m)		
Months	Maximum	Minimum	Daily	Maximum	Minimum	Daily
January	12.8	5.0	8.6	20.6	7.3	14.1
February	14.4	6.2	10.1	22.9	9.2	16.1
March	18.8	9.7	14.2	27.3	12.7	20.0
April	22.1	12.8	17.5	31.8	16.1	24.0
May	22.5	14.2	18.3	31.6	18.9	25.2
June	23.3	16.4	19.8	32.3	21.0	26.7
July	22.7	17.1	19.9	31.5	21.9	26.7
August	23.1	17.0	20.1	31.0	21.5	26.3
September	22.2	15.9	19.1	30.4	20.6	25.5
October	19.9	13.0	16.7	29.8	16.0	22.9
November	17.2	9.5	13.3	26.8	11.0	18.9
December	14.0	6.2	10.1	22.6	7.6	15.0
Annual Average	19.4	11.9	15.7	28.3	15.4	21.8

Source: Climatological records of Nepal (different years), Department of Hydrology and Meteorology, HMG/N.

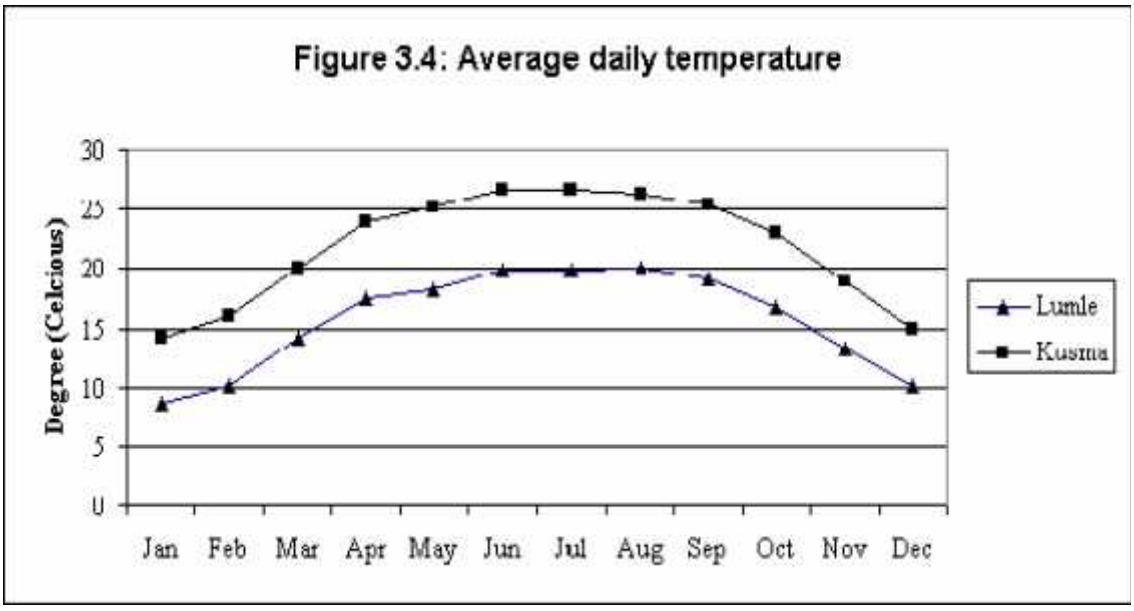


Table 3.2 indicates that the average maximum and minimum temperature is higher in Kusma as compared to that of Lumle. The highest temperature was recorded in June and the lowest in January in both the places. The average daily temperature of all the months is higher in Kusma as compared to that Lumle (Figure. 3.4). December, January and February are the coldest months and June, July and August are the hottest months of the year. The annual average temperature for Lumle and Kusma is 15.7^0C and 21.8^0C respectively. One of the reasons for this temperature variation is altitude differences of the two places. This also indicates that temperature decreases with the increase in altitude from the south to the north in the watershed.

There are altogether five meteorological stations with precipitation records in the study area. These are Lumle, Kusma Ghandruk, Ghorepani and Karkineta. Fifteen years' (1987 to 2000) monthly average rainfalls of all the five stations are given in Table 3.3 and Figure 3.5.

Table 3.3 Average monthly precipitations

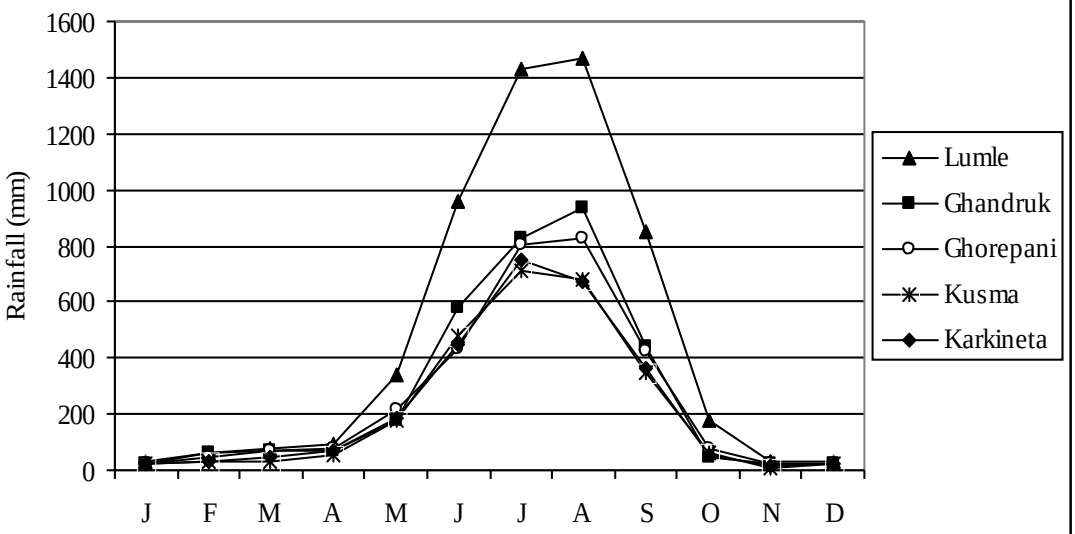
Month	Ghorepani (2742 m)	Ghandruk (1960 m)	Lumle (1740 m)	Kusma (891m)	Karkineta (1720 m)
January	23.5	24.5	34.4	23.4	22.4
February	44.3	58.9	58.1	30.9	32.0
March	66.8	71.9	78.1	33.8	48.6
April	78.1	69.5	89.2	51.6	69.7
May	214.8	175.9	343.8	174.4	185.0
June	432.9	582.9	954.6	481.8	445.5
July	800.9	825.0	1432.0	714.0	748.4
August	826.3	932.1	1469.1	681.1	674.1
September	423.9	438.7	851.8	344.6	362.3
October	77.7	43.8	178.8	63.5	57.1
November	22.4	22.3	29.0	11.3	18.1
December	21.9	26.6	28.1	22.6	22.7
Total	3020.5	3368.7	5546.3	2633.0	2713.4

Source: Climatological Records of Nepal, Department of Hydrology and Meteorology, HMG/N.

Lumle records the highest precipitation not only among five recording stations located in the study area, it is the highest precipitation recording station in the country as well. The average rainfall recorded in the study area ranges from 2,633 mm at Kusma to 5,546.3 mm at Lumle. During fifteen years' period Lumle recorded the highest

amount of precipitation (6,561mm) in 1995. Kusma recorded less than half amount of the Lumle though these stations are not very far apart. This indicates that there is high spatial variation in rainfall distribution. The annual distribution of precipitation is also not constant. May to September is the rainy season of the year. All the five stations showed that more than 82 percent of the total annual rainfall was recorded in these four rainy months.

Figure 3.5 Average monthly rainfall



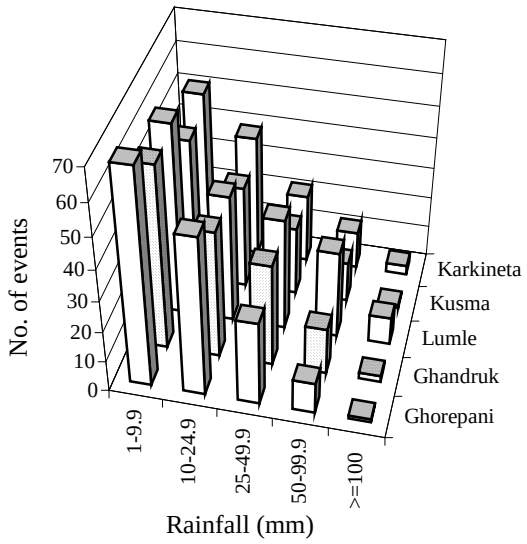
Not only the amount of rainfall but also the numbers of days having precipitation vary by places. The number of days with amount of rainfall is given in Table 3.4. The number of days receiving rainfall is highest in Lumle (173 days) as compared to other stations. Ghorepani ranks second (157 days) in terms of total days having rainfall. Lumle station recorded 9 events having more than 100 mm rainfall within 24 hours while Ghorepani and Kusma recorded only one event. Karkineta and Ghandruk recorded 3 and 2 events with more than 100 mm rainfall respectively within 24 hours. Similarly Lumle recorded 28 events with 50 to 100 mm rainfall within 24 hours. The other centers recorded 10 to 15 events with rainfall amounting 50 to 100 mm within 24 hours in a year.

Table 3.4 Number of events with amount of rainfall within 24 hours

Rainfall (mm)	Average number of rainy days				
	Ghorepani	Ghandruk	Lumle	Kusma	Karkineta
1-9.9	69	59	61	46	51
10-24.99	51	41	41	33	39
25-49.9	27	33	36	22	22
50-99.9	10	15	28	13	12
100 & above	1	2	9	1	3
Total	157	149	173	115	126

Source: Climatological Records of Nepal, Department of Hydrology and Meteorology, HMG/N.

Figure 3.6 Number of events with amount of rainfall within 24 hours



3.1.5 Natural vegetation

The biotic environment of the Modi Khola drainage basin varies with elevation. It changes from sub-tropical to temperate and alpine pasture in quick succession (East Consult, 1998). The vegetation of the Modi Khola basin can be grouped into four major types. These include semi-evergreen hill and riverine forest in subtropical zone, *Quercus lamellas* and mixed broad-leaved forest in lower temperate zone, Birch-Rhododendron and mixed broad leaved forest in upper temperate/ sub-alpine zone and pure grass land and pasture in alpine/ naval zone (Table 3.5).

Table 3.5 Vegetation profile in Modi basin

Altitude (m)	Zone	Vegetation type	Characteristics
Above 3500	Alpine/Nival	Pure grassland and shrub/grass	Bari land with/without grasses more sedge and alpine herbs
2500-3500	Upper Temperate/ Sub-alpine	Birch-rhododendron and mixed broad leaved forest	Medicinal herbs declining shrub and tree increasing
1500-2500	Lower Temperate	*Quercus lamellas* and mixed broad leaved forest	Agricultural encroachment, land slide/erosion and *Alnus sp* regeneration
1000-2000	Sub-tropical	Semi-evergreen hill and riverine forest	Agricultural encroachment, landslide/erosion and *Alnus sp* regeneration in some areas
Below 1000	Tropical	Mixed evergreen hill and riverine forest	Agricultural encroachment, Sal forest

Source: Stainton, 1972; East Consult, 1998; and field observation, 2002/03

a) Tropical zone

Mixed evergreen and reverine forest is confined below 1,000 meters altitude. Sal (*Shorea robusta*), sissoo (*Dalbergia sissoo*), khair (*Acacia catechu*) and jamun (*Sizigium cumini*) are the dominant tree species of this zone.

b) Sub-tropical zone

Semi-evergreen hill and riverine forest is confined in between 1,000 and 2,000 meters altitude especially in the river terraces in the southern parts of the watershed. Sal (*Shorea robusta*), sissoo (*Dalbergia sissoo*), khair (*Acacia catechu*), jamun (*Sizigium cumini*), bayer (*Zyphus jujuba*), saj (*Terminalia tomentosa*), simal (*Bombax sps*.), kutmiro (*Litsea poliantha*), and chilaune (*Schima wallichii*) are the dominant tree species in this zone. Utis (*Alnus nepalensis*) is the dominant tree species in some regenerated areas.

c) Lower-temperate zone

Lower temperate zone (between 1,500 and 2,500 meter) is dominated by *Quercus lamellas* and mixed broad-leaved forest. The dominant tree species in this zone are utis (*Alnus nepalensis*), malato (*Macaranga denticuleta*), okhar (*Juglance regia*), sallo (*Pinus roxburghii*), katus (*Castanopsis indica*), and kabro (*Ficus lacor*).

d) Upper temperate/sub-alpine zone

Upper temperate/sub-alpine zone altitude between 2,500 and 3,500 meter is dominated by birch-rhododendron and mixed forest. The common tree species found in the zone are khashru (*Curcus sp*.), chanp (*Michelia champaca*), nigalo (*Arundinaria intermedia*), laligurans (*Rhododendron sp.*) and dhupi (*Junipurus sp.*). The density as well as height of tree decreases with the increase in altitude.

e) Alpine/Nival zone

Alpine/Nival zone is situated above 3,500 meters altitude. Due to very low temperature in this zone alpine grasses and small bushes are common. A variety of alpine herbs are found in this zone. This zone is covered with snow during winter and with the melting of snow it becomes green. Extensive pasturelands are available in this zone. Thai-Brow, Nade, Maye-Brow, Lem-Mro, Sid-Gai and Bhaisa-Kharka are the main pasturelands where local people graze their herds.

3.1.6 Land use

The information on land use is based on recent topographical maps (scale 1:25,000 and 1: 50,000) and field survey. The areas under different land use categories were calculated using Geographical Information System (GIS). The land use of this region is classified into six different classes. These include cultivated land, forest, bushes/grass land, glacier/ice, rocks/cliffs, and others. The others include water bodies, settlement, roads etc. The area and percentage of coverage by different land use categories are given in Table 3.6 (Figure 3.7). The spatial pattern of land use is shown in Figure 3.8.

Table 3.6 General land use

Land use	Area (km2)	Percent
Cultivated land	133.3	19.7
Forest	256.7	37.9
Bushes/Grass land	81.7	12.0
Glacier/Ice	105.9	15.7
Rock/Cliff	91.7	13.6
Others	7.5	1.0
Total	676.8	100.0

Source: Topographical maps

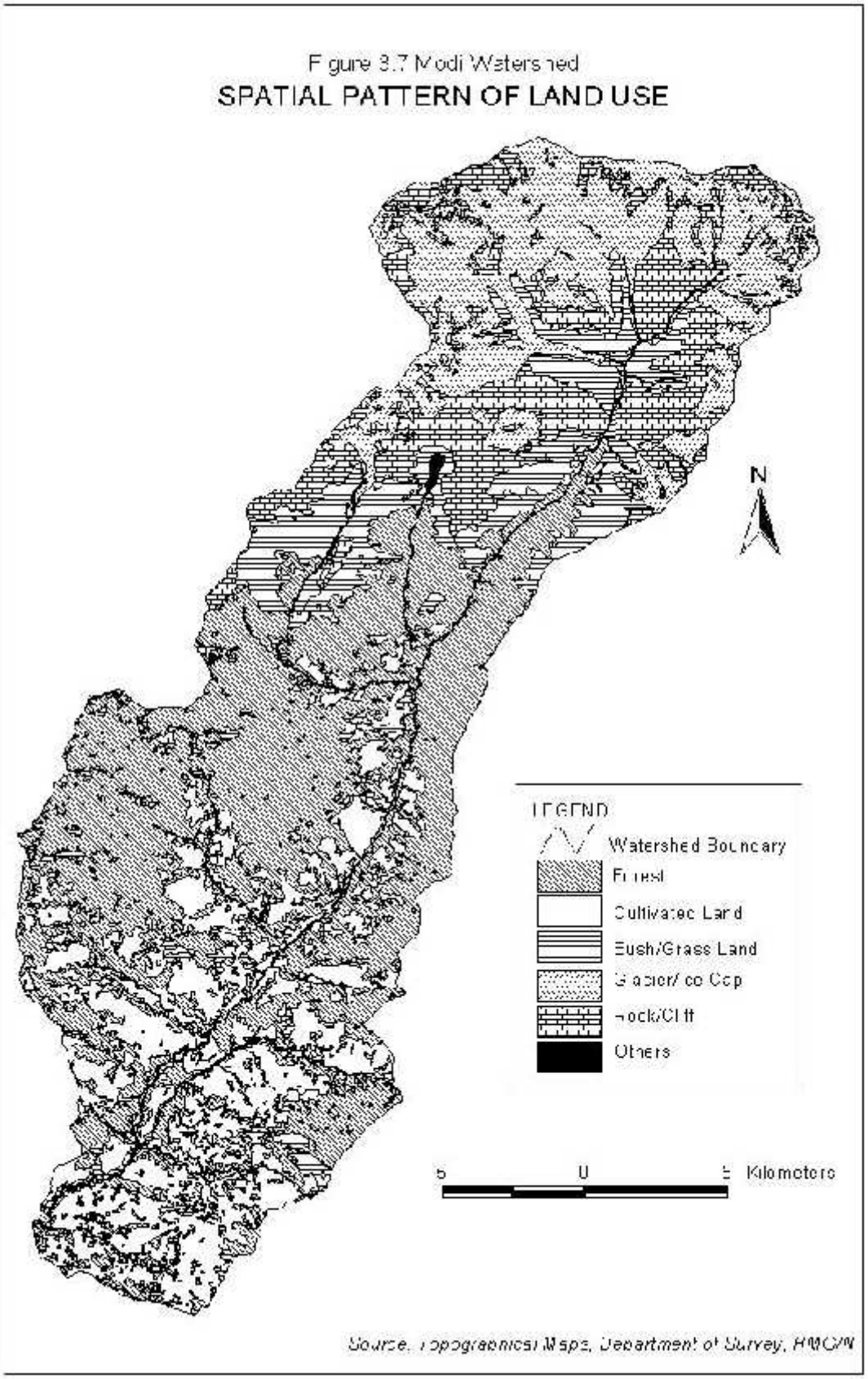
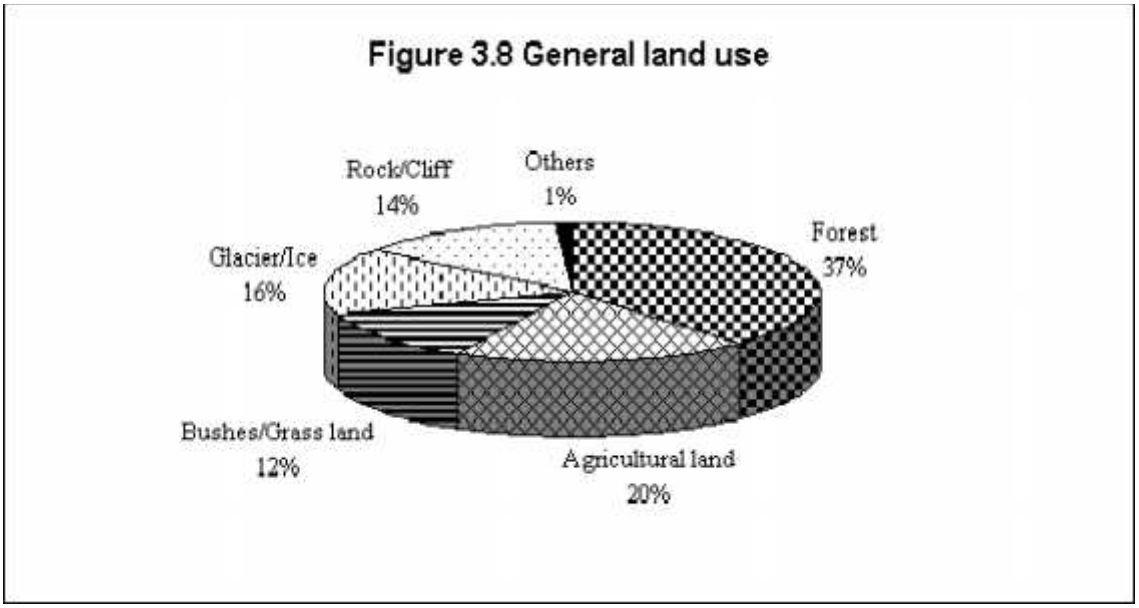


Figure 3.7 Modi Watershed
SPATIAL PATTERN OF LAND USE
N
LEGEND
Watershed Boundary
Forest
Cultivated Land
Bush/Grass Land
Glacier/ Ice Cap
Rock/Cliff
Others
0
5
Kilometers
Source: Topographical Maps, Department of Survey, HMG/N



Forest constitutes 37.9 percent of the total area followed by cultivated land (19.9 percent), glacier and ice (15.7 percent), rocks and cliff (13.6 percent), and bushes/grass land (12 percent). The other category covers negligible proportion (1.0 percent) of the total area. The 'others' category includes sand and gravel/ water bodies, settlements etc.

3.2 Social setting

3.2.1 Population

Watershed level population data is not available for Modi Khola watershed. Since VDC boundary does not follow the watershed boundary in many cases, the calculation of exact number of household and population by sub-region and zone is difficult. Thus, for the analysis of population characteristics VDC level data are used. The total population of the 28 VDCs, (both partially and fully included in the watershed) was 1,01, 766 (46.53 percent male and 53.47 percent female) with 22,136 households in 2001 (Table 3.7). The population within the boundary of the Modi Khola watershed is estimated to be about 75,000 (17,000 households) in 2001. Upstream sub-region constitutes 22 percent (22385 persons) of the total population and rest of the 78 percent is in the downstream sub-region. Female outnumbered the male population in both the sub-regions. The average family size in the watershed was 4.6. It varies from 4.1 persons in Sankhar Pokhari VDC to 5.7 in Ghandruk VDC. The

distribution of population is uneven. The density of population in the watershed is 131persons per square kilometer and this varies greatly by sub-region.

The density of population in the upstream sub-region is 43.7 persons per sq km while in the downstream sub-region it is 298.6 persons per sq km. It is nearly seven times lower as compared to that of the downstream sub-region. The land above 3,000 meters altitude covers almost 43 percent of the total land in the watershed and most of these lands lie in the upstream sub-region where no settlements are found. In contrary downstream sub-region is relatively flatter and most fertile as a result population is highly concentrated in this sub-region.

Table 3.7 Households, population, family size and density by sub-region, 2001

Sub-region	Household	Population			Family size	Population density
		Total	Male	Female		
Downstream	17069	79381	36834	42547	4.7	298.6
Upstream	5067	22385	10508	11877	4.4	43.7
Total	22136	101766	47342	54424	4.6	130.8

Source: CBS, 2002: Population of Nepal, 2001

The population of the Modi Khola watershed is composed of different ethnic groups. Gurung is the dominant ethnic group of the upstream sub-region while Brahmin and Chhetri are the dominant groups in the downstream sub-region. Magar is mostly confined to the higher parts of the downstream sub-region.

Age distribution of population by broad age group is given in Table 3.8. The proportion of population below 15 years of age is 38.5 percent and 60 years and above is 9.0 percent. Thus proportion of economically active population is 52.5 percent. The total dependency ratio is 90.5 for the whole watershed. The total dependency ratio is the ratio of the number of dependent persons (persons of non-working age i.e. 0-14 and 60 and above) per 100 persons of working age. This gives the broad idea of economic dependency of the population.

The total dependency ratio for Kaski, Myagdi and Parbat district as shown in Mapping Census Indicators 2001 and Trends was 73.63 percent, 92.87 percent and 95.97 percent respectively.

Table 3.8 Distribution of population by age groups and sub-region, 2001

Age group	Downstream		Upstream		Total of both sexes
	Male	Female	Male	Female	
Below 15	35.8	42.7	38.8	34.6	38.5
15-59	55.8	48.2	49.7	56.0	52.5
60 & above	8.4	9.1	11.4	9.3	9.0
Total percentage	100.0	100.0	100.0	100.0	100.0
Total number	42545	36836	10511	11874	101766

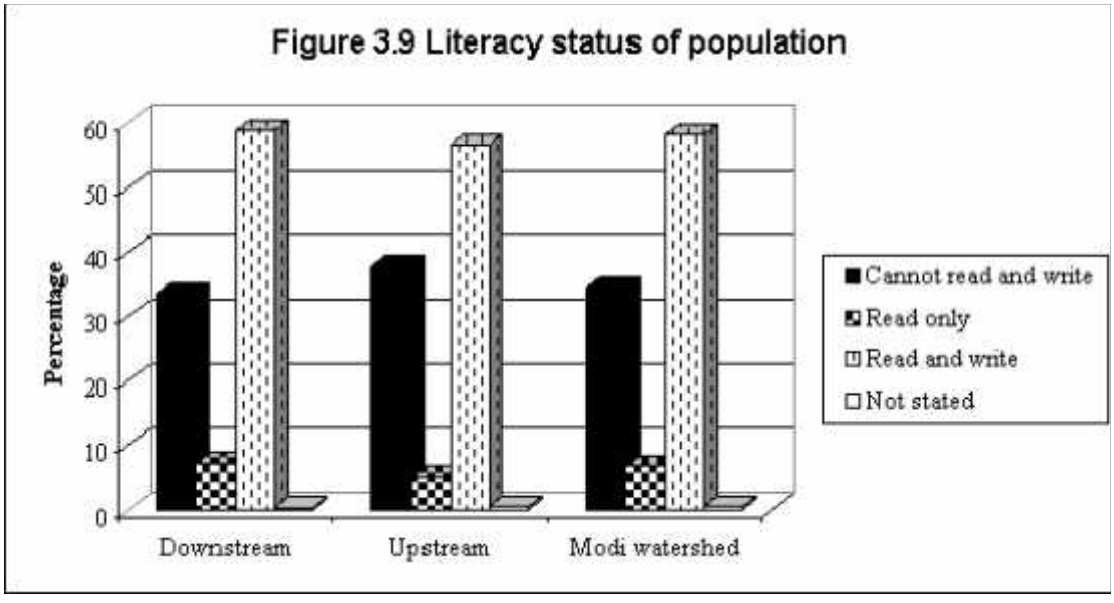
Source: CBS, 2002: Population of Nepal, 2001

The literacy status of population is shown in Table 3.9 (Figure 3.9). Out of the total 6 years and above population 34.6 percent cannot read and write and 6.7 percent can read only. The proportion of population with both reading and writing capacity is 53.8 percent. This proportion is slightly high in downstream sub-region (58.8 percent) as compared to that of upstream sub-region (56.8 percent).

Table 3.9 Literacy status of population

Education level	Downstream		Upstream		Total	
	Number	Percent	Number	Percent	Number	Percent
Cannot read and write	23098	33.7	7398	37.8	30496	34.6
Read only	4964	7.2	989	5.0	5953	6.7
Read & write	40326	58.8	11125	56.8	51451	58.3
Not stated	235	0.3	85	0.4	320	0.4
Total	68623	100.0	19597	100.0	88220	100.0

Source: CBS, 2002: Population of Nepal, 2001



The literacy status of population of 6 years and above by sex is presented in Table 3.10. The total literacy of the population is 58.3 percent (69.5 percent for male and 48.9 percent for female) in the watershed.

The total literacy rate of the Myagdi, Parbat and Kaski was 56.0, 57.0 and 72.1 percent respectively in 2001. The total literacy rate of the study area is lower than that of the Kaski district and little higher than that of the Myagdi and Parbat districts. The literacy rate for both male and female of the downstream sub-region is higher as compared to that of the upstream sub-region. The number of school per thousand population is higher in the downstream sub-region (2.1 schools) as compared to that of the upstream sub-region (1.7 schools).

Table 3.10 Distribution of literate population by sex and sub-region

Sub-region	Total	Percent	Male	Percent	Female	Percent
Downstream	40326	58.8	21954	70.2	18372	49.2
Upstream	11125	56.8	6071	67.1	5054	47.9
Total	51451	58.3	28025	69.5	23426	48.9

Source: CBS, 2002: Population of Nepal, 2001

3.2.2 Migration

As in other areas the population of the Modi Khola basin is composed of both migrants and non-migrants. According to the population Census 2001, a total of 9,199 persons were lifetime in-migrated in 28 VDCs within the Modi Khola watershed. This constitutes 9.0 percent of the total Population residing in the watershed. Among them 7.9 percent were in-migrated from other districts of Nepal and remaining 1.2 percent were in-migrated from outside Nepal from different countries (Table 3.11).

Table 3.11 Number and percentage of inmigrants by sub-region

	Downstream		Upstream		Total	
Migrated from	Number	% of total population	Number	% of total population	Number	% of total population
Other districts	6197	7.8	1804	8.1	8001	7.9
Other countries	1104	1.4	94	0.4	1198	1.2
Total in migration	7301	9.2	1898	8.5	9199	9.0

Source: CBS, 2002: Population of Nepal, 2001

The proportion of total lifetime migrants is higher in the downstream sub-region as compared to that of the upstream sub-region while the proportion of lifetime migrants from other districts of Nepal is higher in the upstream sub-region. The proportion of lifetime migrants from other countries is more than three times higher in the downstream sub-region as compared to that of the upstream sub-region. One of the reasons for this is that the location of district headquarters of the Parbat lies in the downstream sub-region at Kusma and it is one of the market centers of the region. The people of the study area out migrated too. A significant proportion of the population is out migrated to different destination for different purposes. The contribution of remittances sent by migrants is significant in local as well as national economy. The details of out migration and remittances received from migrants and its contribution on household income is analysed in chapter Five.

3.2.3 Settlement pattern

A variety of settlement types are found in the Modi Khola watershed. These types include traditional compact Gurung settlements to isolated settlements and modern market centers. The description of the settlement is based on analysis of topographical maps and field observation. The number of settlements as counted from topographical maps is given in Table 3.12.

Table 3.12 Distribution of settlements by sub-region

Region	Number	Percentage
Downstream	266	70.9
Upstream	109	29.1
Total	375	100.0

Source: Topographical maps

There are altogether 375 settlements distributed in the watershed. The distribution of settlement is uneven and is confined below 3,000 meters altitude. The downstream sub-region constitutes 70.9 percent of the total settlements and remaining 29.1 percent in the upstream sub-region. Out of the total 25 percent settlements are relatively small. Gurung and Magar settlements in the upper parts are compact in nature. For example, Ghandruk, Chhomrong, Landruk, Tolka, Patlekhet, Bhichuk, Kyang and Lespar are of this type and located in the higher altitude in the basin. The settlements

along the Pokhara-Baglung highway are linear in nature. Majority of the settlements in the lower parts are of disperse types. Out of the total 11.0 percent settlements are located below 1,000 meters and 9.0 percent above 2,000 meters of altitude.

3.2.4 Infrastructures and service institutions

The study area is situated in close proximity to Pokhara, Regional Headquarters of the Western Development Region. This locational proximity does have effect on development of infrastructure provision and facilities in this area. The present condition of infrastructure development and their distribution pattern is described below.

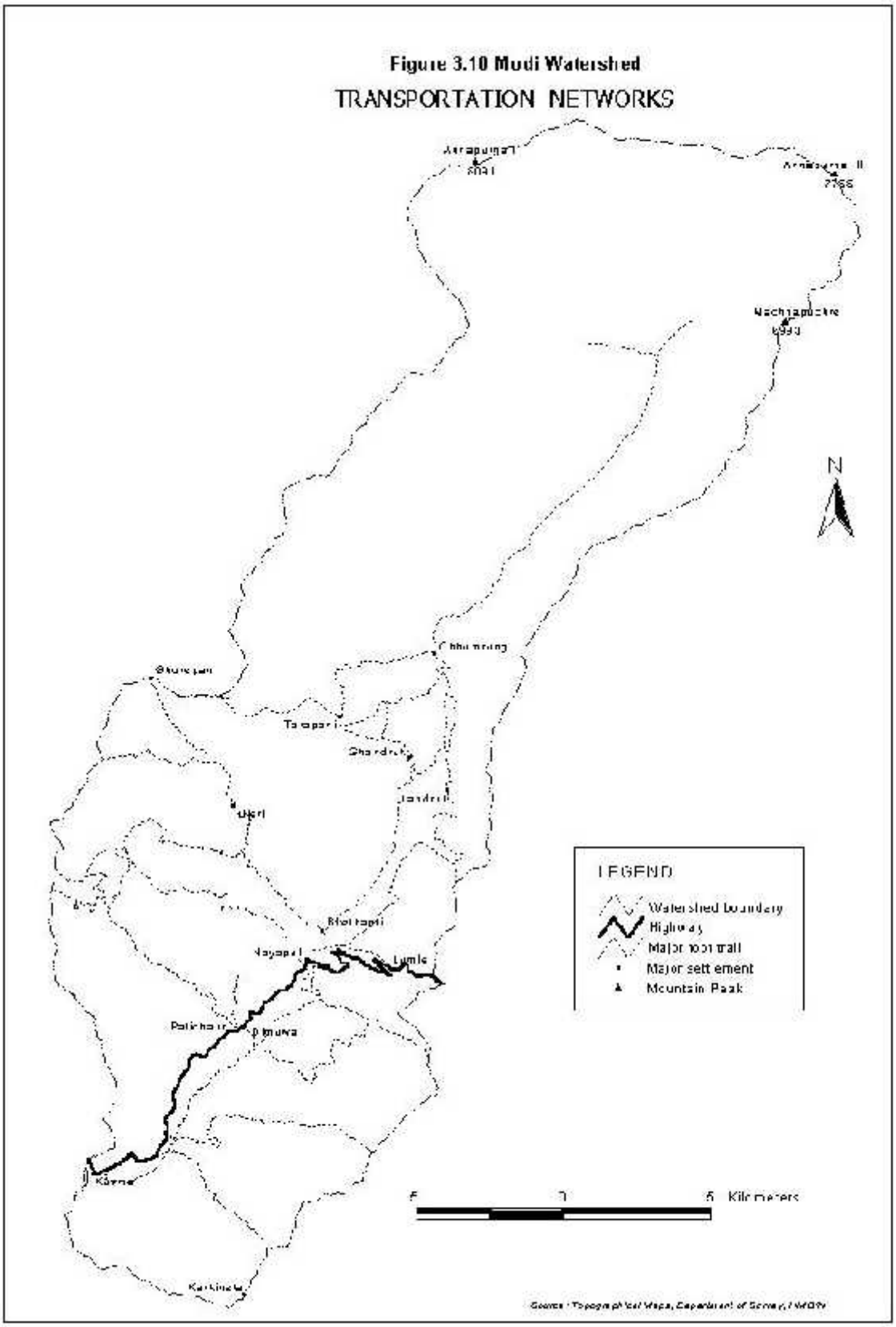
a) Transportation

Allweather motorable roads connect the Modi Khola watershed. The Pokhara-Baglung highway passes through this area. Besides, there are other road connections. Kusma-Halhale and Dobilla-Phalebas fair-weather roads connect the district headquarters Kusma bazaar to its northern and southern hinterlands respectively. The transportation network is shown in Figure 3.10. The road facilities lie entirely in the downstream sub-region, though the Pokhara-Baglung highway passes through the southern parts of the Lumle VDC, which is a part of the upstream sub-region. There are no north-south internal road connections in the upstream sub-region. A number of foot trails serve the upstream sub-region. Thus, transportation of goods and services in the upstream sub-region is very difficult and it fully depends on animals (horse/mules) and people. As a result prices of the goods rise generally from south to the north as distance increases from the road heads.

b) Institutions and facilities

A number of different service institutions are distributed across the Modi Khola watershed, which provides facilities for local people. These include schools, health institutions, post office, bank and agricultural service centers. The distribution of these institutions by sub-region is given in Table 3.13. The details of the spatial locations of the service institutions are given in Figure 3.11.

Figure 3.10 Modi Watershed



There are altogether 205 educational institutions (151 primary schools, 18 lower secondary schools, 29 secondary schools, and 7 higher secondary schools including colleges), 37 health institutions (1 hospital, 6 health posts, 22 sub-health posts and 8 veterinary centers), 7 agricultural service centers, 27 post offices and 3 banks in 28 VDCs in the Modi Khola watershed. Telephone service is available in 16 VDCs. Telephone lines are distributed only in Kusma and its adjoining areas. The health institutions and primary schools are located in all the VDCs. Post office is available in all VDCs except Deurali. Besides, there are number of cooperatives, non-governmental organizations and tourist check points providing facilities. Annapurna Conservation Area Project (ACAP) established in 1986 is the main project located at Ghandruk in the watershed under the King Mahendra Trust for Nature Conservation (KMTNC). Its primary goal is to promote the conservation of all forms of natural resources, biodiversity and cultural heritage in the Annapurna Conservation Area and augment social and sustainable community as well (Bhadra and Karky, 2002). Among 28 VDCs located in the Modi Khola watershed only four VDCs (Dansing, Lumle, Ghandruk and Sikha) are located within ACAP region. Therefore, the people of these VDCs are directly benefited from ACAP. Presently the regional office located at Ghandruk is not functioning due to security reasons.

Table 3. 13 Distribution of service institutions by sub-region

Service/ institutions	Downstream	Upstream	Total
Agricultural service center	**6**	**1**	**7**
Health institutions	**33**	**3**	**36**
Hospital	1	-	1
Health post	5	-	5
Sub- health post	19	3	22
Veterinary hospital	8	-	8
Educational institutions	**167**	**38**	**205**
Primary school	121	30	151
Lower secondary school	14	4	18
Secondary school	25	4	29
Higher secondary/ college	7	0	7
Post office	**24**	**4**	**28**
Bank	**2**	**1**	**3**

Source: 1. PDDP, 2001: Resource Mapping Report, Parbat District and PDDP and DDC, 2002: Poverty Mapping Report, Kaski District (2002).

2. District Profiles of Parbat (2001) and Kaski (2001) Districts.

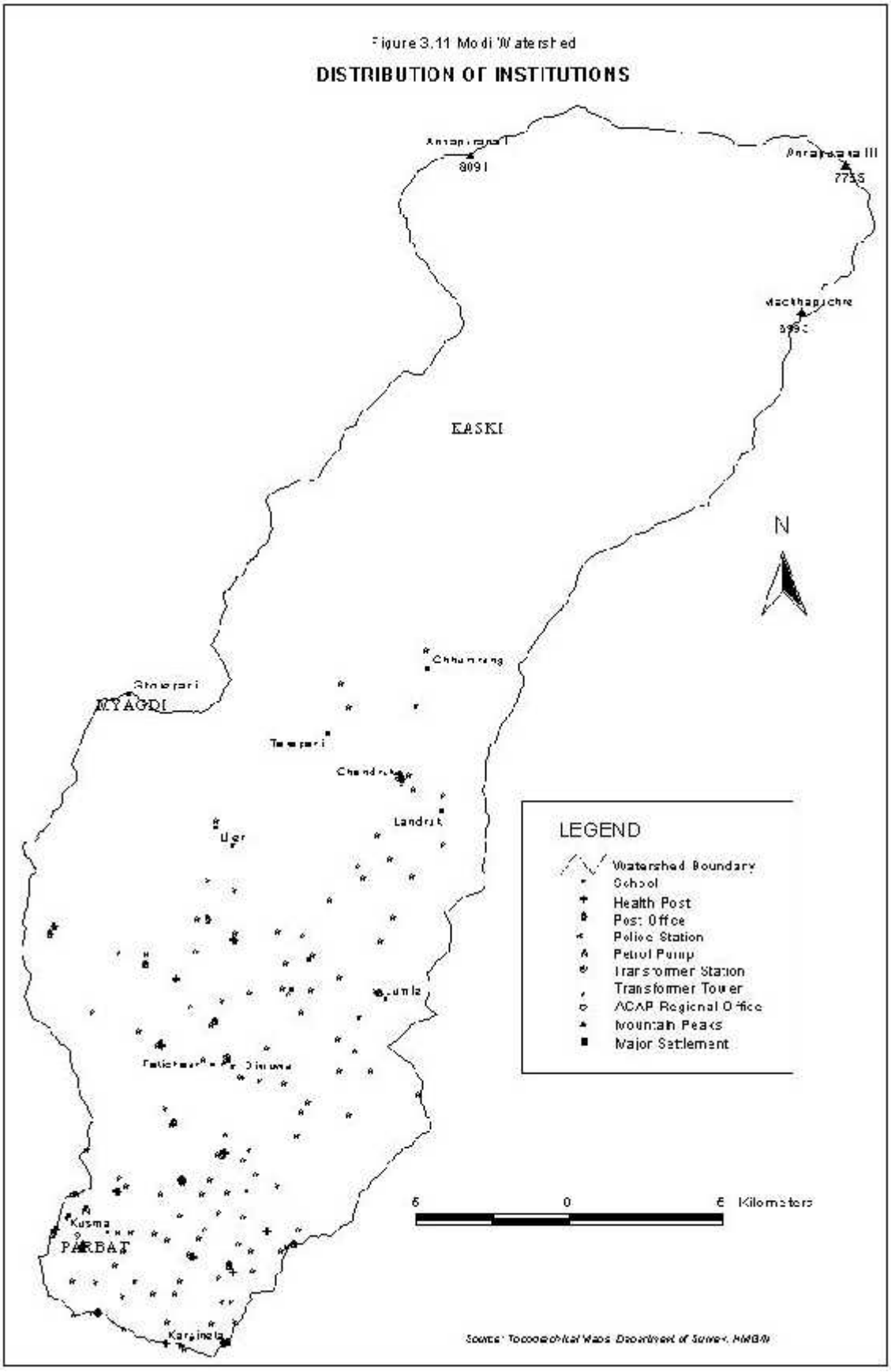


Figure 3.11 Modi Watershed
DISTRIBUTION OF INSTITUTIONS
8091
7755
8090
KASKI
N
MYAGDI
Ghorepani
Tatopani
Chandrakot
Landruk
Ulir
Lumle
Dhampus
Kusma
PARBAT
Kanginola
LEGEND
Watershed Boundary
School
Health Post
Post Office
Police Station
Petrol Pump
Transformer Station
Transformer Tower
ACAP Regional Office
Mountain Peaks
Major Settlement
6
0
6 Kilometers
Source: Topographical Maps, Department of Survey, HMGN

c) Market centers

Kusma is the headquarters of the Parbat district and the major market center in the Modi Khola watershed. Nayapul, Dimuwa, Patichaur, and Dewpur are the other growing market centers located along the Pokhara-Baglung highway. These centers were developed after the construction of Pokhara-Baglung highway in 1986. There are a number of small market centers with a number of hotels and restaurants and shopping facilities. The major centers located along the tourist routs to Annapurna region are Birethanti, Ghandruk, Chhomrong and Landruk. Uleri, and Ghorepani are the major market centers located along the route to Mustang. The regional headquarters, Pokhara, is the main market center of the region from where marketing goods are supplied to the market centers located at Modi Khola watershed.

3.3 Economic setting

Out of total 77,356 population of 10 years and above, 57,411 persons (74.2 percent) were economically active and engaged in different income earning activities. The economy of this region is mainly based on agriculture. Majority of the economically active population are engaged in farming activities. Off farm activities like service, tourism, business, transport etc are other sources of income. A brief account of these activities is presented below.

3.3.1 Agriculture

Though people perform a number of activities for their livelihoods, agriculture is the main activity in terms of people's employment as well as contribution on household income. Varieties of crops are grown in this area. Among them rice, maize, wheat, millet, and potato are considered as major crops in terms of both area occupied and total production. Pulses, oilseeds, and varieties of fruits and vegetables are also grown. Rice is mostly concentrated in the lower parts due to its suitable natural conditions though it is grown up to about 1,800 meter in this watershed. In some places *ghaiya,* kind of paddy grown in dryland is also grown in limited areas. Maize, millet and wheat are grown up to about 2,200 meter in this region. The cropping intensity as well as production per unit is high in the downstream parts due to the

suitable environment. Up to three crops can be grown below 1,000 meters altitude and one or two crops are grown in the upper parts. Both rain-fed and irrigated crop farming is practiced.

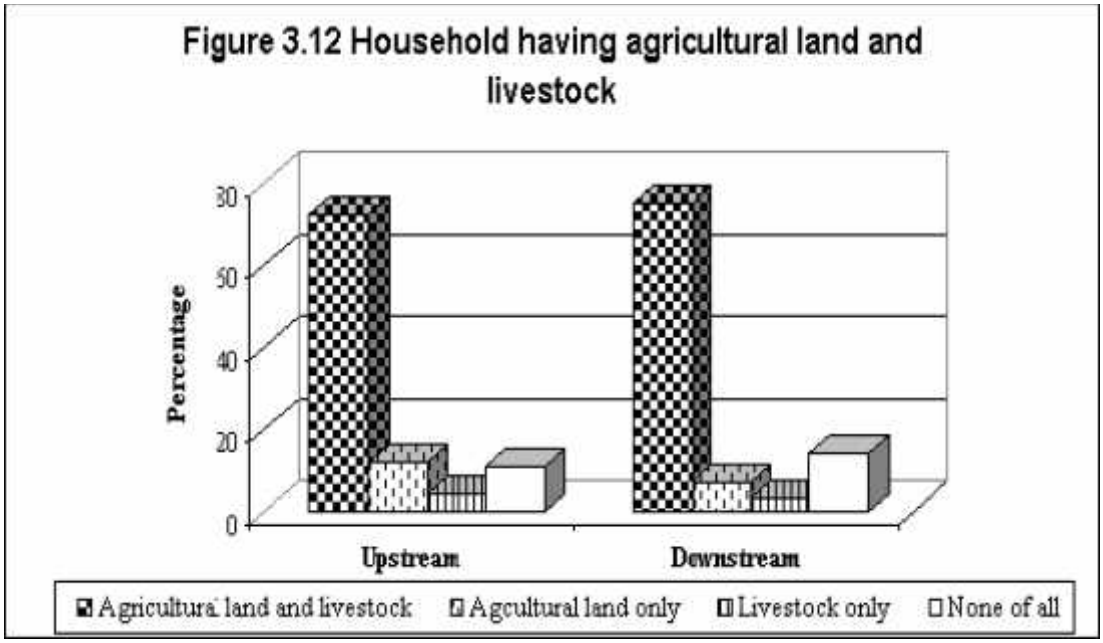
Along with crop farming, livestock raising is the integral part of the agriculture in this region. Cattle, buffalo, goat, sheep, and poultry are the major livestock kept by the farmers. Horse/mule, and other pet animals are also found. The contribution of livestock to livelihood is significant as it provides manure and drought power for cultivation and other livestock consumable products such as milk, wool, meat etc. The people raise livestock either as stall-feeding or as grazing animals. In the past transhumance activity was common but now its importance has declined and limited only in some places in the upper parts. The main causes for this decline are development of tourism activities, shrinkage of winter pasture due to intensification of agriculture in the lower valley and shortage of labour force as caused by increased opportunity of foreign employment. Besides, local people diverted to more lucaritive tourism business from agro-livestock activities.

Land and livestock are important aspects of the agriculture, which play significant role in livelihoods of the people particularly in agrarian country like Nepal. These are important assets and can be considered as one of the measuring indicators of the people's livelihoods. The distribution of agricultural land and livestock among household in the Modi Khola watershed is uneven. The distribution of land and livestock by household and sub-region is given in Table 3.14 (Figure 3.12).

Table 3.14 Percentage of the households having agricultural land and livestock

Types of property	Downstream	Upstream	Total
Agricultural land and livestock	75.3	72.4	74.6
Agcultural land only	7.2	12.2	8.4
Livestock only	3.5	4.5	3.7
None of all	14.0	10.9	13.3
Total household	100.0	100.0	100.0

Source: CBS, 2002: Population of Nepal: Western Development Region



There are altogether 74.6 percent households having both land and livestock. The percentage of households only with land is 8.4 percent and 3.7 percent of household has only some types of livestock. And 13.3 percent households have none of them. The other details of land and livestock and their impact on livelihood will be discussed in chapters 4 and 5.

3.3.2 Off farm activities

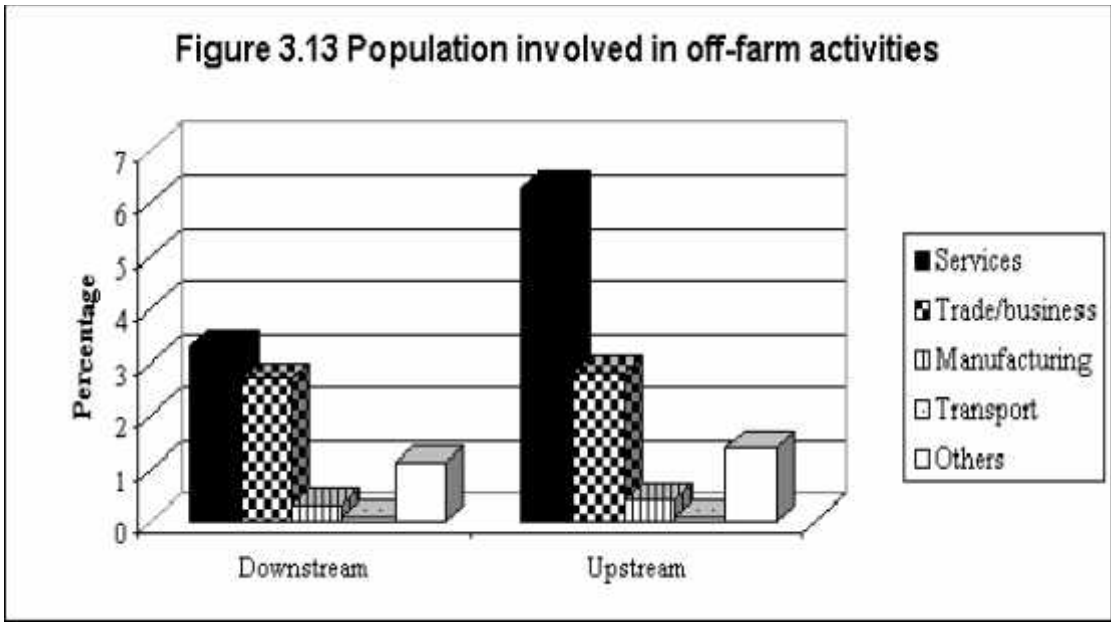
Along with agriculture people perform a number of off-farm activities for the fulfillment of their livelihood goals. These include service in governmental and non-governmental organizations, trade and business, manufacturing activities including cottage industries, transport, and other activities. The proportion of population 10 years and above involved in different off-farm activities is given in Table 3.15 (Figure 3.13).

Out of total 57,411 economically active populations of 10 years and above 8.4 percent are involved in different off-farm activities. The proportion of population engaged in service is 4.0 percent followed by trade and business (2.8 percent). The population involved in manufacturing and transport activities is negligible i.e. 0.3 and 0.1 percent respectively. And 1.2 percent is involved in other activities.

Table 3.15 Population of 10 years and above involved in off farm activities

Activities	Downstream		Upstream		Total	
	Number	Percent	Number	Percent	Number	Percent
Services	1482	3.3	811	6.3	2299	4.0
Trade and business	1214	2.7	363	2.8	1580	2.8
Manufacturing	139	0.3	50	0.4	189	0.3
Transport	57	0.1	17	0.1	74	0.1
Others	498	1.1	177	1.4	676	1.2
Total	3390	7.6	1418	11.1	4819	8.4
Economically active pop^{n}	**44582**	**100.0**	**12829**	**100.0**	**57411**	**100.0**

Source: CBS, 2001: Population of Nepal: Western Development Region



It is summarized from the above discussion that the study area Modi Khola watershed displays a cross profiles of Middle Mountain, High Mountain and High Himalays and represents sub-tropical to alpine types of climate within a short physical distance of about 51 km. General slope raises from south to the north with maximum relief of 5,549 meter. Nearly one-fifth of the area lie above 5,000 meters and about 35 percent below 3,000 meters. The vegetation ranges from mixed evergreen hill and riverine forest in the valley bottom to alpine grassland above 3,500 metres. The settlements are distributed below 3,000 meters representing isolated to compact stttlements and market centers. The watershed has 75,000 population of different ethnic groups with

moderate density (131 persons per sq km) and literacy level (58.3 percent). The area is connected with highway however; the road facilities lie entirely in the downstream sub-region and only a network of trails serves upstream sub-region.

The present study on water and livelihoods is based on the biophysical and socio-economic settings of the study area discussed above. The subsequent chapter deals with livelihood assets and their contribution to livelihoods.

CHAPTER IV

ASSETS AND THEIR CONTRIBUTION TO LIVELIHOODS

4.1 Types of assets

Assets or types of capital refer to both tangible (resource and stores) and intangible (claims and access) things, which provide material and social means for living. Out of these assets people construct and contrive a living, using physical labour, skills, knowledge and creativity (Chambers and Conway, 1991). The assets or types of capital are conceptualized into different categories. Chambers and Conway (1991) grouped into two categories i.e. tangible and intangible assets, while Carney (1998), DFID (1999), and Pani and Lautze (2002) have recognized five categories viz. natural, physical, social, human and financial.

The role of assets in livelihood is significant and equally important because a range of assets is required to achieve varied livelihood outcomes that people seek. However, the contribution of different assets to livelihoods varies by individual or group of people as well as their spatial location as a result of level of access to assets, capabilities of people in exploiting these assets, and the nature of the environment of the locality. Households within the locality can be differentiated not only on the basis of the assets they posses but also according to their ability to get access and control them (Pani and Lautze, 2002).

The local people in the study area owned a number of assets individually or as common property resources (CPR), which have significant effects in their livelihoods. The assets individually owned by households are farmland, livestock, house, pension and remittances, and other household goods and facilities (radio, television, sewing machine etc.). Forest, pasture, water resources, and infrastructures are owned as common property resources. Community groups and organizations existing in this area are social capitals. In the present study the five categories of assets as recognized by DFID are considered. However, some sub-components could not be covered due to paucity of data/information. The details on these livelihood assets are discussed below.

4.2 Natural assets

Natural capital is the term used for the natural resource stocks from which resource flows and services useful for livelihoods are derived (Carney, 1998; DFID, 1999). Natural capital means an extension of the economic notion of capital (manufactured means of production) to environmental goods and services. It refers to a stock (e.g., a forest), which produces a flow of goods (e.g. new trees) and services (e.g. carbon sequestration, erosion control, habitat). Natural capital can be divided into renewable and non-renewable; the level of flow of non-renewable resources (e.g. fossil fuels) is determined politically (Pain and Lautze, 2002). Thus, the natural capital and services deriving from it include land, forests, marine/wild resources, water, air quality, erosion protection, waste assimilation, storm protection and biodiversity degree and rate of change. The contribution of natural capital to livelihood is immense. Life cannot survive without the help of key environmental services and food produced from natural capital. A brief discussion on different sub-components of natural capitals of the study area is given below.

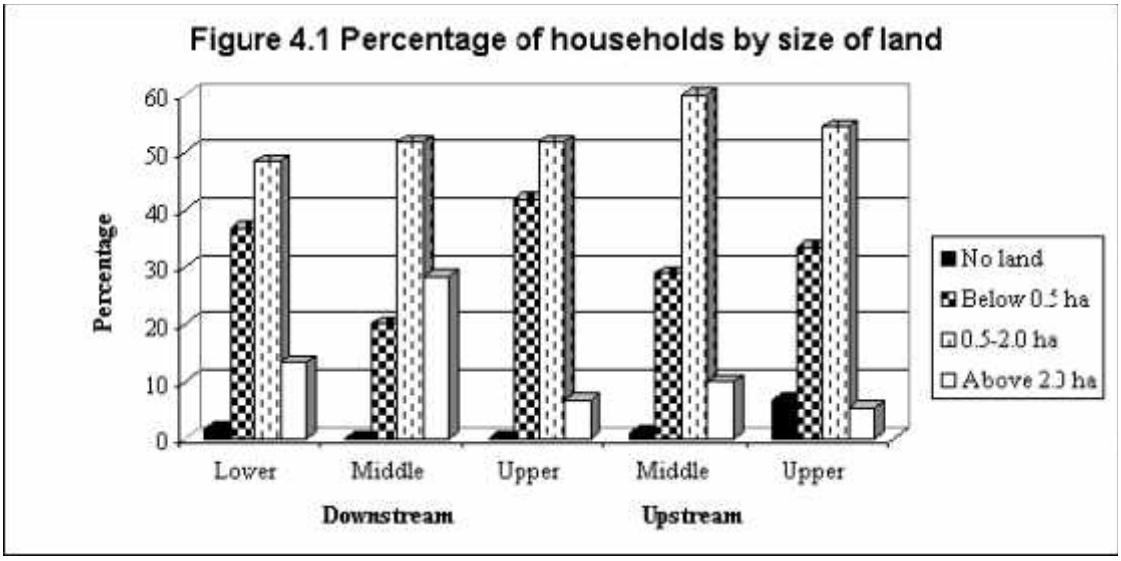
4.2.1 Land

Land is an important natural asset of the local people as agriculture is the main source of subsistence of the people in the Modi watershed. Farmland plays a significant role in livelihoods, as it is the source of food for people and livestock, fuel wood, timber and cash income. Out of the total land area of the watershed 19.7 percent is used for agricultural purposes. The distribution of agricultural land across region is uneven. Table 4.1 shows the land distribution pattern of the surveyed households.

Table 4.1 Number and percentage of size of landholding by sub-region and zones

Land size (ha)	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
	No	%	No	%	No	%	No	%	No	%	No	%
No land	1	1.7	0	0.0	0	0.0	1	1.1	6	6.7	8	2.2
Below 0.5	22	36.7	12	20.0	25	41.7	26	28.9	30	33.3	115	31.9
0.5-2.0	29	48.3	31	51.7	31	51.7	54	60.0	49	54.4	194	53.9
Above 2.0	8	13.3	17	28.3	4	6.7	9	10.0	5	5.5	43	11.9
Total	60	100.0	60	100.0	60	100.0	90	100.0	90	100.0	360	100.0
Average	1.1		1.6		0.8		1.0		0.9		1.1	

Source: Field survey, 2002/03



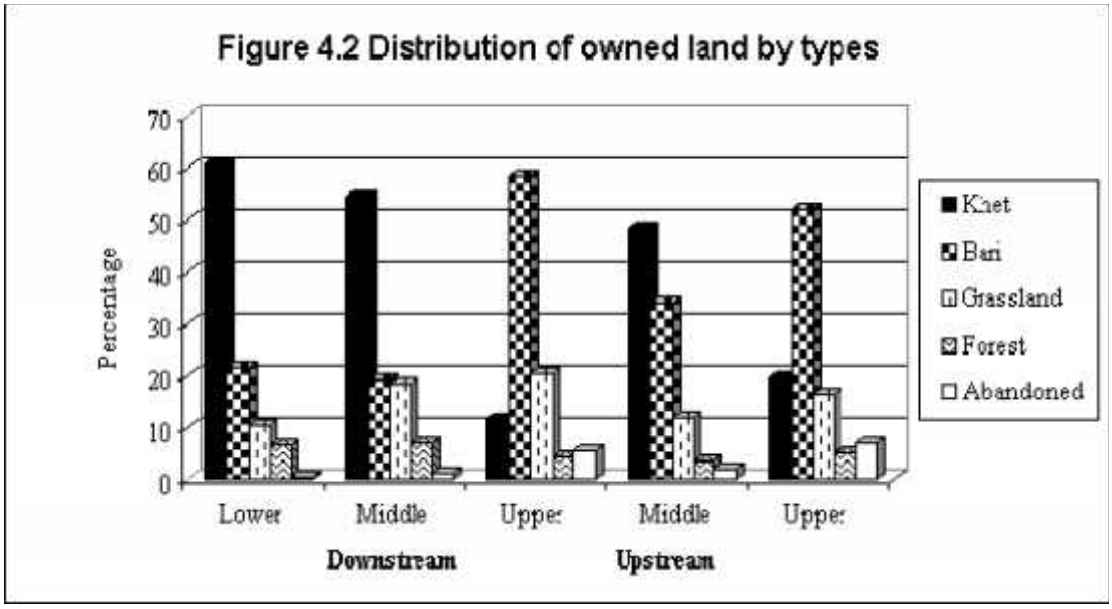
The average size of the landholding in the study area both cropped and other lands is 1.1 ha. This is nearly the same as the average landholding size of Nepal (1.09 ha) and is little below the average size of mountains (1.22 ha) and above that of the Hills (0.89 ha) (CBS, 1996a). The distribution of land is uneven across households, sub-regions and zones. A majority of the households (53.9 percent) own 2 to 5 hectares of land. Nearly 32 percent households have less than 0.5 ha of land and about 12 percent households posses greater than 2 ha of land. Out of the total, 2.2 percent has no farmland (Table 4.1). The percentage of households having larger land holding size (greater than 2 ha) is comparatively higher in the middle zones of the downstream sub-region than in the other zones. The proportion of households with medium landholding size (0.5-2.0 ha) is relatively high in the upstream sub-region.

The land owned by households can be divided into five different categories. These are *khet* (wet terraced land), *bari* (non-irrigated lands), grassland, forest and abandoned land. The distribution of land by types is given in Table 4.2.

Table 4.2 Types of land and its area (ha) owned by household

	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
Land types	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
Khet	39.5	60.7	53.2	54.5	5.5	11.7	41.8	48.5	15.9	19.5	156.0	41.3
Bari	14.2	21.7	18.8	19.2	27.6	58.6	29.3	34.0	42.7	52.2	132.6	35.1
Grassland	6.8	10.4	17.8	18.3	9.5	20.2	10.4	12.0	13.4	16.4	57.9	15.3
Forest	4.5	6.9	6.8	7.0	2.0	4.2	2.9	3.4	4.1	5.0	20.3	5.4
Abandoned	0.3	0.4	1.0	1.0	2.5	5.4	1.8	2.1	5.7	7.0	11.3	3.0
Total	65.2	100.0	97.6	100.0	47.1	100.0	86.2	100.0	81.9	100.0	378.0	100.0

Source: Field survey, 2002/03



Out of the total land, *khet* constitutes 41.3 percent followed by *bari* (35.1 percent), grassland (15.3 percent), forest (5.4 percent) and abandoned land (3.0 percent). The distribution of these lands varies by sub-region and zones. The percentage of *khet* land is high in the downstream sub-region as compared to the case of the upstream zone. Out of total land owned by surveyed households, *khet* land constitutes 60.7 percent in the lower zones of the downstream sub-region followed by middle zones of the downstream sub-region (54.5 percent). It is relatively low in the upper zones of both the sub-regions. The excessive concentration of paddy land in the middle and lower zones are largely due to favorable agricultural land as controlled by climate and topography. The lower part of the watershed is relatively flat as compared to that of the upper part. Generally the extent of *bari* land is more extensive in the upstream. The proportion of abandoned land is also high in upper region. Low productivity, destruction of crops by wildlife and shortage of agricultural labour are reportedly the main causes for the abandonment of agriculture land. Another reason for abandonment is due to shift of local people from farming to tourism and related activities.

Table 4.3 (Figure 4.3) provides information about land ownership pattern of the study area. Nearly 98 percent (352 households) of the households own some agricultural lands. Out of the total 352 households ownning land, 18.2 percent rented-out some or all of their lands to others on different contractual basis. Nearly 19 percent of the total 360 households rented-in some lands from others on contract and operated together with their own lands. It is clear that some of the households ownning lands also

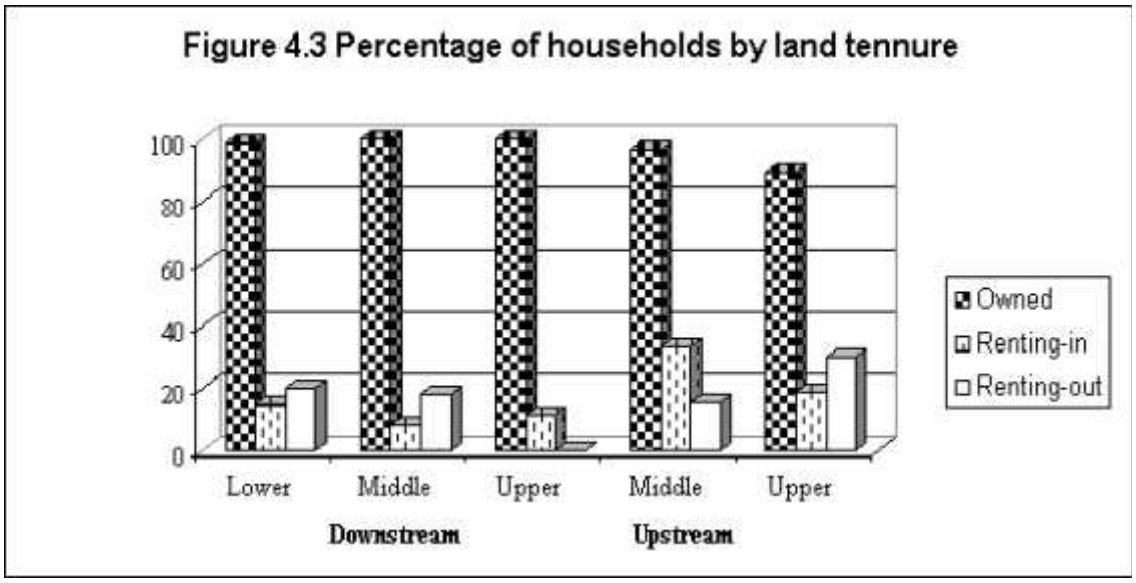
rented-in lands from others. Eight out of total 360 households do not own any land and some of them operate others' land and some are involved only in tourism business hiring other's house. This can be seen particularly in the upstream sub-region where tourism activities are important. The proportion of household owning land is higher in the downstream sub-region as compared to the upstream sub-region. In the upstream part as a result of development of tourism activity some households are in-migrated. These households do not own any land and are involved only in some tourism business.

Table 4.3 Percentage of households with land ownership

	Owned land		Rented-in		Rented-out	
Sub-region/ Zones	Number	Percent	Number	Percent	Number	Percent
Downstream	**179**	**99.4**	**21**	**11.7**	**23**	**12.8**
Lower	59	98.3	9	15.0	12	20.0
Middle	60	100.0	5	8.3	11	18.3
Upper	60	100.0	7	11.7	0	0.0
Upstream	**173**	**96.1**	**47**	**26.1**	**41**	**23.7**
Middle	89	98.9	30	33.3	14	15.7
Upper	84	93.3	17	18.9	27	32.1
Total	**352**	**97.7**	**68**	**18.9**	**64**	**18.2**

Source: Field survey, 2002/03

Note: Some of the households ownning land also rented-in lands from others



The proportion of households that rent-in land is highest in the middle zone of the upstream sub-region and the proportion of household renting-out land is the highest in the upper zone of the upstream sub-region. In the upper zone of the upstream sub-region a remarkable proportion of the population are involved in tourism activities

and different governmental and non-governmental services elsewhere. It is to be noted that most of the agricultural lands of the middle zone of the upstream sub-region belongs to the people of the upper zone. And a significant proportion of these people out-migrated from Modi Khola area to Pokhara, Kathmandu and other city areas.

Table 4.4 shows the land tenure status of the study area. Nearly 92 percent of agricultural land is owner operated and 8 percent is rented-in from others on different contractual basis. The proportion of land rented-out to others is significant. More than 12 percent of the total owned land have been rented-out to others. The proportion of rented-in land is higher in the middle zone of the upstream sub-region. Likewise the proportion of rented-out land is high in the upper zone of the upstream sub-region as compared to that of the other zones. The main reason as noted above is the high concentration of absentee landlords in the upstream sub-region. Some people who possessed lands in this area live in Pokhara, Kathmandu and other cities. And a significant proportion of working age population from this zone has temporarily out migrated for job to India and abroad. Thus, their lands have been rented-out to others on contractual basis of proportionate sharing of outputs without sharing the investment. Lower zone of the downstream sub-region constitute high proportion (15 percent) of the land rented-out to others. This is due to the involvement of landowners in services and business activities.

Table 4.4 Percentage of owner operated, rented-in and rented-out land

Sub-region/ Zone	Owner operated land as % of total operated land	Rented-in land as % of total operated land	Owner operated land as % of total owned land	Rented out as %of total owned land
Downstream	**96.6**	**3.4**	**93.1**	**6.9**
Lower	95.8	4.2	85.0	15.0
Middle	97.6	2.4	95.3	4.7
Upper	95.6	4.4	100.0	0.0
Upstream	**86.0**	**14.0**	**80.7**	**19.3**
Middle	82.8	17.2	88.9	11.1
Upper	90.5	9.5	72.0	28.0
Total	**91.9**	**8.1**	**87.6**	**12.4**

Source: Field survey, 2002/03

4.2.2 Water resources

Water is a natural asset and most important to livelihoods. It is essential for all living things to conduct biological functions. The availability and accessibility of clean and fresh water determines the quality of life. Improved access to water is a powerful tool to diversify livelihoods and reduce vulnerability. An adequate quantity of water is needed for food production, to meet industrial needs and for energy required for different production purposes and activities.

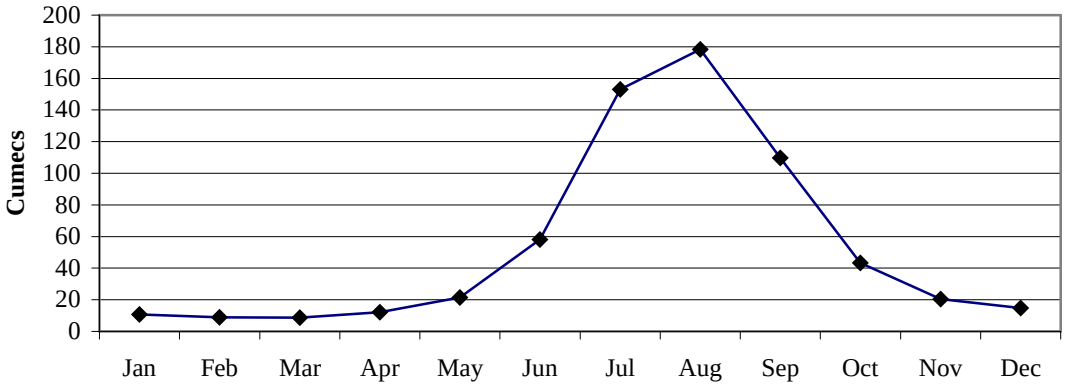
Snow/glacier, rivers and groundwater are the sources of water in the study area. The stocks of groundwater and snow/glacier are not known. Water resources of the basin is analysed on the basis of measured river flow with respect to the gauging station No 406.5 at Nayapul located about 1.5 km upstream of its confluence with the Kaligandaki river. Though there are a number of tributaries (Pati, Rati, Jare and Malayangdi) joining downstream from Nayapul, the flow data is not available for downstream from Nayapul. Dovan, Chhomrong, and Kimrong are its snow-fed tributaries and Modkyu, Porghiun, Chane, Bhurungdi, and Dhoti Khola are the rain-fed tributaries joining upstream from Nayapul. The mean monthly and annual discharge for the period of 12 years (1989 - 2000) of Modi Khola at Nayapul is given in Table 4.5.

Table 4.5 Mean monthly and annual discharges (m^3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1989	12.5	7.2	9.4	12.8	29.9	42.1	164.2	209.9	132.5	54.3	16.1	16.9	59.0
1990	11.7	10.0	10.5	15.1	23.2	63.5	207.1	94.5	77.0	43.2	11.7	12.4	48.3
1991	8.4	7.2	7.2	9.4	17.7	50.1	105.3	182.8	125.1	35.3	18.4	13.4	48.4
1992	10.1	9.4	9.0	11.1	13.8	29.0	76.9	155.9	90.2	46.3	22.4	13.8	40.7
1993	10.3	9.4	7.9	9.7	18.2	38.5	82.4	205.0	131.0	47.5	21.4	14.4	49.6
1994	10.1	8.5	9.0	9.4	16.9	57.8	124.5	157.5	99.3	33.5	16.5	10.7	46.1
1995	7.5	6.4	7.2	10.0	26.1	84.5	201.1	169.9	88.7	37.5	28.0	16.3	56.9
1996	10.4	9.4	7.8	10.1	14.9	66.6	240.0	219.2	88.2	45.2	18.6	13.2	62.0
1997	9.5	8.9	9.0	16.3	17.0	37.2	167.8	136.6	79.4	30.7	19.0	20.1	45.9
1998	15.2	12.2	11.7	16.7	31.3	67.2	163.9	255.6	98.1	50.7	24.0	15.1	63.5
1999	11.0	8.2	7.9	11.8	24.8	74.8	130.3	176.2	174.7	54.3	25.6	15.5	59.6
2000	11.5	9.6	7.6	12.5	23.5	85.9	174.0	177.1	132.1	41.0	23.7	16.4	59.6
Mean	10.7	8.9	8.7	12.1	21.4	58.1	153.1	178.4	109.7	43.3	20.4	14.8	53.3

Source: Tahal Consulting Engineers Ltd, 2002

Figure 4.4 Mean monthly discharge in Modi khola at Nayapul (1989-2000)



During the 12 years period the minimum and maximum annual flows were recorded in 1992 (40.7 m^3/s) and 1998 (63.2 m^3/s) respectively. The mean monthly flow is high for three months (July- September) while it remains very low (less than 9 m^3/s for two months i.e. February and March. Local people have diverted water from different tributaries of Modi Khola and springs nearby for various purposes. Table 4.6 shows the amount of water diverted upstream to the gaiuging station at Nayapul in the Modi Khola. On an average 1.6 m^3/s (3 percent of the mean flow) water is diverted. The maximum amount of water is diverted in June (6.6 m^3/s) and minimum in July and August (0.1 m^3/s).

Table 4.6 Observed mean flow and upstream diversion (m^3/s)

Months	Observed mean flow	Upstream diversion	Percentage of mean flow
January	10.7	1.1	10.3
February	8.9	1.4	15.7
March	8.7	1.0	11.5
April	11.7	0.8	6.8
May	21.4	1.3	11.1
June	58.1	6.6	11.3
July	153.1	0.1	0.1
August	178.4	0.1	0.1
September	109.6	0.2	0.2
October	43.3	3.2	7.4
November	20.4	2.2	10.8
December	14.8	1.6	10.8
Annual	53.3	1.6	3.0

Source: Tahal Consulting Engineers Ltd, 2002

Heavy use of water in June is due to maximum demand of water for agricultural activities. In this month the amount of rainfall becomes low and not sufficient for agricultural activities, as it is the pre-monsoon period, which resulted in more water diversion from rivers and springs.

4.2.3 Biodiversity

The values of biological diversity are strongly expressed in Nepalese culture, religions, arts and literature. Social harmony is based upon the respect of nature, environment and all living souls. Biological diversity has significant role in the livelihoods of people. The direct contributions of biological resources to human livelihoods are numerous and diverse. The most fundamental role of biodiversity is related to supplying food, medicine, and industrial raw materials. It has significant role in ecological balance too. Some of the animals like cows, elephants, monkeys, snakes, dogs, crows, eagles etc. are worshipped on various occasions. Similarly, most of the trees have religious and cultural values and a large number of plants, flowers, and leaves are actually conserved because of their regular use in various rituals and cultural expressions (Shrestha and Gupta, 1993).

The study area is rich in biodiversity. Varieties of flora and fauna are found in this area. Forest is one of the biodiversity components; it affects livelihoods directly or indirectly in many ways. Fuel wood, timber, fodder, wild foods, medicinal herbs, and leaf litters are the main forest products directly used by local people. The natural vegetation of this area varies with elevation. From the river to the ridge, the vegetation changes from the sub-tropical to the temperate and alpine pasture in quick succession. Altogether 1,226 species of plants, and 38 species of orchids were recorded in the Annapurna Conservation Area (East Consult, 1998). Sal (*Shorea robusta*), chilaune (*Schima wallichii*), sallo (*Pinus sp*.) and simal (*Bombax ceiba*) are the dominant tree species in the lower altitudes; utis (*Alnus nepalensis*), malato (*Macaranga denticulate*), okhar (*Juglans regia*), firfire (*Acer oblongum*) and katus (*Castonopsis indica*) dominate the middle and chanp (*Michelia champaca*), rhododendron (*Rhodendron sp*.), and khashru (*Quercus sp*.) dominate the higher altitudes. The major medicinal plants available in this area are kurilo (*Asparagus officinalis*), bojho (*Acorus calamus*), kaliniuro (*Dryoathyrium sp*), chillobatulpate (*Cissapelos pareira*), ghodtapre (*Hydrocotyle asiatica*), gurjolaharo (*Tinospora*

cordifolia), harchur (*Viscum album*), bankapas (*Thespesia lampas*), and satwa (*Paris polyphylla*). The major edible plants available in this area are ainselu (*Rubus ellipticus*), guile (*Elaeagnus latifolia*), chutro (*Berberis aristata*), and kafal (*Myrica esculanta*). Besides, varieties of mushrooms are found in this area.

This area provides good habitat to varieties of wildlife. There are altogether 101 species of mammals, 478 species of birds, 39 species of reptiles and 22 species of amphibians in the Annapurna Conservation Area (East Consult, 1998). Langur (*Presbytis entellus*), yellow-throated marten (*Martes flavigula*), jungal cat (*Felis chaus*), snow leopard (*Penthera unica*), ghoral (*Nemorhaedus goral*), himalayan thar (*Hemitragus jemlahicus*) and endangered and protected species like black bear (*Selenarctos thibetanus*) and musk deer (*Moschus chrysogaster*) are also found in this area. The important birds species reported in this area are rufous-throated partridge (*Arborophila rufogularis*), chestnut-crowned bush warbler (*Cettis major*), grey-cheeked warbler (*Seicercus poliogenyo*), kalij pheasant (*Lophura leucomelana*), bloo pheasant (*Ithaginis cruentus*), and himalayan monal (*Lophophorus impejamus*).

The area is rich in fish diversity too. The diversity in fish is high in the lower parts. Both riverine and riparian varieties are found in the Modi Khola and its tributaries (East Consult, 1998). The fish commonly available include asla (*Schizothorax plagiostamus*), chuche asla (*Schizothoraichtthys progostus*), tauke asla (*Schizothorax fichardsonii*), gadela (*Noemacheilus beavani*), kala sahar (*Tot tor*), pahelo sahar (*Schizothorax macrophthalmus*), gurde (*Osteobrama cotio*), fokate (*Barsilius vagra*), buduna (*Garra gotyla*), gonch (*Bagarius bagarius*), kabri (*Pseudecheneis sulcatus*) and hile (*Channa stewartii*). Asla (*Schizothorax plagiostamus*) is the important fish species of the Modi Khola.

4.2.4 Pasture/grazing land

Pasture/grazing land is considered as one of the most important natural assets. It is one of the common properties of the people residing especially in the upper parts of the Modi Khola area. Animal grazing is common (along with stall-feeding) as raising livestock is an integral part of the agricultural activities in the Modi Khola watershed. Cattle, buffaloes, sheep, and goats are the major livestock species raised by the local people. As livestock provides different consumable products and one of the sources of cash income of the local people, health as well as productivity of livestock depends on

the availability of grass to feed them. The area is rich in terms of availability of grazing lands. Out of the total land area, bushes/grass land constitutes about 12 percent land area. There are a number of grazing lands used by local people to graze their herds. Thai-brow, Nade, Maye-brow, Lem-mro, Sid-gai, and Bhaisa-kharka are the main pasturelands of this area and concentrated in the northern part of the watershed above the permanent settlements.

4.2.5 Trees on farmland

Tree is considered one of the important natural assets owned by households. It is one of the indicators of household economy. Generally rich people with abundance of farmland possess more trees than the poor ones. It has both direct as well as indirect implications in people's livelihoods. It is the main source of fruits, fodder, fuel wood, litter and timber for household construction and others. Other important components extracted from trees are gums and resins. Some of the trees have religious importance too in our society. Trees are equally important for controlling erosion and maintaining ecological balance. The availability of trees in farmlands also shows the economic strength of the households. Households without trees depend on government as well as community forest for products like fodder, firewood, and litter and are considered more dependent than the households with trees in their own farmlands.

Fruit has high economic value and is one of the income sources of local people. Mango, jackfruit, papaya, and banana are common fruits available in the lower parts while, orange, lemon, pear and peach are common in the middle parts. Limited species of fruit trees are grown in the upper parts. Along with fruit trees, local people have preserved a number of fodder as well as other tress for timber and fuel wood in their farmlands.

Table 4.7 shows the percentage of household with the number of trees on their farmlands. It indicates that the distribution of trees across the zone and household is uneven due to uneven distribution of factors like farmlands and climatic limit. A remarkable proportion (45 percent) of the households have no fruit trees, 53.6 percent has up to 50 trees and 1.4 percent has above 50 trees of different fruits. The number of households without fruit trees in farmlands increases from lower altitudinal zone to the higher altitudinal zones gradually. An overwhelming majority (82.2 percent) of

the households have no fruit trees in the upper zone of the upstream sub-region. It is due to altitudinal limit. Likewise, 11.1 percent of the household has no fodder trees, 80 percent has up to 50 trees and 8.9 percent has more than 50 fodder trees. Regarding other trees, 30.3 percent of the household has no trees, 50.6 percent has up to 50 trees and 19.2 percent has more than 50 trees in their farmlands. The average number of trees of all kind is higher in the middle (93) and lower zone (89) in the downstream sub-region as compare to those of the other zones. The number of fruit and other tree is also high in these zones. The number of fodder tree is higher in the upper zone of the upstream sub-region.

Table 4.7 Percentage of households with number of trees in farmlands

Number	Tree types	Downstream			Upstream		Total
		Lower	Middle	Upper	Middle	Upper	
No trees	Fruit	11.7	13.3	66.7	36.7	82.2	45.0
	Fodder	6.7	3.3	15.0	7.8	20.0	11.1
	Other	15.0	16.7	25.0	41.1	42.2	30.3
Up to 50	Fruit	85.0	83.3	33.3	62.2	17.8	53.6
	Fodder	81.7	88.3	83.3	83.3	67.8	80.0
	Other	63.3	53.3	58.3	46.7	38.9	50.6
Above 50	Fruit	3.3	3.3	0.0	1.1	0.0	1.4
	Fodder	11.7	8.3	1.7	8.9	12.2	8.9
	Other	21.7	30.0	16.7	12.2	18.9	19.2
Average	Fruit	12	13	1	5	1	6
	Fodder	21	22	10	18	34	22
	Other	56	58	24	22	34	37
	All trees	89	93	35	45	69	65

Source: Field survey, 2002/03

4.2.6 Aesthetic resources

Aesthetic resource is considered as one of the natural assets. It plays a significant role in people's livelihoods as tourism activity depends on these resources. Tourism activity in this area is one of the main sources of the household income. The area is rich in aesthetic resources and the physical landscape is the most attractive part of the aesthetic resources. In the background of green hills, deep and narrow valleys with 16 Himalayan peaks higher than 6,000 meters, the majestic array of snow wall including Annapurna I (one among 14 highest giant of the world), beautiful sharp pyramid

spotted by two symmetrical buttresses of Machhapuchre and Annapurna Sanctuary encircled by 11 pinnacles higher than 6,000 meters presents a sublime splendour of mountain topographic landmarks in the Modi Basin (East Consult, 1998). Tourists are highly attracted to these scenes. In addition to this, a number of rapids and falls and hot springs (Jhinudada) exist there. The floral and faunal diversity of the region is equally important from touristic point of view. Besides the physical landscape, the region is rich in cultural landscapes too. The architect of the traditional Gurung settlement, their culture and rituals, arts and crafts are the main cultural attraction of the region. The upper part of the basin as a whole is important in the aesthetic resources, as all these resources are concentrated in this section however, its importance differs by sites. The major tourist attraction by tourist routes is summarized in Table 4.8.

Table 4.8 Major tourist attractions by trekking routes

Trekking routes	Major tourist attractions
Nayapul-Birethanti-Punhill	Rhododendron natural forest and mountain views
Nayapul-Birethanti-Ghandruk-Tarapani-Punhill	Rhododendron natural forest, mountain views, wildlife and cultural landscape including traditional compact Gurung settlements and culture
Ghandruk-Chhomrong-Base camp	Wildlife, mountain views, waterfalls, glaciers and avalanches and alpine plants
Chhomrong-Nayapul-Landruk-Tolka-Dhampus	Hot spring, cultural landscapes and mountain views

Source: Poudel, 2003and Field Survey 2002/03

4.3 Physical assets

Physical capital comprises the basic infrastructure (transport, shelter, water supply, energy and communications) and the production equipment and means, which enable people to pursue their livelihoods (Carney, 1998). Like others, physical capital plays a significant role in livelihoods. Lack of particular type of infrastructure is considered to be a core dimension of poverty. For example, without adequate access to these services reduces productivity. The opportunity cost associated with poor infrastructure can preclude education, access to health services and income generation. Furthermore, insufficient and inappropriate producer goods makes unnecessarily disposal of human capital. Peole use a number of different physical assets owned by households and

common property resources for their livelihood security. The distribution pattern of these physical capitals and their significance on local livelihood is as follows.

4.3.1 Shelter/housing

House or shelter is one of the important physical assets, which shows the level of livelihoods. In other words the well being of the population in general depends on the quality and the quantity of the housing available. The basic infrastructure facilities available to the households determine the quality of life (CBS, 1996b: 24). The housing occupancy status in the study area is good. All households possess their own house in the upstream sub-region except one each in Syaulibazar and Ghandruk.

The number of rooms or area of the floor generally measures the size of a dwelling. The number of person per number of room measures the degree of crowding (CBS, 1996b). Here the number of rooms is taken as one of the indicators for evaluating housing condition of the study area. The average number of rooms per house in the study area varies from 2.4 rooms to 4.3 rooms. The number of rooms per house is highest in the lower zone (4.3 rooms) of the downstream sub-region followed by upper zone (4.2 rooms) of the upstream sub-region (Table 4.9).

Table 4.9 Percentage of households with number of rooms in the house

Number Of rooms	Downstream			Upstream		Total
	Lower	Middle	Upper	Middle	Upper	
One	1.7	15.0	20.0	13.3	7.8	11.4
Two	30.0	33.3	48.3	38.9	34.4	36.9
Three	20.0	20.0	18.3	15.6	24.4	19.7
Four	15.0	10.0	8.3	20.0	13.3	13.9
Five - ten	30.0	21.7	5.0	12.2	13.3	15.8
Above ten	3.3	0.0	0.0	0.0	6.7	2.2
Average	4.3	3.2	2.3	2.9	4.2	3.4
Persons per room	1.7	2.2	2.5	2.3	1.4	1.9

Source: Field survey, 2002/03

In this zones people are relatively rich as compared to others due to their involvement in tourism and other business and services. Considering the average number of rooms per house, the upper zone of the downstream sub-region is relatively crowded as compared to the others. The density of population per room is the highest (2.5 persons per room) in this zone. In this zone houses are relatively small, old and less spacious.

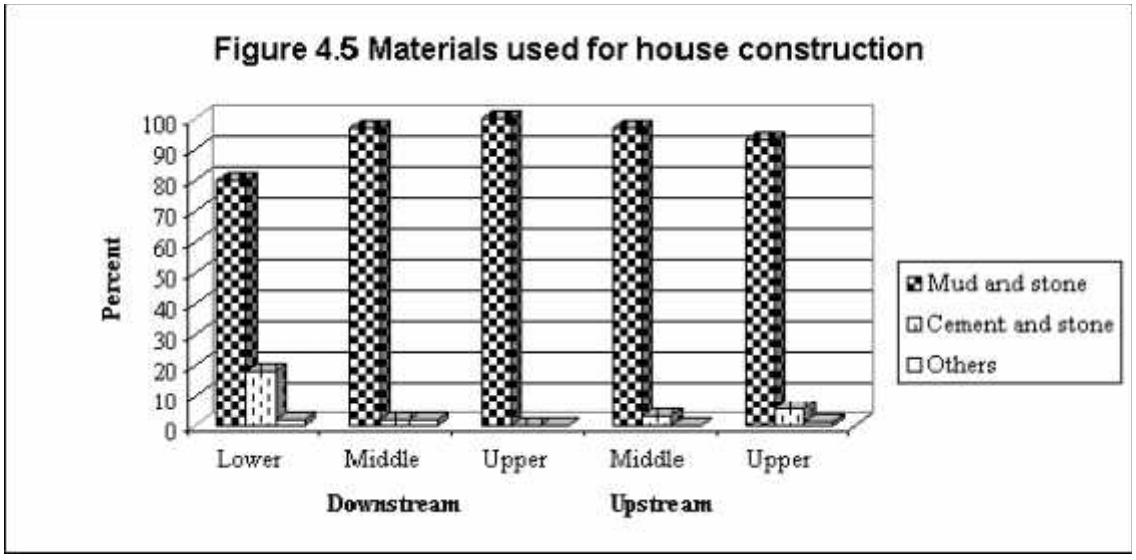
It is mainly due to the poor economic condition of the people. In contrary, the upper zone of the upstream sub-region and lower zone of the downstream sub-region are less crowded in terms of dwelling occupancy. The crowding densities in these zones are 1.4 persons and 1.7 persons per room respectively. In these zones houses are relatively big and newly constructed as a result of better economic condition of people. In the upper zone of the upstream sub-region there are a number of hotels/lodges with a good number of rooms particularly in Ghandruk and Chhomrong as these settlements are situated in the main trekking routes.

The construction materials for wall, floor and roof indicate the structural quality of the housing unit. An overwhelming majority (93.4 percent) of the houses are walled with mud and stone. Nearly 6 percent of the houses are made of cement and stone and remaining 0.8 percent are made of wood or bamboo (Table 4.10 and Figure 4.5). The proportion of houses with cement and stone is high in the lower zone of the downstream sub-region as compared to those of other zones. The reason for the use of cement in this zone is perhaps due to easy access to source. The houses with mud and stone are common in the upper zone of the downstream sub-region.

Table 4.10 Materials used for house construction (in percent)

Construction materials	Downstream			Upstream		Total
	Lower	Middle	Upper	Middle	Upper	
Mud and stone	80.0	96.7	100.0	96.7	93.3	93.6
Cement and stone	18.3	1.7	0.0	3.3	5.6	5.6
Others	1.7	1.7	0.0	0.0	1.1	0.8
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Field survey, 2002/03



The construction materials are an indicator for the structural acceptability of the housing units. Structural acceptability relates to the quality of the housing units and primarily concerned with the safety as well as well being of the household occupants (CBS, 1996b). For the construction of the floor mud is used in 92 percent of the houses in the study area and remaining 8 percent is cemented. Regarding roof types, nearly 60 percent of the roofs are made of stone, 25 percent of zinc and 15 percent of thatch. The availability of good quality stone for roof and its durability are the main reasons for using stone as roofing material. About 70 percent houses are two storied, 20 percent single storied and remaining 10 percent with more than two stories.

4.3.2 Household goods/services

The households pose a number of physical assets. Table 4.11 (Figure 4.6) shows the percentage of households with different household assets. The proportion of households having radio is 90 percent. Forty-six percent of the households possess some furniture. The furniture includes chairs, tables, sofa sets etc. The proportion of households with watch and television is 21.3 percent and 17.2 percent respectively.

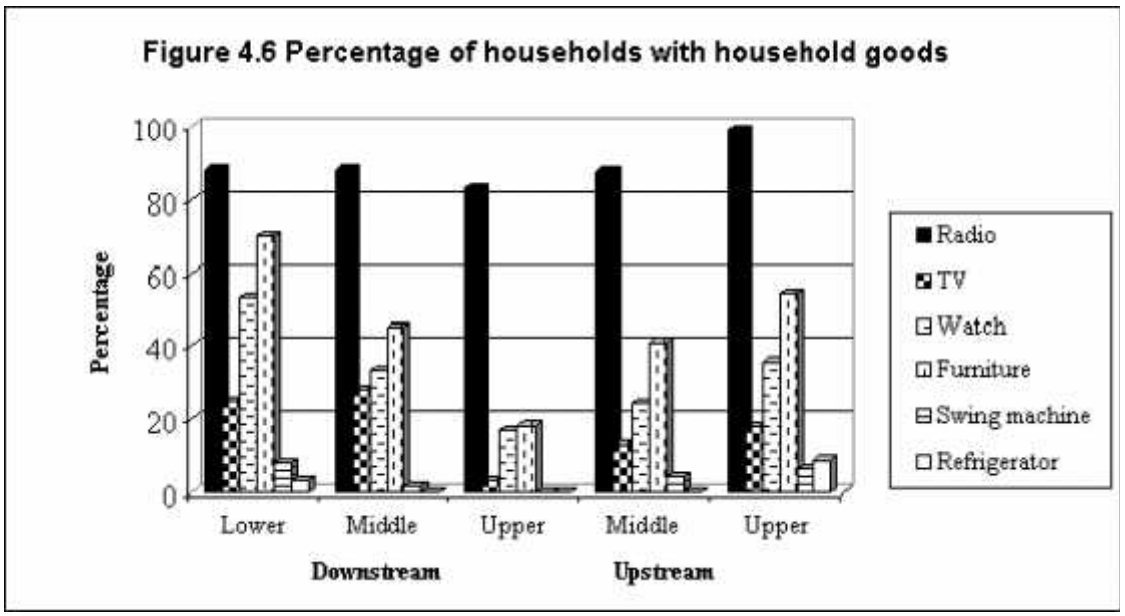
Table 4.11 Percentage of households having different assets/goods

Types	Downstream			Upstream		Total
	Lower	Middle	Upper	Middle	Upper	
Radio	88.3	88.3	83.3	87.8	98.9	90.0
Furniture	70.0	45.0	18.3	41.1	54.4	46.1
Watch	53.3	33.3	16.7	24.4	35.6	21.3
Television	25.0	28.3	3.3	13.3	17.8	17.2
Sewing machine	8.3	1.7	0.0	4.4	6.7	4.4
Refrigerator	3.3	0.0	0.0	0.0	8.9	2.8

Source: Field survey, 2002/03

Only 4.4 percent of the households have sewing machines and 2.8 have refrigerators. The proportion of households with radio is comparatively higher in the upper zone of the upstream sub-region than in other zones, while the proportion of households with furniture, television, watch, and sewing machine is higher in the lower zone of the downstream sub-region. Refrigerator is available in the households only in the upper zone of the upstream sub-region and the lower zone of the downstream sub-region. The refrigerator is mostly confined to hotel/restaurant owners. In addition to different

assets, households own different facilities like piped water, improved latrine, improved stoves, biogas plants and solar power.

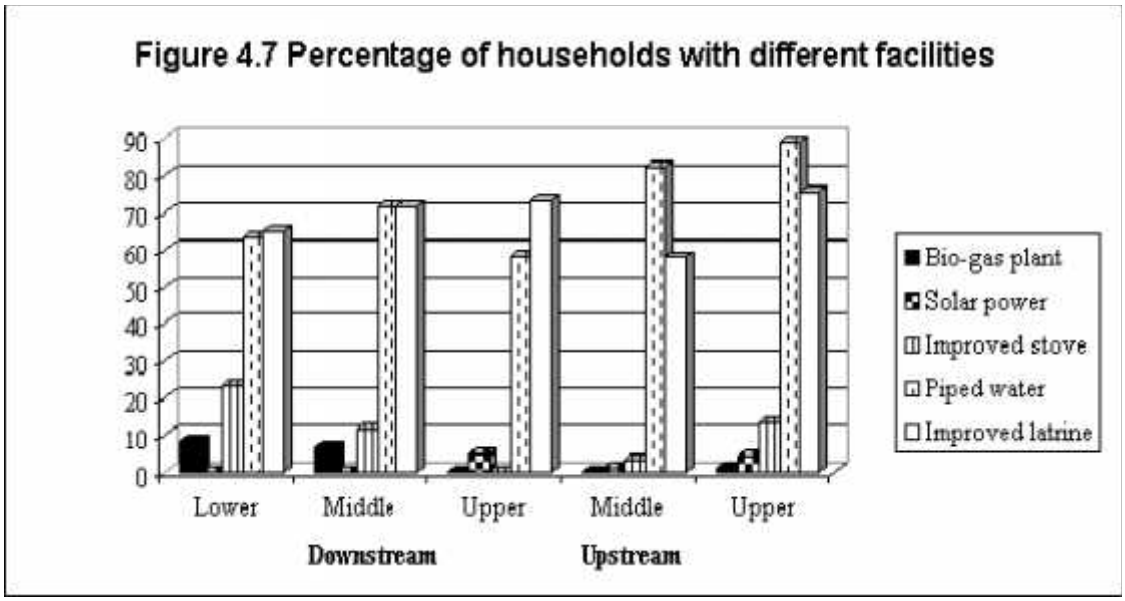


The facilities available in the households by zones and sub-region are given in Table 4.12 and Figure 4.7

Table 4.12 Percentage of households having different facilities

Types	Downstream			Upstream		Total
	Lower	Middle	Upper	Middle	Upper	
Piped water	63.3	71.7	58.3	82.2	88.9	75.0
Improved latrine	65.0	71.7	73.3	57.8	75.6	68.3
Improved stove	23.3	11.7	0.0	3.3	13.3	10.0
Bio-gas plant	8.3	6.7	0.0	0.0	1.1	2.8
Solar power	0.0	0.0	5.0	1.1	4.4	2.2

Source: Field survey, 2002/03



Three-fourth of the households have piped water supply. The proportion of households having improved latrine is 68.3 percent. A very small proportion of the households have installed biogas plants, solar power and improved stoves. The distribution of household facilities is uneven. The proportion of households with piped water and improved latrine is high in the upper zone of the upstream sub-region as compared to the other zones. The proportion of households with improved stove, and biogas plant is high in lower zone of the downstream sub-region. The proportion of households with solar power is high in the upper zones of both the sub-regions. No solar power is installed in the lower and middle zones of the downstream sub-region. Likewise no biogas plant is available in the upper zone of the downstream sub-region and the middle zone of the upstream sub-region.

4.3.3 Infrastructures

Infrastructures are important physical assets that play significant role in people's livelihoods. Good and efficient infrastructures help to improve livelihoods in many ways. The pattern and productivity of agriculture are affected by provision of infrastructure. It also promotes work ability of people. For the purpose of analysis the infrastructures are grouped into two different categories viz. water related infrastructures, and transport and communication. The details of the infrastructures are given below.

a) Water related infrastructures

Water related industries and infrastructures in the study area are presented in Table 4.13. These include *ghatta* (traditional watermills), power plants, piped-drinking water and irrigation schemes. There are altogether 55 watermills, 17 power plants including micro-hydro, 32 drinking water schemes (major) and 11 large irrigation schemes distributed across the watershed. The distribution of these facilities is uneven.

Nearly 93 percent watermills are concentrated in the upstream sub-region with the excessive concentration in the middle zone. The main reasons for the development of watermills in the upstream sub-region are the availability of favorable water flows and service demand resulting from dominance of the cultivation of crops like maize, millet and wheat. The number of watermills is extremely limited in the downstream

sub-region. Similarly micro-hydro plants are also highly concentrated in the upper sub-region. Out of 17 power plants 15 are located in the upstream sub-region with concentration of 10 hydro plants in the upper zone of this sub-region. The development of micro-hydro plants in the upstream sub-region is mostly due to the contribution of ACAP and favorable water flows.

Table 4.13 Water related major infrastructures

Water use schemes	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
	No	%	No	%	No	%	No	%	No	%	No	%
Ghattas	2	3.6	2	3.6	-	-	39	70.9	12	21.8	55	100.0
Hydro plants	1	5.9	-	-	1	5.9	5	29.4	10	58.8	17	100.0
Piped water	4	12.5	20	62.5	-	-	2	6.3	6	18.7	32	100.0
Irrigation	1	9.1	9	81.8	-	-	1	9.1	-	-	11	100.0

Source: Field survey, 2002/03

There are altogether 11 large irrigation schemes in the watershed. Of these, 10 lie in the downstream sub-region with concentration of 9 schemes in the middle zone. The presence of extensive agricultural lands with flat topography is responsible for the development of irrigation schemes in the middle zone of the downstream sub-region. A total of 32 piped drinking water schemes are distributed across the watershed. Out of the total, 75 percent schemes are concentrated in the downstream sub-region with share of 62.5 percent to the middle zone alone. The high concentration of piped water schemes in this zone is due to dense population.

b) Transportation and communication

All-weather motorable roads connect the Modi Khola watershed. The Pokhara-Baglung highway passes through the area in east-west direction. Besides, there are other seasonal road connections. Dobilla-Phalebas road connects district headquartes Kusma bazaar to its southern hinterlands while Kusma-Halhale road connets to its northern hinterlands (Durlung and Halhale area). There is altogether 35 kilometers road in the Modi watershed. Road density per 100 square kilometer is only 5 kilometer and density per 10,000 population is 4.7 kilometers. The road facilities lie entirely in the downstream sub-region. No road connections exist in the upstream sub-

region. A number of foot trails serve the upstream sub-region. Thus, the transportation of goods in this area completely depends on horse/mules and people.

Telephone facility is available in district headquarters and some of the major settlements in both the sub-regions. Out of the 12 surveyed settlements 50 percent settlements have PCO (public call office) telephones. The surveyed settlements having telephone facility are Chhomrong and Ghandruk in the upstream sub-region and Bajung, Jobang, Chuwa and Katuwa Chaupari in the downstream sub-region. Besides, there are a number of post offices, schools, banks and cooperatives in the study area. The details of these facilities are already discussed in Chapter three.

4.3.4 Agricultural tools and equipment

People use locally made traditional tools and equipments for agricultural woks. Most commonly used tools and equipments include *kuto, halo* (traditional plough), *kodalo* (spade), and *hansia* (sickles). *Halo* is used to plough fields, *kuto* and *kodalo* are used for digging and *hansia* is used for cutting grains, weeds and grass for livestock. Hence, the agriculture in this area is labor intensive. All farm households possess *kuto, kodalo* and *hansia*, while *halo* is mostly possessed by those who own draught animals (oxen). None of the farmers of this area use modern tools like thrasher and tractor but some use sprayer to spray insecticides and pesticides to protect crops from insects and pests.

4.4 Social assets

Social capital refers to the social resources (networks, membership of groups, relationships of trust, access to wider institutions of society) upon which people draw in pursuit of livelihoods (Carney, 1998). Woolcock and Narayan (2000) define social capital as the norms and networks that enable people to act collectively. According to the World Bank, social capital refers to the institutions, relationship, and norms that shape quality and quantity of a society's interactions. Social capital is not just the sum of the institutions which underpin a society-it is the glue that holds them together (Cited in Pain and Lautze, 2002). Social capital has a direct impact upon other types of capital by improving the efficiency of economic relations, management of common natural resources and infrastructures and development and sharing of knowledge. It can make important contribution to people's sense of wellbeing. Those communities

endowed with a diverse stock of social networks and civic associations are in a strong position to confront poverty and vulnerability (Woolcock and Narayan, 2000). Employing social capital would seem to increase its stock rather than depleting its reserve; the failure to use leads to depletion. Of the social assets, community groups and cultural organizations are discussed below.

4.4.1 Community groups

Membership in formalized groups helps people in mutual trust and reciprocity and provides a basis for informal safety nets. Such types of the social assets identified in the study area are social organizations namely Mother's group, Youth clubs, and users group. These are the symbols of mutual trust and cooperation of the society. All surveyed communities/settlements have Mother's group and almost all the households of the community are the members of the groups. These groups are devoted to develop well-being and social welfare, however, the intensity and works done by the groups varies by community. The development of social amenities such as drinking water, trail improvement, improvement of watermills and waste managements are examples of works so far done by Mothers' groups. In addition they try to control social evils such as gambling and using excessive alcohol. They have a fund raised by their own, which they use to assist their members for income generating activities (vegetable farming, raising goat, poultry etc.) as well as to overcome difficult situation providing loan in low interest rate without deposit.

A large number of settlements have youth clubs. The communities with youth club are Chhomrong, Ghandruk, Landruk and Moharia in the upstream sub-region and Chuwa and Katuwa Chaupari in downstream sub-region. Most of the youths of the community are tied in the clubs. These clubs are mostly oriented to develop social amenities, health and games. Besides, there are a number of different user groups in this area. These include community forest user groups, irrigation user groups and drinking water user groups and electricity user group. These groups are concerned with maintenance as well as sustainable use of resources.

4.4.2 Cultural organizations

One of the important social youth organizations familiar with Gurung community is 'Rodighar'. Pignede defines Rodi as custom of the evening meeting among the young

popular with Gurungs (Regmi, 1990). As noted by Regmi (1990) Bista (1967) calls it 'club for boys and girls'. Macfarlane (1972) says it 'young people's meeting home' and Andors (1974) describes *rodi* as a 'nightly social gathering place' or 'social night club'. Likewise Messerschmidt (1976) defines rodi as 'an association of young people who work and have fun together'. It is formed under the sponsorship of middle-aged couples who have a daughter of participating age. Membership in the rodi is determined by age and sex. It is not compulsory, however, peer group pressure to join is strong. Girls first join the rodi at about the age of eight or nine and may participate until the mid-twenties by which time they are usually married. All the rodi members are named as rodi friends while the male sponsor is respectably called rodi father and his wife is said rodi mother.

There are a number of youth associations 'rodi ghars, in the Gurung communities in the Modi Khola watershed particularly in the upstream sub-region. Gurung communities are mostly confined to this sub-region. Normally rodi member ranges between 10 and 15 girls from a number of clans. There are two types of *rodi*, differentiated by age. A young girl (*kolo*) joins a *kol-mai rodi* for girls roughly between the age of eight and thirteen. A girl older than that (*theba*), up to age 22 or 23 joins a *theb-mai rodi* (Messerschmidt, 1976)

Rodi has significant role to play in the socio-cultural and economic fields i.e. livelihoods of the people. The main functions are recreation and pre-marital socialization, which aids the smooth transition of youth to adulthood and enhances the efficient functioning of village life. It helps boys and girls to understand each other and enhances in the reciprocity and mutual trust. A no less important function of the rodi according to Messerschmidt (1976) is its role as the nucleus of a type of cooperative agricultural work party called nagor (10 to 20 persons participated). It is a temporary association organized seasonally to perform different agricultural works of the participants of the nagor such as preparing fields, sowing millet, maize, transplanting paddy, weeding and harvesting. The nagor party accomplishes in one day what a single farmer would take many to finish. It is also important in several socio-religious activities.

Besides, there are a number of other socio-cultural and religious informal organizations that play significant role directly or indirectly in livelihoods. These

include *ghatu*, *sorathi*, and *charitra dances* popular in the Gurung society and religious ceremonies like *guthi, diwali* and *dasain*. These festivals strengthen mutual trust and reciprocity among the members of the society and also help in social adjustments and in meeting the needs during the crisis or critical situation.

4.5 Human assets

Human capital was first included in the definitions of capital by Adam Smith in 1776, who described the capital stock of a nation as including the inhabitants' acquired and useful talents. In course of time it has rightly been accepted that human skills increase wealth for society as well as for the individual (Pain and Lautze, 2002:11). It represents the skills, knowledge, ability to labor, and good health that together enable people to pursue different livelihood strategies and achieve livelihood objectives (Carney, 1998; DFID, 1999). At a household level human capital is a factor of the amount and quality of labour available. Thus, human capital gives recognition to the importance of good health, life experience and education in allowing individuals and households to function and achieve their goals. It is also required in order to make use of other types of assets too. Though it is significant for livelihoods, its measurement is very difficult. For this reason, human capital is often defined and measured by proxy indicators. The status of household level human capital secured in terms of level of education, labor, and health status of population are discussed in the subsequent subunit.

4.5.1 Education

The level of education is one of the proxy indicators of human capital (Pain and Lautze, 2002), which has significant role in livelihoods. The level of education determines the level of well being of the household. The literacy status of the population is high in this area. Out of the total population (2,084) of 6 years and over 69 percent (1,437) are literate. The number and percentage of people of 6 years and above by literacy status and level of education is presented in Table 4.14.

Table 4.14 Number and percentage of people by level of education

Status and level	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
	No	%	No	%	No	%	No	%	No	%	No	%
Total	400	100.0	362	100.0	321	100.0	509	100.0	492	100.0	2084	100.0
Illiterate	107	26.8	104	28.7	111	34.6	154	30.3	171	34.8	647	31.0
Literate	**293**	**73.3**	**258**	**71.3**	**210**	**65.4**	**355**	**69.7**	**321**	**65.2**	**1437**	**69.0**
Up to 10 class	172	43.0	170	47.0	200	62.3	325	63.9	277	56.3	1144	54.9
SLC	47	11.8	49	13.5	9	2.8	18	3.5	25	5.1	148	7.1
Intermediate+	74	18.5	39	10.8	1	0.3	12	2.4	19	3.9	145	7.0

Source: Field survey, 2002/03

The above table shows that literacy percentage varies by zone. The lower zone of the downstream sub-region has the highest literacy rate (73.3 percent). The middle zone of the downstream sub-region ranks second in terms of literacy (71.3 percent) followed by middle zone of the upstream sub-region (69.7 percent). The upper zones of both the sub-regions have lower proportion of literacy. Table 4.14 also shows that majority of the literate population (54.9 percent) has up to ten grades education. The number of SLC graduate is 7.1 percent of the total school age population of 6 years and above. Likewise the proportion of population having higher level of education (intermediate and above) is 7.0 percent. The distribution of literate population is uneven. The proportion of population having higher level of education is high in the lower zone (18.5 percent) of the downstream sub-region as compared to others. This zone is situated around the district headquarters where education facilities are better than in other areas. The upper zone of the downstream sub-region has only one person having higher education above SLC.

4.5.2 Ability to labor/labor force

Labor force refers to the population of specified age group, which includes employed as well as unemployed population age of 10 years and above. The economically active population is that part of labor force which actually engages in the production of economic goods and services. The proportion of economically active population changes with population growth. A total of 70.2 percent of the total population of the study area is economically active (Table 4.15). Out of total economically active population, the proportion of male and female constitute 50.9 and 49.1 percent respectively. Proportion of economically active population varies by sub-region and

ecological zones due to variation in education as well as economic level. The proportion of economically active population is higher in lower zone of the downstream sub-region as compared to that of the other zones. Likewise middle zone of the upstream sub-region shares low proportion of economically active population. In this zone the ratio of child and old dependency is higher when compared to that of the others.

Table 4.15 Economically active population of 10 years and above

Sub-region /zone	Male	Percent	Female	Percent	Total	Percent
Downstream	**443**	**51.4**	**419**	**48.6**	**862**	**71.5**
Lower	167	52.0	154	48.0	321	72.5
Middle	145	50.0	145	50.0	290	70.9
Upper	131	52.2	120	47.8	251	70.9
Upstream	**390**	**50.3**	**385**	**49.7**	**775**	**68.9**
Middle	196	49.9	197	50.1	393	67.1
Upper	194	50.8	188	49.2	382	70.9
Total	**833**	**50.9**	**804**	**49.1**	**1637**	**70.2**

Source: Field survey, 2002/03

4.5.3 Health status

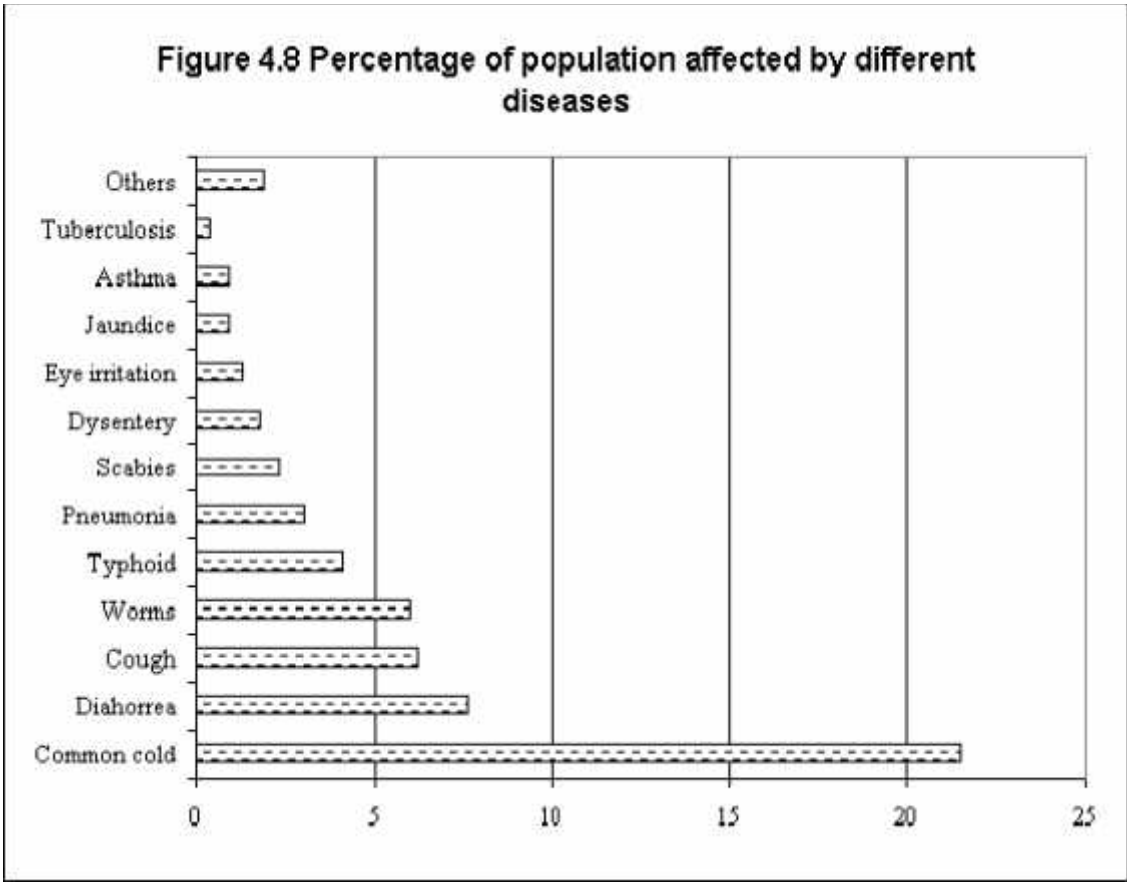
Health is defined as a state of complete physical, mental and social being (Niraula, 1998:465) and fundamental to human survival and development. It is the product of the several factors including environment, personal lifestyle and behavior. The level of education, availability of food and other resources and choices also guide the health condition. Good health is considered as one of the human assets, which enables people to pursue different activities for livelihoods. People having good health can work hard and maximize outcomes of his/her effort.

The general health condition of the local people of the study area is relatively better as a result of improved sanitation condition caused by health awareness activities of ACAP and influence of tourists. The high level of awareness towards improved health and hygiene has resulted in the installation of tap water (75 percent households) and remarkable proportion of households (68.3 percent) has facilities of latrine however, different diseases affected 58.2 percent of population during last year (Table 4.16 and Figure 4.8).

Table 4.16 Percentage of population affected by different diseases last year

Diseases	Downstream			Upstream		Total
	Lower	Middle	Upper	Middle	Upper	
Common cold	18.5	22.2	18.1	24.2	22.6	21.5
Diahorrea/dysentry	6.5	7.8	8.2	17.7	5.0	9.5
Cough	4.1	2.7	3.4	13.5	4.6	6.2
Worms	7.4	4.6	3.1	9.2	4.5	6.0
Typhoid	7.2	7.6	2.5	2.9	1.3	4.1
Pneumonia	2.3	3.2	3.7	3.9	1.9	3.0
Scabies	1.8	2.4	4.2	2.6	1.1	2.3
Eye irritation	1.8	0.2	1.1	2.4	0.7	1.3
Jaundice	2.0	1.5	0.0	0.3	0.9	0.9
Asthma	0.9	1.5	0.6	0.9	0.9	0.9
Tuberculosis	0.5	0.7	0.8	0.2	0.2	0.4
Others	1.8	1.5	2.3	2.2	1.7	1.9
Total population	443	409	354	586	539	3231

Source: Field survey, 2002//03



The figure shows that of the total population, 21.5 percent are affected by common cold. The percentage of population affected by diahorrea/dysentery is 9.5 followed by

cough (6.2 percent), worms (6.0 percent), typhoid (4.1 percent), and pneumonia (3.0 percent). Diseases like scabies, dysentery, eye irritation, jaundice, asthma, tuberculosis and others affected nearly 10 percent of the population. The proportion of population affected by disease is comparatively higher in the middle zone of the upstream sub-region. The proportion of population affected by jaundice and typhoid is higher in the lower zone of the downstream sub-region than in other zones.

4.6 Financial assets

Financial capital denotes the financial resources that people use to achieve their livelihood objectives (DFID, 1999; Pain and Lautze, 2002). These resources include: available stocks (cash, bank deposits or liquid assets such as livestock and jewellery) and regular inflow of money (pensions, transfers of the state and remittances). The role of financial capital to livelihood is great. One of the advantages of the financial capital is its versatility. Financial capital can be converted to other types of capital or used directly for the achievement of livelihood outcomes. It is least available to the poor. The information on cash and bank deposits is not available and difficult to generate this information. Some information on livestock, jewellery, and money inflow (pension and remittances) is collected. On this basis financial capital is assessed for the study area.

4.6.1 Livestock

Livestock is an integral part of the agriculture, and it is one of the sources of the household income in the Modi watershed. It is one of the financial assets, which supports livelihoods in many ways supplying different products such as milk, meat, wool, hides and manure for crop cultivation. Besides, it is used for drought power and as a means of transporting goods. Cattle, buffalo, goat, sheep, horse/mule and chicken are the major types of the livestock reared in this area. The percentage of households with livestock is given in Table 4.17.

Table 4.17 Percentage of households having livestock

Types	Downstream			Upstream		Total
	Lower	Middle	Upper	Middle	Upper	
Animal	91.7	98.3	96.7	95.6	92.2	94.7
Chicken/animal	91.7	98.3	98.3	97.8	92.2	95.6

Source: Field survey, 2002/03

The above table shows that out of the total surveyed household 94.7 percent have some types of animals and 95.6 percent have either animal or poultry. The proportion of household without animal or poultry is 3.4 percent. The table also indicates that there is no distinct variation in proportion of household with livestock by zone. But the number of livestock owned by household varies by zones, which will be discussed under subunit 5.1.2.

4.6.2 Jewellery

Wearing jewels has been regarded as an important tradition for both economic and socio-cultural perspectives in Nepal since historic times. This applies with the female population of the study area too. The local women use different types of ornaments or jewels made of different metallic and non-metallic substances. The most common jewels or ornaments worn by locals are finger ring, earring, nose ring, *phul*i, chain, *tilahari, naugedi*, and many other traditional and contemporary ornaments mostly made of gold and silver. It is one of the indicators of the economic status of the people. Poor people posses very limited or no jewel while rich ones posses a lot of different kinds of jewels and it is common throughout the study area. Generally people wear jewels in special ceremonies like marriage ceremonies, parties etc.

It is one of the liquid assets. As reported local people use these ornaments for other purposes too along with wearing for decoration in different social ceremonies. They use as deposits for borrowing loan from bank, cooperatives and local merchants. And those who are poor sale these jewels to get cash to overcome difficult situation especially in marriage and death ceremonies as well as to purchase food and other requirements of the households.

4.6.3 Money inflow

Remittance is one of the important sources of household income among various sources of money inflow. Out of the total surveyed households, 44.7 percent (161 households) receive remittance (Table 4.18). The proportion of households receiving remittance is high in downstream sub-region as compared to upstream sub-region. But the proportion of household getting foreign remittances is high in upstream sub-region. The reason behind this is that both the zones of upstream sub-region and upper zone of the downstream sub-region are inhabited by Gurung and Magar community

and for years the youth of these communities are more involved in foreign jobs particularly military services.

Table 4.18 Households getting remittances

	Downstream						Upstream					
	Lower		Middle		Upper		Middle		Upper		Total	
Working place	No	%	No	%	No	%	No	%	No	%	No	%
Outside VDC within district	8	13.3	2	3.3	1	1.7	3	3.3	4	4.4	18	5.0
Outside district within country	9	15.0	14	23.3	2	3.3	6	6.7	0	0.0	31	8.6
Other countries	16	26.7	15	25.0	21	35.0	27	30.0	33	36.7	112	31.1
Total	33	55.0	31	51.6	24	40.0	36	40.0	37	41.1	161	44.7

Source: Field survey, 2002/03

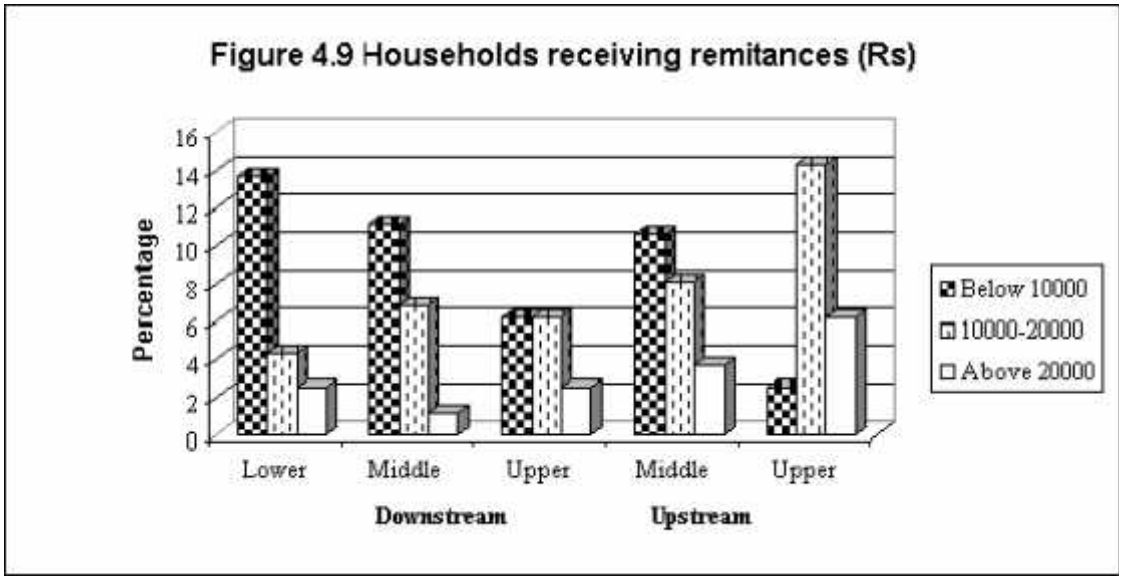
The share of remittances for household income is highest (31.2 percent) as compared to the shares of other sectors. On an average each household received Rs 40,779 from remittances last year (2001). The households getting remittances are categorised into three income groups on the basis of amount of remittances received by the households. The proportion of households receiving remittances by size categories of income and zone is given in Table 4.19.

Table 4.19 Households receiving remittances by size of income and zones

	Downstream						Upstream					
Size of	Lower		Middle		Upper		Middle		Upper		Total	
income (NRs)	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%
Below 10,000	22	36.7	18	30.0	10	16.7	17	18.9	4	4.4	71	19.7
10,000-20,000	7	11.7	11	18.3	10	16.7	13	14.4	23	25.6	64	17.8
Above 20,000	4	6.6	2	3.3	4	6.6	6	6.7	10	11.1	26	7.2
Total	33	55.0	31	51.6	24	40.0	36	40.0	37	41.1	161	44.7

Source: Field survey, 202/03

Nearly 20 percent households receive less than NRs 10,000 remittances last year. Households receiving NRs 10,000-20,000 is 17.8 percent and remaining 7.2 percent households receive above 20,000 remittances. Table 4.19 also shows that the proportions of households receiving remittances of 10,000-20,000 and above 20,000 are high in the upper zone of the upstream sub-region. Gurungs and Magar communities dominate upper part of the watershed. These groups are mostly involved in British army as well as other foreign jobs while people of the lower parts are mostly involved in government services within the country.



Another source of regular inflow of money in the study area is through pension that is received by retired servicemen working within country and abroad. The employment in foreign service is not new for this region. For a long time, a remarkable number of people of this area especially the Gurung and Magar youth are employed especially in Indian and British army. Table 4.20 shows the number of household receiving pension by sub-region and zones.

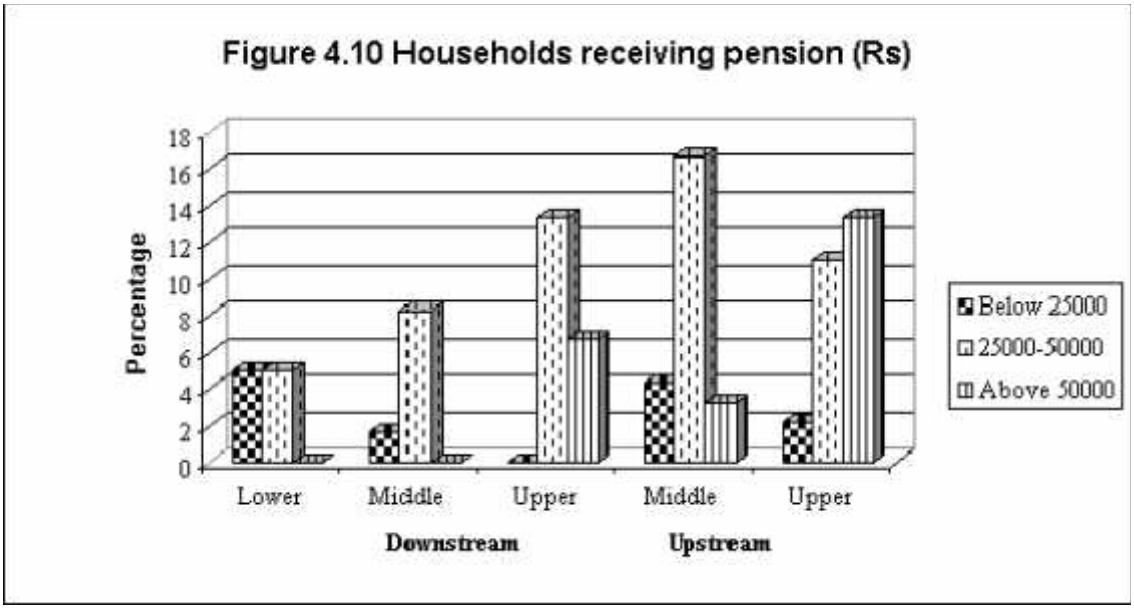
Table 4.20 Households receiving pension

Income (NRs)	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%
Below 25,000	3	5.0	1	1.7	0	0.0	4	4.4	2	2.2	10	2.8
25,000-50,000	3	5.0	5	8.3	8	13.3	15	16.7	10	11.1	41	11.4
Above 50,000	0	0	0	0.0	4	6.7	3	3.3	12	13.3	19	5.3
Total	6	10.0	6	10.0	12	20.0	22	24.4	24	26.7	70	19.4

Source: Field survey, 202/03

A remarkable proportion (19.4 percent) of the surveyed households receive pension. The proportion of households receiving pension is higher in the upstream sub-region as compared to that of the downstream sub-region. Out of the total households receiving pension, 11.4 percent receive in between Rs 25,000 and 50,000 annually. The proportion of households receiving more than Rs 50s000 is 5.3 percent and remaining 2.8 percent receive below Rs 25s000 annually. The proportion of household receiving pension is the highest in the upper zone of the upstream sub-region (26.7 percent) followed by middle zone of the same sub-region (24.4 percent), and upper zone of the

downstream sub-region (20 percent). The proportion of household receiving pension is lower in both middle and lower zone of the downstream sub-region.



4.7 Assets and their implications on livelihoods

The relationship or association between household assets and household income is studied. It is believed that households having large number of assets have higher household income and livelihoods of such categories are more secure as compared to the households having lesser number of assets. Diverse source of household income proved to be beneficial to overcome the harsh or vulnerable situations the people come across.

The association of household level assets and facilities (remittance and pension received by household, land owned, rooms in the house, trees in farm land, literacy level, livestock owned, household having water tap, latrine and radio or television) with household income is tested and analyzed using multiple regression models. Three out of total ten independent variables such as household having water tap, latrine and radio or television are considered as dummy variables. After a thorough checking five influential samples or outliers were removed from the total number of cases and multiple regressions models were run.

The correlation between variable yielded by regression model is presented in the Table 4.21. The entire independent variables show the direct and positive correlation to the household income except livestock unit owned by households. Livestock shows

the inverse relationship with household income. It means livestock unit is less in richer households or vice versa.

Table 4. 21 Correlation between household assets and household income

Variable	Household income	Land owned	Trees in farmland	Livestock owned	Literacy (%)	Rooms in house	Remittances	Pension received	Radio/TV	Water tap	Latrin
Household income	1.0										
Land owned	.340	1.0									
Trees in farmland	.160	.346	1.0								
Livestock owned	-.043	.044	.070	1.0							
Literacy (%)	.144	.218	.132	.001	1.0						
Rooms in house	.237	.207	.134	-.049	.175	1.0					
Remittances	.784	.218	.011	-.072	.035	-.002	1.0				
Pension received	.358	.011	.030	.079	-.040	.117	.085	1.0			
Radio/TV	.126	.116	.082	.094	.120	.087	.065	-.007	1.0		
Water tap	.163	.107	.144	.050	.099	.183	.066	.108	.051	1.0	
Latrine	.194	.111	.066	.092	.122	.089	.104	.188	.177	.122	1.0

Source: Computed from database

For the screening of variable to find out the suitable model, a number of variable screening techniques such as stepwise regression, forward selection and backward elimination techniques were adopted using Statistical Packages for Social Sciences (SPSS). The number of variables entered and their strength on regression model are compared. Screening processes were made both for data without making any transformation and with natural log transformation. The regression model with data without any transformation gave better results. Finally, the following multiple regression model having better results is applied to see the relationship between variables. The model is as:

$$Yi = ß_0 + ß_1 Re + ß_2 Pe + ß_3 Rh + ß_4 Lo + ß_5 Tf + ß_6 Ll$$

Where Yi = Household income

$ß_0$ = Constant and $ß_1, ß_2 \ldots\ldots ß_n$ are coefficient of respective variables

Re = Annual amount of remittance received by household (Rs)

Pe = Annual amount of pension received by household (Rs)

Rh = Number of rooms in the house

Lo = Land area owned by the household (ha)

Tf = Number of trees in farm land

Ll = Literacy level of the household (%)

Out of the total ten independent variables used, six remained in the final model. Variables like livestock owned, and dummy variables such as water tap, latrine and radio or television proved to be insignificant and removed from the model. The model treated these variables as insignificant and redundant variables in relation to other variables. Coefficient of determination (R^2) and Adjusted (R^2) of the regression model is 0.771 and 0.767 respectively. This means the model explains 77 percent of the total variation in the household income. Table 4.22 shows t statistic with significance and standardized betta of the final model.

Table 4.22 Model summary (t statistic, significance and standardized betta)

Predictors	**t statistic**	**Significance at**	**Standardised betta**
Constant	-0.983	0.326	-
Remittance received	27.77	.000	0.736
Pension received	10.60	.000	0.276
Number of rooms in the house	6.09	.000	0.163
Land owned by household	3.49	.001	0.101
Trees in farm land	2.82	.005	0.078
Household literacy level	2.60	.010	0.069

Source: Computed from database

All the coefficients of independent variables in the model are positive. This means that the variables have direct and positive relation in household income. Among the independent variables, remittance has the dominant role; its contribution on household income is greater than that of other variables. If other variable are constant, one unit change in remittance resulted by 0.736 changes in household income. The effect of literacy in the household income is minimum.

The study results discussed above in Chapter four show that the households of the Modi watershed possess a number of livelihood assets of five different categories (both household as well as common property resources) upon which their livelihoods are based. The contribution of different assets on livelihood is significant in determining household income as well as livelihood strategies. However, the role of individual asset varies by locality as a result of variation in local environment.

It is revealed from the delineation above that the livelihoods of local people are largely guided by the availability of assets along with capabilities of people exploiting these assets and people's choices. It is in this context of holistic approach to livelihoods the present study is found useful than the others found on individual assets.

CHAPTER V

STRATEGIES ADOPTED FOR LIVELIHOOD SECURITY

5.1 Livelihood strategies

Livelihood strategies denote the range and combination of activities and choices that people make/undertake in order to achieve their livelihood goals (DFID, 1999). The households and individuals pursue livelihood strategies based on the combination of assets they own and command and opportunities and restrictions created by the institutional environment (Pain and Lautze, 2002:15). People construct and contrive living using physical labor, skills, knowledge and creativity. Skills and knowledge may be required within the household, passed on from generation to generation as indigenous technical knowledge, or through apprenticeship, or more formally thorough education or extension services, or through experiment and innovation (Chambers and Conway, 1991).

The households in poor communities are primarily concerned with achieving food security and income in order to meet their basic needs, but the households and individual objectives go beyond physical needs. This might include the concept of 'well-being' or absence of poverty and embraces a much wider set of social values, including freedom, choice of self-esteem (Pain and Lautze, 2002). The rural poor pursue diverse livelihoods in order to put together enough to survive. Thus a small farmer cultivates his own land, works as agricultural labor, and migrates to work as a casual labor in order to support his family (James and Robinson, 2001).

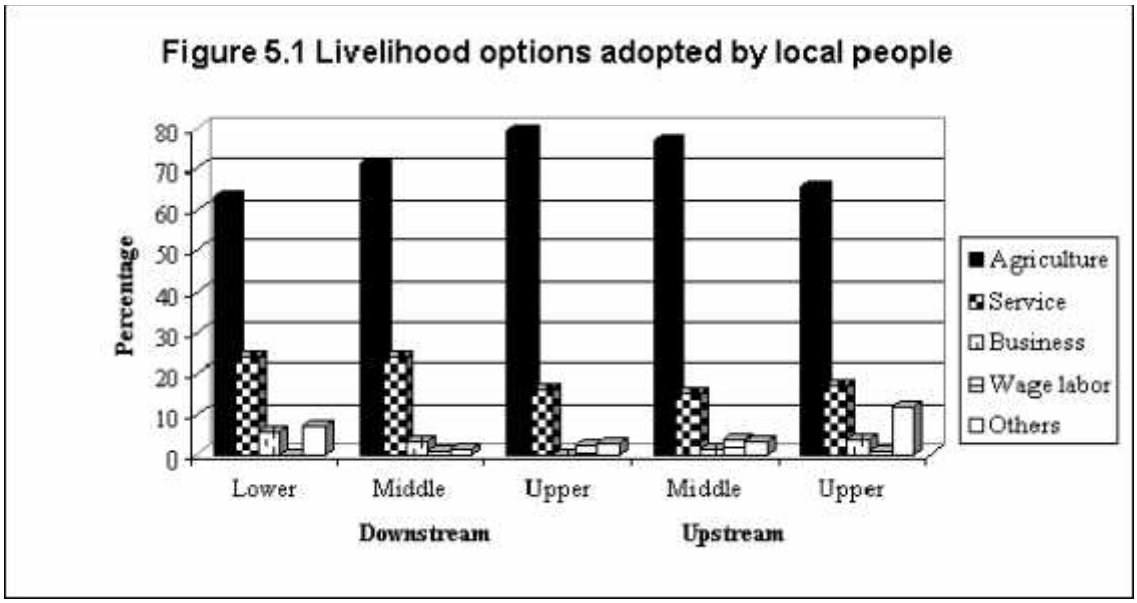
Livelihood strategies can be categorised into two groups i) coping strategies and ii) adaptive strategies (UNDP, 1999a). People adopt a number of strategies to cope with the scarcity of resources and perceived environmental problems (Khanal, 2002). The bundles of poor people's responses to declining food availability and entitlements in abnormal seasons of year are coping strategies while adaptive strategies constitute a permanent change in the mix of productive activities required to meet livelihood needs (Ham, 1995:2). The choices of strategies depend on the nature of the risk and vulnerability as well as their own preferred livelihood outcomes and coping strategies. Caste is one of the factors that also determines strategies of households and individuals (Ham, 1995:10).

The local people in the Modi watershed are generally poor (see Chapter IV) and they perform diverse livelihoods in order to survive. Therefore, food security is the main concern and they adopt different activities for this. The local people adopt both coping and adaptive strategies for their livelihoods. In this study coping strategies are not covered. The local people undertake a range and combination of activities in order to achieve their livelihood goals. They earn cash, food and other goods to satisfy wide variety of their needs performing different activities. These activities include agriculture (crop farming and livestock raising), service in government and non-governmental agencies (within country and abroad), business, tourism, industrial activities, fishing and others. Household members adopt one or more than one activities to meet their needs. The importance of these activities is not similar across the watershed and varies by places as a result of variation in natural as well as socio-cultural environment, which have direct implications on choices of livelihood options. Table 5.1 shows livelihood options adopted in the Modi Khola watershed.

Table 5.1 Livelihood options adopted by people age of 10 years and above

Occupation	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
	No	%	No	%	No	%	No	%	No	%	No	%
Agriculture	142	63.1	165	71.1	153	79.3	239	76.6	207	65.9	906	71.0
Service	54	24.0	55	23.7	31	16.1	47	15.1	54	17.2	241	18.9
Business	13	5.8	7	3.0	0	0.0	4	1.3	12	3.8	36	2.8
Wage labor	0	0.0	2	0.8	4	2.1	12	3.8	3	0.9	21	1.6
Others	16	7.1	3	1.3	5	2.6	10	3.2	38	12.1	72	5.6
Total	225	100.0	232	100.0	193	100.0	312	100.0	314	100.0	1276	100.0

Source: Field survey, 2002/03



An overwhelming majority, that is 71 percent of the population, are involved in agriculture for their livelihood security. Service ranks second (18.9 percent) in terms of employment. The service includes both government and non-governmental services within country and abroad. Business and wage labor rank third and fourth involving 2.8 percent and 1.6 percent population respectively. A significant proportion of population (5.6 percent) adopts other livelihood options. The other category includes tourism, different industrial activities (weaving and knitting, tailoring, brewing etc.), transport activities, fishing and collection of wild products. The details of different livelihood strategies adopted by households are discussed below.

5.1.1 Agriculture

Involvement in agricultural sector is one of the important strategies for people's livelihood. Though it has many challenges, it is the backbone and the main stay of local economy. The effect of natural assets on livelihood strategies is clearly seen in the agricultural activities of the local people. The pattern of agriculture and its production depend on various environmental as well as socio-cultural factors. However, it is the main source of livelihood of the people of the study area as a whole. Its contribution to household income is 16 percent and ranks second after remittance. In terms of employment it ranks first among the sectors of employment. More than 70 percent of the economically active population is engaged in this sector. It is the main source for food not only for human population but also for livestock animals. And it is one of the main sources of cash income as local people sell different agricultural products when they get surplus after household consumption. The detail characteristics of local agriculture such as area and production, cropping pattern, use of inputs, trends of agriculture and food security situation are discussed below.

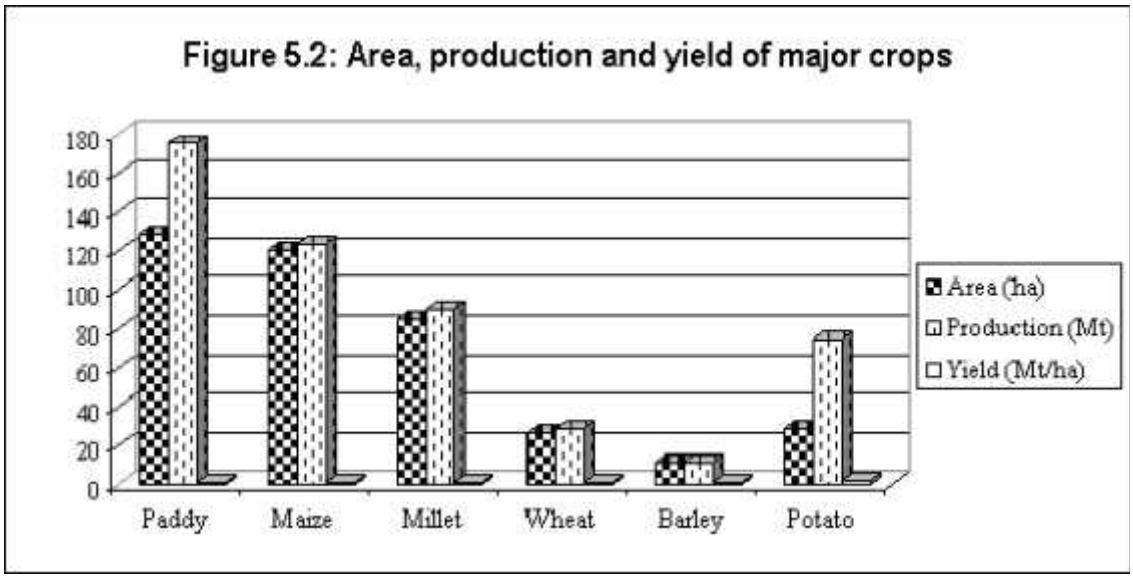
a) Area and production

In response to natural condition varieties of crops are grown in this area. Among them paddy, maize, millet, wheat, barley and potato are considered major crops in terms of both area occupied and total production. The other crops grown in this area include different types of pulses, oilseeds, and varieties of fruits and vegetables. The area, production and yield of major crops by zones are shown in Table 5.2.

Table 5.2 Area, production and yield of major crops (area in ha, production in MT and yield MT/ha)

Crops		Downstream			Upstream		Total
		Lower	Middle	Upper	Middle	Upper	
	Area	26.3	46.1	5.5	43.5	7.8	129.2
	Production	61.850	56.250	4.313	44.550	8.275	175.238
Paddy	Yield	2.350	1.220	.784	1.025	1.056	1.356
	Area	19.5	20.9	20.5	35.9	24.2	120.9
	Production	31.886	20.055	13.552	36.825	21.281	123.599
Maize	Yield	1.633	9.60	.662	1.026	.880	1.022
	Area	6.2	17.0	19.0	26.3	16.5	85.1
	Production	8.359	17.910	15.959	30.543	17.536	90.307
Millet	Yield	1.341	1.055	.838	1.161	1.062	1.061
	Area	7.7	11.5	0.4	3.7	3.3	26.5
	Production	13.739	8.954	.272	2.622	2.877	28.465
Wheat	Yield	1.773	.778	.776	.701	.883	1.075
	Area	0.8	0.2	0.6	2.0	7.7	11.4
	Production	2.145	.187	.204	1.566	7.525	11.628
Barley	Yield	2.570	.818	.334	.779	.976	1.020
	Area	2.4	3.2	10.3	2.3	10.5	28.6
	Production	11.420	8.655	20.400	6.960	27.435	74.870
Potato	Yield	4.804	2.714	1.984	3.066	2.608	2.615

Source: Field survey, 2002/03



Paddy ranks first in terms of both areas occupied and total production (Figure 5.2). Out of the total 401.7 ha area occupied by major food crops in the study area, 129.2

ha is under paddy. The total production of paddy is 175.231 Metric ton in 2003 and the yield per ha is 1.365 MT. Maize ranks second in terms of both area coverage (120.9 ha) and total production (123.599 MT). Per hectare production of maze is 1.022 metric ton. Millet and potato rank third and fourth in terms of both area occupied and total production. Wheat and barley rank fifth and sixth respectively in both area and production. The yield of wheat and barley is 1.075 and 1.020 MT/ha respectively. The area under paddy is high in the lower and middle zones of the downstream sub-region and the middle zone of the upstream sub-region. The natural conditions in these zones are favorable for paddy cultivation. In these zones the production of paddy ranks first compared to production of other crops. The area under maize is high in upper zones of both the sub-regions where natural conditions are not conducive for paddy cultivation. The production of potato is high in these zones. Likewise, the yield of different crops varies by zones. The lower zone of the downstream sub-region shows high yields of all crops. The availability of year round irrigation facility and suitable flat lands are the responsible factors for high productivity in this zone. The upper zone of the downstream sub-region has the lowest productivity of crops except wheat. The low yield of crops in this zone is partly due to insufficient irrigation facility, sloppy land and higher altitude.

Not only area, production and yield of different crops but also the cropping patterns vary by places. The cropping pattern of the area is determined by a number of factors such as soil, climatic condition, altitude, availability of irrigation facilities and other inputs, market, farmer's choice etc. Farmers grow up to three crops in this area. The general cropping patterns are summarized in Table 5.3.

Mostly three crops are grown in year round irrigated areas particularly in the lower valleys in the downstream sub-region and two crops are grown in the seasonal irrigated areas. The dominant crops in this area are paddy and maize. Mostly two crops are grown in none-irrigated *bari* or upland areas, where maize is the dominant crop. In the lower valleys of the upstream sub-region mostly two crops (paddy-wheat or paddy-barley) are grown in both seasonal and year round irrigated areas whereas only one crop is grown in none-irrigated *bari* lands except in few places, which show two crops. In the higher altitudes a single crop is grown. Lands remain fallow here after one crop.

Table 5.3 General cropping patterns

	Irrigation status	Cropping pattern
Lower parts	Year round	Early paddy-main paddy-wheat, maize-paddy-wheat, Paddy-wheat, maize-paddy-fallow, paddy-wheat-fallow
	Seasonal	Paddy-wheat, maize-paddy-fallow, paddy-mustard/others
	Non-irrigated	Maize-millet, maize-mustard/others, maize-fallow
Higher parts	Year round	Paddy-Wweat, paddy-barley
	Seasonal	Paddy-wheat, paddy-barley
	Non-irrigated	Maize-relayed potato, potato-fallow, maize-millet, maize/millet-maize/millet, others-fallow.

Source: Field survey, 2002/03

The cropping calendar also varies by places. The general cropping calendar of major crops grown in this area is shown in Table 5.4.

Table 5.4 General cropping calendar

Crops/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Valleys and lower hill slope												
Early paddy												
Main paddy												
Maize												
Millet												
Wheat												
Middle and higher parts												
Paddy												
Maize												
Millet												
Wheat												
Barley												
Potato												

Source: Field survey, 2002/03

In the downstream sub-region basically in the valleys early paddy is transplanted in the middle of March and harvested by the end of June. Immediately after harvesting the early paddy, main paddy is transplanted in the same field and it is harvested in the middle of November and after main paddy, wheat is shown. Seedbed of paddy is prepared generally one or one and half months before transplanting time. Maize is shown in March and harvested in the first or second week of July, but in the higher

hill slope it is shown in the middle of February. Millet is transplanted in July and harvested in November. In the lower parts it is transplanted after maize while in the higher parts it is transplanted before harvesting maize. Wheat is shown after main paddy in November and harvested by the first week of March. In this way the involvement of farmer in agricultural activities particularly in the lower parts of the watershed runs throughout the year. In the upper parts paddy is transplanted in June and harvested by the middle of October. After that wheat or barley is shown. Maize is shown in February and harvested in August. Potato is shown along with maize and harvested before maize in July.

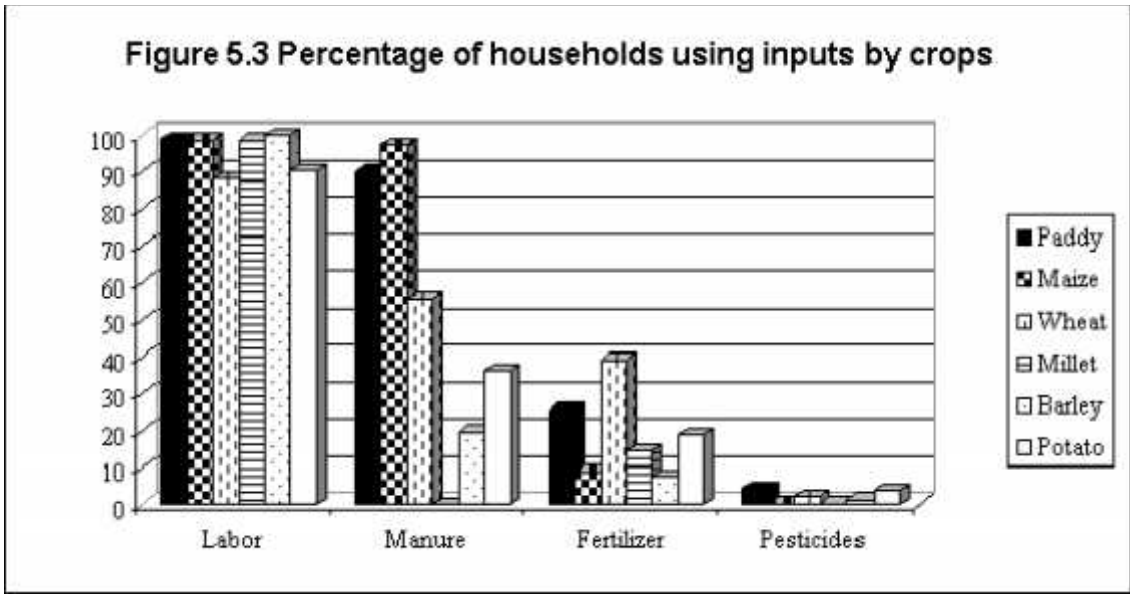
b) Use of input

People use different agricultural inputs, which have significant role in crop farming. These include labor, compost manure, chemical fertilizer and pesticides. Table 5.5 shows the total households growing different crops and households using agricultural inputs in their agricultural production.

Table 5.5 Households producing crops and using agricultural inputs

Crops	Producing HH	Labor		Manure		Fertilizer		Pesticides	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent
Paddy	227	224	98.7	204	89.9	58	25.6	10	4.4
Maize	325	320	98.5	311	97.2	29	8.9	1	0.3
Wheat	135	119	88.1	75	55.6	53	39.3	3	2.2
Millet	295	291	98.6	0	0.0	43	14.6	1	0.3
Barley	66	66	100	13	19.7	5	7.6	1	1.5
Potato	252	227	90.1	91	36.1	48	19.0	10	4.0

Source: Field survey, 2002/03



Labor is one of the various inputs required for agricultural activities. Almost all the households growing crops use labor for different activities of crop cultivation such as the preparation of fields, transplanting/sowing, weeding and harvesting. Agricultural works are seasonal in nature and those who don't have sufficient manpower from their own family use wage labor. However, the proportion of households using labor varies by crops and zones. The use of labor in wheat and potato is comparatively low as compared to other crops. Manure is another agricultural input; its use in the study area is extensive. Except for millet manure is used for all crops. Maize and paddy ranks first and second in terms of percentage of household using manure. Out of the total crop-growing households, the proportion of household using manure in maize and paddy is 97.2 percent and 89.9 percent respectively. People use fertilizer too to increase and maintain agricultural productivity. Wheat ranks first (39.3 percent) in terms of fertilizer use and paddy and potato rank second (25.6 percent) and third (19.0 percent) respectively. Nearly 15 percent households use fertilizer in millet. People use fertilizer in millet generally in seedbed. The proportion of households using pesticides is negligible. It is less than 5 percent in all six crops.

c) Changes in areas and productivity

Regarding the areas and productivity of major crops, the respondents were asked whether there was any change in areas and productivity of crops during the last 10 years. The responses were mixed. The proportions of households reporting decrease in areas under different crops were higher as compared to the proportion of households reporting increase in areas under these crops (Table 5.6).

Table 5.6 Changes in area and productivity of crops during last 10 years (% hh)

	Area			Productivity		
Crops	Increase	Decrease	Constant	Increase	Decrease	Constant
Paddy	8.6	13.1	78.3	8.9	28.9	62.2
Maize	8.6	13.1	78.3	12.5	35.8	51.7
Millet	7.5	11.1	81.4	9.7	27.8	62.2
Wheat	3.9	7.2	88.9	3.6	14.2	82.3
Barley	0.6	2.2	97.2	0.6	2.2	97.2
Potato	5.3	6.4	88.3	11.4	24.2	64.4

Source: Field survey, 2002/03

The main reasons for declining areas under different crops as reported by the households are the abandonment and division of agricultural lands to offsprings. The

agricultural lands located nearby forest is abandoned due to heavy destruction of crops by wild animals with the increase in forest density after the launching of forest protection programs by ACAP particularly in the upstream sub-region, and lack of watchmen due to the migration of significant proportion of working population to city areas and for jobs abroad. The households reporting no change were significantly high in all the zones and crops. A significant proportion of the households reported that the productivity of land has declined during the past 10 years. One of the major reasons for declining productivity as reported is the decline in manure production. Manure production declined with the decrease in livestock number as people particularly in the upstream sub-region diverted to tourism business. The proportion of households reporting increase in productivity for maize is 12.5 percent, followed by potato (11.4 percent), millet (9.7 percent) and paddy (8.9 percent). The proportion of households reporting increase in productivity for wheat and barley is 3.6 and 0.6 percent respectively. As reported the use of fertilizer, pesticides and improved seeds are responsible for this increase.

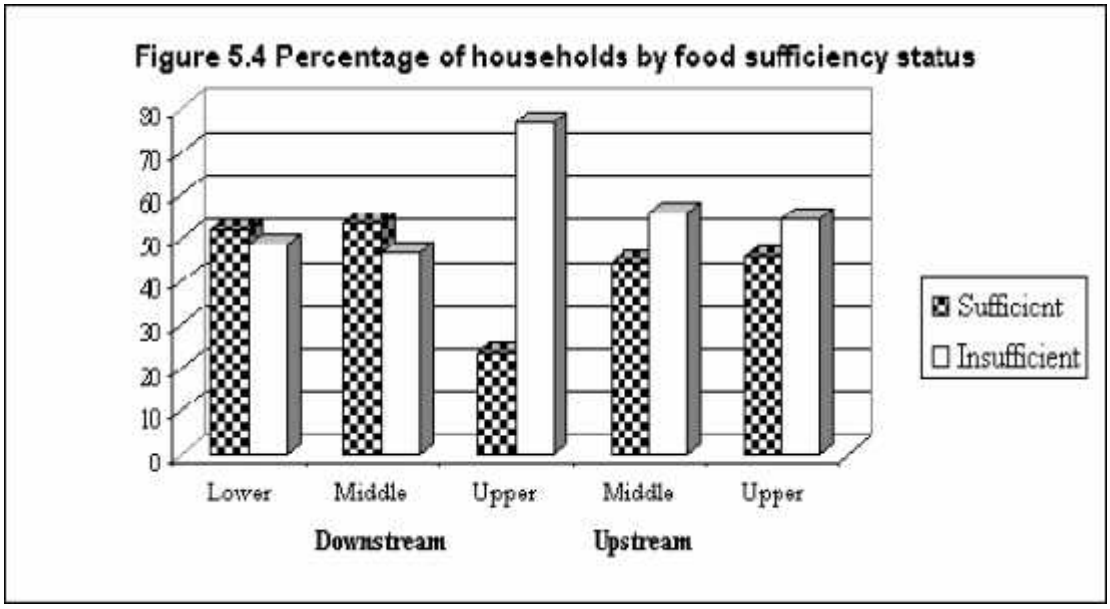
d) Food security

Table 5.7 shows the food sufficiency status of the households in the Modi Khola watershed. Fifty-six percent of the total households do not have sufficient production to meet their annual food requirements. Only 44 percent of the households produce enough foods. The proportion of households having sufficient food is high in the downstream sub-region as compared to that of the upstream sub-region. The proportion of households with sufficient food production is low in the higher altitudinal parts. The proportion of the households with food sufficiency is the lowest in the upper zone of the downstream sub-region. It is mainly due to low productivity as well as low intensity of crops.

Table 5.7 Number and percentage of household by food sufficiency status

	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
Status	No	%	No	%	No	%	No	%	No	%	No	%
Sufficient	31	51.7	32	53.3	14	23.3	40	44.4	41	45.6	158	43.9
Insufficient	29	48.3	28	46.7	46	76.7	50	55.6	49	54.4	202	56.1
Total	60	100.0	60	100.0	60	100.0	90	100.0	90	100.0	360	100.0

Source: Field survey, 2002/03



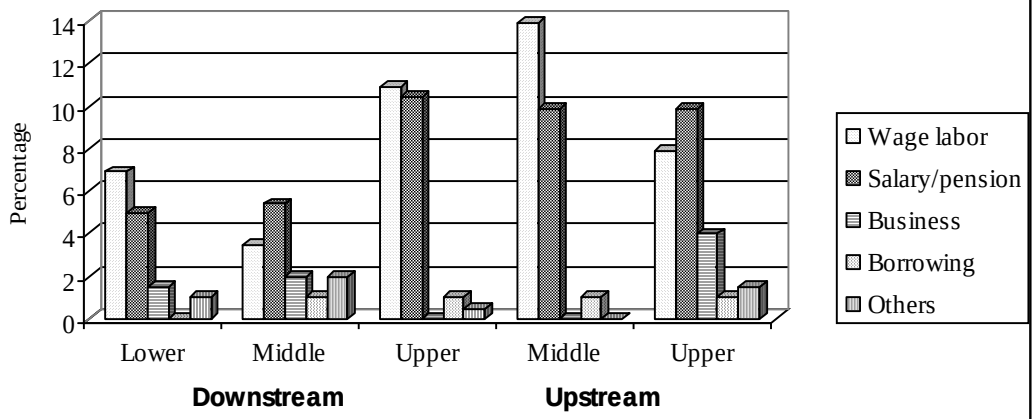
The local people adapt a number of food deficit management practices in order to meet food deficiency (Table 5.8). The households either manage their food deficiency through purchase of food items in local markets using earned income or borrowing of food items as well as use of wage receiving directly in terms of food items. Forty-three percent of the total food deficit households manage their deficit requirements through wage labour either by purchasing food items in the local markets or receiving crops as wage and 40.6 percent use their income from salaries and pension to purchase food items. The proportion of households using business as a source for food deficit management is 7.4 percent followed by borrowing from others (4 percent). Some of the locals borrow grains and repay after harvesting next crops and some borrow cash on interest. And rest of the households uses other techniques and sources (exchange to other goods etc.) for their food deficit management. The proportion of households using wage labor as source of food deficit management is high (13.9 percent) in the middle zone of the upstream sub-region as compared to the others. Likewise the contribution of salary and pension to household food deficit management is high in the upper zone of the downstream sub-region. And proportion of household using business, as source of food deficit management is comparatively high in the upper zone of the upstream sub-region. In this zone a significant proportion of the household is involved in tourism and related business.

Table 5.8 Food deficit management practices

	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
Practices	No	%	No	%	No	%	No	%	No	%	No	%
Wage labor	14	6.9	7	3.5	22	10.9	28	13.9	16	7.9	87	43.1
Salary/pension	10	5.0	11	5.4	21	10.4	20	9.9	20	9.9	82	40.6
Business	3	1.5	4	2.0	0	0.0		0.0	8	4.0	15	7.4
Borrowing	0	0.0	2	1.0	2	1.0	2	1.0	2	1.0	8	4.0
Others	2	1.0	4	2.0	1	0.5	0	0	3	1.5	10	5.0
Total	27	14.4	24	13.9	45	22.8	50	24.8	46	24.3	192	100.0

Source: Field survey, 2002/03

Figure: 5.5 Food deficit management practices



5.1.2 Livestock raising

Livestock farming is one of the means of sustaining livelihoods and food security in the study area. Farmers of this area raise livestock along with crop production. But its contribution to livelihoods is not so high as that of agriculture. The contribution of livestock in the total household income is only about 2 percent. The contribution of livestock to household income was high in the past particularly in the upper parts of the area. Due to development of tourism activities in this area agriculture-livestock based economy is transformed to tourism-agriculture based economy. Still people raise some livestock either as stall-feeding or as grazing animals. Cattle, buffaloes, goat/sheep and horse/mule are the common animals raised by the farmers. Poultry

birds are also kept in the house. The number of livestock by types and zone is given in Table 5.9

Table 5.9 Number of livestock by types and zone

	Downstream						Upstream					
	Lower		Middle		Upper		Middle		Upper			
Types	Total	Avg	Total	Avg	Total	Avg	Total	Avg	Total	Avg	Total	Avg
Cattle	92	1.5	63	1.1	87	1.5	99	1.1	120	1.3	461	1.3
Buffalo	73	1.2	99	1.7	96	1.6	219	2.4	234	2.6	721	2.0
Goat/sheep	47	0.8	76	1.3	160	1.7	152	1.7	184	2.0	619	1.7
Horse	0	0.0	0	0.0	0	0.0	13	0.1	0	0.0	13	0.0
Total animal	212	3.5	238	4.1	343	5.8	483	5.33	583	5.9	1814	5.0
Chicken	326	5.4	70	1.2	114	1.9	234	2.6	268	3.0	1012	2.9
Total	**538**	**9.0**	**308**	**5.1**	**457**	**7.6**	**717**	**8.0**	**806**	**9.0**	**2826**	**7.9**

Source: Field survey, 2002/03

As the above table shows the total number of livestock raised by the sample household is 2,826 heads (1,814 animal and 1,012 chicken). An average number of livestock including chicken per household is 7.9 (5 animals and 2.9 chicken). Buffalo is the most common animal followed by goat/sheep and cattle in this area. On an average 2 buffaloes, 1.7 goat/sheep, and 1.3 cattle are raised in one household. Among zones, the number of buffaloes and goat/sheep per household are high in upstream sub-region as compared to the downstream sub-region. The availability of extensive pasturelands is the main reason for high concentration of buffaloes and goat/sheep in this region. In the contrary the average number of cattle is high in the lower zone of the downstream sub-region. The figure of the cattle per household is 1.5 heads in this zone. Raising cow is considered to be a very important activity for religious purpose particularly for Barhmin and Chhetries as they use cow dung and urine for different religious ceremonies and this zone is dominated by these castes.

The number of chicken per household is 2.9. Among zones the number of chicken per household is high in the lower zone of the downstream sub-region followed by the upper and middle zones of the upstream sub-region. Mule/Horse is limited in the upstream sub-region and mostly used for transporting merchandise goods.

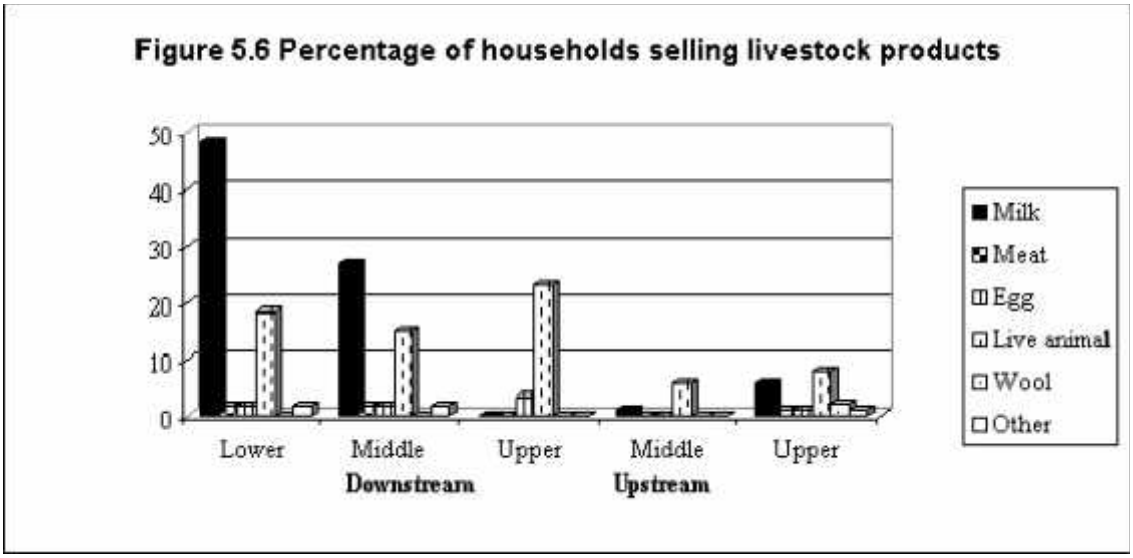
Livestock product is one of the sources of the household income. Milk, meat, wool, live animal and eggs are the main livestock products, which are used for both

household consumption and for sale to supplement household income. The proportion of households selling different livestock products is shown in Table 5.10 (Figure 6.)

Table 5.10 Percentage of households selling livestock products

Products	Downstream			Upstream		Total
	Lower	Middle	Upper	Middle	Upper	
Milk	48.3	26.7	0.0	1.1	5.6	14.2
Meat	1.7	1.7	0.0	0.0	1.1	0.8
Egg	1.7	1.7	3.3	0.0	1.1	1.4
Live animal	18.3	15.0	23.3	5.6	7.8	12.8
Wool	0.0	0.0	0.0	0.0	2.2	0.6
Other	1.7	1.7	0.0	0.0	1.1	0.8

Source: Field survey, 202/03



Out of the total, 14.2 percent households sell milk and 12.8 percent sell live animals. The distribution of households selling these products varies by sub-regions and zones. The proportion of households selling milk is highest (48.3 percent) in the lower zone of the downstream sub-region followed by middle zone (26.7 percent) of the same sub-region. District headquarters is located in close proximity of this sub-region where the demand for milk is high.

The production of milk in the upper zone of the downstream is limited and no market is in close proximity to this zone. As a result the households consume milk what they produce. But the proportion of households selling live animal is 23.3 percent in this zone. It is 18.3 percent in the lower zone and 15.0 percent in the middle zone.

Table 5.11 shows the average sale of livestock products of households by sub-region and zones. On an average a household received Rs 1,427 from livestock products for the year 2001. Among livestock products live animal sale shares 84.1 percent of the total income from livestock. Milk ranks second sharing 11.8 percent of the livestock income. The share of other livestock products such as wool, meat, and egg constitutes only 4.1 percent. The average income per household from livestock product is comparatively high in the middle (Rs 2,166) and upper zones (Rs 2,103) of the downstream sub-region. It is relatively very low (Rs 309) in the middle zone of the upstream sub-region. The income from milk sale is high in the lower zone of the downstream sub-region. A large milk market (district headquarters) is located within this zone. With the introduction of tourism related activities the raising of livestock has declined in the upstream sub-region. As a result the income from livestock has declined in this zone.

Table 5.11 Average sale of livestock products

Livestock products	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
	Rs	%	Rs	%	Rs	%	Rs	%	Rs	%	Rs	%
Milk	556	27.9	212	9.8	0	0.0	89	22.3	74	6.5	168	11.8
Live animal	1383	69.5	1868	86.3	2084	99.1	309	77.6	933	81.9	1200	84.1
Other	50	2.5	86	4.0	18	0.9	0	0.0	132	11.6	59	4.1
Total	1989	100.0	2166	100.0	2103	100.0	398	99.9	1139	100.0	1427	100.0

Source: Field survey, 202/03

Stall feeding and grazing are two practices commonly used by local people for raising livestock. Transhumance is also practiced particularly in the upper parts. It has a long history in this region. As reported, local people adopted this activity from the time of their settlement in this area. It is one of the income sources and means of livelihood for some of the local people particularly in the upper zone of the upstream sub-region. In the past, the economic importance of this activity was high. But in recent years its importance has declined. The development of alternative sources of income like tourism and remittances has negative impact on this activity. Besides, the decrease of demand for livestock products (woollen) also negatively impacted.

In the past there used to be several herds (*goth*) of different animals mainly sheep and goat buffalo and cattle in the upper parts of the study area. But at present, as reported

there are altogether six herds (*goth*) of sheep and goat (three each in Ghandruk and Chhomrong) in the whole watershed. Both the number of herds and number of animal per herd has declined. At present the number of animals in the herd ranges from 300 to 400 while it ranged 500 to 700 in the past.

The movement of herds for grazing depends on season. The herdsmen move along with their herds for grazing ups and down the valley. There are many pastures used by people of different localities and the grazing routes vary accordingly. In the past there were strict rules regarding the movement of grazing animals. But recently no such rules are followed. There is no pressure on pasturelands due to the decline in the number of herds as well as number of grazing animals.

The transhumance activity has greater implications in local livelihoods. Both herd owner and non-owner households are benefited from pastoral activity. Herd owners directly benefited from getting livestock products like milk, ghee, wool, meat, live animals and manure from their flocks. Non-owner households are also benefited from getting manure from these flocks during their movement. Usually, local people install herds requesting herdsmen in their agricultural fields for manure to increase agricultural productivity. And some are benefited by getting employment in this activity. As reported, generally 4-5 persons are needed to manage a herd of 300 to 400 goats and sheep in this area.

5.1.3 Tourism

Tourism is one of the main sources of income of local economy. It contributes about 10.5 percent to the total annual household income. In terms of share it ranks fourth. Out of total surveyed households, 7.5 percent received some income from this activity last year (Table 5.12).

Table 5.12 Household's involvement in tourism activities

Involvement	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
	No	%	No	%	No	%	No	%	No	%	No	%
Involved	1	1.7	1	1.7	0	0	3	3.3	22	24.4	27	7.5
Not involved	59	98.3	59	98.3	60	100	87	96.7	68	75.6	333	92.5
Total	60	100.0	60	100.0	60	100.0	90	100.0	90	100.0	360	100.0

Source: Field survey 2002/03

Tourism activity is flowrished especially in the upper parts of the watershed. The proportion of households involved in tourism activity is high in the upper zone of the upstream sub-region (24.4 percent) as compared to the others. And none of the households in the upper zone in the downstream sub-region were involved in tourism activities.

The Modi watershed, which extends from sub-tropical river valleys about 500 meters to the Annapurna ranges above 8,000 meters, possesses excellence of all the attractions of the mountain environments for tourists. The diverse natural and cultural landscapes are tourist resources themselves (Sharma, 2000:350). Along with rich natural scenery, white glittering mountains with a number of rapids and falls and hot springs in Jhinudada are equally important which please the tourists. In combination of these sceneries, except in the higher Himalayan parts, climate is agreeable with mild winter and pleasant summer. Except for the months of July and August rainfall and sunshine are not distressing. The average wind speed ranges between 2.74 km/hrs in December to 5.4 km/hrs in June (Poudel, 1996; East Consult, 1998). Clusters of Gurung's settlements, and traditional costume are other assets attracting tourists. Easy accessibility from Pokhara after opening of Pokhara-Baglung Highway, renovation of bridges and trails, and establishments of different tourism activities like hotel/lodges, restaurants and tea stalls have acted as catalyst factors to draw more trekkers to this area and develop mountain tourism in this area.

a) Trends

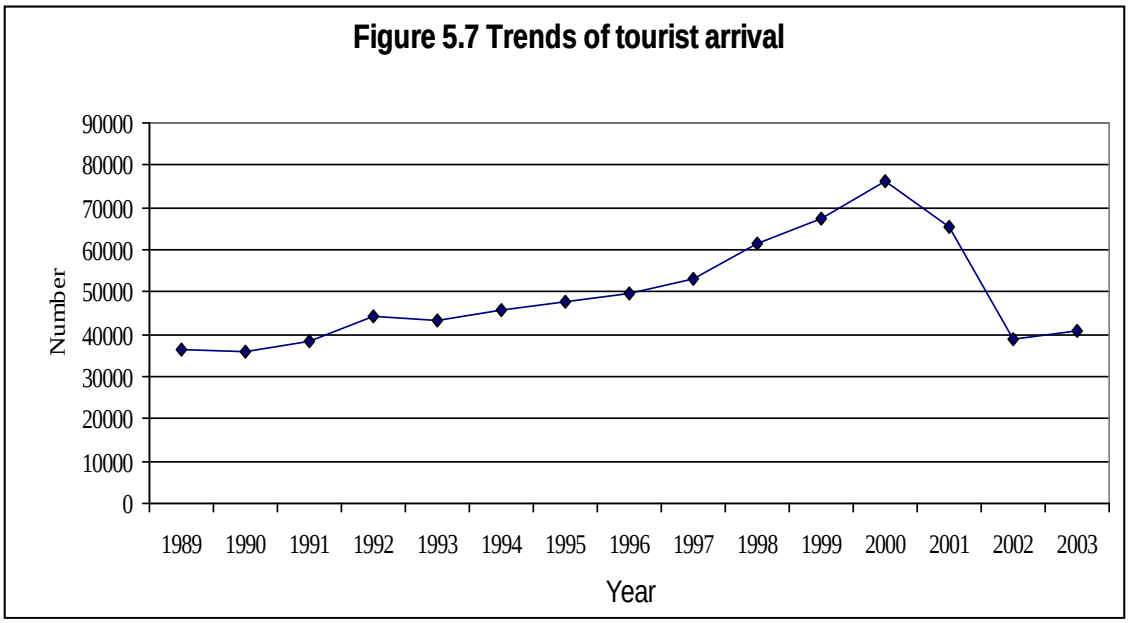
Tourism is a flourishing economic activity and one of the sources of livelihoods for the local people of the Modi watershed. Tourism activity is flourished basically in the upper parts of the area due to availability of number of different assets mentioned above. One of the most popular tourist destinations of Nepal, the Annupurna sanctuary, which is located within the Modi Khola watershed, is a part of Annapurna Conservation Area. A large number of tourists visit this area every year, however, the exact data on tourist arrival for the watershed are not available. Therefore, the data for Annapurna Conservation Area have been used for trend analysis. The trend of tourist visiting this area during the period of 1989 to 2003 is shown in Table 5.13 (Figure 5.7).

Table 5.13 Trends of tourist visiting Annapurna Conservation Area

Year	Number of tourist visited	Increase (number)	Percentage increase
1989	36594	-	-
1990	35811	-783	-2.14
1991	38513	2,702	7.55
1992	44453	5,940	15.42
1993	43140	-1,313	-2.95
1994	45723	2,583	5.99
1995	47584	1,861	4.07
1996	49887	2,303	4.84
1997	53183	3,296	6.61
1998	61715	8,532	16.04
1999	67485	5,770	9.35
2000	76407	8,992	13.22
2001	65313	-11,094	-14.52
2002	38642	-26,671	-40.84
2003	40668	2,026	5.24

Source: ACAP Office, Ghandruk, 2002.

Though there is a fluctuation in the number of tourists visiting this area during the period of last 15 years, the general trend is increasing up to 2000 AD with some exception. The number of tourists declined in 1990 and 1993. The number of tourists who visited this area was 36,594 in 1989, which declined to 3,5811 (-2.14 percent) in 1990. One of the reasons for such a decline in the number of tourists in 1990 might be the impact of popular movement for the restoration of democracy in the country during that period. In the year 2000 the number of tourists reached 76,407 and it declined to 65,313 (14.52 percent) in 2001 and 38,642 (40.84 percent) in 2002. One of the main reasons for the decline in number of tourists after 2000 is due to the bad security situation of the country as caused by Maoist activities. The number of tourists slightly increased in the year 2003 as compared to the situation of the previous year. The increase was by 5.24 percent.



b) Tourism infrastructures

Tourism infrastructures are different facilities directly related to the service provision for tourists. These include roads and trails; tourist check posts/information centers, security and health facilities, hotels and restaurants etc. The network of motorable roads and trails is shown in Chapter 3 Figure 3.11. The Pokhara-Baglung highway provides easy access to Modi Khola watershed. Besides, there are other road connections such as Kusma-Halhale and Dobilla-Phalebas fair-weather roads, which connect the district headquarters, Kusma bazaar with the northern and southern areas respectively. The road facilities lie entirely in the downstream sub-region. The upper parts have foot trails only. The physical condition of foot trail is good except in Komrong Khola area. During the survey for the present study the foot trail in this area were heavily destroyed due to landslide. And most of the foot trails in the upstream sub-region looked dirty and smelt bad, as they were full of horse/mule dungs scattered everywhere.

Health and security play significant role in tourism. There are altogether 28 health institutions (1 hospital, 5 health posts, 22 sub-health posts) providing different health facilities in the study area. Hospital is located in Kusma bazar, the district headquarters of Parbat and 3 sub health posts are located in the upstream parts.

General medical facilities are available in these centers. There are two tourist checkpoints (Birethanti and Chhomrong) within the study area and another checkpoint is located at Dhampus area. These check points provide information for tourist on various aspects.

The provision of good and sufficient hotel/lodges is one of the main infrastructures, which play a significant role in the development of tourism activities. There are a number of hotels and lodges along the main trekking routes to Annapurna sanctuary and Pun hill (way to Mustang area). The number of hotels/lodges their bed capacities in the upper parts of the Modi Khola watershed as registered in the ACAP is given in the Table 5.14

Table 5.14 Number of hotels and lodges and their bed capacities

Routes and places	Number of hotels	Number of beds
Gnandruk Bensi including Jhinudanda and Yumle	23	262
Ghandruk	16	229
Komrongdanda, Chuile, Ghurjung, and Komrong Khola	15	122
Chhomrong Dhaulo	14	283
Sinwa to Base camp	26	334
Bhaisakharka, Tadapani, Banthanti and Ghandruk Deurali	17	192
Landruk including Seuli	16	206
Tolka, Bherikharka, Pitamdeurali, Pothana, Australian base camp and Chandrakot	29	367
Lamakhet, and Birethanti to Tikhedhunga	26	379
Uleri, Banthanti and Nangethanti	12	90
Ghorepani	21	266
Total	215	2720

Source: Field survey, 2002/03

There are altogether 215 hotels/lodges with 2,720 beds. Besides, there are a number of hotels and lodges along the Pokhara-Baglung highway and Kusma bazaar. More than a dozen hotels and lodges in Kusma bazaar providing accommodation facilities to both internal and international tourists. About 40 stalls with some bed and food provision providing facilities for internal tourists. There is no record of tourist visiting this area due to lack of tourist check-post in this route. More than 700 persons are employed in these hotels and lodges.

c) Impacts on livelihoods

Tourism is one of the main sources of income and field of employment of the people particularly in the upstream sub-region of the study area. It can also have multiplier effects on the economy and create backward and forward linkages in the production system (Sharma, 2000:350). A number of employment opportunities have emerged due to development of tourism. A large number of people of this region are involved directly or indirectly in tourism activities. The employment opportunities arising from tourism include hotels and lodges, shopkeepers, handicraft workers, carpenters, trekking and travel agents, NGO staffs working in various tourism related projects, guides and sirdars, cooks and porters.

The socio-cultural impacts of tourism are clearly seen in the lifestyle of local people as a result of direct or indirect association with tourist and tourism related activities. The norms and behavior and patterns of consumption of tourist can have a direct impact on society, particularly among the young. These impacts may result in the decline of local cultural practices and institutions, commercialization of arts, loss of symbolism from cultural events, theft of cultural and religious objects and artifacts and thriving black market (Sharma, 2000: 363). The society of the upper parts of the Modi Khola area is becoming more commercialized and materialistic. Strict cultural practices are becoming more liberal and being replaced by modern developments. As for example, cultural songs and dances like *sorathi, teej, krishna charitra* and *ghatu* are being replaced by modern pop music and filmy songs. *Rodi*, a popular youth association of Gurung is becoming less attractive and in some communities virtually non-existent. It can be clearly seen that changes have taken place in the behavioral patterns of local people particularly the youths. Increasing use of English language, changes in dressing pattern especially of youth and food habits are common examples. Majority of entrepreneurs engaged in tourism business speak English. Youths have completely abandoned their traditional dress. A complete set of traditional dress for male includes *bhoto, kachhad*, belt, Nepali cap, and *bhangra* (used as bag and worn around back). They put *khukuri* in the waist and gold ring in the finger. Traditional female's dress includes blouse, sari (black cotton), *patuka* (belt of cotton cloth), *majetro* (shawl), *ghalek* (hung in shoulder), and *tikese* (a flap around heap). Females wear ornaments made of gold and silver. Now their traditional dresses of young males and females have been replaced by modern dresses like shirts, Jeans

pants, hats, *kurta* and *salwar*, and imported shoes (both leather and sport shoes). Traditional *bakhu, bhangra, ghalek* and *tikese* are virtually non-existent among the youths. Regarding food habits, local people mostly use biscuits, cakes and loafs, eggs, porridge, and noodles instead of traditional food items made in their own houses such as popcorn, bread (made by maize, millet and buckwheat) etc. for breakfast. *Dhido* a food item of the majority of the local people has been replaced by imported rice. Instead of local liquor, imported drinks (both soft and hard), tea and coffee are common. Another important impact of tourism clearly visible in the local community is improvement in health and sanitation. Majority of the local people use toilets. The settlements look clean. Almost all-household use piped water. However, garbage from camping sites and hotels/lodges is creating problem and is polluting local water sources.

The local economy of the study area particularly of the upper parts is greatly conditioned by tourism. Traditional subsistence hill farming with agro-pastoral activities of the locals has diverted to economic activities directly related to tourism business. The operation of hotels and lodges, shops, guiding and portering, and construction works are the main employment opportunities opened by the development of tourism in the Modi Khola area. The hotels and lodges provide employments to 518 persons (Table 5.13). In addition, a remarkable number of stalls (having facilities with tea and snacks) along different tourist routes provide employment to a number of people. Employment in construction sector has also increased. A number of hotels and lodges are being constructed along the tourist routes have provided employment to local people.

Tourist expenditures are the sources of gross income to the lodges and local communities. Tourist expenditures consist of expenditures made by visitors on accommodation, food and drinks, payments to porters, payments for entertainment, purchase of gift items (handicrafts), and the conservation area fee. According to Banskota and Sharma (1997) an average free individual trekker (FIT) and group trekker (GT) spend Rs 4,280 and 7,635 respectively during their entire stay in Annapurna region. Considering the number of tourists visiting this area and the amount of money spent by the tourist, its contribution to the local livelihoods is remarkable.

Traditional architecture and aesthetics of the villages are being gradually replaced by modern cement and concrete structures. Newly constructed houses especially along the tourist routes have replaced traditional design and architectures. Construction materials have also been changed. The use of cement and iron rod is increasing in spite of local construction materials.

Tourism also brought some changes on land use pattern of the local area. The conversion of agricultural lands to camping grounds, construction of new buildings for hotel/lodges can be seen throughout the upper parts of the study area. The intensity of change is high in main settlements along the tourist routes especially in Ghandruk, Chhomrong, Landruk, Tarapani, Uleri and Ghorepani area. Cropping pattern and seasonality have also been changed. Locals grow both seasonal and off-season vegetables, which they sell to local hotels and restaurants. Cabbage, cauliflower, radish, peas, garlic are the main vegetables grown in this area.

5.1.4 Migration

Migration is another livelihood strategies adapted by local people of the study area for their livelihood security. The people of this area temporarily migrate to different places outside their own village in search of employment. The population working outside villages is grouped into three categories i) people working outside VDC within the district ii) people working outside district within the country and iii) people working outside Nepal. Out of 2,330 surveyed population 352 persons are migrated. This figure constitutes 28 percent of the total employed population (Table 5.15).

Table 5.15 Number of people working outside village

	Downstream						Upstream					
	Lower		Middle		Upper		Middle		Upper		Total	
Working place	No	%	No	%	No	%	No	%	No	%	No	%
Outside VDC within district	21	9.3	4	1.7	2	1.0	7	2.2	43	13.7	77	6.1
Outside district within country	41	18.2	25	10.8	6	3.1	19	6.1	15	4.8	106	8.4
Other countries	27	12.0	24	10.3	31	16.1	43	13.8	44	14.0	169	13.5
Total	**89**	**39.6**	**53**	**22.8**	**39**	**20.2**	**69**	**22.1**	**102**	**32.5**	**352**	**28.0**
Employed pop[n]	225	100.0	232	100.0	193	100.0	312	100.0	314	100.0	1256	100.0

Source: Field survey, 2002/03

Of the migrants nearly half are migrated to foreign countries. The proportion of population working outside VDC but within country is one-sixth of the employed population. Rest of the population working outside village constitutes 8.4 percent of the employed population. The amount of remittances sent by them is remarkable. Its share in the total household income for surveyed household is more than 31 percent as compared to over 25 percent of the total national income as reported by Adhikari (2001). The proportion of people working outside their own VDC differs by sub-region and zones. The proportion of population working outside is high in the lower zone of the downstream sub-region as compared to others. About 40 percent of the employed population of this zone is working outside VDC. Out of these 12 percent are working abroad and 18.2 percent within country outside district. The proportion of population working in other countries is slightly high in the upper zone of the upstream sub-region. Gurung communities dominate this region and are mostly employed in the British and Indian army. The proportion of population working outside VDC within district is also high in this zone. A large number of people from this zone are migrated to Pokhara for business and other purposes.

5.1.5 Business

Business is one of the strategies adopted by local people for their livelihood security. The proportion of population age of 10 years and above involved in business activities is 2.8 percent (Table 5.1). The involvement of houserhold in business activities by zones and sub-region is given in Table 5.16. Nearly 11 percent of the surveyed households are involved in business activities in the study area. The proportion of households involved in business is high in the lower zone (20.0 percent) and low in the upper zone 91.7 percent) of the downstream sub-region as compared to the others.

Table 5.16 Households involved in business activities

Involvement	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
	No	%	No	%	No	%	No	%	No	%	No	%
Involved	12	20.0	8	13.3	1	1.7	5	5.6	13	14.4	39	10.8
Not involved	48	80.0	52	86.7	59	98.3	85	94.4	77	85.6	333	89.2
Total	60	100.0	60	100.0	60	100.0	90	100.0	90	100.0	360	100.0

Source: Field survey 2002/03

There are a number of shops along the trekking routes to Annapurna and Ghodepani and the market centers along the Pokhara-Baglung highways. These shops provide both wholesale and retailing services of varieties of goods such as groceries, cloths, medicine, hardware and others. Besides, there are a number of personal services such as hair cutting saloon, beauty parlor, tailoring, shoe making and a number of repairing workshops in this area providing specialized services to the local people. Many locals and outsiders are involved in these activities. The contribution of business to household income is 8.1 percent (Table 5.20).

5.1.6 Wage labor

Wage labor is another option adopted for livelihood security especially by poor people. A total of 1.6 percent population of 10 years and above are involved in this sector (Table 5.1) and its contribution to average household income is 4.4 percent (Table 5. 20). The people are involved in varieties of works for wage labor such as agricultural works, porter, construction (woodwork and brickwork) and other activities. The households receiving income from wage labour is given in Table 5.17. The households involved in hired labour for livelihood is high in the upstream sub-region (32.8 percent) as compared to the case of the downstream sub-region (21.7 percent). The involvement of households in hired labour is the highest in the middle zone of the upstream sub-region (40 percent) among all the zones.

Table 5.17 Households receiving income from wage labour

Involvement	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
	No	%	No	%	No	%	No	%	No	%	No	%
Involved	8	13.3	8	13.3	23	38.3	36	40.0	23	25.6	98	27.2
Not involved	52	86.7	52	86.7	37	61.7	54	60.0	67	74.4	262	72.8
Total	60	100.0	60	100.0	60	100.0	90	100.0	90	100.0	360	100.0

Source: Field survey, 2002/03

Labor market for agricultural works is available throughout the study area during the agricultural season, while portering is highly flourished in the upstream sub-region with tourism activities, as it does not have road link. The transportation of different materials including tourists' loggages solely depends on people's back. The level of wage differs by types of labor work. The wage of porter carrying goods of the tourist

is higher as compared to other porter. It ranges from Rs150 to 250 per day per person for portering of the loggages of tourist. Porter charge for carrying merchandise and other construction materials depends on distance and weight of goods carrying.

5.1.7 Collection of forest products

The collection of forest products is also an activity that local people use for livelihoods. Local people collect a number of forest products such as firewood, leaf and litter, timber, fruits and herbs. They collect firewood from the forest to fulfill their own household requirements and some are involved for selling. Leaf and litter is used for bedding of livestock and also for manure. Almost all households of the study area collect leaf and litter from the local forest. Fruit is another important forest product that is collected by local people. The fruits collected from forest include *kaphal, katus, jamunu, amala, chiuri,* and *chutro.* Some of the local people collect these fruits for sale. Local people collect timber from forest for building materials and for making furniture. Besides, they also collect mushrooms and different types of herbs. Almost all households collect forest products for household requirement but very few households (1.4 percent) earn cash income by saling forest products (Table 5.18).

Table 5.18 Involvement of households in forest product collection for sale

Involvement	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
	No	%	No	%	No	%	No	%	No	%	No	%
Involved	1	1.7	0	0	2	3.3	1	1.1	1	1.1	5	1.4
Not involved	59	98.3	60	100.0	58	96.7	89	98.9	89	98.9	355	98.6
Total	60	100.0	60	100.0	60	100.0	90	100.0	90	100.0	360	100.0

Source: Field survey 2002/03

The proportion of households involved in selling forest products is relatively high in the upper zone (3.3) of the downstream sub-region as compared to others. The main selling intems include firewood; vegetables like *tusa, niguro,* fruits like *kafal, katus* and herbs.

5.1.8 Industrial activities

The industrial activities in this area are limited. However, a number of cottage industries such as watermills, weaving and sewing, paper, bamboo, and metal products, woodcarving and furniture, brewing and others exist in this area. The contribution of industrial sector to household income and employment is negligible. Its contribution to total household income is only 0.1 percent. However, local industrial products are quite important for household purpose. Some of the households are involved partially or fully in different industrial activities for household consumption or for income generation. Major industrial activities of this area are as follows.

a) Milling

Among different industries operated in this area the contribution of water mill is remarkable in the local livelihoods. People use watermills for grinding cereals from time immemorial as a cheap and convenient means of food processing. Mill operation is seasonal, with peaks in processing during festival and harvest times. There are altogether 55 watermills in operation and are distributed across the watershed (Table 5.19). The distribution of watermills is uneven and mostly concentrated in the upstream sub-region. Out of the total 55 watermills, 93 percent (51) are located in this region with excessive concentration of 39 mills in the middle zone (1000-2000 m) of this sub-region. The concentration of watermills in the upstream parts is largely due to favorable water flows in the local tributaries, common practice of growing millet, wheat and maize requiring grinding and test preference of local people. As reported the local people prefer test of flour that is grinded in watermills. There are only 4 watermills in the downstream sub-region. In this part there are some mills operated with other sources of energy such as diesel and electricity.

Table 5.19 Number of watermill, household benefited and income per rmill

Description	Downstream			Upstream		Total
	Lower	Middle	Upper	Middle	Upper	
Watermill	2	2	0	39	12	55
HH benefited	200	200	0	1600	500	2500
Income per mill (NRs)	2000	1800	0	1500	1500	1500

Source: Field survey, 2002/03

The number of households benefited from watermills is estimated to be 2,500. Out of the total households benefited, 84 percent lies in the upstream sub-region. The average monthly income per water mill in the watershed is estimated to be Rs 1500. The average income from mill varies by sub-region and zones. The average income per watermills is high in the lower zone as compared to others. One obvious reason is that the mills operated in the lower zone run throughout the year with relatively large number of mill users.

b) Weaving and sewing

The involvement of people in weaving and sewing activity for commercial purpose is limited but its importance in local livelihood is significant. Local people make woollen materials such as *bakhu, radi* and others from sheep and goat wool using locally developed processing technique and handlooms. The use of *radi* is extensive. *Bakhu* is used by elder people and herdsmen to protect themselves from cold and drizzle. The production of woolen materials is limited to the upper parts mostly in communities like Ghandruk, Chhomrong, Melache, and Landruk. About 5 percent of the households reported that some of their household members are involved partially in weaving activity. Along with woolen materials they also weave *bhangra* and other clothes. *Bhangra* is the sign of Gurung community that they put around back and use as bag to put some thing during their work. Mostly females are involved in weaving these *Bhangra* cloths. Some people (especially Damai) are involved in sewing activities. It is their traditional occupation and means of livelihoods. They sew clothes of other people on yearly contract basis or rent. In market areas there are some people involved in tailoring.

c) Bamboo and metal products

Local people produce a number of bamboo goods and use both for household consumption and for sale. The major bamboo products include *bhakari, chitra, doko, thunche* and others. Local people use *chitra* to make shades for livestock, *bhakari* for storing grains and *doko* and *thunche* use as transporting vessels. Many other bamboo materials such as *dalo, nanglo, damlo* etc. are produced and used for different household purposes. The use of bamboo products is common throughout the study area. Mostly poor people having skill are involved in this activity. It is one of the

income sources and means of their livelihoods especially of poor. And some produce these items for household consumption during leisure time.

Local people use a number of metal products produced locally for their agricultural and household use. These include *kuto, kodalo, hasiya, khukuri, bancharo* and others. It is the traditional occupation of the blacksmiths. They are involved in the production as well as repairing of these materials. For this, they receive cash and kind from the costumers. There are some workshops making grill and shutters particularly in the Kusma area.

d) Woodcarving and furniture

In terms of employment and source of income the share of woodcarving and furniture industry is very limited. Out of total 360 sample households, only 11 households (3.1 percent) are involved in woodcarving and furniture making activities in this area. As watermills, some woodcarving works are operated with the help of water flow. Local *chadharoes* make wooden materials such as *theki, batta, chautho, harpe* and *tongbapot* for household use. They produce these materials either on order or for sale. Furniture industries are mostly concentrated in Kusma and other market areas.

e) Brewing

The production of liquor (brewing) is another activity performed by the local people. About 40 percent (143 households) of the total surveyed households are involved in this activity. Most of the Gurung and Magar and some other caste groups of the study area produce liquor (*jand* and *raksi*) in their house for household consumption and some of them sell these products in local markets. They prepare *jand* and *raksi* from different cereals such as millet, maize, wheat and others. They produce this from fruits also. The liquor- *jand* and *raksi* are considered as most essential components for hospitality of guests as well as for different religious ceremonies especially of Gurung and Magar communities.

5.1.9 Fishing

Fishing is also a source of livelihood for some people. The details of this activity are elaborated in Chapter six.

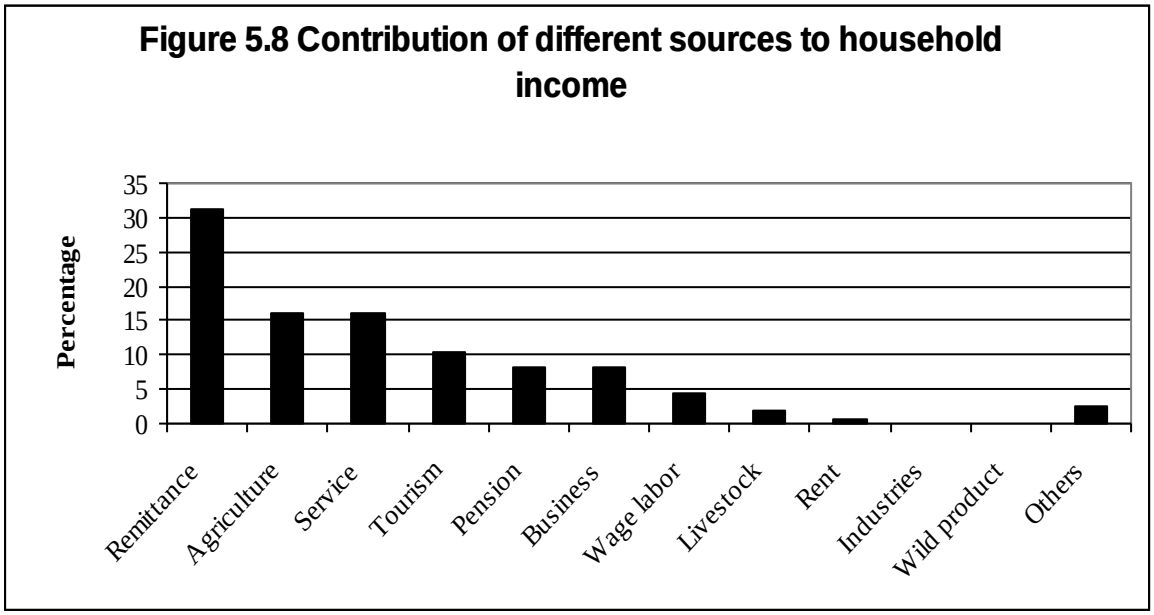
5.2 Income and expenditure pattern

There are a number of sources of household income of the local people. The major ones include income from agriculture, service in governmental and non-governmental organization, tourism, income from pension and remittances, rental income, business, and wage labor. As in other areas, the contribution of these sources to household income is not uniform across households and localities. Per household annual average income from different sources for the surveyed household is given in Table 5.20.

Table 5.20 Contribution of different sources to household income (NRs)

Income sources	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
	Rs	%	Rs	%	Rs	%	Rs	%	Rs	%	Rs	%
Remittance	24113	16.1	21267	15.1	64375	59.5	34167	37.0	55378	34.0	40679	31.2
Agriculture	32094	21.4	26678	19.0	20305	19.0	16872	18.0	13977	9.0	20892	16.0
Service	36605	24.4	58100	41.2	3177	2.9	10784	11.7	7631	4.7	20918	16.0
Tourism	667	0.4	60	0.0	0	0.0	5111	5.5	48989	30.1	13646	10.5
Pension	2410	1.6	3793	2.7	10973	10.1	10424	11.3	21404	13.1	10820	8.3
Business	31843	21.2	15717	11.1	250	0.2	1656	1.8	8700	5.3	10557	8.1
Wage labor	3512	2.3	2933	2.1	6342	5.9	10133	11.0	4540	2.8	5799	4.4
Livestock	5183	3.5	3145	2.2	1840	1.7	1571	1.7	1713	1.1	2516	1.9
Rent	3047	2.0	0	0.0	0	0.0	1222	1.3	0	0.0	813	0.6
Industries	633	0.4	0	0.0	0	0.0	28	0.0	239	0.1	172	0.1
Wild product	250	0.2	0	0.0	35	0.0	111	0.1	80	0.0	95	0.1
Others	9665	6.4	9332	6.6	867	0.8	216	0.2	329	0.2	3447	2.6
Total	150023	100.0	141025	100.0	108164	100.0	92295	100.0	162979	100.0	130354	100.0

Source: Field survey, 2002/03



The average total annual income of the surveyed household is Rs 130,354 and per capita income (family size 6.5 persons) Rs 20,054. Considering the per capita income of the hill region of Nepal for the year 2003/04 as reported in Nepal Living Standard Survey (Rs 19,823), the area shows slightly better condition. The average annual income of the household varies by sub-regions and zones. The upper zone of the upstream sub-region has the highest average household income (Rs 162,979) and the middle zone of the same sub-region has the lowest (Rs 92,295) average annual income. Remittance is the main source of household income in this area. The contribution of remittances to the total household income is 31.2 percent followed by agriculture including livestock (17.9 percent), service (16 percent), tourism (10.5 percent), and business (8.1 percent). The share of the other activities in the household income is 16.3 percent. The contribution of different sources to household income varies by sub-region and zones. The share of remittance is high in the upper zone of the downstream sub-region. Nearly 60 percent of the household income is contributed by remittances in this zone. The contribution of remittance to household income is 37 and 34 percent in the middle and upper zones of the upstream sub-region respectively. Service ranks first in the share of household income in the middle and lower zones of the downstream sub-region. The contribution of service to household income is 41.2 percent in the middle zone of the downstream sub-region while it is 24.4 percent in the lower zone. The share of tourism in household income is high in the upper zone of the upstream sub-region. Tourism shares 30.1 percent in household income in this zone. Agriculture ranks second in the share of household income except in the upper zone of the upstream sub-region.

Households of the study area are grouped into four categories on the basis of the number of sources of income- having only one to four and above sources. Average income of the households by number of sources is given in Table 5.21.

Table 5.21 Average yearly income of households by number of sources

Number of sources	Downstream			Upstream		Total
	Lower	Middle	Upper	Middle	Upper	
One	16650	16900	30550	12057	38033	22760
Two	107217	140200	80119	57703	155813	106014
Three	127334	162273	148240	113614	199150	149632
Four and above	436786	159233	183824	316471	159496	247293
Total	150023	141025	108164	92295	162979	130354

Source: Field survey, 2002/03

The average income of the household increases with the number of sources. The average income of the households having single source is only Rs 22,760 which raises to Rs 247,293 for four and more than four sources. The average yearly income of the household having two sources is nearly five times higher than the households having single source of the income. Among households having single source of income, the middle zone of the upstream sub-region has comparatively low level of income. The table also shows that the average household income increases with an increase in the number of income sources in all the zones except the middle one of the downstream sub-region and upper zone of the upstream sub-region. In these zones average household income having three sources is higher than the four and more than four sources of income.

A two-way Analysis of Variance (ANOVA) test is applied to test two sets of hypothesis i) whether there is significance difference in level of household income by zones and ii) whether there is significance difference of household income in terms number of sources of household income. The results of the ANOVA are given in table 5.22. The calculated variance ratio of the household income between zones is 0.44. The table value at df 1 = 4 and df 2 = 12 at 5% level of significance is 3.26. The calculated value is smaller than the table value. Thus, F statistic clearly shows that there is no significant difference in level of household income by zones. In the same time the calculated value between household income sources (8.65) is higher than table value (3.49) at df 1 = 3 and df 2 = 12 in 5% level of significance. This clearly shows that there is a significant difference between average incomes of the household by number of income sources. Household income significantly increases with increasing number of sources of household income. In other words, the more the sources of household income the higher the level of household income or vice versa.

Table 5.22 Results of F test of household income by number of income sources

Source of variation	Sum of squares	Degrees of Freedom (df)	Mean square	Variance Ratio
Between zones	SSC = 9154	C – 1 = 4	MSC = 2989	FC = 0.44
Between source	SSR = 132028	R – 1 = 3	SSR = 45009	FR = 8.65
Error	SSE = 62472	(C-1) (R – 1) = 12	MSE = 5206	-
Total	SST = 206654	N-1 = 19	-	-

Source: Based on table 5.20

On the basis of average annual income, households of the study area are grouped into six different income categories. The percentage of households by income categories and the sub-region and zone is given in Table 5.23.

Table 5.23 shows that out of the total households, 37.5 percent of the households earn more than Rs 100,000 annually while nearly 10 percent households earn less than Rs 20,000. A majority of the households (52 percent) earn in between Rs 10,000 to Rs 80,000 annually. The level of income varies by sub-region and zones. The proportion of households with more than Rs 100,000 annual income is high in the upper zone of the upstream sub-region as compared to the others. Fifty percent of the surveyed households in this zone earn more than Rs 100,000. The high level of household income in this part is largely due to tourism business in this zone. Similarly high proportion of households with this income level is also found in the lower and middle zones of the downstream sub-region sharing 40 to 45 percent households. Higher income for a large number of households in these zones is perhaps due to high agricultural production and high involvement in service activities. The middle zone of the upstream sub-region constitutes relatively small proportion (18.9 percent) of household with annual income above than Rs 100,000. The proportion of households with annual income of less than Rs 20,000 is high (16.7 percent) in the middle zone of the upstream sub-region as compared to the others.

Table 5.23 Percentage of households by annual income categories

	Downstream			Upstream		
Income (Rs)	Lower	Middle	Upper	Middle	Upper	Total
Below 20,000	8.3	8.3	5.0	16.7	13.3	9.7
20,000-40,000	13.3	8.3	31.7	22.2	6.7	16.9
40,000-60,000	8.3	21.7	20.0	22.2	12.2	16.1
60,000-80,000	13.3	16.7	11.7	14.4	8.9	12.8
80,000-100,000	11.7	5.0	5.0	5.6	8.9	6.9
Above 100,000	45.0	40.0	26.7	18.9	50.0	37.5
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Field survey, 2002/03

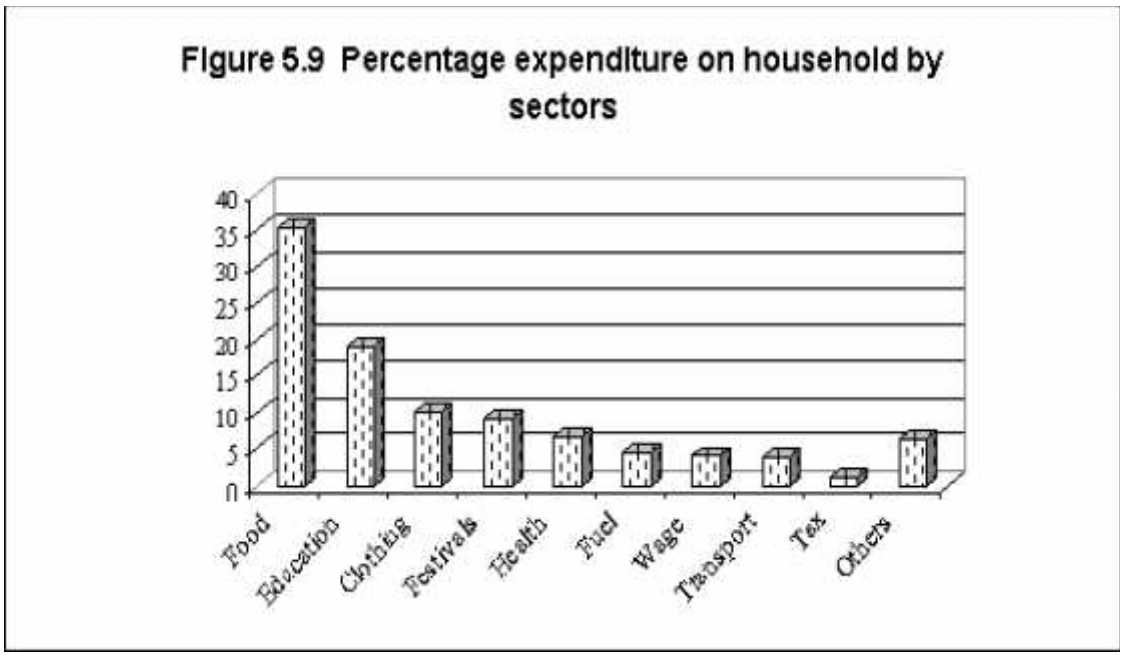
Local people spend their household incomes on different purposes. These include food, clothing, education, health, transportation and others. The respondents were asked to allocate their total annual expenditure on different sectors. Based on these responses the expenditure of household for different purpose is presented in Table 5.24. The average annual expenditure of household is Rs 56,506. The average annual

expenditure is high in the upper zone of the upstream sub-region and the lower zone of the downstream sub-region as compared to the other zones. In both the zones the average annual expenditure is more than Rs 70,000. The middle zones of both the sub-region show medium level of expenditure showing above Rs 50,000. The upper zone of the downstream sub-region shows the low level of annual expenditure as compared to the others. The expenditure on food constitutes 35.2 percent of the total household expenditure followed by education (19.1 percent), and clothing (10.2

Table 5.24 Average annual expenditure of the households

	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
Sector	Rs	%	Rs	%	Rs	%	Rs	%	Rs	%	Rs	%
Food	17898	25.3	16621	31.1	15602	51.0	21282	41.1	24901	35.0	19899	35.2
Education	17005	24.1	10315	19.3	4100	13.4	5799	11.2	16426	23.1	10793	19.1
Cloth	6574	9.3	5721	10.7	2758	9.0	6548	12.6	6364	8.9	5737	10.2
Festivals	5786	8.2	6294	11.8	4240	13.9	4806	9.3	5105	7.2	5198	9.2
Health	5991	8.5	4062	7.6	1447	4.7	4686	9.1	2646	3.7	3750	6.6
Fuel	3008	4.3	1811	3.4	964	3.1	2099	4.1	3930	5.5	2471	4.4
Wage	3027	4.3	2247	4.2	537	1.8	1376	2.7	3832	5.4	2271	4.0
Transport	2953	4.2	2565	4.8	807	2.6	1594	3.1	3032	4.3	2211	3.9
Tax	1067	1.5	544	1.0	134	0.4	328	0.6	893	1.3	596	1.1
Others	7295	10.3	3333	6.2	7	0.0	3228	6.2	4009	5.6	3582	6.3
Total	70603	100.0	53512	100.0	30594	100.0	51746	100.0	71138	100.0	56506	100

Source: Field survey, 2002/03



percent). A remarkable proportion of the household expenditure (9.2 percent) goes for the celebration of different festivals. Health sector constitutes 6.6 percent of the total household expenditure. Fuel, wage, tax and others constitute nearly 20 percent of the total household expenditure. The expenditure pattern of household distinctly varies by sub-regions and zones. In all the zones the expenditure on food is the highest as compared to the other items of the expenditures. The proportion of expenditure on food is the highest in the upper zone of the downstream sub-region. In this zone 51 percent of the total household expenditure goes on food. The proportion of expenditure on education is highest in the lower zone (24.1 percent) of the downstream sub-region followed by the upper zone (23.1 percent) of the upstream sub-region. The proportion of expenditure on cloth is the highest (12.6 percent) in the middle zone of the upstream sub-region. The proportion of expenditure on health is lowest in the upper zones of both the sub-regions as compared to others. Likewise the proportion of expenses on tax is highest in lower zone of the downstream sub-region and the upper zone of the upstream sub-region

On the basis of annual expenditure households are categoried into five groups viz. households having total annual expenditure less than Rs 10,000 to above Rs 100,000. The percentage of households by level of expenditure and zones is shown in Table 5.25.

Table 5.25 Percentage of households by amount of annual expenditure

	Downstream			Upstream		
Expenditure (Rs)	Lower	Middle	Upper	Middle	Upper	Total
Below 10,000	1.7	3.3	5.0	3.3	1.1	2.8
10,000 to 20,000	6.7	6.7	20.0	7.8	11.1	10.3
20,000 to 50,000	41.7	53.3	65.0	46.7	38.9	48.1
50,000 to 100,000	30.0	23.3	8.3	33.3	27.8	25.6
Above 100,000	20.0	13.3	1.7	8.9	21.1	13.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Field survey, 2002/03

There are altogether 2.8 percent households with annual expenditure of below Rs 10,000 and 13.3 percent with annual expenditure above Rs 100,000. The proportion of household with less than Rs 10,000 annual expenditure is high in the upper zone (5 percent) of the downstream sub-region and middle zone (3.3 percent) of the upstream sub-region as compared to the other zones. In the contrary the proportion of

household with annual expenditure above Rs 100,000 is high in upper zone (21.1 percent) of the upstream sub-region and lower zone (20 percent) of the downstream sub-region. There is only 1.7 percent households with more than Rs 100,000 in the upper zone of the downstream sub-region. This indicates that the average expenditure of the household is high in upper and lower parts of the watershed as compared to the case of the middle parts.

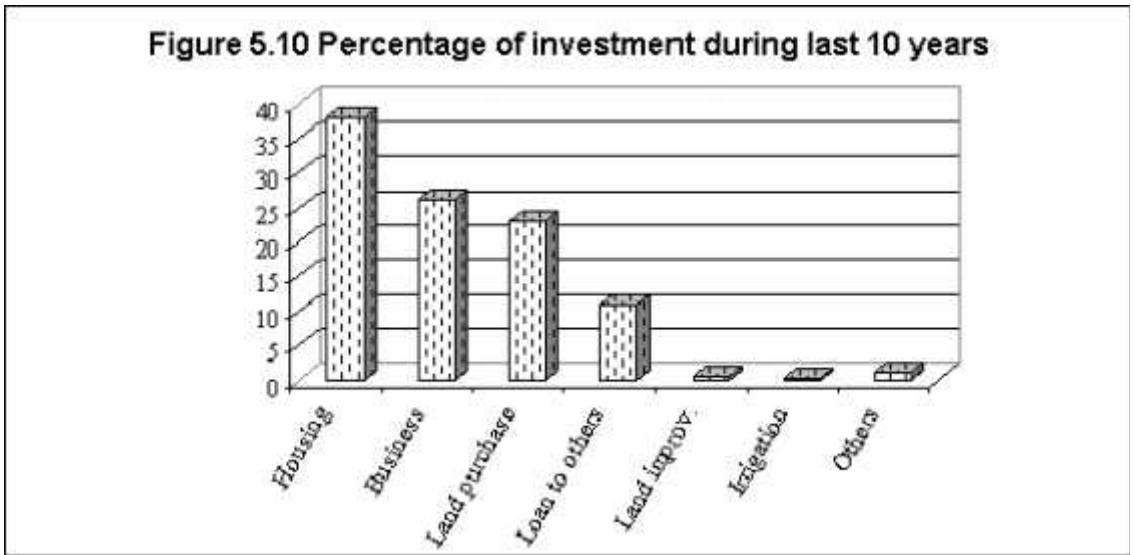
5.3 Investments and borrowing

Investments and borrowing are the household's strategies opted by local people for their livelihood security. People invested money in different fields during the period of last 10 years to improve their quality of life. The important fields of investment include housing, business, land purchase, loan to others and land improvement. On an average every household invested a total of Rs 205,725 during last 10 years period. The amount of households' investment varies by zones and sub-region. The average investment of household is the highest in the upper zone of the upstream sub-region (Rs 410,221) and lowest in upper zone (Rs 89,596) of the downstream sub-region as compared to others (Table 5.26).

Table 5.26 Average investment of the households during the last 10 years

	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
Fields	Rs	%	Rs	%	Rs	%	Rs	%	Rs	%	Rs	%
Housing	73963	41.1	124292	59.3	31967	35.7	32933	35.4	126456	30.8	78343	38.1
Business	48833	27.2	27417	13.1	167	0.2	5444	5.9	158789	38.7	53794	26.1
Land purchase	29500	16.4	38667	18.5	50475	56.3	47311	50.9	63650	15.5	47514	23.1
Loan to others	22967	12.8	12833	6.1	3567	4.0	3967	4.3	58833	14.3	22261	10.8
Land improvt.	1886	1.1	1258	0.6	654	0.7	2551	1.8	1382	0.3	1619	0.8
Others	2625	1.5	5017	2.4	2767	3.1	722	0.8	1111	0.3	2193	1.1
Total	79775	100.0	209483	100.0	89596	100.0	92938	100.0	410221	100.0	205725	100.0

Source: Field survey, 2002/03



The proportion of investment in different field is uneven. Out of the total investment, 38.1 percent is in housing followed by business (26.1 percent), and land purchase (23.1 percent). Land purchase includes purchase of land both for agricultural and housing purposes. Loan to others constitutes 10.8 percent of the total investment. Investment in land improvement including irrigation is only 0.8 percent of the total investment. The proportion of investment in housing is comparatively high in the middle zone (59.3 percent) of the downstream sub-region and low in the upper zone (30.8 percent) of the upstream sub-region. Likewise, investment in business is high in the upper zone (38.7 percent) of the upstream sub-region. Investment in business is negligible (0.2 percent) but comparatively high in land purchase (56.3 percent) in the upper zone of the downstream sub-region. The proportion of investment on loan to others is high in the upper zone (14.3 percent) of the upstream sub-region as compared to others.

People borrow from others for various household purposes such as purchasing food and cloth, education, treatment, and for festival, marriage and death ceremony. People borrow loan from others for investments in business, housing, land purchase and improvement. Out of the total surveyed households, 54.4 percent (196 households) borrow loan from different sources (Table 5.27). The proportion of households burrowing loan is high in the lower zone of the downstream sub-region (75.0 percent) and low in the upper zone of the upstream sub-region (37.8 percent).

Table 5.27 Households borrowing loans

Loan	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
	No	%	No	%	No	%	No	%	No	%	No	%
NO	15	25.0	24	40.0	30	50.0	39	43.3	56	62.2	164	45.6
Yes	45	75.0	36	60.0	30	50.0	51	56.7	34	37.8	196	54.4
Total	60	100.0	60	100.0	60	100.0	90	100.0	90	100.0	360	100.0

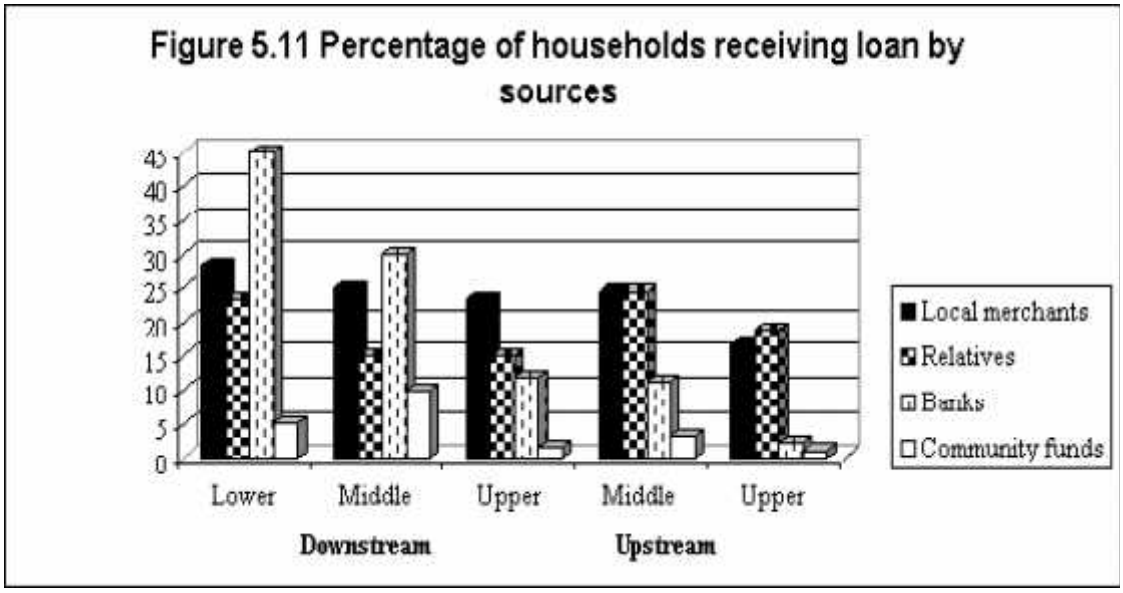
Source: Field survey, 2002/03

The local people incurred loans from different sources. These sources include banks, local moneylenders, community funds and relatives. Table 5.28 shows the number and percentages of households receiving loan from different sources. Local moneylender is the main source of loan of local people in terms of number of households receiving loan from this source. Out of the total loan-receiving households, 42.3 percent receive loan from this source. Though the interest rate is very high (36- 60 percent) people take loan from local moneylenders.

Table 5.28 Households receiving loans from different sources

	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
Sources of loan	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%
Local merchant	17	8.7	15	7.6	14	7.1	22	11.2	15	7.6	83	42.3
Relatives	14	7.1	9	4.6	9	4.6	22	11.2	17	8.7	71	36.2
Bank	27	13.8	18	9.2	7	3.6	10	5.1	2	1.0	64	32.6
Community fund	3	1.5	6	3.1	1	0.5	3	1.5	1	0.5	14	7.1

Source: Field survey, 2002/03



Lack of banking facilities in nearby areas and lengthy processes (terms and conditions for taking loan) force local people to borrow loan from local moneylenders on high interest rate. Relatives rank second in terms of number of households receiving loan from this source. The share of relatives in loan giving is 36.2 percent. Banks and community funds rank third and fourth with 32.6 and 7.1 percent share in loan taking respectively. The proportion of households receiving loan from different sources varies by zones and sub-regions. The proportion of households receiving loan from

moneylender is high in the middle zone of the upstream sub-region (11.2 percent) as compared to the others. Likewise the proportion of households receiving loan from relatives is high in the upper zone of the upstream sub-region and bank's contribution to loan is high in the lower zone of the downstream sub-region. Households receiving loan from community fund is remarkable (3.1 percent) in the middle zone of the downstream sub-region. Community funds raised by mother groups help local people in difficult situation. Loan procedure is easy and rate of interest also low in this case.

5.4 Use of energy

Like in other areas the local people use a number of sources of energy for lighting, heating and cooking. These energy sources include firewood, kerosene, electricity, biogas, solar power and LP gas. Firewood is the main source of cooking and space heating. Majority of the households use electricity for lighting. Though main grid lines of the electricity do not connect most of the upper parts of the study areas, electricity is supplied here from a number of micro-hydro plants. The proportional share of different sources in household energy use is given in Table 5.29.

Table 5.29 Energy use pattern of the households

Sub-region		Lighting			Cooking		Heating	
	Zones	Kerosene	Electricity	Solar	Firewood	Others	Firewood	Others
Downstream	Lower	13.3	86.7	0.0	56.7	43.3	16.7	6.7
	Middle	23.3	76.7	0.0	83.3	16.7	40.0	3.3
	Upper	95.0	0.0	5.0	100.0	0.0	76.7	0.0
Upstream	Middle	23.3	76.7	0.0	93.3	6.7	72.2	3.3
	Upper	14.4	82.2	3.3	73.3	26.7	76.7	7.8
Total		31.4	66.9	1.7	81.4	18.6	61.9	5.6

Source: Field survey, 2002/03

In total, two-thirds of the households use hydro-electricity for lighting followed by kerosene (31.4 percent) and solar power (1.7 percent). The upper zone of the downstream sub-region does not have electricity facility. Almost all households (95 percent) of this zone use kerosene and five percent use solar power for household lighting. Solar power for lighting is used only in the upper parts of both the sub-regions. An overwhelming majority (81.4 percent) of the households entirely depends on firewood for cooking and rest of the households (18.6 percent) use varieties of different sources of energy for cooking. The households in the upper zone of the

downstream sub-region solely depend on firewood. A significant proportion of households in the lower zone of the downstream sub-region (43.3 percent) and the upper zone of the upstream sub-region (26.7 percent) use alternative sources (kerosene, electricity, biogas and LP gas) of energy along with firewood for cooking. Easy excess to other sources (kerosene and LP gas) and limited availability of firewood, and introduction of biogas in the lower zone are responsible for heavy use of alternative sources of energy for cooking. And in the upper zone of the upstream sub-region use of electricity is high especially in hotels and restaurants. The proportion of household using firewood for space heating and other heating purpose is also high (61.9 percent) and a few households (5.6 percent) use alternative source of energy. Solar power is the main alternative source of energy for water heating especially in the hotels of the upper parts.

It is evident from the results discussed above that the people in the Modi Khola watershed perform diverse livelihood activities. These activities include a range and combination of activities such as agriculture, raising livestock, employment in government and non-governmental agencies, business, wage labor, migration, fishing, liquor making, forest product collection, tourism, industrial activities, tailoring and others. Household members adopt one or more often several activities to meet their household needs, ensure their future and improving standard of living. However, the contribution of these activities to livelihoods as well as household income varies by localities. The variation in livelihood strategies is mostly attributed by access to assets than the other factors in the Modi Khola basin.

CHAPTER VI

WATER AND LIVELIHOODS

6.1 Water and its users

Water is one of the plentiful natural substances available in the earth. There is more than 1.4 billion cubic kilometers of the stuff (Khan, 1994; ADB, 1999; Subba, 2001); enough to give every person more than 230 million cubic meters each if divided evenly (ADB, 1999). More than 89 percent of the world's water is salt water. We depend for basic vital needs on fresh water, which constitute only 11 percent. Most fresh water is locked in the polar ice caps. Less than 1 percent of the earth's fresh water is accessible in lakes, rivers, and ground water aquifers (ADB, 1999). The most accessible water is that which flows in river channels or stored in freshwater lakes and reservoirs. The major portion of water diverted for human needs is taken from this renewable, readily accessible part of the world's fresh water resources.

Water, a precise gift of nature, is found in different forms- solid, liquid and gases. They have different uses depending upon the quality, quantity and the levels at which they are available. It is most fundamental for human survival. Without water life on the earth cannot be possible. It is required for basic human needs such as drinking, cooking and bathing, for irrigation to grow crops, for hydropower to produce energy, recreation, navigation, for industry and environment. It is also an important component of the ecological chain on which all life and life supporting system depend. It has cultural and spiritual significance too. Water provides means for the diversification of livelihoods. People gather a range of products from common property resources i.e. water bodies like rivers, lakes and seas. These products include fish and other aquatic animals, aquatic plants, and other materials such as sand and gravel. These products are fundamental to the viability of people's livelihoods. These products can be used to meet subsistence needs and /or to provide secondary income sources.

Providing safe water and improved health is an investment for people. A healthy population is more creative in husbanding land and water for generating household wealth and achieving social well-being (Dixit, 2000: 219). Water security can play a

wider role in poverty reduction and improving livelihoods. Improved domestic water supplies and improved institutions surrounding them bring multiple benefits: they reduce sickness, save time, generate income, enhance food security, strengthen local organizations and build co-operation between people (International Water and Sanitation Center, 2003). Poor quality or availability affects the health, productivity and workload of the poor and especially of women who assume the primary burden for the provision of water and it's many domestic uses (Soussan, 1998).

Competition for water is increasing among different water users including water for ecological needs. Nearly 70 percent of global freshwater withdrawals are directed towards agriculture, mainly for irrigation (ADB, 1999:2). There has been a rapid increase in the demand for water for both drinking and irrigation, and it is expected to grow even more in the future in all areas (Banskota, 2000). The growth process, the increase in population and the expansion of economic activities has inevitably led to increasing demands for water use. Livelihood of people is also shaped by supply side. The rhythm of the seasons and the flow of water through them still shape the livelihoods of most of the world's population (Moench et al., 2003).

Recently water has been recognized as a scarce resource. Since 1950s policy makers have begun to espouse the economic and environmental values of water. Since the 1970s a series of international meetings have addressed water issues starting with the first UN water conference at Mar del Plata in March 1977 (ADB, 1999: 6). As a result a consensus is growing among scientists, water planners, government and civil society that new policies and approaches will have to be adopted in the future to avoid calamity, and that supply, use and management of water resources will have to be integrated across sectors and between the regions sharing the same source (ADB, 1999: 6). The concept of fully integrated water resource management (IWRM) emerged from the Dublin and Rio Conferences of 1992. The four guiding principles are

i) Fresh water is finite and vulnerable resource, essential to sustain life, development and environment,

ii) Water development and management should be based on participatory approach, involving users, planners, and policy makers at all levels,

iii) Women play central part in providing, managing, and safeguarding water; and

iv) Water has an economic value in all its competing users and should be recognized as an economic good.

Water resources are vital inputs into livelihood production activities in a wide variety of ways. Crop production is highly water intensive activity (Postel, 1996) and its viability is closely linked to reliable access to water. There are many other productive activities that depend on water as key input including fishing, tree and garden cultivation around homestead, livestock, small scale manufacturing such as pottery, brick making and tanning, services such as laundering and others. It is also vital for many types of manufacturing and other large economic activities. People depend upon water in four different ways: as an input into production, for the maintenance of health and welfare, to ensure ecosystems integrity and reduce vulnerability to hazards (Sousan and Frames, 2004: 86).

In all its critical functions water is linked to food supply and livelihood security (Shah, 1998:117). Nepal's living conditions are closely tied to water resources. Since most of the people depend upon farming, the need for water to provide food security is paramount (WECS, 2002:42). According to the estimation made by WECS for the year 2000, irrigation sector constitutes 87.4 percent (13,000 million cubic meter/year) of the total water use (14880 million m^3/year) of the country. The use of water for hydropower generation, domestic and industrial use is estimated to be 6.7, 5.4 and 0.5 percent (1000, 800 and 80 million m^3/year) respectively.

Snow and ice, springs, rivers, lakes, ground water stocks and precipitation are the sources of water in the Modi basin. The stock of water in the form of solid (snow and ice) and ground water is not known. Even the complete information on surface water is also not available. The total natural flow of the Modi Khola at Nayapul gauzing station is 54.9 m^3/s. (see Table 4.6 in Chapter 4 for detail). The surface as well as groundwater support for both flora and fauna, which also have conditioned people's livelihoods. As in other areas, the people of the Modi Khola area use water for different purposes and contribution of water to local livelihood is immense. The most common uses are irrigation, household use and power generation. Other uses include industrial (operation of watermills, and woodcarving workshops), and religious and cultural activities (religious bath, offering at temple and funeral activities). The details of different consumptive and non-consumptive water uses are elaborated below.

6.2 Irrigation

Water is a life-giving agent to plants. However, the requirements of water for different plant vary markedly for healthy growth. It also differs on both temporal and the spatial perspective. Moreover, irrigation is considered to be one of the most important and basic means for supplying water for plants where rainfall is inadequate and unpredictable (Singh and Dhillon, 1984). Irrigation helps in the process of transformation of agriculture. Irrigation is the technique of artificially applying water to land in order to meet the water requirement of a crop during its growing period. An irrigation system diverts water from a source and transfers it to land plots in order to meet the water requirements of the crops being cultivated there (Dixit, 2002: 302). Water is one among several inputs to improve agricultural performance; it is treated as the sine qua non of agricultural productivity (Gyawali, 1989). It ensures multiple cropping and high yields per unit area (Mainali, 1987; Bhandari, 1994 and Bhandari, 1996). According to Singh and Dhillon (1984) irrigation is an agricultural strategy design to reduce moisture deficiency-imbalance between the moisture supplied by rainfall and the evapotranspiratory demand.

6.2.1 Irrigation facility

Agriculture is the mainstay of livelihood of the people in the Modi Khola watershed. As agriculture is the main source of livelihood, the use of water for irrigation in the Modi Khola watershed is common. Of the total cultivated area only 20 percent has irrigation facility. Of the total irrigated land, 84 percent lies in the hill slopes and 16 percent in the valleys (Tahal Consulting Ltd., 2002). People of this area have used water for irrigation diverting water from rivers and springs from time immemorial. Traditional *kulos* as well as modern canals are used for water diversion. In some places water from ponds are also used for irrigation in limited scale. Water for irrigation is mainly diverted from tributaries of the Modi Khola and springs. The use of water for irrigation is extensive throughout the watershed; however, the percentage of area under irrigation is low in the upstream sub-region as compared to the downstream. In the upstream sub-region the demand for irrigation was low due to colder climatic conditions.

There are altogether 75 irrigation schemes in the Modi Khola watershed (Tahal Consulting Ltd., 2002). Out of total 13 are agency-developed modern irrigation

schemes and the rest are small traditional ones. The modern schemes are constructed under Nepal Irrigation Sector Project (NISP) and Dhawalagiri Irrigation Project with the financial assistance of International Labour Organization (ILO). There are 62 traditional irrigation schemes in this area. The contribution of traditional irrigation system to agriculture is remarkable. Out of the total 2,430 ha irrigated area (Tahal Consulting Engineers Ltd, 2002), 82 percent (1985 ha) area is irrigated under these traditional system and remaining 18 percent (445 ha) is irrigated under modern irrigation systems. A total of 6645 persons are directly benefited by these schemes (Table 6.1).

Table 6.1 Agency developed major irrigation schemes and population benefited

Sub-region	Zones	Name of scheme	Command Area (ha)	Population benefited
Downstream	Lower	Suntare (Pipaltari)	8	100
		Sanobagar (Siwalaya)	28	301
	Middle	Rati Khola (Tilahar)	120	1769
		Danabagar (Tilahar)	10	112
		Sundare Khola (Chuwa)	19	558
		Marangsing (Chuwa)	18	496
		Jahare Khola (Pakuwa)	60	150
		Amdanda (Pipaltari)	20	478
		Patichaur (Bajung)	20	500
		Sarangde (Sankharpokhari)	15	208
		Gyadi (Katuwa Chaupari)	100	1115
		Arther	12	300
	Upper	-	-	-
Sub-total			**430**	**6087**
Upstream	Middle	Parache Khola (Bhukatangle)	25	558
	Upper	-	-	-
Sub total			**25**	**558**
Grand total			**455**	**6645**

Source: Field survey, 2002/03

The distribution of traditional irrigation canals is uneven. Most of these schemes lie in the downstream sub-region. Similarly, the distribution of modern irrigation schemes is also uneven and is mostly concentrated in the downstream sub-region. Out of the total 13 modern irrigation schemes, 12 are concentrated in the downstream sub-region

(Figure 6.1). Out of 12 irrigation schemes located in the downstream sub-region 10 are located in middle zone and only two in the lower zone. The upper zones of both the sub-regions do not have any modern irrigation schemes. There was only one irrigation scheme located in middle zone (1000-2000 m) of the upstream sub-region. Tilahar (120 ha) and Gyadi (100 ha) irrigation schemes are the bigger irrigation schemes in terms of both command area and population benefited.

Local people also use sprinkler irrigation. It is used particularly for watering small gardens and vegetable farms. Sprinkler irrigation is widespread throughout the watershed. It is relatively common in the lower parts.

The major source of irrigation water is the river. An overwhelming majority of the households (76.2 percent) has been using water for irrigation from river source (Table 6.2). Irrigation water is diverted from the tributaries of the Modi Khola. Nowhere in the Modi Khola watershed water is used from the main channel for irrigation due to topographical reason as caused by deep river channel. Lifting of water from this river is not done due to reason of cost. Nearly 24 percent of the households use spring water for irrigation. These spring sources are located within agricultural fields or adjoining areas from less than 2 minutes of average walking distance whereas the average canal distance for river source is 12.6 minutes.

Table 6.2 Households using different sources for irrigation and distance of source

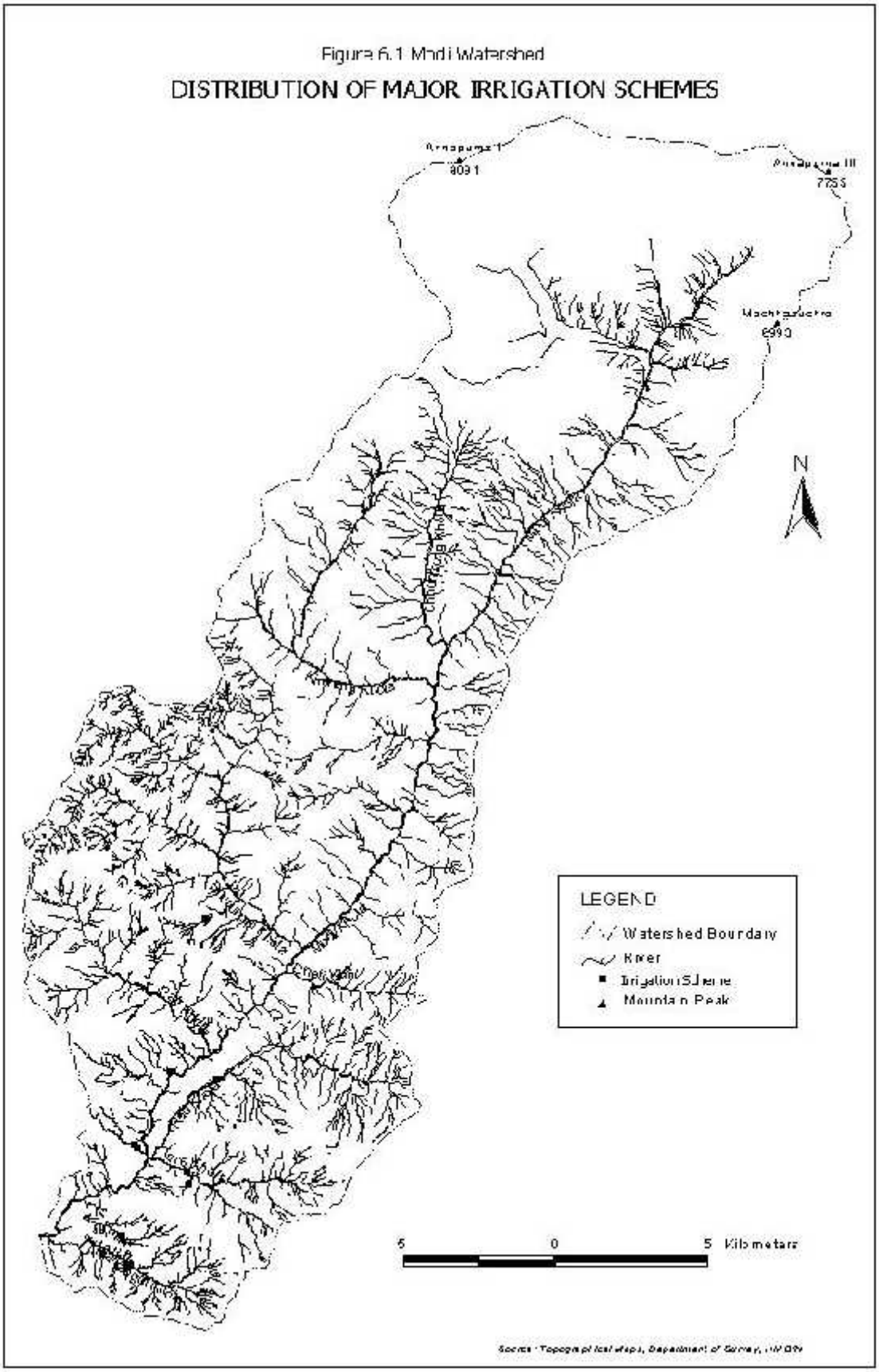
Sources	Number	Percent	Average distance (minutes)
River	182	76.2	12.6
Spring	57	23.8	1.4
Total	239	100.0	7.0

Source: Field survey, 2002/03

6.2.2 Water diversion for irrigation

As noted above, a number of irrigation schemes diverted water for irrigation from different tributaries. The total amount of water diversion for irrigation is summarized in Table 6.3 and Figure 6.2. The water diversion for irrigation significantly varies by months due to unequal distribution of rainfall and variation in water demand during different stages of crop growth. The highest amount of water (6.43 m^3/s) has been diverted in June. This is the time for rice transplantation and rainwater is not

Figure 6.1 Madi Watershed

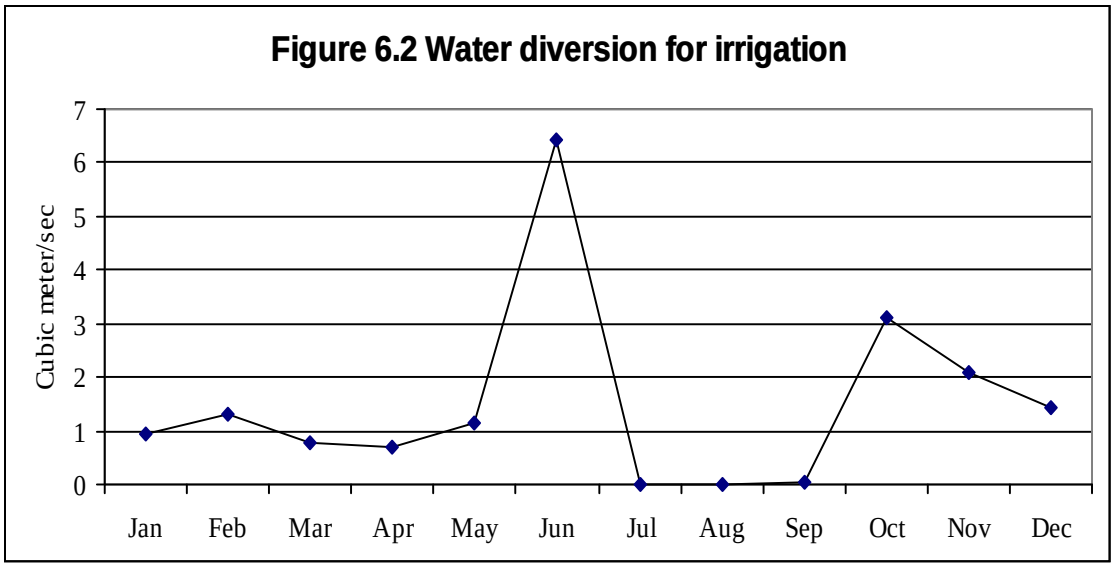


sufficient to meet the demand of water for rice cultivation. October ranks second in terms of water demand for irrigation. The total water diversion in this month is 8.33 m^3/s. The water demand in this time is also high. During this time the amount of rainfall decreases and demand of water for crop becomes high. Growing and flowering period needs more water for paddy. No water has been diverted for irrigation during July and August. In these months the area receives sufficient rainfall for crops. In the winter season water is used for winter crops such as wheat, barley, potato and others.

Table 6.3 Water diversions for irrigation in the Modi Khola watershed

Months	Water diversion	
	(m^3/s)	Million cubicmeter per month
January	0.93	2.49
February	1.29	3.12
March	0.78	2.33
April	0.70	1.81
May	1.15	3.08
June	6.43	16.67
July	0.00	0.00
August	0.00	0.00
September	0.04	0.10
October	3.11	8.33
November	2.07	5.37
December	1.45	3.88

Source: Tahal Consulting Engineers Ltd, 2002: Nepal Irrigation Sector Project, Technical Report No 7.



6.2.3 Contribution of irrigation to crop production

Agriculture in this area is characterized by irrigated and monsoon dependent types. Irrigation in this area is considered as one of the most important and basic inputs and has significant role on productivity, crop intensification, and diversification. The cropping intensity, crop combination and yields by irrigation status are discussed below.

a) Cropping intensity

Irrigation is one of the important inputs for agricultural production. It has significant role not only in cropping intensity but also for diversification. As reported, the development of irrigation canal brought significant changes in cropping intensity as well as production especially in the lower parts of the watershed. These changes have direct impacts on local livelihoods. The cropping intensity is high in irrigated areas as compared to seasonal irrigated areas (Table 6.4). The overall cropping intensity of irrigated cultivation (both seasonal and yearround irrigation) is 177 percent while it is 127 percent in non-irrigated areas

Table 6.4 Cropping intensity by irrigation status

Irrigation	Downstream			Upstream		Total
	Lower	Middle	Upper	Middle	Upper	
Year round	250.0	200.0	175.0	185.0	175.0	196.0
Seasonal	165.0	152.0	160.0	155.0	160.0	158.0
Non irrigated	115.0	120.0	135.0	130.0	133.0	127.0

Source: Field survey, 2002/03

The cropping intensity is not uniform throughout the study area due to variation in different physical and non-physical factors such as climatic condition, nature of soil and availability of irrigation facility. Irrigation facility has significant role in cropping intensity in this area. The overall cropping intensity is 196 percent in the Modi Khola area where irrigation facility is available throughout the year while it is 158 percent in seasonally irrigated and 127 percent in non-irrigated areas. The cropping intensity also varies by zones and sub-regions. It is 250 percent in the lower zone of the downstream sub-region while it is 175 percent in the upper zone of both the sub-regions where irrigation facility is available throughout the year. It ranges from 152 to 160 percent in the seasonally irrigated areas. The cropping intensity in non-irrigated

area is low in the lower zone of the downstream sub-region (115.0 percent) as compared to others.

Mostly three crops are grown in the lower zone in the downstream sub-region where year round irrigation facility is available. The main localities growing three crops are Gyadi, Pakuwa, Tilahar, Patichaur, Bajung and Chuwa. In these areas agriculture is dominated by rice. Early paddy, main paddy and wheat are grown in a year in most of the areas. Two to three crops are grown in seasonl-irrigated areas.

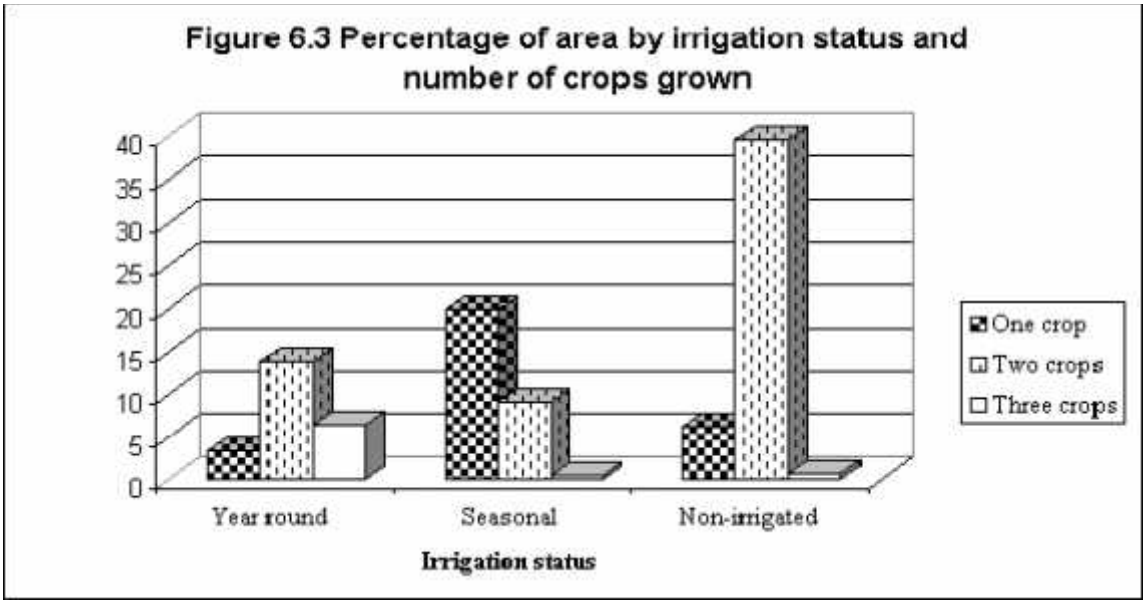
The cropping intensity by irrigation status is tested using Chi-square test. The Chi-square statistic yielded the calculated value of 16.16. Table value at 5 % level of significance in 8 degrees of freedom [(r-1) (c-1)] is 15.51 (Appendix 2). The calculated value is bigger than the table value, which indicates the rejection of Null hypothesis. This means there is a significant difference in cropping intensity by irrigation status or cropping intensity in this area depends on availability of irrigation facility.

The number of crops grown in an area by irrigation status is summarized in Table 6.5.

Table 6.5 Percentage of areas by number of crops grown and irrigation status

Crops grown	Area by irrigation status (in percent)			
	Year round irrigated	Seasonal irrigated	Non-irrigated	Total
One crop	3.4	19.9	6.3	29.6
Two crops	13.9	9.2	39.7	62.8
Three crops	6.5	0.5	0.6	7.6
Total	23.8	29.6	46.6	100.0

Source: Field survey, 2002/03



Two to three crops a year are grown in the irrigated areas particularly in the downstream sub-region where year round irrigation facility is available. Only one or two crops are grown in the upstream sub-region in irrigated areas. Out of the total agricultural land of the surveyed households, 23.8 percent is under irrigation throughout the year and 29.6 percent under seasonal irrigation and remaining 46.6 percent area has no irrigation and depends solely on monsoon rainfall. The proportion of area under two crops is 62.8 percent followed by one crop (29.6 percent) and three crops (7.6 percent). Three crops are grown mostly under areas having year round irrigation particularly in the valleys.

b) Yield of crops

Yield of a crop depends up on a number of factors such as quality of seed, nature of soil, climatic condition, timing of sowing and weeding, and manuring practices, water supply and others. Among these factors water is an important input for crop production, as it is a life-giving agent to plants. The yields of different crops vary in the study area as a result of variation in availability and application of these factors to crop production. The contribution of irrigation to crop production is clearly seen in Table 6.6.

Table 6.6 Yield of major crops by irrigation status (kg/ha)

	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
Crops	Irr	Non irr	Irr	Non irr	Irr	Non irr	Irr	Non irr	Irr	Non irr	Irr	Non irr
Paddy	2350	-	1220	-	784	-	1025	-	1056		1356	-
Maize	1609	1655	1042	942	1003	659	656	1074	669	883	1239	986
Millet	-	1341	-	1055	-	838	-	1161	-	1062	-	1061
Wheat	1843	1070	768	851	1338	681	618	719	595	930	1173	855
Barley	2695	1873	557	1338	-	334	446	806	892	978	1884	922
Potato	4838	3798	2589	3412	-	1984	1921	3270	4254	2511	3586	2360

Source: Field survey, 2002/03

Note: Irr represents irrigated areas and non-irr represents non-irrigated areas.

In totality, the yield is high in irrigated areas for all crops as compared to non-irrigated areas with minor exceptions. The yield of paddy is highest (2350 kg/ha) in the lower zone of the downstream sub-region with year round irrigation facility. The yield of paddy is relatively very low in the upper parts of both the sub-regions though

irrigation facility is available. This is obviously due to climatic condition. The yields of other crops are also high in the lower zone of the downstream sub-region as compared to the others.

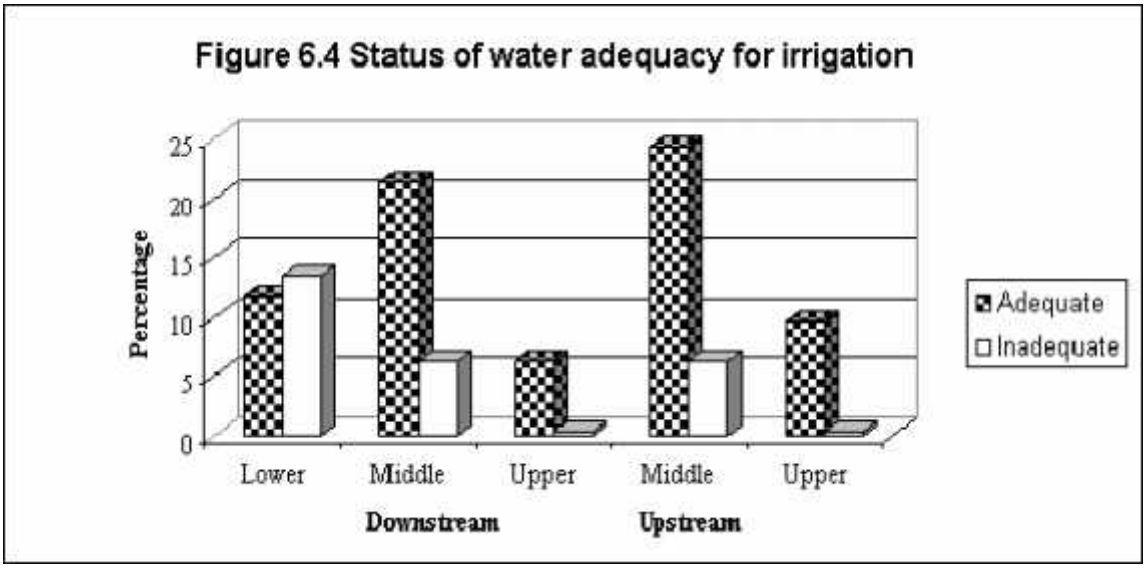
6.2.4 Water adequacy for irrigation

There is plenty of water for irrigation in the Modi Khola; however, as noted above water from the main channel of the Modi Khola is not used for irrigation. Water for irrigation is diverted only from tributaries of the Modi Khola and natural springs. Water level in these sources depends on monsoon rain that declines sharply during dry season as a result many canals face water shortages during dry season. Out of the total 360 households surveyed, 66 percent irrigate lands. Out of them, 64 households (26.8 percent) face water shortage during dry season (Table 6.7).

Table 6.7 Households reporting water shortage for irrigation during dry season

Sub-region/ zones	Households	% of total households irrigating lands
Downstream	**48**	**20.1**
Lower	32	13.4
Middle	15	6.3
Upper	1	0.4
Upstream	**16**	**6.7**
Middle	15	6.3
Upper	1	0.4
Total	**64**	**26.8**

Source: Field survey, 2002/03



The proportion of households reporting water stress during dry season is high in the downstream sub-region in comparison to the case of the upstream sub-region. In this area agriculture is intensive with rice dominated cropping pattern resulting in high demand of water. The proportion of household reporting water shortage is highest in the lower zone of the downstream sub-region as compared to the others. The middle zones of both the sub-regions ranks second in terms water stress for irrigation.

6.3 Household use

Water is one of the basic components and more fundamental element to life. It is used for a number of household purposes. These include drinking, cooking, bathing, washing and cleaning and others. Good quality sufficient quantity of water for drinking and sanitation is a critical determinant of the standard of life. For human survival, the absolute minimum water requirement is about 5 liters per day, whereas, the daily requirement for sanitation, bathing and cooking, needs, as well as for assuring survival is about 50 liters (ADB, 1999). Population levels, socio-economic circumstances and local food preferences all drive the levels of water used in association with food consumption (Allan, 1999). Local people use different sources of water for household use. These include piped water, stone taps, well and others. Among these sources, piped water is common.

6.3.1 Household water supply

Local people use different sources of water for household use. The sources of water include piped water, ditches, tubewell, stone tap and stream. Among these sources majority (78 percent of the total household) have access to piped water facility. Though, piped water is used throughout the watershed, the proportion of population having access to piped water for household use varies by sub-region and VDC (Appendix 3). The proportion of population using piped water is high in the upstream sub-region (91.3 percent) as compared to the population of the downstream sub-region (75.8 percent). All the VDCs in the upstream sub-region have piped water supply to more than 90 percent households except Bhukatangle. Ghandruk VDC has better provision of piped water supply among VDCs in the upstream sub-region. In this VDC, 99.7 percent households have access to piped water supply. The availability of adequate water sources from small streams and springs coupled with ACAP efforts is attributable to the development of piped drinking water facilities in

the upstream parts. The provision of piped water supply facility is comparatively low in the downstream sub-region. Durlung VDC in the downstream sub-region has the worst situation. In this VDC only 31 percent population have access to piped water and an overwhelming majority (71 percent) of households use other sources such as well, springs and stone taps in this VDC. The provision of piped drinking water has contributed much in peoples' livelihoods in many ways. As reported, improvements in health, time saving and reduction of drudgery are the benefits derived from safe drinking water in this area.

There are altogether 73 drinking water projects with scheme varing from 1 to 6 in the Modi Khola watershed. These projects were financed by a number of governmental and non-governmental agencies like UNICEF, Indian and British welfare, British and Indian Army. An inventory of drinking water projects is given in Appendix 4 and the distribution pattern is shown in Figure 6.5. Out of the total 73 drinking water projects 63 (86.3 percent) projects are located in the downstream sub-region and 10 (13.7 percent) in the upstream sub-region. The drinking water projects are highly concentrated in the middle parts of the watershed at altitude levels of 1000-2000 meters. These are the parts with extreme concentration of settlements.

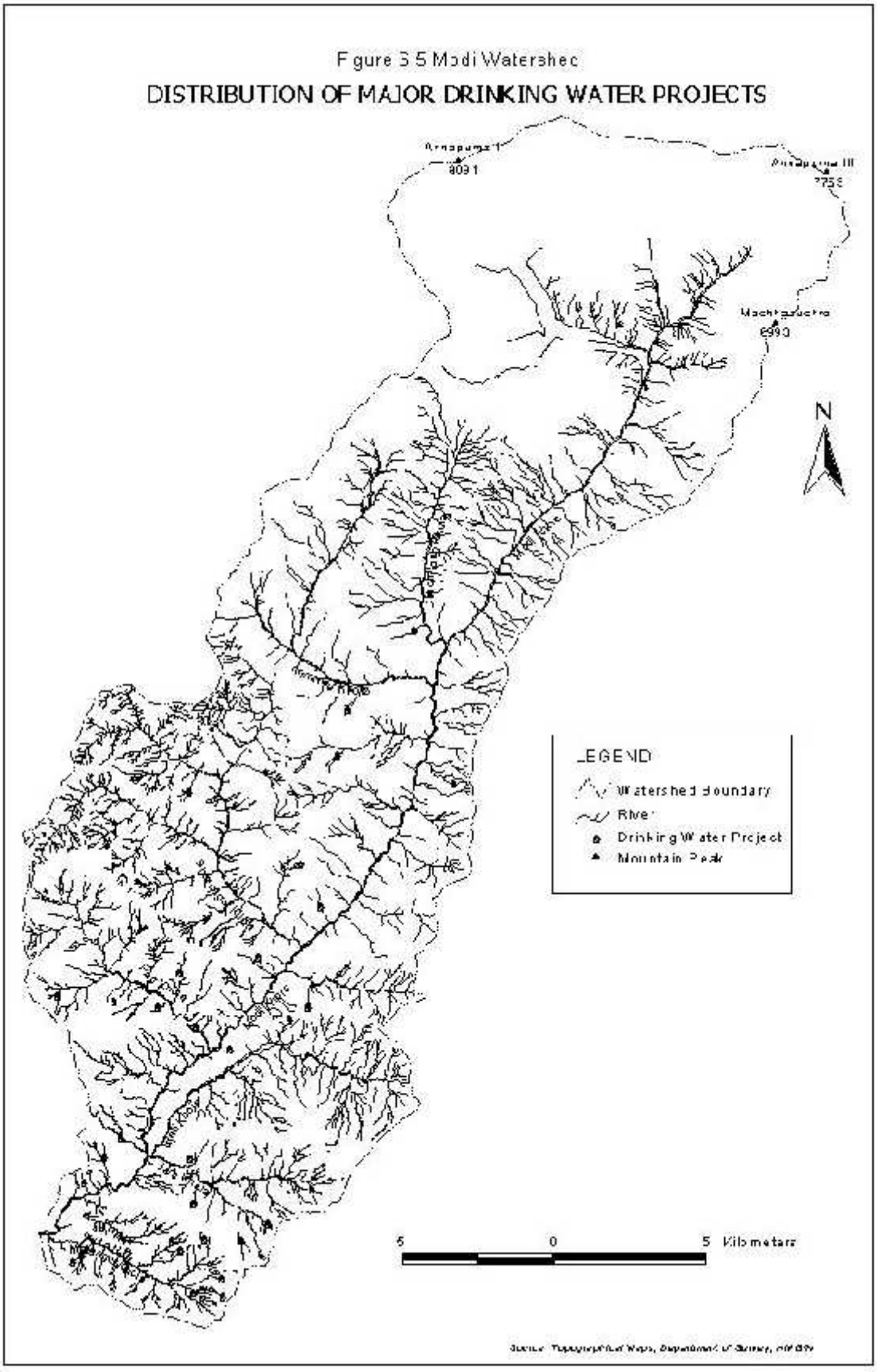
6.3.2 Accessibility of water for household use

The accessibility of water for household use depends on different factors like availability of water sources, socio-economic condition of the people in the locality, external intervention and local effort. Due to variation in these factors, the accessibility of water for household use varies by sub-region and localities in the Modi Khola area. The accessibility of safe water for household use in terms of distance of water source is given in the following table.

Table 6.8 Percentage of households with distance of water supply

Distance	Downstream	Upstream	Average of total
Less than one hour	71.1	97.6	74.9
One to three hours	6.1	0.8	5.3
More than three hours	11.8	0.0	10.1
Distance not reported	11.0	1.6	9.7
Total	100.0	100.0	100.0

Source: Calculated from District profiles of Kaski (2058 B.S) and Parbat districts (2001)


F gure 3 5 Modi Watershec
DISTRIBUTION OF MAJOR DRINKING WATER PROJECTS
9091
6993
N
LEGEND
Watershed Boundary
River
Drinking Water Project
Mountain Peak
5
0
5 Kilometers

The households of the study area are categorised into three groups on the basis of distance to water sources. The accessibility of water for household use is relatively better in the upstream sub-region as compared to the case of the downstream sub-region. In this sub-region, 97.6 percent of the households have access to safe water for household use within the distance of less than one-hour of walk. Less than one percent of the households have to travel more than one-hour distance to fetch safe water. Bhukatangle VDC in the upstream sub-region has comparatively better situation. In this VDC 100 percent households lie within the distance of one-hour from water source for household use. In the downstream sub-region, 71.1 percent of the households have access to safe water within the distance of one hour. The distance to water source sharply varies by VDCs in this sub-region. Less than 20 percent of the households in Chitre and Durlung VDCs have access to safe water within the distance of one hour. Likewise, about 49 percent of the households of Chitre and Kyang VDCs have to spend more than three hours walk to fetch safe water for household use. The better situation prevails in VDCs like Bhadaure Tamangi, Chuwa, Ramja Deurali and Tilar in this downstream sub-region. In these VDCs more than 98 percent households lie within the distance of less than one from safe water source.

Total consumptive water demand for household use include daily water requirement for domestic purposes (drinking, cooking, bathing and sanitation) and water requirement for livestock. The minimum daily water requirement for human survival is only 5 liters/person/ day, whereas the daily requirement for sanitation, bathing and cooking needs, is 45 liters /day/person. Considering the total population of the Modi Khola watershed (75,000 persons within the watershed in 2001), the total daily water demand for drinking, cooking, washing and cleaning purposes is estimated at 3,375,000 liters/day (0.039 m^3/sec) whereas, the total water requirement for household use (both livestock and animal use) is estimated to 7,483,900 liters/day (0.087 m^3/ sec).

6.3.3 Water for livestock

Water is indispensable for both the human as well as the livestock. It is used for drinking, washing and cleaning for livestock. It is one of the components of water for household use. Healthy growth and productivity of livestock depends on good quality and sufficient amount of water.

As in other areas livestock in this area is characterized by both stall-feeding and grazing. Thus, local people use different sources of water for watering livestock and other purposes for livestock use. Streams, ponds, and pipe water are the common sources. In some place, especially in the downstream sub-region rainwater is also collected making ponds for watering livestock.

Daily water requirement for cattle and buffalo is 45 liters/day/head (Tahal Consulting Engineers, 2002). Cattle and buffalo are the dominant livestock in the basin. The total demand of water for livestock would increase by 25 percent to account for sheep, goats, pigs and other animals (Tahal Consulting Engineers, 2002). Considering the average number of livestock raised by households (1.3 cattle and 2.0 buffaloes), total population of cattle and buffalo is estimated to be 73,048 (cattle 28,776 and buffalo 44,272). The total water requirement for cattle and buffalo is estimated to 3,287,160 liters/day. Thus, the total water requirement for livestock (including sheep, goat and others) is estimated to 4,108,900 liters/day (0.048 m^3/sec).

6.3.4 Water adequacy for household use

As mentioned above local people use different sources of water for household uses. Though there is plenty of water in the Modi Khola area and its tributaries flowing either side of the main channel and springs, which are the sources of water for household use, a remarkable number of households (13.6 percent) reported water stress. Water stress is reported during dry seasons. During dry season water volume in some of the water sources decline sharply. As a result some of the households have to spend long time in public taps waiting for water or travel long distance to reach permanent water sources i.e. natural springs or streams to fetch water. The proportion of household reporting water stress is high (15 percent) in the downstream sub-region as compared to the upstream sub-region (12.2 percent). The lower zone of the downstream sub-region ranks first (18.3 percent) in terms of the proportion of households reporting inadequacy of water for household use. The upper zone (16.7 percent) and the middle zone (10 percent) rank second and third respectively. The proportion of household reporting water stress is low in the upper zone (3.3 percent) of the upstream sub-region (Table 6.9).

Table 6.9 Adequacy of water for household use

Sub-regions/zones	Adequate		Inadequate	
	Number	Percent	Number	Percent
Downstream	**153**	**85.0**	**27**	**15.0**
Lower	49	81.7	11	18.3
Middle	54	90.0	6	10.0
Upper	50	83.3	10	16.7
Upstream	**158**	**87.8**	**22**	**12.2**
Middle	71	78.9	19	21.1
Upper	87	96.7	3	3.3
Total	**311**	**86.4**	**49**	**13.6**

Source: Field survey, 2002/03.

6.4 Fishery

Fishery is one of the important economic activities of some of the ethnic groups residing riverside. Livelihoods of Majhi, Bote, Darai and Kumal are traditionally based on fishing at river water. Subsistence, commercial and sport fishing are commonly practiced in this region. As in other areas, some of the people residing riverside of the Modi Khola are also involved in fishing. A brief discussion on fish resources available in the Modi Khola and fishing activity is given below.

6.4.1 Fish resources

A number of fish species are reported to have found in the Modi Khola. However, the species reported by various studies vary greatly. Twelve fish species are reported by CEMAT Consultants (2000), 7 by GEOCE Consultants (2001) and 6 by East Consult (1998) from the upper Modi basin. Five fish species were reported from the lower basin by NEA (1996). It seems that the study on fish species of the watershed is comprehensive and complete. The fish species available in the Modi Khola is already discussed in sub-section 4.2.3. Modi Khola was rich in terms of both species diversity and fish population but fish population has sharply declined in recnt years. The construction of Pokhara-Baglung highway and Modi hydroelectric project caused sharp decline in fish population. Heavy exploitation of fish during road construction by a huge number of labor and their dependants using poison, electric current and explosive materials reduced fish population sharply. The construction of dam for Modi hydropower further deteriorated the situation. The path of fish migration

disturbed due to creation of dewater zone between powerhouse and dam site during low water flow period.

6.4.2 Fishing activities

The fishing in this area is not extensive in terms of both number of people involved as well as amount of fish catch. In the past fishing was important in this area. According to an old local fisherman, a resident of Dimuwa, the people from Pokhara and other areas come to Modi Khola valley for fishing. Later such fishing declined in this area. At present there are only a few families involved in fishing especially in the lower parts of the river. The people undertake fishing either as a recreation or as a part time job. Fishing is a seasonal activity. The people residing close to the river are engaged in fishing practice mainly during the beginning of summer and winter seasons. People use different traditional tools and techniques for fishing. The use of fishnets, *balchi, lahare paso*, and poisoning are the common practices. However, poisoning is prohibited within Annapurna Conservation Area, which lies in the upper Modi sub-region. Table 6.10 shows the number of households involved in fishing.

Table 6.10 Households involved in fishing

Sub-region/zone	Households	Fishing place			
		Modi Khola	Bhurungdi Khola	Chane Khola	Pati khola
Downstream	**1**	**-**	**-**	**-**	**1**
Lower	-	-	-	-	-
Middle	1	-	-	-	1
Upper	-	-	-	-	-
Upstream	**12**	**9**	**2**	**1**	**-**
Middle	10	7	2	1	-
Upper	2	2	-	-	-
Total	**13**	**9**	**2**	**1**	**1**

Source: Field survey, 2002/03

Out of the total surveyed household 3.6 percent (13 households) are involved in fishing. Out of total 13 households involved in fishing, 92 percent (12 households) were from upstream sub-region. Modi Khola and its perennial tributaries such as Bhurungdi, Channe and Pati Khola are the main fishing places. The average catch of fish as reported is 2-3 kg per day per person. It is used for both household consumption and sale. Local fishermen sell it in the local markets at a cost of Rs. 150-

200 per kg depending on season. Though, it is one of the sources of nutrient for some local people, its contribution to peoples' livelihoods in terms of income source and employment is negligible.

6.5 Industrial use

Water resources are vital for industrial activities. It is used for both small scale as well as large scale manufacturing activities for processing, as a source of energy and other purposes. The use of water for industrial purpose has a long history in the study area. It is used for a number of industrial purposes such as the operation of watermills, processing of raw materials (*lokta* to prepare Nepali paper, wool and leather processing) and brewing or liquor making. These activities provide some employment to local people and provide support for their livelihoods. The details of water use for industrial activities are given below.

6.5.1 Water for milling

The use of water for milling in Nepal has long history. In the mid and high hills of the country traditional watermills are located at the bank of stream and rivers. The operation of watermills have been the parts of villager's life and used as important source of energy for centuries for grinding the food grains (Joshi, 1981). Altogether more than 25,000 watermills are in operation in Nepal (GTZ and CRT, 2000).

The use of water for milling purpose is heavy in the Modi Khola watershed. People use watermills for grinding cereals from time immemorial as a cheap and convenient means of food processing. However, millwork is seasonal, with peaks in processing during festival and harvest times. There are altogether 55 watermills in operation and distributed across the watershed (Table 6.11). The location of watermills and their duration of operation are given in Appendix 5 (Figure 6.6). The distribution of water mill is uneven and mostly concentrated in the upstream sub-region. Out of the total 55 watermills, 93 percent (51) are located in this sub-region. Of them, 39 lie in middle zone (1000-2000 m) of the upstream sub-region. The main reasons for concentration of watermills in the upstream parts are favorable water flow in the tributaries and traditional practice. There are only 4 watermills in operation in the downstream sub-region. Crops dominated by paddy that does not require milling into flour and establishments of diesel mills are responsible for this.

On the basis of operation time watermills can be classified into three groups: those operated year round, operated in winter season (December-May) and operated in rainy season (June-September). The operation time or seasonality of watermills depends on water availability at mill site. About 50 percent of the watermills are operated throughout year, 40 percent only in rainy season and 10 percent only in the winter season.

Table 6.11 Distribution of watermills by operation season

Operation season	Downstream			Upstream		Total
	Lower	Middle	Upper	Middle	Upper	
Throughout the year	2	2	-	20	4	28
Only in rainy season	-	-	-	14	8	22
Only in winter/dry season	-	-	-	5	-	5
Total number	2	2	-	39	12	55

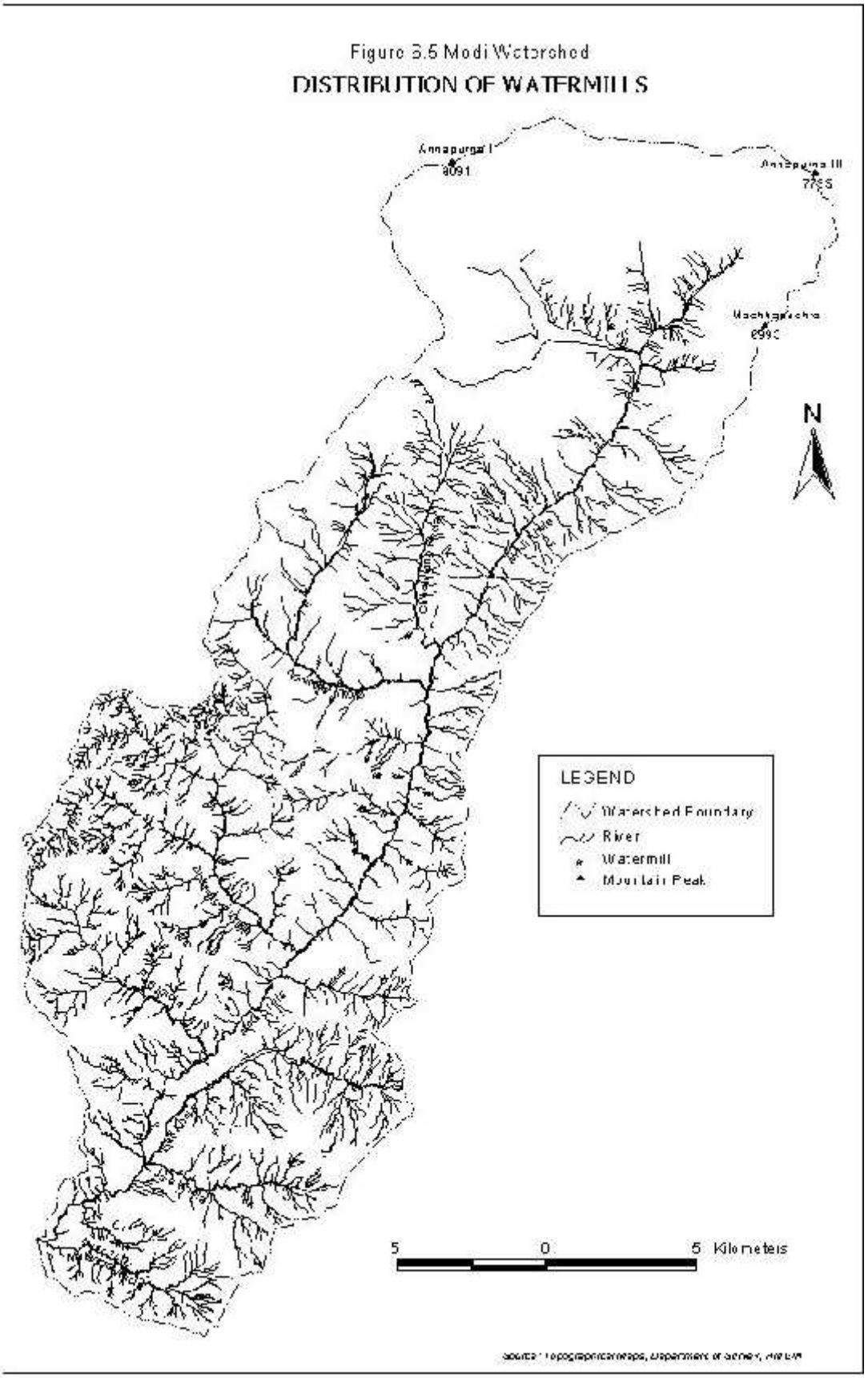
Source: Field survey, 2002/03

Out of total, only two watermills are operated with the water from the main channel of the Modi Khola. These are located at Syauli bazar and operated only in winter. In summer these are shifted to Thado Khola (Sadkiyu Khola). The total number of households benefited from wate mill is estimated to 2500.

The employment in the watermills is very limited. A total of 55 persons are employed as mill operatosr. Of them about 50 percent (27 persons) are partially employed since 50 percent of the watermills are seasonally operated. Except four operators in community-operated watermills all mill operators belongs to family members of mill owner.

The operation of watermill is one of the income sources of mill owner. The income from watermill is determined by a number of factors like the duration of watermill operation, number of household in the mill's catchments, types of grain and processing capacity of mill. Almost all watermills in this area are of traditional type resulting in low processing capacity. Grinding time depends on types of cereals; on an average a watermill grinds 4 *pathi* of cereals per hour. It is faster than the grinder operated manually resulted in time saving. Grinding charges of cereals paid by people is gross income of the mill owner. The amount of charge varies by places and cereal types.

Figure 3.5 Modi Watershed



Generally mill charge ranges between 4-8 *mana* or equivalent per *muri* (20 *pathi*) cereals in private watermill in the study area. The charge is relatively low in community owned watermills as compared to that of the private ones.

The number of households benefited and average income from watermill is already discussed in chapter five. Gouping of watermill on the basis of average income is given in Table 6.12. Out of total 55 watermills operated in the watershed six watermills earn less than Rs 1000 per month, 35 earn in between Rs 1000 and Rs 2000 and 14 more than Rs 2000 per month.

Table 6.12 Number of watermill with average monthly income

Income (Rs)	Downstream			Upstream		Total
	Lower	Middle	Upper	Middle	Upper	
Less than 1,000	-	-	-	4	2	6
1,000- 2,000	-	2	-	25	8	35
More than 2,000	2	-	-	10	2	14
Total	2	2	-	39	12	55

Source: Field survey, 2002/03

6.5.2 Water adequacy for milling

The status of water adequacy for milling is given in Table 6.13. Out of the total 55 watermills operated in the watershed, 60 percent have adequate water for mill operation and remaining 40 reported water stress during dry season. None of the watermill operated in the downstream sub-region reported water shortage for mill operation. The watermills in this area are operated either with water from perennial river or with improved technology. All watermills facing water shortage are concentrated in the upstream sub-region. Most of the watermills in the upstream sub-region are established in Thado Khola and these are small and seasonal in nature. In the winter and dry season, the volume of water decreases sharply in most of the tributaries and cannot rotate the turbine of watermills; hence some of the watermills are either closed or shifted to the large tributaries.

Table 6.13 Adequacy of water for mill operation

Sub-region/zones	Total number	Adequate		Inadequate	
		Number	Percent	Number	Percent
Downstream	**4**	**4**	**7.3**	**-**	**-**
Lower	2	2	3.6	-	-
Middle	2	2	3.6	-	-
Upper	-	-	-	-	-
Upstream	**51**	**29**	**52.7**	**22**	**40.0**
Middle	39	25	45.4	14	25.5
Upper	12	4	7.3	8	14.5
Total	**55**	**33**	**60.0**	**22**	**40.0**

Source: Field survey, 2002/03

The management of watermills is the responsibility of individual household i.e. private ownership except in four watermills (two in Chhomrong, one each in Ghandruk and Ghurjung), which are operated under community ownership.

6.5.3 Use of water for other industrial purposes

Besides milling, water in the Modi Khola area is used for other industrial purposes also. These include processing of *lokta* bark to prepare Nepali paper, wool and leather processing, brewing and others. There is a paper producing industry located at Ghandruk. This industry produces Nepali paper using bark of *lokta* tree. The production of this industry is estimated at 100 thousand sheets per year and it is mainly supplied to Pokhara. In this paper producing industry water is heavily used for refining Lokta bark. It is one of the income sources of the owner and provides employment to some locals.

Wool processing and leather processing are other water users. Wool processing is found only in the upper parts. Some households owning ship and goat are involved in this work. They use water for cleaning and dying wool. Local people make woolen goods like *radi*, *bakhu* and other materials for household consumption. This activity was extensive in the past and later sharply declined. One of the main reasons for declining this activity is the decrease in sheep and goat population and shrinkage of market of local woolen products resulting from availability of imported woollen material in relatively cheaper price. Water is also used for leather processing. Only a special dalit caste group known as Sarki undertakes leather processing. They are

involved in leather works as their traditional occupation and make shoes and other leather goods from locally processed leather. But recently processing of leather by local has declined due to popular use in imported leather products.

Brewing or making liquor is considered as one of the traditional activities of local people. Water is heavily used for making local liquor. Almost all households of Gurung and Magar community and some other castes like Newar, Kami, Damai make liquor at household level. It is considered one of the essential components for their religious ceremonies and for hospitality of guests. Some households prepare liquor for commercial purposes too.

6.6 Hydroelectricity

Water is the main source for power generation among different sources of power. Water is renewable resource and can be used for the same as well as other purposes again after power generation. Hydroelectricity has great significance in people's livelihood directly or indirectly. It can be used for different purposes such as lighting, cooking, heating and cooling, as a source of energy for industrial operation and others. It also helps for reduction of drudgery by providing alternative energy to the traditional forest-based energy and the protection of environment by reducing dependency on forest. The details of development and distribution of hydro plants and water adequacy for hydropower development and its future is discussed below.

6.6.1 Development and distribution

Hydroelectricity is one of the important sources of energy in the study area. The development of hydroelectricity in the Modi Khola area was initiated after the establishment of Annapurna Conservation Area Project (ACAP) in 1986. The first Micro-hydro project with an installed capacity of 50 KW was commissioned at Ghandruk in 1990 with the financial and technical support of ACAP. After that a number of Micro-hydro plants were constructed at different locations. During the survey there were 17 hydro-plants including peltric sets (mini hydro-plants). The micro-hydro projects were constructed following two issues of conservation of natural resources and development of community infrastructure for enhancing livelihood condition of the local people, which are the dual principal philosophies of King Mahendra Trust for Nature Conservation (KMTNC). Along with micro-hydro plants

Modi Hydro-electric project with an installed capacity of 14.8 MW was completed in 2000. This project is located on Modi Khola nearby Pokhara-Baglung highway at Dimuwa of Deupur Village Development Committee in Parbat district.

Altogether there are 17 hydro-plants including peltric sets distributed across the Modi Khola watershed (Figure 6.7.). The total power generated from 16 micro-hydro plants is 272 KW and the number of household supplied with electricity from these plants is 695 (Table 6.14).

Table 6.14 Location, capacity and population benefited by hydro-plants

Sub-region	Zones	Location of plants	Capacity (KW)	HH Benefited	Remarks
Downstream	Lower	Dimuwa (Modi Khoa)	14800	NA	-
	Middle	Ghatte Khola	16	154	-
	Upper	-	-	-	-
Upstream	Middle	Jhilubarang	27	140	-
		Tikhedhunga I	40	102	-
		Tikhedhunga II	40	149	-
		Kimrung khola	5	25	Peltric set
		Landruk	35	117	-
	Upper	Ghandruk	50	262	-
		Tarapani	2	10	Peltric set
		Kimrong Danda	5	21	Peltric set
		Chuile khola	7	43	Peltric set
		Ghurjung Tallo tole	5	20	Peltric set
		Ghurjung	2	15	Peltric set
		Chhomrong	30	65	-
		Bamboo	1	1	Peltric set
		Bamboo	1	1	Peltric set
		Dovan	5	3	Peltric set

Source: Field survey, 2002/03

The distribution of hydroelectric plant is uneven. Out of the total 16 micro-hydro plants (including peltric sets), 15 are located in the upstream sub-region. In the downstream sub-region there is only one micro-plant. Out of the 15 micro-hydro plants located in the upstream sub-region, 10 (67 percent) are located in the upper zone (above 2000 m). These projects are developed with the support of ACAP.

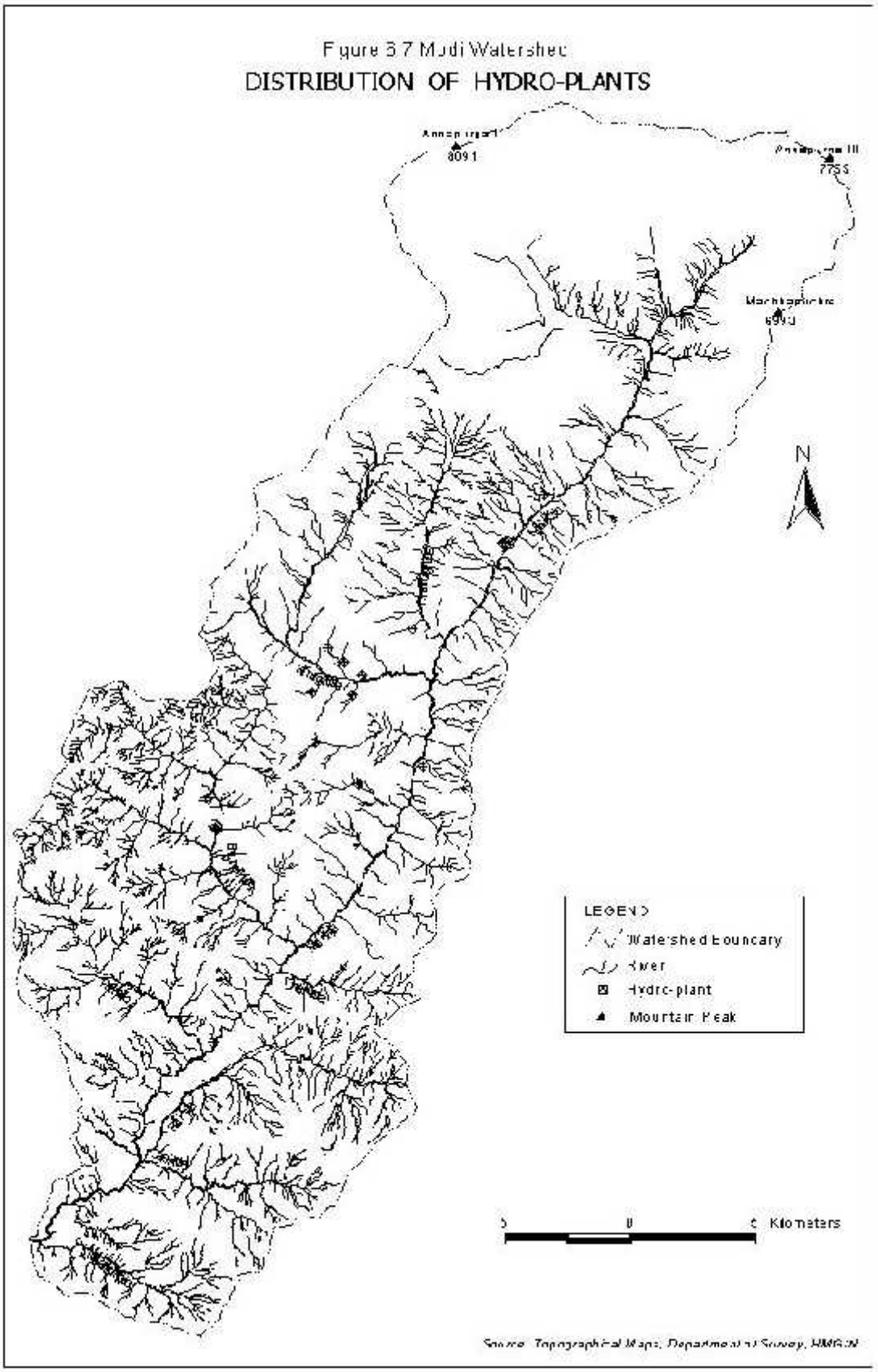


Figure 3.7 Modi Watershed
DISTRICTION OF HYDRO-PLANTS
8091
7755
6993
N
LEGEND
Watershed Boundary
River
Hydro-plant
Mountain Peak
0
Kilometers

The area lying outside the ACAP area does not enjoy this opportunity. This is how the area has developed less micro-hydro plants. The peltric sets are operated especially in the hotels of the upper parts.

Households adjoining to the Modi hydro projects are supplied with electricity from this project. The distribution of electricity in the other parts of the downstream sub-region is ongoing. The power generated from this project is transmitted to the national electricity transmission grid through 132 Kilovolt transmission line to Pokhara substation. The local households especially in the upstream sub-region get power mainly from micro-hydro plants. Table 6.15 shows household level use of hydroelectricity in the Modi Khola watershed.

Table 6.15 Percentage of households using hydroelectricity

Use	Downstream			Upstream		Total
	Lower	Middle	Upper	Middle	Upper	
Lighting	86.7	76.7	0.0	76.7	82.2	66.9
Cooking	6.7	-	-	1.1	10.0	3.9
Space heating	-	-	-	-	3.3	0.8

Source: Field survey, 2002/03

Out of the total surveyed households 66.9 percent use hydroelectricity for lighting, 3.9 percent for cooking and 0.8 percent for space heating. More than 75 percent of the surveyed households use hydroelectricity for lighting purposes except in upper zone of the downstream sub-region. Hydroelectricity is not supplied in this zone. The use of hydroelectricity for cooking is limited to upper zone of the upstream sub-region and lower zone of the downstream sub-region. In these zones the percentage of households using electricity for cooking is 10.0 and 6.7 respectively. Some hotels especially in Ghandruk, Landruk, Chhomrong, Tikhedhunga, Tarapani and Kusma area use hydroelectricity for cooking. The use of electricity for space heating is limited only in the upper zone of the upstream sub-region. The use of hydroelectricity for industrial purpose is limited. Grill and furniture workshops as well as bakery industries especially in Kusma area use electricity for the production purposes. To some extent hydroelectricity has assisted local people in reducing dependency in fuelwood by providing renewal energy. Its contribution to livelihood is also realized in terms of improvement in health condition and time saving for firewood collection.

The micro-hydro projects installed with the support of ACAP are community-based projects where local people are involved right from the project initiation through completion to maintenance. The local communities are responsible for the operation, maintenance, and management of the projects. After the completion of construction, the project is handed over to the local community. The community then becomes responsible for its operation. For the maintenance of the project the management committees fix certain tariff for electricity users. The tariff rate varies by plants and types of users. The tariff rate also varies with the amount of power used by the households. For example, three types of tariffs are employed at Ghandruk. (Rs 0.50 per watt per month for household use, Rs 0.75 per watt per month for lodges and Rs 600 per month for micro-enterprises). Two types of rates are employed in Chhomrong (Rs 0.45 per watt per month for household use and Rs 1.20 per watt per month for lodges).

6.6.2 Water adequacy and its future

The water adequacy status of hydroelectric projects installed in different parts of the Modi Khola watershed is given in Table 6.16. Out of the total 17 projects, 17.7 percent (3 projects) reported water shortage during the dry season. Water stress is reported only in the upstream sub-region. None of the hydro plants operated in the downstream sub-region reported water stress. All these three projects reporting water shortage are located on the rain-fed rivers, which have very low discharge in the dry season. These hydro plants reporting water shortages during dry season are located in Landruk, Chhomrong and Ghandruk.

Table 6.16 Status of water adequacy for hydro-plants

Sub-region/zones	Number	Adequate		Inadequate	
		Number	Percent	Number	Percent
Downstream	**2**	**2**	**11.8**	**-**	**-**
Lower	1	1	5.9	-	-
Middle	1	1	5.9	-	-
Upper	-	-	-	-	-
Upstream	**15**	**12**	**70.5**	**3**	**17.7**
Middle	5	4	23.5	1	5.9
Upper	10	8	47.0	2	11.8
Total	**17**	**14**	**82.3**	**3**	**17.7**

Source: Field survey, 2002/03

The prospect of hydropower generation is high in the Modi Khola area due to favorable conditions. Two hydropower projects have already been identified on the Modi Khola within a short physical distance in the headwaters from the existing Modi Khola project. A hydroelectric project (Upper Modi A Hydroelectric Project) with an installed capacity of 38 MW is identified near Nayapul, Himal Kyu, at a point about 150 m downstream from the confluence of Kimrung and Modi Khola in Ghandruk VDC (East Consult, 1998). Preliminary environmental study has already been completed. Another potential hydroproject identified is the Upper Modi Hydropower Project (UMHEP) with a capacity of 14 MW. Nepal Electricity Authority (NEA) has already completed its feasibility study. The project site is located at about 8 km north of Nayapul along the Pokhara-Baglung highway. The location of head works is proposed at Kimchebensi and powerhouse at Birethanti near the confluence of Modi with Bhurungdi Khola. The total installed capacity of these two projects is estimated at 52 MW power.

There are a number of perennial tributaries in the study area. Many micro-hydro projects are possible from these tributaries. The development of Micro-hydro project is cost effective particularly in scattered mountainous villages where the extension of central grid is difficult and bears high cost. The development of micro-hydropower is an important policy option of King Mahendra Trust for Nature Conservation's Annapurna Conservation Area Project. The identification and development of new Micro-hydro projects is a part of its regular activities. Thus, the prospect of further development of Micro-hydro project is high in this area.

6.7 Tourism and recreation

Like in other sectors of livelihood activities, water is considered as one of the important components for the development of tourism. The provisions of sufficient amount of potable water, good sanitation, provision of hot and cold water shower in the hotel, and opportunities of recreation such as swimming and bathing, rafting and boating and sport fishing play significant role in the development of tourism. The existing water supply system and water availability in general is discussed in section 6.3. The use of water for hotel keeping and recreation is discussed below.

6.7.1 Water use for hotel keeping

As noted earlier tourism is an important livelihood source for the local people especially in the upper parts of the Modi Khola watershed. Water has significant role for the development of tourism business and is heavily used for different purposes especially in hotels and lodges for the betterment of tourists and for maintaining good sanitation. These water uses include hot and cold water shower for bathing, washing, cleaning and waste management. Most of the hotels are connected with piped water and there is continuous supply of water. Hot water shower is available in most of the standard hotels having better provision. The hotels without hot water showers also have provision of hot water bucket to the tourist.

Good sanitation is important not only for tourism development but also for maintaining personal health of the local people. Good health ensures potentiality of work as well as longevity. Good sanitation can only be possible with the provision of sufficient amount of potable water. As reported there is plenty of water and none of the hotels reported shortage of water. The provision of toilet facility with sufficient water supply is considered as one of the indicators of good sanitation. Out of total 213 hotels and lodges operated in the upper parts of the Modi Khola area almost all (99 percent) have toilet facility and almost all the hotels have good water supply. The number of toilets and their provision of waste management are given in Table 6.17. An overwhelming majority (85.6 percent) of the hotels have provision of pit or septic tank for waste management. A remarkable proportion (13.6 percent) of hotels and lodges have toilet facility without septic tank.

Table 6.17 Toilet facilities in hotels and lodges

Provision	Total number	Percentage
Septic tank	154	72.3
Pit	28	13.1
Directly linked to stream	29	13.6
No provision	2	1.0
Total	213	100.0

Source: Field survey, 2002/03

Toilets without proper waste management are mostly confined to areas like Nayapul, Birethanti, Komrong Danda and Ghurjung areas along the river. In these areas mostly

toilets are located nearby water bodies and are directly linked to streams. This leads to water pollution in this area.

6.7.2 Water for recreation

Recreation is a part of people's livelihood. Both tourist and local people use water from the Modi Khola area for a number of recreation purposes. The recreation activities in this area include swimming, bathing and sport fishing. No rafting as well as water transportation is developed in this area. It is perhaps due to low volume of water in the river. Both the locals as well as the tourists undertake swimming in the Modi Khola and its tributaries. However, swimming in this river is not extensive. Local people and tourist swim in this river basically in summer season. In the winter season river water becomes too cold as it originates from glaciers of Annapurna Himalaya. People use river water extensively for washing purposes. Besides, local people and tourists (both pilgrims and trekkers) take hot spring bath at Jhinudanda hot spring. This is a famous hot water spring in this area. People believed that bathing at hot water spring is beneficial for skin diseases.

6.8 Cultural or religious use

Water from Modi Khola and its tributaries is used for various religious and cultural purposes. Pilgrimage bath and cremation are important cultural uses. Majhbeni, a confluence of Modi Khola and Kaligandaki River, is an important place of religious importance. A number of pilgrims visit this place for religious bath every year especially during occasions like *Magheshakranti*, *Thuli Ekadasi*, *Janaipurnima* and *Shripanchami*. Another place for religious importance is the hot springs located at Jhinudanda little upstream from Modi-Kimrung Khola confluence. A number of pilgrims visit this area every year for religious bath especially in Shripanchami festival. Apart from pilgrimage bath local people bring dead bodies in the Modi Khola and its tributaries for cremation. There are a number of cremation ghats located in different parts along the Modi Khola. Mostly, local people use confluence sites for cremation. It is another important cultural use of river.

6.9 Extracting sand and gravel

Local people extract sand and gravels from Modi Khola and its tributaries. Sand and gravel extracted from riverbed are used for different construction purposes such as

buildings, roads and bridges. Extracting sand and gravel is extensive in the downstream sub-region as compared to the upstream sub-region. Since district headquarters is located at Kusma bazaar in the downstream sub-region, building construction is high due to increasing trend of urbanization. Due to development of road, transportation of sand and gravel is easy in this part. Some people basically poor living nearby rivers are involved in sand and gravel extracting work. It is one of the income sources for their livelihoods.

6.10 Water use conflicts and management

6.10.1 Water use conflicts

Water stress creates occasional water use conflicts. Conflicts occasionally arise within as well as between different users. The conflicts are mainly confined to the lower parts of the watershed particularly in Kusma and Gyadi areas where water stress is high. Seasonal decline in volume of water is the main cause of conflict. In the dry season, people have to spend long time in queue for waiting their turn to fetch drinking water especially in Kusma area. Interference in the queue results in conflicts.

Occasional conflicts also arise during agricultural season between users of drinking water and irrigation water users. In this time, in some places, drinking water is diverted to agricultural field. As reported, these conflicts are not serious and settled locally with mutual understanding. The frequency of water use conflict is high in Gyadi irrigation scheme within water users. In this scheme conflicts arise during the time of long dry spell in the transplantation season. The conflicts are mainly confined between users of source region and tail of the canal. To date all the conflicts are settled locally through discussions and mutual understandings.

6.10.2 Water management

For the management of water for irrigation, there is a provision of irrigation management committees for all agency-developed irrigation schemes in the study area. Management committees are formed selecting representatives from water users. All water users of a particular irrigation scheme are the general members of water user committee of that particular irrigation scheme. They have developed certain rules for the smooth operation of irrigation schemes, maintenance of canal and use of

water. The rules are both written and unwritten. Regarding water use, occasional conflicts are reported among members especially in winter and dry season. The shortage of water leads to violation of rules that creates conflicts naturally. Conflicts are mostly common in the downstream parts. In this area agriculture is intensive and the demand for water is high and water supply does not meet the requirement especially in dry periods of the year. The conflicts that emerged due to violation of rules for water use are mostly settled locally. To date no conflicts are reported that cannot be resolved within the community. There is a practice of resolving conflicts through mutual understanding and discussion among users.

For the smooth operation of irrigation water, canals are normally cleaned twice a year. All members of water users are involved for cleaning by contributing either labor or cash. Though the management practices vary by irrigation schemes, all users have to contribute proportionally in the case of maintenance of irrigation canals. For example in the case of Gyadi Irrigation scheme, all users have to pay proportionally on the basis of area that is irrigated by that scheme. This is a well-managed scheme, and there is a provision of watchmen appointed by water users for regular maintenance and distribution of water. For this, all water users have to pay Rs 20 per *ropani* of land per year.

Almost all agency developed drinking water schemes also have management committee. All water users are the general members of that particular drinking water scheme. As reported, all members have to contribute equally for the maintenance of drinking water scheme. There are two types of drinking water schemes in the watershed i.e. run-off type and reservoir system. From schemes with reservoir system particularly in Ghandruk, Bajung and Kusma areas water is regulated and distributed twice a day- morning and evening time. For this there is a provision of watchman nominated by water management committee with fixed duties and responsibility. The watchman controls the water circulation. Water users have to pay certain amount for this provision however, that varies by schemes. For example, each water user households of Bajung have to pay 12 *mana* (equivalent to 6 kg) grains for the provision of watchman monthly.

6.11 Discussion on the application of water use model

Water use model as discussed in Chapter II provides the relationship between supply and demand of water, the influencing factors, use types and their implications on livelihood outcomes. It has helped to examine how and to what extent water is essential and important for livelihoods. Therefore, the water use model adopted in this study proved useful in analyzing water-based livelihoods. In several cases, the application of the model has been based on qualitative assessment. In these cases objective assessment has not been possible due to lack of quantitative data. The suggested model appears to be a potential conceptual basis for the future research along this direction.

It is evident from the above discussion that livelihoods of the people of Modi watershed heavily depend on water resources. It is used in a wide variety of livelihood activities such as irrigation, household use, power generation, mill operation, fishing, tourism, processing activities and cultural uses. Agricultural production, a major livelihood base of the local people is directly related to irrigation facility. The contribution of water is significant not only in different production activities but also in animal health. Any changes in water availability would have significant impacts on local livelihoods as well as ecological balance. The changes in water availability as caused by global warming and effects of these changes on livelihoods are discussed in Chapter seven.

CHAPTER VII

CLIMATE CHANGE AND LIVELIHOODS

7.1 General

Chapter six dealt with different water uses and its contribution on local livelihoods. As water is heavily used in a variety of livelihood activities, any changes in water availability as caused by changes in climatic elements due to global warming would have significant effects on local livelihoods. Trends of temperature, precipitation and river flows in the watershed and possible impacts on local livelihoods are discussed below.

Earth's climate has remained relatively stable for a period of about 10,000 years. Over this period modern society has evolved and in many cases successfully adapted to the prevailing local climate and its natural variability (Watson et al., 1996: 21). Now present society has started facing potentially rapid changes in climate because of human activities that alter the atmospheric composition. During the past century, the global climate has warmed by an average of 0.5^0 C, the largest increase at least in one thousand years. As a result of increase in temperature, snow covered area is decreasing, glaciers are retreating, lakes and rivers are warming, rainfall patterns are changing and El Nino episodes are occurring more often (Bergkamp et al., 2003). Most of the warming observed over the last 50 years is attributable to human activities. The warming is continued and the global mean surface temperature is projected to increase by 1.4-5.8^0 C by 2100- a rate of warming that's very likely without precedent during at least the last 10,000 years (The Red Cross and Red Crescent Climate Center, 2003).

Atmospheric dynamics create locally distinct topographical microclimates that influence a wide range of environmental factors (Beniston et al., 1996). The warming varies by region. For mid latitude regions, an average global warming would be 1-3.5^0 C over the next 100 years. The South Asian region is likely to be one of the worst hit region around the world due to its high susceptibility to extreme weather events as a consequences of high temporal, spatial and inter-annual climate variability (Choudhury et al., 2002). Some recent studies have shown that air temperatures have

shown slight increase in all the countries of the South Asia (Mitra, 2002). In Nepal, the increase in temperature has clearly been observed after the mid 1970s (Shrestha et al., 1999), however, the rate of warming varies by region. The trend of warming is higher in higher altitude regions of the country (Shrestha, et al., 1999; Mool et al., 2001; Mitra, 2002). The rate of change is 0.6^0 to 1.2^0 C per decade in the middle mountain and the Himalayan region and less than 0.3^0 C in the Siwalik and Tarai region (Mitra, 2002:4).

Changing temperature obviously results in change in pattern of precipitation. The temperature change is accompanied by both increases and decreases in precipitation, depending on region and aspect. Alterations to the seasonal distribution of precipitation with the likelihood of more rain, less snow, and higher evaporation resulting from temperature increase will be common (Berkamp et al., 2003:6). In Nepal, there is no long-term fixed trend of annual rainfall identified (Shrestha et al., 2000; Nayava, 2004). The annual rainfall shows large inter-annual and decadal variation (Shrestha et al., 2000). The changes in precipitation also vary by places. The precipitation is concentrated in monsoon season (70-90 percent). Monsoon precipitation in Nepal is related to El Nino and other large-scale climatological parameters (Shrestha et al., 2000).

The changes in temperature and precipitation result in change in water availability. Relatively small changes in temperature and precipitation can have large effects on soil moisture status and the volume and timing of runoff (Hayes, 1991). The impacts on water supply in river basin, regions and country can be large. South Asia including Nepal is highly vulnerable from changing water balance, arising from increasing demand and also from climate change (Mitra, 2003:1). A change in the volume and the distribution of water will affect ground and surface water supply for domestic and industrial uses, irrigation, hydropower generation, navigation, in stream ecosystem and water based recreations (Watson et al., 1996:8).

The changes in water availability along with increase in temperature and alteration in pattern and intensity of rainfall would have greater impacts on livelihoods. The potential effects of increasing temperature are more indirect and can only be estimated qualitatively however, these determine the general strategy of population and economy (Georgiyevsky, 1998). The most important effects of these changes would

lie on the food production (Pratap and Pratap, 2001; Cooper, 2000; Mendelsohn and Dinar, 1999) and increased threats to human health (Longespeth, 1991).

7.2 Trends of temperature and precipitation change in the study area

As noted above, warming is a global phenomenon. The increase in temperature varies by region and locality. The changes in temperature obviously result in changes in amount, intensity and pattern of precipitation, which lead to changes in water availability. These changes have varieties of implications, both positive and negative on livelihoods. Considering this, an attempt has been made to study the climate change scenario, water availability and its impact on local livelihoods of the study area. To discuss the trends of temperature and precipitation changes and likely impacts on livelihoods, information from three different sources have been collected and analyzed. These include

i) recorded data of temperature and precipitation,
ii) perception of local people, and
iii) secondary information collected from previous study reports of that area.

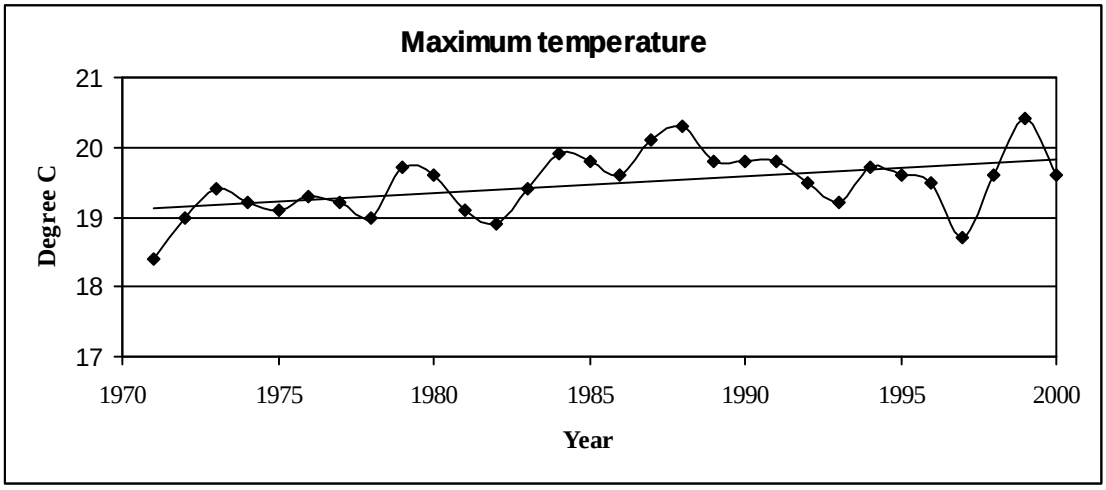
For the analysis of recorded data, information from three stations are used. Of the three stations, only one station (Lumle) has complete set of temperature data for 30 years. For this reason the trend analysis of temperature has been based only on Lumle station while precipitation data are analyzed for three stations. The perceptions of people regarding changes in temperature, precipitation, snow cover area and natural disasters and associated loss have been collected through group discussions and consultations. Earlier studies related to climate change of this area are the other sources of information for the study. The detail discussions on trend of temperature and precipitation change and river flows and their potential impacts on livelihoods are presented below.

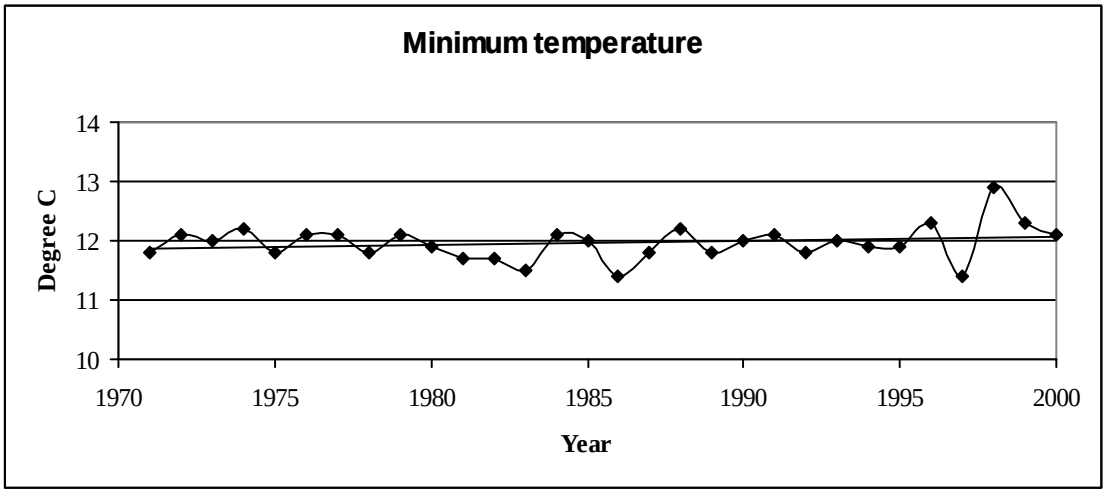
7.2.1 Trend of temperature

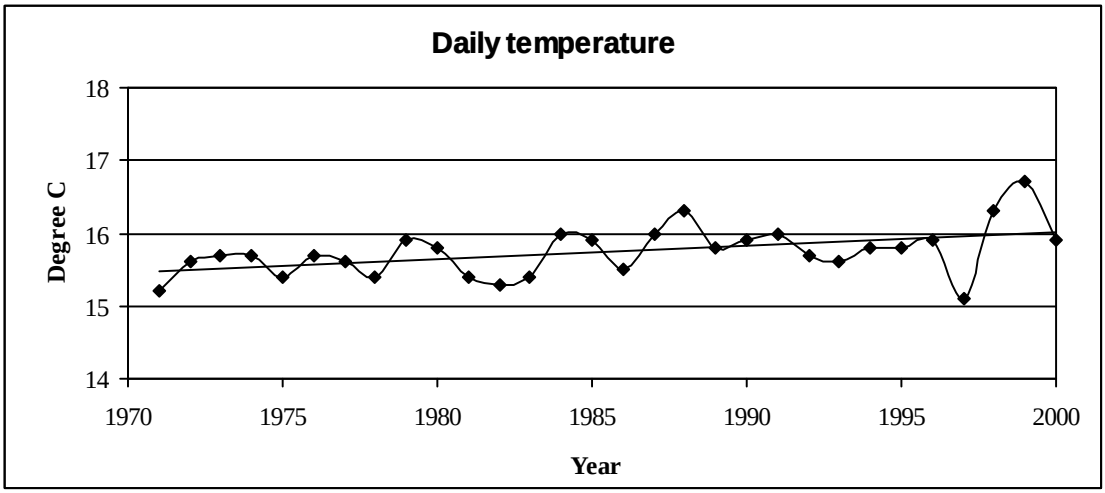
The temporal variations of average maximum and minimum temperature for the period of 30 years (1971-2000) for Lumle station located within the Modi watershed have been plotted. A trend analysis of maximum, minimum and daily temperature has been performed and it is shown in Figure 7.1. All three graphs show the positive trends. This indicates that the temperature in the Modi Khola area has been

increasing. The trend value is higher for maximum temperature than for the minimum. A similar trend of increasing temperature was presented by Shrestha et al. (2002). The highest average temperature was recorded in 1999 during a period of 30 years.

Figure 7.1 Trends of maximum, minimum and daily temperature



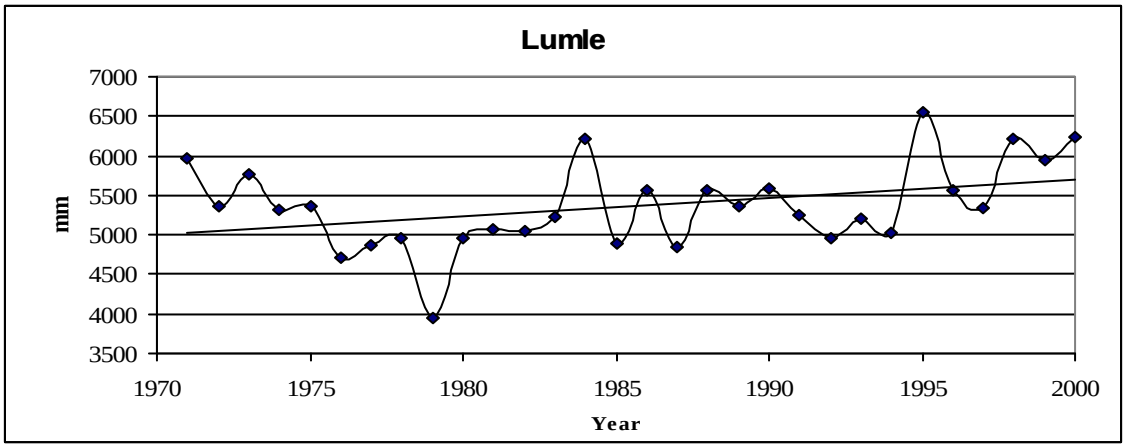


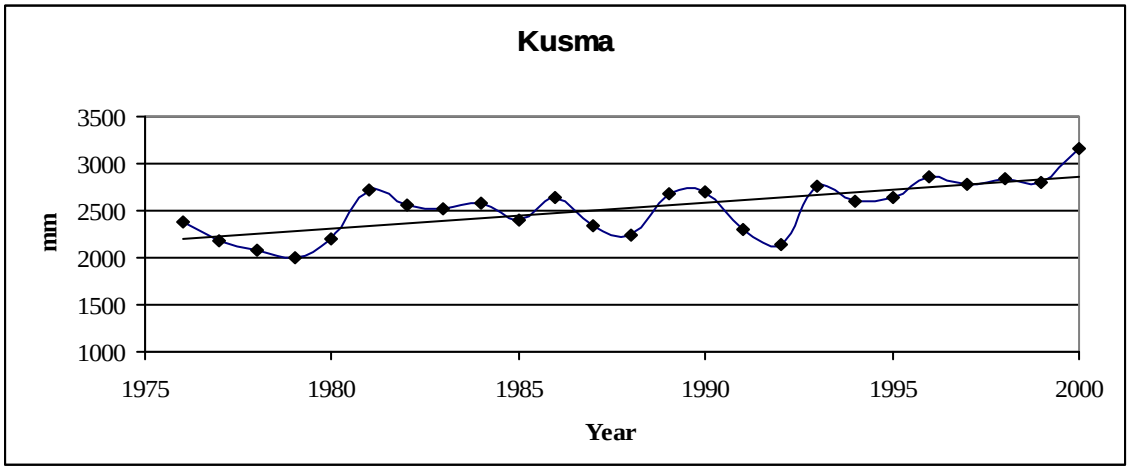


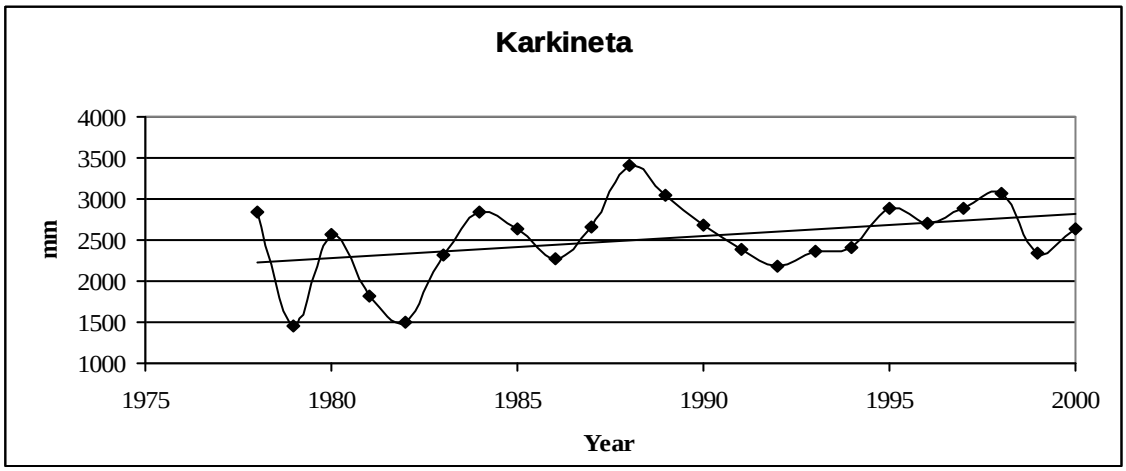
7.2.2 Trend of precipitation

The temporal variations of annual rainfall for three stations namely Lumle (1971-2000), Kusma (1976-2000) and Karkineta (1978-2000) are plotted and trend analysis is preformed. Time series data of yearly precipitation for these three stations show an increasing trend (Figure 7.2).

Figure 7.2 Trend of precipitation in Lumle, Kusma and Karkineta stations





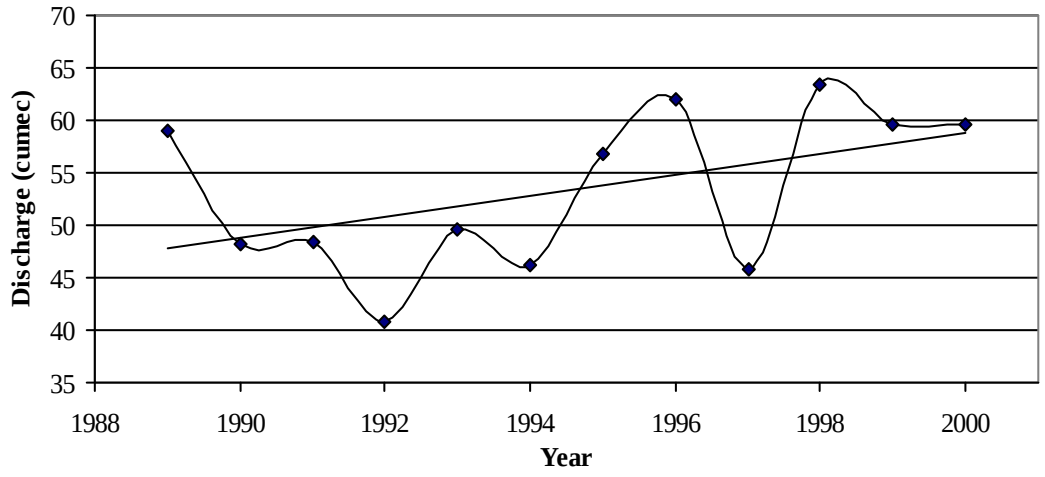


Previous studies also showed the same results of increasing precipitation in the Modi Khola area (Shrestha et al., 2002; Nayava, 2004). Shrestah et al. (2002) have shown the increase of rainfall by 23.5 and 25.2 mm per year respectively for Lumle and Kusma stations. Nayava (2004) has also identified the increasing trend of precipitation for Lumle station. Figure 7.2 also shows the inter-annual variation of rainfall. The minimum average annual rainfall was observed in 1979 in all three stations whereas the year of maximum rainfall did not coincide. During 30 years' period Lumle received maximum rainfall in 1995 whereas Kusma received maximum rainfall in 2002 during the period of 25 years. The above figure 7.2 shows this.

7.3 Trend of river flow

Water is most sensitive to climate. Any change in temperature and precipitation obviously results in change in water availability. As noted above, both temperature and precipitation in the Modi Khola basin have been increasing. In this context, a trend analysis is performed to see the effect of change on river flow discharge of the Modi Khola. For this, temporal variation of average annual discharge of Modi Khola at Nayapul gauging station for the period of 12 years (1989-2000) is analyzed. The plotted trend line is shown in Figure 7.3.

Figure 7.3 Trend of average annual discharge of Modi Khola

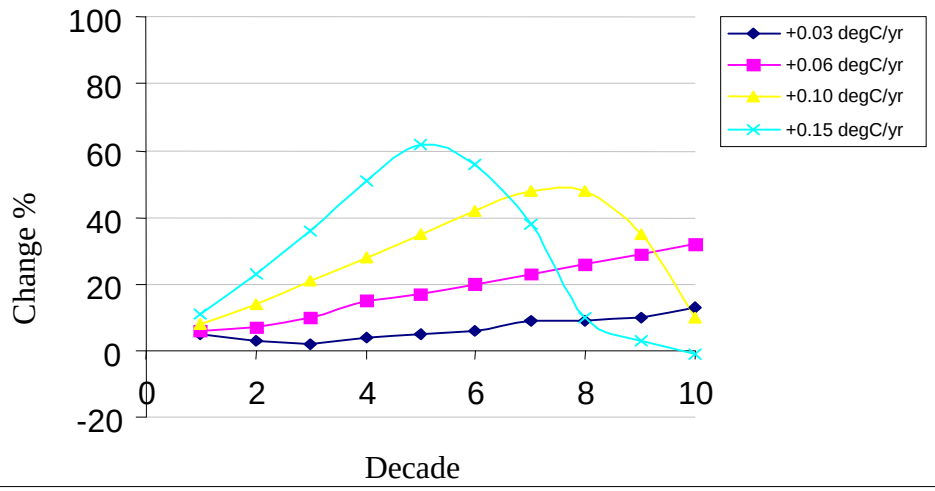


The trend line indicates that the average discharge of the Modi Khola has been increasing. Figure 7.3 also shows the inter-annual variations in discharge. The minimum and maximum average annual flow was recorded in 1992 and 1998 respectively. Similar an increasing trend of discharge in this river was noted by

Shrestha et al. (2002). The flow is in increasing trend in both wet and dry months. The increasing trend of annual discharge is perhaps due to an increase in both temperature and precipitation. The increase in monsoon rainfall amount in the basin caused increase in discharge during monsoon season. Likewise, the increase in discharge during dry months or pre-monsoon time is mainly due to an increasing trend of pre-monsoon rainfall and snowmelt as caused by increase in temperature.

Rees and Collins (2004) estimated the decadal variation in mean flow of the Modi Khola for the period of 100 years using different models. The estimation is based on different temperature change scenarios from 0.03^0 C per year to 0.15^0 C per year. The forecasted mean flow of the Modi Khola at Kusma area is shown in Figure 7.4. The figure clearly indicates that the volume of river flow would increase for many decades, however the volume would vary by temperature scenarios.

Figure: 7.4 Future decadal variations in mean flow at Modi Khola, Kusma



Source: Adopted from Rees and Collins (2004)

As discussed above, water discharge in the Modi Khola has been increasing with the increase in precipitation and snow melting caused by temperature rise. The intensity and pattern of the precipitation have also been changing. The changes in intensity and pattern of precipitation along with temperature rise lead to water induced disasters and associated loss.

Floods, draughts, landslides, snow/avalanches, hailstorm and windstorms are the common water induced natural disasters, which cause loss of people, livestock, cropland, crops and other properties in the Modi Khola watershed. The frequency of

events and magnitude of loss vary by time and place. A number of households in the Modi Khola watershed were affected by these disasters during last 10 years. The households reporting loss from different disasters during the period of 10 years is presented in Table 7.1.

Table 7.1 Trend of loss by disasters

	Floods		Droughts		Landslides		Snow/ Avalanche		Hailstorms		Windstorms	
Year	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%
1993	1	0.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1994	1	0.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1995	0	0.0	1	0.3	1	0.3	0	0.0	5	1.4	0	0.0
1996	0	0.0	0	0.0	2	0.6	0	0.0	0	0.0	0	0.0
1997	0	0.0	4	1.1	3	0.8	0	0.0	1	0.3	0	0.0
1998	2	0.6	3	0.8	0	0.0	1	0.3	2	0.6	1	0.3
1999	0	0.0	4	1.1	3	0.8	4	1.1	2	0.6	0	0.0
2000	5	1.4	15	4.2	8	2.2	3	0.8	8	2.2	0	0.0
2001	19	5.3	22	6.1	30	8.3	6	1.7	104	28.9	7	1.9
2002	21	5.8	12	3.3	27	7.5	0	0.0	90	25.0	5	1.4
Total	49	13.6	61	16.9	74	20.6	14	3.9	212	58.9	13	3.6

Source: Field survey, 202/03

Among disasters, hailstorm is the most common, which has caused heavy loss of crops every year. Out of the total surveyed households, 58.9 percent of the households lost some amount of crops and other properties by hailstorm during 10 years' period. The number of households affected by hailstorm is in increasing trend. The proportion of households reporting loss from landslide is 20.6 percent. A total of 30 households (8.3 percent) have lost some croplands in 2001. At the same period people reported draught events too. The number of households reporting loss by draught is 16.9 percent. The number of households reporting loss from draught is high in 2000 and 2001. In these years, the amount of rainfall was relatively low as compared to the cases of the earlier years. The number of households reporting loss from flood, snow/avalanches, and windstorm is 13.6, 3.9 and 3.6 percent respectively. The households reporting loss from snow/avalanche are confined only to the upper parts of the watershed.

Table 7.2 shows the loss by types of disasters and zone. The proportion of households reporting loss by flood is high in the middle zone of both the upstream and downstream sub-regions as compared to other zones. The proportion of households

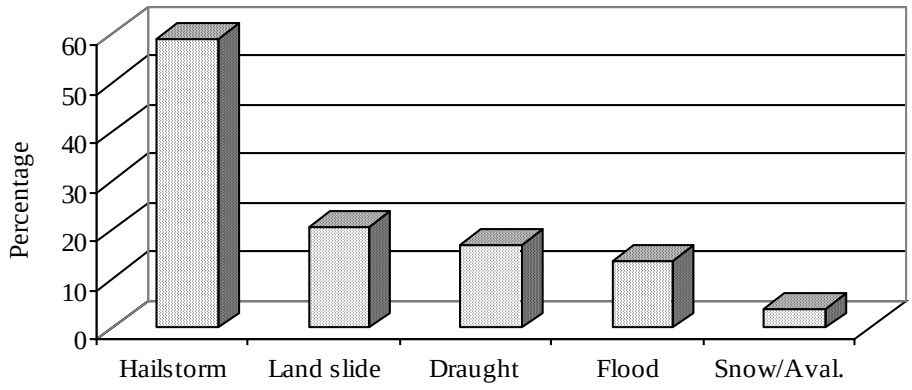
reporting loss from draught is high (28.9 percent) in the upper zone of the upstream sub-region. The proportion of household reporting loss from draught is 17.8 percent in the middle zone of the upstream sub-region. The crop production of both these areas are adversely affected due to low rainfall. Loss from landslide is high in the middle zones of both the sub-regions. The loss of snow/avalanche and hailstorm increases from south to the north with increase in altitude. The proportion of the households reporting loss from storm is high in middle zone of the upstream sub-region.

Table 7.2 Households reporting loss by disasters during 10 years' period

Types of disaster	Downstream						Upstream				Total	
	Lower		Middle		Upper		Middle		Upper			
	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%
Hailstorm	9	15.0	28	46.7	50	83.3	55	61.1	70	77.8	212	58.9
Land slide	4	6.7	14	23.3	4	6.7	24	26.7	28	31.1	74	20.6
Draught	8	13.3	5	8.3	6	10.0	16	17.8	26	28.9	61	16.9
Flood	6	10.0	8	13.3	0	0.0	20	22.2	15	16.7	49	13.6
Snow/Avalanche	0	0.0	0	0.0	5	8.3	1	1.11	7	7.78	14	3.9
Storm	1	1.7	0	0.0	1	1.7	8	8.89	3	3.33	13	3.6

Source: Field survey, 202/03

Figure 7.5 Households reporting loss by types of disaster



7.4 Climate change

Since air temperature and precipitation are two important elements of climate, they become major basis for the evaluation of climatic condition. The recorded temperature data of Lumle station for the period of 30 years (1971-2000) clearly shows the increasing trends in all maximum, minimum and daily temperatures. The

previous study made by Shrestha et al. (2002) also reported the similar trend of increasing temperature for Lumle station. Analyzing the average trend of the mean temperature of seven selected stations in the Modi Khola watershed and vicinity, Shrestha et al. (2002) have found the increasing trend of temperature in this area. The increase was 0.0246^0 C/year.

Similarly, precipitation data also shows the similar increasing trends. As discussed above, recorded data of all three stations located in the watershed namely Lumle, Kusma and Karkineta show the increasing trends. However, there are some inter-annual and decadal variations. Earlier studies showed the temporal variations with similar trend of increasing precipitation in both Lumle and Kusma stations (Shrestha et al., 2002; Nayava, 2004). The increase was 23.5 mm/year for Lumle and 25.2 mm/year for Kusma station.

River flow is directly associated with temperature and precipitation. The effect of changes in temperature and precipitation can clearly be seen in the discharge of Modi Khola, the discharge has been increasing. Shrestha et al. (2002) and Rees and Colins (2004) also identified the increasing trends of discharge of Modi Khola. The flow was rising for both wet and dry seasons. Obviously, the increase in river flow is either due to increase in rainfall or snow melting caused by temperature rise or both.

The changes in terms of temperature, precipitation and river discharge clearly indicate the changes of climatic conditions. The data indications are also strongly supported by perception of local people. To know how local people have perceived about changes in temperature, precipitation and river discharge over time, the perceptions of people have been collected through participatory group discussion and consultations.

Regarding temperature local people perceived some changes. Out of total 12 discussion groups, 6 groups noticed that temperature has been rising in the watershed (Appendix 6). They expressed that temperature has been rising over the last few decades. The reported indicators of increasing temperature were shrinkage of snow-cover area, increase in flow of river, and prevalence of mosquito in the higher altitude. They also noted that crops were ripening earlier than in the past. Two-third of the discussion groups of the downstream sub-region reported increase in temperature while one-third of the groups of the upstream sub-region reported the same feeling.

The other groups noticed no change in temperature. The groups reporting no change in temperature were mostly from the upper zones where weather conditions all the time are cold and the local people perhaps could not perceive a slight change of temperature.

One-third of the discussion groups reported that precipitation in terms of amount and intensity had been increasing (Appendix 7). They noticed more events of localized high intensity rainfall. In addition, the changes in pattern of hailstorm and snowfall had also been noticed. In the past hailstorms usually occurred in the month of April, but now they seemed to be occurring earlier. However, majority of the discussion groups reported in other way. It seems that people living in close vicinity to rivers perceived the increase of precipitation whereas those away from the river course felt in other way.

Local people also perceived that snow-covered areas in the study area had shrunk. Nine out of 12 groups noticed reduction of snow-covered areas (Appendix 8). They noticed shrinkage in snow-covered area and upward shift of permanent snow line. The shrinkage in snow-covered area is seemingly due to increase in temperature. It is to be noted that three discussion groups did not notice any change in snow-covered areas. Perhaps people residing in the lower valley do not have any precise idea about the extent of snow-covered area.

Thirty year's recorded data for the analysis is not sufficient for analyzing climate change. However, recorded data and proxy indicators as well as perceptions of local people appear to be a strong indicator of climate change in the study area.

7.5 Some observations on likely impacts on livelihoods

Both intensity and pattern of precipitation have been changing with the increase in temperature in the study area. Water availability has also been increasing with the increase in river discharge caused by changes in climatic elements. The changes would have varieties of implications, both positive and negative on livelihood activities depending on locality. The study conducted in this area by Caroline et al. (2004) also concluded along this line. However, no remarkable changes in local livelihoods are identified yet. If the scenario continues there is possibility of likely

changes in livelihood activities. Some observations on likely impacts of climate change on livelihoods activities are given below.

a) Impacts on Agriculture: Agriculture is an important source of livelihoods in terms of supply of foodstuff, percentage share in household income and employment. Both temperature and availability of water greatly influence the agricultural pattern and productivity. As discussed above, both temperature and precipitation have been increasing in the study area. Changes in temperature and water availability caused by climate change would have significant impacts on livelihoods resulting from effects on production and productivity of crops.

b) Impacts on industrial activities: As noted above water is used for a number of industrial purposes. Among different users, water use for hydropower development and mill operation is extensive. A remarkable number of watermills operated in this area are seasonal due to the shortage of water during dry season. Some of the power plants are also facing water shortages during dry seasons. The increase in water availability as caused by climate change would bring changes in operation of watermills and hydropower plants. Such changes would have impacts on local livelihoods affecting watermill operation and power production.

c) Impacts on fishing: Though fishing is not extensive in terms of both number of people involved and amount of fish caught, it is one of the sources and means of livelihoods of some of the people specially those who live by riversides. The increase in temperature and rainfall both would have direct and indirect impacts on fish population in the river and also in fishing activity. Longer growing seasons, lower natural winter mortality and upward shift of spawning ground and changes in migration pattern are likely due to increase in temperature. Likewise, the increase in river flow as a result of climate change would also have impacts on fish availability pattern. The construction of dam for Modi hydropower project has created dewater zone between dam site and powerhouse during low water flow period which causes sharp decline in fish population in the Modi Khola due to disruption of path of fish migration. The increase in water flow in the river might have changes the situation. The disrupted fish path get restored with the increase in river volume, which results in increase in fish availability allowing fish migration and fish breeding. These changes

help maintain aquatic ecosystem. Obviously, these changes can bring lots of changes on livelihoods of people who depend on fishing activity.

d) Impacts on tourism: Snow-capped mountains are the major attractions for the tourists in this region. Upward shifting of snow line and decline in snow-covered area as a result of increase in temperature are noticed in this area. The shrinkage or decline in snow-covered area may have negative impact in tourism. The decline in natural beauty reduces tourist attraction and ultimately shortens the duration of their stay in this area. As mentioned earlier, the economy and livelihoods of the people of the upper parts of the Modi watershed is heavily based on tourism. The decline in tourism activities as a result of decline in attraction due to snowmelt will have serious impacts on livelihoods of the local people and economy of the area.

e) Impacts on infrastructure: The changes in temperature and precipitation can have a number of positive and negative impacts on infrastructures related to energy, industry and transportation. The increase in extreme events causes damages of dams, irrigation canals, trails, roads and bridges. At the same time changes in amount and intensity of precipitation can have positive impacts for infrastructures like watermills and micro-hydro plants in the study area. A number of watermills and micro-hydro plants facing water shortage during dry season can run smoothly throughout the year with the increase in amount of water flow that is caused by increase in precipitation and snowmelt. These changes have impacts on livelihood activities.

f) Impacts on other sectors and activities: Changes in water availability leave an impact on a number of other sectors directly or indirectly. One of the direct impacts is change in growth and regeneration capacity of forest and pasture lands. This may cause changes in the availability of fodder and other forest resources. Changes in the availability of fodder may have impacts on both livestock and wildlife. Besides, the changes in forest density have impacts on water resources. All these things are directly or indirectly related to the people's livelihoods. Climate change would also affect the processes of soil formation and bio-organisms. These changes have direct or indirect bearing on assets and livelihood strategies of the local people.

The above discussion clearly shows that Modi Khola watershed area has been experiencing some changes on different climatic elements. Water availability in this

area has also been increasing with the changes in pattern and intensity of precipitation. Local people also perceived these changes. Both recorded data and proxy indicators that perceived by local people provide clear indication of climate change in the study area. The change in climate is not localized one; it might be the effects of global warming. There is no doubt that the changes in climate may have direct or indirect implications on people's livelihood affecting different livelihood activities both positively and negatively. However, no remarkable changes on livelihood activities as caused by climate change are identified yet in the study area. Local people are aware about possible effects of these changes on their livelihoods.

CHAPTER VIII

SUMMARY, CONCLUSION AND RECOMMENDATION

8.1 Theoretical and methodological basis

The present study aimed at examining livelihoods of the people living in Mountain areas. The objectives are to assess the present livelihoods and strategies adopted by the people, to analyse different assets and their implications in livelihoods and to assess the role of water in livelihoods, its utilization and management. The study area is Modi Khola watershed, located in the Western Development Region of Nepal. The watershed covers an area of 676.8 sq. km and displays cross profiles of different altitudinal zones (Middle Mountain to the High Himalayas) within a short physical distance of about 51 Km. The altitude ranges from less than 500 meter in the south to above 8,000 meter in the north and climate ranges from sub-tropical to alpine types. The area consists of 28 VDCs (18 entirely and 10 partially) of Kaski, Parbat and Myagdi districts. The population of the watershed is 75,000.

The study is based on the livelihood concept developed by Robert Chambers and framework of DFID. For the analysis of water use and related aspects, a water use model is developed. Both primary and secondary data used in the study. Household survey, group discussions, mapping of water related infrastructures and services and observation techniques were used for primary data collection. A total of 360 households were randomly selected for household survey. Twelve group discussions were organized. An inventory of different water uses was made through consultation with local people and field observation. These were mapped using GPS and recent topographic maps. Extensive field observation was made as a supplementary method. The community level assets and socio-cultural aspects of the study area were observed and recorded.

The spatial database was prepared by digitizing recent topo-sheets (scales1: 25,000 and 1:50,000) using GIS. Both statistical and non-statistical tools were applied for data analysis. Altogether three sets of hypotheses were statistically tested using different parametric and non-parametric statistical tools (multiple regression, Analysis of Variance and Chi square test).

8.2 Summary of findings

The major findings of the study are mentioned below in the context of livelihood assets, livelihood strategies, water and livelihoods and climate and livelihoods.

8.2.1 Livelihood assets

A range of assets is required to achieve varied livelihood outcomes, however, the contribution of different assets to livelihoods varies by individual/household and localities as a result of variations in the level of access to assets, capabilities of people in exploiting these assets, and the local environmental condition. Major findings of five different types of assets analyzed in the study are presented below.

a) Natural assets: Natural assets have significant role in shaping local livelihoods. Land, water, physical landscape, bio-diversity, pasturelands and trees in farm are the main natural assets of this area.

Land has significant role in livelihoods, as it is the only source of food for people and livestock, fuel wood, timber and cash income. The average size of the landholding in the study area both cropped and uncropped is 1.1 ha. Nearly 54 percent households own 2 to 5 hectares of land while 32 percent households has less than 0.5 ha of land. Percentage of households having larger land holding size is comparatively high in the middle zones of the downstream sub-region. Nearly 18 percent of the households rented-out some or all lands to others and 19 percent rented-in some lands. Lower zone of the downstream sub-region show high proportion (15 percent) of the land rented-out to others.

Water is indispensable for livelihoods and ecological balance. Snow/glacier, rivers and groundwater are the sources of water for sustaining livelihoods and ecological balance. The mean annual natural flow of the Modi Khola is 54.9 cumecs but the stock of snow/ice and underground water in this area is not known.

Physical landscape is the most attractive part of the aesthetic resources. There are 16 Himalayan peaks higher than 6000 meter, the majestic array of snow wall including Annapurna I beautiful sharp pyramid spotted by two symmetrical buttresses of

Machhapuchre and Annapurna Sanctuary encircled by 11 pinnacles higher than 6000 meter. In addition to this a number of rapids and falls and hot springs exist.

The floral and faunal diversity of the region is equally important. There are altogether 1,226 species of plants, and 38 species of orchids, 101 species of mammals, 478 species of birds, 39 species of reptiles and 22 species of amphibians and a number of fish species in the Annapurna Conservation Area. The major vegetation types in this area include semi-evergreen hill and riverine forest in subtropical zone, *Quercus lamellas* and mixed broad-leaved forest in lower temperate zone, Birch-rhododendron and mixed broad-leaved forest in upper temperate/ sub-alpine zone and pure grassland/pasture in alpine/naval zone.

Pastureland is also an important natural asset of this area. Thai-brow, Nade, Maye-brow, Lem-mro, Sid-gai, and Bhaisa-kharka are the main pasturelands of this area. These pasturelands are concentrated to the northern parts of the watershed. Local people use grazing lands as common property resources.

Trees on farmland have significant contribution on livelihoods. Nearly 54 percent households have up to 50 trees and 1.4 percent has above 50 trees of different fruits in their farmlands. Forty-five percent households have no fruit trees at all. Likewise 80 percent households have up to 50 fodder trees and 9 percent had more than 50 and remaining 11 percent have no fodder trees. Regarding other trees, 50.6 percent have up to 50 trees and 19.2 percent has more than 50 trees and remaining 30.3 percent of the households reported no other trees in their farmlands.

b) Physical assets: Shelter, household facilities, water delivery infrastructures, transportation and communication linkages are the main physical assets of this area.

All household posses own housing units (except two in the upstream sub-region). The average number of rooms per house varies from 2.4 to 4.3 rooms. The number of rooms per house is greater in the lower zone (4.3 rooms) of the downstream sub-region as compared to others. Most of the houses (93.4 percent) in this area are walled with mud and stone. Nearly 6 percent houses are made of cement and stone and remaining 0.8 percent are made of wood or bamboo. About 70 percent houses are two storied, 20 percent single storied and remaining 10 percent with more than two stories.

The proportion of households having household goods such as radio, television, furniture, sewing machine, and refrigerator is 90, 17.2, 46, 4.4 and 2.8 percent respectively. The number of households with radio is comparatively high in the upper zone of the upstream sub-region, while households with furniture, television, and sewing machine is high in lower zone of the downstream sub-region. Refrigerator is limited to some households of the upper zone of the upstream sub-region and the lower zone of the downstream sub-region especially in hotels and shops. Three fourth of the households has piped water supply. The proportion of households having improved latrine is 68.3 percent. A very small proportion of the household posses biogas plants, solar power and improved stoves. The proportion of households with piped water and improved latrine is high in the upper zone of the upstream sub-region while improved stove, and biogas plant is high in lower zone of the downstream sub-region. Solar power is concentrated in the upper zones of both the sub-regions.

There are altogether 55 watermills, 17 power plants including micro-hydro, 73 drinking water schemes and 13 large irrigation schemes distributed across the watershed. Nearly 93 percent watermills are concentrated in the upstream sub-region with excessive concentration in the middle zone. Out of 17 power plants, 15 are located in the upstream sub-region with concentration of 10 hydro plants in the upper zone of this sub-region. Out of 13 large irrigation schemes 12 lie in the downstream sub-region with concentration of 9 schemes in the middle zone. Likewise, out of the total 32 piped drinking water schemes, 75 percent are concentrate in the downstream sub-region with a share of 62.5 percent in the middle zone alone.

All-weather motorable roads connect the Modi Khola watershed. The Pokhara-Baglung highway passes through the area. Besides, there are other seasonal road connections. The road facilities lie entirely in the downstream sub-region. Telephone facility is available only in district headquarters and some of the major settlements. The settlements having telephone facility are Chhomrong and Ghandruk in the upstream sub-region and Bajung, Jobang, Chuwa and Katuwa Chaupari in the downstream sub-region.

c) Social asset: Community groups such as Mother's group, Youth clubs, and Users committee and *Rodighar*, a cultural organization of the Gurung and other socio-cultural and religious informal organizations are the social assets of this area.

All surveyed settlements have Mother's group. Settlements like Chhomrong, Ghandruk, Landruk and Moharia in the upstream sub-region and Chuwa and Katuwa Chaupari in downstream sub-region have Youth clubs. Forest, irrigation, drinking water and electricity user group are community users group of this area. The development of social amenities, controlling social evils and promotion of income generation activities are the major works of Mother's group while community user groups are concerned with maintenance as well as sustainable use of resources. Cultural organizations have significant role in socialization and recreation. Youth association, *rodighar* has significant role in recreation and pre-marital socialization.

d) Human asset: Literacy level, proportion of economically active population and general health condition shows the strength of human asset of this area.

Literacy level of this area is relatively high. Out of the total population (2,084) of 6 years and above 69 percent (1,437) are literate in this area. The lower zone of the downstream sub-region has the high literacy rate (73.3 percent) in comparison to others. The majority of the literate population (54.9 percent) has up to ten grades education and 7.1 percent SLC graduate. Likewise, the proportion of population having intermediate and above qualification is 7.0 percent. The lower zone of the downstream sub-region has high proportion (18.5 percent) having higher-level of education.

A total of 70.2 percent of the total population of the study area is economically active (10 years and above). The proportion of male and female constitute 50.9 and 49.1 percent respectively. About 58.2 percent population suffered from different diseases last year.

Waterborne diseases have mostly affected people of this area. Common cold is the most common disease that affected a total of 21.5 percent population last year. The proportion of population affected by diahorrea and dysentery is 7.6 percent, cough 6.2 percent, worms 6.0 percent, typhoid 4.1 percent, and pneumonia 3.0 percent. Diseases like scabies, dysentery, eye irritation, jaundice, asthma, tuberculosis and others affected nearly 10 percent population.

e) Financial asset: Livestock and money inflow (pension and remittances) are the financial assets of the household of this area.

Cattle, buffalo, goat, sheep, horse/mule and chicken are the major types of livestock reared in this area. Out of the total surveyed households 94.7 percent has some types of animal.

Remittance is one of the sources of household income, 45 percent of the surveyed households receive remittances and its share on household income is 31.2 percent. On an average each household received Rs 40,779 from remittances last year. Out of the total households, 44.1 percent has received less than Rs 10,000, whereas 40 percent has received Rs 10,000-20,000 and the rest of the households received above Rs 20,000 remittances. Pension is another source of regular inflow of money. Nearly 20 percent of the surveyed household received pension last year. Out of the total households receiving pension, 11.4 percent received amount ranging from Rs 25,000 to 50,000, 5.3 percent received more than Rs 50,000 and remaining 2.8 percent received below Rs 25000 annually. The proportion of households receiving pension is high in the upper zone of the upstream sub-region (26.7 percent).

Test of relationship of asset: Household level assets like remittance and pension received by household, land owned, rooms in the house, trees in farm land, literacy level, livestock owned, household having water tap, latrine and radio or television were selected to assess the relationship with household income. It was tested and analyzed using multiple regression models. Of the selected variables, livestock owned and dummy variables such as water tap, latrine and radio/television are insignificant while others are significant in the model. The model explains 77 percent of the total variance in the household income. Among independent variables remittance has the dominant role in the household income.

8.2.2 Livelihood strategies

People in the Modi Khola watershed perform diverse livelihoods. Agriculture, service in government and non-governmental agencies, business, tourism, industrial activities, fishing and others are the main strategies adopted by people. Besides, there are some other strategies adopted by the people. Household members adopt one or more than one activities to meet their household needs.

Agriculture is one of the important sources of livelihood. Seventy-one percent of population is involved in this sector and its contribution to household income is 16

percent, which ranks second after remittance. Paddy, maize, millet, wheat, barley and potato are major crops in terms of both area occupied and total production. Paddy and maize rank first and second in terms of both areas occupied and total production. All households growing crops use labor. Manure is used for all crops except millet. People use fertilizer to increase and maintain agricultural productivity. Fifty-six percent of the total households do not have sufficient production to meet their annual food requirements. The proportion of households having sufficient food is high in the downstream sub-region as compared to case of the upstream sub-region. Low food supply in the upper parts is due to low productivity. People have adopted a number of food deficit management practices like wage labor (43 percent) and use income from salaries and pension (40.6 percent), business (7.4 percent) and others (4 percent).

Raising livestock is one of the means of sustaining livelihoods and food security. The contribution of livestock in the total household income is only about 2 percent. On an average 2 buffaloes, 1.7 goat/sheep, and 1.3 cattle are raised per household. Buffaloes and goat/sheep per household are high in upstream sub-region as compared to the downstream sub-region while average number of cattle is high in the lower zone of the downstream sub-region. Milk, meat, wool, live animal and eggs are main livestock products, which are used for both household consumption and for sale to supplement household income. On an average a household received Rs 1,427 from livestock products last year. Live animal sale account for 84.1 percent of the total income from livestock. Milk rank second sharing 11.8 percent of the livestock income.

Tourism is a flourishing economic activity especially in the upper parts. Trend of tourists' flow shows fluctuation. The number of tourists visited this area was 36,594 in 1989 which declined to 35,811 (-2.14 percent) in 1990. In 2000 the number of tourists reached 76,407 and it declined to 65,313 (14.52 percent) in 2001 and 38,642 (40.84 percent) in 2002. The number of tourists increased in the year 2003 as compared to previous year. The impacts of tourism are clearly seen in lifestyle of local people as a result of direct or indirect association with tourists. Changes in dressing pattern and food habits and increasing use of English language are clearly seen. Traditional subsistence hill farming with agro-pastoral activities has declined due to development of economic activities related to tourism business. Traditional architecture and aesthetics of the villages are being gradually replaced by modern cement and concrete

structures. Tourism has also brought some changes in land use pattern. The conversion of agricultural lands to camping grounds, construction of new buildings for hotel/lodges can be seen especially in the upper parts of the watershed.

Migration is another livelihood strategy adapted by local people for their livelihood security. The people of this area temporarily migrated to different places outside their own village in search of employment. Out of total 2,331 surveyed population, 352 (28 percent) persons have migrated out. Of the migrants nearly half went to foreign countries. The proportion of population working outside is high in the lower zone of the downstream sub-region as compared to others. About 40 percent of the employed population of this zone is working outside VDC. Out of them 12 percent is working abroad and 18.2 percent within country outside district. The proportion of population working in other countries is slightly high in the upper zone of the upstream sub-region.

The industrial activities in this area are limited; its contribution on household income was only 0.1 percent last year. Industrial activities such as watermills, weaving and sewing, paper, bamboo, and metal products, woodcarving and furniture, brewing and others exist in this area. Nearly 3 percent of the population is involved in business and its contribution in household income is 8.1 percent. A total of 1.6 percent population is involved in wage labor and its contribution to household income is 4.4 percent. Some people are involved in wild product collection.

The average annual income of the surveyed household is Rs 130,354. The upper zone of the upstream sub-region has the highest average household income (Rs. 162,979) and the middle zone of the same sub-region has the lowest (Rs. 92295) average annual income. Nearly 38 percent of the households earn more than Rs 100,000 annually while nearly 10 percent household earn less than Rs. 20,000. And 52 percent earn from Rs 10,000 to Rs 80,000 annually. The average income of the household with single source is only Rs 22,760 while it is Rs. 247,293 for four and more sources. Analysis of Variance (ANOVA) clearly shows that there is no significant difference in level of household income by zones but household income significantly increases with increasing number of sources of household income.

The average annual expenditure of household is Rs 56,506 for the year 2001. The average annual expenditure is high in the upper zone of the upstream sub-region and the lower zone of the down stream sub-region (Rs 70,000), while upper zone of the downstream sub-region shows the low level of annual expenditure. Expenditure on food constitute 35.2 percent of the total household expenditure followed by education (19.1 percent), and clothing (10.2 percent). A remarkable proportion of the household expenditure (9.2 percent) goes for celebration of festivals. Health sector constitutes 6.6 percent of the total household expenditure. Fuel, wage, tax and others constitute nearly 20 percent of the total household expenditure.

Investments and borrowing are also the household's strategies adopted by local people for their livelihood security. People have invested money in different fields such as housing, business, land purchase, loan to others and land improvement like development of irrigation canal. On an average every household has invested a total of Rs 205,725 during last 10 years. Out of the total investment, 38.1 percent is in housing followed by business (26.1 percent) and land purchase (23.1 percent). Loan to others constitutes 10.8 percent of the total investment. Investment in land improvement including irrigation is only 0.8 percent of the total investment. The proportion of investment in housing is comparatively high in the middle zone (59.3 percent) of the downstream sub-region and low in the upper zone (30.8 percent) of the upstream sub-region.

Along with investment people also borrow money from others for various household purposes. Out of the total surveyed households, 54.4 percent borrow loan from different sources. The proportion of households borrowing loan is high in the lower zone of the downstream sub-region (75.0 percent) and low in the upper zone of the upstream sub-region (37.8 percent). Local moneylender is the main source of loan of local people in terms of number of households receiving loan from this source. Out of the total loan-receiving households, 42.3 percent receive loan from this source. The share of relatives in lending money is 36.2 percent. Banks and community funds rank third and fourth with 32.6 and 7.1 percent shares in lending money respectively.

Firewood is the main source of cooking and space heating. Two-thirds of the household use hydro-electricity for lighting. About 31.4 percent use kerosene and 1.7 percent solar power. Upper zone of the downstream sub-region do not have electricity

facility. Ninety-five percent household of this zone use kerosene and five percent use solar power for household lighting. More than 81 percent of the total households of the watershed entirely depend on firewood for cooking. In the upper zone of the upstream sub-region the use of electricity is high especially in hotels/lodges and restaurants. Solar power is the main alternative source of energy for water heating especially in the hotels in the upper parts of the upstream sub-region.

8.2.3 Water and livelihoods

Water resources are vital inputs into livelihood production activities in a wide variety of ways. The most common water users are irrigation, household, power generation, watermills, woodcarving, and cultural activities. The use of water for irrigation in the Modi Khola watershed is common. The irrigated land occupies about 20 percent of the total cultivated area. There are altogether 75 irrigation schemes of them 13 are agency developed modern and large irrigation schemes and the rest are small traditional ones. Out of the total 13 modern irrigation schemes, 12 are concentrated in the downstream sub-region. Many canals face water shortages during dry seasons. Water shortage is high in the lower zone of the downstream sub-region as compared to the others.

The overall cropping intensity of irrigated area is 177 percent. The intensity varies by irrigation facility and landscape. It is 196 percent in the year-round irrigated areas while it is 158 percent in seasonal irrigated and 127 percent in non-irrigated areas. The cropping intensity is high in the lower parts as compared to the upper parts of the watershed. It is 250 percent in the lower zone of the downstream sub-region while it is 175 percent in the upper zone of both the sub-regions where irrigation facility is available throughout the year. It ranges from 152 to 160 percent in the seasonal irrigated areas. The cropping intensity in non-irrigated area is low in the lower zone of the downstream sub-region (115.0 percent) as compared to others. Chi-square test shows that there is a significant difference in cropping intensity by irrigation status. The proportion of the area under two crops is 62.8 percent. It is 29.6 percent for one crop and 7.6 percent for three crops. Three crops are grown mostly in areas having year round irrigation particularly in the valleys. The yield is high in irrigated areas as compared to the case of non-irrigated ones.

Drinking, cooking, bathing, washing and cleaning and livestock use are household uses of water. Seventy-eight percent of the total households has access to piped water facility. The proportion of population using piped water is high in the upstream sub-region (91.3 percent) as compared to the downstream sub-region (75.8 percent). A total of 73 drinking water projects are distributed across the watershed. Of them, 63 projects are located in the downstream sub-region and 10 in the upstream sub-region. The accessibility of water for household use is relatively better in the upstream sub-region where 97.6 percent of the households have access to safe water for household use within the distance of less than one-hour of walk while in the downstream sub-region, 71.1 percent of the households have access to safe water within the distance of one hour. For example, 100 percent households lie within the distance of one-hour from water source for household use in Bhukatangle VDC of the upper parts while less than 20 percent of the households of Chitre and Durlung VDCs in the downstream sub-region have access to safe water within this distance.

Total consumptive water demand for household use include daily water requirement for domestic purposes (drinking, cooking, bathing and sanitation) and water requirement for livestock. Total water requirement for household use is estimated to be 7,483,900 liters/day (0.087 m^3/ sec).

Fishing is another water use in the study area. Commonly available fish species include *asla, chuche asla, tauke asla, batle, kala sahar, pahelo sahar, gurde, tude, king fish, fokate, chibe, buduna, gonch, kabre, hile* and *pothe.* The fishing in this area is not extensive in terms of both number of people involved as well as amount of fish catch. Out of the total surveyed households 3.6 percent (13 households) are involved in fishing. The average catch of fish per day as reported is 2-3 kg. The people residing close to the river are mainly engaged in fishing practice. People use traditional tools for fishing.

Water is used for operation of watermills, processing of raw materials and liquor making. There are altogether 55 watermills in operation. Of them 51 watermills are located in the upstream sub-region with excessive concentration in middle zone (39) while only 4 watermills are in operation in the downstream sub-region. About 50 percent watermills are operated throughout the year, 40 percent only in rainy season and 10 percent only in the winter season. The total number of households benefited

from watermill is estimated to be 2,500 in the watershed. About half of the watermills have reported water stress during dry season especially in the upstream sub-region. Fifty-one out of total are operated under private ownership. The watermills have provided very limited employment and the average income of a watermill is estimated at Rs 1,500 in the operated months.

Altogether there are 17 hydro plants including Modi hydroelectric plant distributed across the Modi Khola watershed. The total power generated from 16 micro-hydro plants (except Modi hydro-plant) is 272 KW and the number of household with electricity supply is 695. Out of total 16 micro-hydro plants, 15 are located in the upstream sub-region, excessive concentration (10) being in the upper zone. Local communities are responsible for operation, maintenance and management of the micro hydro projects. For the maintenance of the project the management committees fix tariffs, which vary by plants and types of users.

Water is heavily used in hotels and lodges for bathing, washing and cleaning and waste management. Hot-water shower is available in most of the standard hotels for tourist. The hotels without hot-water showers also have provision of hot-water bucket to the tourist. Both tourist and local people use water from the Modi Khola area for swimming, bathing and sport fishing. No rafting as well as water transportation is developed in this area. People use river water extensively for washing purposes. Besides, local people tourists both pilgrims and trekkers take hot spring bath at hot spring located at Jhinudanda.

Local people extract sand and gravels from Modi Khola and its tributaries and use for different construction purposes such as buildings, roads and bridges. Extracting sand and gravel is extensive in the downstream sub-region as compared to the upstream sub-region.

Water stress creates occasional conflicts among water users. The conflicts are mainly confined in the lower parts of the watershed particularly in Kusma and Gyadi areas where water stress is high. Seasonal decline in volume of water is the main cause of conflict. Occasional conflicts also arise during agricultural season among and between users of drinking water and irrigation. As reported, these conflicts were not serious and settled locally with mutual understanding. Water is managed through

management committees for all agency-developed irrigation and drinking water schemes.

8.2.4 Climate and livelihoods

Climate change leads to substantial impacts on livelihoods. Some changes are noticed in both temperature and precipitation in the study area. The temporal variations of average maximum and minimum temperature for the period of 30 years (1971-2000) for Lumle station show that the temperature in the Modi Khola area has been increasing. The trend value is higher for maximum temperature than the minimum. Likewise, time series data of yearly precipitation for Lumle, Kusma and Karkineta stations show an increasing trend with inter-annual variation. During 30 years period Lumle has received maximum rainfall in 1995 where as Kusma received maximum rainfall in 2002.

The increase in temperature and precipitation has direct impact on river discharge and water availability in this area. The analysis of temporal variation of average annual discharge of Modi Khola at Nayapul gauging station for the period of 12 years (1989-2000) indicates that the average discharge of the Modi Khola has been increasing with inter annual variation in discharge. The minimum and maximum average annual flow was recorded in 1992 and 1998 respectively. Rees and Collins (2004) forecasted the similar increasing volume of river flow for many decades in Modi Khola.

The changes in amount and intensity of rainfall lead to water induced disasters and associated loss. Floods, landslides, snow/avalanches, hailstorms and windstorms are common water induced disasters affecting life and properties in this area. Nearly three-fifth of the total surveyed households have lost some amount of crops and other properties by hailstorm during 10 years' period. The proportion of households reporting loss from landslide is 20.6 percent; among them some households (8.3 percent) lost some croplands due to landslide. The number of households reporting loss by draught is 16.9 percent. The number of households reporting loss from flood, snow/avalanches, and windstorm is 13.6, 3.9 and 3.6 percent respectively. The proportion of households reporting loss by flood is high in the middle zone of both the upstream and downstream sub-regions as compared to other zones. Some households have reported loss due to draughts as well. Loss from landslide is high in the middle

zones of both the sub-regions. The loss of snow/avalanche and hailstorm increases from south to the north with increase in altitude.

Since air temperature and precipitation are two important elements of climate, they become major basis for the evaluation of climatic conditions. Recorded data shows that both temperature and amount of precipitation have been increasing in this area. During 30 years period (1971-2000), the increase in temperature was 0.0246^0 C/year for Lumle whereas the increase in precipitation was 23.5 mm/year for Lumle and 25.2 mm/year for Kusma station. The discharge of Modi Khola has also been increasing. These changes in terms of temperature, precipitation and river discharge clearly indicate the changes of climatic conditions. The data indications are also strongly supported by perception of local people. Local people noticed the shrinkage of snow-covered area, increase in flow of river, prevalence of mosquito in the higher altitude and early ripening of crops. They also noticed more events of localized high intensity rainfall with the changes in pattern of hailstorm and snowfall.

The changes in climatic conditions would have varieties of implications, both positive and negative on livelihood activities depending on locality. However, no remarkable changes in local livelihoods are identified yet.

8.3 Conclusions

8.3.1 Application of livelihood model

The livelihood model adopted in this study clearly shows how availability or access to different levels and combination of assets affect both the choice of livelihood strategies and livelihood outcomes. It also helps to examine the influence of external factors on livelihoods. The complex relationship between different components of the model is tested objectively. However, some of the components on transforming structures and processes (such as laws and policies) are not covered in this study. The model proved highly useful for livelihood analysis. It is found that this model shows a potential conceptual basis for further investigation.

8.3.2 Other concluding remarks

The households of the Modi watershed possess a number of livelihood assets of five different categories (natural, physical, human, social and financial) upon which their livelihoods are based. The contribution of different assets on livelihood is significant in determining household income as well as livelihood strategies. However, the role of individual asset in livelihoods varies by locality. The livelihoods of the local people are largely guided by the availability of assets along with capabilities of people exploiting these assets.

The people of the Modi Khola area have adopted diverse strategies for their livelihood security. Household members adopt one or combination of activities to meet their household needs. These activities vary by household and localities resulting from variable effects of access to assets, capabilities of people and nature of the environment. In the upper parts of the watershed, people's livelihood is largely based on tourism activities and regular inflow of money in terms of pension and remittances while in the lower parts it is based on the combination of different activities mainly agriculture, business, service and remittances. The reason behind flourishing tourism in the upper parts is the richness in natural and cultural resources.

Household income of the local people is largely determined by types and number of income sources. In the study area, household income significantly increases with increasing number of livelihood activities. The households adopting diverse activities have higher household income and more secure and less vulnerable livelihoods as compared to the households adopting single or lesser number of activities. Livelihoods of households having diverse sources are more sustainable and the possibility of positive adaptation to changing circumstances is high.

The area has been experiencing some changes on climatic elements. Climatic elements like temperature and precipitation in this area have been increasing. Snow-covered areas have been shrinking and permanent snowline shifting upwards as a result of increase in snow melting caused by temperature rise. River discharge has also been increasing due to increase in snow melting and increase in precipitation. The changes in terms of temperature, precipitation and river discharge clearly indicate the changes of climatic conditions of the Modi Khola watershed area. The data

indications are also strongly supported by perception of local people. The change in climate is not localized one; it might be the effect of global warming. Obviously, the changes in climate may have direct or indirect implications on people's livelihood affecting different livelihood activities both positively and negatively. However, no remarkable changes on livelihood activities as caused by climate change are identified yet in the study area. Local people are aware about possible effects of these changes on their livelihoods.

8.4 Recommendations

The changes in climatic conditions and water availability have both positive and negative effects on people's livelihoods. To reduce the possible negative effects on livelihoods the following measures are recommended.

a) Changes in cropping pattern and substitution of crop varieties and species: Agriculture in the Modi Khola watershed is characterized by food crops dominated crop farming. Over the last decade, extreme events have been increasing with more events of localized high intensity rainfall and changes in periodic pattern of hailstorm and snowfall. The changes badly affect production and productivity of crops. The introduction of new varieties of crops suited to changing pattern of weather condition and changes in cropping pattern greatly help in reducing the vulnerability associated with.

b) Promotion of social networks: Promotion of social network directly related with environment greatly helps local people in difficult situation. The existing social networks for example, Mothers' groups, Youth clubs and cultural organizations working in the field of socio-cultural motive are not adequate to cover environmental issues. There is a need for organization to increase awareness of local people regarding global climate change and associated impacts on different sectors of livelihoods such as production of crops, forest, infrastructures, and animal health. This may help to overcome the harsh situation brought by climate change.

c) Development of early warning systems: As reported extreme events are frequent and loss of life and property is increasing in the region. It was also predicted that water flow in the Modi Khola is likely to increase for a number of decades. There are many settlements situated nearby river such as Himalkyu, Syaulibazar, Birethanti, and

Dimuwa. Increased flow coupled with high intensity rainfall may cause heavy floods causing damages of life and properties in these areas. The development of early warning system is necessary in these areas to protect damages from extreme flood events.

d) Development of fishponds and fish breeding: Fish population in the Modi Khola has declined sharply. The main reasons for this decline are the construction of Pokhara-Baglung highway and dam of Modi hydroelectric project. Over exploitation of fish during the construction of these projects and dewater zone created by dam disrupted fish migration and fish breeding. Fishing is not only the sources of income for some of the people residing by riverside; it is one of the cheapest sources of nutrient. The development of fishponds may greatly help in restoring fishing activities.

e) Promotion of cultural tourism: The contribution of tourism in household economy is significant in the upstream region of the Modi Khola watershed. A large proportion of population of this region is engaged in tourism and related activities, such as hotels and restaurants, lodges, guides and portering. The natural beauty of the Annapurna area is likely to decline due to shrinkage in snow cover area as caused by deglaciation. Deterioration in natural beauty may affect tourism activities and tourism business. The establishment of natural and cultural museum would be beneficial in promoting tourism activities in this region. A suitable area for museum is also available in the upper parts. In addition, the construction of road, connecting Nayapul-Ghandruk-Chhomrung, provides easy access for comfortable trekking especially for old age people.

f) Changes in design specifications and modification of existing structures: Design specification of water use infrastructures such as watermills and micro hydro plants should be modified. Most of the watermills in this area are of traditional type and operate only in rainy season. The processing capacity is also low. There is a need of improvement in processing capacity so that time could be saved. In addition, improvement of irrigation canal and construction of reservoir for micro hydro plants are necessary to overcome the adverse situation of the dry season.

g) Equitable water management to prevent conflict: The reduced water supply is not a likely phenomenon in the area for decades. However, there are issues arising out of seasonal fluctuation of water flow and conflict between users. Majority of watermills in this region remain closed during dry season due to low volume of water in tributaries. Micro-hydro plants and irrigation system are also facing same problems. It is also likely that new opportunities may come up in the water use. This may further intensify the water use conflicts. In connection with this the preparation and implementation of a relevant water use plan is desirable.

REFERENCES

Adhikari, J. (2001). *The role of mobility and remittances in diversifying the livelihood opportunities in rural Nepal*. (Paper presented in Regional Livelihoods Workshop: Reaching the Poor, 8-10th May, 2001), Dhaka.

Ahmad, Q. K., Biswas, A. K., Rangachari, R., & Sainju, M. M. (2001). *Gangas-Brahmaputra-Meghna region: A framework for sustainable development*. Dhaka: The University Press Limited.

Ahmad, N., Nyborg, I., & Aquil, G. (1998). *Gender, resource management and livelihood security.* (High altitude integrated natural resource management report No 5). Islamabad: Aga Khan Rural Support Program.

Allan, A. (1999). *Water stress and global mitigation: Water, food and trade*. Retrieved January 12, 2003, from http://ag.arizona.edu/OALS/ALN/aln45/allan.html

Andors, E. B. (1974). The Rodighar and its Role in Gurung Society, *Contribution to the Nepalese Studies,* 1 (2): 10-14.

Arnold, J. E. (1998). Forestry and sustainable rural livelihoods. In D. Carney (ed.), *Sustainable rural livelihoods: What contribution can we make?* (pp. 155-66). London: Department for International Development.

Ashley, C., & Carney, D. (1999). *Sustainable livelihoods: Lessons from early experience.* London: Department for International Development.

Asian Development Bank. (1999). *Water in the 21st century*. (Theme paper No. 8). Manila: Asian Development Bank.

Banskota, K., & Sharma, B. (1997). *Case studies from Ghandruk: Contribution of tourist expenditure to the local economy in the Annapurna area.* (MEI discussion paper 97/5). Kathmandu: International Center for Integrated Mountain Development.

Banskota, K., & Sharma, B. (1998a). *Mountain tourism and local community development in Nepal: A case study of Syaphrubesi, Langtang National*

*Park***.** (Mountain Enterprises and Infrastructure Series 98/3). Kathmandu: International Center for Integrated Mountain Development.

Banskota, K., & Sharma, B. (1998b). *Mountain tourism for local community development: A case study of Upper Mustang.* **(**Discussion paper series 98/1). Kathmandu: International Center for Integrated Mountain Development.

Banskota, K., & Sharma, B. (2000). *Village Tourism in Sirubari: Implications for Sustainability*. Kathmandu: International Center for Integrated Mountain Development.

Banskota, K., & Upadhyay, M. (1991). *Impact of rural tourism on the environment, income and employment in the Makalu-Barun Area.* (The Makalu-Barun Conservation project, working paper publication series 17). Kathmandu: Department of National Parks and Wildlife Conservation, HMG/N and Woodland Mountain Institute.

Banskota, M. (2000). Water harvesting practices in mountain areas. In M. Banskota & S. R. Chalise (eds.), *Waters of life: Perspectives of water harvesting in the HKH*. (pp. 39-58). Kathmandu: International Center for Integrated Mountain Development.

Banstola, S. N. (1994). *Water resource development of the mighty Himalayan rivers (Indus, Ganga-Yamuna, Brahmaputra rivers).* Kathmandu: Sunil Banstola.

Barraclough, S. L., & Ghimire, K. B. (1995). Forest and livelihoods: The social dynamics of deforestation in developing countries. London: The United Nations Research Institute for Social Development.

Beniston, M., & Fox, D. G. (1996). Impacts of climate change on mountain regions. In R. T. Watson, M. C. Zinyowera, & R. H. Moss (eds.), *Climate change 1995- impacts, adaptations and mitigation of climate change: Scientific technical analysis (pp 191-213), Cambridge:* Cambridge University Press.

Bergkamp, G., Orlando, B., & Burton, I. (2003). *Change: Adaptation of water resources management to climate change.* Gland, Swetzerland and Cambridge, UK: International Union for Conservation of Nature and Natural Resources (IUCN).

Bhadra, C., & Karky, B. S. (2002). *Assessment of the role of women in water resource use in the Annapurna Conservation Area.* Kathmandu: King Mahendra Trust for Nature Conservation.

Bhandari, B. B. (1994). *The impact of Kankai irrigation project on agricultural production: A case study of paddy production*. Unpublished master's thesis, Tribhuvan University, Kathmandu.

Bhandari, R. (1996). *The impact of Kankai irrigation project on paddy production in Panchgachi VDC, Jhapa district, Nepal*. Unpublished master's thesis, Tribhuvan University, Kathmandu.

Bhole, H. G., & Adhikari, J. (1998). Rural livelihoods at risk: How Nepalese farmers cope with food insecurity. *Mountain Research and Development,* 18 (4): 321-332.

Bhurtel, B. (2000). *Changing livelihood strategies of the Kumals living in Pokhara valley of western Nepal*. Unpublished master's thesis, Tribhuvan University, Kathmandu.

Bishop, B. C. (1990). *Karnali under stress: Livelihood strategies and seasonal rhythms in a changing Nepal Himalaya.* Illinois: University of Chicago.

Bista, D. B. (1967). *People of Nepal*. Kathmandu: Department of Publicity, His Majesty's Government of Nepal.

Blakie, P. (2000). *Livelihood diversification, migration and soil fertility: Some connections*. (Paper presented at the Regional Conference on Physical Mobility and Development in Mountains, 15-17th March 2000), Kathmandu.

Braudel, F. (1976). *Afterthoughts on a material civilization and capitalism*. Baltimore: Johns Hopins University Press.

Briscoe, J., & Feranti, D. (1998). *Water for rural communities: Helping people help themselves.* Washington, DC: The World Bank.

Canadian International Water and Energy Consultants. (CIWES). 1998: Upper Karnali hydroelectric project: Environmental impact assessment *(Main report). Kathmandu: CIWES.*

Carney, D. (1998). Implementing the sustainable rural livelihoods approach. In D. Carney (ed.), *Sustainable rural livelihoods: What contribution can we make? (pp. 3 - 23*). London: Department for International Development.

Carney, D., Drinkwater, M., Rusinow, T., Neefjes, K., Wanmali, S. & Singh, N. (1999). *Livelihoods approaches compared: A brief comparison of the livelihoods approaches of the UK Department of International Development (DFID), CARE, Oxfam, and the United Nations Development Program (UNDP).* London: Department for International Development.

Central Bureau of Statistics. (1997a). *Nepal living standard survey report 1996*. (Main findings Vol. 1). Kathmandu: National Planning Commission Secretariat, His Majesty's Government, Nepal.

Central Bureau of Statistics. (1997b): *Nepal living standard survey report 1996.* (Main findings Vol. 2). Kathmandu: National Planning Commission Secretariat, His Majesty's Government, Nepal.

Central Bureau of Statistics. (2002). *Population of Nepal: Village development committee/municipalities, population census 2001-selected tables (Western Development Region).* Kathmandu: National Planning Commission Secretariat, His Majesty's Government, Nepal.

CEMAT Consultants. (2000). *Environmental impact assessment of the Upper Modi hydroelectric project, Vol. 1.* (Main report). Kathamandu: Nepal Electricity Authority.

Chambers, R. (1988). Irrigation against rural poverty. In J. S. Kanwar (ed.) Water management- the key to developing agriculture. *(pp. 725-759). New Delhi: Agricole Publishing Academy.*

Chambers, R. (1995). Poverty and livelihoods: Whose reality count?". *Environment and Urbanization,* 7 (1): 173-204.

Chambers, R., & Conway, G. R. (1991). Sustainable rural livelihoods: Practical concepts for the 21st century (Discussion Paper 296). Brigton: Institute of Development Studies (IDS).

Choudhury, A. M., Quadir, D. A., Neelormi, S., & Ahmed, A. U. (2002). Water resources in South Asia: An assessment of climate change-associated vulnerabilities and coping mechanisms: Bangladesh country report. *(APN project No 2002-12), A cooperative Program of Bangladesh, India, Nepal and Pakistan.*

Cooper, R. N. (2000). International approaches to global climate change. In S. Devrajan (ed.), *The World Bank Research Observer.* 15 (2): 145-172.

Critchfield, H. J. (1987). General climatology. *New Delhi: Prentice Hall of India Private Limited.*

Dahal, K. B. (2001). *Struggling with development: A case study of the changing livelihood strategies of the Baramus from western Nepal.* Unpublished master's thesis, Tribhuvan University, Kathmandu

Dembner, S. (1995). Forest-dependent livelihoods: Links between forestry and food security. *Unasilva*, 46 (3): 85-90.

Department of Hydrology and Meteorology. (Different years). *Climatological records of Nepal*. Kathmandu: His Majesty's Government of Nepal.

Department for International Development. (1999). *Sustainable livelihoods guidance sheets*. London: Department for international Development.

District Development Committee. (2001). District Profile 2058 (B.S.). *Pokhara: Information and Record Center, DDC, Kaski.*

District Development Committee. (2001). District profile of Parbat. *Kathmandu: District Development Committee, Parbat.*

Dixit, A. (2000). Water as an agent of social and economic changes in Nepal. In P. P. Molinga (ed.), *Water for food and rural development: Approaches and incentives in South Asia.* (pp. 197- 230). New Delhi: Sage Publication.

Dixit, A. (2002). *Basic water science*. Kathmandu: Nepal Water Conservation Foundation.

Dixit, R. D.(1999).Geographical thoughts: Contextual history of ideas. New Delhi: Prentice Hall of India Private Limited.

Drinkwater, M., & Rusinow, T. (1999). *Application of CARE's livelihood approach*. Retrieved January 5, 2003, from http://www.livelihoods.org

East Consult. (1998). *Preliminary environmental study of Upper Modi 'A' hydroelectric project*. Kathmandu: East Consult.

East Consult. (1992). *Kaligandaki 'A' hydropower project- detail feasibility study: Environmental impact assessment* (Final report). Kathmandu: East Consult.

Ellis, F. (1998). Livelihood diversification and sustainable rural livelihoods. In D. Carney (ed.), *Sustainable rural livelihoods: What contribution can we make?*. (pp. 53-65). London: Department for international Development.

Ellis, F. (1999). Rural livelihood diversity in developing countries: Evidence and policy implications. *Natural Resource Perspective* (40). Retrieved January 12, 2003, from http://www.odi.org.uk/nrp/40.html

Ellis-Jones, J. (1999). Poverty, land care, and sustainable livelihoods in Hillside and Mountain regions. *Mountain Research and Development,* 19 (3): 179-190.

Ellis-Jones, J., & Mason, T. (1999). Livelihood strategies and assets of small farmers in the evaluation of soil and water management practices in the Temperate Inter-Andean Valleys of Bolivia. *Mountain Research and Development***,** 19 (3): 221-234.

Furer-Haimendorf, C. V. (1981). Social structure and spatial mobility among the Thakalis of western Nepal. In C. V. Furer-Haimendorf (ed.), *Asian highland societies in anthropological perspective.* (pp. 1-19). New Delhi: Sterling Publishers Private Limited.

GEOCE Consultants. (2001). *Upper Modi 'A' hydroelectric project: Environmental impact assessment. Vol. 1*. (Final report). Kathmandu: GEOCE Consultants.

Georgiyevsky, V. Y. (1998). Global climate warming effects on water resources. In Zebidi (ed), *Water: A looming crisis?.* (Proceedings of the International Conference on World Water Resources at the Beginning of the 21st Century, Paris 3-6 June 1998). Paris: UNESCO.

German Technical Cooperation & Center for Rural Technology Nepal. (2000). *Improvements of water mills (Ghattas) in hilly areas of Nepal for rural applications,* Kathmandu: GTZ and CRT.

Gould, S. J. (1980). *The Panda's thumb: More reflections in natural history* (1st ed.). New York: Norton.

Gould, S. J. (1990). The individual in Darwin's world. Speech given at the Second Edinburg medal address.

Gurung, C. B., Thapa, F., & Adhikari, T. (1995). Contribution of forest resources in the livelihood of the Chepang community: A case study in Chitawan. In F.P. Neupane (ed.), *IAAS research report (1993-94),* (pp. 179 – 186). Rampur, Nepal: Institute of Agriculture and Animal Science.

Gurung, H. (2005). Mountain environment and landscape change. In B.P Subedi &P. C. Poudel (eds.), *Geography and geographers' work in Nepal: Reflections on mountain environment and human activities* (pp 11-19), Kathmandu: Nepal Geographical Society, Central Department of Geography, and National Centre of Competence in Research, North-South.

Gyawali, D. (1989). *Water in Nepal*. (Occasional paper No 8). Honolulu: East-West Center.

Gyawali, D. (2001). *Water in Nepal.* Kathmandu: Himal Books and Panos South Asia with Nepal Water Conservation Foundation.

Ham, L. (1995). *Livelihood security in mountain ecosystem: Coping and adapting in two Himalayan villages, India.* (Technical Report No 5). Shastri Project on Sustainable Development of Mountain Environments in India and Canada.

Hayes, J. T. (1991). Global climate change and water resources. In R. L. Wyman (ed.), *Global climate change and life on earth.* (pp. 18-42). New York: Chapman and Hall.

HMG/DOT. (1998). *Introducing Nepal Himalaya*. Kathmandu: Department of Tourism, HMG/N.

HMG/N, (2003). *Economic survey, fiscal year 2002/03*. Kathmandu: Ministry of Finance, HMG/N.

Hoeck, W. van der (2001). *Water and rural livelihoods*. Retrieved January 13, 2003, from http://www.ifpri.org/2020/ focus09/ focus09_05.htm.

Huq, H. (2001). *People's organization and livelihood practices: An anthropological view.* (Paper Presented at Department for International Development, Regional Livelihood Workshop: Reaching the Poor in Asia, 8-10 May 2001), Dhaka.

Industrial Service Center. (1979). *Khumbu region tourism study*. Kathmandu: Industrial Service Center.

International Water and Sanitation Centre. (2003). *Rethinking basic needs: The multiple roles and benefits of WATSON*. Retrieved June 25, 2003, from http://www.irc.nl/page.php/257

IUCN & METCON Consultants. (1999). *Environmental impact assessment of Melamchi diversion scheme.* Kathmandu: Melamchi Water Supply Board.

James, A. J., & Robinson, E. (2001). *Water and sustainable rural livelihoods in Andhra Pradesh: Background paper*. (WHIRL Project Working Paper No 3, Draft), Retrieved February 10, 2003, from http://www.aplivelihoods.org/other_initiatives.html

Joshi, C. B. (1981). *Sample survey of traditional water wheels and small water turbines in Nepal*. Kathmandu: Research Center for Applied Science and Technology, Tribhuvan University.

Karki, M. B. (2000). Commercialization of natural resources for sustainable livelihoods: The case of forest products. In M. Banskota, T. S. Papola & J. Richter (eds.), *Growth, poverty alleviation and sustainable resource management in the mountain areas of South Asia (Proceedings of the International Conference held from 31 January – 4 February 2000 in Kathmandu, Nepal).* (pp. 293-320). Kathmandu: International Center for Integrated Mountain Development, Zentrallstelle fur Ernahrung und Landwirtwirtschaft (ZEL) Feldafing/Zschortau and Food and Agriculture Development Centre.

Karky, B. S., & Cushing, J. (2002). *Improving water use technology: Improved traditional water mills and safe drinking water stations*. Kathmandu: King Mahendra Trust for Nature Conservation, Annapurna Conservation Area Project.

Kaushik, S. (ed.). (1998). *Understanding livelihoods of the rural poor and marginal farmers: Proceedings of the second workshop on marginal agriculture*. New York: Society for Promotion of Wastelands Development.

Khadka, M. S. (1998). Water utilization and sewerage load. In *A compendium on environment statistics 1998, Nepal.* (pp. 274-270). Kathmandu: Central Bureau of Statistics.

Khan, C. M. A. (ed.). (1994). World water resources. In *Progressive Farming,* Vol. 14 (5). (pp. 5-9). Islamabad: Pakistan Agriculture Research Council.

Khanal, N. R. (2002). *Land use land cover dynamics in the Himalaya: A case study of the Madi watershed, western development region, Nepal.* Unpublished doctoral dissertation, Tribhuvan University, Kathmandu.

Kirschbaum, M. U. F., & Fishlin, A. (1996). Climate change impacts on forest. In R. T. Watson, M. C. Zinyowera, & R. H. Moss (eds.), *Climate change 1995: impacts, adaptations and mitigation of climate change-scientific technical analysis.* (pp. 94 -129). Cambridge: Cambridge University Press.

Knowled, R,. & Wareing, J. (1996). *Economic and social geography*. New Delhi: Rupa & Co.

Koziell, I. (1998. Biodiversity and sustainable rural livelihoods. In D. Carney (ed.), *Sustainable rural livelihoods: What contribution can we make?.* (pp. 83-92). London: Department for international Development.

Kumar, R., & Pandey, O. N. (1995). Forest based socioeconomy and livelihood of tribals of Chotanagpur. In N. K Joshi, P. Khullar, D. N. Ray, P. Khanna & V. K. Wadhwa (eds.), *The Indian Forester***,** 121 (1): 51-54.

Lamjung Electricity Development Company (LEDCO). (2001). *Khudi hydropower project; Environmental impact assessment* (Main report). Kathmandu: Ministry of Population and Environment, His Majesty's Government of Nepal.

Lamjung Electricity Development Company Ltd. (1999). *Nyadi hydropower project Environmental impact assessment* (Final report), Kathmandu: Ministry of Population and Environment, His Majesty's Government of Nepal.

Leon-Velarde, C., Quiroz, R., Zorogastua, P. & Tapia, M. (2000). Sustainability concerns of livestock-based livelihoods in the Andes. In P. M. Tulachan & other (eds.), *Contribution of livestock to mountain livelihoods: Research and*

development issues. (pp. 183-201). Kathmandu: International Centre for Integrated Mountain Development.

Longspeth, J. (1991). Global climate change: Potential impacts on public health. In R. L. Wyman (ed), *Global climate change and life on earth*. (198-208). New York: Chapman and Hall

Macfarlane, A. (1976). *Resources and population: A study of Gurungs of Nepal*. London: Cambridge University Press.

Macfarlane, A. D. J. (1972). *Population and economy in central Nepal: A study of the Gurung.* Unpublished doctoral dissertation, University of London.

Mainali, S. R. (1987). *Irrigation projects: Its impact on rice production in Nuwakot, Nepal.* Unpublished master's thesis, Benguet State University, La Trinidad, Benguet

Mendelsohn, R., & Dinar, A. (1999). Climate change, agriculture and developing countries: Does adaptation matter?. In M. Syrquin (ed.), *The World Bank Research Observer*, 14 (2): 277-293.

Messerschmidt, D. A. (1976). *The Gurungs of Nepal: Conflict and change in a village society*. New Delhi: Oxford and IBH Publishing Company.

METCON Consultants. (1997). *Andhi khola storage hydel project- feasibility study phase 1: Environmental impact assessment*. Kathmandu: Nepal Electricity Authority.

METCON Consultants. (1998). *Budhi Ganga (BG-O) hydropower project: Environmental impact assessment, Vol. 1* (Final report). Kathmandu: Nepal Electricity Authority.

METCON Consultants. (2001). *Supplementary EIA of Melamchi diversion scheme* (Stand for water supply only). Kathmandu: Melamchi Water Supply Board.

METCON Consultants in Association with INSEEN. (1997). *Kulekhani III environmental impact assessment*. Kathmandu: Nepal Electricity Authority.

Mitra, A. P. (2002). Climate in South Asia and water resources (South Asia Regional Background). In *Water resources in South Asia: An assessment of climate change-associated vulnerabilities and coping mechanism* (A cooperative program, Bangladesh, India, Nepal and Pakistan), APN Project No. 2002-12.

Moench, M., Dixit, A., Janakarajan, S., Rathore, M. S., & Mudrakartha, S. (2003). *The fluid mosaic: Water governance in the context of variability, uncertainty and change.* Kathmandu: Nepal Water Conservation Foundation and Institute for Social and Environmental Transition, Boulder, Colorado.

Molnar, A. (1981). Economic strategies and ecological constraints: Case of the Kham Magar of Northwest Nepal. In C. V. Furer-Haimendorf (ed.), *Asian highland*

societies in anthropological perspective. (pp. 20-51). New Delhi: Sterling Publishers Private Limited.

Mool, P., Samjwal, K., Bajracharya, R., & Joshi, S. P. (2001). *Inventory of glaciers, glacial lakes and glacial lake outburst floods: Monitoring and early warning systems in the Hindu Kush-Himalayan region Nepal.* Kathmandu: International Centre for Integrated Mountain Development.

Moriarty, P. (2003). *Water, sanitation and livelihoods-based approaches*. Retrieved June 6, 2003, from http://www.worldwaterday.org/devpaper.html.

Mukherjee, N. (2002). *Alternative perspectives on livelihoods, agriculture and air pollution: Agriculture in urban and peri-urban areas in a developing country.* New Delhi: Concept Publishing Company.

Nayava, J. L. (2004). Temporal variation of rainfall in Nepal since 1971 to 2000. In M. L. Shrestha & Other (eds.), *Journal of Hydrology and Meteorology*, 1 (1): 24-33.

Nepal Electricity Authority. (1996*). Modi khola hydropower project: Environmental impact assessment* (Final report). Kathmandu: Environmental Division, Nepal Electricity Authority.

Nepal Electricity Authority (NEA) and TACE Consultants. (2001). *Environmental impact assessment study of Middle Marshyangdi hydropower project* (Vol. 1, Main EIA Report), Kathmandu: Nepal Electricity Authority.

Nepal Engineering Consultancy Services Center Limited (NEPECON). (2001). *Environmental impact assessment report of Kulekhani III hydroelectric project*. Kathmandu: Nepal Electricity Authority.

Nicol, A., Peacocke, B., Akabar, Y., Ariyabandu, R., Cordier, S., Joshi, D., Josiah, O., Milazi, L., & Slaymaker, T. (2001). *Secure water: Building sustainable livelihoods for the poor into demand-responsive approaches* (Concept paper). Retrieved June 6, 2003, from http://www.securewater.org

Niraula, B. P. (1998). Health. In *A compendium on environment statistics 1998, Nepal*. (pp. 465-497). Kathmandu: Central Bureau of Statistics.

Ohta, Y., Chikara, A., Kajunori, A., & Yuji, M. (1973. Pokhara-Gurkha region. In O. Yoshihide & A. Chikara (eds.), *Geology of the Nepal Himalayas.* (pp. 159-188). Hokkaido: Saikon Publishing co., Ltd.

Pageni, S. H. (1987). *The impact of Chitawan irrigation project: A case study of Narayan village panchayat, Chitawan*. Unpublished master's thesis, Tribhuvan University, Kathmandu

Pain, A., & Lautze, S. (2002). *Addressing livelihoods in Afghanistan*. Kabul: Afghanistan Research and Evaluation Unit.

Pandey, T. R. (1987). Livelihoods of landless peasants: A study of evicted resettlers. (Research Paper Series 33). Kathmandu: Strengthening Institutional Capacity in the Food and Agriculture Sector in Nepal.

Participatory District Development Programme (PDDP). (2001). *Resource mapping report, Parbat district*. Kathmandu: PDDP.

Participatory District Development Programme (PDDP) and DDC Kaski. (2002). *Poverty mapping report of Kaski district*. Kathmandu: PDDP.

Poste l, S. (1996). Dividing the waters: food security, ecosystem health and the new politics of scarcity. In J. A. Petersion (ed), *World water* (132). World Water Institute.

Poudel, K. P. (2003). *Watershed management in the Himalayas: A resource analysis approach*. Delhi: Adroit Publishers.

Poudel, P. C. (1996). *Tourist resources and environmental appraisal in Pokhara region, Nepal: A geographical analysis.* Unpublished doctoral dissertation, Banaras Hindu University, Baranasi.

Pratap, U. & Pratap, T. (2001). Declining apple production and worried Himalayan farmers: Promotion of honeybees for pollination. In *Issues in Mountain Development 2001/1*. Kathmandu: International Centre for Integrated Mountain Development.

Rashid, S. A. (2000). Climate change with particular reference to Dal lake. In S. Soz (ed.), *Climate change- impact and awareness with special reference to Kashmir* (Proceedings of the Seminar Held in Srinagar, Kashmir, India, October 21-22, 1998. (pp. 119-124). New Delhi: Peoples' Environment Mission, Srinagar and UNESCO.

Rees, G. & Collins, D. (2004). *An assessment of the potential impacts of deglaciation on the water resources of the Himalayas* (Summary report, DFID KAR Project No. R7980). Wallingford: Center for Ecology and Hydrology.

Regmi, M. P. (1990). *The Gurungs thunder of Himal: A cross cultural study of a Nepalese ethnic group*. New Delhi: Nirala Publications.

Rosegrant, M. W., Cai, X., & Cline, S. A. (2002). *World water and food to 2025: dealing with scarcity.* Washington: International Food Policy Research Institute.

Ritzer, G. (2000). *Sociological theory* (5th ed.). Singapore: McGraw-Hill.

Saman Engineering Consultants Co. Ltd & Water Resource Consult (p) Ltd. (2001). *Modi khola hydropower project: Project completion report*. Submitted to Kathamandu: Nepal Electricity Authority.

Scoones, I. (1998). Sustainable Rural Livelihoods: A framework for Analysis (Working paper 72). Brigton: Institute of Development Studies.

Seddon, D., Gurung, G., & Adhikari, J. (1999): Foreign labour migration and the remittance economy of Nepal. *Quarterly Development Review,* XIV (20): 67-76.

Shah, T. (1998). Water against poverty: Livelihood-oriented water resource management. In A. Dixit (ed.), *Water Nepal***,** 6 (1): 117-143.

Sharma, C. K. (1973). *Geology of Nepal*. Kathmandu: Mani Ram Sharma.

Sharma, P. (2000). Tourism and livelihood in the Mountains: Regional overview and the experience of Nepal. In M. Banskota, T. S. Papola & J. Richter (eds.), *Growth, poverty alleviation and sustainable resource management in the mountain areas of South Asia (Proceedings of the International Conference held from 31 January - 4 February 2000 in Kathmandu, Nepal).* (pp. 293-320). Kathmandu: International Center for Integrated Mountain Development, Zentrallstelle fur Ernahrung und Landwirtwirtschaft (ZEL) Feldafing/Zschortau and Food and Agriculture Development Centre.

Sharma, V. K. (1985). *Water resource planning and management*. Delhi: Himalayan Publishing House.

Shrestha, A. B., Cameron, P. W., Jack, E. D., & Ayeswki, P. A. 2000: Precipitation fluctuations in the Nepal Himalaya and its vicinity and relationship with **s**ome large scale climatological parameters. *International Journal of Climatology.* 20, 217-327.

Shrestha, A. B., Wake, C. P., Mayeski, P. A., & Dibb, J. E. (1999). Maximum temperature trends in the Himalaya and its vicinity: An analysis based on temperature records from Nepal for the period 1971-94. *International Journal of Climatology.* 12, 2775-2786.

Shrestha, K. L., Shrestha, M. L., Sapkota, B., Shakya, N., & Ghimire, M. L. (2002). Country report of Nepal. In *Global Change Impact Assessment for Himalayan Mountain Regions, Resource Management and Sustainable Development. Country Report for Year 2002 (India, Nepal and Pakistan).* APN Project No 2002-03.

Shrestha, S., Sharma, H. R., & Sharma, S. (1997) Sustainable farming and livelihoods in the HKH: Micro-level evidence. In M. Banskota and T. Pratap (eds.), *Investing in the future: Agriculture research and education for sustainable mountain agriculture.* (pp. 29-34). Kathmandu: International Centre for Integrated Mountain Development

Shrestha, T. B., & Gupta, V. N. P. (1993). Biodiversity profile and conservation strategy for Nepal. In M. K. Dahal & D. R. Dahal (eds.), *Environment and sustainable development: Issues in Nepalese perspective.* (pp. 1-10). Kathmandu: Nepal Foundation of Advanced Studies.

Singh, J., & Dhillon, S. S. (1984). *Agricultural geography*. New Delhi*:* Tata McGraw-Hill Publishing Company Limited.

Singh, R. B., Bas, K., & Datta, P. (1995). Environmental implications of horticulture on sustainable livelihood and food security in Kullu Valley. In R.B. Singh (ed.), *Sustainable development of mountain environment in India and Canada.* New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.

Singh, R. B., & Pandey, B. W. (1998). Common resources and sustainable livelihood of mountain environment: A micro-level experiences of Upper Kullu valley. In R.B. Singh and M. J. Haigh (eds.), *Sustainable reconstruction of highland and headwater region, (Proceedings of Third International Symposium on Headwater Control, New Delhi, October 6-8, 1995).* (pp. 663-679). New delhi: IBH Publishing Co. Pvt. Ltd.

SMEC International. (1999). *West Seti hydroelectric project: Environmental impact assessment* (Executive summary). Kathmandu: Nepal Electricity Authority.

Soussan, J. (1998). Water/irrigation and sustainable rural livelihoods. In D. Carney (ed.), *Sustainable rural livelihoods: What contribution can we make?*. London: Department for International Development.

Sousan, J. & Frames, D. (2004). The role of water in the development of sustainable livelihoods of the poor in water and poverty: The themes (A Collection of Thematic papers), *Water for All.* Series 4.

Soz, S. (2000). Climate change: The Kashmir experience. In S. Soz (ed.), *Climate change- impact and awareness with special reference to Kashmir (Proceedings of the Seminar Held in Srinagar, Kashmir, India, October 21-22, 1998).* (pp. 113-118). New Delhi: Peoples' Environment Mission, Srinagar and UNESCO.

Stainton, J. D. A. (1972). *Forests of Nepal*. London: John Murray.

Stevens, S. F. (1993). *Claming the high ground: Sherpas, subsistence and environmental change in the Highest Himalayas.* California: University of California Press.

Subba, B. (2001). *Himalayan waters: Promise and potential, problems and politics*. Kathmandu: Panos South Asia.

Subedi, B. P., & Pandey, R. (2002). Livelihood strategies of Rai communities in Arun valley: Continuity and change. In R. P. Chaudhary, B. P. Subedi, O. R. Vetaas & T. H. Aase (eds.), *Vegetation and society: Their interaction in the Himalayas,* Kathmandu: Tribhuvan University, Nepal and University of Bergen, Norway.

Sulivan, C. A., Rijal, S. P., Shrestha, M., Khanal, N., & O'regan, D. P. (2004). *An assessment of the potential impacts of climate-induced deglaciation on communities and their livelihoods in the Hindu Kush Himalaya.* (DFID KAR Project No. R7980). Wallingford: Center for Ecology and Hydrology

Tahal Consulting Engineers Ltd. (2002). *Nepal irrigation sector project, technical report No. 7* (Final report), Kathmandu: Department of Hydrology and Meteorology, HMG/N.

Tashi, N., & Pratap, T. (2000). Livestock based livelihoods in Tibet, China, and sustainability concerns. In P. M. Tulachan, M. A. Mohamed, S. J. Maki-Kokkoren & T. Pratap (eds.) *Contribution of livestock to mountain livelihoods: Research and development issues.* (pp. 171-182). Kathmandu: International Centre for Integrated Mountain Development.

The Red Cross/red Crescent Climate Center. (2004). Preparedness for climate change. *Retrieved December 15, 2003, from http://www.climate center.org*

Townsley, P. (1998). Aquatic resources and sustainable rural livelihoods. In D. Carney (ed.) *Sustainable rural livelihoods: What contribution can we make*?. (pp. 139-153). London: DFID.

UNDP. (1999a). *Making livelihoods more sustainable*. Retrieved January 12, 2003, from http://www.undp.org/sl/Documents/ General%20info/Journel/

journel.htm

UNDP. (1999b). *Sustainable livelihoods: Concepts, principles and approaches to indicator development*. Retrieved January 5, 2003, from http://www.undp

.org/…sl_concept_priniples_and_approaches_to_ indicator_development.ht

UNDP. (1999c). *Sustainable livelihoods concept paper*. Retrieved January 5, 2003, from http://www.undp.org/sl/ Documents/Strategy_papers/Concept_paper/

Concept_of_DSL.htm

UNDP. (1999d). *The sustainable livelihoods approach, infrastructure financing and reduction of poverty and inequality*. Retrieved January 10, 2003, from http://www.undp.org/sl/Documents/General%20info/Infrastruct…/ infrastructure,_financing.ht

Water and Energy Commission Secretariat (WECS). (2002). *Water resources strategy Nepal*. Kathmandu: WECS, HMG/N.

Watson, R. T, Zinyowera, M. C., Moss, R. H., Moreno, R. C. Adhikari, S. & others. (1996). Technical summary: Impacts, adaptations, and mitigation options. In R. T. Watson, M. C. Zinyowera, & R. H. Moss (eds.), *Climate change 1995: impacts, adaptations and mitigation of climate change-scientific technical analysis.* (pp. 19-53). Cambridge: Cambridge university press

Woolcock, M., & Narayan, D. (2000). Social capital implications for development theory, research, and policy. In S. Devarajan (ed.), *The World Bank Research Observer*, 15 (2): 225-249.

Wyss, S. (2004). *Organization and finance of International labour migration in Nepal*. Kathmandu: Nepal Institute of Development Studies.

Yogacharya, K. S., & Sharma, K. N. (1998). Water supply potential, existing water supply and hydrological aspect. In *A compendium on environment statistics 1998, Nepal*. (pp. 205-219). *Kathmandu:* Central Bureau of Statistics

Zoomers, A. (1999). *Linking livelihood strategies to development: Experiences from the Bolivian Andes.* Amsterdam: Royal Tropical Institute.

APPENDICES

Appendix 1 Questionnaire and checklist

1. Background information

Date of Survey: ……Name of the interviewer: ……

District: …… VDC:…… Village…….……. House No……

NAME OF THE

RESPONDENT:……

Ethnicity:……. Religion:……. Mother tongue:……

2. House type and ownership

Roof type:……..Wall type: ……..Window type:…….……..…… Floor type…….. Number of room:…..…… Storey:…… ……. Ownership: a) Own b) Rented

3. Facilities available in the house

a) Radio b) Television c) Wall clock d) Electricity
e) Wall mirror f) Bio-gas plant g) Improved stoves h) Solar power
i) Water tap j) Improved latrine k) Refrigerator l) Sewing machine
m) Furniture (chair, table, cupboard etc.) n) Others (specify)……..

4. Migration: a) Native b) Migrant

If migrant: a) Year of in-migration: …… b) Place of origin :…….……

c) Place of birth if different……d)Reasons for migration:.……

……

.....

.....

5. Family size: Total family members……Member present…… Member absent……

SN	Family members	Age	Sex	Marital status	Education	Occupation		Working outside village			Remarks
						Primary	Secondary	Work Place	Duration	Earning (monthly)	
1	Head										
2											
3											
4											

5											
6											
7											
8											
9											
10											

Note: Marital status: 1 = unmarried, 2 = married, 3 = widow/widower, and 4 = divorced

Work place: 1 = within VDC, 2 = outside VDC within district, 3 = other district within country, and 4 = other countries

6. Land distribution by ownership (in Ropani)

Ownership	Khet	Bari	Kharbari	Pasture	Forest	Abandoned land	Other if specify
Own land							
Land rented in							
Land rented out							
Total land							

7. Area and production of major crops by irrigation status

Crops	Irrigated area				Non irrigated area			
	Local seed		Improved seeds		Local seed		Improved seed	
	Area	Production	Area	Production	Area	production	Area	Production
Paddy								
Maize								
Wheat								
Barley								
Potato								
Vegetables								
Fruit orchards								
others								

8.Is there any difference in productivity of crops between areas irrigated from Modi River and other rivers? a) Yes b) No

If yes, how much and why? ……

……

…….....

.....

9. Area by cropping intensity and irrigation status (in Ropani)

Irrigation facility	One crop	Two crops	Three crops
Through out the year			
Only in rainy season			
Only in winter season			
No irrigation at all			

10. Use of agricultural inputs by irrigation status:

Major crops	Labor (Number)	Manure		Chemical fertilizer		Pesticides	
		Irrigated	Non-irrigated	Irrigated	Non-irrigated	Irrigated	Non-irrigated
Paddy							
Maize							
Millet							
Wheat							

Barley							
Potato							
Others....							

11. Changes in area and productivity of major crops (within 10 years)

Major crops	Area		Productivity	
	Increased/decreased/same	Reasons for change	Increased/decreased/same	Reasons for change
Paddy				
Maize				
Millet				
Wheat				
Barley				
Potato				
Others				

12. Types and number of trees in private land

Types	Number by types	
	At present	10 years ago
Fruit trees		
Fodder trees		
Other trees		

13. Livestock: Number by types

Types	Number		Types	Number	
	Local	Hybrid		Local	Hybrid
Cow			Sheep		
Oxen			Pig		
Yak/Nak			Horse/Mule		
She buffalo			Chicken/Duck		
He buffalo			Pigeon		
Goat			Others (specify)……		

14. Animal grazing (place, duration and distance):

Types	Number	Place	Duration	Distance from house
Cow/oxen				
Yak/Nak				
Buffaloes				
Goat				
Sheep				
Others				

Total man-days spent for animal grazing (yearly):…….

15. Who grazes the animal (% involvement)

a) Male …… b) Female ….…….c) Children …. ...……d) Whole family……...

16. If transhumance is practiced, specify the rotation and movement cycle……..

……
…….

17. Production and sale of livestock, and livestock products (last year)

Product types	Production quantity	Amount sold	Changes in production during 10 years		
			More	Less	Same
Milk products					
Meat					
Egg					
Live animals					
Wool					
Skin/hide					
Others…..……..					

18. Food sufficiency by own production in months: a) At present…… b) Ten years ago……
If changed, causes of change:……
.....
.....
.....

19. If deficit, how you manage?:
……..……
……
…….

20. If surplus, how do you use?
a) Exchange other goods b) Store for next years

c) Sale in local markets: Place……d) Other uses (specify)……..…
.....
.....
.....

21. Persons affected by common diseases (last years)

Waterborne diseases	Persons affected	Other diseases	People affected
Diarrhea		Whooping cough	
Dysentery		Tuberculosis	
Typhoid		Asthma	
Jaundice		Common cold	
Worms		Pneumonia	
Scabies		Eye irritation	
Others……..		Others……	

22. Industrial production (last year)

Types	Employment	Duration of operation	Production	% sale	Remarks
Brick and tile					
Cement blocks/Hume pipes					
Liquor making					
Wool materials					
Leather materials					
Jute materials					
Paper making					
Limestone (Chun)					
Wooden materials					
Bamboo materials					
Ghatta (water mill)					
Power generation					
Metal works					
Candle making					
Others……..…….					

23. Sources of energy

Types	Purpose of use				Remarks
	Lighting	Heating	Cooking	Production purposes	
Fuel wood					
Kerosene					
Electricity					
Bio-gas					
Solar power					
LPG gas					
Others …….					

24. Annual expenditure of last year (%)

Food…….. . Clothing……

Education……..Health…… Transport…… Fuel wood ……. Tax/donation…… Wages…….

Electricity/kerosene…….Social ceremonies……..... Other (specify)…….……

25. Investment during last 10 years (in Rs)

a) Land purchase…… b) Land improvements…… c) Irrigation……. d) House ……. e) Cottage industry……f) Business……..
g) Bus/trucks etc…… h) Loan to others…….. i) Others (specify)……

26. Status of loan/borrowing

Sources	Purpose	Amount	Interest rate
Banks/ Cooperatives			
Community funds			
Local merchants			
Relatives			
Other if any……			

27. Sources of family income (last year)

Source	Yes/No	Annual income (in Rs)
Crop production		
Fruits		
Vegetables		
Livestock		
Industrial production		
Business (shops)		
Tourism /hotel/ lodge		
Wages/Portage		
Service		
Remittances		
Pensions		
Rent (house and other)		
Sale of forest products		
Other sources……..		

28. Water use:

i) Agriculture (Irrigation)

Sources	Irrigated area			Canal/ pipe distance	Adequacy	If inadequate Reasons
	Year round	Summer	Winter			

ii) Use of water for household

Use type	Sources	Quantity	Quality	Distance	Adequacy	Remarks
Drinking and cooking						
Washing and bathing						
Livestock						
Others……..						

iii) Industrial use of water

Types	Source	Quantity	Distance	Adequacy	Remarks
Brick and tile factory					
Cement blocks/Hume pipes					
Liquor making					
Wool processing					
Leather processing					
Paper making					
Chun making					
Wood carving					
Ghatta (Water mill)					
Power generation					
Metal works					
Candle making					
Bio-gas plant					

Others……..….					

iv) Cultural and religious use of water

- Ghat a) yes b) No If yes, place……

.....

- Religious bath a) yes b) No If yes, place and frequency……

.....

- Raise/offer at temple a) yes b) No If yes, place and frequency……

.....

v) Fish/ Acquaculture a) yes b) No If yes, source…..……

.....

vi) Transportation

- Goods a) yes b) No If yes, place……...

.....

- People a) yes b) No If yes, place……...

.....

vii) Swimming/recreation a) Yes b) No If yes, place……...

.....

viii) Waste management a) Yes b) No If yes, work……...

.....

ix) Construction works a) Yes b) No If yes, source……

.....

x) House cleaning/ washing a) Yes b) No If yes, source and frequency……..…

.....
.....

xi) Other uses (specify)……..a) Yes b) No

……..

……
……

29. Water use conflict

Conflicts on use	Types and causes of conflicts	Frequency	Process of conflict management
Irrigation			
Irrigation and household use			
Irrigation and industrial use			
Household use			
Household use and industrial use			
Industrial use			
Other use			

30. Participation in water use and management committee

Use type	Institutions/ committee	Membership	Types and amount of contributions
Irrigation			
Household use			
Industrial use			
Other use			

31. Water induced disaster and loss/damages of property

Types	Recurrence interval	Last event (Year)	Loss/ damages			
			Land	Crop	Animals	Other properties
Floods						
Draught						
Landslides/debris flow						
Snow/ Avalanches						
Hail storm						
Storms						

32. How would it effect you if the river flow would reduce?……..

……
……
.....
.....
.....
.....

.....
.....

33. If present source of water would not be functioning, where would you get your water
supply?……
……
…….....
.....
.....

34. How would it influence your farming if the cold weather continued until March?
……..
..……
……
.....
.....
.....
.....

35. If the weather would become hotter, would it be good or bad for:

i)	Crops:	a) good	b) bad	c) No change
ii)	Animals:	a) good	b) bad	c) No change
iii)	People:	a) good	b) bad	c) No change
iv)	Forest:	a) good	b) bad	c) No change
v)	Infrastructure:	a) good	b) bad	c) No change

36. If there would be more rainfall, would it be good or bad for

i)	Crops	a) good	b) bad	c) No change
ii)	Animals	a) good	b) bad	c) No change
iii)	People	a) good	b) bad	c) No change
iv)	Forest	a) good	b) bad	c) No change
v)	Infrastructure	a) good	b) bad	c) No change

37. Would it be better for people if the river would become
a) Bigger b) Smaller c) The same

38. Overall perception on environmental change in locality

Sectors	Changes within 20 years			Reasons for change	Future trend
	Increase	Decrease	Same		
1. Agriculture					
⁾ Agricultural Area					
⁾ Area under cereal crops					
⁾ Area under fruits					
⁾ Area under vegetables					
⁾ Diversity of crops					
⁾ Intensity of crops					
⁾ Productivity					
⁾ Use of improved seeds					
⁾ Use of fertilizer					
⁾ Use of pesticides					
2. Forest					
⁾ Area of forest					
⁾ Number of tree species					
⁾ Crown cover					
⁾ Availability of fuel wood					
⁾ Availability of timber					
⁾ Availability of fodder					
⁾ Availability of litter					
⁾ Availability of herbs					
⁾ Forest foods					
⁾ Wildlife					
3. Pasture/grassland					
⁾ Area under pasture					
⁾ Productivity of pasture					
4. Waste land					
⁾ Area of waste land					
⁾ Use of waste land					
5. Environmental hazards					
⁾ Surface runoff					
⁾ Soil erosion					
⁾ Landslides					
⁾ Floods					
⁾ Pests and diseases					
⁾ Forest fire					
5. water					
⁾ Quantity					
⁾ Quality					
⁾ Distance for collection					
6. Weather					
⁾ Rainfall					
⁾ Temperature					
⁾ Snow line					
⁾ Volume of river flow					
⁾ Changes in seasons					

39. General comment on climate change and water availability if any:.....

.....
.....

Checklist for group discussion

- **Natural Resources**
  - Existing condition of the natural resources -Land, Forest, Water, and Pasture
  - Access right on these resources and households benefited
  - User's committee (number, size, decision making process, problems)
  - Conflict between committees or within community over the use of these resources with particular focus on water and pasture
  - Changes on the status of resources over time
  - Availability of forest products and related issues
  - Area and production of crops, cropping intensity, use of inputs, changes over time, major export items, irrigation coverage, and major problems related to agricultural development.
  - Use of energy and its availability (types, number, size, ownership, effectiveness, problems and prospects)

- *Physical Resources*
  - Existing road links and their condition
  - Availability and frequency of public transport
  - Post offices, and telephone services, health institutions and facilities available
  - Schools by types and level and their condition
  - Piped water distribution and coverage and its management
  - Industries, major products and potentials
  - Development trend of physical resources (roads, electricity, piped water etc.)
  - Fulfillment of local needs and sustainability
  - Existing/ongoing and future plans/programs related to physical resources.
  - Water mills and power generation (number, quality and problems)

- *Human resources*
  - Accessibility of information -sources and benefited groups
  - Use of modern technologies by community members (radio, television, email, internet)
  - People's feeling about sources and reliability of information sources
  - Perception about government policies with particular focus on water use.

- Availability skilled and semi-skilled manpower
- Employment opportunities

- *Financial capital/resources*
- Types of financial service organizations available and types of services provided
- Access to these organizations
- Households getting remittances and utilization

- *Social capital/Resources*
- Number of CBOs, traditional social organizations and formal groups (extent of membership)
- Degree of participation on decision-making.
- Kin, income and occupational structure of the group
- Social problems in the community (types and degree)
- Religious and cultural ceremonies
- Religious bath (place, frequency, problems)

- *Climate change and relations*
- Perception of people regarding climate change (temperature, rainfall, snow cover area)

  How would people's life change, if the weather become

  a) Hotter and drier b) Wetter/more rainy

  c) More colder d) Season changed
- What would people do, if there were

  a) More landslides b) The forest died c) Decrease tourist d) Difficult to grow staple crops

Appendix 2 Cropping intensity by irrigation status (Chi-square calculation)

Observed frequencies (O)	Expected frequencies (E)	O-E	$O-E^2$	$O-E^2/E$
250	216.62	33.38	1114.34	5.14
165	174.17	-9.17	84.17	0.48
115	139.21	-24.21	586.00	4.21
200	192.91	7.09	50.23	0.26
152	155.11	-3.11	9.70	0.06
120	123.97	-3.97	15.79	0.13
175	192.10	-17.10	292.25	1.52
160	154.46	5.54	30.73	0.20
135	123.45	11.55	133.45	1.08
185	192.10	-7.10	50.35	0.26
155	154.46	0.54	0.30	0.00
130	123.45	6.55	42.93	0.35
175	191.28	-16.28	264.97	1.39
160	153.80	6.20	38.45	0.25
133	122.92	10.08	101.55	0.83
		Calculated Chi-square		16.16

Source: Calculated from Table 6.4

Appendix 3 Households with piped water supply and water fetching distance

VDC/Municipality	Piped water supply	Households by distance of water supply			
		<1hour	1-3 hour	>3 hour	No reported
Bhuktangle	60.4	100.0	0.0	0.0	0.0
Dansing	95.4	96.8	0.7	0.0	2.5
Ghandruk	99.7	98.6	1.4	0.0	0.0
Lumle	91.9	91.9	0.0	0.0	8.1
Upstream total	***91.3***	***97.6***	***0.8***	***0.0***	***1.6***
Arthar Dadakharka	55.0	65.2	8.1	0.8	25.9
Bajung	72.1	85.4	5.7	3.6	5.3
Bhadauretamangi	95.6	99.5	0.5	0.0	0.0
Bitalawa Pipaltari	57.7	68.9	4.8	22.4	3.9
Chitre	45.5	16.5	24.4	49.2	9.8
Chuwa	99.0	99.0	0.0	0.0	1.0
Deupurkot	79.9	94.1	0.8	0.0	5.1
Deurali	78.9	44.6	14.1	18.3	22.9
Dhikurpokhari	91.8	95.2	2.6	0.3	1.9
Durlung	31.1	17.4	22.8	3.8	56.1
Karkineta	71.3	97.6	0.0	0.0	2.4
Katuwa Chaupari	93.0	94.0	0.0	0.0	6.0
Khaulalakuri	79.9	95.0	0.0	0.0	5.0
Kyang	89.8	32.9	8.0	49.4	9.7
Mudikuwa	89.2	67.6	2.9	23.6	5.9
Pakuwa	92.8	92.6	0.6	3.8	3.0
Ramja Deurali	91.3	99.2	0.0	0.0	0.8
Salyan	60.7	77.1	16.1	1.0	5.9
Shankar Pokhari	73.2	32.6	8.8	39.8	18.9
Shivalaya	95.6	56.0	6.5	30.9	6.6
Thapathana	74.2	28.1	8.6	35.0	28.3
Thulipokhari	52.8	83.4	0.0	0.0	16.6
Tilahar	77.5	98.2	0.0	0.5	1.3
Downstream total	***75.8***	***71.1***	***6.1***	***11.8***	***11.0***
Grand total	**78.0**	**74.9**	**5.3**	**10.1**	**9.7**

Source: Field survey, 2002/03

Appendix 4 Drinking water projects and benefited population

Name of VDC	Name of Project	Population benefited		Name of VDC	Name of Project	Population benefited
	Arthar Dandakharka	2527			Thuldhunga	407
	Manjkatera Atmanirva	323			Biyad	131
Arthar dandakharka	Andherineta	195			Bahipandhera	170
	Newa	578			Kyang	954
	Bajung Pokhare	400			Kyang	463
Bajung	Bajung Kalimati	2359			Bhumethan	247
Bhuktangale	Kadoori	1980		Kyang	Kamdhenu	199
	Pipaltari	635			Rugdi	295
	Nameless w/s Project	200			Budho	136
	Chilne Khole	390			Dudhpani	137
	Jhnakri Khola	440			Patale Khet	250
Bitawala Pipaltari	Katuwa Chaupari	780			Thulopandhero	98
	Barathan Pancholy	296			Alaichi Khola	56
	Birkharka	411			Dudhpani	64
Chitre	Kalimati	314			Gaudel	68
Chuwa	Sundare Khola	260		Mudikuwa	Tatopani	408
	Dansing Moharia	525			Thada Khola	378
	Dansing Moharia	695		Pakuwa	Grameen	1224
	Ulleri	3805			Andheri Khola	250
Dansing	Ulleri Helvetas	Na			Ward no 2	239
	Deupurkot Deurali	1147		Ramja Deurali	Ramja Deurali	926
	Makha Kalyani	1306			Sankar Pokhari	2130
Deupurkot	Gairathok	108		Sankar Pokhari	Simkhola	198
	Deupur Deurali	1420			Salyan	1368
	Kadoori	370		Salyan	Luthara	Na
Deurali	Helvetas	332			Kushma	5813
	Durlung Deurali	1540		Shivalaya	Kushma	888
Durlung	Durlng	685			Paudhera Khola	200
	Ghandruk	4173			Tunet Khola	105
Ghandruk	Sunkhani	435		Thapathana	Judhane	353
	Landruk	1250		Thulipokhari	Thulipokhari	698
Lumle	Lumle	5164			Daray Atmanirvar	615
Karkineta	Karkineta	1021			Chapako	1302
	Katuwa Chaupari	1976			Jhobaun	1451
Katuwa Chaupari	Tatopani Mul	80			Chanaute	540
	Khaula	609		Tilahar	Kamaleshwora	362
Khaula Lakuri	Okhadi khola	100		***Total***	***73***	***61952***

Source: Field survey, 2002/03(official records)

Appendix 5 Ownership, household benefited and water sufficiency status of water mills, 2002

Sub-region	Zone	Location	Ownership	Operation	HH Benefited	Average income (Operated months)	Water Adequacy
Upstream	Upper	Ghandruk	Private	June-Sept.	60	2000	I
		Ghandruk	Private	June-Sept.	60	2000	I
		Ghandruk	Public	Year round	150	2000	A
		Ghandruk	Private	June-Sept.	50	2000	I
		Ghandruk	Private	June-Sept.	50	2000	I
		Mirdi	Private	June-Oct.	20	500	I
		Mirdi (Chadaro)	Private	June-Oct.	NA	NA	I
		Ghurjung	Private	June-Oct.	35	1000	I
		Ghurjung	Public	Year round	35	1000	A
		Taulung	Private	June-Oct.	36	1000	I
		Chhomrong	Public	Year round	66	-	A
		Chhomrong	Public	Year round	66	-	A
	Middle	Syauli Bhatti	Private	June-Nov.	25	400	I
		Syauli bazar	Private	June-Oct.	40	2000	I
		Syauli bazar	Private	June-Oct.	40	2000	I
		Syauli bazaar (Modi)	Private	Dec.-May	150	3000	A
		Syauli bazaar (Modi)	Private	Dec.-May	150	3000	A
		Tikhyan	Private	June-Oct.	30	1000	I
		Narthok	Private	Year round	50	2500	A
		Narthok	Private	Year round	50	2500	A
		Siwai	Private	Year round	60	3000	A
		Siwai	Private	Year round	60	3000	A
		Channe	Private	June-Sept.	40	1000	I
		Channe	Private	June-Sept.	50	2000	I
		Ghandruk	Private	Sept.-June	50	2000	A
		Ghandruk	Private	Sept.-June	50	2000	A
		Ghandruk	Private	Sept.-June	50	2000	A
		Chuile	Private	Year round	12	300	A
		Kimrung Khola	Private	Year round	40	1500	A
		Landruk	Private	June-Oct.	150	2500	I
		Landruk	Private	June-Oct.	150	2500	I
		Purgiyu	Private	Year round	50	2000	A
		Purgiyu	Private	Year round	50	2000	A
		Purgiyu	Private	Year round	50	2000	A
		Purgiyu	Private	Year round	50	2000	A
		Dilgara	Private	Year round	60	2000	A
		Near Mirdi	Private	Year round	60	1500	A
		Bhichuk	Private	Year round	60	1500	A
		Bhichuk	Private	June-Sept.	50	1500	I
		Patlekhet	Private	June-Sept.	50	800	I
		Birethanti	Private	Year round	30	1500	A
		Matathanti	Private	Year round	50	2500	A
		Birethanti	Private	Year round	30	1500	A
		Sabed	Private	June-Sept.	30	800	I
		Sudame	Private	Year round	60	3000	A
		Sarkiu	Private	June-Sept.	25	1000	I
		Phulbang	Private	June-Sept.	20	400	I
		Thado Khola	Private	June-Sept.	45	1000	I
		Patlekhet	Private	Year round	50	2000	A
		Tikhedhunga	Private	Year round	75	1500	A
		Dhoti Khola	Private	Year round	150	3000	A
Downstream	Upper	-	-	-	-	-	-
	Middle	Hupra khola	Private	Year round	100	1500	A
		Tuhure khola	Private	Year round	100	2000	A
	Lower	Patichour	Private	Year round	50	3000	A
		Patichour	Private	Year round	150	3000	A

Source: Field survey, 2002/03

Appendix 6 Perception of discussion groups regarding changes in temperature

Response	Downstream			Upstream		Total
	Lower	Middle	Upper	Middle	Upper	
Increase	2	2	-	1	1	6
Decrease	-	-	-	-	-	-
Same	-	-	2	2	2	6

Source: Field Survey, 202/03.

Appendix 7 Perception of discussion groups regarding changes in precipitation

	Downstream			Upstream		
Response	Lower	Middle	Upper	Middle	Upper	Total
Increase	1	1	0	0	2	4
Decrease	1	1	0	0	0	2
Same	0	0	2	3	1	6

Source: Field Survey, 202/03.

Appendix 8 Perception of discussion groups regarding changes in snow-covered area

	Downstream			Upstream		
Response	Lower	Middle	Upper	Middle	Upper	Total
Increased	-	-	-	-	-	-
Decreased	1	2	2	1	3	9
No change	1	-	-	2	-	3

Source: Field survey, 202/03