A Report on

Water and Poverty Linkages in Mountainous Areas : A Case Study from Nepal

Submitted to:
International Water Management Institute, Colombo, Sri Lanka

February 2003

Acknowledgements

The Center for Environmental and Agricultural Policy Research Extension and Development (CEAPRED) is thankful to Nepal Water Partnership (NWP) for entrusting the responsibility of carrying out this important study. The International Water Management Institute (IWMI), Colombo, Sri Lanka provided financial support to complete the study. CEAPRED expresses its indebtedness to IWMI.

Many professionals, both national as well as international, contributed towards enriching the quality of the work. It is practically difficult to name all, but there are a few names which we must mention. These persons are Dr. Hari Krishna Upadhyaya, Mr. Iswor Raj Onta, Mr. D.R. Bajracharya, Dr. Vijaya Shrestha, Dr. Upendra Gautam , and Mr. Pradeep Mathema from Nepal. Likewise, Dr. Intizar Hussain and Mr. Izhar Hunzai of IWMI deserve our recognition.

Various stakeholders at different levels were consulted during the course of the study. We express our appreciation to all of them for their cooperation and feedback. Various international institutions such as Asian Development Bank, International Water Management Institute, sponsored the participation of study coordinator in various regional consultative meeting/forum. The Center with due respect acknowledges their their contribution to this study.

Last but not the least, CEAPRED expresses its thankfulness to all individuals and institutions who contributed to the study directly or indirectly.

Madan P. Pariyar

Program Director

February 28, 2003

Executive Summary

1. Introduction

Improving water security for the poor has been a matter of immense concern in recent years. There is a growing recognition that a strong linkage exists between water and poverty, both in terms of alleviation as well as perpetuation of poverty. In South Asia, however, there is a dearth of information on how water and poverty is linked together under different conditions. Realizing the above facts, this study was initiated by South Asia Technical Advisory Committee of Global Water Partnership with the financial support of International Water Management Institute. The study, carried out in Nepal, envisages to analyze and reflect the relationship between water and poverty in mountainous conditions. Under the supervision of Nepal Water Partnership, the study was executed by Center for Environmental and Agricultural Policy Research Extension and Development.

2. Country Background

The hills and mountains in Nepal occupies over three-fourth of its land area, constitutes about 49 percent of the cultivated area, and provides home to nearly 54% of the population. Agriculture, the largest sector of Nepalese economy, is the main source of livelihood for the majority of population. Despite high priorities accorded to it, the agriculture sector performance has been weak and unstable. Among the major factors responsible for poor performance of agriculture sector is the inadequacy and unreliability of irrigation facilities. It is estimated that only a third of the potential productivity of the agriculture has been realized at present. Agriculture, thus, holds the main key to the reduction of poverty. These are the realities prompting all development plans to accord high priority to the agriculture sector.

3. Objectives of the Study

The main objectives of the study are to identify and understand linkages between water and poverty in mountainous situations; identify constraints and opportunities for alleviating poverty; and draw implications and develop guidelines for effective implementation of IWRM for alleviation of water related poverty.

4. Methodological Framework

The study is based on reviews, consultations, use of secondary data/information and supplemental field studies. The key activities included: review of literature, identification of secondary data/information, preparation of field study methodology, brainstorming workshop, presentations in international forums, and implementation of the study. The field study methodology specifies: types of water uses considered, variables studied, selection of study district, selection of VDCs/villages, and spelling out the methodology for field surveys..

Four different types of water uses, viz., drinking water and sanitation, irrigation, micro-hydro power generation, and agricultural processing, were considered for the study. Farms were categorized based on their size, access to water for domestic purposes and status of irrigation. Kavre was selected as the study district. Altogether 84 households belonging to 12 different categories were selected for household surveys in 8 villages of selected five VDCs.

Additionally a hydro-power site at Katunje Besi VDC, one *Ghatta* or traditional water mill site at Methinkot VDC, and one improved water mill site at Charenge Phedi village in Khanal Thok

VDC were also studied. Focus group discussions were held in each village, and key informant interviews were held with relevant, knowledgeable persons.

5 Description of Study Area

Kavre, a mid-hill district, is predominantly an agricultural area with almost 90% of its population dependent on agricultural activities for their day-to-day living. Agriculture, which encompasses both crop and livestock activities, contributes to the most of its economic growth. Due to the variation in altitude and the prevailing climates, a wide range of horticultural crops (fruits, vegetables, spices, herbs and flowers) are being grown in the district successfully. The district has an immense potential for increasing agricultural production. Irrigation is one of the major constraints to agricultural developments.

6 An Overview of Nepal's Water Resources

Nepal at present consumes less than 8 percent of its annual renewable water potential of 232 billion cubic meters (224 billion cubic meters surface runoff and eight billion cubic meters rechargeable groundwater). The most important non-consumptive use of water is in hydro power generation and milling; while the consumptive use of water is primarily in the three sectors, namely, agriculture, household and industry. The country's total theoretical hydropower potential of 83000 MW, out of which 42,000 MW is considered economical potential. The present installed capacity of 584 MW is not sufficient to meet even the internal demand of the country. Most of the power plants are run-of-river type. Only some are storage power plants.

About 67% of the cultivated land in Nepal is reported irrigable (24% in the mountains, 34% in the hills, and almost all land in the *Terai*). While surface water is the only source of irrigation in hills and mountains, both surface water and ground water are the major sources of irrigation development in the *Terai.* At present irrigation is provided to 42% of the net cultivated land, and 41% of irrigated area is being supplied with irrigation on a year-round basis. Existing irrigation systems are the basis for almost 33% of the current agricultural production.

About one third of Nepal's population does not have access to safe water and almost three-fourth of the population lack sanitation facility. Industries in Nepal are still in the early stage of development. It is estimated that the industrial water requirement constitutes only a small fraction of total water requirement. Micro-hydro power in the form of milling has existed in the hills and mountains of Nepal for centuries. A total of 1956 micro-hydro electric power schemes with an installed capacity 13,064 kW have been installed in the country since 1962.

7 Poverty Situation in Nepal

Poverty remains pervasive and wide spread in Nepal. Although a recent estimate claims a poverty level of 38% at the national level, the real poverty appears to be much higher. The magnitude and severity varies across regions and communities/ethnic groups. The situation is worst in the hills, mountains, and remote parts of rural areas. The social indicators, reflecting the quality of life in Nepal, also paint a gloomy picture. Gender disparities are large and persistent. Women and children are more affected by poverty than are men, in both rural and urban areas.

Poverty alleviation has been the main development agenda of Nepal. Water resources development has been a key component in most of the poverty alleviation plans, programs and initiatives. The highest importance accorded to irrigation development in the Agriculture Perspective Plan, the national commitment to provide safe water (for drinking and sanitation) to all Nepalese households, and the priority accorded to hydro power development for internal uses and exports, evince the importance of water resources in a broader perspective. At village/farm level, the impact of micro-irrigation facilities can be observed in several districts where poor farmers have switched over to high value labor intensive cash crops, and thereby, are able to raise their income several folds.

8 Findings of Field Studies

The field studies have reflected the following:

- Family size was larger in households with good access to drinking water than those with poor drinking water supply.
- The level of education and access to drinking water sources showed a direct relationship.
- Schooling of boys was mainly affected by irrigation status or indirectly by income, but schooling of girls was affected by the accessibility to drinking water
- Expenditure in education was higher in the categories with good access to drinking water as compared to those with poor access to drinking water. However, the percent of income spent on education was highest in the category with poor access to both irrigation and drinking water, as their income was low.
- More than 40% of economically active population were involved in agriculture. Higher percentage of people in the categories with good accesses to irrigation had agriculture as their main occupation compared to the category with poor accesses to irrigation.
- Migration was higher in case of the categories with poor access to irrigation.
- In households with good access to drinking water, well and tap/pipe were the major sources. Likewise, for the households with poor access to drinking water, stone taps, wells and spouts were the major sources. These groups of people faced water scarcity in the months of March, April and May.
- Streams/rivers/springs were the most dominant sources of irrigation. Other irrigation sources included pipes and tanks. In most of the households, lands received only partial/seasonal irrigation, and there were water deficit periods. The charges for the irrigation also varied from one place to other. In some places the payment was made on annual basis while in others, it was done on area under irrigation/acreage basis.
- The categories with good access to irrigation had bigger size of khet land than the bari land and vice versa. The average land holding of households with good access to irrigation was 0.84 ha while it was 0.95 ha for households with poor access to irrigation.
- Yield of the crops showed variation with irrigation status. In almost all the crops the yield was higher in irrigated farms as compared to the rainfed farms except in case of monsoon vegetables grown in *bari* land which had good drainage.
- Increases in crop yields under irrigated condition were much higher when on-farm water management practices and high level of improved inputs such as hybrid seeds, chemical fertilizers, intensive agricultural extension services and organized marketing facilities, were practiced.
- Cropping intensity was higher in irrigated land (213%) than in case of rainfed land (107%). It also varied inversely with the size of farm.

- Farmers with good access to irrigation gained higher farm income compared to the farmers with poor access to irrigation.
- Farmers with good access to drinking water earned more from the livestock than those with poor access to drinking water.
- Off-farm incomes were higher in case of households with poor access to irrigation than those with good irrigation facilities.
- The total income was higher in categories with good access to irrigation than the categories with poor access to irrigation.
- Households with good access to irrigation and drinking water were found to be self-sufficient in food and the remaining categories were food deficit.
- With improved access to drinking water the health status of people in the survey area improved over the years. Incidence of water borne diseases and skin diseases was reduced. But expenditure on health care increased after having access to improved water resources, because of better economic status and awareness on health care.
- Sanitation condition was although quite poor in general, it was better amongst the households with good access to water than those with poor water access.
- Incidence of landslides and floods had increased due to improper irrigation, increased population and encroachment of the forest areas.
- The diversion of rivers in an unmanaged way had affected the downstream aquatic life.
- Unmanaged water resources had also affected the vegetation status in the area.
- The mosquito nuisance had increased over the years, and was more severe in households with poor access to water resources than those with good access.
- With improvement in access to water resources, there has been considerable increase in the physical asset holding of the farmers.
- Access to electricity has reduced the hardships faced. It has created a better environment for the children to study and saved the money on kerosene.
- The traditional water mills, *'Ghattas'*, were used for grinding cereals. The beneficiaries expressed that the cereal flour of the mill was tastier, and storable for a longer duration.
- The improved watermill, used for grinding cereals, had enhanced the family income.

9 Issues Identified

- There are many households without access to safe drinking water.
- The quality of drinking water during the monsoon season is bad in wells due to seepage.
- In want of drains, stagnating water acts as a breeding ground for mosquitoes.
- With increasing population, pressure on the existing drinking water sources is increasing.
- Most of the land under irrigation has only partial irrigation.
- The study area lacks water harvesting technologies.
- Electricity generated from micro-hydro scheme has almost no use during the day time.
- Because of inability to contribute, many ultra poor households, which remain struggling for two square meals a day, are devoid of improved water access.

10. Conclusions

Nepal possesses a huge untapped potential for hydro-electricity and irrigation development. These developments, *the blue revolution*, will foster poverty reduction, which remains the country's most pressing concern in the days ahead. Water is mainly used for domestic (drinking water and sanitation), irrigation, micro-hydro power generation and milling purposes.

The study shows a strong linkage between water and poverty in the hills and mountainous regions. In general, water has contributed to reducing poverty and improving the quality of life of the people. But many a times, water management problems have accentuated poverty.

The availability of piped water for domestic purposes has improved health and sanitation status. The incidence of water-borne diseases is reduced notably, and the hygienic habits are enhanced. The drudgery faced by family members, especially women and children, in fetching water from long distances, are also greatly reduced. The time and labor , thus saved, has facilitated better education opportunity for the children and women's involvements in income generating activities. This has ultimately helped to improve the economic status of the family. The waste water emanating from the drinking water taps are often used for kitchen gardening, which contributes to the improved nourishment of the families.

The availability of irrigation water has enhanced agricultural productions and farm income. The productivity of crops, and cropping intensity are increased; commercialization of agriculture through a shift from subsistence agriculture is becoming a reality, and crop diversification through production of high value cash crops, e.g., off-season vegetables production, vegetables seeds production, production of fruits, are taking place. All these changes together with enhancement of employment opportunities and agro-based enterprises, have greatly enhanced the family income and living standard of the people.

The study also reflects that sanitation facilities has not expanded with the development of domestic water supplies. Adverse effect of unmanaged irrigation is also seen in terms of deteriorating land conditions and aquatic life. Lack of drainage system and sanitation awareness of the people has resulted in increased mosquito population.

The hills and mountains are also characterized by existence of innumerable *Ghattas* (traditional water mills). Now-a-days improved water mills by virtue of their efficiency and multiple end-uses, are replacing the traditional *Ghattas*. In recent years, several micro-hydro schemes are also gaining in popularity in the mountain areas. The recent advancements in promoting micro-hydro power has certainly benefited the mountain people by providing locally generated self-contained electricity supplies.

Overall it is concluded that water plays a vital role in poverty alleviation. The efficiency in reducing poverty will be enhanced if there is access to improved technologies and other material inputs along with access to improved water resources.

11. Recommendations

- Efforts should be made to avail round the year safe drinking water to all households.
- Efforts are also required to improve the sanitation condition of the people.

- Efforts should be made to improve/expand the irrigation schemes for year-round irrigation.
- Technical and material supports should also be provided to farmers in order to maximize the benefits of irrigation water.
- Micro-hydro power generation should receive priority for development of hills and mountains. People should be trained on the end-use applications of electricity.
- While designing/developing a development program, it should be ensured that the ultra-poor are not left behind. This will require programs specially tailored for these specific target groups.

Study Team Composition

1.	Dr. Madan P. Pariyar	Water - Poverty Expert / Study Coordinator
2.	Mr. Purna Lal Shrestha	Sociologist
3.	Ms. Amina Maharjan	Economist
4.	Ganga Ram Yadav	Field Officer
5.	Keshav Pandey	Field Officer
6.	Moti Man Limbu	Field Associate
7.	Bauye Lal Yadav	Field Associate

TABLE OF CONTENTS

List of Acronyms/Abbreviations

SASTAC – South Asian Technical Advisory Committee
IWMI – International Water Management Institute
NWP – Nepal Water Partnership
JVS – Jalsrot Vikas Sanstha
IWRM – Integrated Water Resources Management
CDS – Central Bureau of Statistics
Km – Kilometer
Sq. Km. – Square Kilometer
mm. – Millimeter
Ha – Hectare
GNP – Gross National Product
GDP – Gross Domestic Product
VDC – Village Development Center
MW – Megawatt
KW – Kilowatt
US – United States
UNDP – United Nations Development Program
CECI – Canadian Center for International Studies
WDR – World Development Report
EDR – Eastern Development Region
CDR – Central Development Region
WDR – Western Development Region
MDR – Mid-western Development Region
FDR – Far- western Development Region
APP – Agriculture Perspective Plan
NLSS – Nepal Living Standards Survey
NPC – National Planning Commission
HDI – Human Development Index
GDI – Gender Development Index
SFDP – Small Farmer Development Program
PCRW – Production Credit for Rural Women
BWP – Bishweshor-with-the Poor
IREF – Interim Rural Energy Fund
ADB/N – Agricultural Development Bank of Nepal
REDP – Rural Energy Development Program
RADC – Remote Area Development Committee
NGO – Non-government Organization

List of Tables

List of Figures

List of Annexes

PART-I

BACKGROUND

1. INTRODUCTION

Improving water security for the poor has been a matter of immense concern in recent years. The water security, in a broader context, implies that all people, including the poor, have access to water services and sanitation to meet their basic needs, they are able to take advantage of the food security and income generation opportunities that water resources provide, they are protected from water-related hazards, and they have recourse where conflicts over water arise. Many developing countries have made huge investments in water resource developments to achieve several broader objectives such as economic growth, rural and agricultural development, national food security, protection against famines and intensification of land use. All these efforts are believed to have contributed to enhancement of food security and overall economic development.

Empirical evidences, however, also show that water resources development has favored the well-to-do sections of the communities, and has widened the gap between the rich and the poor. The overall impact of these developments although appear appreciative, but at the micro or grass root levels, the scenario quite often looks different. The irrigation infrastructures, for example, in many systems have benefited mostly the rich people or large landholders who have the ownership of irrigable fertile low lands. But the poor people who often are ether landless or have a small patch of non-irrigated upland, are deprived of the benefits accruing from such investments which mostly come from the national treasury or international grant/loan assistances. Likewise, many of the drinking water schemes constructed under a broader framework of action for ensuring health and hygiene to the common people are occasionally tapped by influential sections of the society. The poor people, because of their sparse settlement, inability to contribute, unwillingness of the well-to-do communities or for other reasons, do not have adequate access to these facilities. The challenge, therefore, is to develop and manage water resources 'to maximize the resulting economic and social welfare in an equitable manner".

Water and poverty can also be examined from a different perspective. There is a strong linkage between water and poverty, both in terms of alleviation as well as perpetuation of poverty. Water as a socio-economic 'good' plays an important role in the lives of the poor in several ways including its uses for domestic purposes, for production purposes and for nature/environment. Water can also become a socio-economic "bad" when it leads to problems such as water borne diseases (malaria, shistosomiasis), floods, and land degradation including water logging and salinity, water pollution and associated destruction of living beings and natural ecosystems. The poor and marginalized population, which with limited resources remain unable to adopt preventive or defensive measures, are most affected by consequences of water as a socio-economic 'bad'. While these are two extreme views, there is a general acceptance of the relationships between water and poverty, and the vital role of water resources in livelihoods of the poor. Improved management of water resources is, therefore, essential to enhance the benefits and to reduce the detriments of water to the poor (Hussain et. al. 2002).

Many of the relationships between poverty and water resources are circular. Poor people are generally ill (because of poor sanitation, unsafe water and poor nutrition). The illness stops them from working; and hence, further reduces their income and perpetuates poverty. To help them escape the poverty trap, a key component is reliable and affordable water of good quality (Wilk and Lundquist, 2001).

Water and poverty is going to be a key theme in many important international forums. It is also an important cross-cutting theme in the South Asian Technical Advisory Committee (SASTAC)'s Work Program. It is, however, realized that there is a dearth of information on how water and poverty is linked together in South Asia under different conditions. As such, in order to provide an important input into the upcoming high profile international forums, and

also to develop an understanding on how the precious resource, water, can be managed effectively and efficiently using the Integrated Water Resources Management (IWRM) approach to maximize the benefits and at the same time minimize its detrimental effects, in June 2002 meeting of SASTAC of Global Water Partnership in Colombo, it was decided to undertake case studies on water and poverty linkages in five different situations in member countries. The overall goal of the case studies is to draw lessons and identify interventions that can help policy makers, planners and other stakeholders to develop actions that are effective in water resources management for the poor. One of the proposed case studies is on "Water and Poverty Linkages in Mountainous Areas", and Nepal, because of its mountainous physiographiy, has been selected to carry out this case study. The International Water Management Institute (IWMI), Colombo is providing financial supports to this study, and the Nepal Water Partnership (NWP) – represented by Jalsrot Vikas Sanstha (JVS) is the focal point for the execution of the study in Nepal. The Terms of Reference of the study is given in ***Annex-1***.

2. COUNTRY BACKGROUND

Nepal, a landlocked country on the northern rim of South Asia, is bordered by China in the north and India in the east, south and west. Physically, stretching 880 km from east to west, and 150-200 km from north to south, the country occupies a land area of 147,181 sq. km. Within the narrow width, it embodies a wide range of climate varying from the sub-tropical in the south to the cold temperate in the north. The average annual rainfall is 1,600 mm with 80% of it occurring during monsoon. The winter is mostly dry.

The heterogeneous physiography divides the country into five major regions, viz., *Terai, Siwaliks*, Middle Mountains, High Mountains, and Hgh Himalayas (***Figure-1***). However, for the sake of brevity, the country is divided into three parallel ecological zones running east to west – *Terai* (includes *Siwaliks*), Hills (constitutes mostly Middle Mountains), and Mountains (constitutes High Mountains and High Himalayas). These zones differ greatly from one another in topography and altitude. The *Terai*, an extension of the Indo-Gangetic plain, is a narrow strip of land along the southern border of the country. The elevation of the region ranges from 75 to 300 meters. In the north of the *Terai* lies the Hills characterized by a maze of deep valleys, hills and spurs. The northern extension of the belt is demarcated by the contour of 3,000 meters. The northernmost part of the country is comprised of the mountains which locate Mount Everest, the world's highest peak.

Only about 2.64 million hectares or roughly 18 percent of the total land area is cultivated. According to a recently conducted census, the country's population in 2001 was 23.2 million, and the average growth rate of population during the last decade was about 2.27 percent per annum (CBS, 2001). The population is unevenly distributed across the three ecological regions, following closely the distribution of the cultivated land rather than total land area. The mountain region accounts for about 35% of the land area and 9% of the cultivated area, and provides home to 7% of the country's population. The hill region (including the Siwaliks) covers 42% of the land and 40% of the cultivated area, and houses 47% of the population. The *Terai* region, covering 23% of the total land and 51% of the cultivated area, provides home to 46% of the country's population. Consequently, although population density per square kilometer of total land is very low in the mountains (36.6%) compared to the hills (167.4) and the *Terai* (330.8), population density per ha of cultivated land is very high in all the three ecological zones, i.e., more than 7 persons per ha. With the GNP per capita of US $ 220 per annum, Nepal is one of the 12th poorest country in the world and the poorest in South Asia (WDR, 2002).

The religious and linguistic divisions also tend to follow the ecological divisions. The mountain population is dominated by the Tibeto-Burman speaking, largely Buddhist groups;

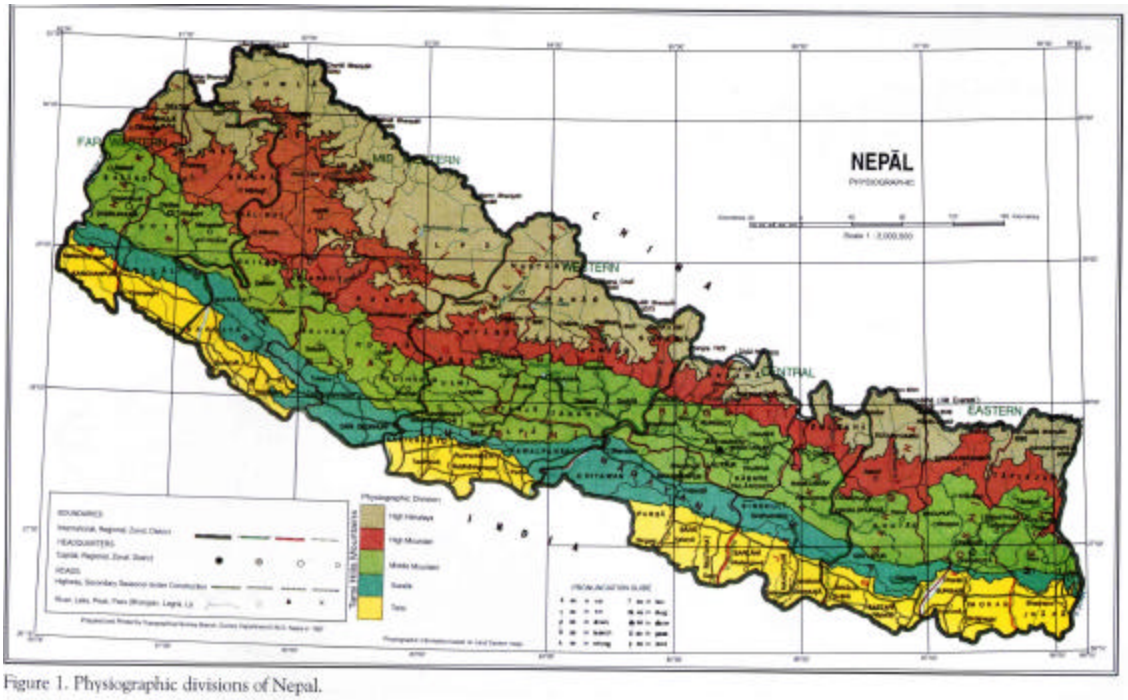


Figure 1. Physiographic divisions of Nepal.

the hill population by the Nepali speaking Hindu groups; and the *Terai* population by the Indo-Aryan Hindu groups, mainly speaking Maithili and Bhojpuri. Nepali is the national language, but some 35 other languages and dialects are also spoken. The caste and ethnic compositions also mark great diversity; the population is divided into more than 65 different caste/ethnic groups.

Administratively, the country is divided into five development regions (Eastern, Central, Western, Mid-western and Far-western Development Regions), 14 zones and 75 districts (***Figure-2***). A district is comprised of Village Development Committees (VDCs) and municipality. At the lowest level of division, each VDC is composed of nine wards, while number of wards in a municipality ranges from 9 to 35. The total number of wards is 36,032, the number of VDC and municipality wards being 35,226 and 806 respectively.

Based on type of residence, the country is also divided into rural and urban. The residence type reflects the status of development and availability of services required for a decent living. The municipalities are generally considered urban areas although some of the wards in the municipality lack the services which qualify them to be a part of the municipality. The VDCs are considered rural areas. The average size of a household tends to be smaller (4.8 persons per household) in the urban than in rural areas (5.5 persons per household). About 16 per cent households live in the urban area against 14 per cent population. On the other side, 84 per cent households live in rural area against 86 per cent population (CBS, 2001).

Agriculture is the backbone of Nepalese economy. Although its contribution to gross domestic product (GDP) is declining over time (from 70 percent in 1974/75 to 39 percent in 1999/00), it is still the largest sector of the economy. With about 80 percent of the rural labor force engaged in agriculture, agriculture is main source of livelihood for the majority of the population. Agricultural development has received high priority in all development plans, programs and policies of the government in terms of the total capital outlay allocated for the development of the sector. The Agriculture Perspective Plan which has been endorsed by the government as the guiding document for planned agricultural development in the country

also recognizes agriculture as the most potential sector for rapid transformation in rural economy. Yet, the agriculture sector performance has been weak and unstable. With an average growth rate of 2.5 percent during the last decade, the agricultural growth has been one of the lowest among all the major components of GDP and barely kept pace with the growth of population over the period 1991 to 2001 (ASPR, 2002). The per capita growth of GDP in agriculture of 0.23 percent is still far from the goal of 3 percent proposed in the Agriculture Perspective Plan (APP, 1995)[1].

Low productivity, slow rate of technological dissemination and its limited impact on production, have confounded policy makers, planners and agriculturists. The low productivity has been attributed to the lack of environment-specific technologies, limited use of production inputs (irrigation, fertilizer and good quality seeds), and extension of cultivation to marginal land. Among the major factors responsible for poor performance of agriculture sector is the inadequacy and unreliability of irrigation facilities. Irrigation being one of the key inputs for rapid growth in the agricultural productions[2], its development has received high priority by farmers and government agencies. However, despite various efforts made in developing/extending the irrigation infrastructure, the agriculture in Nepal remains largely dependent on the vagaries of weather. Out of a total of 2.64 million ha of cultivated land, only about 42% (1.1 million ha) receives irrigation. Year-round irrigation is available to only 0.45 million ha of cultivated land.

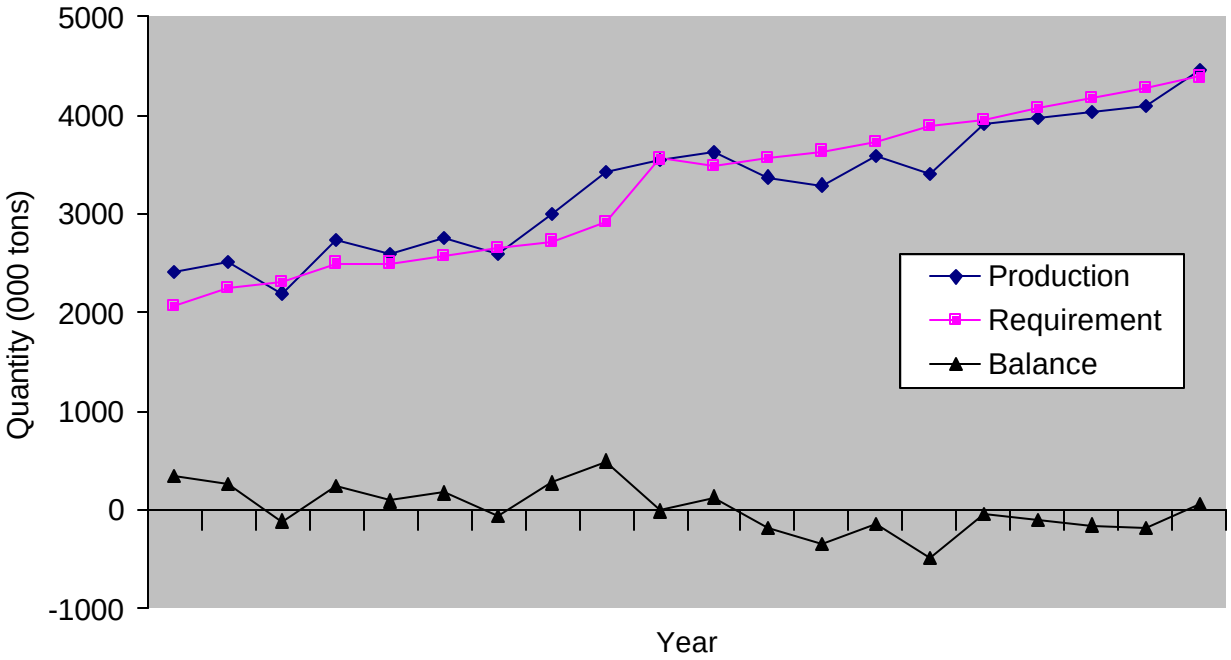
Figure 2: Map of Nepal showing Physiographic Regions and Ecological Zones

[1] APP is the guiding document endorsed by government for agricultural development in the country.
[2] It is reported that the timely and adequate availability of water alone can contribute to as high as 25% increases in crop yields, besides contributing to crop intensification, and diversification to high value cash crops.

Over the years, with increases in population, food demand has grown sharply; but the production of food grain has increased only marginally. Consequently, food grain production has not kept pace with population growth rate. The trends in food production, requirement and balance during 1980-2000 are depicted in ***Figure 3***, which clearly indicates a general trend of highly fluctuating food availability situation. Weather conditions during production have always influenced the food balance situation in the following year. During the past decade, the level of food shortage reached 485,000 ton in 1995, gradually declined to 182,000 ton in 1999 and recorded a surplus in 2000.

The food availability situation at the national level masks the actual extent of food insecurity prevalent in Nepal, as the situation varies greatly across regions and across districts within a region. Food shortages have remained the persistent problem in hill and mountain regions. It has been reported that 39 districts out of 75 in Nepal, suffered from food deficiency in the fiscal year 2001/2002. In general, the severity of food insecurity problem in a district is directly related to the remoteness of the district. The number of poverty stricken populace is increasing year after year.

Figure 3: Trends in domestic foodgrain production, requirement and balance, 1980/81-1999/2000.



Since the expansion of land frontier for cultivation is no longer feasible, increase in agricultural production is possible only through increasing the productivity per unit area of cultivated land. This requires a shift from the current subsistence-oriented farming to high value commercial agricultural production and to other agro-based income generating enterprises/opportunities, which might be locally sustainable.

The economy in Nepal is still mired in the initial stage of its development where the income generated through industrial sector as well as internal market expansion from non-agricultural sector depends upon the development of agriculture sector. Given the geographical diversity, only about one-sixth of land receiving year round irrigation facility, and only a fourth of the productive essentials being used in production, only a third of the potential productivity of the agriculture has been realized at present but that can be raised

through the use of state of art and technology (Economic Survey, 2002). Thus agriculture holds the main key to the reduction of poverty; and only through a broad-based agricultural growth that a high and sustainable economic growth and improvement in the living conditions of poverty-stricken rural people can be possible in Nepal. These are the realities prompting all development plans to accord high priority to the agriculture sector. It is also believed that the timely and adequate availability of water alone can contribute substantial increases in crop yields, besides contributing to crop intensification, and diversification to high value cash crops. Thus, water and poverty has a strong linkage in Nepal.

3. OBJECTIVES OF THE STUDY

The main objectives of the study are to:

- identify and understand linkages between water and poverty in mountainous situations;
- develop an analytical framework for studying relationships between water related poverty using IWRM as a redeeming tool;
- apply the framework to the real world situations;
- identify constraints and opportunities for alleviating poverty through IWRM approach; and
- draw implications and develop guidelines for effective implementation of IWRM for alleviation of water related poverty.

Some of the questions to be addressed in the case study include:

- What are the characteristics of water and poverty issues in the selected case?
- How these are linked to each other?
- Who are/were the poor?
- What are/were their water related problems?
- What actions have been or are being undertaken by local communities, and by external agencies?
- What has been the impact of these actions?
- Are these actions/interventions sustainable? and
- Can they be up-scaled and replicated?

The cases will also be related to national strategies and initiatives for poverty reduction and livelihood improvements; will highlight the coping strategies adopted and will have Integrated Water Resources Management (IWRM) perspective.

4. METHODOLOGICAL FRAMEWORK

4.1 General Approach

The study is based on:

- Review of the past and on-going national/international research and development studies/documents;
- Consultation with policy makers, planners, experts and professionals, and beneficiaries and affected communities;
- Existing secondary data/information; and
- Supplemental primary data collected through quick field work.

4.2 Key Activities

(i) Review of Literature

The review examined past and on-going national as well as international studies/work on water and poverty linkages in relation to the mountainous situation. It identified specific methods/indicators for testing the linkages. The indicators included physical, hydrological, socio-economic, demographic, agronomic, health, environment and management related indicators.

(ii) Identification of Secondary Information/Data Sources

This involved identifying data and information sources, and developing a comprehensive list of data sources.

(iii) Preparation of Field Study Methodology

The study methodology was developed based on review of literature, set of identified indicators, identified data and information sources. The methodology was further refined and improved with input from the brainstorming workshop.

(iv) Brainstorming Workshop

A brainstorming workshop was held on November 3, 2002 in Kathmandu to discuss the findings of the review, to refine and improve the methodological framework, and to finalize the specific study locations for implementation of the study framework. The workshop was participated by 26 experts/professionals/institutional representatives (***Annex-2***). The subject matter was discussed at length; and the participants provided fruitful insights and guidance for the study execution. The proposed methodology was also sent to IWMI, Colombo for comments and feedback. The input received from IWMI is incorporated in the final methodology.

(v) Presentations in International Forums

A paper entitled "Water and Poverty Linkages in Mountainous Areas: Highlights of Proposed Nepal Case Study" was presented in a regional consultation workshop[3] in Dhaka, Bangladesh (Pariyar, 2002a); and during the course of discussions and interactive meetings, valuable suggestions on the proposed case study were received from the participating delegates and experts. Similarly, a paper entitled "Water and Poverty Linkages in Mountainous Areas: Methodological Framework and Preliminary Findings of Nepal Case Study" was presented in the Second South Asia Water Forum (SAWAF-II) in Islamabad, Pakistan[4] (Pariyar, 2002b). The subject was discussed at length, and valuable comments/suggestions were received from various scholars, professionals and other participants of the forum.

(vi) Implementation of Study

The study is being implemented by Center for Environmental and Agricultural Policy Research, Extension and Development (CEAPRED), which is a national NGO dedicated to the cause of promoting participatory economic development in the country. Over more than 13 years of its operation, CEAPRED has executed several programs/development projects focused on rural poverty alleviation through income generation, micro-environmental action programs, and policy/action research in various parts of the country. A summarized information on CEAPRED's completed and ongoing projects/programs is presented in ***Annex-3***. The International Water Resources Management Institute (IWMI) provides an overall supervision to the study.

[3] The Asia-Pacific Regional Consultation Workshop was held in Dhaka, Bangladesh on 22-26 September 2002.
[4] The SAWAF-II was held in Islamabad, Pakistan on 14-16 December 2002.

4.3 Field Study Methodology

(i) Type of Water Uses Considered

The major uses of water in the mountainous areas are for domestic purposes (e.g., drinking water, sanitation) and for agricultural production (e.g., irrigation, livestock raising). As such, the case study primarily focuses on these two types of water uses. However, the water uses for agro-processing (e.g., *Ghatta* – the traditional water mill and improved water mill), and hydro-power generation also exist to some extent in the hills and mountains of Nepal. Hence, a limited study on these two types of water uses are also covered.

(ii) Variables Studied

Three different variables, viz., size of land holding, status of irrigation, and status of domestic/drinking water supplies, were studied. The land holdings were classified into: (a) small, medium and large[5] based on size, (b) irrigated and non-irrigated[6] based on availability of water for irrigation, (c) households with good access to drinking water and those with poor access to drinking water[7].

(iii) Selection of Study District

The criteria/parameters considered for selecting the study district were: geo-physical conditions, spatial location, socio-political situation, accessibility, demographic variability, familiarity, and existing support network. The Kavre district was selected because:

- It is located in the mid-mountain physiographic region
- It falls within the Central Development Region, and is almost centrally located.
- Field studies can be conveniently monitored and supervised, and any follow-up action/support required can be delivered appropriately.
- Study sites can be located at reasonable walking distance from the road heads.
- The current socio-political situation does not favor such surveys to be convened in remote mountainous areas.
- A wide range of demographic variability (ethnicity, caste) can be included.
- The variability in terms of water uses can be observed in the district.
- CEAPRED, the study implementing organization, is well familiar with the district. It is/was executing several development projects in the district. The existing network of its field offices and staff can be used in the proposed study to gain information.

(iv) Selection of VDC/Villages

Altogether 19 villages belonging to six different Village Development Committees (Maslotole village in Sarsyunkharka VDC, Majhdihi, Panditdihi and Ramchedihi villages in Jaisithok VDC, Bakhreldihi village in Panchkhal VDC, Dandaghar, Chhapgaun, Pathagaun, Thumka, Rumtagaun, Dahaldanda, Sarkigaun, Tallodharapani, Chauribot and Dandagaun villages in Devbhumi Baluwa VDC, Deurali, Mitinchhap, and Chhahare villages in Devitar VDC, and Ramche village in Sathighar VDC) were selected as potential locations for field studies based on: interactive meetings with field staff, representation of required variables, demographic variability, and socio-political/workable environment.

---

[5] As per the National Planning Commission norms, households having less than or equal to 10 ropanis of land will be classified as Small, likewise those having more than 10 or equal to 20 ropanis will be classified as Medium, and households greater than 20 ropanis will be classified as Large.

[6] Households having 50% or more of its land irrigated, will be classified as Irrigated Households, and conversely, the households having more than 50% of land unirrigated (rainfed) will be classified as Non-irrigated households.

[7] Households fetching water from 250 m or less horizontal distance or 50 m or less vertical distance will be classified as Households with Good Access to Drinking Water, while other households will be classified as Households with Poor Access to Drinking Water.

(v) Methodology for Field Survey

The field study included focus group discussions (FGD), key informant interviews (KII), household surveys, direct observations and transect walk. Semi-structured checklists were designed to administer the FGDs (***Annex-4***) and KIIs (***Annex-5***). Likewise, semi-structured, open-ended questionnaire (***Annex-6***) was developed to administer the household survey.

A rapid field survey was conducted in selected VDCs/villages. The field staff visited each of the selected villages, interacted with local knowledgeable persons, and prepared a list of households with preliminary data, using a standard format (***Annex-7***). Altogether 588 households were enlisted (***Annex-8***). Based on the information received, the households were classified into (i) small, medium and large, (ii) irrigated and non-irrigated, and (iii) households with good access and poor access to drinking water. Thus, altogether 12 different household categories (SIG, MIG, LIG, SIP, MIP, LIP, SNG, MNG, LNG, SNP, MNP, LNP[8]) were identified, and households were grouped based on the category they belonged to. For carrying out the detailed household survey, seven percent of the population (enlisted households), i.e., 84 households were considered to be representative sample size. Since there were 12 different categories, 7 households were randomly selected from each of the category for the household level survey. It was observed that each of the farm category contained no less than 14 households, i.e., 100% more than the sample size under each category. The households thus selected represent eight villages belonging to five different VDCs (Maslotole village in Sarsyunkharka VDC, Majhdihi,and Panditdihi villages in Jaisithok VDC, Bakhreldihi village in Panchkhal VDC, Dandaghar and Pathagaun villages in Devbhumi Baluwa VDC, and Deurali and Mitinchhap villages in Devitar VDC). ***Annex-9*** presents the list of selected households.

In each of the eight selected villages, one focus group discussion was conducted. The list of the persons who participated in the focus group discussion is presented in ***Annex-10***. Additionally a hydro-power site at Katunje Besi VDC ward-1, and one *Ghatta* or traditional water mill site at Methinkot VDC, one improved water mill site at Charenge Phedi village in Khanal Thok VDC were visited, and information were derived from beneficiaries of these water-powered technologies. Relevant data/Information were collected, both for with and without, and before and after situation, wherever applicable. The field surveyors were advised to take notes on specific observation, if any, during field visits and transect walks.

Similarly, key informants from village health posts were also interviewed. Key informant interviews were conducted at various district level offices such as Agricultural Development Office, District Public Health Office, and District Soil Conservation Office. The list of the persons contacted is presented in ***Annex-11***. Consultative meetings at central level were held with various stakeholders including the government agencies/policy makers, experts, implementers, funding/donor agencies, researchers and development practitioners.

Annex-12 shows the photographs taken during the study. Similarly, a few typical cases which depict water and poverty linkages, were also recorded during the field survey. These cases have been presented in ***Annex-13***.

8 The first letter indicates size of land holding, the second letter indicates the status of irrigation, and the third letter reflects the accessibility to drinking water.

5. DESCRIPTION OF STUDY AREA

The study area, Kavre, is a mid-hill district in Bagmati zone of Central Development Region, surrounded by Ramechhap and Dolakha districts in the east, Sindhupalchok district in the north, Kathmandu, Lalitpur and Bhaktapur districts in the west and Sindhuli and Makwanpur districts in the south. Kathmandu, the nation's capital is 30 km away in the west of the district head quarter, Dhulikhel. The major types of climate in the district are sub-tropical, warm temperate and cool temperate. The temperature ranges from 10^0 – 31^0 Celsius. The elevation ranges from 200 m to 3018 m from mean sea level. About 97% of the district lies in mid-mountain region.

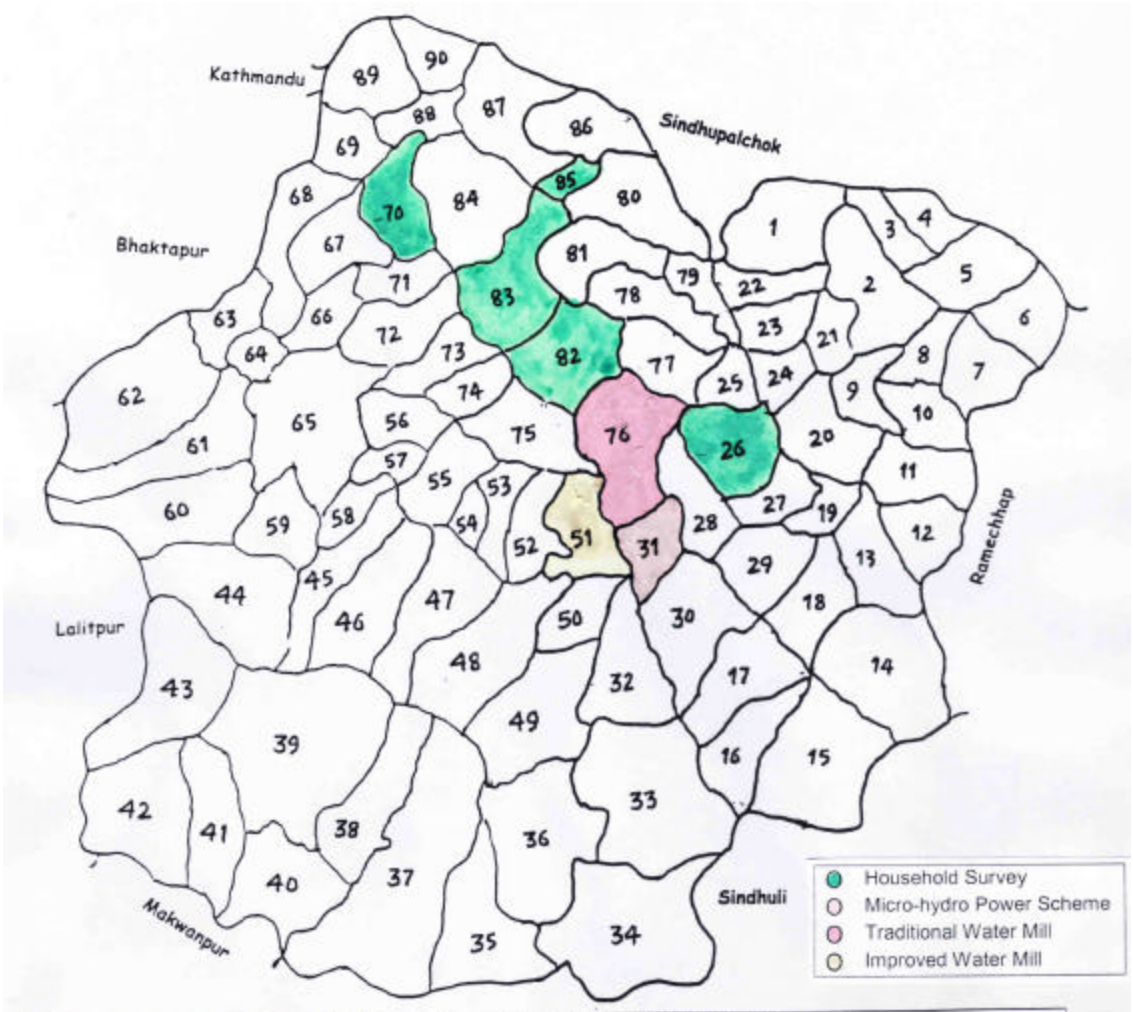
There are 87 VDCs and 3 municipalities (Banepa, Dhulikhel and Panauti). The district map showing VDCs/Municipalities boundaries, and the VDCs where field studies were carried out is shown in ***Figure-4***. The district population is estimated to be around 0.40 million, with male and female ratio of almost 1:1. Out of a land area of about 0.14 million hectares, about 44% is cultivable. The current land use pattern shows that about 26% of the land is cultivated, 18% is cultivable uncultivated land, 28% is under forest, 24% is under shrubs, about 3% is under pasture, and the rest 1% is under water bodies, settlements and other uses. Only 14 % (4950 ha) of cultivated land is irrigated.

The district has a road network of 723.6 Km. Three Municipalities and 65 out of 87 VDCs are accessible by road. Electricity is available to 3 Municipalities and 31 VDCs through National Grid Line benefiting 19,000 households. Additionally, micro-hydro projects and solar panel have benefited 11 and 4 VDCs, respectively. Telephone service is available to 3 Municipalities and 27 VDCs and postal service to all 87 VDCs. Drinking water facility is available to about 65 % of the population. There are 1 District Health Office, 3 Hospitals, 10 Health Posts, 81 Health Sub-posts, 8 Nursing Homes, 5 Ayurvedic Pharmacies and 4 Primary Health Centers providing health services in the district. Educational opportunities are being provided by 509 Primary Schools, 112 Lower Secondary Schools, 85 Secondary Schools, 9 Higher Secondary Schools, 3 Campuses and 2 Universities.

Kavre is predominantly an agricultural district with almost 90% of its population dependent on agricultural activities for their day-to-day living. Agriculture, which encompasses both crop and livestock activities, is the backbone of the district economy contributing to the most of its economic growth. The major agricultural products of the district are potato, tomato, seasonal vegetables and cereals. Due to the variation in altitude and the prevailing climates, a wide range of horticultural crops (fruits, vegetables, spices, herbs and flowers) are being grown successfully. Being close to Kathmandu metropolitan city, there has been an assured market for agricultural production. The products are regularly marketed to the city though the facility still needs to be improved. Since road network within Kavre and outside has improved drastically, market force has started imparting pressure in order to bring commercialization in agriculture.

The district was food deficit in 1997/98 and 1998/99 and surplus in 1999/2000 (Nepal District Profile, 2002). Based on the progress reports of Participatory District Development Program VDCs (21), about 22 % of the households was food sufficient for less than 3 months, 31 % for 4–6 months, 25 % for 6–9 months and 15 % for 9–12 months and 7 % for more than 12 months. The district has an immense potential for increasing agricultural production. Irrigation is one of the major constraints to agricultural developments.

Figure 4: Map of Kavre District showing Study VDCs



87 Village Development Committees and 3 Municipalities

1 Saping	16 Baling	31 Katunjebesi	46 Mahankalchaur	61 Kushadevi	76 Methinkot
2 Chaubas	17 Mangaltar	32 Sipali Chilaune	47 Khahare Pangu	62 Rayale	77 Kharelthok
3 Simthali	18 Kurubas	33 Budhakhani	48 Shikhar Ambote	63 Sanga	78 Sathighar
4 Ghartigaun	19 Boldephediche	34 Banakhu	49 Sisakhani	64 Mahendra Jyoti	79 Dolaighat
5 Saruwangthali	20 Birta Deurali	35 Ghartichhap	50 Mahadevtar	65 Panauti Municipality	80 Jyamdi Mandan
6 Nagre Gagarche	21 Salle Bhumlu	36 Phoksingtar	51 Khanalthok	66 Banepa Municipality	81 Hokse Bazar
7 Mahicheda	22 Bhumlutar	37 Gokule	52 Daraune Pokhari	67 Nala	82 Devbhumi Baluwa
8 Dhuseni	23 Phalante	38 Dandagaun	53 Dapcha Chhatrabas	68 Tukucha Nala	83 Panchkhal
9 Gothpani	24 Kolanti	39 Phalametar	54 Puranogaun	69 Nayagaun	84 Anekot
10 Pokhari Chaur	25 Kosidekha	40 SalmeChakla	55 Syampati	70 Devitar	85 Jaisithok
11 Kanike	26 Sarsyukharka	41 Saldhara	56 Batase	71 Ravi Opi	86 Chandeni Mandan
12 Kundan	27 Saramthali	42 Milche	57 Shankhu	72 Dhulikhel Municipality	87 Mahadevsthan Mandan
13 Thulo Parsel	28 Kanpur Kalapani	43 Chyamrantusi	58 Balthali	73 Kabhre Nityananda	88 Devpur
14 Machchegaun	29 Pokhari Narayansthan	44 Dhunkharka	59 Chalal	74 Patalekhet	89 Baluwapati Naidung
15 Bhimkhori	30 Kharpachok	45 Chyasinkharka	60 Kalante Bhumidanda	75 Phulbari	90 Gairibsauna Devpur

PART-II

FINDINGS

6. AN OVERVIEW OF NEPAL'S WATER RESOURCES

Nepal is blessed with huge water resources potential. The country, though small in size, possesses about 2.27 percent of the world water resource, and is one of the rich countries in South Asia region. Total annual renewable water potential is 232 billion cubic meters: 224 billion cubic meters surface runoff which is 41% of the total discharge of river Ganges and eight billion cubic meters rechargeable groundwater. The total present annual consumptive use is less than 17 billion cubic meters and thus almost 92% of the renewable water potential remains surplus.

There are about 6000 rivers and rivulets in the country having a total drainage area of about 194,471 sq. km, of which about three-fourth lies in Nepal alone. The rivers can be typically classified into three types, viz. major rivers, medium rivers and small rivers, depending on their source and discharge. Kosi, Gandaki, Karnali and Mahakali are major river systems which originate in the Himalayas and carry snow-fed flows with significant discharge even in the dry season. Mechi, Kankai, Kamala, Bagmati, West Rapti and Babai are medium rivers which originate in the Midlands or Mahabharat range of mountains and are fed by precipitation as well as groundwater regeneration including springs. These rivers are also perennial but are commonly characterized by a wide seasonal fluctuation in discharge. In addition to these river systems, there are a large number of small rivers in the *Terai*, which originate from southern Siwalik range of hills. These rivers are seasonal with little flow during the dry season, but characterized by flash floods during the monsoon.

Nepal has two rainy seasons: one June to September when southwest monsoon brings about 80% of its total annual rainfall, and the other in winter, accounting for the rest of the total amount of annual rainfall. About 64% of the rainfall goes immediately as surface runoff. Out of the remaining 36%, some are retained in the form of snow and ice in high Himalayas, some percolate through ground as groundwater and some are lost by evaporation and transpiration. The retained water in the forms of snow and groundwater acts as natural reservoirs, which feed the rivers to keep them flowing during dry season. The mean annual precipitation is 1530 mm.

Besides surface water, Nepal is also endowed with extensive groundwater resources. Groundwater is found in most of the *Terai* (southern plains) and in some mid-hill valleys like the Kathmandu valley and the Dang valley. In the *Terai*, present annual withdrawal of groundwater, for various purposes, is estimated at 1.04 billion cubic meters, which is about 20% of the minimum possible annual recharge estimate of 5.80 billion cubic meters. However, in Kathmandu valley, the total annual abstraction estimated presently at 23.4 billion cubic meters is much greater than the maximum recharge estimate of 14.6 million cubic meters. Groundwater mining and pollution, in Kathmandu valley, is highly alarming.

The influence of heavy rain during monsoon causes wide variation in river flow, land erosion and landslides. Coupled with the extreme topographic relief and fragile geological composition of the country, these factors cause the rivers to carry high sediment loads during high flows. Besides this, snow and glacier melt also bring heavy loads of sediments during summer months. The heavy sediment load in the rivers is an important factor in determining the extent of water related hazards. This year the country has observed an unusual heavy rain during the monsoon. This has caused severe floods in the *Terai* plains and disastrous landslides and soil erosion in the hills and mountains. Losses to lives, crops and property have been enormous, and among the most affected from and vulnerable to the catastrophe are poor and marginalized people who usually have their huts and land in flood and landslide/erosion prone areas.

The multifarious wants satisfied by water resources in Nepal can be divided into two categories, namely, consumptive use and non-consumptive use. The most important non-

consumptive use of water in Nepalese economy is in hydro power generation; while the consumptive use of water is primarily in the three sectors, namely, agriculture, household and industry. Within agriculture sector, it is mainly used for crop activity. As crop production is increasingly taking place under irrigated conditions, demand for irrigation water is steadily rising, and the overall demand for water would preponderantly continue to be from agriculture sector.

6.1 Hydropower Potential, Development and Demand

The high slope and perennial runoff of the Nepalese rivers make the total theoretical hydropower potential of 83000 MW, out of which 42,000 MW (***Table-1***) is considered economical potential. Due to large seasonal variability of discharge in the rivers most of the economical potential power generation is based on big storage reservoirs. The promotion of non-consumptive use of water in hydropower generation leads to the additional production of hydropower and export to neighboring countries. This could play a very important role for the prosperity of the country, mitigation of floods in Nepal, India and Bangladesh and regulation of flow and conservation of water for the dry season.

Table-1: Basin-wise Hydropower Potential in Nepal

River Basin	Theoretical Potential (MW)			Economical
	Major Rivers	Small Rivers	Total	Potential (MW)
Koshi	19,000	4,000	23,000	11,000
Gandaki	18,000	3,000	21,000	5,000
Karnali and Mahakali	32,000	3,000	35,000	25,000
Others	3,000	1,000	4,000	1,000
Total	72,000	11,000	83,000	42,000

Source: Framework for Action: Achieving Nepal Water Vision 2025

Total installed capacity at present is 584 MW[9] which is only 0.7% of the potential and is not even sufficient to meet internal demand of the country. Most of the current power plants are run-of-river type, and only some are storage power plants. Still many virgin sites with high potential remain unused. Majority of the studied potential schemes is multipurpose schemes from which other benefits like irrigation, flood control, domestic water supply, navigation, recreation can be obtained. The regulated flow can provide huge benefits to downstream riparian countries especially for irrigation and flood mitigation. The current situation of electricity supply can be summarized as follows:

- Only 20% of the populations of Nepal are served with electricity connection.
- Electricity tariff in Nepal is one of the highest in the South Asia Region.
- Neighboring countries are also in short supply of electricity.
- The system loss in electricity is 23%, and 35% of electricity is unaccounted for.

Forecast of load in optimistic scenario predicts a peak load of 1025 MW and 5033 MW for the year 2005 and 2025. The Power System Master Plan for Nepal, prepared by Nepal Electricity Authority, predicts that additional 1103 MW is required to meet internal demand by the year 2016. However, the plan is prepared to meet conservative domestic demand only.

6.2 Irrigation Potential, Development and Demand

About 67% of the cultivated land (1,766 thousand hectares out of 2,641 thousand hectares) in Nepal is reported irrigable. In addition to this 0.412 million ha irrigable non-agricultural land (presently under forest) is available which makes the total potential irrigable land 2.178

[9] The Rising Nepal Daily, 20 August 2002

million ha by traditional irrigation methods. Remaining 0.875 million ha land, too, may be irrigable by modern technologies such as water harvesting, micro-irrigation, etc. and selection/development of crops of which water requirement match with the availability of water.

Analysis of the distribution pattern of irrigable land in various ecological regions indicates that about 24% of cultivated land (55 thousand hectares out of 227 thousand hectares) in the mountains, about 34% of the cultivated land (355 thousand hectares out of 1,054 thousand hectares) in the hills, and almost all the cultivated land (1,356 thousand hectares out of 1,359 thousand hectares) in the *Terai* are irrigable (DOI, 1990). While surface water is the only source of irrigation in hills and mountains, both surface water and ground water are the major sources of irrigation development in the *Terai*; and hence, the possibilities of harnessing these two resources within the socio-economic and technical constraints determine the potentials of irrigation development in the country. It is reported that the country has surplus water resources for both surface and groundwater irrigation development of 1.8 million hectares of land available for irrigation; and the country is using less than 8% of its water resource potential (APP, 1995).

At present irrigation water is provided to approximately 42% of the net cultivated land, 63% of irrigable cultivated area is irrigated, and 41% of irrigated area is being supplied with irrigation on a year-round basis. Existing irrigation systems are the basis for almost 33% of the current agricultural production of the country. ***Table-2*** summarizes the irrigation development status.

Table-2: Irrigation Potential, and Development Status in 1999/2000

Geographic Region	Land Area '000 ha	Cultivated Area '000 ha.	Cultivated Irrigable Area '000 ha	Irrigated Area '000 ha.	Year Round Irrigated Area '000 ha.
Mountains	5,181.7	227	55	48	18
Hills	6,134.5	1,054	355	167	66
Terai	3,401.9	1,360	1,356	889	368
Totals	14,718.1	2,641	1,766	1104	452

Source: Water Resources Strategy Nepal, 2001, and other documents

The Agriculture Perspective Plan (APP) has been launched since 1997 and it is hoped that around 612,000 ha of irrigable land will be turned into year round irrigation system by emphasizing tube will irrigation in the *Terai*. By the end of APP in 2016/17, it is hoped that irrigation will command about 1.44 million hectares or 55% of the cultivable land, although the progress made till is far behind the target (Pariyar, 2002c).

The target for the year 2005 and 2025 is to cover 70% and 100% of the land. Corresponding annual water requirement will be 23 and 37 billion cubic meters, respectively. Future irrigation water requirement will also be greatly influenced by the development plans, irrigation technology, cropping pattern and water stress imposed within a river basin by internal and external elements. If population growth cannot be checked and the increase in agricultural production cannot meet the demand, the forestland suitable for cultivation may be converted into agricultural land. There will be pressure for increasing cropping intensity to 300 percent. In this scenario the total irrigation water demand would amount to 70 billion cubic meters per year.

6.3 Household and Industrial Water Potential, Development and Demand

Despite its huge water resources potential, one third of Nepal's population does not have access to safe water. The latest domestic water supply coverage figures for rural and urban areas are shown in ***Table-3***.

Table-3: Coverage[10] of Drinking Water Service in Nepal in 1998/99

Development Region	Total Benefited Population, in '000			
	Urban	%	Rural	%
Eastern	376	58	2,586	54
Central	1,191	79	3,834	63
Western	354	65	2,852	70
Mid-Western	155	67	2,012	74
Far-Western	105	43	1,555	85
Total	2,181	66	12,839	66

Source: Water Resources Strategy Nepal 2001

Official estimates suggest that 66 percent[11] of the population have some access to drinking water facility, and about one-fourth of the population has access to sanitation facility. However, these figures are likely to be overestimated and the actual size of the population having access to such facilities is likely to be much smaller, both qualitatively and quantitatively. Not only that the coverage of drinking water and sanitation is low, there is also wide disparity among the various regions. The hill and mountain regions show very low coverage (UNDP 2001). It is estimated that the total projected water use at the present pace of development by the end of 2005 and 2025 is 754 and 1825 million liters per day i.e. 0.3 and 0.7 billion cubic meters per annum. Development target for domestic water supply is to provide tapped water supply to 100% of population by 2005. So the total water demand at 2025 for whole projected population of 40 million at the rate of 200 liters per person per day is 3 billion cubic meters per annum.

Industries in Nepal are still in the early stage of development. The share of industrial sector is less than 10% of the country's GDP. The main industries in Nepal include cement, sugar, tobacco, alcohol, clothes. HDP pipes, plastic products, brick and tile, agricultural and forest products etc. according to 1996 economic survey report, 311 industrial establishments were in operation and 58 new industries were under construction. Records for water for these establishments are not available. However, it is expected that the industrial water requirements would rise but it will be only a small fraction of total water requirement.

6.4 Status of Micro-Hydro Power

6.4.1 Introduction

Micro-hydro[12] power in the form of milling has existed in the hills and mountains of Nepal for centuries. However, the first modern micro-hydro power plant was installed only four decades ago. It has been followed by the installation of thousands of plants, initially used mainly for milling, but increasing over the past two decades as 'add-on[13]' and 'stand-alone[14]' plants for generating electric lighting.

[10] A person is deemed to have drinking water coverage if he lives within 50 meters in altitude and 250 meters in horizontal distance of a drinking water source.
[11] A more recent report (NPC, 2002) puts this figure to 69%.
[12] Micro-hydro is the generic term used for installations up to 100 kW irrespective of the technology.
13 These installations generate both mechanical power (usually during daytime) and electricity (usually at night).
14 These installations generate electricity only.

Widespread dissemination of micro-hydro technology has occurred as a result of a combination of factors that include external assistance, indigenous innovation and conducive government policies, most notably the government subsidy that has been available for the last two decades, initially from the Agricultural Development Bank of Nepal (ADB/N) and more recently from the Alternative Energy Promotion Center (AEPC)'s Interim Rural Energy Fund (IREF), as part of a promotion program that links subsidy with a structures project cycle, productive end-use and quality requirements.

Stakeholders in the micro-hydro power sector consist of a manufacturing base concentrated in Butwal and the Kathmandu Valley, various promoting and supporting agencies, consulting firms, banks and, not least, local entrepreneurs and communities in the hills and mountains of Nepal who increasingly put electrification high on their agendas. By doing so, they justify His Majesty's Government of Nepal (HMG/N)'s continued prioritization of micro-hydro power as a viable means of electrifying areas that are unlikely to be reached by the national grid.

6.4.2 Policy context

Micro-hydro electrification has featured increasingly prominently in the Five-Year Plans of Nepal since 1980. In the Eighth (1992/93-1996/97) and the Ninth (1997/98-2001/02) Five Year Plans, targets for micro-hydro were set at 5 MW for each period. The past couple of decades have witnessed deregulation of the sector with the abolishment of licensing requirements for micro-hydro plants as a major feature.

Subsidy in various forms has been a key policy feature since 1985. It was initially channeled through the ADB/N, with subsidy of electrical components only being provided at 75% of cost for remote areas and 50% for non-remote areas. The establishment of the APEC in 1997 as a government agency for promoting renewable energy technologies, including micro-hydro, led to a reformulation of the subsidy policy. Since 2000, the APEC's Interim Rural Energy Fund (IREF), supported by the DANIDA Energy Sector Assistance Program (ESAP), has administered subsidy for micro-hydro.

The introduction in 2000 of a new HMG/N subsidy policy and delivery mechanism channeled through the APEC saw a marked increase in subsidy levels, from 20-25% of total investment to 50-75% of total investment. Additionally, subsidy is provided as part of a promotion program that links financial support with a structured project cycle, protective end-use and quality requirements.

The key to this link is provision of a subsidy on a kW-output basis: a push-pull element that leads developers and manufacturers to pay attention to quality as well manifested in actual output. The new policy also places micro-hydro in a rural development perspective by marking 10% load from productive use mandatory. Subsidy is augmented by a program that supports the project cycle with detailed procedural guidelines, promotes productive end-use, develops local support structures, and supports training activities and the development of standards.

The subsidy policy contains the following key provisions:

- NRs 55,000 per kW for new micro-hydro projects up to 3 kW capacity (mainly Peltric sets)
- NRs 70,000 per kW for new micro-hydro projects above 3 kW
- NRs 35,000 per kW or 50% of costs for rehabilitation projects
- From NRs 8750 to NRs 21,000 per kW as a transport subsidy

- NRs 27,000 for add-on electricity generation from improved *ghattas*[15]
- An investment ceiling per kW of NRs 150,000.

6.4.3 Organizations involved in micro-hydro

In addition to the AEPC's macro-hydro support program, supported by ESAP-DANIDA, the Rural Energy Development Program (REDP) of the United Nations Development Program (UNDP) provides significant assistance to the sector. REDP-supported micro-hydro projects obtain subsidy funds from AEPC's Interim Rural Energy Fund. The REDP sees micro-hydro as an entry point to enhancing rural livelihoods, and supports community projects in 15 districts. The REDP's major feature is involvement of local government in energy planning and social mobilization. It has supported 9 Peltric[16] and 60 non-Peltric[17] projects from 1998 to mid-2001.

The HMG/N's Remote Area Development Committee (RADC) is another key player in the promotion of micro-hydro. Supporting community-owned plants with an aim of achieving regionally balanced growth, efforts are directed at remote areas. Between 1995 and mid-2001, 24 non-Peltric projects have been supported. Additionally, a number of NGOs and INGOs are involved in the sector of which the Annapurna Area Conservation Project (ACAP) and the Canadian Center for International Studies (CECI) are the most prominent.

6.4.4 Distribution, installed capacity and types of micro-hydro schemes

A total of 1956 micro-hydro schemes with an installed capacity 13,064 kW have been installed in Nepal since 1962 (ESAP, 2002). The largest number of schemes has been installed in the Eastern Development Region (665 schemes) followed by the Western Development Region (594 schemes), the Central Development Region (347 schemes), the Mid-western Development Region (259 schemes) and the Far-western Development Region (81 schemes). In terms of installed capacity, the highest capacity has been installed in the WDR (5328 kW), followed by the CDR (2798 kW), the EDR (2044 kW), the MDR (1950 kW) and the FDR (887kW). Apart from reflecting a skewed regional pattern of infrastructure development when moving from east to west, the type of schemes installed also reflect regional income disparities, agricultural practices and location of support structures.

A critical review of the size of installation and type of turbines, reflects that the capacities of both Peltric and non-Peltric installations are at the lower end of their respective ranges. The vast majority (83%) of Peltric sets are less than 1.5 kW capacity thus ruling out any traditional productive end-use applications.

Among the non-Peltric applications, about two-thirds of plants are smaller than 15 kW, with 10 kW as the most frequent capacity. The relatively small size of plants reflects small settlement size and, consequently, the lighting requirements of milling, as a typical productive end-use, can be accommodated by this size of plant. It also reflects the fact that transmission costs, in what are often scattered settlements with difficult topography, are a hindrance to benefit associated with economies of scale in micro-hydro.

---

[15] *Ghattas* are traditional waterwheels with a vertical axis. In improved g*hattas,* wooden waterwheels have been replaced with steel wheels with round buckets. This increases output significantly. Most of the improved g*hattas* do not produce electricity; they are used for grinding and dehusking.

[16] These small units, normally below 5 kW, are combined vertically mounted, impulse type turbines and induction-type generators. Peltric sets may be operated with a small quantity of water but requires a high 'head', typically 45 to 50 m.

[17] Micro-hydro, normally more than 5 kW - medium or high head in which case, Pelton turbines are used - low head in which case, cross-flow turbines are typically used.

The few relatively successful plants of sizes above 40 kW are located either in tourist areas (mainly the Annapurna region) or in areas of high economic activity (e.g., Barpak in Gorkha district) and are characterized by relatively concentrated settlements and diverse productive end-uses. The trend, in general, throughout the 1990s has been towards larger-than-average schemes.

6.5 Other Non-Consumptive Uses

There are other significant non-consumptive uses of water in Nepal that must be considered for water sector planning, as these may compete or conflict with other uses. Such uses include:

- Recreational/tourism uses – rafting, pleasure boating, bathing, aesthetic values of rivers, lakes and glaciers (e.g., for trekking, mountain climbing, sightseeing)
- Traditional/commercial fishing – catch and cage fisheries
- Navigation of rivers (mainly crossings but some rivers could be made navigable)
- Natural aquatic habit and wetlands – (often associated with parks and wildlife reserves)
- Cultural and religious – temples, *ghats* of sacred waters
- Sand and gravel extraction form river beds
- Unique water sources or bottling spring water
- Large-scale industrial uses (for cooling or process water).

Although these uses have not been well documented or quantified, they are important and their contribution to the economy is clear and needs to be better appreciated. These uses will likely expand in future; and hence, should be included in the framework of water resources planning.

7. POVERTY SITUATION IN NEPAL

Despite decades of development efforts, poverty remains pervasive and wide spread in Nepal, and the overall living standards of a majority of population, especially in rural areas, are far below the acceptable levels. The poverty situation can be viewed from two perspectives, namely, economic poverty and social poverty (Upadhyaya, 2000).

7.1 Economic Poverty

The estimate of poverty provided by the Nepal Living Standards Survey (NLSS) conducted by the Central Bureau of Statistics during 1994-95 places 42 percent of the population below poverty line[18]. In urban areas, the percentage of population below poverty line was estimated at 23 percent compared to 44 percent in the rural areas (NPC, 1998). Given that close to 86 percent of the total population resides in rural areas of Nepal, poverty is much more severe in rural areas compared to the urban areas. One quarter of the Nepali population has been identified as poor and 17 percent as the hardcore poor. As shown in ***Table-4***, the mountains region has the highest poverty level of 56 percent. This region has also the highest proportion of the poor (29.3 percent) and the hardcore poor (26.7 percent). Thus, the incidence of poverty is higher in rural than in urban areas and particularly extreme in more remote parts of rural areas.

[18] The Government of Nepal defines poverty line in terms of the value of an annual per capita consumption level considered just sufficient to assure 2,124 calories per person per day, plus a few essential non-food items. At average 1995/96 prices, the cost of food items able to fulfill the caloric requirement is estimated to be Rs 2,637 which can be interpreted as the "food" or "extreme" poverty line. The cost of essential non-food items when added to this cost, the resulting figure arrived at is Rs. 4,404 (US $ 78 at the exchange rate of Rs 56.8 = US$ 1 for 1995/96) per person per annum which can be taken as the basic poverty line.

Table-4: Poverty Incidence in Nepal

Area		Poverty Incidence Percent		
		Total	Poor	Ultra Poor
Ecological Zone	Mountains	56.0	29.3	26.7
	Hills	41.0	21.3	19.7
	Terai	42.0	28.7	13.3
Sector	Urban	23.0	13.2	9.8
	Rural	44.0	26.4	17.6
National Average		42.0	24.9	17.1

Source: The Ninth Plan (1997-2002), National Planning Commission, 1998

Table-5 presents the poverty incidence, intensity (measured by poverty gap index) and severity (measured by squared poverty gap index) by region. At the national level, the poverty intensity is estimated at 0.12 and the severity at 0.05. However, these values in rural areas are twice as high as in the urban areas, suggesting that poverty is much more rampant, deeper and severe in rural areas than in urban areas. The same data suggests that the poverty situation in the mountains region is more rampant, deeper and more severe than that in the hills and the *Terai*. Likewise, poverty is more rampant in the hills than in the *Terai.*

Table-5: Poverty Measures for Nepal 1995/96

Area		Head-Count Index (Population Below the Poverty Line)	Poverty Gap Index	Squared Poverty Gap Index
Ecological Zone	Mountains	0.56 (0.059)	0.185 (0.027)	0.082 (0.015)
	Hills	0.41 (0.031)	0.136 (0.014)	0.061 (0.008)
	Terai	0.42 (0.025)	0.099 (0.009)	0.034 (0.004)
Sector	Urban	0.23 (0.058)	0.070 (0.025)	0.028 (0.012)
	Rural	0.44 (0.020)	0.125 (0.008)	0.051 (0.004)

Source: Nepal Human Development Report 2001

Note: Figures in parentheses are standard errors adjusted for stratification and clustering in the sample

Clearly, poverty appears to be mostly a rural phenomenon, with poorer people living in more fragile and vulnerable ecosystems of rural Nepal. Since 1996, no other surveys similar to NLSS have been conducted to measure changes in poverty incidence thereafter. Although based on the recently completed Mid-term Review of the Ninth Plan (1997-2002), it is officially claimed that there has been a reduction in the poverty level since 1996 by 4 percentage points, from 42% to 38%, at the national level the real poverty appears to be much higher. The situation is worst in the hills and mountains which provides residence to 54% of the population.

7.2 Social Poverty

The social indicators, reflecting the quality of life in Nepal, also paint a very gloomy picture. Gender disparities are large and persistent. Women and children are much more affected by poverty than are men, in both rural and urban parts of the country. Nearly two-thirds of the adult population are illiterate. Malnutrition is widespread, and so is illness. About half of the children below 5 years of age are underweight. Infant and maternal mortality rates are among the highest in the world. Income disparities are also wide, both among regions and among households within a region. According to the NLSS data, the poorest 10% shared only 3.2% in consumption expenditure compared with 29.8% shared by the richest 10%

Average life expectancy at birth is 58.6 years; women are expected to live shorter than men. Only 41.8 percent of the adult population is literate and the rate is much smaller among women than men. Less than one-third of the population has access to adequate sanitation facilities and about one-fifth of the population do not use any improved water sources. Less

than one-third of births are attended by a trained health worker (including traditional birth attendant). Infant and child mortality rates per 1,000 live births are still high, 64 and 28 deaths, respectively. Undernourishment among children is common in rural areas; and again, a girl child is likely to be undernourished more than a male child. The under-five mortality rate is estimated at 91 deaths per 1,000 live births.

The total fertility rate of women (age 15-49) is estimated at 4.1 children per woman – 2.1 for urban and 4.4 for rural areas. The rate has declined significantly in the past one decade, from 5.1 in 1991 to 4.6 in 1996 and further to 4.1 in 2001. Similarly, there has been considerable increase in the proportion of married woman in rural areas using a family planning method. According to a recent survey, 39% of currently married women use a family planning method and 35% use a modern method. Considerable improvements have also been recorded in child health care facilities in recent years.

The Human Development Report 2002 of the United Nations (UNDP 2002) has placed Nepal in 142th position in terms of HDI ranking among 173 countries. The Human Development Index (HDI) estimated at 0.490, which is although a significant improvement over the past two decades since the HDI was 0.329 in 1980 and 0.415 in 1990, indicates a low level of human development even by South Asian standards. All countries in South Asia are better placed than Nepal in terms of HDI value, except for Bangladesh (0.478). The Human Poverty Index for Nepal is estimated as 43.4 per cent with a rank of 76. This HPI value is higher (indicating a worse situation) than for any other South Asian country, for example, 42.4 for Bangladesh, 41.0 for Pakistan, 33.1 for India and 17.6 for Sri Lanka. The proportion of people below $1 a day (1993 PPP) is estimated at 37.7%, much lower than the proportion estimated on the basis of the NLSS data collected in 1994. With respect to the Gender Development Index (GDI), Nepal has been placed in the 119th position among 173 countries. The Nepal Human Development Report 2001 (UNDP 2001) estimates the HDI value for Nepal as 0.464, and the HPI value as 41.5.

7.3 Water-Based Poverty Alleviation Initiatives

Poverty alleviation has been the main development agenda of Nepal since the 1970s. A number of programs have been launched since then targeting to the poor, starting with the integrated rural development programs. The Small Farmer Development Program (SFDP) launched in 1975 and the Production Credit for Rural Women (PCRW) Program launched later have been the prominent national programs targeting to the rural poor. More recently, the Government has launched the Bishweshor-with-the Poor (BWP) and *Mahila Jagriti* (Woman Empowerment) programs focusing on the poorest and woman members of the rural community. In addition, a number of specialized programs are being implemented focusing on the backward and downtrodden communities.

Simultaneously, various national and international NGOs have been targeting their social and economic empowerment programs to the poor and disadvantaged groups, and their impacts have been significant, al beit in small and scattered pockets. Similarly, some NGOs are actively involved in promoting the production and marketing of high-value agricultural commodities, such as the off-season vegetables, contributing to a significant increase in the incomes of small and marginal farmers in a short period. The role of NGOs in social mobilization has been particularly emphasized in recent years in all major poverty reduction programs of the Government.

Water resources development has been a key component in most of the poverty alleviation plans, programs and initiatives. The highest importance accorded to irrigation development in the Agriculture Perspective Plan, the national commitment to provide safe water (for drinking and sanitation) to all Nepalese households, and the priority accorded to hydro power development for internal uses and exports, are a few of the examples, which evince

the importance of water resources in a broader perspective. At village/farm level, the impact of micro-irrigation facilities can be observed in several district, e.g., Dhankuta, Kavre, Surkhet, where poor farmers have switched over to high value labor intensive cash crops, and thereby, are able to raise their income several folds. Along the road corridors or in accessible areas, the production of off-season vegetables has grown significantly while in remote inaccessible belts, the production of vegetable seeds is being picked up as better alternatives for the poor producers. In many villages, the farmers have initiated kitchen gardening, utilizing the waste water of their drinking water systems. This practice has opened up a new source of income for the poor families on one hand, and on the other, the inclusion of vegetables in the daily diet has also enriched the nutrition level and health of the poor families.

8. FINDINGS OF FIELD STUDIES

8.1 Demographic Characteristics

For analysis purposes, the sample households are broadly classified into four categories based on their access to water resources. Category-I households are the households which have good access to both irrigation and drinking water. Category-II households are the households which have good irrigation, but have poor access to drinking water supplies. Likewise, Category-III households are those which have good access to drinking water supplies, but have poor access to irrigation. And, finally, Category-IV households are those which have poor access to both irrigation and drinking water supplies.

8.1.1 Population distribution by age and gender

Table-6 presents population distribution of sample households by age and gender. Of the total population covered in the study, 28.5% had good access to irrigation and drinking water, i.e., the first category, 21.1% had good irrigation facility but poor drinking water supply, 26.9% had poor access to irrigation but good drinking water supply and 23.5% had poor access to both irrigation and drinking water. This way, the population covered under all the four categories was almost equal.

In all the four categories of farmers, the male percent was slightly higher than the female percent; but in case of children, the number of girl child was less than the number of boys. Economically active population was highest (60.2%) in Category-III, and about 57% in rest of the categories.

Table-6: Population Distribution under Different Farm Categories by Age and Sex

Category	Below 14 Years			Between 14-60			60 Years and Above			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Good access to irrigation and drinking water	36	28	64	47	50	97 (56.7)	5	5	10	88 (51.5)	83 (48.5)	171 (28.5)
Good access to irrigation but poor drinking water	28	19	47	34	39	73 (57.9)	3	3	6	65 (51.6)	61 (48.4)	126 (21.1)
Poor access to irrigation but good drinking water	36	19	55	44	53	97 (60.2)	4	5	9	84 (53)	77 (47)	161 (26.9)
Poor access to irrigation and drinking water	28	24	52	47	34	81 (57.4)	3	4	8	78 (55)	63 (45)	141 (23.5)

Figures in parenthesis indicates percentages

8.1.2 Population distribution by VDC

The population distribution by VDC was, however, not uniform. A total of 599 people belonging to 84 households were covered in this study. These households were spread over 5 VDCs. Devitar VDC had the highest sample population of 258, followed by Sarsyunkharka (123), Jaisithok (99), Panchkhal (65) and Baluwa (54). Out of the five VDCs, only Panchkhal showed a higher percent of females to males while in the remaining VDCs percentage of males were higher than females. The details are given in ***Table-7***.

Table-7: Population Distribution by VDC

VDC	Below 14 Years			Between 14-60			60 Years and Above			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Jaisithok	23	16	39	28	27	55	2	3	5	53 (53.53)	46 (46.47)	99
Baluwa	10	6	16	15	18	33	2	3	5	27 (50)	27 (50)	54
Devitar	58	39	97	72	77	149	6	6	12	136 (52.71)	122 (47.29)	258
Panchkhal	12	10	22	16	23	39	3	1	4	31 (47.69)	34 (52.31)	65
Sarsyunkharka	25	19	44	41	31	72	2	5	7	68 (55.28)	55 (44.72)	123
Total	128	90	218	172	176	348	15	18	33	315 (52.58)	284 (47.42)	599

Figures in parenthesis indicates percentage

8.1.3 Family size of sample households

The average family size of the Kavre district is 5.47 (2001 census). The size of the family is greatly affected by whether nuclear family or joint family system is followed. ***Table-8*** shows the details of the family structure of the sample households. Family size was found to be larger in case of the households with good access to drinking water than those with poor drinking water supply. One of the reasons for this higher family size was the higher number of households with joint family system in this category of households and also improved drinking water availability seems to have contributed to the longevity. The family size was also related with the farm size. The average family size of the small farmers were 5.96, medium farmers 7.04 and in case of the large farmers it was 8.39.

Table-8: Average Family Size of Sample Households

Category	Adults		Children		Total		
	Male	Female	Male	Female	Adults	Children	Total
Good access to irrigation and drinking water	2.48	2.62	1.71	1.33	5.10	3.05	8.14
Good access to irrigation but poor drinking water	1.76	2.00	1.33	0.90	3.76	2.24	6.00
Poor access to irrigation but good drinking water	2.29	2.76	1.71	0.90	5.05	2.62	7.67
Poor access to irrigation and drinking water	2.38	1.86	1.33	1.14	4.24	2.48	6.71

8.2 Social Characteristics

8.2.1 Level of education

The level of education and access to drinking water sources showed a direct relationship. Illiteracy was found to be highest in the households with poor access to drinking water sources as compared to the households with good drinking water facility. During the survey it was observed that in the households with poor access to drinking water, children (especially

girls) and women were responsible for fetching water from the far-off places. As a result the children were deprived of schooling. Gender discrimination in education was also found to be prevalent in the study area. In most cases, once the girl child was grown and strong enough to do the household chores, they were taken out from the school and were absorbed in looking after the family chores. So there was a drastic reduction in females seeking higher education (beyond primary level) as compared to the males. The details of the levels of education of males and females under different farm categories are given in ***Table-9***.

Table-9: Level of Education of Sample Population

Category	Education of Males						Education of Females						Education of all					
	I	JL	P	S	>S	In	I	JL	P	S	>S	In	I	JL	P	S	>S	In
Good access to irrigation and drinking water	11	11	29	38	5	7	25	22	18	29	2	4	36	33	46	66	7	11
Good access to irrigation but poor drinking water	17	16	26	29	1	10	33	22	28	13	0	6	49	38	53	42	1	17
Poor access to irrigation but good drinking water	14	25	25	25	3	8	25	21	24	19	7	3	39	46	49	43	10	11
Poor access to irrigation and drinking water	19	24	25	12	14	5	39	22	27	9	0	5	58	46	52	22	14	9

Note: I - Illiterate, JL – Just literate, P – Primary level, S – SLC level, >S – Greater than SLC, In – Infants

8.2.2 Schooling of children

Different factors seem to be affecting schooling of the boys and girls. While schooling of boys was mainly affected by irrigation status or indirectly by income, schooling of girls was affected by the drinking water status. It was observed that most of the parents were interested to send their boys to school if they could afford financially. But, in case of girls, access to drinking water was one of the major factors affecting their schooling apart from income. In fetching water mostly girls were involved. So the family had good drinking water access, the time required in fetching water from distant places was saved and families could afford to send their girl child to the school. The details of the schooling of children are given in ***Table-10***.

Table-10: Schooling of Children

Category	Total boys upto 18 years of age	Total boys upto 18 going to school	Total girls upto 18 years of age	Total girls upto 18 going to school
Good access to irrigation and drinking water	46	37 (80.4)	35	32 (91.4)
Good access to irrigation but poor drinking water	31	26 (83.8)	23	18 (78.2)
Poor access to irrigation but good drinking water	41	31 (75.3)	27	22 (81.4)
Poor access to irrigation and drinking water	34	27 (79.4)	27	21 (77.7)

8.2.3 Expenditure on education

Expenditure made on education by access to water resources is given in ***Table-11***. From the table it is seen that expenditure in education was higher in the categories with good access to drinking water as compared to those with poor access to drinking water. However, the percent of income spent on education was highest in the category with poor access to both irrigation and drinking water, as their income was low. Also in this category, the number of person seeking higher education was more; and hence, there was more expense on education. However, in the category with good access to irrigation but poor drinking water,

the income was high but expenditure on education was low and so percent expenditure was also low. In this category the number of girls going to school was low compared to the other categories, as they were required to fetch drinking water from long distances.

Table-11: Annual Expenditure on Education

Category	Total expenditure	Total Income	Percent of total income
Good access to irrigation and drinking water	18052	225123	8.02
Good access to irrigation but poor drinking water	11871	191698	6.19
Poor access to irrigation but good drinking water	17218	180837	9.52
Poor access to irrigation and drinking water	16128	118541	13.61

8.2.4 Occupation

In the sample households, more than 40 percent of economically active population were involved in agriculture. The percentage of people with agriculture as their main occupation was higher in the categories with good accesses to irrigation as compared to the category with poor accesses to irrigation (***Table-12***). This is primarily because of higher yield and income from the farms in irrigated condition as compared to unirrigated farms. When the income is high there is no need to seek other sources of income. In case of households with poor irrigation access, the percent of people with other sources of income like service, business etc was high because of low yield and income from the farmlands. Likewise, higher percentage of unemployment was seen in households with poor access to irrigation.

Table-12: Occupation of Economically Active Population

Category	Main occupation of population							
	Agriculture	Service	Wage earner	Business	Abroad	Study	Infants	Unemployed
Good access to irrigation and drinking water	42.7	0.5	0.5	0.0	0.7	47.2	5.3	3.2
Good access to irrigation but poor drinking water	49.6	4.3	0.0	0.7	0.0	36.9	8.5	0.0
Poor access to irrigation but good drinking water	40.9	8.0	0.0	0.0	0.0	43.3	4.9	3.0
Poor access to irrigation and drinking water	40.9	7.4	0.0	3.8	0.0	38.8	4.8	4.3

8.2.5 Migration

The migration figures indicate that migration was higher in case of the categories with poor access to irrigation. The survey revealed that people migrated for two primary reasons. Firstly some people migrated in search of employment, as the source of income in the village was not sufficient to meet the requirements of the family. Secondly people also migrated to the city for higher education, as the possibilities were limited in the village. The migration seen in the category with good access to irrigation and drinking water was mainly for higher education while in the categories with poor irrigation the migration was for employment purpose. ***Table-13*** gives the details about the migration status of the sample population.

Table-13: Migration Status of Sample Population

Category	Home			Away		
	Male	Female	Total	Male	Female	Total
Good access to irrigation and drinking water	84	83	167	4	0	4
Good access to irrigation but poor drinking water	64	63	127	0	0	0
Poor access to irrigation but good drinking water	80	74	154	4	3	7
Poor access to irrigation and drinking water	72	60	132	6	3	9

8.2.6 Drinking water

Tap/Pipe, well, stone taps and spout were the major sources of drinking water in the study area VDCs. In households with good access to drinking water, well and tap/pipe were the major sources. For tap/pipe water they had to make certain payment each month (about Rs.14.25 /month) and there was no scarcity period. Likewise, for the households with poor access to drinking water, stone taps, wells and spouts were the major sources. They did not have to pay for the water on a regular basis but had to contribute in the repair and maintenance of the water sources. These groups of people also faced water scarcity in the months of March, April and May. The details are given in ***Table-14***.

Table-14: Drinking Water Status of Sample Population

Category	Source	Average one-way distance	Average one-way time	Charge (Rs/month)	Deficit months
Good access to irrigation	Tap/Well	46.67	3.86	14.25	0
Poor access to irrigation	Well/Stone tap/Spout	604.74	13.83	0.00	March, April and May

8.3 Agricultural Characteristics

8.3.1 Sources of irrigation

Streams/rivers/springs from which water was diverted to the fields through canal system, were the most dominant sources of irrigation. Other irrigation sources included pipes and tanks. Broadly land is classified into two types, the khet land and the bari land. Mostly the khet lands are the lowlands with easy access to irrigation while the bari lands are the upland which has low access to irrigation facility. In most of the households the irrigation was not round the year but only partial/seasonal and there were water deficit periods. The charges for the irrigation also varied from one place to other. In some places the payment was made on annual basis while in others, it was done on area under irrigation/acreage basis. The detail is given in ***Table-15***.

Table-15: Irrigation Water Status by Sample Population

Category	Source		Charge		Deficit months	Average command area
	Khet	Bari	Rs./Year	Rs./Ropani		
Good access to irrigation	Canal/Pipe	Canal/Pipe	435		March, April & May	66.61
Poor access to irrigation	Canal/Tank	Canal/Pipe/ Tank	500	28.75	Feb, March, April & May	32.38

8.3.2 Land holding

Table-16 shows the average land holding and the land tenure system by access to water resources. From the table it is seen that the categories with good access to irrigation had bigger size of khet land than the bari land and vice versa. This is because in the khet land access to irrigation is much easier than the bari land. The average land holding of the households with good access to irrigation was 0.84 hectares while that of households with poor access to irrigation was 0.95 hectares. Renting in and out of land was more common in case of farmers with poor irrigation. Farmers with good irrigation facility were not found to rent in the land.

Table-16: Average Size of Land Holding (hectares/household)

Category	Land type	Irrigated				Rainfed				Total			
		Own	Rented in	Rented out	Total	Own	Rented in	Rented out	Total	Own	Rented in	Rented out	Total
Good access to irrigation	Khet	0.36	0.00	0.02	0.38	0.00	0.00	0.00	0.00	0.36	0.00	0.02	0.38
	Bari	0.30	0.00	0.01	0.31	0.13	0.00	0.01	0.14	0.43	0.00	0.02	0.45
	Total	0.66	0.00	0.03	0.69	0.13	0.00	0.01	0.14	0.80	0.00	0.04	0.84
Poor access to irrigation	Khet	0.11	0.02	0.02	0.15	0.08	0.00	0.00	0.08	0.19	0.02	0.02	0.23
	Bari	0.01	0.00	0.00	0.01	0.65	0.02	0.02	0.69	0.66	0.02	0.02	0.70
	Total	0.12	0.02	0.02	0.16	0.73	0.02	0.02	0.77	0.86	0.04	0.04	0.94

8.3.3 Crop production

In the study area, yield of the crops showed variation with irrigation status. In almost all the crops the yield was higher in irrigated farms as compared to the rainfed farms except in case of monsoon vegetables. In case of vegetables grown in monsoon season the income was higher in rainfed condition (Rs. 50164/ha) as compared to irrigated condition (Rs. 45974/ha). Vegetables were found to be grown in bari land in monsoon season in the study area. The bari land is suitable for vegetable production as it has good drainage system. Also from the field visits it was observed that the bari lands were closer to home and so were easier to look after and people also used more inputs in these lands as compared to vegetables grown in khet land. So if the rainwater was timely and adequate, higher yields were obtained. The detail is given in ***Table-17***.

Table-17: Area, Production and Productivity of Crops by Season under Irrigated and Rainfed Conditions

Crops	Irrigated			Rainfed		
	Area (ha)	Production (Kg)	Yield (Kg/ha)	Area (ha)	Production (Kg)	Yield (Kg/ha)
Monsoon Paddy	22.34	89650	4268.08	2.95	10950	3887.88
Summer Paddy	2.25	8350	3166.67	0.00	0	0.00
Wheat	10.80	19320	1835.95	2.60	3180	1450.56
Monsoon Maize	11.20	29900	2827.21	10.10	23874	2437.03
Summer Maize	11.64	32409	2971.98	20.38	48555	2641.62
Potato	7.78	109514	15861.55	1.60	11950	11583.33
Monsoon Vegetables	0.44	22000	45974.03	1.40	78800	50164.50
Winter Vegetables	5.83	452000	91512.70	0.84	22500	23888.89
Summer Vegetables	3.78	333000	97034.25	0.40	11500	20000.00
Monsoon Others	0.29	13000	44827.59	0.50	2680	5360.00
Winter Others	1.45	15257	10616.88	0.25	1975	7583.33

During focus group discussions, the respondent farmers revealed that increases in crop yields under irrigated condition were much higher when on-farm water management practices and high level of improved inputs such as hybrid seeds, chemical fertilizers, intensive agricultural extension services and organized marketing facilities, were practiced.

8.3.4 Cropping Intensity

Cropping intensity was found to be higher in irrigated land than in case of rainfed land. This was because of the fact that when there was sufficient irrigation, farmers cultivated various crops in the same piece of land and made maximum utilization of their resources. As agriculture formed the major source of income and employment for most of the sample farmers, they liked to grow additional crops, which accrued additional income for the family. As availability of family and hired labor was not much of a problem, availability of inputs mainly accounted for crop intensification and yield improvement.

The cropping intensity was also affected by the size of the farm apart from the irrigation facility. In irrigated condition, cropping intensity was highest in large farm followed by small farm and it was lowest in case of medium farms. While in case of rainfed condition, the cropping intensity was highest in case of small farms, followed by medium farms and lowest in large farms. In small farms irrigation of the field manually by buckets and cans is possible as the land is small and needs less water, but in large farmers it is not possible to irrigate the land by hand. So mostly the land remains fallow if there is no irrigation facility. ***Table-18*** shows the cropping intensity by farm size and irrigation status.

Table-18: Cropping Intensity by Farm Size and Irrigation Status

Farm size	Irrigated			Rainfed		
	Cultivated area (ha)	Cropped area (ha)	Cropping intensity (%)	Cultivated area (ha)	Cropped area (ha)	Cropping intensity (%)
Small Farms	5.10	9.70	190	4.72	6.33	134
Medium Farms	12.40	21.71	175	9.95	11.36	114
Large Farms	19.17	45.95	240	23.62	23.49	99
All Farms	36.67	77.36	211	38.29	41.18	108

As shown in ***Figure-5***, of the 36.68 hectares of irrigated land, 34.27 ha were under various crops in monsoon season. The most dominant crops in monsoon are paddy and maize. Vegetables and other crops are taken up in small area. During winter season, 17.67 ha land was cultivated, in which wheat and potato were the most dominant crops. Likewise in summer season, the crops grown were maize, vegetables and paddy in small area. Together they covered an area of 25.86 ha.

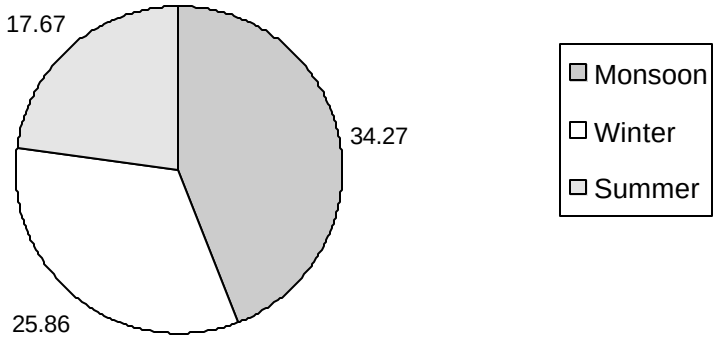


Fig.5: Cropped Area in Irrigated Land by Season (hectares)

In rainfed land, 14.95 hectares of land was under crops during the monsoon season out of 38.30 ha (***Figure-6***). Similarly during winter the cropped area was 20.78 ha in summer season and 5.29 ha in winter. The most dominant crops in monsoon are maize, paddy and vegetables; in winter wheat and potato and during summer maize and vegetables.

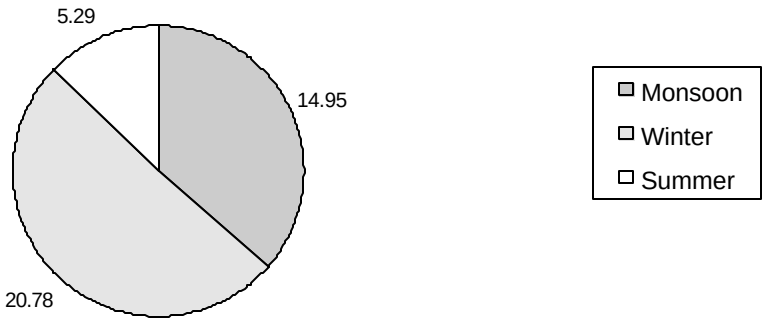


Fig.6: Cropped Area in Rainfed Land by Season (hectares)

8.4 Economic Characteristics

In this survey, the economic status of the farmers was studied in two periods; one before access to improved water resources and the other after access to improved water resources. With the improved access, the yield potentials of land has increased several folds. With this view in mind, the respondent farmers were asked about their farm and off-farm income before and after access to improved water resources, in particular improved irrigation.

8.4.1 On-farm income

Farmers in the study area were involved in various farm activities like crop production, livestock raising, fishery, apiculture and others. Of all these farm activities, crop production formed the major share followed by livestock raising. Among the various categories of farmers, the farmers with good access to irrigation showed higher farm income compared to the farmers with poor access to irrigation. But livestock raising was related to availability of drinking water. The farmers with good access to drinking water were seen to be earning more from the livestock than those with poor access to drinking water. The details about the farm income status by access to water resources are given in ***Table-19***.

Table-14: On-Farm Income Status by Category[19] (in Rupees)

Category	Crop production	Livestock	Fishery	Apiculture	Others	Total Income
Good access to irrigation and drinking water	202851	18667	0	0	1429	222946
Good access to irrigation but poor drinking water	171941	14952	0	0	3703	190596
Poor access to irrigation but good drinking water	155800	19905	0	71	1429	177205
Poor access to irrigation and drinking water	100463	11810	0	0	452	112725

During the focus group discussion, all the farmers opined that their farm income has increased since having improved access to irrigation and drinking water sources.

[19] The farm sizes in all the four categories were almost similar (0.90, 0.78, 0.93, and 0.97 ha respectively)

8.4.2 Off-farm income

Apart from the farm income the families surveyed were also involved in various sources of off-farm incomes like business, service, wage and others. Off-farm incomes were higher in case of households with poor access to irrigation than those with good irrigation facilities. The details about the sources and amount of off-farm incomes are given in ***Table-20***.

Table-20: Off-Farm Income Status by Category (in Rupees)

Category	Business	Service	Wage	Others	Total
Good access to irrigation and drinking water	816	340	0	1020	2177
Good access to irrigation but poor drinking water	34	748	320	0	1102
Poor access to irrigation but good drinking water	340	3136	156	0	3633
Poor access to irrigation and drinking water	1224	2272	156	2163	5816

8.4.3 Family income status

Total income figures revealed the proportion of on-farm income much higher that the off-farm income. The total income was found higher in categories with good access to irrigation than the categories with poor access to irrigation. This was due to higher farm income in these categories. Income status of households by access to water resources is given in ***Table-21***.

Table-21: Farm Income Status by Access to Water Resources (in Rupees)

Category	Farm Income	Off-farm income	Total
Good access to irrigation and drinking water	222946	2177	225123
Good access to irrigation but poor drinking water	190596	1102	191698
Poor access to irrigation but good drinking water	177205	3633	180838
Poor access to irrigation and drinking water	112725	5816	118542

8.4.4 Food sufficiency

Among the various categories of households, those with good access to irrigation and drinking water were found to be self-sufficient in food and the remaining categories were food deficit. In order to meet the deficit situation vegetable farming and wage earning were two most important alternatives. After meeting the domestic requirements surplus was marketed by the farmers. This marketable surplus production is given in table below by categories with good and poor access to irrigation. In Nepal agriculture is still subsistence oriented. Cereals form the staple food for Nepalese households. So almost all the sample farms produced cereals like rice, wheat and maize for home consumption and very little amount was marketed. Vegetable consumption was rare because of lack of awareness and low affordability. So almost all the vegetables grown in the field was marketed. Due to higher productivity, households with good access to irrigation had larger marketable surplus production than those with poor irrigation facilities. Details are given in ***Table-22***.

Table-22: Marketable Surplus Production by Category

Category		Marketable surplus production		
		Potato (Rs.)	Vegetables (Rs.)	Others (Rs.)
With good access to irrigation	Average	1992.88	13833.33	20827.62
	Total	83701.00	581000.00	874760.00
With poor access to irrigation	Average	335.71	3333.33	16944.76
	Total	14100.00	140000.00	711680.00

8.5 Health and Sanitation Characteristics

With access to better drinking water the health status of people in the survey area has improved over the years. Incidence of water borne diseases and skin diseases is reduced significantly. But expenditure on health has, in fact, increased after having access to improved water resources. This increase in expenditure was not because of increased health problems but because of the improved economic status and awareness regarding health care. Expenditure on education has increased from Rs. 2699/year to Rs. 4890/year in case of households with good access to water and from Rs. 2759/year to Rs. 5113/year in households with poor access to water. There was also difference in the expenses on health in between the households with good and poor access to irrigation. Higher expenditure on health in families with poor access to irrigation was because of their poor sanitation habits leading to many health problems.

8.5.1 Incidence of water borne diseases

In this study the respondents were asked about their view in relation to access to drinking water and incidence of water borne diseases, such as diarrhea, dysentery, cholera, etc. Though the response from the farmers with good access to drinking water and those with poor access to drinking water differed slightly, in totality they were of the opinion that with access to improved drinking water the incidence of the water borne diseases have reduced greatly. The details are given in ***Figure-7***.

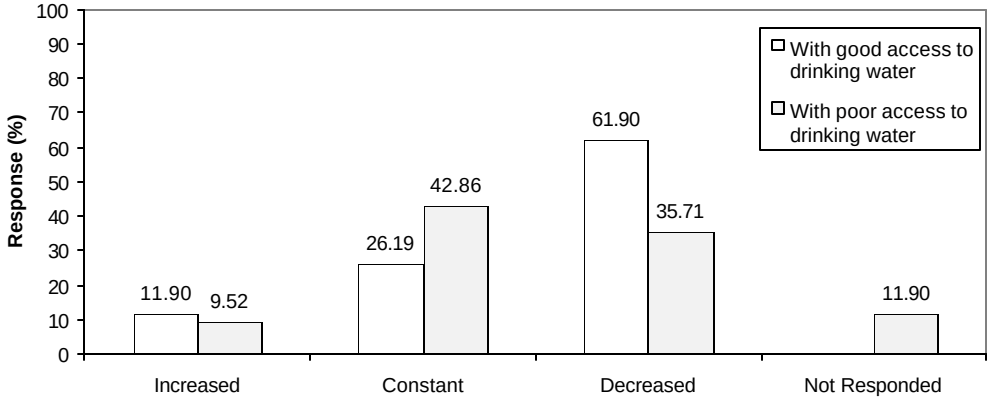


Fig 7: Incidnece of Water Borne Disease

8.5.2 Incidence of skin diseases

In case of skin diseases, 45% and 35% of the respondents with good and poor access to drinking water, respectively, said that incidence of skin disease have reduced over the years. About 38% of respondents of both the categories opined that skin disease has remained constant and 16% said it increased over the time. The details are given in ***Figure-8***.

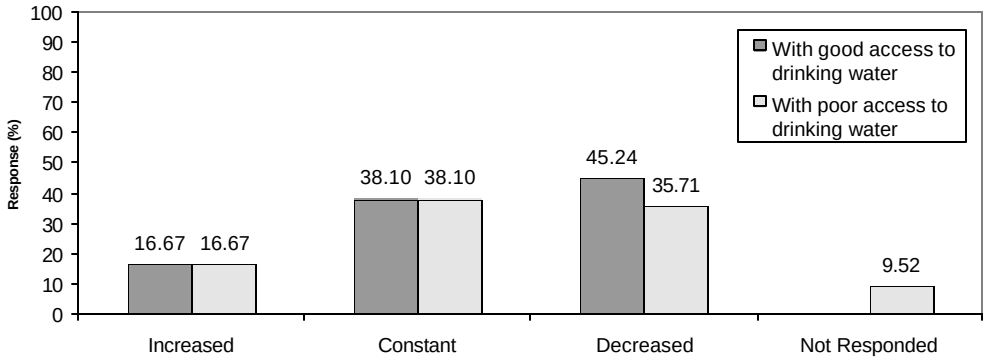


Fig 8: Incidence of Skin Diseases

8.5.3 Incidence of mortality/physical inability

With respect to mortality and physical inability due to water related problems, 50% of the farmers with good access to drinking water said that it has decreased after access to improved water resources while 40% said it has remained constant and 10% did not respond. The views of the farmers with poor access to water resources were slightly different. About 47% of the respondents in this category said that mortality/physical inability has remained constant over the time and about 30% said it has decreased while about 10% said it has increased over the time. The details are presented in ***Figure-9***.

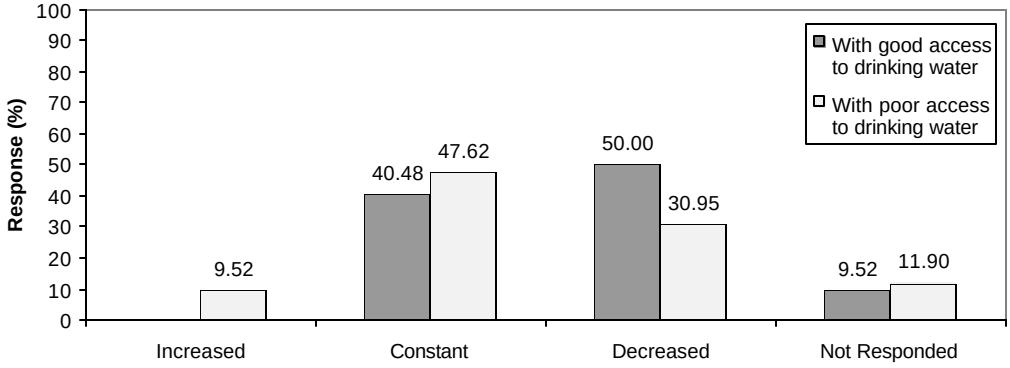


Fig 9: Incidence of Mortality/Physical inability

8.5.4 Sanitation condition

Poor sanitation condition was found in the study area during the field visits. Whole study area was lacking badly on toilet facilities. Over the years people had becoming more aware about the fact that good sanitation leads to healthy life. So there has been considerable improvements in the habits of the people, still it requires further improvement. Sanitation condition was much better amongst the households with good access to water than those with poor water access. The response of the farmers regarding the sanitation status before access to improved water resources and after is given in ***Figure-10***. Almost 90% of the farmers with good access to water said that their sanitation condition has improved after access to water resources while the figure for farmers with poor access to water was only 54%. This clearly showed the importance of water in improving sanitation and health status.

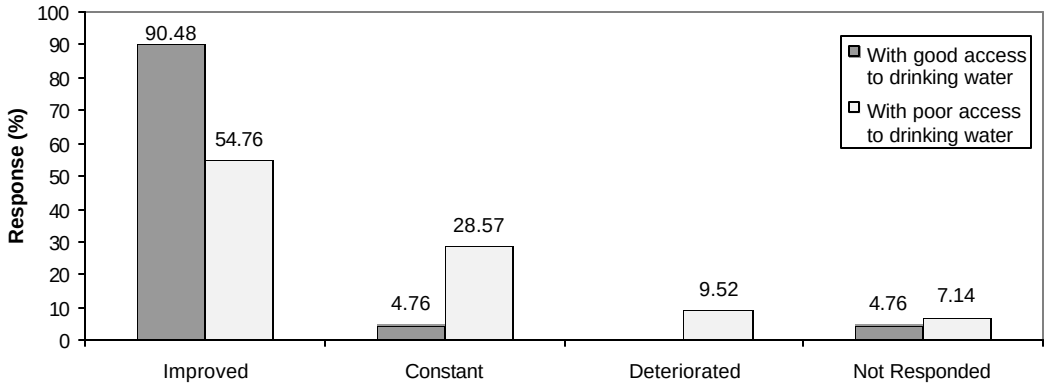


Fig 10: Sanitation Condition

8.6 Environmental Indicators

8.6.1 Incidence of land degradation and flood

The respondents were asked about the status of land over the period of time (before and after access to improved water resources). Most of them were of the opinion that the land has degraded with more use of irrigation over the years. Incidence of landslides and floods has increased. Improper irrigation has lead to loss of the fertile topsoils. But these impacts were not merely due to irrigation alone. They were also due to increased population and encroachment of the forest areas. Increased deforestation and excessive cultivation of the forestlands have caused imbalance in the environment leading to huge variation in the weather condition. The detail of the farmers' response to the impact of water resources on land degradation and flood is given in ***Figure-11*** and ***Figure-12***, respectively.

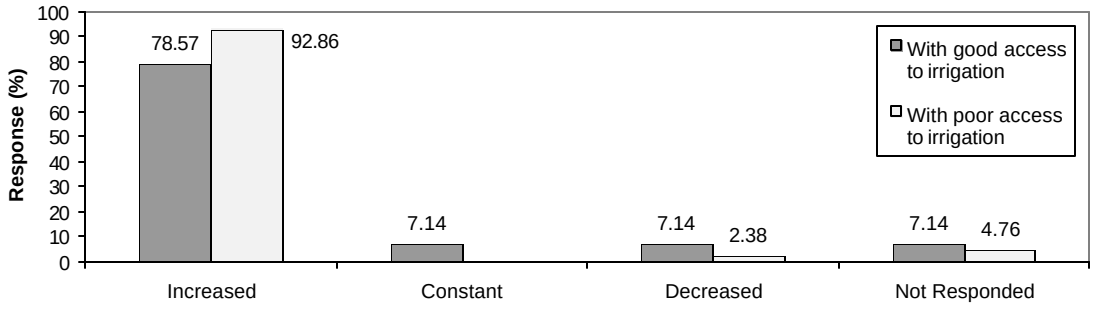


Fig.11: Incidence of Land Degradation

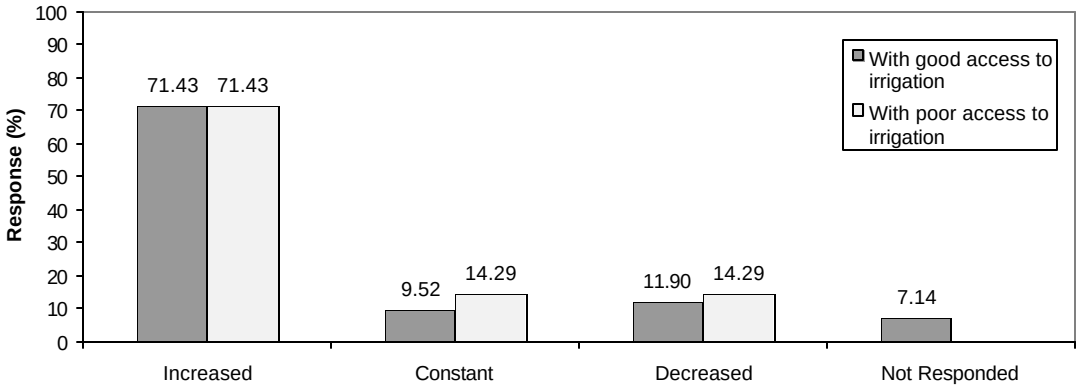


Fig 12: Incidence of Flood

8.6.2 Impact on aquatic life

In the study area the most popular form of irrigation was diverting the river water by canals. This diversion of the rivers in an unmanaged way has affected the downstream flow of the river, which in turn has affected the aquatic life in the river. Rivers well known for fresh water fish now get dried up, particularly during non-monsoon seasons, because of water offtakes for irrigation. The drying of the river, many a times, poses threats to both domesticated and wild animals who use the river water for quenching thirsts as well as for bathing and merry making. Response of the farmers to the impact of water resources on aquatic life is given in ***Figure-13***. Most of the respondents from both the categories were of the opinion that improved access to water resources has affected the aquatic life.

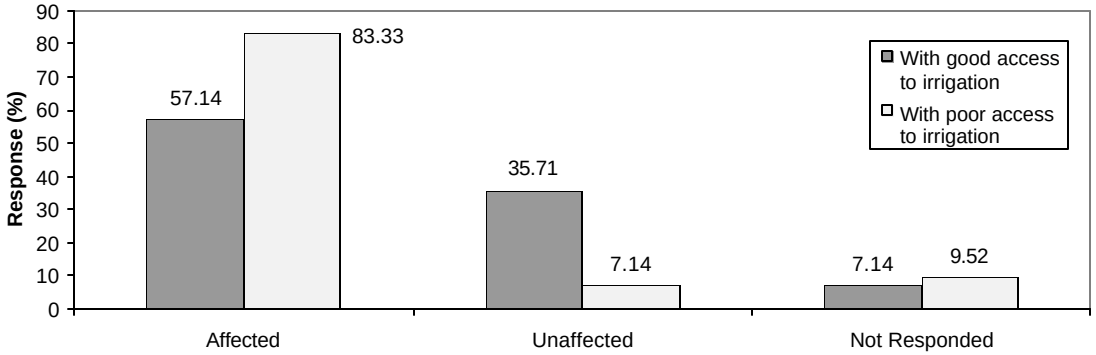


Fig 13: Impact on Aquatic Life

8.6.3 Impact on vegetation

Unmanaged water resources has also affected the vegetation status in the area. Even though there is ample scope for utilizing the water resources, in reality this has not happened. Irrigation is highly limited and haphazard. Therefore, productivity of the land is not increasing an par with the increasing population. This situation has increased pressure on land, forcing people to encroach on the forestlands. So the forest in the study area are vanishing at a very high rate. Farmers in the area were of the opinion that better irrigation facility together with other technical and material inputs could stop this process and improve the vegetation condition of the area. Around 93% of the respondents with poor access to irrigation and 62% with good access to irrigation viewed that improved water access has affected the vegetation status in the area. The responses are shown in ***Figure-14***.

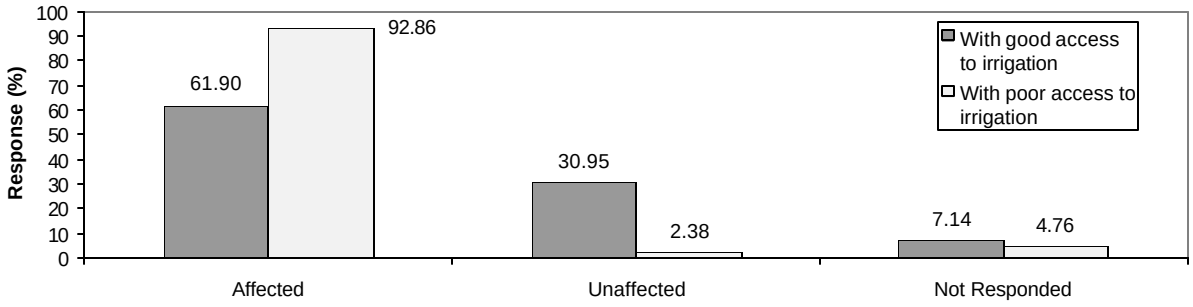


Fig 14: Vegetation Status

8.6.4 Incidence of mosquito nuisance

Mosquitoes are considered to be the indicators of the sanitation condition of the place. Greater the mosquitoes, dirtier the environment. In the survey area, the mosquito nuisance has increased over the years. Even though mosquito has increased over the whole area, this problem was more in case of households with poor access to water resources than those with good access to water resources. This was because of the difference seen in day-to-day habits like frequency of bathing, washing, cleaning etc. General increase in the mosquito problem in the area was mainly due to the stagnating pools of water near the water sources like tap, well, spouts etc. another reason for the increased mosquitoes was the lack of toilet facilities in the area, even when there was water available. Open defecation had also increased the mosquito problem. 93% of the respondents with poor access to water resources has said that mosquito problem has increased with more use of water in the area and it was 74% in case of respondents with good access to water resources (***Figure-15***).

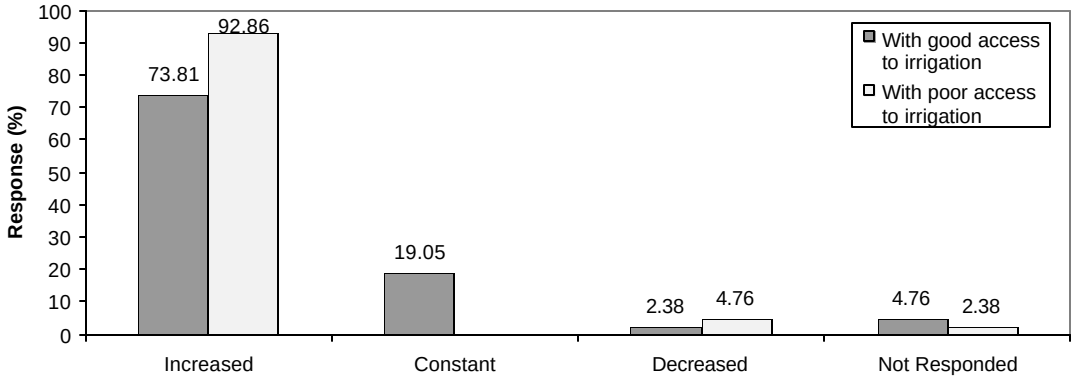


Fig 15: Incidence of Mosquito Nuisance

8.7 Physical Indicators

Physical asset holding of the sample households was studied during the two period, before access to improved water resources and after access to improved water resources. With the improvement in access to water resources, there has been considerable increase in the physical asset holding of the farmers. This increase was higher in the categories with good irrigation facility than in case of categories with poor irrigation facility. There was an impressive increment from Rs.10.6 thousand to Rs. 2532.25 thousand in case of the category with good access to irrigation and drinking water. Increased asset position directly reflects improved economic condition of the households. So with improved access to water resources there has been considerable increase in income and economic status of the households in the study area. Details about the physical asset status of various categories of farmers before and after access to improved water resources are given in ***Table-23***.

Table -23: Total Physical Asset Position (before and after access to water resources)

Category	Radio				Cassette Player				TV				Land				Mill				Tractor				House				Others				Total Value (Rs.)	
	Before		After		Before		After		Before		After		Before		After		Before		After		Before		After		Before		After		Before		After		Before	After
	N	V	N	V	N	V	N	V	N	V	N	V	A	V	A	V	N	V	N	V	N	V	N	V	N	V	N	V	N	V	N	V	V	V
Good access to irrigation and drinking water	12	5.6	3	1.45	3	5.0	9	23.9	0	0	4	47.0	0	0	0.89	880.0	0	0	3	60.0	0	0	1	20.0	0	0	2	1500.0	0	0	0	0	10.6	2532.35
Good access to irrigation but poor drinking water	3	2.9	13	9.4	0	0	3	4.9	1	3.0	5	37.2	0	0	0	0	0	0	0	0	0	0	1	125.0	0	0	0	0	0	0	3	29.0	5.9	205.5
Poor access to irrigation but good drinking water	2	1.1	14	6.0	0	0	7	14.6	1	3.0	4	31.0	0	0	0	0	0	0	1	70.0	0	0	0	0	0	0	0	0	0	0	3	40.0	4.1	161.6
Poor access to irrigation and drinking water	1	0.5	14	7.85	0	0	3	10.7	1	4.0	2	10.5	0	0	0	0	0	0	1	70.0	0	0	0	0	0	0	0	0	1	0.5	2	43.0	5.0	142.05

Note: N – Number, V – Value in Thousand rupees.

8.8 Observations on Non-Consumptive Uses

8.8.1 Micro-hydro power scheme

The study team visited Roshi Khola Micro-Hydro Power Scheme at Katunje Besi VDC Ward-1. The scheme was constructed with the assistance of Rural Energy Development Project (REDP) of the UNDP-Nepal in the year 2000. The total project cost was Rs. 2,400,000, of which REDP contributed the electrical equipment, turbine, generator, etc., HMG/N provided a grant assistance of Rs. 195,000, and the rest was contributed by different agencies/sources such as VDC (Rs. 100,000), DDC (Rs. 50,000), Electoral Constituency Development Fund (Rs. 25,000), Bank Loan (Rs. 325,000), beneficiaries @ Rs 1,100 per household, and other sources.

The specifications of the scheme are:

Name:	Roshi Khola Micro Hydro Power Scheme
Source:	Rosji Khola
Water Discharge:	400 lit/sec
Capacity:	8 kW
Canal Length:	650 m
Penstock:	Steel, Length 13 m
Turbine:	Propeller (Low Head)
Generator:	Single Phase, 13 KVA, 220V, Induction
Controller:	I.G.C., 14 kW
Transmitter Length:	1410 m
Beneficiary Households:	47

There is a total of 55 households in the area but only 47 households are the real beneficiaries, The remaining 7 households are barred from taking the benefit because they did not contribute to the scheme construction. These non-beneficiary households are too poor to make necessary monetary and labor contribution, as a result of which they are unable to take advantage of the facility. The plant generates 8 KW which is distributed equally among the 47 households.

Earlier the charge for the electricity was Rs.1/watt/month but now it is charged on unit basis at the rate of Rs. 5/unit. Since utilization of the electricity is not similar amongst the households, energy meters are fixed in each household to record the electrical units consumed. The money collected is kept in the bank account and is used for paying the operating persons and for maintenance of the plant. For the proper management of the plant, a 11-member committee is selected by the beneficiaries. This committee takes decisions on all matters related with the management of the scheme.

At present the plant remains closed during the daytime, as electricity is used for lighting alone. Lack of awareness regarding other uses has kept the households from making optimum use of the electricity. Also the plant remains closed for about 2-3 months in a year because of the plant breakdown and problems of washing away of the diversion structure by floods during monsoon. The beneficiaries strongly urge for permanent type of diversion structure to get rid of the threats of floods.

Access to electricity has greatly reduced the hardships faced. It has created a better environment for the children to study and saved the money on kerosene. But so far, electricity has not been used for income generating activities. This possibility needs to be looked for in future.

8.8.2 Traditional watermill

The study team visited a traditional water mill, locally called *'Ghatta'* in Meringhat village of Methinkot VDC. The *Ghatta i*s driven by the running water diverted from river *Dapcha*. The mill is used for grinding rice, wheat, maize, millet and other cereals. People residing at 2-3 km radial distance from the mill , take benefit from the facility. The beneficiaries expressed that the cereal flour of the mill is tastier, and can be stored for a longer duration. The expansion of electricity-powered modern mills are ,however, rapidly replacing the traditional water mills because of their location in the midst of the settlements/villages, higher output capacity, and possibilities for performing a range of agro-processing activities.

8.8.3 Improved watermill

The study team visited an improved watermill at Charenge Phedi village of Khanal Thok VDC. The total cost of the watermill was Rs. 35,000. The mill was used for grinding rice, wheat and maize. It grinds 300 to 400 kg of cereal per day, and generates a daily income of Rs 90 to 120. The water from Charenge river is diverted to run the watermill. The diverted water runs a micro-hydo scheme generating 200 W supplying electricity at night to 4 households, and the tailrace water is then diverted to the watermill which carries out agro-processing. This way, the farmer takes multiple benefits from the establishment. It has not only enhanced the family income, but has also improved the quality of living.

9. ISSUES IDENTIFIED

From the various reviews, household survey, focus group discussions and key informant interviews, a number of issues were identified. These are summarized below.

- There were many households without access to safe drinking water even today. Such families had to depend on far-off wells, stone taps and spouts for their drinking water needs. Even in households with access to drinking water, round the year supply was available only to a limited portion of the population and remaining had to suffer from water scarcity during March-May. During this period they had to depend on the alternative source like well, canal or even river water. Therefore, there is an urgent need to ensure safe drinking water round the year.

- Many households depended on well for their drinking water needs. The quality of water during the monsoon season was bad in well due to seepage. Construction of wells with cement rings will check this problem.

- Another problem seen in drinking water system was the lack of drains near the tap/wells. Stagnating water pools acts as a breeding ground for the mosquitoes. Proper drainage and sanitation condition can greatly reduce this problem.

- With increasing population, pressure on the existing drinking water sources is increasing. In order to meet the present and future requirements, construction of new wells and more tap water connection are highly urgent.

- Benefits of irrigation have been maximum in areas where intensive agricultural supports, e.g., on-farm water management, availability of improved seeds, chemical fertilizer, plant protection chemicals, technology and extension services, are provided. In areas where these supports could not reach simultaneously, the benefits of irrigation was only nominal.

- Most of the land under irrigation had only partial irrigation. There was no or less irrigation during the months March to May. This has reduced the opportunity to cultivate the land and make some earning.

- The study area was sadly lacking in water harvesting methods. Capturing the run-off water in the rainy season in small ponds/reservoirs and using them later for irrigation was very rare. Being a mountainous area this kind of water harvesting structure would have helped in irrigating the lands. Attention has to be given in the feasibility and development of such water harvesting structures.

- Improved access to water resources showed a direct impact on the food security situation of the households. Food and nutritional security was much better in case of households with good access to irrigation and drinking water. Households with poor access to water showed a fragile food security situation.

- The electricity generated from the micro-hydro scheme is used for lighting during the nights. There is almost no use during the day time. As such, the plant remains closed during the day time, although water at the source remains available all the twenty four hours. There are ample possibilities of utilizing the day-time electricity generation in running several enterprises such as agro-processing – milling, grinding, oil expelling, saw mill, carpentry workshop etc., and it would greatly contribute to the economic well-being of the benefiting households. This component was not considered duly as a package in the hydropower development scheme.

- In order to have access to water resources, the households need to contribute in form of labor or cash or both. The contributions required from every household irrespective of their economic level as per the prevailing rules, regulations and practices, have many a times led to exclusion of the ultra poor households which are incapable of making such contribution. This sector of the society is thus left behind, and the gains from the access to water are reaped by better-off families. In the long run, this may widen the gap between the poor and rest of the communities.

- In Nepalese mountains, a community called *dalits,* the so called low caste people dwell all around either in isolated clusters or in mixed settlements. These people are among the ultra-poor Nepalese population who deserve preference in development activities; and in fact, the government also time and again reiterates its commitment to accord higher priority for the welfare of the *dalit* community. But, when it comes to actual operation/execution at the grass root level, these communities are often left behind, for different reasons, e.g., their inability to contribute proportionately, ignorance, unwillingness of other participating households to include them. The lack of specific provisions for these targeted groups along with a flat rule for participation has eventually excluded these poor families which remain struggling for two square meals a day. A number of water related projects thus suffer from this issue of equity.

PART-III

CONCLUDING REMARKS

10. CONCLUSIONS

Nepal's huge water resources remain largely untapped. The country possesses vast potentials for hydro-electricity and irrigation development. These developments, to be appropriately termed as *blue revolution*, will bring about economic transformations and foster poverty alleviation, which remains the country's most pressing concern in the decade ahead.

Water is mainly used for domestic (drinking water and sanitation) and irrigation purposes in the studied mountainous areas. The non-consumptive uses such as micro-hydro power generation and agro-processing through *Ghatta* and improved water mills are also common.

The study has clearly evinced that there is a strong linkage between water and poverty in the hills and mountainous regions. In general, water has contributed to reducing poverty and improving the quality of life of the people in the hills. But many a times, it has accentuated poverty through promoting various ill-effects of water.

There are instances that availability of piped water for domestic purposes has greatly contributed towards improvement of health and sanitation status. The incidence of water-borne diseases, such as diarrhea, dysentery, cholera, etc. is reduced notably. The hygienic habits, e.g., taking baths regularly, washing cloths, cleanliness, etc. are enhanced, and these have led to reduction in skin diseases as well. It is also observed that the family expenditure on medicines and health care has increased over time, but these increases may not be accountable for increase in occurrences of health problems. These increases are indicators of enhanced affordability of farm families, greater awareness on health care, and reduced dependence on traditional witch doctors.

The drudgery which the family members, especially women and children had to bear with in fetching water from long distances, are also greatly reduced with the availability of drinking water in the vicinity. The time and labor saved in fetching water has resulted in better education opportunity for the children and more income generating activities for the women. This has ultimately helped to improve the economic status of the family. The waste water emanating from the drinking water taps are often used for kitchen gardening, which contributes to the improved nourishment of the families.

It is also observed that emphasis on improvement and extension of sanitation facilities has not gone side by side with the availability of domestic water supplies. The surveys have revealed that only a few households among the beneficiaries of piped water supply have established toilets for their family. The habits of defecation in open fields or along the banks of rivers still prevail, and this practice is undesirable from environmental point of view as well.

Farmers derive water for irrigation from rivers/streams, springs, capture ponds, and tanks integrated with micro-irrigation appliances such as drip, sprinkler or piped water supply. The most commonly used practice constitutes diverting the river/stream water by constructing temporary stone or wire brush dams, and carrying water to the field through small channels. In some cases, the spring water is tapped through construction of small ponds/reservoirs. Diverting spring/stream water to a tank, and then conveying the water to the fields through low head sprinklers, drip irrigation system or closed pipes is also promoted in recent days. Farmers have also built capture pond which stores the runoff, and the stored water is diverted to fields as and when necessary.

The availability of irrigation water has greatly enhanced agricultural productions and farm income. The productivity of crops, and cropping intensity are increased; commercialization of agriculture through a shift from subsistence agriculture is becoming a reality, and crop diversification through production of high value cash crops, e.g., off-season vegetables production, vegetables seeds production, production of fruits are taking place. All these changes together with enhancement of employment opportunities and agro-based enterprises, have greatly enhanced the family income and living standard of the people.

Food security situation is much better in case of farmers possessing irrigated land. Their own production, in majority of cases, are adequate to meet the family requirement. But farmers with poor access to irrigation are vulnerable to food insecurity. Family production is not sufficient to meet the requirement throughout the year, and the farmers have to resort to other sources of income including migration to other places for employment. In case of farmers with irrigation facility, family labor is more or less fully utilized in farming, and unemployment problem is minimal. But farmers with poor irrigation suffer from both underemployment and unemployment.

Family income is much higher in case of farmers with good access to irrigation. From the survey on-farm income is observed to be dominant over the off-farm income and the households with good irrigation facilities have higher on-farm income. Because of their increased income level, their physical asset position is much better. They can afford to buy radio, cassette player, TV etc. from the saved money.

Farmers in the hills and mountains have an age-old history of participatory irrigation management which has been recognized as an invaluable social asset/capital of the mountain community. And, lessons drawn from these experiences are being transferred to the recently developed irrigation schemes.

Adverse effect of irrigation is also seen in terms of deteriorating land conditions and aquatic life. Unmanaged irrigation has increased run-off causing degradation of the cultivated lands. This has also resulted in increased incidence of landslides. Unchecked diverting of river water through canals has reduced the downstream flow of water, which has adversely affected the aquatic life. Lack of drainage system and sanitation awareness of the people has resulted in increased mosquito population. Small pools of stagnating water near the taps and well have become good breeding grounds for mosquitoes.

The hills and mountains are also characterized by existence of innumerable *Ghattas* (traditional water mills) which basically convert water power into mechanical power using wooden chute, wooden water wheel containing straight wooden paddles, and grinding stones are used for milling/grinding maize, wheat, rice and other cereals. The wide existence and popularity of these water mills have occurred because of remoteness of the area and lack of electricity supplies. Now-a-days improved water mills[20], which can perform several agro-processing activities are replacing the traditional *Ghattas*. Thus, this non-consumptive use of water has greatly facilitated the agro-processing activities, and has relieved the household members, especially women from the backbreaking job of grinding and milling using traditional technologies such as, *Janto* (hand grinder), *dhiki* (pedal-operated pounder), *okhal* (hand ponder), etc.

[20] The improved water mills, generally called Multi-Purpose Power Units, contain metallic water wheels with cup-shaped metallic paddles. These mills are more efficient, and are use for several purposes such as milling, grinding, oil expelling, carpentry works, etc.

In recent years, several micro-hydro schemes are also gaining in popularity in the mountain areas. The mountains by virtue of the topography, steep slopes, perennial streams and rivers have immense potential for hydropower generation at local level. This hydropower is especially of great significance because of the sparse and highly scattered settlements in the hills and mountains, and also because of high costs involved in expanding the national grids for electricity supplies in these areas. The majority of the population in the hills and mountains have remained almost completely dependent on kerosene lamps for lighting during the nights. The recent advancements in promoting micro-hydro power has certainly benefited these people by providing locally generated self-contained electricity supplies. A microhydro power plant installed in a survey site, benefited 47 households from 800 watts of electricity generation. Apart from lighting during the nights, some households were also seen with televisions, and some also expressed that education of their children improved, since children could study comfortably during evenings in their houses. Health hazards caused by kerosene smokes, and high costs involved in buying kerosene are also eliminated.

Overall it is concluded that water plays a vital role in poverty alleviation. It has multiple roles in socio-economic upliftment of the community, and the country as a whole. But water alone may not bring the expected results if it is not supported by other technical and material supports. The efficiency of water in reducing poverty will be enhanced if there is access to improved technologies and other material inputs along with access to improved water resources. The most important step is to generate awareness among the people on the various uses of water.

11. RECOMMENDATIONS

- The first and the most crucial issue is that of drinking water supplies. Efforts are to be made for availing safe drinking water to all the households through out the year. Clean and safe drinking water is the key for improved health status.

- Efforts are also to be made to improve the sanitation condition of the people in the area. Toilet facility is very poor in the area because of lack of awareness even when there is water available. So awareness generation regarding toilet habits is essential.

- Most of the irrigated land in the hills and mountains has seasonal irrigation. Provision for irrigating these lands through out the year is necessary to increase the productivity and income from the farms. There is scope to bring more area under irrigation.

- Most of the respondents in the area are of the view that they lack the technical know-how and material inputs like hybrid seeds, fertilizers etc to improve their farming practices. Government/Non-government organizations should provide the technical and material support to these formers to improve their livelihoods.

- Instead of concentrating wholly on large hydropower projects, the Government should also concentrate on micro-hydro power schemes, which are less expensive and feasible in the mountainous areas. People should be trained on the end-use applications of the electricity generated from such plants, e.g., agro-processing, carpentry workshop, etc. This will also improve the employment situation of the area apart from enhancing the income levels.

- Most of the programs/projects dealing with poverty alleviation end up widening the gap between the ultra-poor and the poor in the society. While designing any program, it should be ensured that the ultra-poor are not left behind. This will require programs specially tailored for these specific target groups.

References

APP (1995). Agriculture Perspective Plan: Main Document, APROSC, Kathmandu/John Mellor Associates Inc. Washington D.C., June 1995.

ASPR (2002). Agriculture Sector Performance Review: Main Document, Kathmandu.

CBS, 2001. Population Census 2001 of Nepal: Provisional Population Report, Central Bureau of Statistics, National Planning Commission Secretariat, HMG/N, Kathmandu, December 2001.

District Development Profile of Nepal 2002. Informal Sector Research & Study Centre, Kathmandu, Nepal.

DOI (1990). Irrigation Master Plan, Department of Irrigation, HMG/N, Kathmandu, 1990.
Economic Survey 2002, Ministry of Finance, HMGN

ESAP (2002). Micro-Hydro Data of Nepal (1962-MidJuly 2001). Alternative Energy Promotion Center, Energy Sector Assistance Program, Ministry of Science and Technology, His Majesty's Government of Nepal, Kathmandu, April 2002.

Hussain, I., Regassa, N., Deeptha W., and M. Samad (2002). Water, Health and Poverty Linkages: Conceptual Framework and Empirical Evidences. Paper prepared for the National Workshop on Water, Health and Poverty Linkages in Sri Lanka, GWP/Colombo Resource Center and IWMI, Colombo, 21 August 2002.

NPC (2002). Basic Paper on The Tenth Development Plan (2002/03-2006/07), National Planning Commission, Kathmandu 2002.

NPC (1998). The Ninth Plan (1997-2002), National Planning Commission, Kathmandu 1998.

NWP/JVS (1999). Framework for Action: Achieving Nepal Water Partnership Vision 2025, Nepal Water Partnership/Jalsrot Vikas Sanstha, Kathmandu, December 1999.

Pariyar, Madan P. (2002a). "Water and Poverty Linkages in Mountainous Area: Highlights on Proposed Nepal Case Study" – paper presented at the Asia-Pacific Regional Consultation Workshop held in Dhaka, Bangladesh on 22-26 September 2002.

Pariyar, Madan P. (2002b). "Water and Poverty Linkages in Mountainous Area: Methodological Framework and Preliminary Findings of Nepal Case Study" – paper presented at the Second South Asia Water Forum held in Islamabad, Pakistan on 14-16 December 2002.

Pariyar, Madan P. (2002c). Report of the Irrigation Specialist, Agricultural Sector Performance Review, ADB TA 3536-NEP, HMGN and ADB, Kathmandu, Nepal, January 2002.

UNDP (2001). Nepal Human Development Report 2001: Poverty Reduction and Governance, UNDP, Kathmandu, Nepal, 2001.

UNDP (2002). Human Development Report 2002: Deepening Democracy in a Fragmented World, UNDP, Oxford University Press, New York, 2002

Upadhyaya, H.K. (2000). *Sustainable Poverty Alleviation and Mountain Development in Nepal: Status, Experience and Strategy* in Growth, Poverty Alleviation and Sustainable Resource Management in the Mountain Areas of South Asia: Proceedings of International Conference held from 31 January to 4 February 2000 – eds. Banskota, M., Papola T. S. and Jurgen Ritcher, ICIMOD, Kathmandu, Nepal.

WDR, 2002. World Development Report 2002: Building Institutions for Markets. Oxford University Press, World Bank, Washington, USA.

Wilk, J. and J. Lundqvist (2001). Triple Integration: targeting poverty with water and social programmes.

WRSN (2001). Water Resources Strategy Nepal, HMGN/WECS, Kathmandu, October 2001.