# CHAPTER-I

# INTRODUCTION

## 1.1 Background

Natural resources are the main determining factors for the economic development. The economic growth rate is dependent upon the availability and uses of such resources. Therefore, the present policy of any government is guided by the resources allocation. When there is a crisis on these components then the economic development is disturbed. Nepal's main natural resource is its abundant hydropower potential. Nepal has immense stock of endowed natural resources, unfortunately we are still poor and the least developed because of underutilization of the available resources. On one hand, Nepal's economic growth rate is low. On the other hand Nepal's economic development is at infant state. However, more or less, all sectors such as agriculture, industry, trade and commerce, communication, social services and tourism are developing smoothly.

Water is the only renewable energy source that has been exploited by man on a large scale and that has a well-developed technological base to support its continued exploitation. At present, hydropower plants have fulfilled about 23 percent of the demand of world's electricity supply (Hari Krishna Ghimere 2003). Sooner or later, the world will have to move to an electricity based energy regime as all the new energy sources under development are mainly exploitable through electricity generation. The energy situation in Nepal is characterized by a very low per capita energy and total dependence on imported commercial energy and only very limited people's access to electricity. Nepal's per capita energy consumption is as low as 14.6545 making it one of the five least per capita energy consuming countries in the world. Since economic development and living standard of the people of a country is

directly related to per capita energy consumption. It is clearly reflected in the poor living standards of the people and low economic development of the country. Nepal is the second richest country of the world and first richest country in Asia in the context of water resources. Nepal has about 6300 large and Small River hurling from the Himalayas and high mountains towards the plain and Terai. The total length of those large and small rivers is about 45000 km. The perennial nature of Nepalese river and stepped grand of the country topography provided ideal condition for the development of some of the world's largest hydropower project in Nepal. The total hydropower potential of these rivers is estimated about 83,290 MW of and which 45,520 MW (54.69%) and 42,133 MW 50.59 percent are technically and economically feasible from 93 and 66 sites respectively. The countries theoretical potentiality occupies 2.77 percent of worlds at potentiality of hydropower. Nepal has generated 697 MW hydropower up to the end up to FY 2009/10 it is 0.84 percent and 1.66 percent theoretical and economic potentialities respectively. Total installed capacity has reached 751 MW including thermal power.

The demand of electric power has increased by more than 11.12 percent in FY 2008/09 whereas the overall energy supply had increase by 8.60 percent in comparison to FY 2007/08. It is suppressed due to the limited supply. Industries trade and commerce services, transportation, communication and other infrastructures are expanding rapidly. In this way, there is a large gap between demand and supply of electric power because its demand exceeds supply. So there is high and continuous requirement of installation of hydroelectricity projects.

Energy is the one of the major components of the natural resources. Energy plays a vital role in the economic development of a nation, because it is very important for the industrialization of a country. It is the primary need for all economic and social development. Energy itself is not a sustainable used

connect to diverse process such as lighting bulbs charging battery is burning fuels and propelling machines. In the modern stage, energy is the indicator of the living standard of the people. Energy is also the primary need for all economic and social development; its adequate supply helps to accelerate the speed of the development.

The energy consumption is gradually increasing along with the growth of the population and economic development which means that either affluent nation have to reduce their energy consumption or the reserve of the resource will decline faster than estimated. This increasing growth rate is greater than the population growth rate. This means the living standard of the Nepalese people is gradually increasing day by day. Out of the total energy consumption, 84.4 percent come from traditional sources and the remaining 14.9 percent comes from commercial sources and 0.7 percent comes from renewable sources (Economic Survey of Nepal, 2065/66). Traditional Sources comprise of fuel wood, agriculture residues and animal waste. Coal Petroleum products and electricity constitute the commercial source of energy. As a result, large share of foreign exchange is spent an importing the energy. Among national sources consumption of fuel wood has increased.

Nepal is facing enormous challenges in the path of economic development. One of the major-infrastructures required for sustainable development of any nation is power sector. Due to the unique topography with scattered settlements the national grid electricity expansion has difficulties, so the electrification through mini or micro-hydro is suitable. There are more than 6000 rivers and innumerable rivulets crisscrossing the country. So, mini or micro-hydropower has a great potentiality for fulfilling the energy requirements of rural Nepal to a great extent.

The two-third of its land mass hilly and mountains region and 85 percent areas of the country still rural. So, special rural electrification scheme need to be adopted to electrify such region. The country is still rough terrain about micro-hydro means that extending the grid to isolated rural communities scattered in the hills across the nation in slow, and prohibitively expensive. Today, only 15 percent of the country 21 million population have accessibility to electricity through grid connection. Due to the consciousness about the negative environmental and socio-economic impact of large-scale hydropower development, electrification through small-scale decentralization mini-hydropower (MHP) emerges as available alternative for rural electrification in Nepal.

Solar and wind energy sources are technically complicated and highly expensive, Bio gas is suitable only in warmer areas. Furthermore, among all the popular renewable energy technology is the most proven most reliable and potentially cost effective. With the bitter picture of energy, it is clear that hydroelectric power is suitable sources of energy, which is non fossil and none polluted. Hydro power is the major component of the Nepalese energy scenario.

Considering all these obstacles, Government of Nepal has brought out new liberal policy about the development of hydropower to encourage private sector (foreign as well as local investor), by the implementation of water resources Act 1992. Especially Nepal gas adopted this liberal policy to attract private investment for the development of small hydropower projects. Nepal electricity authority has announced its policy to purchase the power generated by its private developers/investors of small hydropower projects to 5 MW capacities, in order to support the capital requirement for the installation of hydropower projects. The government has established a Power Development Fund (PDF) support the private investors. Similarly, domestic commercial

banks have been also autonomously investing on hydropower project is priority sector investment. This policy has been encouraged the private investors to hydropower projects to much the growing national demand for energy in the country.

Pharping, the first hydropower plant of 500KW was constructed in Nepal as early as 1911, and financed by the British Government. 701 MW of hydropower has been developed till now. Classification of hydropower plants took place in 1975, when the government of Nepal (GON) established the Small Hydro Development Board (SHDB) to electrify remote district headquarters through the construction of isolated type small hydropower schemes. At that time, hydropower plants from 100KW to 5,000 KW were called small-hydro and plants of less than 100KW capacity we categorized as mini/micro hydropower plants. In 1985, the Nepal Electricity Authority (NEA) was formed as per the Nepal Electricity Act 1984, to take after all electricity-related jobs by merging the electricity department, the Nepal Electricity Corporation (NEC) and the SHDB currently, there is a separate department called the small hydropower and rural electrification department under the NEA charged with developing out rural electrification ventures through the extension of the national grids system.

A new classification of hydropower schemes has emerged recently for practical reasons. As different institution are involved in the development of hydropower projects. This is also due to the liberal hydropower development policy (1992 and 2001), which is mainly meant to attract private investors and encourage the rural electrification process. Now, hydropower plants of less than 100KW fall under micro-hydro and plants between 100 KW to 1000 KW (1 MW) are called mini-hydro, other hydropower plants between 1000 KW to 10 MW fall under small-hydro and those more than 10 MW capacity are

classified as medium and large hydro. In the short, classification of hydropower project has been categorized as below:

Micro-hydropower (below 100 KW)

Mini-hydropower (between 100 KW to 1 MW)

Small-hydropower (1 MW to 10 MW)

Large- hydropower (greater than 10 MW)

(AEPC, 2000:3)

Thousands of traditional water wheels (Ghatta) are in use throughout Nepal since early days. This primitive water is being developed as Multi-Purpose Power Units (MPPUs) for agro-processing and electricity generation purpose. They are popular for the electrification of scattered and isolated settlements in the hilly areas of Nepal. During the daytime they provide mechanical power for rice hulling, grinding, oil expelling and so on, and recreational purpose. A number of agencies and institutions are supporting the implementation process of micro-hydropower plants (MHPs). To date, around 2,200 MHPs, including 800 mechanical schemes, have been installed and the total installed capacity generation from these plants has reached to around 7.5 MW. After 1970, the GON provide subsidies of up to 75% for electro-mechanical equipment for micro-hydropower plants through the Agricultural Development Bank, Nepal (ADB/N) to electrify remote rural areas of the country. But, from 1995/96 onward the process for implementation of micro-hydropower schemes took new momentum as a new institution called the Alternate Energy Promotion Centre (AEPC) was established under the ministry of science and technology. The main objective of AEPC is to promote and disseminate renewable/alternative energy technologies and meet basic energy needs of rural people residing in remote areas of the country. AEPC administer

provide subsidies to enthusiastic micro hydropower developers through its interim rural energy fund supported by the Energy Sector Assistance Program (ESAP). Apart from the AEPC, there are institutions and organizations like the UNDP's Rural Energy Development Committee (RADC), the government's Remote Area Development Committee (RADC) and the Annapurna Conservation Area Project (ACAP).

At present, the effort of the government and Nepal Electricity Authority (NEA) is not adequate to harness the vast power generation potentiality of the country and meet the growing demand in the short run. Electricity act 1992 has facilitated wide business opportunities to local and foreign investors for developing hydropower projects. In this regard, the government has already granted permission to independent power producers to develop hydropower project. Recently adopted rural electrification strategy to provide energy and to reduce the socio-economic disparity by giving the importance in the rural electrifications as mini hydro power projects. Mini hydropower (MHP) system is increasingly found to be widely adopted in many countries of the world, both developed and developing countries.

## 1.2 Statement of the Problem

The supply of energy is often a major constraining factor in the development of a country's economy. Many development countries spend a large proportion of their development budgets on energy. The energy consumption is the increasing function of the population growth and industrialization which means that either affluent nations have to reduce consumption or the reserve of the resources will decline ever faster than the estimated. This energy consumption growth rate is greater than the population growth rate. In the Nepalese context, the energy consumption pattern is predominated by the traditional sources has caused serious environmental

problems. About, 68.1 percent of the people still depend on firewood. This pressure is increasing by 2.3 percent annually.

Nepalese economy is based on traditional agriculture system. In addition to agriculture other sectors of economy such as industry, trade and commerce, transportation, communication and tourism are developed yet due to their inadequate electric power and financial resources. On the other in the absences of infrastructures like road and transmission line, hydropower development cannot be achieved more over infrastructures are required for proper exploitation of other available resources in the country. Economic development has not got proper acceleration due to insufficiency of electricity.

Now a days, people's demand on electricity has grown. It is most important factors on human life. Electricity is most important for our life style to make simple and facilitated on every difficult work. Such as Thotnekhola mini hydropower project is an example of electricity which has established in 2035 AD with 125 KW capacities expecting more advantages. Its main objectives is to electrification overall Okhaldhunga district headquarter but now the MHP has distributed in Barnalu and Rumjatar VDC also. According to NEA Okhaldhunga, there are so many pressure and demand to fulfill electricity in nearer VDC such as Naraynsthan, Baruneshowr and Sisneri. But there are impossible to fulfill in demanded VDC.

The study area's people are using electricity mainly for the house lighting purpose after establishment of Thotnekhola MHP. Not only for lighting but also using electricity for cooking, industrialization and other electric activities. Its main purpose is establishment to fulfill the people's multipurpose demand and needs, although lack of the proper knowledge of its utility and possibility is being back.

People's demand is increasing day by day but capacity is limited, so that they are not using electricity regularly as their demand. People are bearing loadsheding till ten hours in per day in winter season. Only rainy season hardly consumer's demand is fulfill.

With the help of provided electricity, now a days, people are avoiding using traditional lighting like fuel, firewood, candle and dung as a house lighting purpose. But lacks of the sufficient hydroelectricity, people are still using solar energy for its alternatives. People think that life is impossible without energy, so that they are searching its permanent solution.

Really Thotnekhola rivulet has one of the most potential project, then the other rivulet even though, people are not getting sufficient electricity power from the source. The study area's people are trying to connect the Thotnekhola MHP with the central project circulation for using energy regularly.

The study area's people are interested to establish some of the mini/middle and cottage industries in Okhaldhunga district headquarter and Rumjatar VDC. The main causes of sufficient electricity, increases the number of consumer and regular loadsheding they have no courage to invest as their wish. Any way they want to use regular electricity. So it has seen many obstacles being insufficient of electricity, local investors are afraid to invest. By which reason, local people are not getting employment opportunity and economical activities has also affected. On the other hand structural function of Thotnekhola MHP has been weak day by day. It is most important to focus to reconstruction and its maintenance to make it regular.

Wrap up, the main object of this study is to analyze socio-economic impact of study area's people. The object is related with the health, education, sanitation, environmental effect, culture, irrigation etc. above given of issues are studied and searched with the central point with the taking goal result. For

these purposes many and more reliable information has tried to collect from the respondents. With the basis of these information has been minutely studied and analyzed about the central objects and has given well and effective suggestion.

## 1.3 Objective of the Study

The specific objectives of the study are as follows:

1. To state the potentiality of hydro-electricity generation and present status of hydropower.
2. To analyze the socio-economic impact of the study area's people.
3. To find out the attitude of community towards Thotnekhola Mini hydropower project.
4. To suggest the sustainable development of mini hydropower project in Nepal.

## 1.4 Significance of the Study

While the development of a micro hydropower is still at it's infancy in Nepal. The country's planners and policy makers appear to have already become skeptical about the economic viability of such projects while constructions cost have been rising substantially, installation cost per KW are highly disparate between similar projects. The revenues collected by all of the commissioned projects are less than the capital required for operation and maintenance. The MHP has been proved conclusively by many countries that the quality of human resources plays a crucial role, so the investment in all people is needed. The developing countries have been setting, aside budgetary allocations to improve the quality of life with basic facilities like education, health, drinking water, electricity etc. but the reality of Nepal is that only 11% of the population has access to electricity and for the 89% of the population,

most of them living in alternative way to the centralized development plants for rural electrification. The MHPs are one of such best alternatives.

The development of all sectors of an economy depend on energy, the utilization of energy especially electricity is centered in urban area and most of the rural areas have been passed by the existing energy development schemes in Nepal, Generally sources of energy are divided in to broad two part viz. traditional and commercial. Out of the total energy consumption, the traditional resources contributed 86 percent to 90 percent and commercial resources contributed 1.4 to 2.0 during the ninth plan and in the tenth plan, domestic contribute 95.92 percent and commercial contribution is 0.44 percent. Almost all the households are found to have consumed traditional sources specially fuel wood for domestic use and other necessary activities of human life in the hilly and mountainous areas. Electricity cans significantly diversity rural activities. The electricity can raise the living standard of people advantage of electricity are:

Electricity makes human life easier by providing domestic as well as non domestic facilities creates employment opportunities. In the presence of electricity, electronic devices may be available. They improved both quality and quantity of communication and education.

Electricity helps to discover, develop, expand, promote new techniques and technologies in various sectors.

Electricity helps to develop infrastructures which are preconditions for the economic development. Development of electricity and infrastructure has correlated with each other.

Improve in extracurricular activities which help to raise the living standard of the people.

Electricity helps to improve overall sectors of the economy.

As electricity is significant in the development so the researcher has conducted a researcher as a mini hydropower project. This study will be helpful and resourceful in the following ways.

Possibly this is a first research about the mini hydropower project especially for mid East region of Nepal. However many research of micro, small, middle and large hydropower projects have been already done.

This project is contributing to the electrification of hilly and mountainous, districts Okhaldhunga. However their hydropower project is also in operation in Okhaldhunga district now.

An outcome from this research many are helpful to other individuals and institutions to implement programs effectively such type of project.

Research will help to know externalities for other project and programs and to implement such type of new project.

Socio economic impacts of this project inform us the role of project in the socio economic up-liftment of a community.

Finding of this research may be valuable information to those people's institutions that are interested about people of related area.

In short, the importance of mini hydro project is increasing in every aspect of the society. Therefore the study which attempts to identity the socio economic impacts of this Thotnekhola mini hydropower project in significant at present.

## 1.5 Research Methodology

This study is based upon primary and secondary information. The secondary information was used mainly to trace the potentiality and status of hydropower in Nepal. The information have been collected from different sources of government and non-government organization such as Water and Energy Commission Secretariat (WECS), CBS, District Profile of Okhaldhunga, World Bank Report, ADB, NEA, Various Bulletin, Journals, Published and Non-Published Reports, Various Websites and Official Records. The primary information has been collected from sample survey household questionnaire and detail observation in concerned field.

### 1.5.1 Method of Data Collection

For the collection of information about socio-economic impact of Thotnekhola mini hydropower project, data were collected through direct personal interview with help of structured questionnaire (see Annex- I for detail). The questionnaire was designed to assess the impact and people's attitude towards mini hydropower project of study area. The questionnaire is divided into two sections. First section of questionnaire covers socio-economic impact and Second section covers Attitude of community towards of MHP.

### 1.5.2 Sample Selection

The respondents of this study were people who have been using electricity by Thotnekhola mini-hydro project. This study was conducted on 478 household; 108 households of Barnalu VDC, 226 and 144 households of Okhaldhunga and Rumjatar VDC respectively. 20 percent of total household i.e. 95 were selected by random sampling method. For this purpose, out of total 478 households from were numbering from 1 to 108, 1 to 144 and 1 to 226 household of Barnalu, Rumjatar and Okhaldhunga respectively, and kept in to a

basket. Then picked up the total number 95 households i.e. 21, 45 and 29 of Barnalu, Rumjatar and Okhaldhunga VDC respectively. And data were collected by this sampling method. The respondents of this study were indigenous people, professional, students, businessmen, male, female and all necessary.

### 1.5.3 Data Processing

Field questionnaire is carefully checked for possible errors. The data are carefully edited and processed by traditional method i.e. Tally bar, then the required tables is generated by using computer software program.

### 1.5.4 Nature of Data

This study is based on primary data. The primary information has been collected from field survey. Additionally, secondary data is also included in this study from different sources such as survey reports, feasibility reports and journals etc.

### 1.5.5 Data Analysis

The data are collected through personal interview and presented in suitable tables and figures. They are analyzed and tabulated according to the objective of the study. The method of data analysis is descriptive.

## 1.6 Limitation of the Study

This is a quick study based entirely on information from secondary and field surveys suffer from certain limitations. The question of locations and energy demand etc and their implication for the financial and economic efficiency of the study can be hardly investigated without in depth inquiry based on filed survey. However, these approached would ruled due to time and

budgetary constraints. The hydropower plant is located in ward no. 1 of Barnalu VDC of Okhaldhunga district.

This study has been conducted for this study is focused on socio-economic impact of the mini hydropower project. This project covers Barnalu, Okhaldhunga and Rumjatar VDC of Okhaldhunga district. This study has been limited in ward no. 1, 3, 5 and 7 of Okhaldhunga VDC, ward no. 1, 4 and 8 of Barnalu VDC and ward no. 3, 5, 8 and 9 of Rumjatar VDC of Okhaldhunga district. The impact that occurs by contraction of a MHP is the derivation of numerous social and economic effects. Thus the study has been limited only social and economical perspective. Moreover, the social indicators are less factual which had made some difficulties to analyze social impact and pre-electrification information has been depended on the user groups saying and other secondary information. The study limited only to power plants above 100 KW which is not recommend to other projects because it is mini hydro projects of 125 KW in Okhaldhunga districts (Nepal Electricity Authority, Okhaldhunga).

# CHAPTER-II

# REVIEW OF LITERATURE

Limited research has been conducted on energy, socio-economic and environmental impacts of mini-hydropower scheme projects. There are many studies in other sector of micro-hydro projects. Generally, the studies on medium and large, small, mini and micro-scale hydropower projects have been conducted to identify various types of impacts created by the rural development of mini-hydropower projects. Numbers of the studies have been carried out in this field in different countries; most of them installed MHP to fulfill the demand of power which is cheap and environment friendly renewable energy sources. It is the best energy sources for the rural maintaining countryside electrification. This study focuses on the socio- economic impacts of the mini hydropower plant in the remote areas of Nepal and its sustainability. Particularly, it takes Thotnekhola MHP as a case study for this research.

This chapter reviews the previous studies from journal, reviewed text book, working papers, discussion papers, research reports and theses and dissertation both in national and international arena focusing on socio- economic impact on people and research about its sustainability.

## 2.1 Conceptual review

In 21th century electricity is no longer a luxurious but it needs of people everywhere. Hydropower is a white energy due to its non- polluting and renewable characteristics which can be integrate with irrigation and water supply. It is synonymous with a letter standard of living and is vital for letter communication, healthcare and reduced physical labor.

Hydropower is the well-proven technology, relying on non-polluting,

renewable and indigenous resources. During the last two decades, there is a renewed interest in the development of mini-hydropower (MHP) projects mainly due to its benefits particularly concerning environment and ability to produce power in remote areas. Mini hydro projects are economically viable, do not need the big investment and have relatively short gestation period. Due to the scatters settlement of our country low investment capacity of government and people as well as our topography where lots of small rivulets falling from up to down it is becomes best energy source for the country. Renewed interests in the technology of mini-scale hydropower actually have attracted a large number of researchers for the examination of economic and social impact of mini hydropower plant in the rural areas.

In many developing countries electricity usage is widespread in urban areas but for many rural areas, infrastructure investment is much lower, and many communities rely on batteries or nothing at all. With the current population rise in many developing countries there is even greater demand to generate more electricity, and also to distribute it to poorer people so that they do not get left behind in the race to develop. Electricity provision to rural communities results in a better quality of life for householders, but also has positive impact on school, hospital, businesses and agriculture/ industry.

Water powered mills have been in use for nearly a thousand years. In Europe, Asia and parts of Africa, water wheels were used to drive industrial machinery, such as mills and pumps. The first effective water turbines appeared in the mid $19^{th}$ century and these quickly replaced the older water wheels in many applications. In contrast to water wheels and the early turbines, modern turbines are compact, highly efficient and capable of turning at very high speed. Water power can be harnessed in many ways; the most common way is to use a turbine which is turned by water moving in a controlled manner. It is a technology that has been used throughout the world, by a diverse range

of societies and cultures, for many centuries. Large dams hold water which can be used to provide energy industry and grid electrification systems. Smaller systems can provide energy remote regions without the need to build dams.

Hydropower schemes range from the massive to the very small. The biggest schemes involve damming huge rivers, and supply large urban population centers with electricity. A dam built across a river valley creates an artificial storage reservoir and an increase in hydrostatic head (heigh through which water will fall). A powerhouse containing turbines and generators is built at the foot of the reservoir. The storage capacity of the dam reduces the effects of seasonal changes in river flows and allows regulation of release through the turbines. These hydro schemes will usually be grid connected, although smaller projects may serve localized users, particularly in rural areas.

Globally, hydro-power is the largest source of renewable electricity, providing about 16% of the world's electricity (3,100 TWh in 2008), but most of this from large scale systems. In 1995 the micro-hydro capacity in the world was estimated at 28 GW, supplying about 115 TWh of electricity. About 60% of this capacity was in the developed world, with 40% in developing areas (AMY YEE 2012). For MHP sustainability "community mobilization must be, its sustainability" said Bhupendra Shakya, a renewable energy expert in Kathmandu.

Traditional and commercial sources of energy shares have been 86.5 percent and 12.8 percent respectively but renewable energy sources share only 0.7 percent. Unable to supply the power as people's demand is a pressing problem only about 50 percent of people use electricity at all (ES 2011/12). In winter season, above 12 hour per day power cuts have become routine, even in Kathmandu, the capital. Meanwhile, energy consumption has continued to increase, Nepal's annual peak power demands reached above 950 (MW) last

year, outpacing capacity of 705.6 MW (ES 2011/12). An estimated 2,200 micro hydropower plants, generating a total 18,000 kilowatts, have been built in Nepal since the 1970s, according to Nepal Micro Hydropower Development Association (NMHDA). But within a few years many of them broke down because of a lack f community participation and maintenance systems low paying by customer and high turnover of operator.

## 2.2 Empirical review

Acharya, K.(1983), in her thesis "Hydroelectricity Development in Nepal and its contribution to Nepalese economy", mentions the contribution of hydroelectricity to Nepalese economy. It plays significant role by developing various fields such as agriculture, industries, transportation, social services etc. Water resource is the Nepal's greatest asset but unfortunately very insignificant portion has been harnessed to this data. She says that there is unequal distribution of electricity in different development regions. Nepal is facing many problems with respect to hydropower development. These are lack of, capital, skilled manpower, technical know-how sufficient market and economic status of people as well as country.

WECS (1994) is a final report on the improvement of economic viability of MHP plants funded by UNDP and executed by WECS. This study is the first of its kind to analyze the wide ranging issues related to MHP development. This study has raised more issue for further consideration than it has resolved which is natural due to the initial stage of MHP development. This report also studies on the identified and unresolved issue will be crucial to the successful promotion of MHP. The main objective of the study to prepare a set of guidelines to increase the economic viability of the MHP plants. This study is based on the information collected from four case studies namely Barpak, Bhandruk, Angaha and Bhadure MHP plants. From these four case studies the

report has identified some important conclusions and recommendations. The result of the study indicates that MHP plant is the only major source of energy capable of supporting the efforts towards breaking the socio-economic stagnation of the remote rural hills of Nepal. This report suggested that the subsidy on MHP may be gradually withdrawn as it starts to bring positive socio-economic changes in the rural hills. The results of the study also indicated that the introduction of subsidies for MHP in 1985 played a vital role for MHP promotion. This study concluded that the development of a MHP promotion has been able to mobilize considerable resources from the people of hills. This report suggested that for successful promotion of end uses the reliability and quality of electricity need to be improved. This study recommended that the government agency by given the responsibility for micro hydropower development. It also recommended that the outing subsidy for MHP should be continued on a long term basis and appropriate legal framework to support MHP development be formulated. It suggested 50% of the electrical component cost be financed through the resolving fund for non remote areas. And for remote area 25% of the electrical component cost and 50% of the mechanical cost be financed through the revolving fund. The study also suggested that as currently individual village entrepreneurs are not likely to be able to mobilize enough resources for large MHP, the efforts should be made for promotion of company type MHP ownership as well. The study also recommended that the lift irrigation be developed as a major end used of MHP.

Aitken (1991) was conducted by ICIMOD to analyze the environmental social and economical impacts of mini and micro hydropower plants. This paper mainly concentrated on hydro electricity. This study found on the principle issues in the development of hydropower resources. In Nepal, the cost of hydropower, government subsidies, development of domestic resources, energy efficiency, coordination and control, impacts and benefits,

Electrification from hydropower in Nepal. This paper concluded that the private installations plants are more profitable than that of public installations. Reason for the profitability of the private sector installations include the fact that many started by providing agro-processing services and electricity generation was only added on later. By contrast, the government installations produce electricity only and have been expected to cover their running costs at least from the beginning. It also concluded that the lack of disposable incomes in remote areas and the lack of the other infrastructural inputs required for industrialization are causes of little demand for electricity. This report has been made some recommendations. This paper suggested that the plans for grid extension must be made available because investors are deterred by the fear that the grid may be extended to their area, putting their plant out of business by providing electricity at subsidized prices. It also recommended that the technical training is needed in both public and private sectors. Particularly at the operative level to improve present standards this paper suggested that the mini and micro industry has become a national export industry as well as a local supplies.

"East Consult P. Ltd. (1990). Analyzes socio-economic impact evaluation of the MHP schemes in rural communities of Nepal" is the final report prepared by East Consult P. Ltd. under the study sponsorship of ITDG Nepal. This study especially reports to the evaluation of micro-hydro power, its socially acceptance and economic viability. It encompasses many studies areas of micro-hydropower. But it especially focuses to the investigation especially on such questions like who are the real beneficiaries and to what extent does that get benefit. This study is interested to know the constraints prevailed in rural energy. It also keeps the interest to finding the answer of the question who gets the access to the rural lighting and why? This study was conducted in torture of Tanahun district, Karmasingh of Gorkha, BulingArkhala of

Nawalparasi, Karputar of Lamjung, Arghali of Dolpa and Karnali of Baglung district.

This study has been centered to the socio-economic evaluation of the impact of private and community owned micro-hydro schemes on members of rural communities who are not the owners of micro-hydro schemes. It focuses to the target groups and aims to enhance the knowledge about relationship between nature and MHP scheme. The objectives of the study are to examine the characteristics and perception of those local people who are benefited by micro-hydropower. It especially examines the satisfaction/dissatisfaction ratio of micro-hydropower users and tries to recommend for action to maximize the benefit to the rural poor. It also tries to establish the indicators for monitoring the effects of any such actions. According to the finding of the study, the viability of this technology under the set of technical and social circumstances, which prevails in perceived benefit, accrues to the mill owner as well as the community. It reveals that; in one hand, agro-processing makes positives impact on community saving the drudgery, especially to women and in other hand, it is not effective to the cash starved people.

It says it is not fully beneficial where the time is consumed by the transportation to mill and waiting, although it depends upon the located area of mill from the settlements. The study indicates that only one or two percent of the customers make payment in king for the service of the mills who cannot afford the cash payment. But about (3 to 8%) of village inhabitants are poorest, of the poor in most of rural areas of Nepal who do not use, the mills even with payment in kind because they do not have such affordability also. But it is naturally that, the payment in kind is anywhere between (50 and 500) higher than the cash down payment depending upon the local prices of agro-production. It further indicates that except the oil processing kol, the traditional agro-processing mills, such as Dhiki and Janto have not been replaced at all

because this turbine mills have not yet been able to reduce the risk reliance of the community vis-à-vis traditional sustainable practices.

Dhital R.P. (2003) this is the conference paper presented in international conference on renewable energy technology for rural development (Returned 03) prepared by Dhital, Ram Prasad and ET.al. The report is published in every four years. It is important information to the energy sector, which combines the present states, past experience and future plan of this energy sector with the view of national and foreign experts. The paper tries to analyze the initial evaluation of investments and optimizes the components to observe on total projects cost. This analysis deals with the approach for financial analysis to calculate the cost where three scenarios that is, with subsidy, without subsidy and with net economic benefit.

Hora. P.(1996), in her thesis "Role of Micro- hydropower in Rural Electrification of Nepal" explains that among the alternative energies more popular and available, continuously renewable, non-polluting, efficient widely distributed and based on simple as well as flexible energy sources is micro-hydropower (MHP) in Nepal. It is technically feasible as well as economically viable and the most appropriate technology for Nepal indeed, micro-hydropower projects are not sufficient to meet the national demand of electricity on the hand, we have no economic resources, technology and skilled manpower to install large-scale hydropower project on the other hand, small scale hydropower projects can play very important role in such context. This technology provides access to electricity and other mechanical from of energy for agro processing. Furthermore, it is also capable of providing rural electrification to a limited scale.

Hilly topography and enough availability of water resources so the huge potential for micro-hydropower in the country. Micro-hydropower help to

reduce the alarming deforestation, import of petroleum products thereby playing a vital role to improve the economic condition of the people. Agriculture Development Bank of Nepal (ADB/N) not only providing loan and subsidies but also providing resources survey, feasibility studies, promotion of manufactures involvement technical assistance and training has financed over 90 percent of the private MHPs in Nepal. It may not generate electricity in dry season. Likewise the skilled manpower may not be available to get it repaired. Sufficient research has not been carried out yet. These are a few problems involved with MHPs.

Shrestha B.R. (2000) "Role of Hydro-electricity in economic development" mentions that the development of hydro-electricity is possible due to the enormous water resources as well as favorable topographic and climate condition. Hydro-electricity has tremendous advantages for the people, and its helps to develop energy sector economy. Electricity is one of the infrastructures of upgrading the socio-economic condition of Nation. The proper utilization of electric power accelerates the motion of national development. Our experiences show that the developed countries like Japan, UK, USA, China, France, etc. achieved advancement in time through electric power. At present, the stock of non-renewable resources like petroleum products, coal, natural gas, fuel, wood etc. is decreasing. The hydroelectricity has become economically attractive because it is renewable and environment friendly. He has discussed the role of hydroelectricity in various economic as well as non-economic sectors. Industries, agriculture, transportation social services and other sectors can be promoted by the utilization of electricity. He has also discussed but the development during the plan periods. Actually micro-hydro plant is very necessary for Nepal as well as rural areas, where the national projects cannot cover electrification, in such places the small project known as micro-hydropower plant may be very useful. The micro-hydropower

project conducted in district head quarter as well as another places cannot cover the whole district. So, the micro-hydro project of Lakharkhola must be suitable and usable.

Karki B.B. (2010) has evaluated the social and economic impacts of Rupatar micro hydropower, a micro hydropower plant in eastern Nepal, in the study area and has concluded that the plant has a positive impact on health, education, information and communication, drudgery reduction, income increment and in totally on the overall living standard of people in the study area. His study has shown that the plant has been an aid for social and economic up liftmen in the study area. However, operation and maintenance is a major problem for the plant. So his study has recommended that training should be given to the villagers, preferably to married women, about the operation and maintenance of the plant.This study is descriptive as well as analytical using primary as well as secondary data. The primary data were collected through the interview field survey, participant observation and key informant interviews. Structured questionnaire was used as a tool to collect both quantitative and qualitative data.

Jha,H.B. (1995) “Sustainable development of small Hydropower in Nepal” says that one of the major reason for poverty and backwardness of the Nepalese economy is power deficit. Shortage of power creates a problem in the development of agricultural industrial, trade and other sectors of the economy. With a view of meet the medium or mega projects but also small scale hydropower projects. The small hydropower projects might contribute significantly by providing electricity in isolated pocket area as well as to the grid since the electrification is related to productivity. Small hydropower might help to increasing working efficiency of the rural families. For the sustainable development of small and micro-hydro projects by adopting the program approach instead of providing subsidy, comprehensive institutional base is

required it provide supporting services such as agriculture extension input supply. Marketing services credit facility etc and development of capability of the farmers.

Bastola S.N. (1990) “Water resources development on highly Himalayan Rivers” says that geographical and geological condition of the country has been rise to such a river system in our country. It surveys that some of the cheapest hydropower station can be developed in the country. 15 million Kilo Watt hydropower potentiality of our country is so such greater compared to our consumption. It can be exhaustible for our economic uplift. We most look for market, external input for isolated hill area, medium size projects to meet national needs in relation to entry, irrigation water supplies and large scale project primarily for export and securing navigation facilities from lower riparian to ease the difficulties by Nepal’s landlocked status. Rivers are not only the ornaments of the country bur also diamonds if they are properly utilized by involving a long term plan for its development. Fifth development plan has (NPC, 1970) scouted to distribute the benefits of economic and social development high priority has been given in bringing rural electrification to the hilly regions economic activities are not sufficient over there. However, there are rivulets whose capacities range from 1 to 200 K.W.

Pokhrel, B.M. (1998), in his thesis “The study of hydropower in Nepal: A case study of Socio-economic Impact of Jhimruk Hydro Project, Pyuthan”, has mentioned that energy is important for economic development. Without it, he pace of economy cannot be accelerated. The development of the productive sector of an economy depends on development of the energy sector. In the hilly and mountainous areas, almost all the households are found to have consumed traditional sources of energy for cooking, heating, lighting and other necessary activities. Traditional energy sources cannot be sustainable to fulfill energy requirement. From the present analysis, it has been observed that most of the

people depend on forest for energy sources and livestock. As a result, the deforestation has brought about ecological and environmental hazards along with shortage of fuel wood, soil erosion, deterioration of water sources and hampers both electricity generation and drinking water. Hydroelectricity occupies a very eminent place in the energy sector of Nepal. The utilization of energy is concentrated on urban areas and most of the rural areas have been by-passed by this power development. The hydropower project has brought about changes in socio-economic, cultural and other aspects of the people living in the project located area and its surroundings. To find Jhimruk Hydro Project's impact and to introduce the total effect of the project at the study area is main objective case study. For this study the qualitative as well as quantative method is used the study find the every kind of socio economic and environment effect in the study area as well as surrounding area.

Sharma N.K. (2003) "Economics of Nepal" is another important publication. This publication includes overall macro economics aspects and their scenes of Nepalese economy. He explains about utilization of water sources and its role in economic development. He mention about hydropower potentiality. He explains the development of hydropower project in Nepal. Pharping (500 KW) be the installed hydropower project in 1911 in the history of hydropower development of Nepal. Total generated capacity was 2077 MW before the initiation of economic plan (1956). Sixth plan brought out new vision in the development, if small hydropower project. He mentions the installment of all scale projects up to that date. Similarly is brought out new policy to develop water resources and hydropower as well. Consequently, private sector has been encouragingly investing in the development of hydropower, it has mentioned region wise distribute, sector wise consumption of electric power within the Nepal. These was 62.6 percent (which is in top position) of total generated capacity in CDR installed until the date of 2001.

Similarly WDR, MMWER, EDR and FWDR occupied 30.3 percent, 3.0 percent and 0.5 percent of the total generated capacity development respectively up to the same time. It seems that most of the total capacity is used by household sector than commercial sector, which are 95.6 percent and 2.3 percent respectively. He points out some problem related to the hydropower for sustainable development of hydropower he suggests to solve the debate between Nepal and India to make and implement appropriate policies about water resources to reduce cost, leakages, integrated approaches national commitment. In short it requires suitable policy and programs to develop small and middle scale project to meet national demand for electric power and it can equitable alternative measure to reduce power imported from India.

Paudyal, S. (1999) “pattern of energy consumption and its impact on economic development of Nepal”, has analyzed the energy scenario of 1990s. In average shares of traditional and commercial energy consumption seem more than 90 percent and less than 10 percent respectively. Either share of fuel wood, in traditional or in total energy consumption, it is very high and adverse in the case of electricity. Use of electricity is high in domestic sector, although its use is increasing rapidly in industrial as well as commercial sector. High GDP cannot be accomplished without technological progress, which requires increasing use of commercial energy. Use of energy is essential for industrialization and transformation of agriculture to the other sector, more time are required to collect fuel wood as a result there remains very little time for productive works. The use of hydropower helps to reduce deforestation that will grow agriculture production through conserving the soli pumping, irrigation water. Dryings crops grinding factor, threshing machine this demand of commercial energy positively linked with increased income of household. He emphasized that micro and small hydropower should be developed to meet

rural demand for energy but medium 23 and large scale projects are essential to meet the demand for industrial and commercial sector.

Gurung, S.B. (2000), in his thesis 'Impact of Modikhola Hydroelectricity Project in Parbat District." Reveals that the total water provides nearly 25 percent of the world's energy. It is estimated that 73,000 TWH can be generated where as today; the world has produced 3,207 TWH can hydroelectricity. Asia consists of 28 percent of the world's hydropower potentiality. High run off potentiality of several rivers and mountainous topology support to raise hydropower development in the context of our country. The study analyzes potentiality and historical perspective of hydropower development in Nepal. Major rivers and small rivers contribute 87 percent and 13 percent in theoretical hydropower potentiality of Nepal respectively. Total technically feasible hydropower potentially is 4, 55,320 MW from 93 projects sits of different rivers basins. He also analyzes the sustainable development of small hydropower projects in the present context of Nepal. He recommends that we should develop the small hydropower projects in the present context of Nepal.

Shrestha P.B. (2003) has studied on "Sustainable Development of MHP in Nepal, prospect and changes". His study emphasized sustainable use of available rural energy resources to fulfill basic need of the overall development of the nation. Huge water flowing from the mountains can be exploited through locally made MH technology adopted in local level. Therefore, local grid powered by MHP can be the best option of providing electricity to the rural people.

The study reveals the government subsidy in electrification component and credit assistance of ADB/N. ADB/N still has played a crucial role for the development of MHP in Nepal. Community based energy planning and

management approach offered an appropriate alternative for implementation at MHP in remote and inaccessible areas.

Thapa B. (2004) “Dobbar Vikas” says that development of hydropower has been doubled in twelve years of restoration of democracy in comparison to thirty years of panchayat. Statistically, existing capacity of hydropower is more than 600 MW now. It was only 281 MW capacities before twelve years. Per capita energy consumption reached around 60 KW per year now. However, it was less than 20 KW at that time. The total number of customers as reached 9, 70,000 during that period. Now NEA became capable not only to solve the problem of load shedding but also to export. New liberal hydropower policy facilitated investors in the various cases then private sector has been attracted and it become has developed the local industries which create the employment opportunity. Likewise, it helped to raise the value of goods and services and performed the integrated energy system of Nepal and positive impact on overall economy. National capital, skills, knowledge technicians and technologies have become capable to apply small hydropower plants after came of the new policy private sector has generated about 145 MW electricity in Nepal in this period.

Dhungel K.R. (2002) “Trends and patterns of Energy Consumption in Nepal” mentioned that main sources of energies are biomass (traditional which constitutes fuel wood agriculture waste, animal dung etc). and commercial sources which constitutes coal petroleum products, hydro electricity etc. Energy consumption in Nepal is dominated by biomass, which accounted for 95 percent, 94.9 percent, 91.7 percent, and 86.4 percent and remained shares of commercial energy in total energy consumption in FY 1984/85, FY 1989/90, FY 1995/96 and FY 2000/01 respectively. Average growth rate of biomass and commercial energy consumption during the FY 1984/85, FY 2000/01 were 2.4 percent and 10

percent respectively. Combining both an average growth rate was more than 3 percent annum during this period. The trend of energy consumption in Nepal during the FY 1984/85- FY 1995/96 also shows that biomass was growing by 2.2 percent per annum. Similarly, commercial energy was growing by more than 5 percent per annum. Annual growth rate of fuel wood, coal, petroleum products and electricity during the FY 1984/85 to 2000/01 were 2.7 percent, 27.2 percent, 12.7 percent and 1.0 percent respectively. Income electricity for electro products consumption and electricity were 1.75 percent and 1.4 percent respectively.

Upadhyaya, R.P. (2051a B.S.) "Jalasrotko Barema Sunna Bujhna Parne Kuraharu" is an important article, about water resources of Nepal. He mentions that Koshi, Gandaki and Karnali rivers are international level rivers. Total 244 MW capacities had been installed till to that date. Nepalese people have getting neither irrigation facility nor electricity facility adequately. India is taking more advantages than Nepal from large barrage, near to the border of Nepal's large rivers. Out of the total land and irrigated by Koshi and Gandaki irrigation project, only 2.4 percent lies in Nepal and the remaining 97.6 percent in India. In other words, he suggests that we should reserve large water resources as USA did. It would be better to install small scale hydropower projects from small rivers in the present context of Nepal. After becoming capable to invest on our own, we can install large- scale projects at low cost by utilizing our large rivers. Alternative measure to develop hydroelectricity in Nepal at present context is to develop suitable small and middle scale projects, which fulfill annual demand of electricity, by utilizing available local resources. He suggests that people's participation is required to make policy for utilizing water resources as national resources.

Upadhyaya R.P. (2051b B.S.), Jalvidhyut Utpadanko Vaikalpik Upaya" is an important article in this regard. He explains in this article that source of

small rivers is reducing day by day due to the environmental degradation. Nepal's large-scale hydropower projects are costly in comparison to India and China. Besides this, there are other causes as well. So, Nepal neither can export due to the high generation cost nor can its people consume (because their purchasing power is declining. Nepal is facing the problems of debt trap. If Nepal generates large-scale projects (either by taking foreign loan or by bringing foreign investors), that may be expensive one hand and Nepal should bear large burden of foreign debt on the other hand. So, installation of cheap and small scale projects which are possible to install by using local resources to fulfill annual national demand of electricity and participation in decision making are alternative measures for development of small scale hydropower projects instead of large scale hydropower project at present context.

# CHAPTER-III

# POTENTIALITY AND PRESENT STATUS OF HYDROPOWER IN NEPAL

## 3.1 Introduction

The main sources of water are sea, rivers, artesian well, lake and rainfall. But Nepal has not access to sea. Nepal’s mountainous topography coupled with the favorable hydrology, dense and perennial rivers-network provide good condition and prospect for development of hydropower plants of any capacity ranging from micro to mega projects.

Nepal has a huge hydropower potential. In fact, the perennial nature of Nepali rivers and the steep gradient of the country's topography provide ideal conditions for the development of some of the world's largest hydroelectric projects in Nepal. Current estimates are that Nepal has approximately 40,000 MW of economically feasible hydropower potential. However, the present situation is that Nepal has developed only approximately 600 MW of hydropower. Therefore, bulk of the economically feasible generation has not been realized yet. Besides, the multipurpose, secondary and tertiary benefits have not been realized from the development of its rivers.

Although bestowed with tremendous hydropower resources, only about 40% of Nepal's population has access to electricity. Most of the power plants in Nepal are run-of-river type with energy available in excess of the in-country demand during the monsoon season and deficit during the dry season.

Nepal's electricity generation is dominated by hydropower, though in the entire scenario of energy use of the country, the electricity is a tiny fraction, only 1% energy need is fulfilled by electricity. The bulk of the energy need is

dominated by fuel wood (68%), agricultural waste (15%), animal dung (8%) and imported fossil fuel (8%). The other fact is that only about 40% of Nepal's population has access to electricity. With this scenario and having immense potential of hydropower development, it is important for Nepal to increase its energy dependency on electricity with hydropower development. This contributes to deforestation, soil erosion and depletion, and increased flooding downstream in the Ganges plain. Shortage of wood also pushes farmers to burn animal dung, which is needed for agriculture. Not only this, the development of hydropower will help to achieve the millennium development goals with protecting environment, increasing literacy, improving health of children and women with better energy. Growing environmental degradation adds a sense of urgency.

## 3.2 Potentiality of Hydropower in Nepal

Hydro-energy has become economically attractive because it is renewable as well as environmental friendly. The energy generated from water resources covers about 25 percent of the world’s energy. It is estimated that 73,000 TWh could be provided. Asia holds 28 percent of world’s total potentiality. There are about 63,000 large and small rivers in Nepal and total length of all these rivers is 45,000 km (WECS). Mostly, hydropower potentiality has been broadly categorized in three ways; (i) Theoretically, (ii) Technically and (iii) Economically.

### 3.2.1 Theoretical Potentiality

Theoretical potentiality of hydropower is estimated on the basis of hydrological and topographical conditions of a given territory. The theoretical hydropower potentiality is divided into three categories: rivers (i) with catchments area equal to or greater than 1,000 sq.km. as major rivers: (ii) with catchments area from 300 to 1,000 sq.km. as small rivers and (iii) the rest (less

than 300 sq.km.) rivulet/streams. Theoretical potentiality of hydropower of our major rivers like Saptakoshi, Saptagandaki, Karnali and Mahakali, and other southern rivers is shown in the table below.

**Table 3.1**

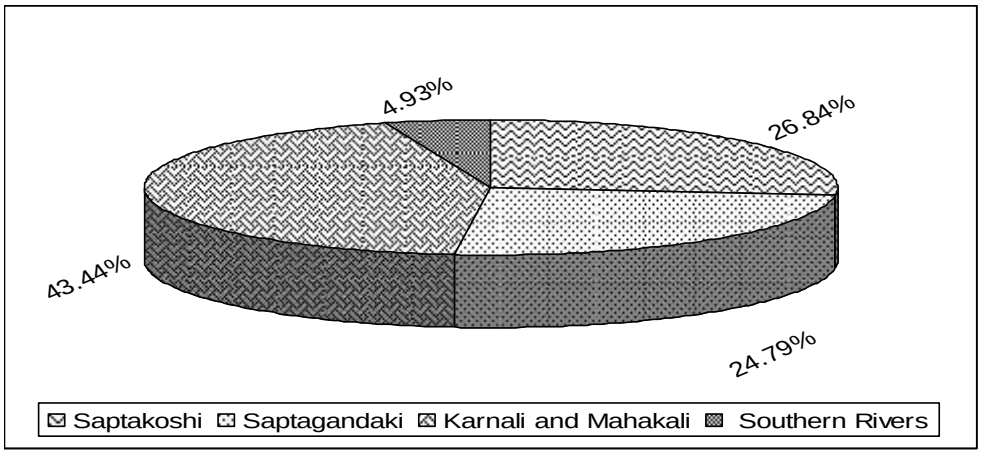
**Basin wise Theoretical Potentiality of Hydropower in Nepal**

| **River** | **Major River** | | **Small River** | | **Total** | **Potential of Basin slope** |
|---|---|---|---|---|---|---|
| Basin | MW | Percent | MW | Percent | Potentiality (MW) | |
| Saptakoshi | 18,750 | 22.51 | 36,000 | 4.32 | 22,350 | 33,400 |
| Saptagandaki | 17,950 | 21.55 | 2,700 | 3.24 | 20,650 | 29,000 |
| Karnali and Mahakali | 32,680 | 39.23 | 35,00 | 4.20 | 36,180 | 56,500 |
| Other Southern Rivers | 3,070 | 3.69 | 1,040 | 1.25 | 4,110 | 8,500 |
| Total | 72,450 | 86.9 | 10,840 | 13.01 | 83,290 | 1,27,400 |

*Source: WECS, "Perspective Energy Plane." Supporting Document No. 2, MOWR, HMG/N, Kathmandu, 1995.*

**Figure 3.1**

**River Basin wise Theoretical Potentiality of Hydropower in Nepal**




Nepal's total theoretical hydropower potentiality is 83,290 MW. The theoretical hydropower potentiality of major river courses and small river courses are 86.99 percent and 13.01 percent respectively. The Karnali and Mahakali have the highest theoretical hydropower potentiality (43.44 %). Then come Saptakoshi (26.83%) and Saptagandaki (24.79%). Lastly, Southern rivers, which originate from Mahavarat range, have the lowest (4.93%) theoretical hydropower potentiality.

### 3.2.2 Technical Potentiality

Technical Potentiality of Hydropower is assumed on the basis of technically viable and possible sites to generate electricity. To generate hydropower, technically feasible sites are limited in number. So, total technical potentiality. The total number of technically feasible hydropower sites is 93.

**Table3.2**

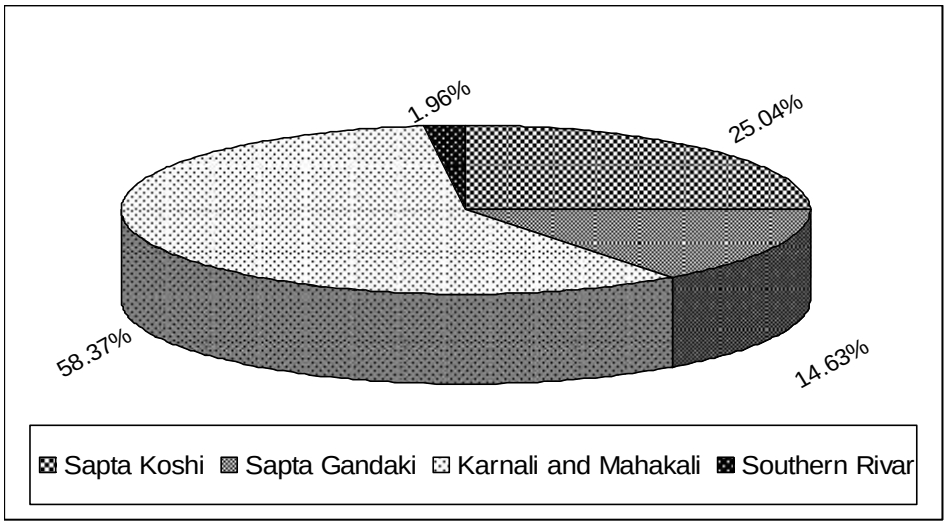
**Basin wise Technical Potentiality of Hydropower in Nepal**

| River Basin | No. of Identified Sites | Technical Capacity | Total Percent of Technical Potentiality | Percent of Theoretical Potentiality |
|---|---|---|---|---|
| SaptaKoshi | 53 | 11,400 MW | 25.04 | 13.69 |
| SaptaGandaki | 13 | 6,660 MW | 14.63 | 8.00 |
| Karnaliand Mahakali | 18 | 26,570 MW | 58.37 | 31.90 |
| Southern River | 9 | 890 MW | 1.96 | 1.07 |
| Total | 93 | 45,520 MW | 100 | 54.66 |

*Source: WECS, "Perspective Energy Plane," Supporting Document No. 2, MOWR, HMG/N, Kathmandu, 1995.*

**Figure 3.2**

**Basin wise Technical Potentiality of Hydropower in Nepal**




The above table shows that the total technical potentiality is 45,520 MW, which is 54.66 percent of theoretical potentiality of hydropower in Nepal.

Karnalian Mahakali consists of the highest capacity of technical feasible. It consists of 26,570 MW (58.37%) out of total 45,520 MW. Saptakoshi holds the second highest position; it consists of 11,400 MW (25.04%). Then Sapta Gandaki and Southern rivers have 6,660 MW (14.63%) and 890 MW (1.96%) respectively.

### 3.2.3 Economic Potentiality

Economic potentiality of hydropower is assumed on the basis of economically viable or feasible sites to generate hydropower. Economic potentiality of hydropower is limited in comparison to technical and theoretical potentiality. Only 51 percent of total theoretical potentiality is economical viable. Likewise, only 66 sites are economically viable.

**Table 3.3**

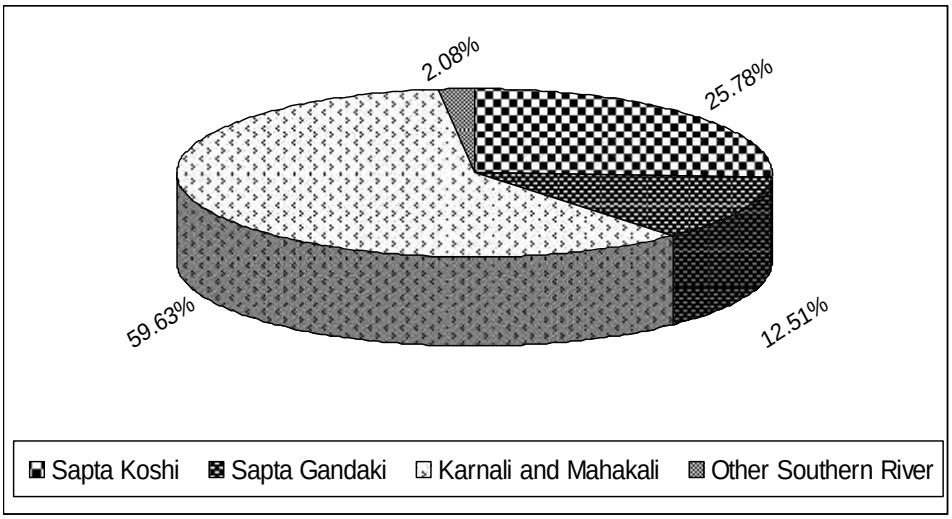
**Basin wise Economical Potentiality of Hydropower in Nepal**

| River Basin | No. of Identified Sites | Total Capacity | Percent of Economical Potentiality | Percent of Theoretical Potentiality |
|---|---|---|---|---|
| SaptaKoshi | 40 | 10,860 MW | 25.78 | 13.04 |
| SaptaGandaki | 12 | 5,270 MW | 12.51 | 6.33 |
| Karnali and Mahakali | 9 | 25,125 MW | 59.63 | 30.17 |
| Other Southern River | 9 | 878 MW | 2.08 | 1.03 |
| Total | 93 | 42,133 MW | 100 | 50.59 |

*Source: WECS, "Perspective Energy Plane" Supporting Document No. 2, MOWR, HMG/N, Kathmandu, 1995.*

**Figure 3.3**

**Basin wise Economical Potentiality of Hydropower in Nepal**




The table shows that economically viable total hydropower is 42,133 MW. Which is 50.59 percent of theoretical potentiality of hydropower in Nepal.Karnali and Mahakali rivers have the highest capacity of economic feasible. It consists the 25,125 MW (59.63%) out of total capacity of 42,133 MW. Sapta Koshi and Sapta Gandaki are in second and third position respectively. Which have 10,860 MW (25.78%) and 5,270 MW (12.51%) respectively. And other Southern rivers have 878 MW (2.08%) capacity of total economical potentiality.

## 3.3 Present Status of Hydropower

Nepal has 700 MW of installed capacity from the hydro electricity system. The hydropower development in Nepal began with the development of 500 kW Pharping power plant in 1911. The most recent significant power plant commissioned is the 144-MW Kali Gandaki "A" Hydroelectric Plant. Until 1990, hydropower development was under the domain of government utility, Nepal Electricity Authority (NEA) only. However, with the enactment of new Hydropower Development Policy 1992, the sector was opened to the private

sector also. There are number of projects already built by the private developers.

The electricity demand in Nepal is increasing by about 7-9% per year. About 40 % of population in Nepal has access to electricity through the grid and off grid system. Nepal's Tenth Five Year Plan (2002– 2007) aims to extend the electrification within country and export to India for mutual benefit. The new Hydropower Policy 2001 seeks to promote private sector investment in the sector of hydropower development and aims to expand the electrification within the country and export.

This part of chapter attempts to show the present status of installed hydropower in Nepal. For this purpose installed hydropower projects are categorically tabulated such as large, small, mini and micro hydropower plants. Hydropower plants of less than 100 KW fall under micro hydro, plants between 100 KW to 1000 KW (1 MW) are called mini hydro, other hydropower plants between 1000 KW (1 MW) to 10 MW fall under small hydro and those more than 10 MW capacity are classified as large hydro. In this part, has tried to analyze the table briefly. There are 144 installed all kinds of hydropower project in Nepal till now which is providing 700 MW capacity. The major hydropower plants with their capacity are listed in the appendix-I.

# CHAPTER- IV

# DATA ANALYSIS AND MAJOR FINDING

This chapter attempts to analyze and interpret the data and information. For this purpose data are tabulated at first then analyzed. This chapter is divided in to two sub-chapters. The first part of the chapter covers the socio-economic impact of Thotnekhola MHP plant and Second part covers the attitude of community towards Thotnekhola mini-hydro-power project in the study area.

## 4.1 Introduction to Study Site

There are five districts in Sagarmatha zone, among them Okhaldhunga is one district which is known as remote and backward. There are fifty-six VDCs in Okhaldhunga district, Okhaldhunga VDCs is also headquarter, Barnalu and Rumjatar VDCs are nearer from Okhaldhunga VDC. Geographically the site is approximately located at 27º32’06” North and 86º32’10” East an altitude of about 1,849 meter above mean sea level and which constitute of total population 1, 47,984 (Census. 2011) Thotnekhola mini hydropower project was established in 2036 B.S. this MHP located in ward no. 1 of Barnalu VDC of Okhaldhunga district: East Development region of the country. The Barnalu VDC is the Northern settlement of the district. It is located nearer from the Rumjatar Airport of Okhaldhunga District. Okhaldhunga, Barnalu and Rumjatar VDCs are also nearer each other geographically.

## 4.2 Socio-Economic Impacts

There may be so many impacts of everything; Thotnekhola mini hydropower project has influenced various aspects of social and economic aspect of human being in the project site. The first part of the chapter covers the socio-economic impact of the MHP plant. This study is focused specially

what types of change occurred in social as well as economic sector. For detail different related data are tabulated and interpreted follow.

### 4.2.1 Caste/Ethnicity

Nepal is rich in caste/ethnic. Nepal is also known as common garden of different caste/ethnicity and language. So there are different caste/ethnicity in the study area. It is attempted to present the caste/ethnicity group separately. Mainly there are so many Janajati (Rai, Sunuwar, Newar, Tamang, Magar, Gurung and Sherpa), Bahun/kshetri and dalit( kami, damai and sarki) people. The table 4.1 shows the distribution of respondents by caste/ethnicity.

**Table 4.1**

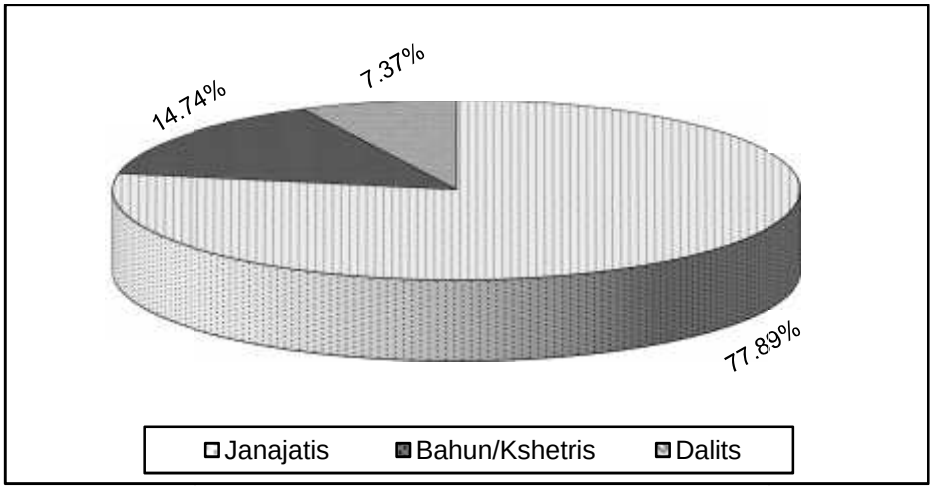
**Distribution of Respondents by Caste/Ethnicity**

| Caste | Number | percent |
|---|---|---|
| Janajatis | 74 | 77.89 |
| Bahun/Kshetris | 14 | 14.74 |
| Dalits | 7 | 7.37 |
| Total | 95 | 100.00 |

*Source: Field Survey, 2011*

**Figure 4.1**

**Distribution of Respondents by Caste/ Ethnicity**



The table and figure 4.1 shows the distribution of respondents by Caste/ Ethnicity. Out of the total 95 respondents highest proportion is known Janajatis i.e. 74 (77.89%). Then lowest proportion is known Dalits i.e. 7 (7.37%) and out of the total 95 respondents i.e. 14 (14.74%) are Bahun/Kshetris.

### 4.2.2 Change in Living Standard

The modern facilities mostly affects in human being. After using such facilities it is expected that there must change in living standard of human. Actually living standard refers to the higher living. The study area's households are using the electrical goods and instrument like TV, computer, fridge, rice cooker etc. they are getting different kinds of electrical facilities in the outside of their house. There are so many electrical facilities in their area which has directly affected by hydroelectricity. By which reason, they have felt changes in living standard to make easier their life. The table 4.2 shows that aggregate using status of electrical facilities after MHP.

**Table 4.2**

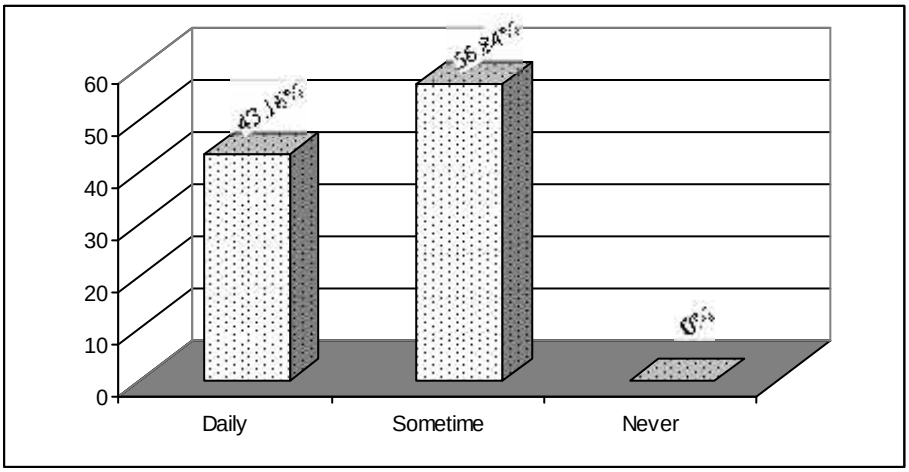
**Status of Using the Electrical Facilities after MHP**

| Using Status | Number | Percent |
|---|---|---|
| Daily | 41 | 43.16 |
| Sometime | 54 | 56.84 |
| Never | 0 | 0.00 |
| Total | 95 | 100.00 |

*Source: Field Survey, 2011*

**Figure 4.2**

**Status of Using the Electrical Facilities after MHP**




It is expected that modern facility like electricity may effect in human life style. So, this table shows the using status of electrical facilities of respondents. The question was asked to respondents that have their living standard been changed or no. After the MHP plant, all respondents i.e. 95 (100%) reported that living standard has been changed after the MHP. But they are unable to use the electrical facilities continuously. Above this table 41 respondents i.e. (43.16%) only uses the electrical facilities daily. In addition, it is proved that electricity is one of the most affecting factors of living standard.

### 4.2.3 People's Perception about the Income in their Income after MHP

These respondents who have able to use the electricity properly, who have sufficient knowledge and ways about electricity facilities, they have been able to increase family income. Those people who have credit of loan when interested in MHP, they reported that their family income not increased, some of the respondents income neither increased nor decreased. They are living in neutral position even after electricity. The percentage and the number of households about income generation/increase after MHP is presented the table and figure below.

## Table 4.3

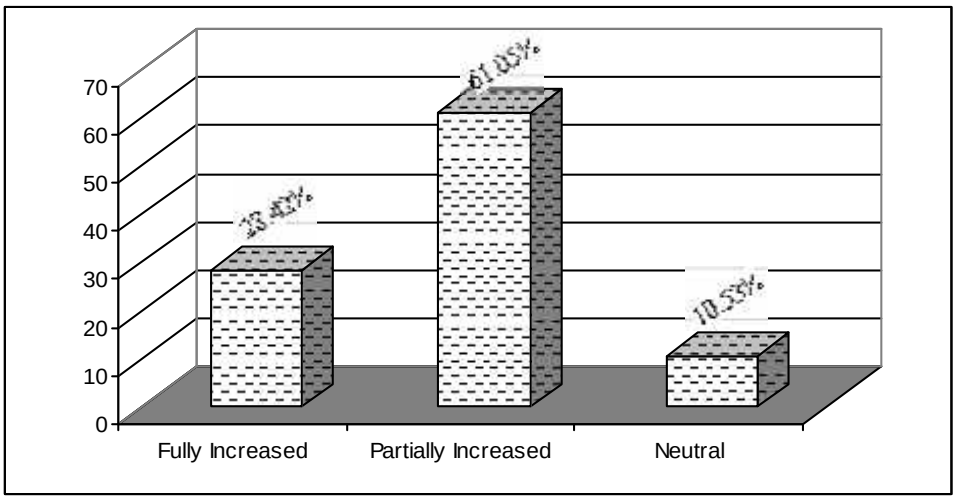
## People's Perception about the Income in their Income after MHP

| Status | Number | Percent |
|---|---|---|
| Fully Increased | 27 | 28.42 |
| Partially Increased | 58 | 61.05 |
| Neutral | 10 | 10.53 |
| Total | 95 | 100.00 |

*Source: Field Survey, 2011*

## Figure 4.3

## People's Perception about the Income in their Income after MHP




The table shows that the status of people's perception about the income in their income after MHP. Out of total 95 respondents highest proportion i.e. 58 (61.05%) reported that their family income has partially increased. Among 95 respondents only 10 (10.53%) respondents reported their family income is in neutral situation. 27 (28.42%) respondents reported that their income has fully increased after MHP.

### 4.2.4 Agriculture Product Promotion due to MHP

In our country more than 80 percent people are involved in agriculture. This study area being the village, 100 percent people here adopt the agriculture but not fully dependent on that. Around 73.68 percent people have not been sufficient to raise their product directly and indirectly after MHP. The people perception about agriculture product is presented below.

**Table 4.4**

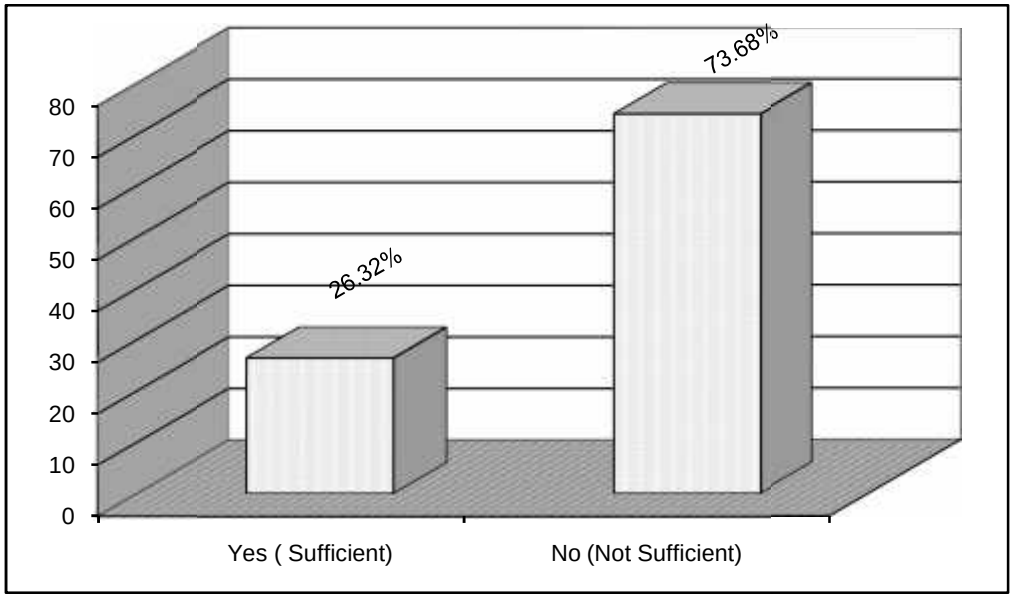
**Agriculture Product Promotion due to MHP**

| Status | Number | Percent |
|---|---|---|
| Yes ( Sufficient) | 25 | 26.32 |
| No (Not Sufficient) | 70 | 73.68 |
| Total | 95 | 100.00 |

*Source: Field Survey, 2011*

**Figure 4.4**

**Agriculture Product Promotion due to MHP**




The table and figure shows that maximum proportion i.e. 70 (73.68%) out of 95 respondents reported that they are unable to meet their annual

agriculture product promotion. Remaining 25 (26.32%) respondents reported they are able to meet their agriculture product promotion due to MHP.

To sum up Dalit and Janajati are known as backward and indigenous. So they have not proper land for cropping and livestock and unable to meet their basic need as well as annual food demand. Those people who has medium level land and other grassy land they are able to promote agriculture product.

### 4.2.5 Status of Sanitation

People must be care about indoor and outdoor sanitation. In the negligence of sanitation there may happen different kinds of problems. Human health has been risky without sanitation. It is hoped that people would be able to get awareness and sensitive about sanitation after using modern technology. During the survey time of this project the village reform committee has lunched the awareness programs about sanitation in the village and every household had compulsion to build toilet. Electricity is also known as modern technology therefore it is attempted to find out the status of sanitation after electricity in the study area.

**Table 4.5**

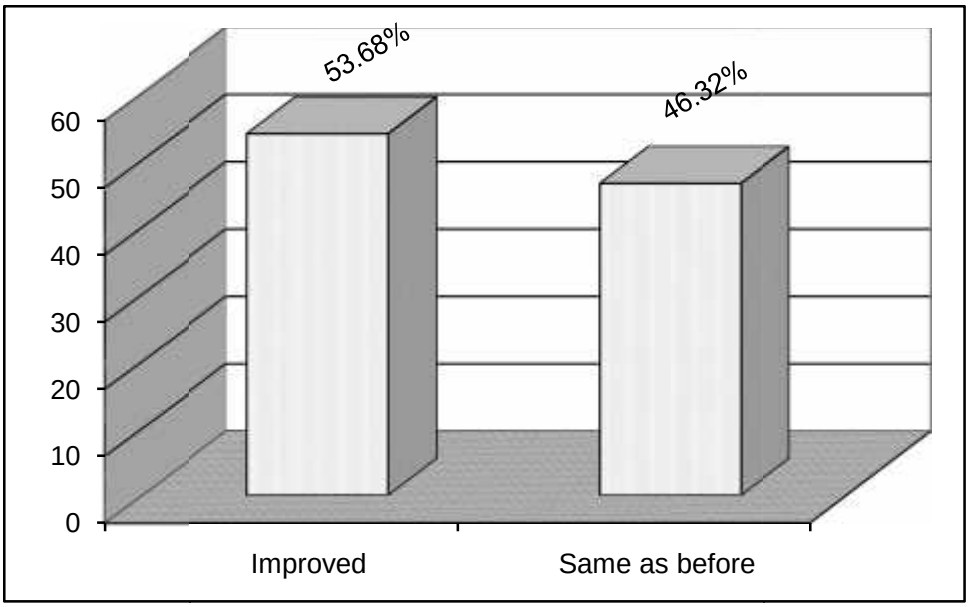
**Status of Sanitation after Electricity**

| Status | Number | Percent |
|---|---|---|
| Improved | 51 | 53.68 |
| Same as before | 44 | 46.32 |
| Total | 95 | 100.00 |

*Source: Field Survey, 2011*

**Figure 4.5**

**Status of Sanitation after Electricity**




The table and figure shows the status of sanitation after electricity with reference to environmental impact. Out of 95 respondents maximum proportion i.e. 51 (53.68%) reported the sanitation is improved. Remaining 44 (46.32%) reported there is not any change occurred in sanitation after electricity i.e. same as before.

To sum up, who have proper knowledge that what is the use of electricity those people changed their behavior and cared about indoor and outdoor sanitation? It is proved that most of the negligence about sanitation happened at the time of night. But after electricity people have been using the lighting time to remove the pollution.

### 4.2.6 Effect in Drinking Water

Some of the constructions may effects on different sectors. Electricity is nearest to water therefore, it may affects on drinking water in some places but not everywhere. This table 4.6 presents the situation that what is the effect of projects in drinking water supply.

**Table 4.6**

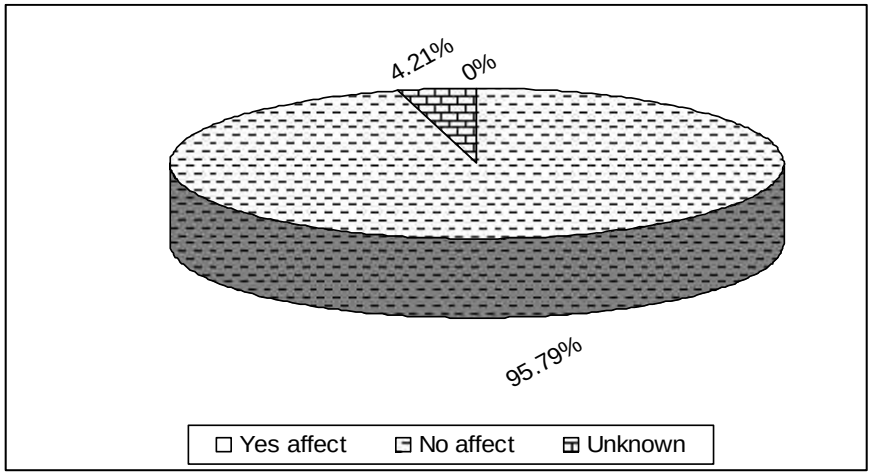
**Effect of Project in Drinking Water Supply**

| Effect | Number | Percent |
|---|---|---|
| Yes affect | 0 | 0 |
| No affect | 91 | 95.79 |
| Unknown | 4 | 4.21 |
| Total | 95 | 100.00 |

*Source: Field Survey, 2011*

**Figure 4.6**

**Effect of Project in Drinking Water Supply**




Out of the total 95 respondents, maximum proportion i.e. 91(95.79%) reported that the project has not affected on drinking water. Only 4 (4.21%) respondents reported that he is unknown about any kinds of effect. Nobody told whether the project affected on drinking water. In addition, it can be proved that the main origin of MHP water and drinking water are in different places.

## 4.2.7 Establishment of Industries

Electricity is main foundation of any kinds of industries. Without electricity no one industries can be conducted. The life is very difficult as well as being backward due to able to use modern technology in the absence of

power. After MHP, people lunched various industries in this study area, which help to raise the income level of the people as well as make the villagers way of living much easier. The firms that lunched after NHP in study area. Although the MHP is known as small scale but it is attempted to find out that what types of industries are there established ?

**Table 4.7**

**Establishment of Industries after Electricity**

| Firms | No. of Industries/Firms |
|---|---|
| Poultry Firm | 2 |
| Knitting Industries | 10 |
| Furniture | 5 |
| Sawmill | 1 |
| Agro mill | 4 |
| Computer Institute | 4 |
| Press | 2 |
| Motor workshop | 1 |
| Total | 29 |

*Source: Field Survey, 2011*

The table 4.7 shows that people installed 29 small industries/firms/institutes where around 42 people have partially/fully job. The people's life becomes easier after installed agro mill and able to generate income from these firms. Students have gain computer knowledge from the computer institutes. People are using different kinds of instruments of wood in various uses from furniture industries. The others business such as food shop, stationary, medical and photo studio has been run which generate the income as well as make the social life easy too.

### 4.2.8 Status of Education

Nepal is stated is second position with reference to water resource in the world. Most of the rural areas of Nepal have been dark at the night. People have been using kerosene and burning firewood for light. By this situation schooling aged generation is mostly affected. It is attempted to find out in the table and figure what is the status of student's education after electricity?

#### 4.2.8.1 Effects on Children Study Habits after Electricity

After MHP the study habits of children have raised. 97% households are agreed that the performance of the children has improved in the school than before. In the rural sector, in the absence of electricity, the students (children) are obliged to use kerosene lamp while studying in evening and night time by this situation schooling, aged generation is mostly affected. They cannot study for long time due to the deficiency of enough kerosene and deem light.

**Table 4.8**

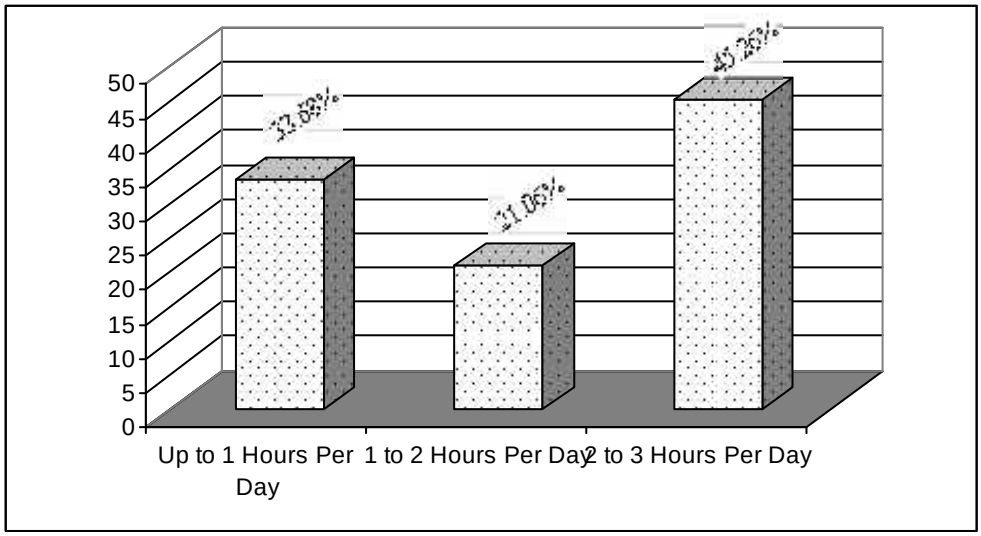
**Effects on Children Study Habits after Electricity**

| Increased Hours | Number | Percent |
|---|---|---|
| Up to 1 Hours Per Day | 32 | 33.68 |
| 1 to 2 Hours Per Day | 20 | 21.06 |
| 2 to 3 Hours Per Day | 43 | 45.26 |
| Total | 95 | 100.00 |

*Source: Field Survey, 2011*

**Figure 4.7**

**Effects on Children Study Habits after Electricity**




Out of the total 95 sample, 43 (45.26%) households children raised their study time 2 to 3 hours, 20 (21.26%) households children raised 1 to 2 hours and 32 (33.68%) households children raised up to 1 hours only. Hence most of the guardian of schooling children found that their children have been studying at the night time using electricity by this situation, it can be said that most of the student's educational status is improved after electricity.

### 4.2.8.2 Change in Children's Daily Activities Using Electronic Instruments (TV/Radio/Computer)

The uses of electrical instruments have caused multiple changes on children's behaviors. Almost all the children of the project affected areas got positive changes and learn many things by watching TV or using computer some negative outcomes such as watching TV for long time, play game in computer mobile etc. the table shows the improvement percentage on children activities on various aspects.

**Table 4.9**

**Change in Children's Activities Using Electronic Instruments (TV/Radio/Computer)**

| Child's Activities | Improved | | Not Improved | |
|---|---|---|---|---|
| | Number | Percent | Number | Percent |
| Talking Style | 80 | 84.21 | 15 | 15.79 |
| Dress Up | 70 | 73.68 | 25 | 26.32 |
| Sport | 67 | 70.53 | 28 | 29.47 |
| Reading Habits | 73 | 76.84 | 22 | 23.16 |
| Dance | 74 | 77.90 | 21 | 22.10 |

*Source: Field Survey, 2011*

Above the table shows the change in children's activities using electronic instruments. According to this table maximum respondents children's activities has improved after MHP. Their children's activities like talking style, dress up, sport, reading habits and dance are improved before than.

### 4.2.9 Condition of Environmental Pollution in the Constructed Area after MHP

There are seems different kinds of pollution. In this study, it is attempt to find out the status of environmental pollution. Positive and negative result occurs after every change but in the study area disadvantages must be dominated by advantages. Therefore, we can conclude that there is not bad environmental pollution in study area. Is there seen any kinds of pollution after MHP plant? If so what kinds of pollution have occurred? The table 4.10 has shown about that.

**Table No. 4.10**

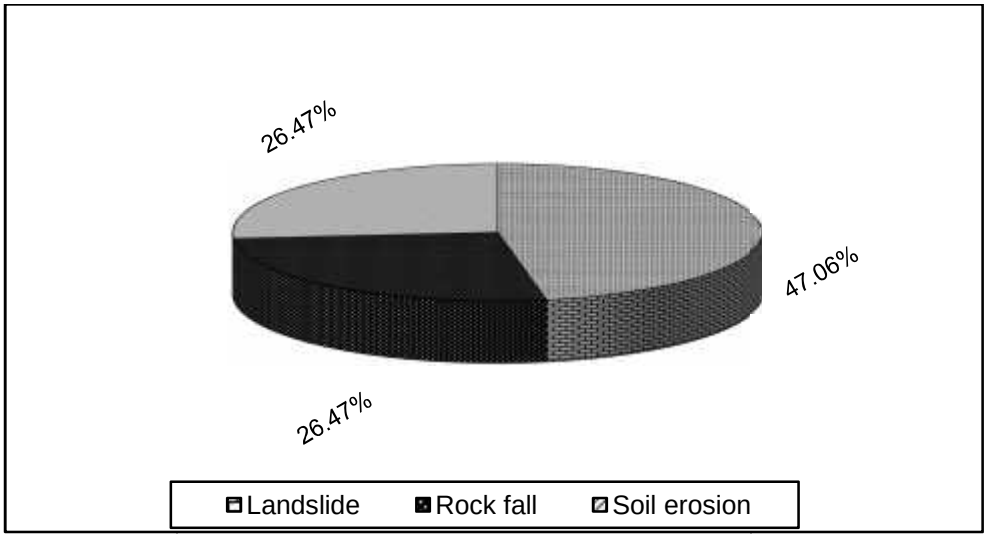
**Type of Pollution Occurred after Project**

| Type of pollution | Number | Percent |
|---|---|---|
| Landslide | 16 | 47.06 |
| Rock fall | 9 | 26.47 |
| Soil erosion | 9 | 26.47 |
| Total | 34 | 100.00 |

*Source: Field Survey, 2011*

**Figure 4.8**

**Type of Pollution Occurred after Project**




Out of 95 total respondents only 34 respondents reported that there is environmental pollution after the project. The researcher asked them what kinds of pollution occurred after the project. Out of 34 respondents maximum proportion i.e. 16 (47.06%) respondents reported landslide occurred in the place, 9 i.e. (26.47%) respondents reported rock fall and 9 (26.47%) respondents reported soil erosion occurred after the project. To sum up, there is minor environmental pollution occurred after the MHP plant.

## 4.2.10 Trend of Migration

Naturally people want many more facilities and easy living, where the availability of services people wants to move there from another places. There is two factors of migration, those are pull factors attracts the people and push factor push the people from origin. Electricity is one of the important pull factors in urban areas. To find out the such types of situation. The table 4.11 presents the migration trend after the MHP implementation in the study area.

**Table No. 4.11**

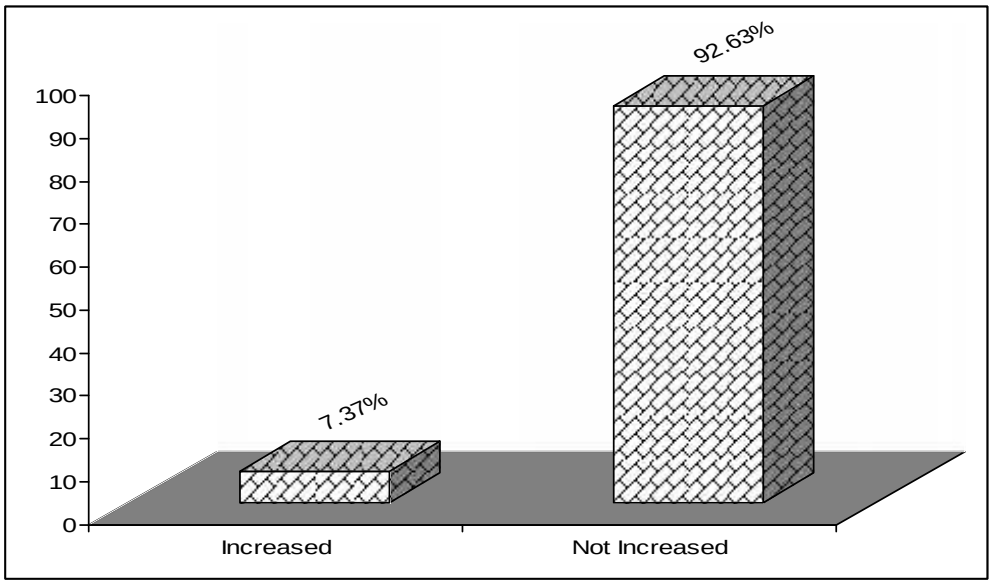
**Trend of Migration after Project**

| Trend | Number | percent |
|---|---|---|
| Increased | 7 | 7.37 |
| Not Increased | 88 | 92.63 |
| Total | 95 | 100.00 |

*Source: Field Survey, 2011*

**Figure 4.9**

**Trend of Migration after Project**




Out of 95 respondents i.e. 88 respondents, maximum proportion 88 i.e. (92.63%) respondents reported that there are not increased migration in their

area. Remaining only 7 i.e. (7.37%) respondents reported that there are increased migration. In addition, the MHP is implemented in rural area; but also there is chance of immigration and emigration in district headquarters.

## 4.3 Attitude of Community towards MHP

The chapter is divided into three sections according to objectives. In this sub-chapter or section it is attempted to find out the thinking, feeling and vision of the community towards MHP. What kinds of mind making with respondents for MHP related data are tabulated and analyzed?

### 4.3.1 Social and Cultural Effect

The invention of new technology can effect directly and indirectly in different sectors. The electricity is also knows as modern technology in rural areas of Nepal. The table 4.12 and 4.13 presents the effect of plant and factors affected by MHP in social and cultural properties.

**Table 4.12**

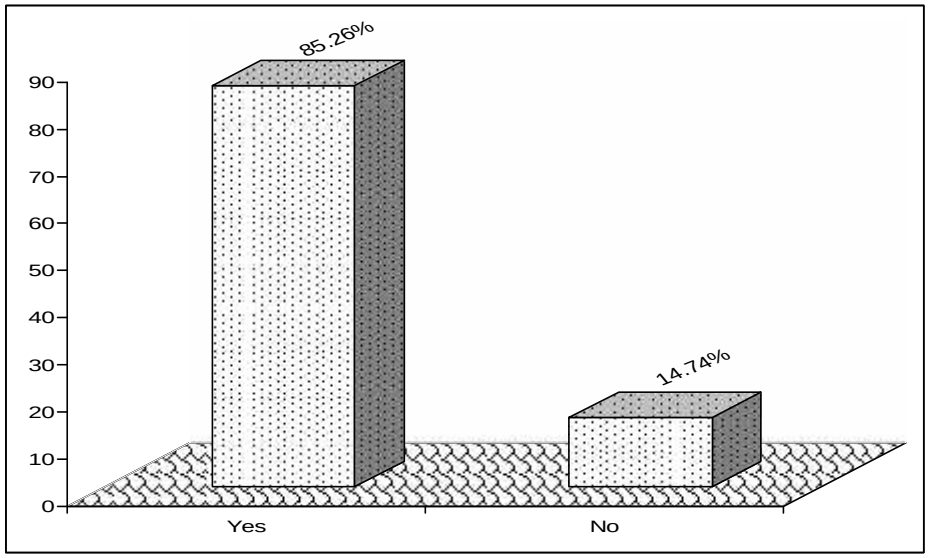
**Effect of Plant in Social and Culture Properties**

| Effect | Number | percent |
|---|---|---|
| Yes | 81 | 85.26 |
| No | 14 | 14.74 |
| Total | 95 | 100.00 |

*Source: Field Survey, 2011*

**Figure 4.10**

**Effect of Plant and Culture Properties**




Among the total 95 respondents highest proportion i.e. 81 (85.26%) respondents reported that the plant affected in social and cultural properties. Likewise among 95 respondents lowest proportion i.e. 14.

In addition modern services directly and indirectly affects in traditional attitudes, eating, speaking, clothing and behavior. So, MHP has also affected in social and cultural properties

**Table No. 4.13**

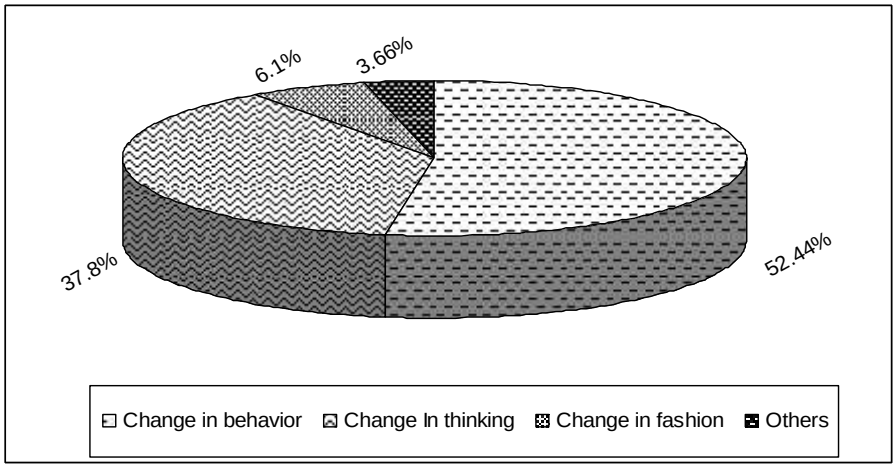
**Factor Affected by project**

| Factors | Number | Percent |
|---|---|---|
| Change in behavior | 43 | 52.44 |
| Change in thinking | 31 | 37.80 |
| Change in fashion | 5 | 6.10 |
| Others | 3 | 3.66 |
| Total | 82 | 100.00 |

*Source: Field Survey, 2011*

**Figure No. 4.11**

**Factor Affected by project**




The table and figure represents the respondent's attitudes towards project, so it is attempted to find out the factors affected by the MHP. Of the total 95 respondents 82 reported the project can affects the social and cultural properties, therefore the question is asked for them what are the factors affected by the plant? In this question among the total 82 respondents, highest proportion i.e.43 (52.44%) reported change in behavior. Lowest proportion i.e. 3 (3.66%) reported in other factors. Likewise change in thinking constitute 31 (37.80%) change in fashion, 5 (6.10%) respectively.

To sum up, when electricity facility is available there increases the use of audio and video visual media. By those types of media new generation can imitate or copy of every things that they have heard or saw. So it is proved that projects has affected in social and cultural properties.

### 4.3.2 Feeling/Concept of People towards MHP

Feeling or concept refers the any kinds of response towards and things. People have either satisfaction of dissatisfaction toward electricity. What they have been feeling after MHP established. There is not worth of construction in the absence of sustainability. For this purpose this part of chapter includes the ways of sustainability of MHP also in study area. What kinds of methods and

ways should be implemented for maintenance, which must be responsible for operation and maintenance? It is attempted to find out that what is the feeling of people towards electricity in the study area.

**Table 4.14**

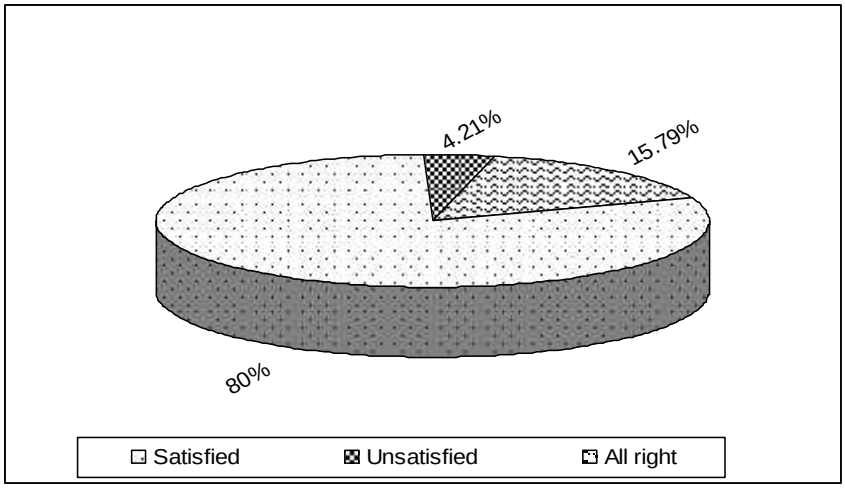
**Feeling of people towards Electricity**

| Feeling | Number | percent |
|---|---|---|
| Satisfied | 76 | 80.00 |
| Unsatisfied | 4 | 4.21 |
| All right | 15 | 15.79 |
| Total | 95 | 100.00 |

*Source: Field Survey, 2011*

**Figure No. 4.12**

**Feeling of People towards Electricity**




Among total 95 respondents highest proportion i.e.76 (80%) reported that they are satisfied by electricity service. The lowest proportion i.e. only 4 (4.21%) respondents reported they are unsatisfied and remaining 15 (15.79%) respondents reported all right.

In addition electricity facility is closely related with human life. It is not only necessary in day time, but also in night time. Electricity made the human

life easier and comfortable. It is also able to make the whole world as a one star. In rural area electricity is a strange thing. So, most of the respondents are satisfied by electricity.

### 4.3.3 Interest of Loan

There is need of loan for the completion of any kinds of project. For this MHP plant people have taken the private loan. It is attempted to find out the respondent's feeling about the interest rate of the loan high low, or medium. What's they have feeling (Table 4.15).

**Table 4.15**

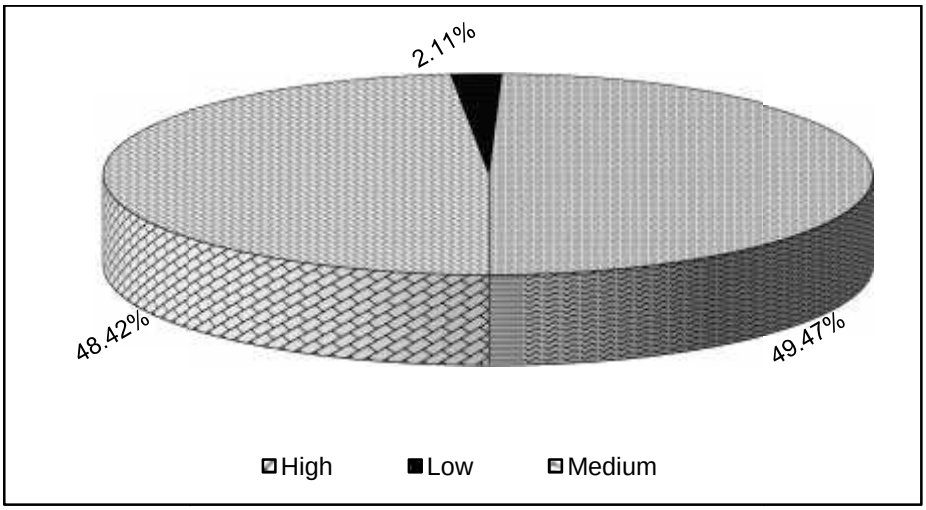
**Feeling of Respondents towards Interest Rate of the Loan**

| Feeling | Number | percent |
|---|---|---|
| High | 46 | 48.42 |
| Low | 2 | 2.11 |
| Medium | 47 | 49.47 |
| Total | 95 | 100.00 |

*Source: Field Survey, 2011*

**Figure 4.13**

**Feeling of Respondents towards Interest Rate of the Loan**



The table shows the feeling of respondents towards interest rate of the loan, which they have taken for MHP. Among the total 95 respondents highest proportion i.e. 47 (49.47%) reported that the interest rate is medium. Only 2 (2.11%) respondents reported the low and remaining 46 (48.42%) respondent reported the interest rate of the loan is high.

In addition the entire user group has taken private loan to conduct MHP. Most of the people have known that as medium because the rate is monthly 3 percent.

### 4.3.4 Operation Schedule

A clothes needs to be washed, houses needs to be colored and so many things needs repairing and maintenance. So that there is necessity of operation schedule in powerhouse. It is attempted to find out that either there is operation schedule or not, regular or irregular schedule have been practiced.

**Table 4.16**

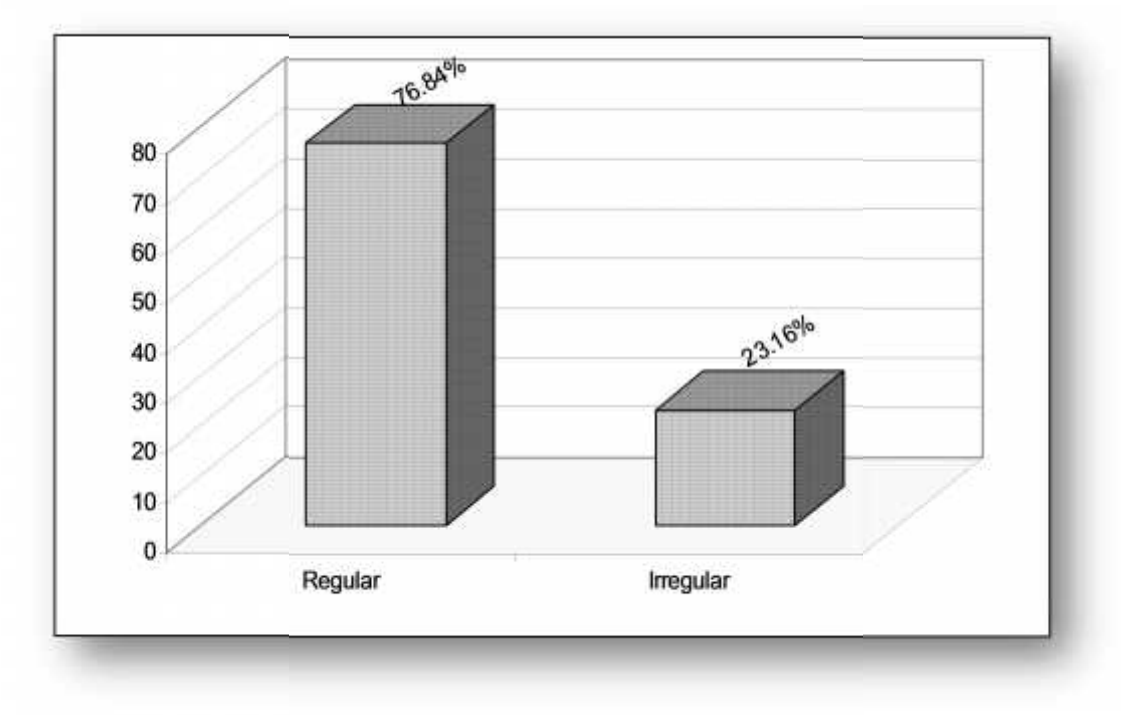
**Status of Operation Schedule in Power Houses**

| Operation schedule | Number | percent |
|---|---|---|
| Regular | 73 | 76.84 |
| Irregular | 22 | 23.16 |
| Total | 95 | 100.00 |

*Source: Field Survey, 2011*

**Figure 4.14**

**Status of Operation Schedule in Power House**




The table and figure shows that the statuses of operation schedule in powerhouse. Among the total 95 respondents highest proportion i.e. 73 (76.84%) respondents reported that there is regular operation schedule in powerhouse and remaining only 22 (23.16%) respondents reported there is not regular operation schedule in powerhouse.

To sum up, it is known that repairing and maintenance is necessary every- non-living things. So, MHP must need repair and maintenance. That makes things sustainable. Most of the people are known about operation schedule and least people unknown about that.

### 4.3.5 Peoples' Responsibility

Responsibility is also known as accountability. Everything needs maintenance. For this purpose someone must be responsible. In this study it is attempted to find out who is responsible for maintenance, what is the concept of people?

**Table No. 4.17**

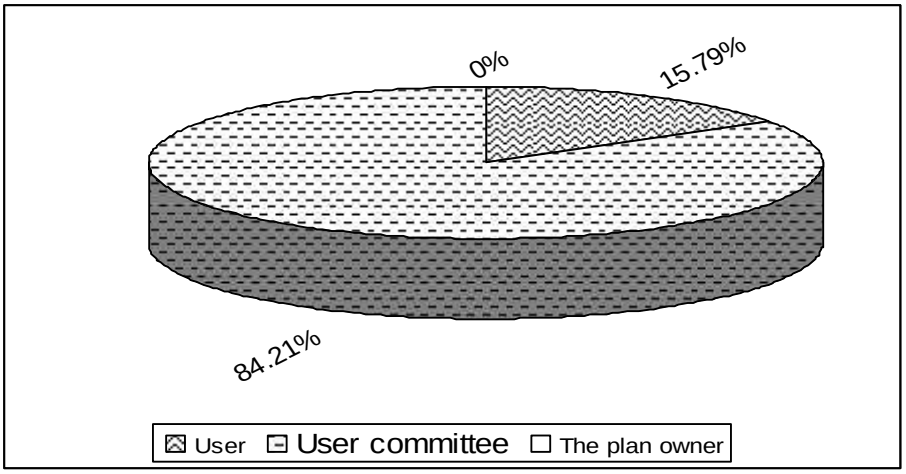
**Concept of People towards Maintenance responsibility**

| Responsibility | Number | percent |
|---|---|---|
| User | 15 | 15.79 |
| User committee | 80 | 84.21 |
| The plan owner | 0 | 0.00 |
| Total | 95 | 100.00 |

*Source: Field Survey, 2011*

**Figure 4.15**

**Concept of People towards Maintenance Responsibility**




The table presents the concept of people towards maintenance responsibility. Among 95 respondent highest proportions i.e. 80 (84.21%) respondent reported the maintenance responsibility goes to user committee and remaining 15 (15.79%) reported on the favor of users. Nobody reported on the plant owner.

To sum up it is known that “it take to makes a quarrel” therefore user community and a kind of committee organized by selected people must take such responsibility.

### 4.3.6 Women's Participation

Women are backward in our society with reference to every issue. They have not courage and proper knowledge about every subject matter. Men and women are known as two cards of a wheel but it is limited only in saying not in reality. It is attempted to find out the status of women's participation in maintenance and use of electricity by a question high, low of zero.

**Table 4.18**

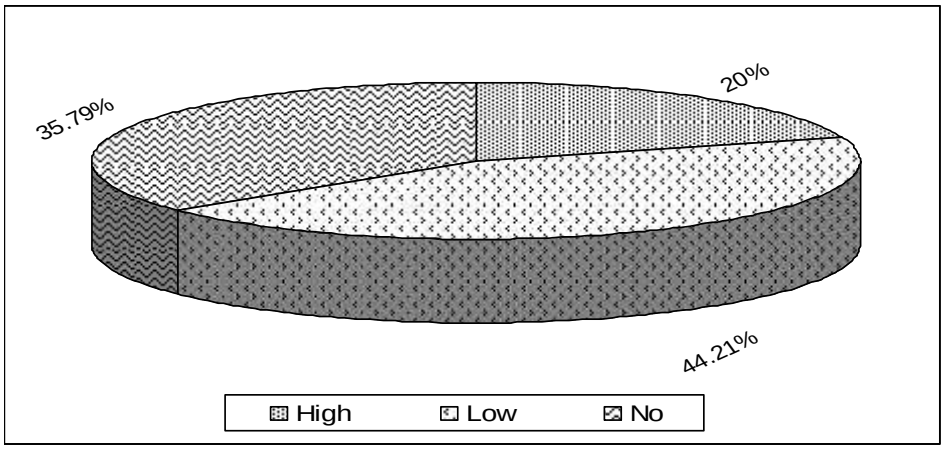
**Status of Women's Participation in Maintenance and Use of Electricity**

| Status | Number | percent |
|---|---|---|
| High | 19 | 20.00 |
| Low | 42 | 44.21 |
| No | 34 | 35.79 |
| Total | 95 | 100.00 |

*Source: Field Survey, 2011*

**Figure 4.16**

**Status of Women's Participation in Maintenance and Use of Electricity**




The table and figure shows that status of women participation in maintenance and use of electricity. Out of the total 95 respondents highest

proportion i.e.42 (44.21%) reported that women's participation is low in maintenance and use of electricity. Likewise lowest proportion 19 (20%) reported high and remaining 34 (35.79%) reported there is not women's participation in maintenance and use of electricity.

To sum up it is known that "Men and women are two cards of wheel." So equal opportunity and participation is necessary in maintenance and use of electricity. Due to lack of awareness and traditional thinking women's participation is constituted low proportion.

# CHAPTER-V

# SUMMARY, CONCLUSION ANDRECOMMENDATIONS

## 5.1 Summary

Hydropower as a non- polluting environmentally friendly, renewable, locally available and reliable source of energy that needs to be exploited to the fullest extent possible, to meet national energy objectives in the Nepal context. Due to the unique operating characteristic of hydropower plants, reliability and social development, a dependable supply of electricity is a necessity. In a country where (apart from hydropower) other energy resources of an economically exploitable scale are not available, hydropower development is an important mean to provide reliable and affordable electricity. Electrification may not be a big problem where the national grid can be extended economically. In very remote areas, however, where the national grid cannot be extended in the near future due to economic reasons, a group of interconnected mini-hydropower plants seems to be a viable proposition for the total electrification of the country. For this purpose, project sites, target areas and load centers should be carefully selected and implemented. Over the long run, local grids can be connected to the national grid system and the system can function economically and reliably. With its limited technical ability and financial resources, Nepal alone is not a good position to construct mini-scale hydropower plants and establish local grids in all remote hilly areas of Nepal. Hence, the government of Nepal should create a conducive environment for foreign assistance and should request development countries of the world to offset investment under carbon swaps and clean development mechanisms.

Nepal has more than 90 years of experience in the field of mini- scale hydropower development. Many success and failure stories have happened during this period. Many governmental, non-governmental and private agencies are involved in the field of mini/micro hydropower development, including

almost two dozen manufacturers/installers and equal number of specialized consulting agencies.

This study attempts to show about hydropower potentiality and its present status in Nepal. It also analyzes impacts of Thotnekhola on socio-economic condition and attitude of people towards this mini hydropower in the study area around the project.

Nepal has occupied the second position in the field of the water resource in the world. The feasibility is shown there may be possibility of 83000 MW electricity but nowadays load shading is known as burning issue in Nepal. In this complex context lower power MHP may be note worthy in the rural areas of Nepal. Potentiality and present status of hydropower in Nepal has shown in this study. Thus the Thotnekhola MHP is known as an innovative attempt by a courageous. This has brought noteworthy modification on the rural society. This is a descriptive study designed to find out the socio-economic impact of mini-hydropower project of Thotnekhola of Okhaldhunga district.

For this proposes different chapters are included in the study. First chapter includes background, statement of problem, objectives of the study, significance of the study, research methodology, and limitation of the study. Chapter two includes the literature review. Chapter three includes theoretical, technical and economical potentiality and present status of hydropower in Nepal. Chapter four includes data analysis and major finding to study's area and at last chapter five includes summary, conclusion and recommendations and suggestions.

Nepal has great potentiality of hydropower. The theoretical potentiality of hydropower is estimated to be 83,290 MW on the basis of hydrology and topography the technical hydropower potential is accounted 45,520 MW and the economically exploitable capacity of the kingdom, however, is 42, 133 MW.

The hydropower development in Nepal has long history starting from the local water mill known as Ghatta. the first hydropower plant was Pharping hydro project (500KW) which was built in 1911 A.D

144 hydropower plants are in operation for the providing electricity.

7o1.52 MW hydro electricity is generated from different kind of power scale.

580 MW, 104 MW, 15.243 MW (15243 KW) and 1.477 MW (1477 KW) hydro electricity is generated from large scale hydropower plants, small hydropower plants, mini hydropower plants and micro hydropower plants respectively.

This study based on socio-economic impact of Thotnekhola MHP, interview method among 95 respondents. Those respondents were selected by random selection.

Proportion of Janajati is found highest (i.e. 71.58%) in study area and lowest proportion of respondents found in Dalit i.e. (10.52%).

The living standard of all respondents (i.e. 100%) has changed after electricity.

28.42 percent respondents reported that their income fully increased after MHP.

26.32 percent respondents able to promote their agriculture production due to MHP.

The highest percentage of respondents (i.e. 53.68%) reported the sanitation situation is improved.

Maximum percentage of respondents (i.e. 95.79%) reported the MHP has not affected the drinking water.

29 industries has been established in the study area of the Thotnekhola MHP.

Most of the student's educational status is improved after electricity.

There is minor environmental pollution occurred after the MHP.

92.63 percent respondents reported that there is not increased migration in their area.

The highest percentage of respondent (i.e. 85.26%) reported that the MHP affected the social and cultural properties.

Majority of the respondents (i.e.76.84%) reported there is regular operation schedule in powerhouse.

Most of the respondents (i.e. 44.21%) reported there is low participation of women in maintenance and use of electricity.

## 5.2 Conclusion

Lower scale MHP may be most useful in rural and remote areas. There is sufficient feasibility of such types of lower scale MHP, but neither government nor private sector's vision goes there. The conclusion of the study area as follows.

The demand for electricity is higher in comparison to the generated capacity.

Okhalkhunga district is known as main place of Janajati. Therefore, most of the respondents found Janajatis (Rai, Sunuwar, Newar, Magar, Gurung, Tamang and Sherpa) which are listed in Janajati.

Electricity is the closely related with human life therefore all respondent's living standard have been changed after MHP.

After electricity facility most of the respondent's family income is increased.

In rural areas, farming and keeping livestock is main occupation but the respondents have not able to meet their annual food needs by that occupation.

The status of sanitation is improved after electricity facility.

Before electrical facility people have been using he flaming firewood and kerosene at the night, after electricity they are reduced such types of materials, so positive impact is found in human health. Most of the respondents are satisfied by MHP.

Electricity is major foundation of industrialization, so there are some small and domestic industries is established.

The origin of drinking water and MHP used water is in difference places. So the project has not affected in drinking water.

After electrical facility, students have been using evening time for study therefore it is found that study habits of students have improved. And their educational activities also positively changed.

Major environmental pollution has not seen after MHP but minor pollution has found.

The MHP is known as lower scale plan and established in rural hilly area, therefore there is neither immigration nor emigration trend.

Respondents has started to use audio and audio-visual materials, therefore plant has effected on social and cultural properties like change in behavior, changing in clothing and thinking.

To build the MHP sustainable, repair, maintenance and operation schedule should be necessary therefore there is operation schedule in powerhouse. For these propose user committee is fully responsible.

Men and women are known as two cards of a wheel but in rural and remote area of Nepal the statement is limited in saying. In some place there is zero participation and some places lower participation of women found in maintenance and using electricity.

## 5.3 Recommendations and suggestions

Electricity generation is an important part of the infrastructure development of any country. A conductive national strategy must be lunched to enhance and accelerate the electricity generation. So as to meet the yearly demand and then after export the surplus energy to neighboring countries, which would uplift the economy of the country in the long-run. India needs 20000 MW of energy at present and the demand may increase future in future. In such a scenario, a national strategy must be set up for the hydropower development of our country. Bhutan exports 1500 MW to India which has led a faster growth of economy of that country. Similarly Laos exports electricity to Thailand which s also contributing lot the economy of that country. In this way many countries are exploiting their water resources and exporting electricity to other countries this has certainly boosted their economy. Nepal also must follow this path. According to World Bank Report, Nepal can earn 4 to 6 billion US dollars by exporting electricity to other countries if laws, rules and regulations must not be clumsy and complicated. They must simple and mainly development oriented. The government policies must be consistent and should not be changed frequently. In recent years some IPPs (independent power

producers) are also taking interest in this sector. It is very disgusting and appalling that some entrepreneurs are just holding the survey license of hydropower projects since many years and the development process have been stagnant. In such cases the government of Nepal must have stringent rules and regulations and must cancel those licenses after the expiry of time limitations. Such practices must be allured to invest by simplifying the necessary laws, rules and regulations.

It is already known that electricity is not only night partner of human being but also a 24 hours close friend. The electricity is able to make unification of the all nations of the world. Nepal is second rich country in the world with respect to water resources, but people of the rural area always have been living in dark not only at nighttime but also in day. People are far away from modern technology. Nowadays the most of the urban area, which are known as facilitated, have compulsions of load shading. This complex issue has become the headache of governor and common people.

Due to this conclusion the lower scale MHP is relevance in remote and hilly areas. The following recommendations are presented.

Electrical energy must be established as fundamental and basic needs of human being.

Nepal is rich in water resource but there is not specific vision and policy of state. Therefore the government should formulate and implement the proper policy.

Government should emphasize the development of infrastructures in remote, hilly and mountains districts like the Okhaldhunga which support the development of hydropower.

Government is frosted and quiet in the sector of small as well as large scale MHP. Government should increase the amount of subsidy for this projects.

The government in the sector of electricity should conduct feasibility survey.

The multipurpose hydropower project should be installed to promote industries especially cottage and small scale industries and irrigation facilities.

Priority should be given for the development of mini, micro and small hydropower project because it helps to reduce regional imbalance of development, meet the local and national demand for electricity and implement, large scale project as export oriented project.

A portion of project's revenue should be invested to lunch various programs for raising the living standard of the people.

Income generation programs should be launched by project in the study area.

Efficient plants and equipment like that Thotnekhola MHP should be used in hydropower project, which may help to generating power at low cost.

Mini hydropower project should be installed in rural, isolated and hilly areas.

Technology promotion and entrepreneurial development programs should be organized.

The subsidy program encourages the development of MHP system. Government has done rights things by providing.

Strong financial agencies should be established to facilitate the investment on the development of small hydropower.

The environmental friendly, technically feasible and economically profitable hydropower plants should be installed.

The private sector should be encouraged to develop hydropower specially small and mini/micro hydropower projects.

The clear and supportive policy and programs ought to be developed and implemented in various regions of the country.

Participatory approach should be adopted to involve local people in the development activities as far as possible.

Community must be sensitive to demand necessary facilities.

In every opportunity preference should be given to the local people.

Local people should be also ready and conscious to help the upcoming projects and program and grab advantages.

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# APPENDIX-I

**Large Scale Hydropower Project**

| S. No. | Power plants | Capacity (MW) |
|---|---|---|
| 1 | Kaligandaki A | 144 |
| 2 | Middle Marsyangdi | 70 |
| 3 | Marsyangdi | 69 |
| 4 | Trisuli | 24 |
| 5 | Sunkoshi | 10 |
| 6 | Gandak | 15 |
| 7 | Khulekhani I | 60 |
| 8 | Devighat | 14 |
| 9 | Khulekhani II | 32 |
| 10 | ModiKhola | 14.8 |
| 11 | Jhimruk (Piuthan) | 12 |
| 12 | Khimti (Dolakha) | 60 |
| 13 | Bhotekoshi | 36 |
| 14 | Chilime | 20 |
| | Total | 580.8 |

*Sources: NEA, a year in review-FY 2012/13*

**Small Scale Hydropower Projects**

| **S. N.** | **Plants** | **Capacity (MW)** |
|---|---|---|
| 1 | PuwaKhola | 6.2 |
| 2 | Andhikhola (Syanza) | 5 |
| 3 | Indrawati (Sindhupalchok) | 7.5 |
| 4 | Piluwa (Sankhuwasava) | 3 |
| 5 | Sunkoshi | 2.6 |
| 6 | ChakuKhola | 1.5 |
| 7 | Panauti | 2.4 |
| 8 | Chatara | 3.2 |
| 9 | Seti I (Kaski) | 1.5 |
| 10 | Fewa | 1 |
| 11 | Tinau | 1 |
| 12 | Tatopani | 2 |
| 13 | Sunkoshikhola (Sindhupalchok) | 2.5 |
| 14 | Khudikhola (Lamjung) | 3.45 |
| 15 | Baramchikhola | 4.2 |
| 16 | Thoppalkhola (Dhading) | 1.6 |
| 17 | Ridikhola (Gulmi) | 2.4 |
| 18 | Mardi khola (Kaski) | 4.8 |
| 19 | Mai khola (Ilam) | 4.5 |
| 20 | Hewakhola ( | 4.45 |

| | | |
|---|---|---|
| | Sankhuwasava) | |
| 21 | Siurikhola | 4.95 |
| 22 | Lower Modi (Parbat) | 9.90 |
| 23 | Bijayapur I (Kaski) | 4.40 |
| 24 | Sipringkhola (Dolakha) | 9.65 |
| 25 | Tadikhola | 5 |
| 26 | Middle Chaku | 1.8 |
| 27 | Charnawotikhola (Dolakha) | 3.5 |
| | Total | 104 |

*Sources: NEA, a year in review-FY 2012/13*

**Mini Hydropower Projects**

| **S.N.** | **Plants** | **Capacity (KW)** |
|---|---|---|
| 1 | Sundarijal | 640 |
| 2 | Pharping | 500 |
| 3 | Jomsom | 240 |
| 4 | Baglung | 200 |
| 5 | Khadbari | 250 |
| 6 | Phidim | 200 |
| 7 | Surnaiyagad | 200 |
| 8 | Doti | 200 |
| 9 | Ramechhap | 150 |
| 10 | Terhathum | 100 |
| 11 | Gamgad | 400 |
| 12 | Dhankuta | 240 |
| 13 | Jhupra (Surkhet) | 345 |
| 14 | Jumla | 200 |
| 15 | Darchula | 300 |
| 16 | Taplejung | 125 |
| 17 | Chaurijhari | 150 |
| 18 | Syaprudaha | 200 |
| 19 | Pikhuwa (Bhojpur) | 250 |
| 20 | Bajura | 200 |
| 21 | Bajhang | 200 |
| 22 | Arughat (Gorkha) | 150 |
| 23 | Thotnekhola | 125 |
| 24 | Rupalgad(Dadeldhura) | 100 |
| 25 | Achham | 400 |
| 26 | Dolpa | 200 |
| 27 | Kalikot | 500 |
| 28 | Heldung (Humal) | 500 |
| 29 | Rairangkhola | 500 |
| 30 | Sisnekhola | 750 |
| 31 | SaliNadi (Kathmandu) | 332 |
| 32 | Phemekhola | 995 |
| 33 | Patikhola | 996 |

| | | |
|---|---|---|
| 34 | Seti II | 979 |
| 35 | Upper Hadikhola | 991 |
| 36 | Lower Piluwa | 990 |
| 37 | Jhankre Mini Hydropower | 510 |
| 38 | Syange | 185 |
| 39 | Ganesh Himal Project | 150 |
| 40 | Nipo Power Plants | 500 |
| 41 | Ratmoli and Satteshwar | 100 |
| | Total | 15243 (15.243MW) |

*Sources: NEA, a year in review-FY 2012/13*

**Micro Hydropower Projects**

| **S. N.** | **Power Plants** | **Capacity( KW)** |
|---|---|---|
| 1 | Gorkhe (Ilam) | 64 |
| 2 | Dhading | 32 |
| 3 | Syangja | 80 |
| 4 | Helambu | 50 |
| 5 | Chame | 45 |
| 6 | Manang | 80 |
| 7 | Khaping MHP | 8 |
| 8 | Nuplung MHP | 5 |
| 9 | Chulepu MHP | 24 |
| 10 | Lili MHP | 35 |
| 11 | Priti MHP and Kanasthali MHP | 35 |
| 12 | Solukhola MHP | 50 |
| 13 | Thunglung MHP | 15 |
| 14 | Kanolg Gad, Karmi II and Dogti | 40, 80 & 50 |
| 15 | Daramiji, Jingamali and Patlekharka | 20 |
| 16 | Kaduri MHP, Pokhara | 23 |
| 17 | Nyshar MHP | 30 |
| 18 | Nylam MHP | 20 |
| 19 | Helambu MHPP | 40 |
| 20 | Shriantu, Ilam | 16 |
| 21 | KTS, Jumla | 24 |
| 22 | Badagaun, Gulmi | 5 |
| 23 | Ghandruk MHP | 50 |
| 24 | Kotiala, Baitadi | 12 |
| 25 | Jhupal, Dolpa | 20 |
| 26 | Yanger, Humla | 25 |
| 27 | Biruwa, Syanja | 5 |
| 28 | AngahaKhola, Palpa | 5 |
| 29 | Arghakhanchi | 10 |

| | | |
|---|---|---|
| 30 | Hile, Baaglung | 25 |
| 31 | Ratna Man, Kalikot | 24 |
| 32 | Marang, Mustang | 10 |
| 33 | Lomanthang, Mustang | 36 |
| 34 | Chandra, Tanahu | 4 |
| 35 | Bhatna, Baitadi | 12 |
| 36 | Chhunup, Mustang | 12 |
| 37 | Jharkot MHPP | 36 |
| 38 | Late I, Mustang | 2 |
| 39 | Sitapur, Arghakhanchi | 6 |
| 40 | Khali Danda, Gulmi | 3 |
| 41 | Dipal, Jumla | 10 |
| 42 | Namche MHPP | 12 |
| 43 | Tamghas MHPP | 40 |
| 44 | Lorpa, Jumla | 10 |
| 45 | Khuldighar, Kaski | 2 |
| 46 | Surlichour, Rolpa | 6 |
| 47 | Barthola | 12 |
| 48 | Purtighat, Gulmi | 12 |
| 49 | Khara, Baglung | 12 |
| 50 | Bijaya Nagar, Pyuthan | 4 |
| 51 | WamiTaxar, Gulmi | 10 |
| 52 | Gorkhe, Ilam | 10 |
| 53 | Harichour, Baglung | 12 |
| 54 | Goosmili, Baglung | 3 |
| 55 | Jogbudha, Daduldhara | 6 |
| 56 | Burtibang, Baglung | 16 |
| 57 | Lai, Darchula | 10 |
| 58 | Karaputar, Lamjung | 80 |
| 59 | Kusmi Sera, Baglung | 10 |
| 60 | Hatya, Baglung | 12 |
| 61 | Khaireni MHPP | 12 |
| 62 | Turture MHPP | 8 |
| | Total Capacity | 1477KW (1.477 MW) |

*Sources: NEA, a year in review-FY 2012/13*

Considering above the tables, there are 140 hydropower plants in different areas of Nepal and total installed capacity is 701.5 MW till now. According to above table, table 3.4 presents that the total installed capacity of

large scale hydropower is 580.8 MW. Kaligandaki is largest hydropower projects among 14 projects which have 144 MW capacities. Middle marsyangdi, Marsingdi, Khulekhani I and jhimruk are main and famous hydro projects which have70 MW, 69 MW, 60MW and 12 MW capacities respectively.

Table 3.5 shows the present status of small hydropower in Nepal. There are 27 SHP (Small Hydropower Project) tabulated with their own capacity. According to various presented data 104 MW capacities have been installed from 27 hydropower projects. Lower Modi SHP have highest capacity i.e. 9.90 MW. Along with other projects Spring Khola SHP is second largest project between them, which have 9.65 MW capacities.

Then, present status of Mini hydropower has shown in table number 3.6. There are 41 mini hydro projects with 15243 KW (15.243 MW) capacities are in operation. Acording to given projects Patikhola, Phemekhola, Upper Hadikhola, Lower Piluwakhola, Seti II main mini hydro project among them. Which has 996 KW, 995 MW, 991 MW, 990 KW and 979 KW capacity respectively. Pharping is the first project in hydro electrical history of Nepal which has 500 KW capacity. Thotnekhola MHP (125 (KW) also has shown in the table.

At last, table number 3.7 shows that total micro hydropower capacity are 1477 KW (1.477 MW). 62 projects have shown with their own capacity. The given table shows that all projects are installed in rural areas of Nepal.

# ANNEX-1

# QUESTIONNAIRE

## General Information

Household No.:

Interview Date:

1. Respondent's name:

   a) Age: b) Gender: c) Village:

   d) Ward No.:

2. Number of family:

   a) Son …… b) Daughter……

   c) Other ……

3. Occupations

## Questionnaires:

1. Do you use any kinds of electronic instruments after electricity?

   a) Yes b) No

2. What is the status of your family income after having electricity?

   a) Increased b) Decreased c) No Change

3. Is the product of crops and livestock meet the annual food demand of your family?

   a) Yes b) No

4. What is his status of sanitation in the village after electricity?

   a) Improved  b) same as before

5. What kind of change occurred on your health after the project being implemented?

   a) Positive  b) Negative  c) No change

6. Is there irrigation in your farm?

   a) Ye  b) No

7. If yes, what is the status of irrigation of facilities?

   a) Regularly  b) Irregularly  c) Sometimes

8. Is the project affected to drinking water supplies?

   a) Milling  b) Furniture  c) Knitting  d) Other

9. What type of industries is installed in your area?

   a) Yes  b) No

10. Are your family employed in the industries?

    a) Yes  b) No

11. After electrification, is your children's study has increased?

    a) Improved  b) No improved  c) Unknown

12. Is there environmental pollution after this project?

    a) Yes  b) No

13. If yes, what types of pollution?

a) Landslide b) Rock fall c) Soil erosion

14. Is there any increase in migrated people after this project?

    a) Yes b) No

15. If yes how many people?

    …….

16. Has the plan affected your social and cultural properties?

    a) Yes b) No

17. If yes, in which factor is affected after project?

    a) Change fashion b) Change behavior c) Change in thinking

    d) Others ……..

18. Is there any change occurred in governmental and non-governmental sectors after established project? Yes given name.

19. What is the impact of project in infrastructural development?

    a) Positive b) Negative

    ……. ……..

    ……. ……..

    ……. ……..

    ……. ……..

20. What was the installation cost of project?

    ……..

21. How did your self-fund to install MHP?

    Rs. …….

22. How much subsidiary did you get about it?

    Rs. ……

23. Have you taken self-loan for project?

    a) Yes Rs. ……  b) No Rs. ……..

24. What do you fell about interest rate of the loan?

    a) High  b) Low  c) Medium

25. Do you have the continuous operation schedule in powerhouse?

    a) Yes  b) No

26. If no, have you done maintenance schedule?

    a) Yes  b) No

27. Who is responsible for maintenance?

    a) User  b) User committee  c) The plant owner

28. What is your feeling about the electricity facilities?

    a) Satisfied  b) Unsatisfied  c) All right

29. What is the women's participation the use of the electricity?

    a) High  b) Low  c) No change

30.What type of activities should be done for sustainability of the projection loan run term? Give option.

| Opinion | suggestion |
| --- | --- |
| a) …….. | a) …….. |
| b) …….. | b) …… |
| c) …… | c) …… |
| d) …….. | d) …….. |