

**CONTRIBUTION OF MICRO HYDRO IN PROMOTING
RURAL LIVELIHOOD**

(A Case Study of Bhalayedanda Village, Udayapur, Nepal)

A Thesis Submitted To The
The Central Department of Rural Development, Tribhuvan University
In partial fulfilment of the requirements for the degree of the
Master of Arts (M.A.)
In
Rural Development

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August, 2019

DECELERATION

I hereby declare that the thesis entitled **CONTRIBUTION OF MICRO HYDRO IN PROMOTING RURAL LIVELIHOOD: A Case Study of Bhalayedanda Village, Udayapur, Nepal** submitted to the Central Department of Rural Development, Tribhuvan University, is entirely my original work prepared under the guidance and supervision of my supervisor. I have made due acknowledgements to all ideas and information borrowed from different sources in the course of writing this thesis. The result of this thesis have not been presented or submitted anywhere else for the award of any degree or for any other purpose. I assure that no part of the content of this thesis has been published in any form before.

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Recommendation Letter

The thesis entitled **CONTRIBUTION OF MICRO HYDRO IN PROMOTING RURAL LIVELIHOOD: A Case Study of Bhalayedanda Village, Udayapur, Nepal** has been prepared by **Mr. Shaligram Kumar Shrestha** under my guidance and supervision. I hereby forward this thesis to the evaluation committee for the final evaluation and approval.

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The thesis entitled **CONTRIBUTION OF MICRO HYDRO IN PROMOTING RURAL LIVELIHOOD: A Case Study of Bhalayedanda Village, Udayapur, Nepal** has been prepared by **Mr. Shaligram Kumar Shrestha** in partial fulfillment of the requirements for the Master's degree (M.A.) in Rural Development has been evaluated and approved by the evaluation committee.

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ACKNOWLEDGEMENTS

It is a great opportunity for me to write thesis about subject "Contribution of Micro Hydro in Promoting Rural Livelihood ". I tried to collect all the relevant documents on this topic. I don't know how much I've been able to do that. There may be inconveniences, factual errors, misconceptions. I am responsible for them but I will try to do better in the future.

Without the help of some people, this thesis would not have been possible to complete and their contribution was sincerely appreciated and gratefully acknowledged. However, I want to express my deep appreciation to them.

I would like to express my special gratitude and thanks to my supervisor Prajwal Man Pradhan for his guidance, supervision and constant support. I am also grateful to all the lecturers in Department of Rural Development for their support.

I would like to express my warm appreciation to Suyog Shrestha for his co-operation and continuous support in his endeavor. I am also thankful to Suv Narayan Yadav for his kind support.

I extend my sincere thanks to Tank Shrestha, president of ward committee in study area, and Tank karki, head of the micro-hydro power committee in study area, Dinesh Khadka, teacher from Government school and other members, villagers, teachers and students who helped me to collect the information. I humbly extend my thanks to all concerned persons who co-operated with me in this regard.

Above all, I would like to thank my wife Krishna Kumari Ghimire for her personal support and great patience at all times. My special thanks go to my son Sakriya Shrestha and my daughter in law Swosti Shrestha. They all kept me going and encouraged me to complete the task.

Shaligram Kumar Shrestha

ABSTRACTS

Livelihood covers the activities necessary to protect a person's ability, wealth, income, and living needs, so it is a means of survive. A sustainable livelihood enhance people's well-being and preserve the natural environment or resource base for future generations, and it helps people recover from conflicts and stresses, such as natural disasters, and economic or social upheavals. Micro hydro projects play a major role in sustainable rural livelihood. The facility of electricity has not been fulfilled yet in most of the remote villages of mountain and hill region, which leads to the negative impact in health, education, business, technology and whole economic status of the rural people. Generally when we focus on people in some remote sectors who don't use heater, light, fan, radio, television, computer because they have no electricity facilities. There are no good hospitals, health canthers having no x-ray and other lab facilities which bring difficulties to find out the diseases and where immediate treatment is required is not all possible because there is no electricity. They cut the trees and use woods for their daily cooking which not only invites the environmental degradation but also pollute the air and brings health problem and harms biodiversity.

Nepal is rich in water resources which prove to have huge potential in hydropower. Hydro power is an easy available and reliable source of energy needed for human beings. However, there are a lot of possibilities of making the country rich by producing electricity from our innumerable rivers flowing across the country. Nepal has low rate of per capital energy consumption. Energy consumption is considered to be one of the key factors of measuring the development of the country.

The remote hilly and mountainous areas of Nepal are suitable for installing Micro Hydro Power Plants. The research work was carried out focusing on the contribution of micro-hydro in promoting rural livelihood. The specific objectives are; to determine the socio-economic impact of micro-hydro in rural communities and to analyze the role of micro-hydro in environmental conservation. The research was carried out on the basis of social research methodology. Primary data are collected with the help of users' questionnaire, field survey, key informant interview, and observation, focusing on group discussion whereas the secondary data were collected from different documents or literature from individuals, experts and organization which is related to micro hydropower etc. For details of data analysis the help of computer program was taken and simple statistical tools were used.

The research indicates increasing of self-employment, improvement of health condition of the people, work load reduction, forest conservation, community development, economical progress and fulfilling the expectation of the rural people after installing the micro hydropower.

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ABBREVIATIONS/ACRONYMS

ACSR	:	Aluminum Conductor Steel-Reinforced Cable
ADB	:	Agriculture Development Bank
AEPC	:	Alternative Energy Promotion Centre
AVR	:	Automatic Voltage Regulator
CFL	:	Liquid Crystal Display
DDC	:	District Development Committee
DEES	:	District Energy and Environment Section
DFID	:	Department for International Development
ELC	:	Electronic Load Controller
ESAP	:	Energy Sector Assistance Programme
FDFA	:	Federal Department of Foreign Affairs
HHs	:	Households
IHA	:	International Hydropower Association
INGO	:	International Non-Government Organization
IPP	:	Independent Power Producer
kVA	:	Kilo Volt Ampere
KW	:	Kilo Watt
KWH	:	Kilo Watt Hour
LED	:	Light Emitting Diode
LPS	:	Liter per second
MCCB	:	Moulded Case Circuit Breaker
MH	:	Micro-Hydro

MHP	:	Micro-Hydropower
MW	:	Mega Watt
NEA	:	Nepal Electricity Authority
NGO	:	Non-Government Organization
NMHDA	:	Nepal Micro Hydropower Development Association
NRREP	:	National Rural and Renewable Energy Programme
OV	:	Over Voltage
PPA	:	Power Purchase Agreement
PV	:	Photo Voltaic
REDP	:	Rural Energy Development Programme
RPM	:	Revolution Per Minute
SIP	:	Small Irrigation Project
SDC	:	Swiss Agency for Development and Corporation
SLF	:	Sustainable Livelihood Framework
SNV	:	Netherlands Development Organization
SWG	:	Standard Wire Gauge
T&D	:	Transmission and Distribution
TU	:	Tribhuvan University
UNCFD	:	United Nations Capital Development Fund
UNDP	:	United Nations Development Programme
USA	:	United States of America
UV	:	Under Voltage
VDC	:	Village Development Committee

CHAPTER I

INTRODUCTION

1.1 Background of the Study

The movement of water from rivers, lakes and streams produce hydroelectricity. MHP plant is installed to produce a low amount of hydro energy. The principle is when the force of water falls to the turbine continues, it makes turbine to move along with generator and generates electric power in the form of hydro power energy, which is distributed to the users through the transmission line.

In 1878 the first hydroelectric project was introduced to power a single lamp in the Cragside country house Northumberland, England (IHA). Four years later in 1882 the first hydro power plant was installed in Wisconsin, USA to serve private and commercial customers (Adhikari D. , 2006). In the world today, the highest hydropower producing countries are Canada, United States, Brazil, China, Russia, and Norway. The history of hydropower plant in Nepal starts from 1911 AD with Pharping hydropower plant at an installed capacity of 500 KW. The plant was equipped with two turbines of 250 kW each. It is one of the oldest hydropower plants of Asia and the first hydropower plant of Nepal (Adhikari D. , 2006).

Electricity plays the foremost role in the social and economic development of the country. Use of alternate energy is likely to be milestone towards poverty alleviation as well as overall development of the rural sector. The energy scenario shows that the rural population has been using traditional sources like fuel wood and other biomass resources to meet their needs which are not sustainable; therefore traditional energy supply needs to be substituted by modern forms of energy like alternative energy resources. In our rural areas, the possibilities of energy resources are biogas, solar, wind and micro hydro, and out of this micro hydro is the most reliable as well as effective means of electrical power generation, which can fulfill our needs of energy. Despite the fact that our country is rich in water resources, we are still deprived of electricity. Therefore our government, non-government and community based organizations along

with all the stakeholders must have deep interest to implement programs for the promotion of renewable energy like micro hydro plants for economic development.

Some of the sources of alternative energy are solar, wind, hydro power, bio-fuel, geothermal, ethanol, and hydrogen etc. Among them hydropower is the best alternative source of energy produced from water resources in the context of Nepal. This is necessary not only to make the country developed but also to increase the living standard of people by increasing their per capita income. Thus, if we want to be enlisted in the list of developed countries in the world's map the priority should be given to hydropower. Nepal is rich in water resources, which is a primary source of electricity generation. If we use this resource properly by making long term policy we will not be only self-depend in electrical energy but we can also supply electricity to the neighboring country, which opens the door to economic progress of the state. The economic development of our country is hidden inside more than six thousands rivers and streams, which need to be extracted as a source of energy. Water is a renewable source of energy and can be utilized repeatedly without damaging its physical properties. This also helps to protect the natural environment and bio-diversity that seems clean, sustainable and environmental friendly.

We cannot claim a country is developed until unless development reaches the rural parts of the country. Still about 84% of Nepal's population lives in rural areas and depends on agriculture for their livelihood. The availability of health service, education, transportation, communication, irrigation, drinking water etc. are the indicators of development however all these indicators cannot get uplifted without electricity. Rural energy development is one of the major topics which have been discussed many times for the development of the country. We have been facing an energy crisis throughout the country, which is disturbing the industrial production and adversely affecting our daily life as well.

According to Dr. Hari Man Shrestha, Nepal has got a huge potentiality of hydropower generation of about 83000MW of which approximately 43,000 MW power is economically and technically feasible. However, Nepal has developed only approximately 875MW of hydropower till date (Guragain, 2016). It means we still have enough possibilities for the development of hydropower which not only helps us to run

towards development but also plays an important role for poverty alleviation. Small and medium scale hydropower projects are more suitable for Nepal due to geographical situation like hilly and mountainous areas. Government of Nepal including some other reputed companies is trying hard in fulfilling the ever increasing demand of electricity in the country particularly in rural areas.

In Nepal electricity generation is dominated by hydropower but the energy use of the country is surprising. Let us watch the scenario of the percentage of energy fulfilling by different sources. They are: energy from fuel wood 68%, agricultural waste (15%), and animal dung (8%) and imported fossil fuel (8%) but only 1% energy need is fulfilled by electricity (Miyoshi, Raghuvanshi, & Camarao, 2011). The above mentioned figures show, that we are very far from the access of sufficient energy, which leads us to shortage of energy with the increasing population. So it is necessary to produce energy from hydropower, which will help to achieve the development goals like protection of environment, increment of the literacy rate, improvement of health of children and women with better energy. We are proud of being a citizen of mountainous country, because water resources are the natural ornaments of our motherland which can play a vital role to shine the brightness throughout the country. The huge potential of water resource is waiting to give the birth to 43000 MW electricity, which is not only enough to lighten every nook and corner of our nation, but also we can carry our nation towards a new direction by supplying the produced electricity to the abroad.

Number of times, we felt the fact of Energy crisis at its peak. Now, the positive changes have been brought in the country after Kulman Ghising is promoted to the post of managing director of NEA. Ghising focused on demand-side management and strengthened existing supply systems and brought unexpected changes in electricity supply hence dramatically reduced load shedding (2017 to see record hydropower generation, 2017). We can say life has improved with the end of load-shedding. Industries are expanding their capacity. All the businesses are doing their profit by their regular activities without any fear of energy crisis. When entire country suffered from Indian blockade the government promised to generate 10000MW within a decade. According to the NEA's managing directors report only 65% of the population has access to grid electricity. Out of total available energy NEA's own generation

contributed 36.8% where as those imported from India and local IPPs accounted for 34.76% and 28.40% respectively (NEA Managing Director's Report, 2017).

A sustainable livelihood is a way of thinking about the objectives, scopes and priorities for development in order to enhance progress in poverty alleviation (Ashley & Carney, 1999). The advancement and development of the people has come with their livelihoods. The major objectives of this micro-hydro project were to provide livelihood opportunities for the socio-economic upliftment and income of the village, which includes community development and job creation from small enterprises. This study evaluated the effects of MHP on rural livelihoods and tried to fill in the gaps and tried to illustrate the benefits and challenges of MHP.

1.2 Statement of the Problem

It is a matter of bitter truth that despite having many water resources like rivers, streams, lakes, waterfalls and so on running across the motherland, Nepalese citizens are facing energy crisis. We have never been able to concentrate our mind towards development because we have wasted most of our time to manage kerosene, petrol, diesel, cooking gas etc. for day to day usage. Sometimes unnecessary blocked across the border (boundary line) creates shortage of fuels and increases the prices also. This prevents our nation and people from developing. On one hand, we are depending upon other countries for such precious fuels as well as many other things. On the other hand, the use of woods as fuel by cutting trees is destroying our forest. One of the major reasons leading to deforestation is the use of fire wood which is most common traditional source of energy. This has ultimately resulted natural disaster like soil erosion, landslides, flood etc. The fossil fuels imported from abroad not only make us dependent but also pollute our environment due to carbon emission.

The electricity generated and connected to the national grid has been provided to the urban areas mostly, but the rural sector of the nation is still deprived of this very facility that'swhy they use fire wood and kerosene for their day to day life for the purpose of cooking and lighting. This is the major cause of different kinds of diseases especially for women, children and aged parents. It begs a simple question: how can remote villages be developed until and unless there are facilities of education, health, small scale industries, skill based technical training center, hulling and grinding mill, etc.? A very

simple answer that we need to know is that to run development effectively we must have the facility of electricity in remote areas. Most part of the nation is covered by hill and mountain region, so where delivering the electrical power through the grid, installing transmission line is economically very expensive and takes a long period.

Hence, micro hydropower is appropriate for rural electrification, and for the sustainable of rural livelihoods, because local people can manage it themselves, if any problem occurs, also local technician may take responsibilities for some small maintenance, if they are trained. It also promotes the skill enhancement. Its role is positive in environment management and women empowerment in local level.

1.3 Objectives of the Study

The backward community of rural Nepal is seeking a plan to be developed, and for that the best way is micro hydro power, which can play a vital role for overall development. Social improvement, political stability, equal justice, improved education, modern technology, reliable health service, women empowerment and economic progress are today's need. It is a subject of great challenge to overcome problems to achieve the above said needs. We don't have to go anywhere to have better livelihood because we have full water resources as nature's gift that can grow gold in the soil, so no doubt that access to electricity leads to increase in economic activity and change in life habits. **General objectives of the research study are to analyze the role of micro hydropower in promoting rural livelihood. In addition to this, the study has following major objectives.**

- To determine the socio-economic impact of micro hydro in rural communities
- To analyze the role of micro-hydro project for environment conservation.

Along with these, some other objectives are to study the people and community participation for sustainability of Micro-Hydro Project and to make relevant recommendation to policy maker. The purpose of this research is to explore how micro hydro-power plays a major role in economic activities, and how it provides sustainable rural livelihoods. The most important thing is to find out what is entrepreneurial activity in their community through micro hydro power plants. The main research question that this research will answer is: How does the availability of electricity from micro hydro

power affect lifestyle and entrepreneurial activity? What is the role of MHP in rural livelihoods ?

1.4 Significance of the Study

Nepal is a second largest country regarding the water resources. It is not necessary to depend on other energy because hydroelectricity is enough for that. MHP project is much suitable for Nepalese context. Nepal is a mountaineering country having full possibilities of power generation from innumerable rivers. MHP is more feasible and cost effective while comparing with the installation of big hydropower. Using the woods as fuels produces smokes which invites diseases to the people in a closed atmosphere especially to the women who involves in cooking food.

MHP plants are installed in Nepal's remote hilly and mountainous areas. In the context of Nepal, MH plant with installed capacity more than 10 kW to 100 kW are known as Micro Hydro. These are useful to provide electricity for lighting facilities mainly. Agro-processing like; grinding, hulling, milling along with operating radio, TV, computers and some other end use are its benefits. Significantly, this study reflects that having the access of electricity in remote village every personal from rural community may involve in different economic activities to shape their own economic future. The aim of installing MHP is not only for lighting and cooking but also to improve the living conditions of the rural people through promotion of self-employment. People may invest money in trade and small industries. Cooperatives and banks invest loan in minimum interest, which helps youth to conduct micro enterprises. What we have to understand is that, where there is no electricity there are no any other facilities. No banks and cooperatives are interested to come to invest and this badly affects the local marketing, and no technical training, skill base works can be conducted.

The significance of this study is mainly to find out the changes brought by the micro hydropower to the remote people and their economic status changing towards the progress. Now, the ministry of energy has been focusing to wipe out the problem of load shading and this study will also help to find out the changing condition of certain areas where the MHP has been installed. This is also important to know what positive changes have been gained by the local people. Economically they have got progress or not. If yes

what types of progress has been occurring in the sector of health, education, drinking water, irrigation, communication, transportation? The study reflects the condition of employment as well as indicates social, cultural, political, status of the local people. This study also helps to put forward exact figure of location of which MHP is installed so that it will be easy to get the data of local area, easy to conduct the development program for local development office. It helps to identify or emphasize to aware forest conservation.

There is an important, that we should understand, our population is increasing day by day, and demands more electricity, which cannot be easily fulfilled by large scaled hydro power project due to its high cost and long duration whereas the electricity imported by the neighboring country will not give full solution of power cut off, we are facing at present. Still the electricity facility is not reached yet to the large segment of population.

1.5 Limitation of the Study

This research is conducted to analyze the contribution of MH and impact of MHP project on socio-economic transformation in the Bhalayadanda village. Although the research has got its aims, there are some unavoidable limitations. Because of the time limit the research has not got its full analysis as much as it should be, but it is to understand that to generalize the results for whole MHP, the study should have done at different levels taking some more time. This research is carefully prepared under some limitations. The research is conducted taking in mind that there must not be any wrong data or messages so that this paper do represent successfully entire MHP project regarding the contribution of MHP in promoting the rural livelihood and strengthening the rural economy. Since the questionnaire designed to measure the attitude of rural citizen towards the consumption of electricity produced by MHP might give useful information about the socio economic impacts, progress in health and education sector, awareness for the conservation of environment, improve in irrigation process. This study confines in the following limitations.

- This case study belongs to Bhalayadanda Village, which may not be applicable on the other village of the country.

- The present study generates the primary data which is original but sample size is limited so outcome may not be as similar as national level.
- The study is done with some limited variables so which may effect on study area.

1.6 Organization of the Study

This thesis is completed regarding the contribution of MHP in promoting the rural livelihood and strengthening the rural economy. The content of thesis is organized in such a way so that it includes all the aspects of subject. It is the case study of Bhalayedanda MHP lies in Udayapur district. Organization of the study of this thesis is developed under the guidelines provided by Central Department of Rural Development TU.

General Format of the thesis is divided three parts such as preliminaries, the body and reference materials. Preliminaries includes title page, declaration letter, recommendation letter, approval letter, acknowledgement , abstract, table of contents, list of tables, list of figures/illustrations and list of acronyms/abbreviations. Body of the thesis includes five chapters where chapter one is the introductory one which covers the following topics: like background of the study, statement of the problem, objectives of the study, significance of the study, limitations of the study, organization of the study. The chapter Two focuses on the review of the literature. Chapter Three is concerned with the discussion of methodology used in research. The chapter four is related to the analysis and interpretation of the data. Chapter five contents conclusion and recommendation. Reference materials are placed at the last chapter which include list of the tools and instruments used for an experiment or data collection including maps and photos etc.

CHAPTER-II

REVIEW OF LITERATURE

The rural areas of Nepal are facing many problems such as deforestation, landslide, soil erosion, flood including low income, unemployment, shortage of access in good education and healthcare. It needs the facilities of transportation, Health centers, colleges, electricity and so on for sustainable development. Rural community plays an important role for the economic development. Rural areas cover agricultural lands, forests, farms, rivers so the economy of the rural sector specially depend on agriculture, livestock, forestry, fisheries, mining, rural tourism etc. MHP is one of the key components for the rural development which brings positive impact on schools, hospitals, business, agriculture and small scaled industries. Micro-hydro schemes have significantly less negative environmental impacts than larger schemes (Clancy & Redeby, 2000). Most of our rural sector is covered by mountain and hilly region which has the huge storage of water resources, which can be utilized for rural electrification for sustainable development. More than 44% of the people live without electricity in Nepal (Gurung, Ian, Joo, & Oh, 2011). Electricity is considered a key determinant for economic growth of a nation. Still most of the remote areas do not have access to electricity in Nepal. MHP provides reliable and affordable electricity to the remote village of mountain and hilly areas of Nepal. MHP is considered the most feasible decentralized renewable energy option for providing electricity for these areas. Thus, MHP provides clean, affordable and sustainable renewable energy both locally and globally. Rural electrification can bring positive changes in the rural livelihoods. Traditional kerosene lamps will be completely wiped out, and firewood consumption will be reduced. Electric lights through MHP in households provide additional hours for reading and work. The MH based electricity will be used to power modern agro-processing mills in the village, which will reduce drudgery for women.

Micro hydro is defined a type of hydroelectric power generation mechanism, that typically produces up to 100 kW of electricity. MHP installation is useful to provide electricity to an isolated home or small community. MHP can be connected to electric power networks also. The characteristic of some regions where there is a variation in altitude having number of rivers and rivulets indicates the potential of MHP. Comparatively Nepal has more rural areas, so most of the Nepalese people living in rural area who use traditional form of energy to fulfill their energy need. It is necessary

to replace that energy supply by modern forms of energy. Larger portion of the energy for cooking purpose is covered by biomass mostly fuel wood which has a negative impact on the lives of the people and also it passes longer time to collect wood and causes adverse effect on health and environment. It has already been done so many studies about micro hydro power and its impact on rural livelihoods and still going on. Numbers of writers, technologists, intellectuals have been writing books, journals, essays, papers and publishing literature regarding the MHP. The review of the literature reflects the real situation of the subject.

(DFID, 2001) According to Sustainable Livelihoods Guidance Sheets published by Department for International Development, a livelihood includes the capacity, wealth (assets) and activities necessary for living. A livelihood is sustainable, when it can cope with and avoid stresses and shocks, and can maintain or increase its capacity and wealth both now or in the future, without weakening its natural resource base. DFID introduced a Sustainable Livelihood Framework (SLF) as a tool to understand about livelihoods, which includes different factors like vulnerability context, livelihood assets, transforming structures and processes, livelihood strategies and livelihood outcomes. Under the livelihood assets the book described major five key elements and they are human capital, natural capital, financial capital, social capital and physical capital in order to achieve livelihood outcomes. According to book livelihood outcome denoted more income, increment of well-being, reduction of vulnerability, improvement of food security and more sustainability of the natural resource base. This book really gives important guidelines to identify the livelihood of the rural people in depth and shows the way for remedy of sustainability.

(Gurung, Ian, Joo, & Oh, 2011) This is a case study conducted in order to evaluate the scenario of socio economic conditions of a village called Sikles in Kaski District, Nepal. This study represents the condition of all villages in Nepal. It is relevant to all remote areas of Nepal. In study authors focused that Electricity as one of the key determinants for economic growth of the country. They wrote that MHP is the most feasible decentralized renewable energy. It is affordable and reliable to the remote area of Nepal. They believed that the rural electrification through MHP can bring positive changes to the rural livelihoods because they have got strong point to prove this statement by their case study on this subject. They agreed MHP brought positive changes in the village.

They mentioned some examples of positive changes like replacement of traditional kerosene lamp called tuki and panas by electric lights and consumption of firewood is also reduced. Students study hour and villagers working hour is extended due to electric facility. He strongly supported the view, that electricity can directly influence the education level in rural community (Zahnd & Kimber, 2009). Traditional water mills are replaced by modern agro-processing mills. They emphasized that MHP provides clean and sustainable renewable energy. They claimed that still people use traditional biomass like firewood, charcoal, animal dung, and agriculture residues for cooking, heating and lighting in homes. The Case study has extracted a bitter truth that our country has no deposits of petroleum products and natural gas. But god has gifted us huge water resources. This case study indicated that the national grid connection to the mountainous terrain is quite unrealistic due to geographical difficulties and disperses nature of settlement. The authors realized rural society was in the circle of the cast discrimination in past year, but nowadays MHP has contributed to bring revolutionary changes in strengthening the rural society e.g. number of dalit students are increased in schools, and other cast easily appreciates participation of unprivileged dalit in all social works together with them. But I am disagreeing with one of the content from authors' literature where they mentioned, "Electricity seems unimportant in schools of Sikles village because they don't use electronic media for education". In my opinion it should not have written, rather than we should provoke schools to teach using through electronic media also. In the case study authors mentioned an important positive message that is impact of electricity on education. They compared the position of students before providing electricity and after receiving electricity. Students from the village did not receive education through electronic media like computers, TV and other visual equipment but in urban areas students get all these facilities. But students from village have to compete with the students from urban, which is not fare. In village, students spend most of their productive time to collect firewood and other necessary things. Using kerosene lamp is insufficient for lighting whole room. After access to electricity from MHP students are facilitated by electric and electronic media. They have extra time in morning and evening for study. Their drudgery work load is reduced. Their health problem like respiration and eye vision due to smoke from kerosene lamp and firewood is also controlled. Drudgery and work load for women is reduced because they have facilities of agro processing mills instead of water mills. They don't have to spend more time to

collect firewood from the forest, because their demand of firewood is reduced in large quantity due to low consumption. The most importantly, authors claimed that small enterprises can be developed at community level that ultimately increases rural economy due to access of MHP. Authors asserted that people in the village used to go forest for firewood, livestock fodder, and timber before having electricity, which invited adverse impact on environment but after owing electricity from MHP, consumption of firewood reduced and villagers are being aware of environment.

This review concludes that households having access to electricity are benefitted. Positive Impact of electricity can be seen in the field of education, health, environment, social structure and other areas. MHP really contributed in promoting rural livelihood and strengthening the rural economy.

(Parajuli, 2011) In this paper author basically discussed about the vulnerability associated with the micro/mini hydropower technology, climate change vulnerability, MHP services and its contribution to the rural society, social harmonization, environmental management and role of micro hydro in the adaption to climate change.

Parajuli strongly pointed out that due to natural disasters like landslides, floods, erosion, and sedimentation or may be due to extreme events and climate change structure of the power plant can be damaged. High or change in runoff in the river can damage the weir/intake. Flood and landslide can wash away the power canal, penstock, power house, fore bay, and can damage turbine and other electrical, mechanical accessories. When such events demolishes power generating system, which invites adverse impact in the rural livelihood. Such physical vulnerability can affect the sustainable operation of micro hydropower plant. Likewise author worried about resource vulnerability concerning with the degradation of water resources due to climate change also affect the power generation from plant. I agree with the author's one of the line he mentioned in page 3, "However natural disasters have jeopardized economic development in the country".

Parajuli argued about the services and contribution of MHP to the society. He discussed about the various aspect of MHP related to its contribution provided to rural area, like MHP is playing major role to support rural development and management of rural ecosystem. Its contribution towards rural society has assisted social harmony. Regarding

access to energy MHP's role is to treat equal behavior to all members. It has helped to enhance the livelihood of rural sector from different angles. MHP has been found in the rural hamlets as a key factor of improving social, physical and economic sector through energy services, and it is due to the promotion of MHP technology.

Parajuli also mentioned an important fact about increasing threat to ecosystem, which is caused by environmental degradation. He believed MHP technology is the backbone of environmental development, because it is a factor element of clean energy promotion, and it creates only low carbon emissions. Every development process goes through the risk of vulnerability and disaster, but most important is to think and work to overcome these issues. Author presented a figure in page 6 and mentioned how decentralized energy services are co-related to environmental management and poverty alleviation. There are five factors, they are management of biodiversity and ecosystem, access to safe water and sanitation service, air quality and exposure of toxic chemicals, natural disaster and resource based conflict and climate variability and change.

Parajuli concluded that role of decentralized renewable energy technology like MHP is unforgettable which has important role in the development of society and environment. It has contributed in promoting rural livelihood and strengthening the rural economy.

(Ranjitkar, 2014) Significantly, Author focused in his article on some appropriate facts about the scenario of Micro hydro in Nepal. For example; alternative energy sources available in Nepal, success of MHP, supporting hands of MHP in Nepal, fund and institutions to establish MHP, responsibility of community in MHP, synchronization to national grid, challenges of entrepreneur communities, assignments of techno-entrepreneur and social responsibility of MHP. All these aspects are presented briefly in article.

Ranjitkar mentioned use of micro hydro is in top most in Nepal among available sources like biogas, thermal, solar PV, wind energy, micro hydro and some others, and the review about the energy so far shows the same. Establishment of 3300 micro hydro plants connected to around 350,000 households in off grid remote areas in 55 districts of mountain and hilly region writes its success story, which has been raised as an example in other countries. Author informed through this article that AEPC is government agency which conducted NRREP for five years till 2017 July, which was supported by

different sector like DFID, SNV, KfW, UNCFD, UNDP, Norwegian government, Danish government, Asian development bank and World bank.

Ranjitkar believed in the article that government agency has prepared a good policy to conduct MHP project, but he had to mention here the hurdles of sustainable of MHP too. The major point Author raised, user level of MHP are real players of development of MHP. Nowadays the role of the community is getting more important. Without their participation no MHP installation can be done or no MHP gets sustainable. When they make consensus with villagers and decide to install project, by then their responsibilities towards MHP starts. Author said that responsibility should be taken into account for social inclusion and gender equality, while participating in every works of MHP like construction, transportation, maintenance and managing other miscellaneous. After once MHP established accountability goes on continue. Community has to think for sustainability of MHP, there are so many factors which come as hurdles like natural calamities or other possible incidents.

Ranjitkar gave an important message which can be mile stone in the field of energy sector and that is synchronization of MHP generated electricity to national grid, and this technique once has already been tested successfully through mini grid system. This can be proved by this headline "NEA and two micro hydropower plants had entered Power Purchase Agreement (PPA) in late March 2016" (NMHDA, 2016). If so, the community will be paid for the electricity sold. Ranjitkar asserted that techno-entrepreneurs are taking all kinds of job related to MHP. They do supply and delivery of all machinery equipment, they install the MHP. One thing that we have to accept, that is the work ability of Nepal's private company who has been providing installation service of the plant and also supplying turbines, ELCs and other hydropower's' machine in Nepal or in abroad also. Their expertise can be seen where they are supposed to train other personals from foreign countries.

Ranjitkar insisted that promotion of MHP has maintained its role for poverty alleviation in rural sector. It plays role for social uplift by providing electricity. People in the village have been using electricity for different purpose in their day to day life. Along with lighting they are using electricity for different business and cottage industries. MHP indeed has been making villagers life success socially as well as economically. It also

helped to wipe out social discrimination, so its contribution to rural livelihood and strengthening the rural economy is quite fruitful.

(Adhikari M. , 2014) Author strongly raised the question mark in existing modality of micro hydro implementation, and his article mainly concern with possible revision of implementation modalities in the present context of social, economic and demographic changes in rural sector. Whatever the topic is, doesn't matter, because all these attempt of doing things in the field of energy is concerning with the economic development to strengthen the rural livelihood.

Adhikari briefly highlighted that the travel which was started from traditional "Ghatta" has now reached in grid connected micro/mini hydro, passing through various stages. In long run different kinds of modalities has been being used for electricity generation in small scale. Author surprisingly mentioned that in thirty years 30 MW electricity has been produced from off-grid hydro projects which served around one million rural people. According to author's concept it is looking unsatisfied with the existing model of electricity generating system from MHP. He believed that the implementation process of MHP is lengthy, complicated and costly which has resulted poor output. He indicated the main areas where MHP takes time unnecessarily to be completed, e.g. long approval process of the project, improper bidding process, difficult financing arrangement and long construction process. He also raised the question about the subsidy because Government of Nepal (AEPC) provides subsidy only 40% to 50%, and from community consumers' contribution is 15% to 20% cash and kind. To arrange rest of the fund about 30% to 40%, they should do a big workout. They should spread their hands before the government and non-government agencies. In some cases they may even have to take a loan. He strongly suggested paying attention in the existing procedure to make it better, faster and reliable, so he presented three modalities of revision which is mentioned in his article.

In some extent, I agree with author's arguments, so I conclude that construction, operation and maintenance management of MHP should be faster and better to achieve economic benefits in time. Existing pattern of doing work is not satisfactory, so opportunity should be provided to private sector entrepreneur to off-grid areas, which

will reduce the workload of state and will be cost effective. Eventually, MHP can contribute community and strengthen the rural economy, if it is sustainable.

(Pokharel, 2006) Pokharel supported the fact that MHP is serving communities with not only energy but also enhanced economic activities and induced better life. Most of the rural people in the hills and mountains are subsistence farmers and due to increasing population, the farmers are becoming poor with limited land and production of means of survival. Creating employment opportunities would be the immediate route of alleviating poverty. MHP, in this regards, provides a few job opportunities locally and alleviating poverty appreciably, because it has very short gestation period and with the local participation, financially and voluntarily many power plants can be built in a short period and create jobs.

Pokharel in his case study beautifully indicated the impact of MHP. He described that the increasing population invites poverty due to having the limited land particularly in hills and mountains region. He focused to build many power plants which helps to create the jobs and other opportunities that is only way to alleviate poverty and the most important line he emphasized that MHP contributes not only for energy purpose but also runs the economic activities. When talking to economic activities, we should understand that the facility of electricity support the industries, business, transportation, communication, education, health, and many key sectors involve in the daily activities which promote the local citizens to uplift their living standard. The most importantly the farmers can sell their product, involve in marketing and make their better economic status.

(Greacen, 2004) In the research study, author mentioned his point of view with analysis about such factors, which are born as constraints of

community based small scale micro hydro projects in developing countries. There are some elements which have caused to limit the sustainability of cost effective MHP. In the context of Thailand, author claimed that MH is the best community based tools of electrification socially and economically. In the research, author's main theme is to investigate the reason of building of only few micro-hydro projects, so he raised question why some of the MHP cannot sustain. Only few of them are in continuous in operation.

Greacen included that after having national grid connection most of the rural community based MHP are being disappeared where as some MHP are not functioning well due to failure of machinery equipment; quality of equipment is not good so it doesn't long last. In my opinion, poor management, poor monitoring and unskilled technician are the major components of failure of projects and that stops the pace of development in remote village. Author presented the physical appearance of the Thailand, where can be seen steep hill portions with forest and such topography is useful to generate electricity from micro-hydro plant. He mentioned that the structure of settlement of the remote village in mountain side is scattered type, that's why it needs long grid extension which is economically costly, and it is also difficult to build physical infrastructure and take a long time. Rural electrification through MHP bears overall lower cost than national grid connection, and environmental impact is minimal as small or no reservoir is needed and no big infrastructure is must, which makes it affordable for consumption of electricity.

Greacen found in his study that in some villages of Thailand there is either the connection to national grid or no electricity, but the country has passed a long way in renewable energy technology. But

author accepted that there are some good examples of community based MHP which has displayed their capability, providing employment to local residents and MHP has playing role for resource management, capacity building in local level, development of rural enterprise and protection of environment. It means MHP has more positive aspect in the villagers eyes, as if simply arrangements in social side and technical side is adjusted or structured it can be sustained up to future.

(Sapkota, 2011) In this section“ Energy for Rural Development” of the book, author described about different kind of natural energy which can be used in rural development like solar energy, water energy, wind energy and geothermal energy along with rural energy policy of the Nepal government.

Sapkota mentioned that that water energy of Nepal is called white gold. Nepal is second richest country of the water resources having more than six thousands river and rivulets running across the country. Since development is almost impossible without energy, micro hydro power has been proved as a boon in Nepal. Total power generation capacity of Nepal is 83000 MW but economically feasible is 42000 MW.

Sapkota presented that MHP generates the electricity which helps to improve the quality life; it saves women from drudgery work. They do not need to go for traditional water mills or hand operated grain milling tools, because MHP has facilitated electricity operated milling and grain grinding machines. MHP helps to save the time of women and children because they don't need to spend more time for collecting fuel wood. They can use their saved time in another useful income generated work. MHP can play roles for the development of human resources and technology. The most important things are MHP has made rural people responsible towards handling, controlling and managing the plant

themselves, and they can manage the distribution of power supply also. Local community members of MHP may become the shareholders of the plant also

Sapkota wrote about the environmental impact of the hydropower. He asserted micro hydro is taken as a source of alternative energy and it can be established by using our own manpower. Very few equipment are imported otherwise Nepal has its own expertise as well as manufacture, supply and installation of turbine and other machinery equipment work are done by our skilled technician. As we know a large hydropower may invite negative effect in ecology and environment. In comparison with the large hydropower, MHP creates very low or no impact on environment sector so in the context of Nepal, micro hydro has proved to be of more use. Micro hydro power can be installed in hill or mountain areas in low cost even if there is no transport facility. Author mentioned, how MHP has played supporting role in rural livelihood and strengthening the rural economy. He wrote that traditional kerosene lamps have been replaced by electric, bulbs which have helped to save from diseases caused by smoke. MHP has created different opportunities in remote village like different businesses, small industries, skill oriented training centers, modern farming etc. Similarly, improvement in leadership development, skill development and participation in development work is increased. Due to development in communication medium and electronic media like television, radio etc public awareness is increased, and people are being conscious of biodiversity and environmental protection. So importance of MHP is always there for the increment of national income, improvement of per capita income, rural development and economy development. He informed that AEPC provides subsidy for micro-hydro, and government had formulated MHP policy in

1992 AD. Different NGOs, INGOs, World Bank, ADB and others have been taking part for the development of MHP.

Sapkota mentioned his strong believe that in the context of Nepal, small hydroelectric power is of great importance for transforming the huge water resource into power without polluting air, water and land. It is clean, affordable, reliable and freely available renewable energy.

(Adhakari, 2014) Author stated about Nibukhola micro hydro project, which is installed in Panchthar District, and its impact on social and economy of the village. She expected this research provides valuable information to the policy maker to utilize resources for energy generation in the future. Author examined the impact of MHP in the study are in the basis of electricity users income and employment. Also she mentioned some problems associated with micro hydro a long with possible solutions. In my view, whatever facts author mentioned in her paper represents the reality of remote areas of the whole country.

Adhikari emphasized that technology are being advance in the world but still developing countries like Nepal are not having sufficient energy for day to day life. In remote village people still rely on traditional sources as energy for cooking and other purpose, which invites deforestation and other natural disasters like landslide, soil erosion, flood etc. Village where there is no electricity mostly use kerosene for lighting purpose which extract smoke. In both cases, in cooking by fuel wood and lighting by kerosene lamp pollute the surrounding air and invites diseases related to eye and respiration. Electricity connection from national grid connection and diesel generator is expensive for remote village in hill or mountain region. Due to geographical

situation grid connection is economically expensive and physically difficult to install and takes a long time to get there.

Adhikari mentioned that water is a locally available renewable energy which can be used as hydro power. Micro hydro can be essential means of electricity for remote rural areas because it is affordable for all in village. It is difficult to fulfill the energy demand by traditional sources and these sources create negative impact also to the nature, so community based micro-hydro power can address the villagers' energy problem by providing electricity in effective cost, and this is also the objectives of the state to approach electricity in every nook and corner of the country.

Adhikari concluded that MHP helped women from the drudgery, students have got extra time to study early in the morning and in late evening, kerosene lamp is substituted by electric bulbs, positive changes can be seen in the people in health, education, agriculture, business and everywhere due to television, radio and other electronic media, public awareness is improved in sanitation, irrigation, preserving wild life and environment. MHP made people busy in their income generation work like poultry farming, dairy, agro processing mill, technical training center and other small industries. Author accepted that MHP has succeeded to bring positive socio-economic impact in the remote village. It really can play major role for the sustainable development of the country by strengthening the rural economy.

(Murni, Whale, Urme, Davis, & Harris, 2011) Authors completed this case study of two micro hydro projects in remote village called Liang Butan and Tang Paye in Indonesia, where supply of national grid is nearly impossible due to its geographical structure. But this place has possibilities of hydroelectricity for the electrification of rural

areas. Research concerns with the different stages, issues and impacts of MHP in rural communities. Authors believed that good planning and stakeholder involvement in planning process draws the line of success in implementation of micro hydro in rural sector. As for example these two MH has got succeed because there are some reasons which includes technical factors concerning with its design, operation and maintenance, social factors which includes capacity building of community.

A micro hydro project installation system goes through various stages starting from its planning then work design, implementation and operation. In Liang Butan MHS, government played role for the planning of project, but in tang Paye project planning work was undertaken by mutual co-operation between community members and funding body including government. These two MHP projects are run off river type. There is no storage dams constructed because of not feasible in the steep terrain, so MHP electricity generation capacity depends on flow of water in the river.

Authors discussed about the impacts of micro hydro project. Impact can be seen in communities in their social activities and energy consumption. They are using MHP generated electricity not only for lighting but also making snacks, selling meat, ice and fish. In previous days villagers used to make handicrafts during the time only but after having MHP they have got extra time for making handicraft. People use electricity for lighting, operating television and to run appliances like blender and refrigerator. Villagers have been conducting some small scale enterprise since MHP established. If MHP delivers supply regularly it can help rural households to reduce their energy cost. In my view Authors has not discussed about the impact of

MHP regarding the health and environment in the study area. MHP has brought some changes in the village and contributed in promoting livelihood and strengthening to some extent.

(Klumme, 2010) Author found through this research that micro hydropower project is an important electricity generation plant which can play the role for poverty eradication in remote village. The completed research is based on the MHP which is in Africa. He mentioned that Africa has large area of remote sector where national grid is not connected yet and quite impossible near future too, so micro hydro scheme has entered there to serve the remote village by providing affordable electricity. Research is centered in the role of micro hydro in poverty eradication.

Klunne emphasized that it is a great challenge to power up sustainable energy in remote areas where no electricity is available. National grid connection to the remote village is expensive because distance is long and geographical structure creates difficulties. Electricity demand is also low because of scattered settlement. Thus, only way to provide electricity to there is possible by micro hydro scheme. Author also discussed about solar PV system provide to village in study are, but not provided to household because its cost is very high as well as micro hydro can give comparatively better energy services than solar PV. Author tried to show relation of energy access to poverty reduction.

Klunne mentioned that access to energy from micro hydropower plant improves the life of poor people who need electricity for lighting, cooking, transportation, sanitation. MHP is used in productive use like production of goods and services. Its role is positive in health and education sector. Since receiving electricity form MHP they started to participate in various employment based or skill based work for income

generation. It is renewable energy so it helps to protect environment and importantly it reduces emissions of greenhouse gas. So it is necessary to bring a policy in national level to establish more micro hydro projects for development rural community, industry, different institutions, skill oriented training centers, business etc. Hence, MHP can contribute in strengthening the rural economy and promote rural livelihood.

(Dahal & Shrestha, 2014) focused on sustainability of MHP. In this thesis, the author writes not only the effects of micro-hydro power plants in the socioeconomic sector but also the effects of environment change on micro-hydro power plants. This case study was performed in Athbiskot MHP in Rukum.

Authors pointed out that sustainability of MHP depends on different factors like social, economic, technical and environmental. If the benefits of such small hydropower are recognized, then the government agencies can be pushed for additional power generation in the coming days. Despite Nepal has enough power potential, citizens are suffering from power shortage and there is increasing gap between demand and supply of electricity. It is also necessary to increase the power generation capacity and reduce the demand for electricity. It is also necessary to increase the power generation capacity and reduce the demand for electricity. On the one hand, the demand for electricity is increasing, on the other hand, the cost of conventional fuel is also increasing and the uncertainty of oil supply is the same, so we should consider this as a way to generate electricity.

Energy is an important factor for economic and social development, but economic growth requires increasing energy. Industrial and agricultural production and the living standards of the citizens are related to increasing energy consumption. The current generation of electricity

does not seem to be able to address the increasing demand for electricity, which has caused the problem of electricity consumption.

Authors strongly mentioned that there are three essential elements which are the backbone of the sustainability of MHP and they are social, environment and economy. Micro hydro-power plays an important role in the economic development of remote rural settlements poverty alleviation, economic growth, women empowerment and infrastructure development. MHP users are feeling that their social status has increased and they have got the facility of health, education, irrigation, sanitation, television, and internet and so on. This hydropower plant has brought many new development opportunities to the rural areas. Its sustainability can easily provide employment, infrastructure, healthcare, education facility including electricity. Kerosene and dry cell are being replaced by electricity. The importance of rural electrification is unforgettable especially for the livelihood of the rural people.

CHAPTER-III

RESEARCH METHODOLOGY

3.1 Study Area

Geographically Udayapur District belongs to both terai and mountain region. The areas touched with terai have got the facilities of electricity connected to national grid but most of the hilly regions in this district are not connected with electricity. When focusing on Baidhyanath river flowing through the Bhalayedanda have good potentiality of producing small scale electricity. For research study this area is selected due to its geographical structure having the water resources for all seasons and heterogeneous socio economic culture.

The study area where the MHP is installed located in the north side of Udayapur District which is situated at about 488 meter above mean sea level which is known as Baidhyanath Khola Micro Hydropower. Udayapur District lies in Sagarmatha Zone, Eastern Development Region of Nepal. Micro-hydro power project area is one of the mountain regions with full of slope terrain and cultivated land. According to the geographical classification our nation has five development regions, 14 zones, 75 districts along with 58 municipalities and 3915 VDC. This MHP is located in Bhalayedanda VDC ward no 2. According to new provincial structure, Bhalaydanda village where project is established, lies in Udayapurgadhi rural municipality, ward -8, in province no. 1.

According to the detail feasibility study report the topographical features of the project is favorable for the construction work of MHP. The altitude of site where MHP is installed situated in 581 meter (intake) and 488 meter (powerhouse). Geologically MHP site is predominated by sedimentary and metamorphic rock consisting of shale, mudstone and limestone. The source river of micro-hydro project is called Baidhyanath Khola, which is about four kilometer from road head. Its nearest market is Nepaltar Bazaar.

3.2 Research Design

Descriptive research design is conducted for main format to prepare this research work because it needs the exploration for the better understanding of subject or situation which provides information about the topic and easy to address the issues related to the subject. The study is also concern with descriptive system because while reporting the study it is necessary to describe the things related to the MHP plants, its size, installation and condition along with its impact on bio diversity and environment. This method is utilized because the study is to focus on analyzing the changes brought by Baidanath Khola Micro-hydro project on the basis of social, economic, political and cultural point of view and to find out impact of that MHP project in the field of income generation, receiving education and local development.

This study mainly focuses on the socio-economic impact of micro hydroelectricity in rural sector and finds its impact on people and identifies how rural communities are benefitted by project. It is based on the topic, contribution of micro-hydro in promoting the rural livelihood. Research is so designed to find the impact of micro-hydro in sustainable rural livelihoods.

3.3 Nature and Source of Data Collection

This study belongs to the topic "contribution of Micro Hydro in promoting rural livelihood". So Data which are required for research study are provided by various sources. Primary as well as secondary data collection methods are taken into account. Most of the information are taken from primary sources which are also known as field sources which belong to direct observation, information from the informants, information from the witness, obtained by self-experience/research, interview or informal discussion etc. Some information are collected as secondary sources which is also known as documentary sources which are obtained from books, reports, publications, journals, research papers, feasibility study report, internet, other related documents like chart, graph etc. Including this key information are collected from VDC/DDC, NGOs/ INGOs, School too.

3.4 Universe Sample Size and Sampling Procedure

Bhalayedanda VDC where the micro hydropower plant is installed which one is selected for study lies in Udayapur District. There are 151 households in BhalayedandaVDC ward no 2. 103 households have been benefitted but the rest are not benefitted. Total number of users household is 103 (Source: Field Visit 2017). Since people of different caste and ethnicity are found there, stratified random sampling is used to select the sample unit. Out of 104 electricity user HHs is sampled with quota sampling and random sampling are used for household survey. Three different types of questionnaire are developed for households, entrepreneurs and schools. The sample size is taken from nonusers also. Mainly 25 households are taken for sample procedure.

3.5 Data Processing

On the basis of three different types of questionnaire, survey, field visit and other tools and technique work sheets are prepared and collected all the possible and reliable information and cross checked for possible errors whether it is any miswritten or not. The collected raw data are processed and classified according to its nature and characters through editing, coding and tabulating. Separate data sheets have been prepared for different variables and carefully edited and the organized data are subjected to analyze by using different statistical tools processed by computer program word and excel then the required pie-chart, bar diagram and table is developed.

3.6 Data Collection Techniques and Tools

Questionnaire Survey, Key Informant Interview, Field Visit and Observation and Focus Group Discussion pattern are conducted to receive the primary data. Information are also collected from the members of saving group concerning with the electrical users of MHP. For this study, data about the impact and effectiveness of the rural electrification through MHP are collected through direct interview with the help of structured questionnaire to the users in the community. The structured questionnaire and interviews and observation methods are applied to collect the both qualitative and quantitative data. These Data collection techniques and tools are mentioned below.

3.6.1 Questionnaire Survey

Under the primary sources, structured questionnaire sheets are prepared to gain the reliable as well as accurate data from household survey of the electricity users. The users are requested to fill that form for house hold survey of the electricity users of that very micro hydropower plant. Those who are unable to fill the questionnaire sheets themselves are asked, and answers are filled up to collect the required data. The format of questionnaire survey is in annex I.

3.6.2 Field Visit and Observation

MHP plants installed in the local area are observed physically and the households which are considered for taking sampling are also visited for study. Physical condition of micro-hydro, its impact on community, role of MHP in sustainable rural livelihoods, the infrastructure, transmission and distribution of electricity including whatever the data seemed to be necessary are recorded for further analysis during the visit of plant site. Field visit process is completed and collected the name lists of each household during study and tried to understand the people's perception to get the real condition of MHP in village. The format of observation is in annex II

3.6.3 Key Informants Interview

As a primary source there are some key informants taken from the community to whom the interview may concern to generate the information about the subject. The interview is taken with the informants about the importance of micro hydro power and about the changes brought to their life by the help of MHP installed in their own local area. The interview is related to all-round development like educational, cultural, environmental, and political along with economic status of the local people after having MHP in their village. The key informants are the local people who are users, social worker, policy makers and individuals related to hydropower energy development. Mainly the chairman of VDC, chairman and secretary of the saving group and women and entrepreneur are interviewed to know detail about MHP and its role in the society, community. The format of key informant interview guideline is in annex III.

3.6.4 Focus Group Discussion

The Focus Group discussion is conducted in the village where MHP is installed. The participants are from the different sector, different caste, different culture and different organizations including active participation of women and school children who have been benefited from the MHP since the beginning of its installation. The format of focus group discussion is in annex IV.

3.7 Data Analysis

Data which are extracted from different sources are systematically managed, analyzed and interpreted. Manual method as well as computer programming is used for data processing and analyzing. Statistical methods like tables, pie charts, diagrams, graphs, measures of central tendency, dispersion, and co-relation and regression analysis are used for data analysis. The data has been tabulated and analysis is done by descriptive as well as analytical method on the basis of objective of the study. Descriptive methods have been used for qualitative data.

CHAPTER – IV

DATA ANALYSIS AND PRESENTATION

4.1 Introduction to Baidhyanath Khola MHP

According to the former administrative divisions of Nepal, Udayapur, a district of Sagarmatha zone, which lies in Eastern Development Region of Nepal. This MHP project is situated at Bhalayedanda Village Development Committee (ward no 2) north of Udayapur District. Aim of the project is to make benefit to total 151 households with a total population of 830 individuals, but only 103 households are connected to electricity till now. Baidhyanath Khola with a measured flow 112 LPS (data from April 2010), is the source of the project. The design discharge of the project is 78 LPS and the available gross head is 36 meter. The project was designed for an installed capacity of 15 kW with an overall efficiency of 55%. The total length of headrace, penstock pipe, and tailrace canal is 1700 meter, 72 meter and 5 meter respectively. The project includes a cross flow turbine-T15 of 21 kW and a 3 phase synchronous generator rated at 30 kVA. The Transmission and Distribution (T&D) network consist of a low tension line. The total length of T&D network is 4340 m. (2940 m. of three phase network line and 1400 m. of single phase network line).

4.1.1 General Information of the MHP

Source of River	:	Baidhyanath Khola
Location	:	Bhalayedanda VDC, Mahadevthan
District	:	Udayapur
No of Household connected	:	103
Nearest Road Head	:	Nepaltar Bazaar
Walking distance	:	1 hour (about 4 km) from Road head
Ownership type	:	Community
Power Output	:	15 kW

(Source: Detail Feasibility Study Report of Bhalayedanda Micro Hydropower System, Technical Report), 2010.

4.1.2 Topography and Geography

Topography is the study of the physical features of an area which includes hills, valleys, rivers etc., which shows the land elevation and water features of an area. Geography is the study of Earth's landscape, peoples, places and environments. For the construction of MHP the topographical features of the Baidhyanath Khola are suitable. Most of the plant area lies in moderate slopy with full of slope terrain. There is no any sign of major landslide and other instability. The area is predominated by sedimentary and metamorphic rock consisting of shale, mudstone, and limestone. The altitude of the plant is 581m in intake and 488 m in powerhouse. The intake and diversion location is at the left bank of the Baidhyanath Khola and the bank of the river is strong and stable. The alignment of the 1700 m long head race runs through left bank of the Baidhyanath Khola which consists of rocky and grass land.

4.1.3 Hydrological Calculation

Hydrology is the study of water in the environment. It is the scientific study of the movement, distribution and quality of water on the earth. Annual River discharge data (in LPS) is tabulated below.

Table: 4.1.3 Hydrological calculation (Source: Detail Feasibility Study Report, 2010)

Sn	Month	River Discharge (LPS)
1	January	279.42
2	February	210.14
3	March	157.03
4	April	115.46
5	May	105.07
6	June	315.22
7	July	1294.35
8	August	1609.57
9	September	1154.64
10	October	752.82
11	November	525.36
12	December	384.49

4.1.4 Plant Size Calculation

Selection of the plant size is the main task of the project. Plant sizing depends on the factors like water discharge rate, Gross head, and the overall efficiency of the system including. Simple plant sizing calculation is given below.

$$\begin{aligned}\text{Power P} &= (Q \times Hg \times g \times \eta) / 1000 \\ &= (78 \times 36 \times 9.81 \times 55\%) / 1000 \\ &= 15 \text{ kW}\end{aligned}$$

Where,

Q = Design Discharge, 78 lps

H = Gross Head, 36 m

η = Overall efficiency of system

g = Acceleration due to gravity

4.1.5 Technical Information of the MHP

Gross Head	:	30 m
Measured Flow	:	112 LPS / 25 April 2010
Design Discharge	:	78 LPS
Power Output	:	15 kW
Length of Power Canal	:	1700 m
Type of Turbine	:	Cross Flow Turbine T 15, 21 kW
Type of Generator	:	30 KVA, 3 Phase, Synchronous
Type of Load Controller	:	ELC 15 kW with Ballas, 21 kW (7 nos of 3kW)
Penstock Type & Length	:	M.S. 220 mm ID, 72 m Long, 3.5 mm thickness
Length of T&D Lines	:	2940 m. of three phase & 1400 m. of single phase
Pole Type & Nos.	:	Wooden 39 nos-7 m height and 83 nos 8 m height
Productive End Uses	:	Agro Processing, Rural Carpentry, Poultry Farming

(Source: Detail Feasibility Study Report, 2010)

4.1.6 Drive Mechanism

When the water flowing in the penstock pipe hits the turbine, the kinetic energy of the water is converted into rotational energy of the turbine. The speed attained by the turbine is 750 rpm, but the rated speed of the generator is 1500 rpm. So, a flat Habasit belt is connected between the shaft of the turbine and the shaft of the rotor of the generator such that the gear ratio is 1:2 (750 rpm for turbine to 1500 rpm for the rotor of the generator). Since the magnetic field of the rotor is rotating at a relative speed to that of the stationary frame of the generator, an electrical energy is produced and is capable of providing this energy from its 3 phase terminals of the generator.

Belts have a tendency of getting loose in a long run, so to counter this condition, a sliding mechanism is incorporated with generator base, such that the belt remains tight even after a long operation. And for safety these belts are covered.

4.1.7 Control System

As we know the MHPs are system that utilizes the gravitational potential energy of freely flowing water from the height in order to generate AC electricity. An automatic control system is required for the robust operation of the micro-hydro plant to give high performance. The Electronic Load Controller (ELC) is used in this Micro Hydro Plant to maintain the speed of rotor generator at rated 1500 rpm and to control the frequency at 50 Hz for a long time. ELC is reliable; it improves system efficiency which helps to reduce energy prices. In the Baidhyanath Khola micro-hydropower , a 15 kW Electronic Load Controller (ELC) is installed with ballast unit to control the system load which helps to maintain the supply and demand side in order to avoid the overloading and underloading of the generator. A water immersion heater is installed as a dummy load. The heater is submersed in a separate water tank with continuous water flowing in and out of the tank. Heater is rated 21 kW (3 phase 220V, 7 heater of 3 kW each) having 3 phase 220 volt is installed as dummy load at separate water tank with continuous inlet and outlet flow of water.

4.1.8 Transmission and Distribution Network

Generated power is distributed through transmission and distribution lines to the different settlements and the voltage for three phase and single phase are 400 volts and 230 volts respectively. ACSR conductors are used for transmission and distribution purpose and the system is designed considering up to 10% voltage drop. Locally available wooden poles are used for T& D lines.

For support, of the poles, stay sets consisting of MS rod, stay bow, stay insulator, turn buckle and anchor plates are used. Shackle type insulators are used for laying the wire in the poles. Each shackle type insulator is used with D clamp nuts and bolts.

4.1.9 Earthing and Lightning Arrestors

Grounding is important for equipment safety and personnel protection in Micro Hydropower Plant (MHP). The performance of electrical and electronic system is affected by the state of earthing. A good grounding system is a must for safe operation of power system. The grounding system serves personnel safety, equipment and building protection, electrical noise reduction in low voltage network, which distribute the electric power to the end users. The main concern of earthing systems is the safety of consumers who use the electrical appliances and is important to protect them from electric shocks.

For Baithnath khola MHP a copper plate of area 600×600 mm and thickness of 300 mm is used for grounding of generator, distribution box and equipment bodies. As per the normal standard 3 meter earthing pit is covered by mixture of salt, fine silt and charcoal and 10 copper earthing plate of size 3 mm × 600 × 600 mm are used in T& D. The earthing plate is connected to the lightning arrestors and other metal parts through 8 SWG copper wires.

4.1.10 Protection System

Some specific protection system is used in MHP are under voltage (UV)/over voltage (OV) and under frequency (UF)/over frequency (OF) protection, which monitors the voltage and frequency of the electrical output of the generator continuously. If the

voltage and frequency exceeds prescribed level, the protection system output relay turns the alarm 'on' and trips out. The protection system includes MCCBs to protect against overloading and short circuit, thus preventing damage to the generator and other control equipment. A kit kat fuse is used instead of a much reliable MCCB in the main circuit. Consumers' connections are protected through MCBs of appropriate rating.

4.1.11 Maintenance Cost of the Project

Machines have their respective lifetime. Any kind of machine needs to be maintained well for operating it for long period. Periodical maintenance adds usable lifetime of a machine. From the detail feasibility study of the MHP, the annual repair and maintenance cost were estimated to be 3% of the total cost. But the situation is quite different in the practical field.

There is a saving group named Baidhyanath Khola Laghu Jalbidhut Bachat samuha and each house hold represents the group. A saving account is funded by the group members monthly, and they invest the money from the fund in 1.5 % interests to whom who needs it. After installation of the MHP there is no any financial assistance provided by any organization so the salary for the operator and the maintenance expenditure have been maintained by saved money. For the emergency maintenance the MHP saving group has some spare parts like bearing and grease and some others. A local resident is appointed as the operator of the MHP who has also received some training for that. Sometimes the operator does the maintenance himself. Operator is the well trained local person so it is easy and reliable for the operation of the plant.

4.1.12 Population Diversity Information of the MHP Users' Household

Baidhnath Khola micro hydro power plant is proving to be fruitful to the local community. This plant has helped to foster the growth and well-being of the locals. Now the locals use the electricity from the plant for not only to light their houses but in different fields like in agriculture, in irrigation, in small scale industries, in business, in health, in education etc. And this plant has helped for adapting to new technologies, which has come with the use of the electricity. The status of rural livelihoods should be also measured on the basis of the population diversity in the rural community, which

helps to identify the problems and necessary steps for mitigation can be taken time to time.

Based on the information collected from the field visit by communicating with the locals and from questionnaire filled by the locals of the area, some results are summarized below.

4.1.13 Population Diversity on the Basis of Group (*Samuha*)

The people of Bhalayedanda VDC who have subscribed for electricity from Bhalayedanda Micro Hydropower Plant are grouped into 8 (eight) categories, namely –

- i) Bhulke
- ii) Chakamake
- iii) Dalmukhi
- iv) Makhamali
- v) Pakhre
- vi) Shera
- vii) Titribot, and
- viii) Toribari

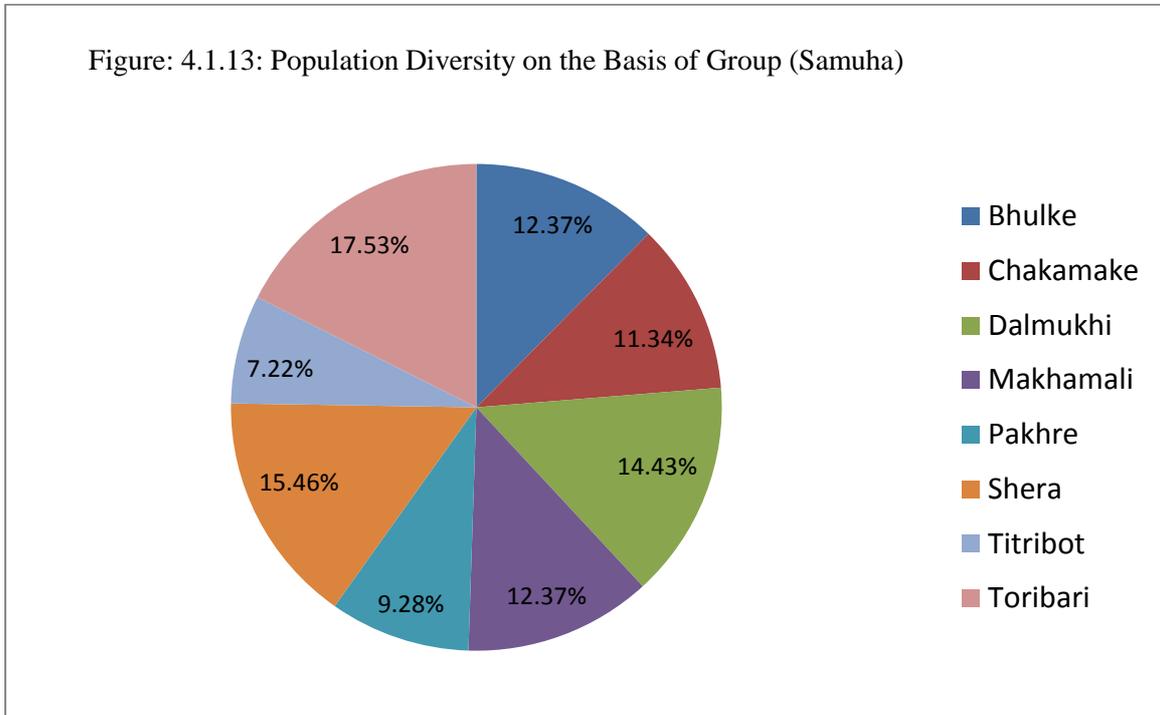
These groups collect money for using electricity from their respective subscribes and submit the collected money to the accountant, making the money collecting process easier.

Table: 4.1.13: Table of Population Diversity on the basis of Group (*Samuha*)

S. No.	Group (<i>Samuha</i>)	No. of household
1.	Bhulke	12
2.	Chakamake	11
3.	Dalmukhi	14
4.	Makhamali	12
5.	Pakhre	9
6.	Shera	15

7.	Titribot	7
8.	Toribari	17

Source: Field Survey, 2017

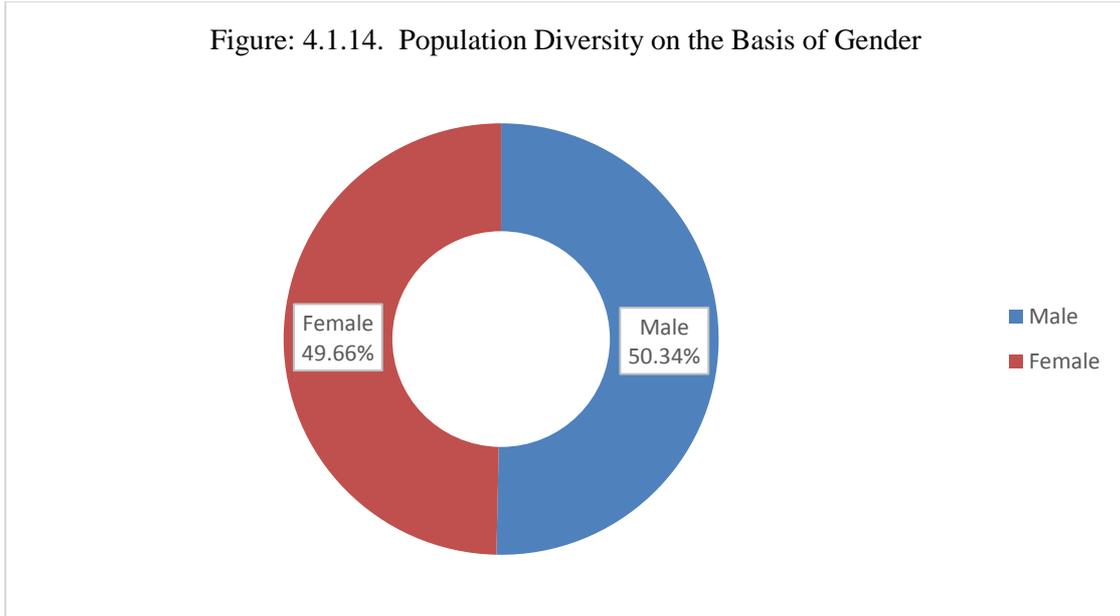


Source: Field Survey, 2017

4.1.14 Population Diversity on the Basis of Gender

During the field survey, sample was taken from 25 households to find out the population diversity on the basis of different angle. From the data it was clearly seen their cast, and their number of male and female family member. This is mentioned below.

Figure: 4.1.14. Population Diversity on the Basis of Gender



Source: Field Survey, 2017

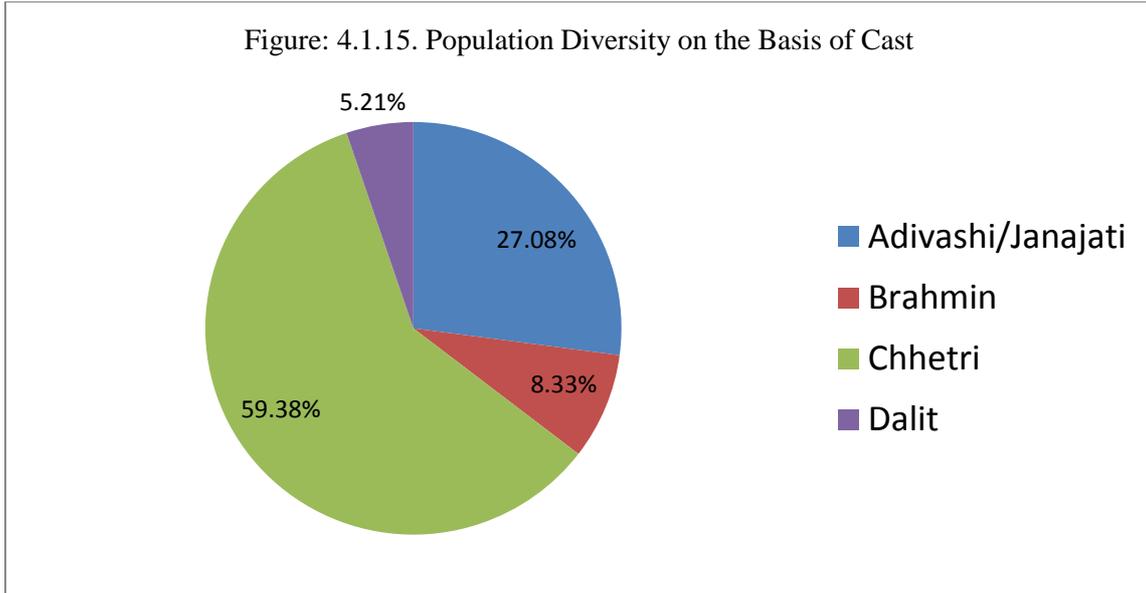
From the above figure, there seems to be an even distribution in the population on the basis of gender, with almost equal percentage of male and female population amongst the total population of the MHP users of Bhalayedanda village.

4.1.15 Population Diversity on the Basis of Cast

Table: 4.1.15: Population Diversity on the Basis of Cast

S. No.	Caste	Percentage
1	Adivashi/ Janajati	27.08
2	Brahmin	8.33
3	Chhetri	59.38
4	Dalit	5.21

Source: Field Survey, 2017



Source: Field Survey, 2017

Based on the above figure, amongst the total population, characterizing based on the cast, the largest in the population (60%) are Chhetris and the second largest in the population (27%) are Adibashi, Janajati with the lowest in population (5%) are Dalit.

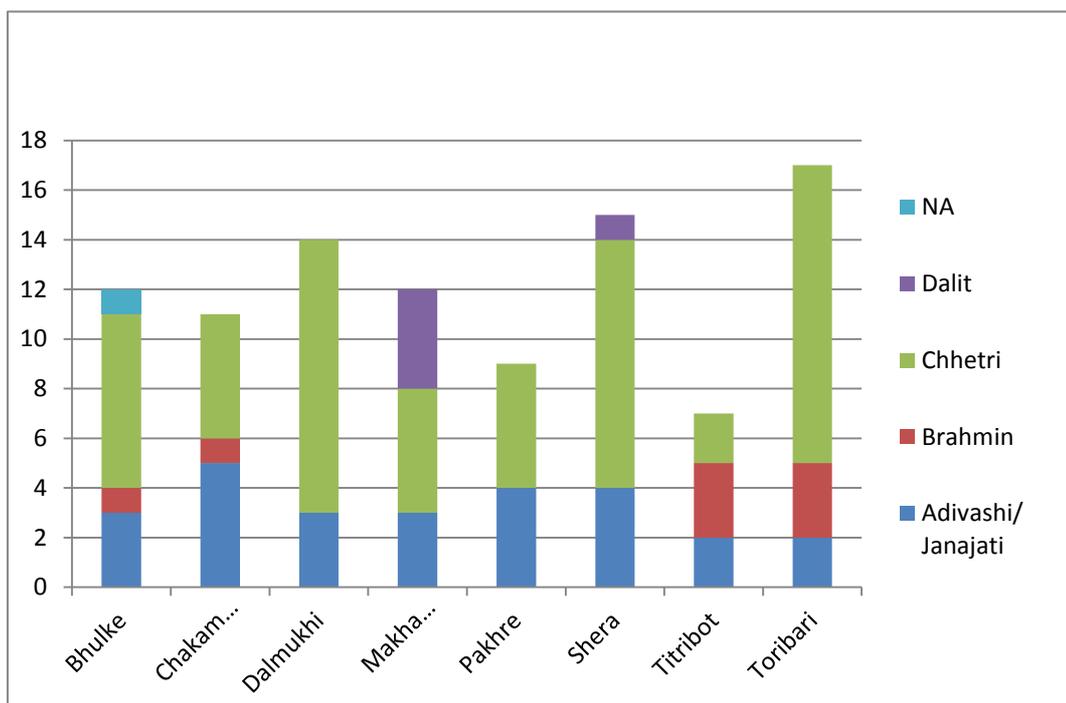
4.1.16 Population Diversity on Each Group (*Samuha*) on the Basis of Cast

Table: 4.1.16 Population Diversity on Each Group (*Samuha*) on the Basis of Cast

S. No.	Samuha	Adivashi/Janajati	Brahmin	Chhetri	Dalit	NA	Total
1.	Bhulke	3	1	7	0	1	12
2.	Chakamake	5	1	5	0		11
3.	Dalmukhi	3	0	11	0		14
4.	Makhamali	3	0	5	4		12
5.	Pakhre	4	0	5	0		9
6.	Shera	4	0	10	1		15
7.	Titribot	2	3	2	0		7
8.	Toribari	2	3	12	0		17
						Grand Total	97

Source: Field Survey, 2017

Figure: 4.1.16 Population Diversity on Each Group (Samuha) on the Basis of Cast



Source: Field Survey, 2017

4.2 Socio-Economic Impact of Baidhyanath Khola MHP on Rural Livelihoods.

It is important to discuss about the socio-economic impact brought by Baidhyanath Khola MHP in study area. In a comparative study of public life style before and after installation of MHP a positive change has been seen to be invited in the life of people and a distinctive brightness can be seen in the face of society. New enthusiasm has been added to the society. Many new local businesses have bloomed. Students' learning and thus education has improved. The study has shown improvements in teaching learning process in schools. Women empowerment is taking place. Cultural harmony and interaction among one another can be seen. Everyone has seen similar participation in the development. Villagers have got the opportunity to hear new news through television and other electronic media. The society is going to be friendly with new technology. Female entrepreneurs are growing. Establishments of new industries, training centers and other institutions are increasing. Banks and cooperative institutions have been established. Income-oriented, skill based and job oriented training programs are being

conducted. Modernization can be seen in agricultural fields. People seem to be politically sensitive. The lights in the village have brought a rainbow. It is delightful to hear that the MHP has been inviting a new dawn in the village.

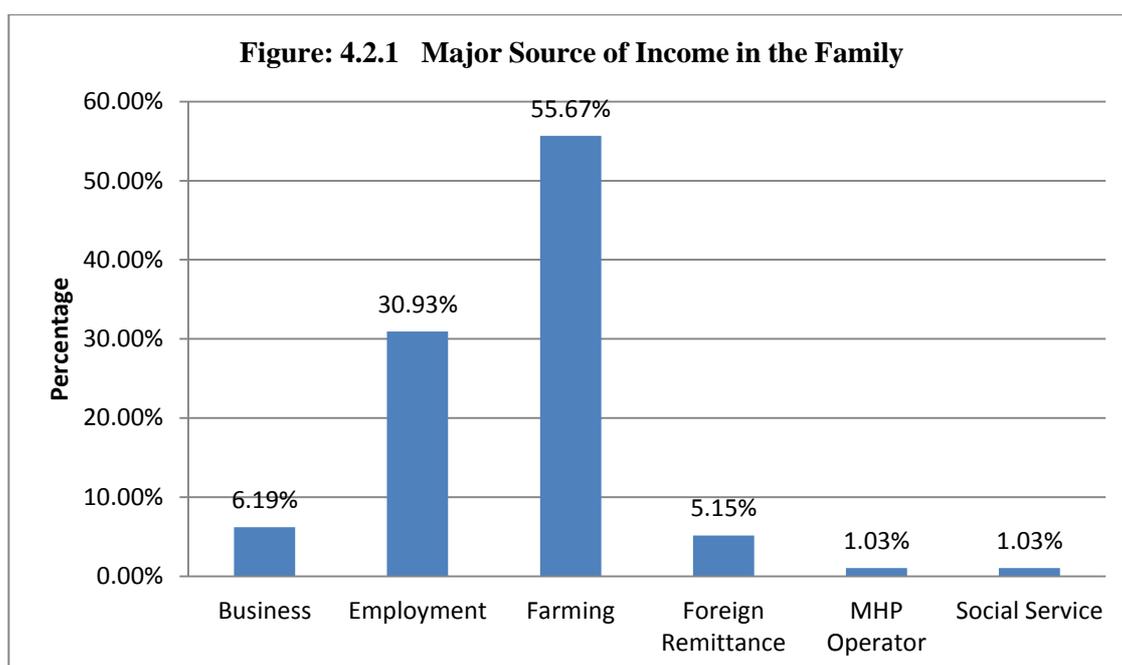
In this study, this chapter belongs to data analysis and their interpretation which is done with the help of table, pie chart and bar-diagram. Significantly, section 4.3 concerns with socio-economic condition of a sector where MHP is installed. It focuses on the sustainability of plant, role of MHP in rural electrification, perception of people in study area, changes in various field brought by MHP and its impact in education, economy, agriculture, culture, religion, politics and so on.

4.2.1 Major Source of Income in the Family

Table: 4.2.1. Major Source of Income in the Family

S. No.	Major Source of Income	Percentage
1.	Business	6.19%
2.	Employment	30.93%
3.	Farming	55.67%
4.	Foreign Remittance	5.15%
5.	MHP Operator	1.03%
6.	Social Service	1.03%

Source: Field Survey, 2017

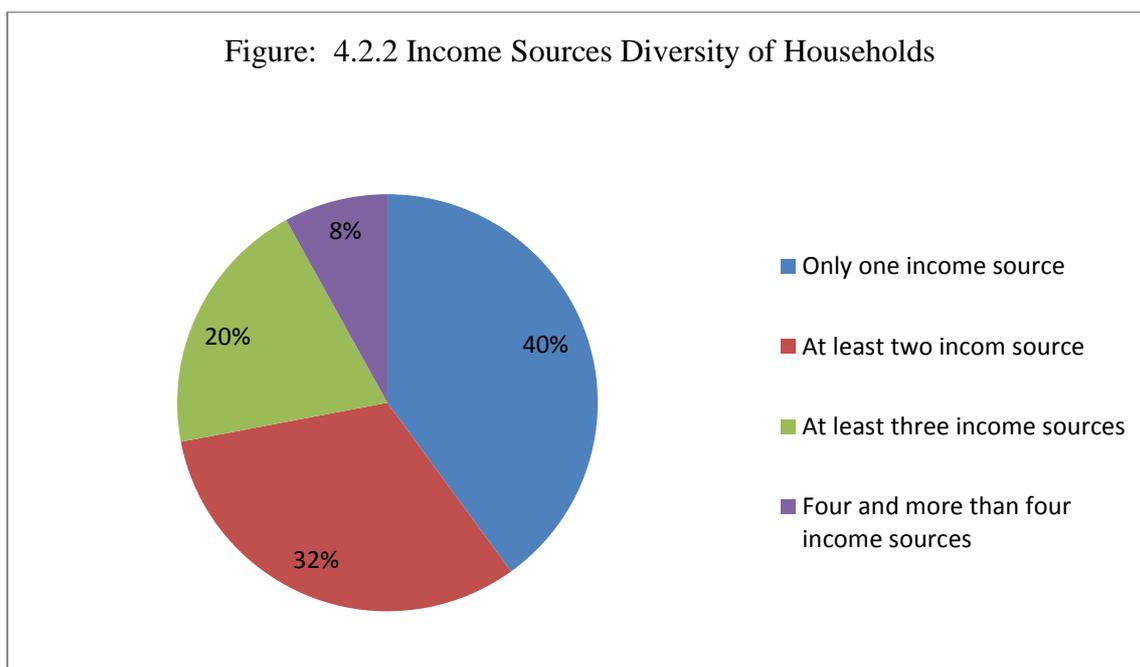


Source: Field Survey, 2017

4.2.2 Income Sources Diversity of Households

Before MHP the main source of income was agriculture and along with that some members were doing different jobs also, but after the installation of MHP their ways of income sources are increased, like some new entrepreneurs started new businesses. Out

of 25 households respondents, 40% households have only one income source, 32% households have at least two income sources, 12% households have at least three income sources and 16% households have four or more than four income sources. Below table exhibits multiple income sources of households. Micro hydro power project has opened the new door for community for generating their income and to make their life easier.



Source: Field Survey, 2017

4.2.3 Role of MHP in Education.

Access to electricity in village has been facilitating sustainable economic and social growth since its installation and this is continuing. Achievement gained in educational sector can be counted and are unforgettable. In early days, students were compelled to study only during sun shining but nowadays they are able to study early in the morning or late into the night by the help of electricity. It means access to light has helped to teachers also for extra hours of teaching earlier and later in the day. Interviews with teachers in school indicated that they started to recruit quality teachers and improvements of the students have been seen on the tests and exam.

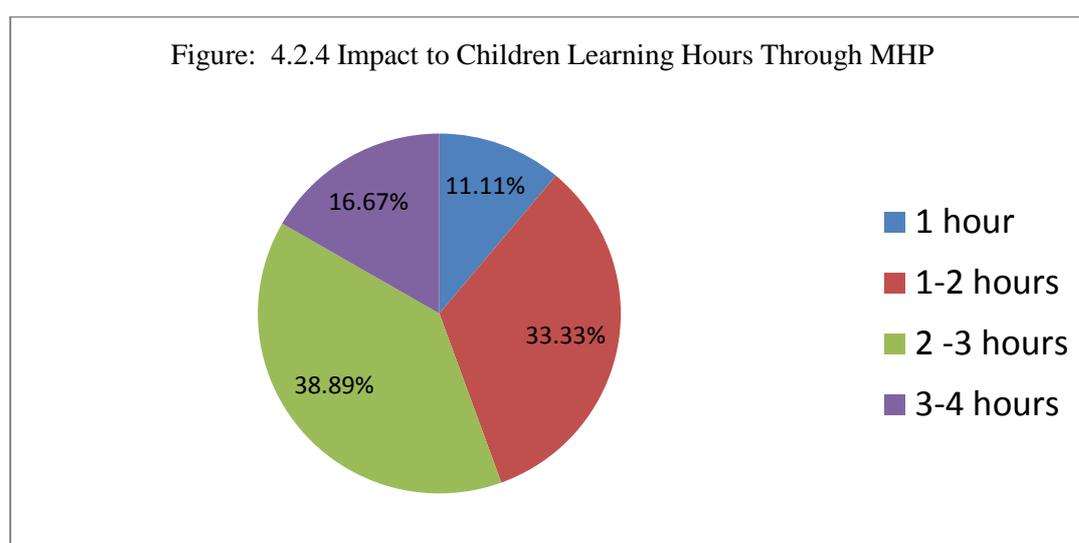
4.2.4 Impact of Children Learning Hours Through MHP.

Collection of data through interview from the students, guardians and teachers and group discussion about students' study hour describes that positive impact can be seen in the study of children. Their performance is being better comparatively in study. It was quite difficult to study in the dim light of kerosene lamp at the time of unavailability of electricity but MHP helped to increase the efficiency of students for learning because they have got extra hours for learning in the light of electricity. Randomly total 36 persons were asked about their study hour increased by MHP and result shown below in the table.

Table: 4.2.4 Impact to Children Learning Hours Through MHP

S. No.	Increased study hours	frequency	percentage
1.	One hour per day	4	11.11%
2.	One to two hours per day	12	33.33%
3.	Two to three hours per day	14	38.89%
4.	Three to four hours per day	6	16.67%
	total	36	100%

Source: Field Survey, 2017



Source: Field Survey, 2017

Among 36 samples, it is clearly seen that 38.89% students accepted that their learning time increased by 3 to 4 hours daily whereas 33.33% students accepted an increase in their study time by 2 to 3 hours daily. Likewise, 16.67% got additional 1 to 2 hours a day for study and only 11.11% has got 1 hour increasing time for learning. Hence, students' additional learning time has improved their education. They are learning and improving their habit because all these are the part of education they got by the help of MHP.

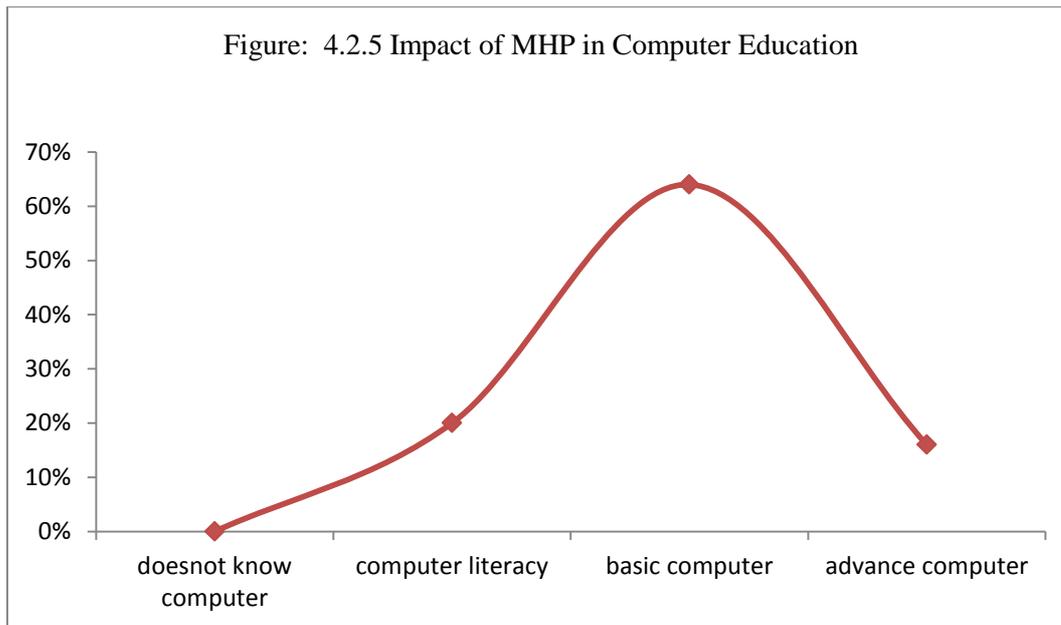
4.2.5 Impact of MHP for Computer Learning.

In early days education could be obtained only by either reading books or listening from teachers. Butnowadays there are different kinds of medium to receive education like computer, email, internet and other electronic media. Computer has become one of the important devices for an average public and, thus, in the recent days, computer has become a must in the education sector. For data collection of computer education total 25 students and trainees of MHP users were asked whether they know or operate computer or not and result is as below.

Table: 4.2.5 Impact of MHP for Computer Learning.

Knowledge of computer	frequency	percentage
Does not know computer operating	0	0.00%
Computer literacy	5	20%
Basic computer learning	16	64%
Advance computer learning	4	16%
total	25	100%

Source: Field Survey, 2017



Source: Field Survey, 2017

Out of 25 MHP user respondents from different schools and training center, nobody was found oblivious about computer. At least 20% were found to have computer literacy, 64% respondents have basic computer knowledge who knows to operate word, excel, power point, email and internet and 16% has obtained advance computer learning education. It shows that due to availability of electricity from MHP, schools have computer facilities and computer training centers are opened in the local area. This is also a great example of positive improvement seen in the field of education invited by MHP.

4.2.6 Change in Different Habits Between MHP Users and Non-users by Using Electrical/Electronic Appliances/Devices.

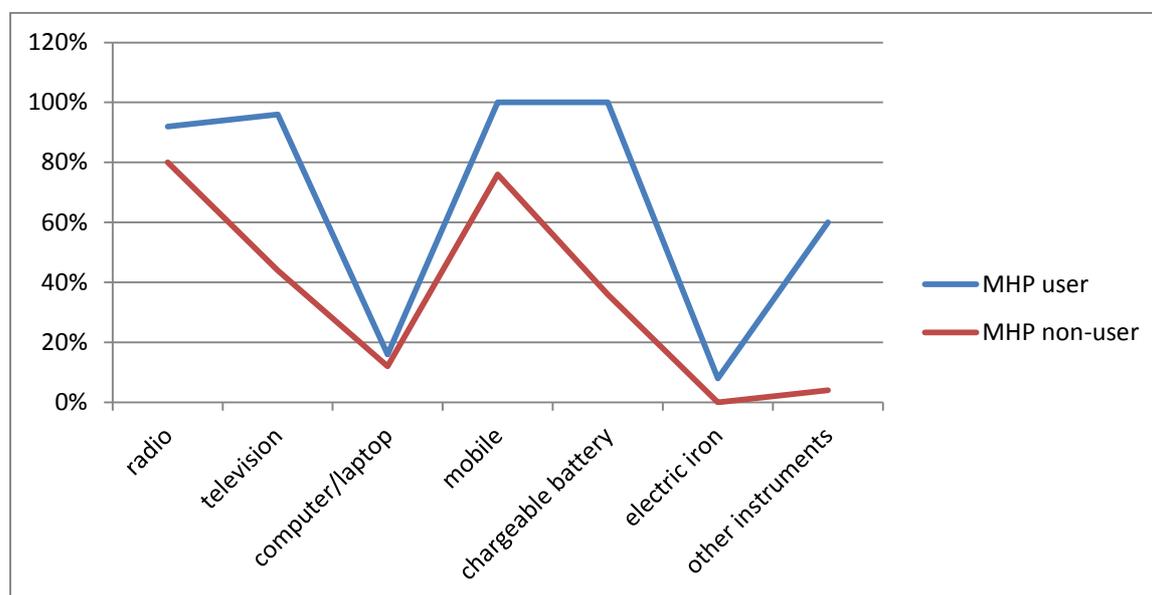
Obviously, Electricity users are more developed than non-users because of various reasons. When there was no MHP in the studied area, people from limited houses use radio and tape recorder by using battery and some few houses use solar panel for television/computer in rare case. But they were getting no continue and sufficient supply because they were facing battery charging problem and solar panel system maintenance problem. But after MHP installed they have been using electricity without any disturbance. A local experienced technician is available there who looks after the MHP. Here some data are collected from MHP users and non-users regarding the using of electrical/electronic appliances and compared them.

Table: 4.2.6: Change in Different Habit Between MHP Users and Non Users by Using Electrical/Electronic Appliances

	Electrical/electronic appliances	MHP user house	MHP non user house
1	Radio	92.0%	80%
2	Television	96%	44%
3	Computer/laptop	16%	12%
4	Mobile	100%	76%
5	Chargeable Battery	100%	36%
6	Electric Iron	8%	0%
7	Other instruments	60%	4%

Source: Field Survey, 2017

Figure: 4.2.6: Change in Different Habit Between MHP Users and Non-Users by Using Electrical/Electronic Appliances.



Source: Field Survey, 2017

The data on chart expresses MHP user 92% households have radio whereas 96% users have television. It is quite surprising that radio users are less than television user because television is an audio video device. Slowly people are leaving to maintain radio. 16% households have computer/laptop but 100% households have mobiles. It is quite

interesting because MHP has brought revolutionary change in technology users. 8% MHP user households use electric iron and 60% use other electrical and electronic appliances like rice cooker, electric water jug, heater etc.

While looking at the result of MHP non users, the study found that 80% households have radio whereas only 44% have television. Some MHP non-users have solar panel provided by AEPC or some has been obtained from other source. Also some houses have both solar panel and MHP connection. Only 12% MHP non user households have computer/laptop, 76% have mobile. Likewise, 36% have chargeable battery, no one use electric iron but only 4% MHP non user have other electrical and electronic appliances. Hence, it can be seen that the MHP users are more benefitted in comparison with the non-users.

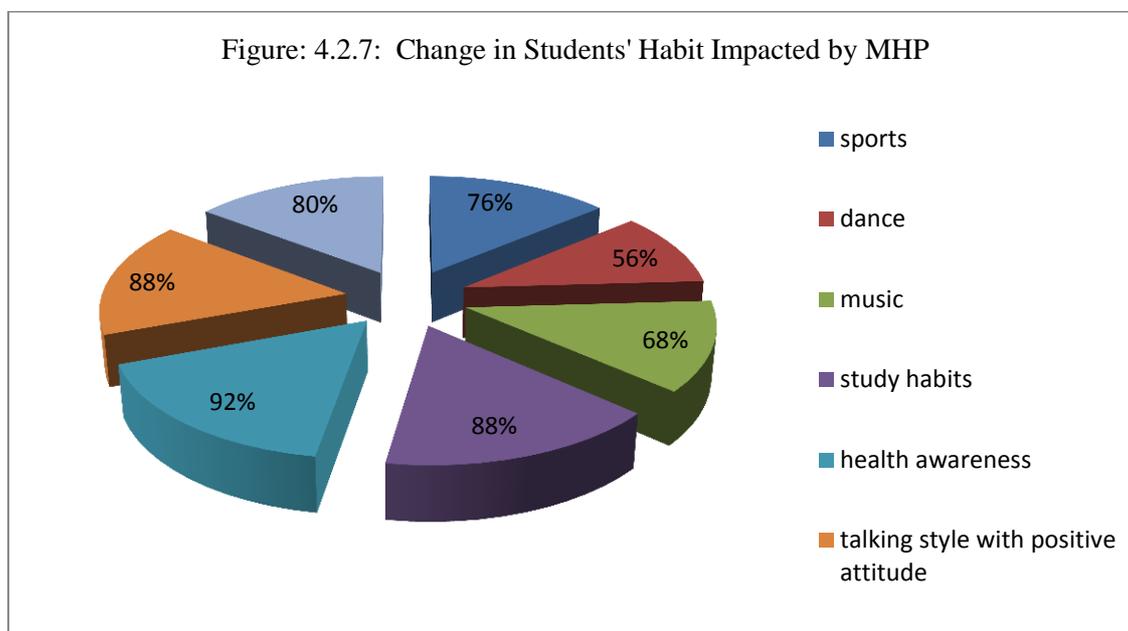
4.2.7 Change in Students' Activities Impacted by MHP

When electrical supply in the village was started by MHP overall performance of the children were impacted positively because they used electrical instruments, they watched different channels in television, they played with computer and mobiles and they used internet which have caused multiple changes in their behavior. The following sample data were obtained by studying 25 respondents on the basis of their deep interest in different fields. Not only children but also other members of the MHP users household have positive impact in their life in some manner.

Table: 4.2.7: Change in Students' Habit Impacted by MHP

S. No.	Activities increased due to MHP	Improved percentage
1.	Sports	76%
2.	Dance	56%
3.	Music	68%
4.	Study habits	88%
5	Health awareness	92%
6	Talking style with positive attitude	88%

Source: Field Survey, 2017



Source: Field Survey, 2017

4.2.8 MHP User Industries

Without electricity no industry, organization, firm or any other institutions can run. In study area, MHP has now become backbone of the village, because there are some industries and institutions, which are running with the help of power supply received by MHP. If we evaluate in in present time of the village, we can see, nowadays villagers are quite busy in doing their work according to their needs. They are making income source by doing different activities. They are going economically forward in comparative to the previous days. Their children are receiving good education. Poultry farming is also running surrounding the area and supplying to the markets in good price. Similarly furniture house is also running in smoothly. People in the village do not need to go somewhere else! to make furniture. Local furniture house produce good products at cheap price. With availability of electricity computer training center is also running in the study area. People of any age can have opportunity to learn computer. Likewise many other businesses have been running smoothly. Directly and indirectly many people have got job for their income.

There are some industries/firms/training centers mentioned below

Table: 4.2.8: MHP User Industries/Firms

Types of Firms	Number
Furniture house	2
Poultry farm	1
Grocery shop	3
Computer institute	1
Tailoring	1
Crushing mill	1

Source: Field Survey, 2017

4.2.9 Irrigation Facilities Due to MHP

Agriculture is the main occupation of the village. But agriculture needs irrigation facility. For that Small Irrigation Project (SIP) took responsibility to make concrete canal. Before the construction of concrete canal earthquake damaged it and just 10-12 kW electricity was produced. In the dry season that in the three months of chaitra, Baisakh and Jestha the plant would be stopped. But after the construction of concrete canal plant has been whole running 12 months in full phase producing 15 KW power. In the irrigation project local man power contributed and local materials were used. Due to the presence of MHP and the construction of concrete canal the people of the village are benefitted in irrigation sector too. Nowadays water flows frequently through the canal and there is no leakage through it. Both hydropower and irrigation system is in good operation which is possible by the unity of local people. It is one of the good examples of community participation in development works. On one hand, MHP is running and giving service to community, and on the other hand farmers are getting irrigation facilities through the same canal.

4.2.10 Sanitation Facilities Due to MHP

Water is one of the most important basic needs for plants, animals and human beings around the earth. No one can imagine life without it. It is importance to be able to manage water for life. Care must be needed in sanitation (e.g. adequate sewage disposal) because it is related to public health or maintaining cleanliness like clean drinking water.

During the survey, it was found that the villagers have already gone through awareness program conducted by some NGOs. After the installation of MHP villagers have been viewing and listening programs in the TV and radio, which has brought positive changes in their life regarding the indoor and outdoor sanitation. Now they know negligence of sanitation may invite many difficulties in their life and allows many kinds of health problems due to diseases. Each respondent accepted that after the installation of in their village, they are maintaining more neatness and cleanliness. They have facilities of tap for drinking water and built toilets in each house.

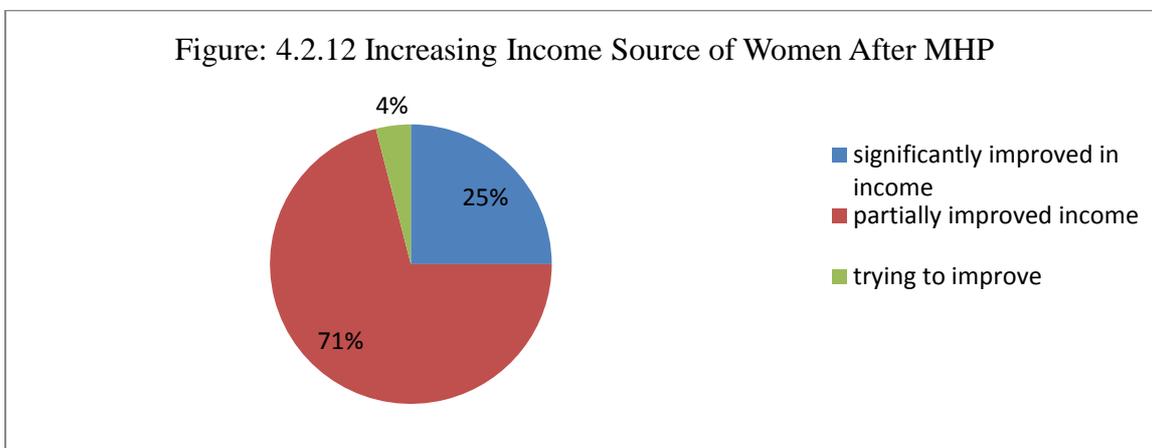
4.2.11 Positive Impact of MHP in Health

For a long time villagers had been suffering from the hazards of smoke due to firewood and kerosene. Their health condition was poor. Especially women suffered from respiratory diseases while staying long time in the kitchen for cooking. Similarly, students and children also suffered from while studying in the light of kerosene lamp. Smoke from the firewood and kerosene lamp caused serious health diseases in the villagers' life. However, electricity provided by MHP replaced kerosene lamp and reduced the use of firewood. Hence, respiratory problem and eye infection including other health problems due to smoke was reduced. People would watch program related to health and education in television regularly which helped them to be aware of their health. Study showed the improvement in health. Diseases like bronchitis, asthma, headache, heart diseases, and eye infection was decreased.

4.2.12 Increasing Income Source of Women After MHP

Electricity has become one of the major components which significantly changed the life of villagers in study area. MHP has provided different kind of opportunities to the rural people. Women were also participating in income generated work. They were also supporting family by earning money. Some women have handled the businesses like grocery shop, poultry farming, mushroom farming, vegetable farming, goat farming and tailoring. During the study respondents have accepted that they were having their income due to MHP. The following chart shows that 71% respondents agreed that they have partially improve their income while 25% respondents said, they significantly improved their income. But still 4% women were trying to improve their life. They wanted to participate in income generation program in future. It is quite difficult for

women because they have to look after their family also. But surprisingly, the result indicate, that the women of the studied region are forward and hard working. If opportunity is provided to them they could achieve success in every field.



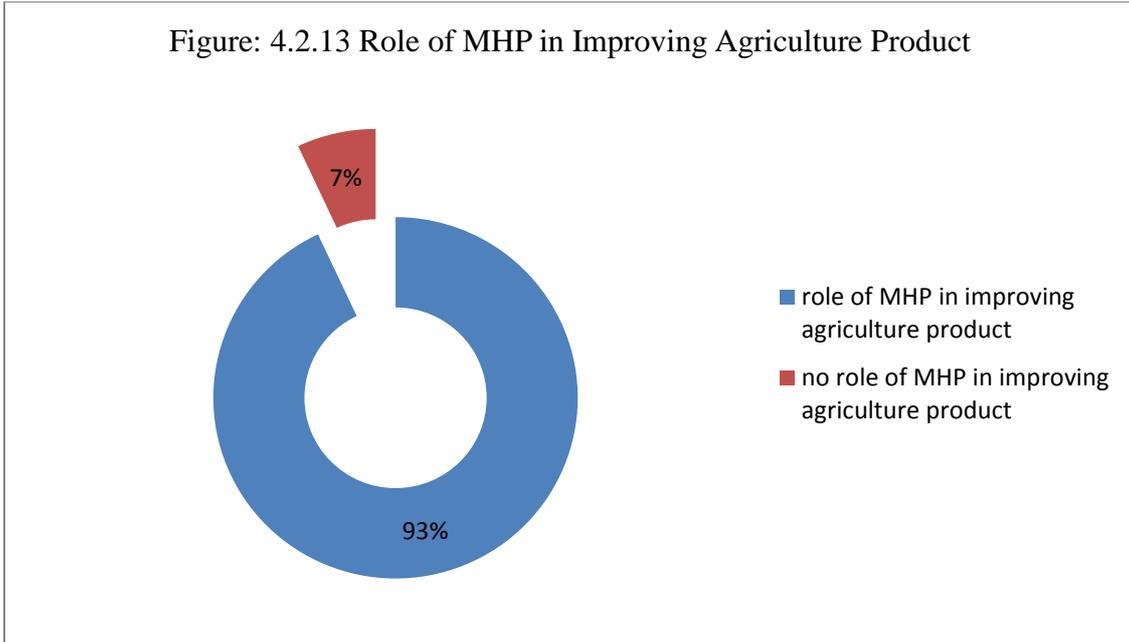
Source: Field Survey, 2017

4.2.13 Role of MHP in Agriculture Product

The main occupation of this study area is agriculture. But along with agriculture some villagers have adopted their other business also. When MHP was not installed, irrigation was irregular because concrete canal was not prepared there. The land areas of this village seem ends to have plenty of potentials especially in the agriculture sector. The main objective of the irrigation is to increase income of rural people from agriculture.

There are two irrigation programs extracted from Baidhyanath River which lies in Udayapurgadhi rural municipality, previously called Bhalayedanda VDC. One is "Thulo Kulo irrigation program" which occupy 17 hector land area for irrigation. Total 74 houses are benefited from this program. The length of canal is 1125 meter. Another one is "Titribot Kulo Irrigation Program" which irrigates 11 hector land and 38 houses are benifitted. The length of the canal for irrigation is 1062 meter. Both irrigation programs were conducted under SIP which is conducting by government of Nepal in collaboration with Federal Department of Foreign Affairs (FDFA), Swiss Agency for Development and corporation (SDC). This irrigation program is handled by local consumers' committee. For these irrigation program the priority was given for local source, local tools and local manpower. Now the relation of MHP and irrigation is attached together. In study, majority of the villagers agreed with the improvement of agriculture product.

Figure: 4.2.13 Role of MHP in Improving Agriculture Product



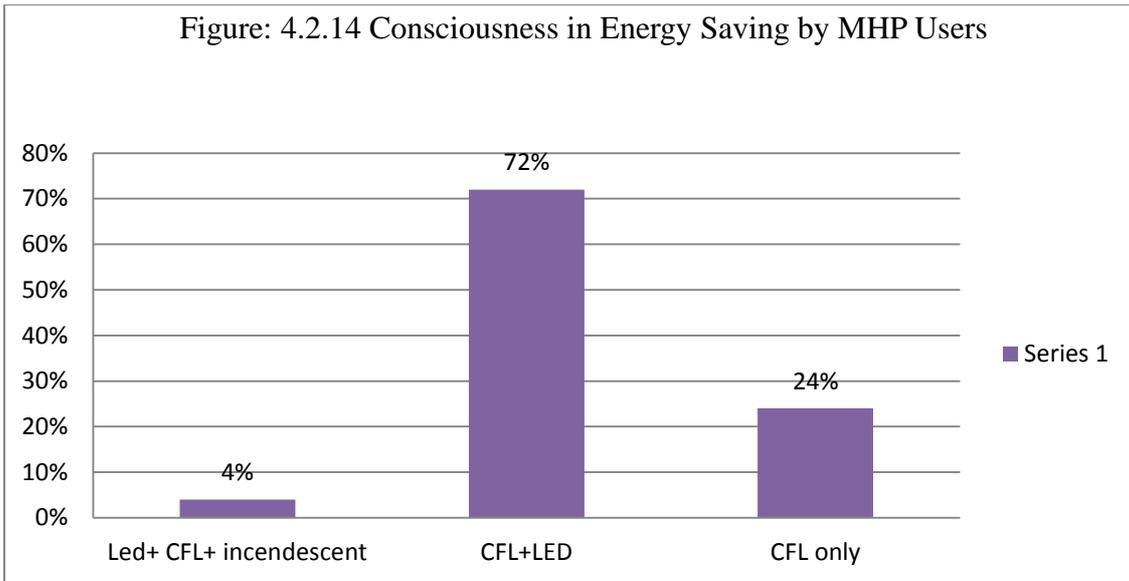
Source: Field Survey, 2017

4.2.14 Consciousness in Energy Saving by MHP Users

When we use electricity we have to be conscious with electric appliances such as electric bulbs. There are different kinds of light bulbs in the market. Over the years technology of lighting appliances has drastically changed. Energy saving is a topic of supreme importance. We have to expend on energy-efficient lighting reduce our energy bills. Traditional incandescent bulbs consumed a lot of energy and are no longer manufactured. Modern LED based bulbs are energy efficient, durable and long lasting.

It is also concern to study if the MHP users were conscious about the development of energy efficient appliances and their help in the reduction of electricity expense. Thus, during the field visit, use of incandescent bulbs, CFL, and LED was surveyed. The data of users is shown in the following chart..

Figure: 4.2.14 Consciousness in Energy Saving by MHP Users

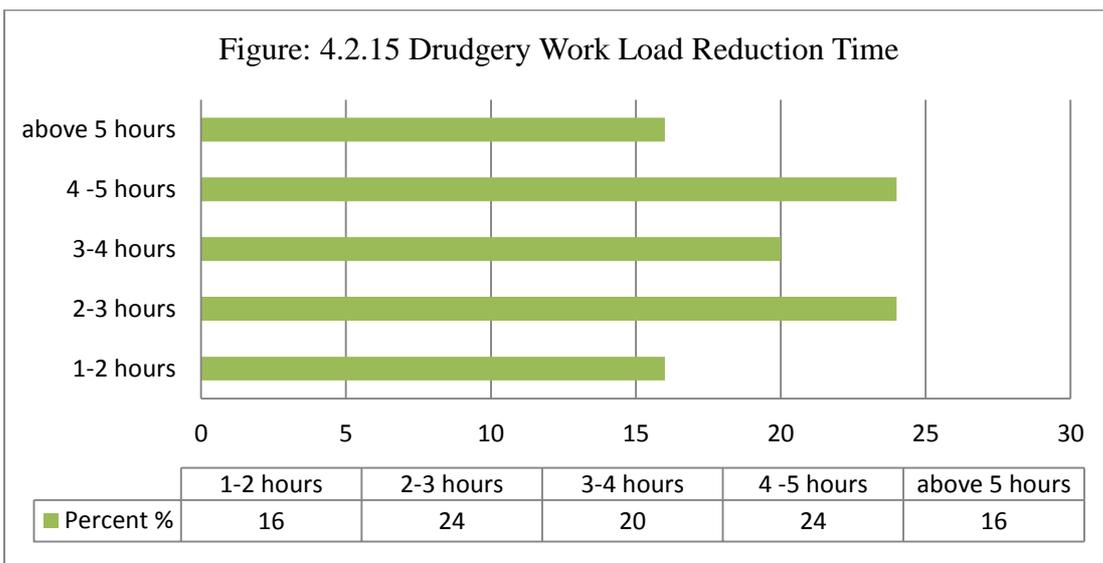


Source: Field Survey, 2017

It was found from the survey that 4% respondents used LED, CFL and incandescent bulbs in their house. 72% respondents used both CFL and LED bulbs in their house, and 4% used only CFL bulbs. Result showed that MHP user households are replacing their traditional bulbs by new ones.

4.2.15 Drudgery Work Load Reduction after MHP

Figure: 4.2.15 Drudgery Work Load Reduction Time

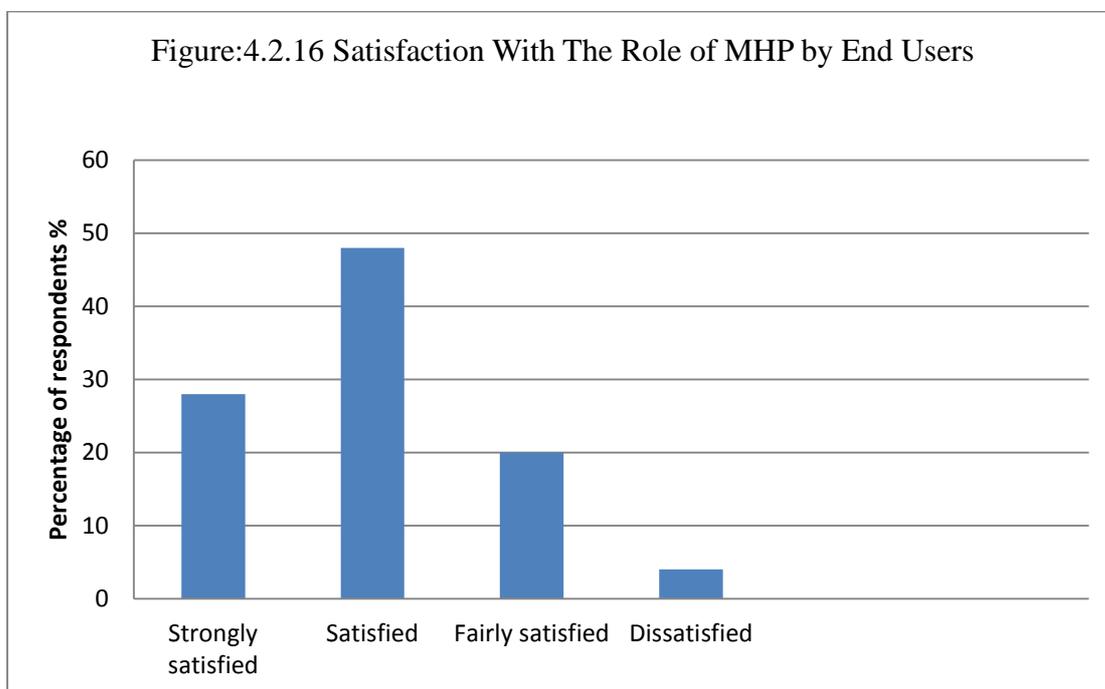


Source: Field Survey 2017

Rural electrification through MHP helped to reduce drudgery work load of community members especially of women by increasing access to modern agro-processing mills in the village, and they have been utilizing their saved time in another households or income generation activities. Drudgery work load reduction time seemed as follows: 16% households saved 1to 2 hours time, 24% seved 2 to 3 hours time, 20% saved 3 to4 hours time, again 24% saved 4-5 hours time and again 16% saved above 5 hours time from drudgery work load. It was clearly seen in the survey that the access of electricity reduced drudgery work and people have got enough time to be participated in social, income-generation and community development activities and other households work as well.

4.2.16 Satisfaction With The Role of MHP by End Users

In the survey households respondents were asked about their intension towards the satisfaction of role of MHP. 24% respondents in the study area confirmed that they were strongly satisfied, 48% stated that they were satisfied, and 20% stated they were fairly satisfied, but 4% stated they were dissatisfied.



Source: Field Visit, 2017

4.3 Role of Micro-Hydro in Environmental Conservation

For the environmental conservation role of micro-hydro is essential. Environment is connected with nature. Natural capital is one of the important components of livelihood assets, and they are forest, land wild resources, water, air quality, erosion protection, waste assimilation, storm protection biodiversity degree and rate of change (DFID, 2001). All these are concerned with environment. Environment is of great importance in the area of micro hydro project. It's a great issue for the sustainability of micro-hydro. The availability of adequate water discharge throughout the year maintains the capacity of micro-hydro project. Well-maintained forest will ensure sufficient water resource. Negative impact of environment invites landslide, sedimentation, soil erosion, flood and other natural disasters which ultimately create adverse impact to the micro hydro-power project. To ensure continued power supply to the community, it is necessary to regulate the use of water resources, otherwise disrupt the operation of plant.

After the installation of MHP, different kinds of activities are being held in the study area for the conservation of environment. Radio, Television and other electronic media broadcasts the programs related to conservation of environment, NGOs, INGOs and other organizations also sometimes conduct awareness programs about conservation of the environment. Sometimes community people discuss themselves for the betterment of local forest and environment.

4.3.1. Environmental Aspect of MHP

Protection of environment should be kept in mind when we go to establish new projects. Generally, environmental problems occur due to mismanagement of natural resources, so the possible adverse impacts of the project on environment and their consequences should be studied during the planning stage of a project. And if any negative impact is foreseen, suitable remedies for such impacts must be identified for the sustainability of the projects.

During the study, it was found that Baidhyanath Khola MHP was established in such a place in such a way, so that the impact on environment was as minimum as possible. Biological impacts on vegetation, forest resources, wild life, crops and aquatic life was in tolerable limit. During the study related to physical impact, it was found that it was

not very much affected by flood, landslide, and soil erosion and no effects were implicated in water and soil quantity.

As the MHP was small scale, so no huge excavation work was done at the intake. It was designed to release minimum of 15% flow in dry season, which would help in preserving the flora and fauna in the downstream. The head race canal is passing through bushes barren land and thin forest, so there is no risk of flooding. Fore-bay area is also located in the bushes and barren land area. The spill water from the fore-bay tank is diverted to the existing irrigation canal. Hence, there is no any risk of erosion. Power house is located in the left bank of Baidhyanath khola and tail water is diverted to existing irrigation canal. There is no heavy excavation and tree cutting. Hence, there is no risk of flooding and soil erosion. Selection of strip of land for the construction of micro hydro components is appropriate. There is no problem of land acquisition and resettlement.

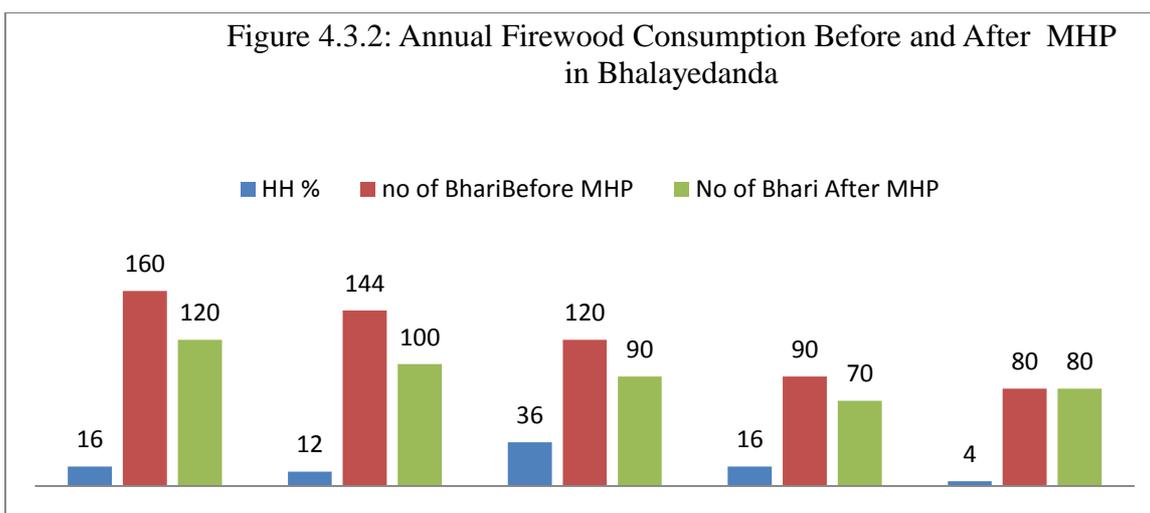
From the study, it was found that environmental impact identification and means of mitigation for MHP are also assessed. Possible environmental impacts in some sections of MHP such as potential soil erosion caused by flushing flows from sedimentation basins and overflow of the fore-bay, dewatering of a section riverbed from the intake, potential ground instability caused by construction and leakage from canal. There were small bushes and few trees in the project alignment. A few trees were cut and used for electric poles. For preventive measures awareness programs were conducted and tree plantation were applied to mitigate the adverse impacts along the canal, intake and penstock alignment.

Thus, there was not any negative impact occurring in the project area and the project did not disturb any households and major cultivable land. Due to this favorable condition after having MHP, land price and market activities were increased considerably.

4.3.2 Role of MHP in Reducing Deforestation

Deforestation is the main problem of the country. In the rural sector, one of the reasons of deforestation is the use of firewood and timber. Still people in the remote village rely on firewood for cooking and other purpose. Until and unless we provide alternative for that, it is difficult to mitigate the problems. And the best alternative is micro-hydro power plant which can provide electricity to the villagers for their day to day usage. In

the study area where MHP is installed, people nowadays are being conscious towards conservation of forest. They sometime discuss about the issue of deforestation. Leaders of the political parties, local community, teachers and students, NGOs, INGOs, all these are the stakeholders who raise the question of reducing deforestation with possible solutions like conducting awareness programs, using alternative way for cooking, doing plantation etc. After MHP the consumption of fire wood is decreased which is shown in the figure below.



Source: Field Survey 2017

Still, wood is considered as the main source for cooking in the village, as electricity from MHP is not sufficient for cooking. However, since the inception of MHP the consumption of wood has decreased. Annual consumption of firewood seemed as follows: 16 percent households have reduced firewood consumption from 160 bhari to 120 bhari, 12 percent households from 140 bhari to 100 bhari, 36 % households have reduced 120 bhari to 90 bhari, and 16% have reduced from 90 bhari to 70 bhari, but 4% have same consumption of 80 bhari before and after MHP. Some households use cooking gas for cooking. People have realized that the forest should not be destroyed. Community forests have also made people responsible for forest conservation. Broadcasting of forest related programs in radio and television has played significant role to conserve the forest and wildlife. But there is still much work to be done. We have to conserve our forest heritage. For that, electricity is one of the most alternatives of firewood.

4.4 Role of MHP in Rural Electrification.

Waiting for national grid electricity line was taking a longer time. People in the village living their life in uncertainty of whether NEA start to take step for electricity or not. Situation made them to live under kerosene lamp. Due to topographical conditions it is quite technically difficult and economically expensive to extend the national grid to this area, yet but it is not completely impossible because concerned place is located under the mountain in a plane geographical region.

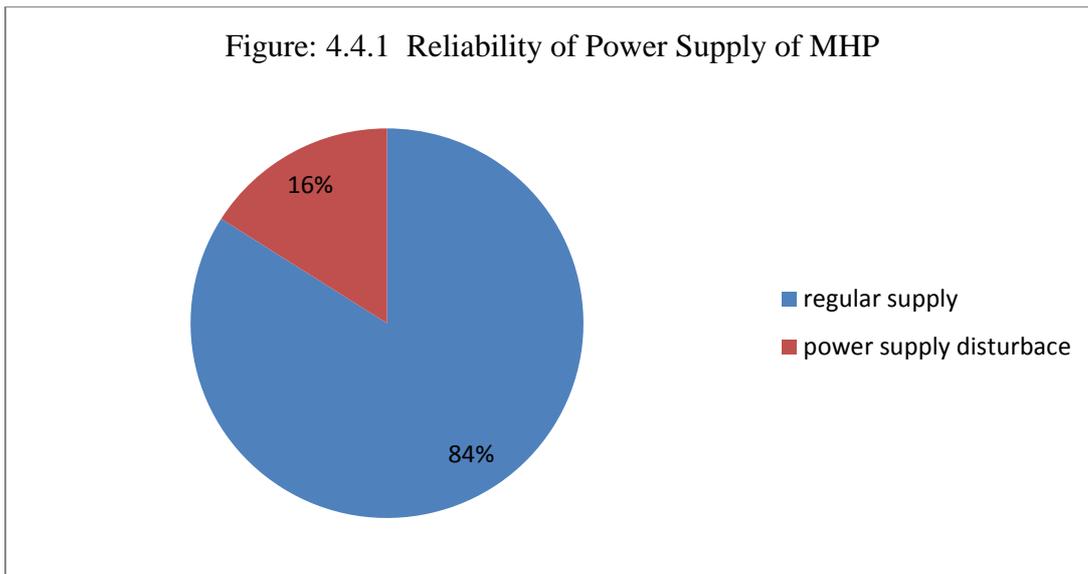
Some local leaders, social workers including villagers attempted to install MHP and went to talk concern department. Consequently DDC: DEES permitted to D.L. Energy Concern Pvt.Ltd. for detail feasibility study. Finally the dream has come true by the attempt of local public participation.

Hence, in study area MHP is playing a vital role in social and economic benefits including the area of education, technology, culture, health care improvement, job creation, productivity and efficiency etc.

4.4.1 Reliability of Power Supply of MHP

According to the operator of MHP the peak hour time is 4 AM to 9AM in the morning and 5PM to 10 PM in the evening. Likewise off- peak hour time is 10 PM to 4 AM and 12 PM to 5 PM. At the day time from 9 AM to 12 PM MHP is in not operational. But sometime this schedule can be modified according to the necessity. The management of electricity during peak hour and off-hours is done by the operator, who is a trained and experienced technician and looks after the MHP full time. He has maintenance knowledge also and manages electricity to houses and industries.

But due to some technical problems sometimes machines have to be stopped, for example during periodical maintenance. Breakdown maintenance has to be done suddenly. Landslide sometimes disturbs the MHP. Sometimes problem occurs in the electric pole or in distribution line. So during the field visit the electricity supply was found quite satisfactory. Out of total respondents 84% said that there was regular electricity supply in their houses. Only 16% said that there was irregular supply in their houses due to occurrence of occasional electrical fault.



Source: Field Survey, 2017

4.4.2. Monthly Electricity Consumption in MHP User Households

It is important to sustain the MHP for a long time so that the villagers can take more benefit in future too. According to the field survey it is identified that minimum unit of consumption was 4 units and maximum unit of consumption was 70 units per month. Here 1 electrical unit is equal to 1kWh. Most of the households used electricity only for lighting. Some of the houses have used electricity for running their small scale industries like poultry farming, furniture house, crushing mill etc. All generated power was not fully consumed as briefed by the operator.

Table: 4.4.2: Monthly Electricity Consumption in MHP User Households

Unit consumed	0-10	10-20	20-30	30-40	40-50	50-60	60-70
No of house	9	8	2	1	2	1	1

Source: Field Survey, 2017

From above table of unit consumption by 24 households of MHP user were observed and their arithmetic mean was calculated to find the average unit consumption.

Unit consumption	Mid value(m)	No of household (f)	fm
0-10	5	9	45
10-20	15	8	120
20-30	25	2	50
30-40	35	1	35
40-50	45	2	90
50-60	55	1	55
60-70	65	1	65
total		N = 24	Σfm=460

$$\text{Arithmetic mean}(\bar{x}) = \frac{\sum fm}{N} = \frac{460}{24} = 19.17$$

Hence, average consumption of MHP user is 19.17 unit.

4.4.3 Monthly Electricity Cost of MHP User

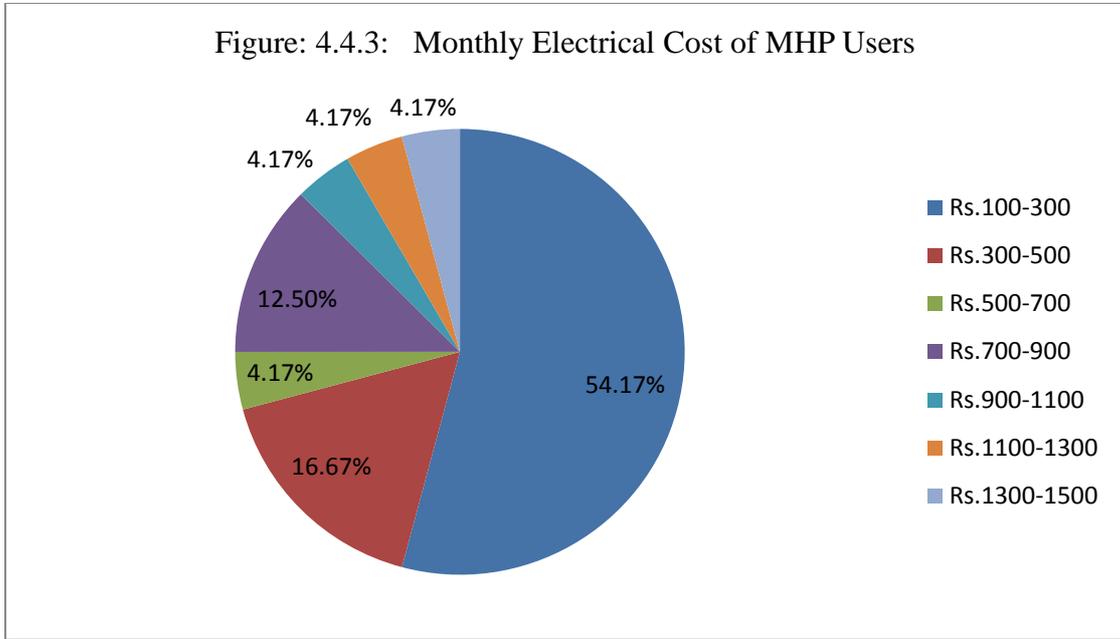
During the installation of MHP tariff rate of electricity was proposed for end use of domestic light has been fixed, but according to situation and based on investment, expenses and other provisions like maintenance the price could be revised regularly. However, the survey shows that to sustain the plant sometimes they have paid even a rate as high as 20 rupees per unit, thus the following data was obtained analyzed accordingly.

Table: 4.4.3: Monthly Electrical Cost of MHP Users

Amount	No of house	percent
100-300	13	54.17
300-500	4	16.67
500-700	1	4.17
700-900	3	12.5
900-1100	1	4.17

1100-1300	1	4.17
1300-1500	1	4.17

Source: Field Survey, 2017



Source: Field Survey, 2017

CHAPTER-V

SUMMARY, CONCLUSION AND RECOMMENDATION

This study is focused on "contribution of micro-hydro in promoting rural livelihood". This is a case study of Bhalayedanda Village, Udayapur, Nepal. The major objectives of this study are to find out how micro-hydro has contributed to livelihood of study area. It is based on primary data which is collected from the field survey and some information and data are received from feasibility study report of the project. This study shows the socio-economic impacts of MHP in rural areas. Whatever the results extracted from the study will be information centered and expect that it will valuable for policy makers, local governments, local leaders and to the general public also. It will help to guide or direct the rural sector where new micro-hydro plant will be installed. It is necessary to know about many factors before going to construct the MHP. There are three major periods of construction they are pre construction, under construction and post construction period. If there is occurrence of any mismanagement in any periods, it invites question in the sustainability of the project. It needs to be economically beneficial, environment friendly, and socially acceptable.

5.1 Summary

It has been a long time, since Nepal established its first hydro power plant, but since then every time Nepalese people has been facing electricity problem. The dream of brightness has never been fulfilled. Now the ray of hope is shined. Priority is given to hydropower by the government. State has to make not only the policy but also should think ways of implementation of it. Immediate action must be taken to implement programs for the promotion of renewable energy like micro hydro plants for economic development. We must have long term policy for power generation from water resources then only we will be self-dependent in electricity and we can supply electricity to other countries also. This will help to strengthen our economy.

To fulfill the energy demand in the country, micro hydro can play an important role because it is locally available renewable energy source which is not only reliable and

affordable but also environment friendly. Energy demand is increasing day by day and that is why we need to think about solutions to fulfill this demand. For a long time rural households have been depending on traditional energy sources like fuel wood and other biomass resources which are not sustainable. Due to use of traditional resources, it is producing negative impact in environment which can create various problems in the future. Our duty is to make country economically strong and environmentally friendly. Water is one of the best resources which can be used as a substitute of traditional energy. Our country is rich in water resources which has huge potentiality of hydropower generation. As Nepal is a mountainous country, a large scale hydropower is expensive to establish, so small scale hydro power plants are more suitable for Nepal. Nepal is a capable country which can produce enough electricity.

Electricity play positive role in the social and economic development of the country which leads to poverty alleviation and infrastructure development. Nepal has to move forward together with technology otherwise we never meet the summit of development. We have a lot of resources available in our land which can help to commercialize the technology. One of them is water resources which can be used to generate electricity. If we do so, it helps to increase our living standard by increasing our per capita income. Door of development of our country can be opened, when we realize that more than six thousands rivers and streams are available in our motherland which is waiting to give us brightness. Water resources help to protect our natural environment and bio-diversity because it is clean, sustainable and environmental friendly.

Development of village is the development of the country. We discuss about the development of rural energy. We can hear the debate in media and also so many organizations have been conducting program regarding the rural energy. But we have been facing an energy crisis which specially disturbs production of our industry and our day to day life. So it is necessary to produce energy from hydropower which will help to achieve the development. Lakes, streams, waterfalls and rivulets are the natural ornaments of our motherland which not only can make beauty but also can support the economy of the country. We have suffered from energy crisis many times, and we spent our valuable time to manage daily consumable goods including fuels like petrol, diesel, kerosene, cooking gas etc. We depend on other countries to have daily consumable goods and fuels. The fossil fuels imported from abroad make us dependent and pollute

our environment due to carbon emission. We forget that nature is our mother who does not let us starve, but we are responsible for deforestation because we are destroying our nature for our personal benefit, which have resulted in natural disaster like soil erosion, landslides, flood etc. Rural sector of our country is still deprived of electricity facility, so they use fire wood, kerosene for the purpose of cooking and lighting which may invite different diseases especially to women, children and aged parents suffers.

The geographical composition of our country is difficult because of hill and mountain, that's why connecting national grid electricity line to the remote area of mountain region, is difficult and installing transmission line is economically expensive and takes a long period. Hence micro hydropower is appropriate means for rural electrification. Local community can manage and control the micro hydropower plant. MHP is a strong base of socio-economic transformation of rural Nepal. It can contribute to the country on the basis of social, economic, political and cultural point of view. Its impact can be seen in income, information and education of the people. Community participation is must for sustainability of MHP. It helps to create new Jobs and increase entrepreneurial activities in local area. It also helps in irrigation for agriculture. It creates positive impact on environment. MHP provides electricity for lighting, agro-processing, computer institute, furniture houses, vegetable farm, poultry farm, crushing machine, and for other small industries or business. This study shows that rural people can involve in different economic activities to shape their own economic future. MHP supply is not only for lighting and cooking but also to strengthen the rural livelihood through promotion of self-employment. People may invest money in trade and small industry. Cooperatives, bank invests loan in minimum interest which helps youth to conduct micro enterprise. Without electricity there are no any other facilities. Banks and cooperatives are not interested to come and invest. Technical training, skill based works cannot be conducted. This badly affects in the field of entrepreneurships and local marketing.

The significance of this study is mainly to find out the changes brought by the micro hydropower to the remote people and their economic status changing towards the progress. The study reflects the condition of employment as well as indicates social, cultural, political, status of the local people. This study also helps to put forward exact figure of location of which MHP is installed so that it will be easy to get the data of local

area, easy to conduct the development program for local development office. It helps to identify or emphasize in the awareness of forest conservation.

Udayapur district covers both terai and mountain region. Some remote areas were not connected to electricity. Bhalayedanda was one of them. Local community decided to install MHP in Baidhyanath river and they took step for the same and succeed to establish. On the basis of feasibility study cross flow turbine is used to produce 15KW electricity. By using different data tools and technique we found information about the MHP. According to the details, mentioned in feasibility study report, some amount of subsidy was provided by AEPC/REDP. VDC and DDC investment was used and bank provided loan. From community side they contributed cash and kind.

Through the MHP, different ethnic groups like Adibasi/.Janjati, Brahmin, Chhetri and Dalit in this area are benefited. People from the village involve in small business, employment, farming, and foreign employment and other sector for their income. MHP has brought positive socio-economic impact in the village. It has played major role in education, health, environment, economy and so on. Kerosene lamps are replaced by electricity and because of this facility students got extra hour for learning which uplifted their ability of study. They have received computer knowledge. They use electrical and electronics devices and appliances frequently, like radio, television, mobile, electric iron, electric jug and other instruments. Students and children's participation in the field of sports, dance, music, health awareness program, study, are increased because they are receiving knowledge from different electronic media. People are being conscious in modern agriculture, irrigation, sanitation, preserving wild life, conservation of environment. Participation of women in various fields is increased and they are also able to support financially to their family by generating their income source in different field. Different skill-oriented training programs are being conducted by different organization. All together study shows villagers are conscious in energy saving. They look after the MHP for its sustainability.

5.2 Conclusion

This study analyzed and found that MHP has brought positive impact in rural livelihoods. People in the village have got opportunity to raise their income by engaging in different work. New entrepreneurs started new small scale businesses like grocery shop, poultry farming, goat farming, computer institute, vegetable farming, furniture house, tailoring and others. Students have obtained some more hours for their study during early in the morning and late evening that brought improvement in their study as well as in extracurricular activities. Because of the access of electricity, women are released from drudgery work and they have got time to involve in social improvement, community development and income generation activities. Since the establishment of MHP, the consumption of firewood in the households has decreased and as a result cutting of wood from the forest has also decreased. Use of kerosene is also less because kerosene lamp is substituted by electric bulbs. Improvement can be clearly seen in health and education of the villagers due to MHP. Community have constructed canal by the help of SIP, which is useful for both MHP and irrigation. People pay attention for the conservation of environment and wild animals. Thus, this study concludes that MHP has contributed in promoting rural livelihood and strengthening the rural economy.

5.3 Recommendations

Following recommendations are made by considering the findings and conclusions of the study.

- Electricity produced by MHP is not fully utilized, so non-user households should be aware to use electricity.
- Number of skilled technician is another problem. There is only one technician who controls whole plant alone 24 hours. If the technician is absent due to any reason, it makes difficult to operate the machine or may invite accidents, so some other skilled man power should be hired.
- Technician needs refreshment training in the concerning field by reputed organization.
- Another fact is that there is no monitoring system by the authority. Community handles MHP, but it is not sufficient because community members do not know technology of the MHP. It is compulsory to visit by some energy center or government unit.
- Canal is built just along with mountain, through the one side of mountain, so

sometimes due to sloppy small landslide happens. So canal should be made more secure.

- MHP user households should use electricity for productive work so that they can earn money.
- More small scale industries should be established in the village.
- A kit kat fuse is used instead of much reliable MCCB in the main circuit. So use MCCB for more safety.
- Foremost, Nepal government should make policy to use water resources appropriately and take a proper action for installing new MHP and think the sustainable of MHP.

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Annex I

Questionnaire Survey

Questionnaire for House Hold Survey

Title: Contribution of Micro Hydropower in Promoting Rural Livelihood

Questionnaire

1. Personal Profile

Name: _____ Village: _____ Ward No: _____
Cast: _____ Sex: _____ Age: _____
Occupation: _____ Religion: _____

2. Family Profile

Sex/Age	1-10	10-20	20-30	30-40	40-50	50-60	60 +
Male							
Female							
Total							

3. Educational Status of the family

Sex/Level	Degree	Bachelor	Certificate	SLC	Class 6-10	Class 1-5	Illiterate
Male							
Female							
Total							

4. Occupation of the family members

Sex/Occupation	Farmer	Civil Service	Student	Teacher	Businessman	Ngo/Ino	Industry
Male							
Female							
Total							

5. Annual Income in thousand

- a. than 30 b. 30 to 50 c. 50 to 70 d. 70 to 100 e. above 100

6. For what purpose you have been using the electricity?

- a. Cooking b. Lighting c. Iron d. Computer e. TV/Radio

7. What kinds of bulbs or tube light you are using in your home?

- a. Cfl b. Indescedent lamp c. Fluorescent tube light d. Lead lamb

8. What other sources you use besides MHP

- a. Solar b. Bio gas c. Kerosene d. No others

9. Electrical Units consume per month?

- a. Maximum.....unit b. Minimum.....unit

10. Condition of Load Shading

- a. Yes b. Sometimes b. Never

11. Reduction of Work load due to electricity

- a. Yes b. No

12. Do you Know safety precaution of using electricity

- a. Yes b. No c. Little

Annex II

Field visit and observation check list

1. The condition of power house a) ok b) not ok c) needs care
2. The condition of canal a) ok b) not ok c) needs care
3. Transmission and Distribution line a) ok b) not ok c) needs care
4. Maintenance of Machines of MHP a) performing in time b) not in time
5. Safety of machine & man a) good b) needs awareness
6. Impact of MHP in health a) normal b) good c) excellent
7. Impact of MHP in education a) normal b) good c) excellent
8. Impact of MHP in rural economy a) normal b) good c) excellent
9. Increase in women empowerment a) yes b) no
10. Reduced drudgery work for women a) yes b) no
11. Reduced firewood consumption a) yes b) no
12. Kerosene replaced by electricity a) yes b) no
13. Students' learning hour a) increased b) not increased
14. Impact on environment by MHP a) positive b) negative c) no impact
15. Role of MHP in irrigation a) positive b) negative c) no impact
16. Role of MHP in sanitation a) positive b) negative c) no impact
17. Role of MHP in agriculture a) positive b) negative c) no impact
18. MHP provide electricity a) regular b) irregular
19. Impact of flood in MHP a) seen b) not seen
20. Which factor can effect canal a) landslide b) soil erosion c) flood
21. MHP brought unity in community a) yes b) no
22. Laghu jalbidhut bachat samuha is a) beneficial b) not beneficial
23. Activities of Bachat samuha a) good b) not good
24. Households, benifitted by Bachat samuha a) yes b) no
25. Objectives of the MHP a) fulfilled b) not fulfilled yet

Key Informants Interview

Chairman Ward Committee:

1. What biggest change you feel in your ward since installation of MHP?
2. What is the total number of households in your ward?
3. What is the total population of your ward?
4. What was the source of energy before installation of MHP?
5. What was the situation of forest before and after installation of MHP?
6. What types of electricity based businesses are running nowadays?
7. What was your role in the installation of MHP?
8. What will you do for the sustainable of MHP?
9. What kinds of role does MHP play for promoting rural livelihood?
10. How this MHP can support rural economy?

Entrepreneurs:

1. When did you open your business?
2. Is it registered? Do you pay taxes?
3. Do you keep written business records?
4. Do you have paid staff?
5. Has this been a profitable business so far?
6. Have you made upgrades since electricity was available?

Micro Hydropower Management Committee Member:

1. When was this plant set up?
2. How was it funded?
3. How was it constructed?
4. What kinds of problems occur in MHP?
5. What do you think about the sustainability of MHP?

Micro Hydropower Plant Operator:

1. Do you have any formal training to operate the plant?
2. Do you perform repairs?
3. How much do you get paid?
4. Do you have another form of employment besides this?
5. What is the operation time of plant per day?
6. What is the peak hour and off-peak hour time and duration?

School Teacher/Headmaster:

1. What change do you feel in school attendance since the households got electricity?
2. How has your school benefitted since the arrival of electricity?
3. Do your school have computer?
4. For what purpose electricity is use in your school?
5. How many computers, laptop, printer and projector do your school have?
6. Is there any change in the performance of students after installation of MHP?
7. Is there any improvement in the study of students after installation of MHP?
8. Is there any improvement in sports after installation of MHP?

Focus Group Discussion Guideline

Topics

1. How to motivate non- users group for the connection of MHP
2. How to transform Bachat samuha to co-operatives
3. Effective management of electricity distribution.
4. Maintenance of canal
5. Spare parts management of MHP
6. How to save canal from soil erosion
7. Rural development activities

PHOTOGRAPHS

MHP operator in Power house



Distribution line



Penstock pipe



Canal



Group meeting



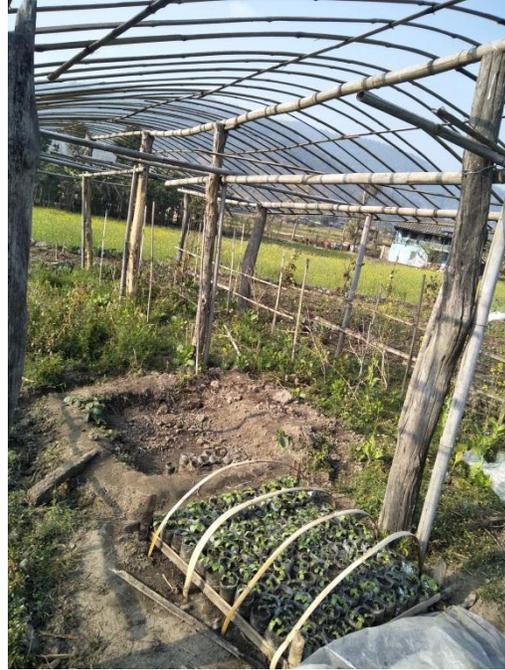
Meetint for saving



Vegetable farm



Vegetable farm



Saving account book



Poultry farm

