CHAPTER - I

INTRODUCTION

1.1 Background of the Study

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

Energy is the one of the major components of the natural resources. Energy plays a vital role in the economic development of a nation, because it is necessary component for the industrialization of a country. It is the primary need for all economic and social development. In the modern stage, energy is the indicator of the living standard of the people. Energy is also the primary need for all economic and social development. Its adequate supply helps to accelerate the speed of the development.

The increasing global demand for energy combined with the ongoing quest for clean, renewable energy has been a topic of perceived interest amongst countries of both developed and developing status worldwide. Hydropower is a renewable, economic, non-polluting and environmental friendly source of energy. It has been one of the sources of energy harnessed for centuries in different parts of the world. Hydropower has generated a great deal of interest because it is inexhaustible source of energy.

Hydropower provides a reliable, efficient, safe and economic source of power for increasing effectiveness of the decentralized industries system. The use of water to produce hydropower has the advantage of absent of carbon dioxide, sulphur-dioxide,

nitrous oxide and solid or liquid wastes. Thus, the water sources should contribute to a substantial reduction in emission of carbon dioxide and other harmful gases responsible for greenhouse effects. The water will continue to fall downhill and will continue to be a resource for men and environment needs as a part of the natural hydrologic cycle. However, it has some disadvantages like high investment along with long lead-time for project realization, long gestation period and environmental and social problems, mainly due to inundation of affected areas by large water reservoirs causing possible destruction of unique biotypes and endemic species. Some other disadvantages include possible destruction of human habitat, high cost for the necessary resettlements and fallouts related to social and political implications (Adhikari, 2006).

Nepal located at the top of Himalayas has about six thousands rivers and rivulets hurling towards south to India with huge potentiality of hydropower generation. Being a small country but rich in water resource, Nepal boasted its first hydropower plant in a way back in 1911 considering the geographical situation small and medium size hydropower project seems more suitable in Nepal. Nepal has great potentiality of 83000 MW out of which 42000 MW is economically feasible. Nepal's electricity generation is dominated by hydropower and it is a tiny fraction of domestic demand. Hydropower plants having capacity between 100 KW and 10 MW are considered as small hydro-projects (NEA 2007). Government of Nepal is trying hard in fulfilling the ever-increasing demand of electricity in the country particularly in rural area.

Hilly areas with natural waterfalls on the dam-toe or canal drops are suitable sites for micro-hydropower plants. For such site, selection long-range studies are not required. Sites for biomass plants are usually located by taking into consideration the availability of water, raw materials for biogas generation, free open space, total space required, minimum gradient, water table, distance from wells, and grid. Wind power plants are situated at a certain place where wind velocities are very high and relatively constant all over the year. Monthly and annual average velocities should be similar year in year out. Suitable locations for solar power plants are areas consisting of flat terrain with no high raised buildings and trees nearby (Wazed and Ahmed, 2008).

Micro-hydropower plants produce nearly constant input power. The only variation results in change of seasons due to the seasonal climate changes and water flow rate.

Therefore, overall, for a certain season, the power is almost constant. The power fed to the main national grid network is very smooth with no such non-linearity that are present in other sources of energy. Power fed to the grid produced by solar and wind energy consists of fluctuations on voltage and frequency levels, harmonic distortion, nonlinearities, and other abnormalities. This usually occurs due to the variation in wind velocities and solar light intensity all throughout the day. In numerous occasions, the power needs to be put off grid because of certain factors going below the threshold level during power transmission and distribution (Wazed & Ahmed, 2008).

Micro-hydropower is easy to operate and there is no need for rigorous maintenance, whereas wind power plant causes severe noise pollution, teething troubles, and poor performance due to operation and maintenance problems. Major challenge relies on designing signal conditioner, computer interfacing, and software for system operation. The pulsating input power pattern for the wind power station is another major problem. Moreover, there are various problems while handling biogas: pollutants such as effluent slurry, accumulation of volatile fatty acids, gas forming methanogen bacteria, and leakage of gas from gasholder. Other problems include drop in Ph. level and failure of digester (Wazed & Ahmed, 2008).

Micro-hydropower, wind, and solar power plants are clean and pollution free. They are very environment friendly sources. Although wind power plants create noise pollution, biomass causes environmental pollution and it does not meet the pollution control regulation, whereas micro-hydropower maintains the ecological balance and stream flow of the rivers (Wazed & Ahmed, 2008).

Pharping micro-hydro of 500 KW was the first hydro plant established back in 1911 in Nepal. After a long interval of 25 to 29 years, two other hydro plants namely Sundarijal 900 KW (640 KW after interchanging of frequently from 50 Hz to 60 Hz) and Panauti 2400 KW came in to operation the demand of electricity increased (Dhungel, 2009).

The electricity demand in Nepal is increasing by about 10 to 12 percent annually. About 70 percent of population in Nepal has access to electricity in Nepal until the end of fourteenth development plan (Fifteenth Plan Approach Paper, 2019). The

hydropower policy seeks to promote private sector investment in the sector of hydropower development aims to expend the electrification with in the country and export.

Micro-hydro technology is electrical energy generation system from water resources with installed capacity respectively up to 100 KW to 3MW of electric power. This technology has been successful to extend and explains rural electricity in rural areas. In Sri Lanka, micro-hydro plants have initially installed primary to improve the quality of life by providing electric light. Similarly, in Nepal after passing the era testing and assessing the technical access to increase rural energy seems for basic lighting facilities (Bist, 2011).

Micro-hydro is an indigenous and source of energy for which the potential exist in the almost the Hindu Kush Himalayan Region which includes Afghanistan, Bhutan, China, Myanmar, Nepal and Pakistan. Micro-hydro is generally is defined as decentralized small scale water power plant less than 100 KW for the power generation up to 100 KW and serve the nearby households through a local grid. It has gained enormous popularity in developing countries during the last for decades (Joshi, 2011). Micro-hydro generation is a cost effective and it would be potential solution for rural electrification in Nepal.

Micro Hydro Project (MHP) had a significant impact on the reduction of consumption of firewood in rural households. It revealed that children have lesser propensity to go for wood collection once their homes connected to the MHP. Similarly, modern electric lights in the households allow more time for students to conduct their study during evening. Access to electricity reduces drudgery for women in the village allowing them to have enough time to be involved in other household related activities including income-generation and social and community development activities. Moreover, it reduces carbon dioxide emissions significantly (Gurung, *et al*., (2011).

Studies on micro hydropower have also shown that men and women have different views on the benefits of the plants. For men, the biggest advantage in the improvement in quality of life and a better education for the children whereas the woman saw the advantage in reduced workload expenditures and an improved health

care. Women in developing countries spend much time on domestic duties that are necessary for the family to survive often they have to walk long distance to collect wood and water. To cook food over open fire in small room having small windows with kerosene smoking lamps have heavy adverse health hazards upon women.

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

1.2 Statement of the Problem

The energy consumption is the increasing function of the population growth and industrialization, which means that either affluent nations have to reduce consumption or the reserves of the resources will decline ever faster than the estimated. This growth rate of energy consumption is greater than the growth rate of population. In context of Nepal, the energy consumption pattern is predominated by the traditional sources has caused serious environmental problems.

Nepalese economy is based on traditional agriculture system. In addition to agriculture, other sectors of economy such as industry, trade and commerce, transportation, communication and tourism are underdeveloped due to lack of inadequate electric power as well as financial resources. In the absences of infrastructures like road and transmission line, the speed of hydropower development weakened. Insufficiency of electricity decelerates the speed of economic growth and development. Nepalese economy faced a decade long hours long load sledding.

The study area's people are using electricity mainly for the house lighting purpose after establishment of Sankhkhola-2 Micro Hydropower Project. Not only for lighting but

also using electricity for cooking, lifting water, electric appliances, running micro and other enterprises, industrialization and other electric activities. Its main purpose is establishment to fulfill the people's multipurpose demand and needs.

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

Really Sankhkhola-2 Micro Hydropower Project rivulet has one of the most potential project, then the other rivulet even though, people are not getting sufficient electricity power from the source. The study area's people are trying to connect the Sankhkhola-2 Micro Hydropower Project with the central project circulation for using energy regularly. The study area's people are interested to establish some of the mini/middle and cottage industries in Musikot Municipality of Rukum West district.

Wrapping the main object of this study is to analyze socioeconomic impact of study area's people. The object is related different benefits that local households are continuously receiving. The study uses before and after technique to evaluate the impact of electricity service on sources of lightings, sources of cooking energy, microenterprises and other enterprises, wheat production, vegetables production, water lifting, health status, employment opportunity, cost efficiency, time saving and electric home appliances. For these purpose, reliable information has been collected from the local respondents nearby Sankhkhola-2 Micro Hydropower Project. With the basis of these, information has been minutely studied and analyzed about the central objects and has given well and effective suggestion. In this background, following research questions are answered:

i. What are the impacts of Sankhkhola-2 Micro Hydropower Project in income, information and education in its project catchment area?
ii. What are the level of consumer satisfaction from the electricity service of Sankhkhola-2 Micro Hydropower Project?

1.3 Objectives of the Study

General objective of the study is to evaluate the socio-economic impact of Micro-Hydro Power on users of Musikot Municipality of Rukum West district. Besides this, the study has following major objectives.

i. To access the impact of Sankhkhola-2 Micro Hydropower Project on household activities, and
ii. To find out consumers satisfaction from electricity service of Sankhkhola-2 Micro Hydropower Project.

1.4 Significance of the Study

Electricity helps to discover, develop, expand, and promote new techniques and technologies in various sectors. Electricity helps to develop infrastructures, which are preconditions for the economic development. Development of electricity and infrastructure has correlated with each other. Improve in extracurricular activities, which help to raise the living standard of the people. Electricity helps to improve overall sectors of the economy. Research will help to know externalities for other project and programs and to implement such type of new project. Socio economic impacts of this project inform us the role of project in the socio economic uplift of a community. Finding of this research may be valuable information to those people's institutions that are interested about people of related area. In short, the importance of mini hydro project is increasing in every aspect of the society. Therefore, the study, which attempts to identity the socio-economic impacts of this Sankhkhola-2 Micro Hydropower Project in significant at present. Outcomes of this study will help to access the impact of the MHP on income of the residents of the Musikot Municipality of Rukum West district.

1.5 Limitations of the Study

This research is conducted to analyze the impact of micro hydropower project on socio-economic condition of the households who live in the Musikot Municipality of Rukum west district. This study is confined to the following limitations.

i. It is the case study of Musikot Municipality, ward no. 7 and it may not be applicable on the other municipalities of the country.

ii. Present study required the frequent visit that cannot be affordable due to the lack of budget.
iii. The present study generated the primary data which will be original but sample size is limited which outcome may not be as similar as national level.
iv. The study narrowed to limited variables and ignores many variables that may alter the results.

1.6 Organization of the Study

The first chapter deals with background, statement of the problem, objectives of the study, significance of the study, limitations of the study, and organization of the study. The second chapter conceptual review, empirical review and research gap. The third chapter explains research methodology. It includes study area, research design, population, sample size and sampling procedure, sources of data,data processing, data collection tools and technique and data analysis techniques. The fourth is devoted to data presentation and analysis. The fifth chapter presents major findings, conclusions and recommendations.

CHAPTER - II

REVIEW OF LITERATURE

The relevant literatures published or unpublished were thoroughly reviewed for this research work. The relevance of the use of such literature is briefly described here under.

2.1 Conceptual Review

In twenty first century, electricity is no longer a luxurious but it needs of people everywhere. Hydropower is a white energy due to its nonpolluting and renewable characteristics, which can be, integrate with irrigation and water supply. It is synonymous with standard of living and is vital for communication, healthcare and reduced physical labor. Hydropower is the well-proven technology, relying on nonpolluting, renewable and indigenous resources. During the last two decades, there is new interest in the development of mini hydropower (MHP) projects mainly due to its benefits particularly concerning environment and ability to produce power in remote areas. Mini hydro projects are economically viable, do not need the big investment and have relatively short gestation period. Due to the scatters, settlement of our country low investment capacity of government and people as well as our topography where many small rivulets falling from up to down, it is becomes best energy source for the country. Renewed interests in the technology of mini scale hydropower actually have attracted a large number of researchers for the examination of economic and social impact of mini hydropower plant in the rural areas.

In many developing countries, electricity usage is widespread in urban areas but for rural areas, investment in infrastructure is much lower, and communities rely on batteries or kerosene lamps or nothing at all. Rise in population in the developing countries, there is even greater demand to generate more electricity, and to distribute it to poorer people so that their living standard is increased. Electricity provision to rural communities not only results in a better quality of life for householders, but also has positive impact on school, hospital, businesses and agriculture/industry.

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

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

While the development of a micro hydropower is still at its infancy in Nepal. The country's planners and policy makers appear to have already become skeptical about the economic viability of such projects while constructions cost have been rising substantially, installation cost per KW are highly disparate between similar projects. The revenues collected by all of the commissioned projects are less than the capital required for operation and maintenance. The MHP has been proved conclusively by many countries that the quality of human resources plays a crucial role, so the investment in all people is needed.

The developing countries have set long goals to improve the quality of life with basic facilities like education, health, drinking water, electricity etc. The MHPs are one of such best alternatives to realize such goals.

2.2 Empirical Review

Acharya (1983) has mentioned the contribution of hydroelectricity to Nepalese economy. It plays significant role by developing various fields such as agriculture,

industries, transportation, social services etc. Water resources is the Nepal's greatest asset by unfortunately very significant portion is utilized to this date. She says that there is unequal distribution of electricity in different development regions. Nepal is facing many problems with respect to hydropower development. There are lack of capital, skilled work force, technical knowledge sufficient market and economic status of people as well as country.

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

East Consult P. Ltd. (1990) presented the socioeconomic impact evaluation of the MHP schemes in rural communities of Nepal which was sponsored by ITDG Nepal. The study especially reports to the evaluation of micro-hydro power, its socially acceptance and economic viability. It encompasses many studies areas of micro-hydropower. However, it especially focused to investigate the real beneficiaries and the extent of benefit. This study is interested to know the constraints prevailed in rural energy. It also keeps the interest to find the answer of the question who gets the access to the rural lighting and why? The study was conducted in Tanahun district, Karmasingh of Gorkha, Buling Arkhala of Nawalparasi, Karputar of Lamjung, Arghali of Dolpa and Karnali of Baglung district. The study has been centered to the socioeconomic evaluation of the impact of private and community owned micro-hydro schemes on members of rural communities who are not the owners of micro-

hydro schemes. It focuses to the target groups and aims to enhance the knowledge about relationship between nature and MHP scheme. The objectives of the study are to examine the characteristics and perception of those local people who are benefited by micro-hydropower. It especially examines the satisfaction/dissatisfaction ratio of micro-hydropower users and tries to recommend for action to maximize the benefit to the rural poor. It also tries to establish the indicators for monitoring the effects of any such actions. According to the finding of the study, the viability of this technology under the set of technical and social circumstances, which prevails in perceived benefit, accrues to the mill owner as well as the community. It reveals that; in one hand, agro-processing makes positives impact on community saving the drudgery, especially to women and in other hand, it is not effective to the cash starved people. It says it is not fully beneficial where the time is consumed by the transportation to mill and waiting, although it depends upon the located area of mill from the settlements. The study indicates that only one or two percent of the customers make payment in king for the service of the mills who cannot afford the cash payment. But about (3 to 8 percent) of village inhabitants are poorest, of the poor in most of rural areas of Nepal who do not use, the mills even with payment in kind because they do not have such affordability also. Nevertheless, it is naturally that, the payment in kind is anywhere between (50 and 500) higher than the cash down payment depending upon the local prices of agro-production. It further indicates that except the oil processing kol, the traditional agro-processing mills, such as Dhiki and Janto have not been replaced at all because this turbine mills have not yet been able to reduce the risk reliance of the community vis-à -vis traditional sustainable practices.

Aitken (1991) analyzed the environmental social and economic impacts of mini and micro hydropower plants which was supported by ICIMOD. This paper mainly concentrated on hydroelectricity. This study found on the principle issues in the development of hydropower resources. In Nepal, the cost of hydropower, government subsidies, development of domestic resources, energy efficiency, coordination and control, impacts and benefits, Electrification from hydropower in Nepal. This paper concluded that the private installations plants are more profitable than that of public installations. Reason for the profitability of the private sector installations include the fact that many started by providing agro-processing services and electricity generation was only added on later. By contrast, the government installations produce electricity

only and have been expected to cover their running costs at least from the beginning. It also concluded that the lack of disposable incomes in remote areas and the lack of the other infrastructural inputs required for industrialization are causes of little demand for electricity. This report has been made some recommendations. This paper suggested that the plans for grid extension must be made available because investors are deterred by the fear that the grid may be extended to their area, putting their plant out of business by providing electricity at subsidized prices. It also recommended that the technical training is needed in both public and private sectors. Particularly at the operative level to improve present standards this paper suggested that the mini and micro industry has become a national export industry as well as a local supplies.

WECS (1994) is a final report on the improvement of economic viability of MHP plants funded by UNDP and executed by WECS. This study is the first of its kind to analyze the wide-ranging issues related to MHP development. This study has raised more issue for further consideration than it has resolved which is natural due to the initial stage of MHP development. This report also studies on the identified and unresolved issue will be crucial to the successful promotion of MHP. The main objective of the study to prepare a set of guidelines to increase the economic viability of the MHP plants. This study is based on the information collected from four case studies namely Barpak, Bhandruk, Angaha and Bhadure MHP plants. From these four case studies, the report has identified some important conclusions and recommendations. The result of the study indicates that MHP plant is the only major source of energy capable of supporting the efforts towards breaking the socioeconomic stagnation of the remote rural hills of Nepal. This report suggested that the subsidy on MHP might be gradually withdrawn as it starts to bring positive socioeconomic changes in the rural hills. The results of the study also indicated that the introduction of subsidies for MHP in 1985 played a vital role for MHP promotion. This study concluded that the development of a MHP promotion has been able to mobilize considerable resources from the people of hills. This study recommended that the government agency by given the responsibility for micro hydropower development. It also recommended that the outing subsidy for MHP should be continued on a long-term basis and appropriate legal framework to support MHP development be formulated. It suggested 50 percent of the electrical component cost be financed through the resolving fund for non-remote areas. In addition, for remote

area finance 25 percent of the electrical component cost and 50 percent of the mechanical cost through the revolving fund. The study also suggested that, as currently individual village entrepreneurs are not likely to be able to mobilize enough resources for large MHP, the efforts should be made for promotion of company type MHP ownership as well. The study also recommended that the lift irrigation be developed as a major end used of MHP.

Hora (1996) explained that micro-hydropower (MHP) energies are more popular in Nepal because it is locally available, continuously renewable, nonpolluting and easily distributed. It is technically feasible as well as economically viable and the most appropriate technology for Nepal. Micro-hydropower projects are not sufficient to meet the national demand of electricity on the hand, we have no economic resources, technology and skilled work force to install large scale hydropower project on the other hand, and small-scale hydropower projects can play very important role in such context. This technology provides access to electricity and other mechanical from of energy for agro processing. Furthermore, it is also capable of providing rural electrification to a limited scale. Hilly topography and enough availability of water resources so the huge potential for micro-hydropower in the country. Micro-hydropower help to reduce the alarming deforestation, import of petroleum products thereby playing a vital role to improve the economic condition of the people. Agriculture Development Bank of Nepal (ADB/N) not only providing loan and subsidies but also providing resources survey, feasibility studies, promotion of manufactures involvement technical assistance and training has financed over 90 percent of the private MHPs in Nepal. It may not generate electricity in dry season. Likewise, the skilled work force may not be available to get it repaired. Sufficient research has not been carried out yet. These are a few problems involved with MHPs.

Pokhrel (1998) stressed that micro-hydropower (MHP) energy is important for economic development. Without it, the pace of economy cannot be accelerated. The development of the productive sector of an economy depends on development of the energy sector. In the hilly and mountainous areas, almost all the households are found to have consumed traditional sources of energy for cooking, heating, lighting and other necessary activities. Traditional energy sources cannot be sustainable to fulfill energy requirement. From the present analysis, it has been observed that most of the

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

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

Dhungel (2002) reported that main sources of energies are biomass (traditional which constitutes fuel wood agriculture waste, animal dung etc. and commercial sources which constitutes coal petroleum products, hydro-electricity etc. Energy consumption in Nepal is dominated by biomass, which accounted for 95 percent, 94.9 percent, 91.7 percent, and 86.4 percent and remained shares of commercial energy in total energy consumption in FY 1984/85, FY 1989/90, FY 1995/96 and FY 2000/01 respectively. Average growth rate of biomass and commercial energy consumption during the FY 1984/85, FY 2000/01 were 2.4 percent and 10 percent respectively. Combining both an average growth rate was more than 3 percent annum during this period. The trend of energy consumption in Nepal during the FY 1984/85FY 1995/96 also shows that biomass was growing by 2.2 percent per annum. Similarly, commercial energy was growing by more than 5 percent per annum. Annual growth rate of fuel wood, coal, petroleum products and electricity during the FY 1984/85 to 2000/01 were 2.7 percent, 27.2 percent, 12.7 percent and 1.0 percent respectively. Income electricity for electro products consumption and electricity were 1.75 percent and 1.4 percent respectively.

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

Adhikari (2006a) examined the huge potential of hydropower in Nepal. The study was based on secondary database and it applied descriptive statistics method to analyze data. The study found a huge potential of hydropower 83,000 MW in Nepal. The total hydropower generation has been 556.8 mw merely 0.7 percent of the potential with connection to 40 percent of the people. By the end of tenth plan 2002 to 2007, 55 percent of the population will have connection to the electricity. The acts and regulations are made friendlier to support the environment and development. The major strategies to develop power sector identified as promoting private sector

participation in power generations and distribution, unbundling the activities of the NEA as well as improving its financial viability, integrating rural electrification with rural economic development program and strengthening power infrastructure.

Adhikari (2006b) in the paper stated that hydropower has been recognized as a sustainable source of energy with almost zero input cost. Its benefits are that it is non-polluting in the sense that it releases no heat or noxious gases, it has low operating and maintenance cost, its technology offers reliable and flexible operation, and hydropower stations have increased efficiencies along with long life. Nepal's huge potential in hydropower is still untapped. Though Nepal has not yet been able to tap even one percent of its potential electricity capacity and 60 percent of Nepal's population is still deprived of electricity, it is fascinating to note that Nepal's start in 1911 in the hydropower generation almost dates back to a century. As a cheap, renewable source of energy with negligible environmental impacts, small hydropower has an important role to play in Nepal's future energy supply. Accordingly, micro-hydro system is becoming increasingly popular as an energy source in rural Nepal. Use of environmentally friendly technologies and implementation of sound legal and institutional issues are critical to improve the reach of the population to hydropower. To make the Plan targets in the power sector a reality, directing more resources to the power projects focusing on rural population remains the pre-requisite. The major strategies of the power sector have been appropriately identified as promoting private sector participation in power generation and distribution, integrating rural electrification with rural economic development programs, and strengthening power infrastructure. The immense role of the power sector in contributing to the generation of broad-based, sustainable and high level of economic growth as well as improving the relative competitiveness of the economy both on a regional and global basis makes. It is imperative that the programs and activities on power sector development as visualized in the plans and policies be given the utmost urgency, priority and focus.

Dhungel (2009) has analyzed the financial and economic condition of micro hydropower in Nepal. The study at first presented the economic condition and energy scenario in the rural areas of Nepal. This is followed by the introduction of micro-hydro power and its role in rural development of Nepal. The final portion and the primary objective of his thesis consist of financial and economic analysis if micro

hydro systems in rural Nepal. In this regard, relevant data concerning three MH systems had been collected. The financial analysis of all three system show that only one the privately owned system, which are community-owned, is in week financial conditions. Lastly, an economic analysis of one of the those three MH system is conducted which shows that Joint Bencher Investment Projects system can be a highly effective means to increase the economic welfare of the people in the rural areas, even though they may be in week financial situation. However, bearing in mind the need to ensure the long-term sustainability of these MH systems the financial viability of a system becomes a crucial consideration.

Upadhya (2009) stated that Nepal is one of the world's poorest countries. One of its most pressing environmental concerns is its need for stable, community-managed power. Because extending the Nepalese national power grid would be expensive and problematic, micro-hydro projects have proven to be an economical and efficient alternative in the effort to power remote villages deep in the mountains. However, the efficiency of many of these projects is debatable. This study investigates the efficacy of community-based micro-hydro projects in two remote villages, Luwang Ghalel and Ghandruk, as well as the role of public participation in these projects. This report employs a case study methodology, with data collection taking the form of interviews, surveys, and document reviews. The results of this study show that micro-hydro projects are a temporary solution at best. Based on internationally accepted criteria, both the technical performance and the level of public participation at both projects were found to be very low. Gender, caste, ethnic group, and socio-economic stratification have also seen an unequal distribution of the project benefits. Our findings indicate that both the Nepalese government and associated non-governmental organizations must make significant policy changes if they hope to achieve success in future development work with community-based micro-hydro projects.

Aydin (2010) examined the economic and environmental impact of the constructing hydro power plants in Turkey. The paper used simulation database with a dynamic CGE analysis modeling. The core variable includes GDP, real consumption, real investment, exports, imports, and trade balance and carbon emission. The study found that expanding hydropower plants having negative effect on agriculture (0.04 percent). Similarly, its negative effects are on fossil-fired electricity (0.15 percent), oil

product industries (0.06 percent), gas (0.3 percent), coal (0.18 percent) and other industries and service (0.03 percent). Similarly, the study found the reverse impact of expanding hydropower generation on carbon emissions and economic growth due to the renewable energy usage instead of fossil fuels emitting carbon into atmosphere. Thus, doubling hydropower have slightly positive effect on macro indicators and carbon emissions for Turkish economy.

Karki (2010) has evaluated the social and economic impacts of Rupatar micro hydropower, a micro hydropower plant in eastern Nepal, in the study area and has concluded that the plant has a positive impact on health, education, information and communication, drudgery reduction, income increment and in totally on the overall living standard of people in the study area. The study has shown that the plant has been an aid for social and economic up liftmen in the study area. However, operation and maintenance is a major problem for the plant. Therefore, his study has recommended that training should be given to the villagers, preferably to married women, about the operation and maintenance of the plant. This study is descriptive as well as analytical using primary as well as secondary data. The primary data were collected through the interview field survey, participant observation and key informant interviews. Structured questionnaire was used as a tool to collect both quantitative and qualitative data. The small hydropower projects might contribute significantly by providing electricity in isolated pocket area as well as to the grid since the electrification is related to productivity. Small hydropower might help to increasing working efficiency of the rural families. For the sustainable development of small and micro-hydro, projects by adopting the program approach instead of providing subsidy, comprehensive institutional base is required it provide supporting services such as agriculture extension input supply. Marketing services credit facility etc. and development of capability of the farmers.

Bista (2011) has compared users, non-users group Tarakhola MHP Tara VDC Baglung to examine the impact of MHP on education, health, and access to information result of the study has shown the positive impact of MHP on education health and information. The number of she passed student are more in users group than non-users group whereas school dropout students are less in users group. The no. of ill household members from respiratory and eye related problem are less in users

group. The households of users group have ownership of electronic devices and information technology.

Gurung, *et al.* (2011) mentioned that electricity is one of the key determinants for economic growth of a nation. Although the benefits of rural electrification are immense, more than 44 percent of the people do not have access to electricity in Nepal. Micro-hydropower (MHP) scheme is considered the most feasible decentralized renewable energy option for providing reliable and affordable electricity to the remote and isolated areas of Nepal. The paper assessed the impact of a MHP plant on socio-economic conditions in the remote village, Sickles, in Nepal. Cross-sectional research design was used to collect information with a structured questionnaire, key informant interviews and focus group discussions. Results revealed that the village electrification had brought a series of positive changes in the rural livelihoods. Traditional kerosene lamps like Tuki and Panas were completely abandoned and firewood consumption was reduced. Electric lights in households extended the day providing additional hours for evening reading and work. The micro-hydro based electricity was used to power modern agro-processing mills in the village, which reduced drudgery for women, as they no longer had to use ineffective and distant traditional water mills. Thus, micro-hydro scheme provides clean, affordable and sustainable renewable energy both locally and globally.

Joshi (2011) has mentioned that energy is important for economic development. The pace of economic development. The pace of economic development cannot be accelerate without hydropower development. The development of productive sector of an economy depends on development of the energy sector in the hilly and mountainous area, almost all the households are found to have consumed traditional sources of energy for cooking, heating lighting and other necessary activities. Traditional energy sources cannot be sustainable to fulfil energy requirement. From the present analysis, it has been observed that most of the people depend on forest for energy sources and livestock. As a result, the deforestation has brought about ecological and environmental hazards along with shortage of fuel wood, soil erosion, deterioration of the fertility of soil etc. Deforestation leads to deterioration of water resources and hampers both electricity generation and drinking water. The utilization of energy is concerted on urban areas and most of the rural areas have been by passed

by this power development. The hydropower project has brought about change in socio-economic, cultural and other aspects of people living in the project located area.

Singh (2011) analyzed the income and employment generation by the project in project area of mini- hydropower project. The study has analyzed problem associated with the project. The study has concluded the project helps to raise income level of local people by establishment of new business and it drastically grounded the expenditure of people on the traditional energy. The health condition of people sufficiently increased and people has access to the modem medical equipment due to electricity preservation of the forest increases sufficiently due to the reduction of dependency of people on the firewood. The educational status of the student uplifted by using evening time for study due to electricity.

Abdullateef (2012) focused on the socio-economic analysis of the operational impacts of Shiroro hydroelectric power generation dam in the lowland areas of middle river Niger in Nigeria. The study designed and administered a closed-ended and pre-coated instrument to conduct the survey of the dam-affected communities located in the study areas. Descriptive statistics were applied to analyze data. The study showed that the economic engagement of the riparian communities have been distorted. Moreover, it is remarkable that particularly, on both fish diversity and ecosystem with a resultant loss of fish-spices. The study further focused on that there is dismal fall in productivity of smallholder farmers and angler concerned by avoidable flooding. The strategic and economic infrastructure have deteriorated and slowed down the socio-economic development. Lastly, there is the suggestion of minimizing the negative effect on hydropower production.

Bird (2012) examined the socioeconomic impact of hydroelectric dams on developing communities through a case study of the Macal River Valley in Belize, Central America and the Chalillo Dam. By analyzing the sample population, as well as comparing demographics within the sample population, the study determined the socioeconomic impact of hydroelectric dams on the communities of the Macal River and factors influencing levels of impact on the local people. It employed a questionnaire with a Likert response scale as research tool, which resulted in quantitative data. By statistically examining the quantitative data, it determined the overall impact of the dam, as well as variables that influence impact including urban

versus rural location, and occupation based on industry sector. This socioeconomic impact analysis of a large infrastructure development project provides insight into the relationship between a water body, the local people, and the local economy. It determined the portion of the population that benefits and the portion of the population that suffers the cost. Assuming that all socioeconomic impact analyzed by the research was directly related to the Chalillo Dam, the overall socioeconomic impact of the Chalillo Dam on communities downstream was negative. Nine indicators reflect a negative impact, while only five indicators reflect a positive impact. The greatest negative impact was reflected by socioeconomic indicators related to river use as a common natural resource, cost of electricity, and wellbeing of the local economy. This research shows that a large infrastructure project, being the Chalillo Dam, placed externalized social, environmental, and economic costs on the communities downstream. Unfortunately, the socioeconomic impact analysis was not completed before the construction of the dam.

Regmi (2012) analyzed the present condition of Nepalese energy system. The summary conclusions of her finding are there should be need of proper utilization of natural resources like water to achieve the goal of development. By proper harvesting of rest water resource by generating aptly trained man-power and investment on water resources dependency on foreign country could be vanished. One of the alternative ways to increase the energy power not only by the formation of new hydro projects but also maintaining and optimizing the existing hydropower plants, which may become panacea to control the wave of problem and has been grossly overlooked for these reasons. The development of hydropower in Nepal has always been dictated by many constraints and conditions. Projects are selected by planning procedure that is deliberately designed to produce a ‘no option’ situation in decision-making. It is too late to understand the government that private sector is not capable to develop sufficient hydropower projects to satisfy the demand, so, public sector must play a sustainable role for important of hydropower project.

Adhikari (2014) evaluated the socio-economic impact of Micro-Hydro Power on women users in Angsarang VDC (Village Development Committee) of Panchthar district. Major objectives were: to study the impact of Nibukhola IV Micro-hydro project in income, information and education of the people and to study the people

participation about sustainability of Micro-Hydro Project. The study applied survey research design and collected data from 50 samples. Descriptive tools were used to analyze the data. The results showed that MHP has positive impacts on income and employment. It helps to rise in income and employment by helping in the establishment of new businesses. MHP reduces the expenditure on different traditional sources of energy in the rural area. By the use of MHP, the health condition also is improved. People who do not have MHP use maximum firewood as light or lamp, cooking but those people who have MHP has reduced such sources, and it has helped to conserve forest. Electricity is closely related with human life therefore all respondents who have use of MHP have been changed their living standard.

The status of sanitation has improved by the use of MHP. By the use of MHP studying hours of students have been improved then non-users. MHP users have improved their education status. MHP reduces the expenditure on different energy sources like: firewood, kerosene, biogas etc. Therefore, it can be a less expensive source of energy in the rural area. To repair, maintains and operation for the MHP management committee is fully responsible. The study recommended that electricity power generation should be increased by further investment as demand is higher than supply. Lack of timely maintenance is another problem. Therefore, government should provide the technicians to maintenance MHPs. The sustainability of MHP is another issue. The dam constructed is located at the weak area as well as 'Kulo' is built on sloppy area. Therefore, there is fear of landside. The dam and 'Kulo' should be repaired for more securely. House should use electricity for more productive activities. Small industries need to be established in the village so that the MHP's revenue can be increased and further investment can be made. Nonusers group should be promoted to use of MHP. Government needs to formulate appropriate policy and should allocate resources for MHP to maintenance and repair.

Ranabhat and Paudyal (2016) analyzed sustainability of micro-hydro projects in Nepal taking Lalitpur district as case study. Energy is one of the important necessities of the society and basic for sustainable development. The demand of electricity is increasing. Micro hydro power plants are one of the effective tools to provide rural household with energy in Nepal. These plants are also provided with government subsidies. Energy is produced by the water current from micro hydro stations. There

are water availability changes due to the climatic changes and other non-climatic changes; this has made water very scarce. There are few studies done in water availability and energy and even less in operator level. There is lack of interlink study of the different water uses like irrigation, drinking water, animal husbandry water use etc. which affects water availability. Integrating interdisciplinary water planning in energy development is one of the important steps to increase the sustainability of micro hydro plants. The operators working in micro hydro plants have already perceived the change in water availability. Thus, it is important to plan the water resources using the operator's local knowledge and situation to cope with increasing demand of electricity and the impacts of decreasing water resources.

Sherpa (2016) stated that hydropower potential of Nepal is one of the most discussed sector within the country. In the absence of other natural resources coupled with the current severe power outage, the State aims to exploit the water resources to not only supply the domestic energy needs but also to sell it in near future to generate revenues for economic development of the country. In this pursuit, the State has made several policies to facilitate hydropower development. The study aims to attempt to have a holistic understanding of the current development surrounding hydropower sector, and analyze the looming issues at different level and present the challenges henceforth. The State led hydropower development strategy entails several impact on the natural resources and it affects the predominantly rural livelihood of the country. While the State strives for economic development of the country with such developmental ventures, its impacts on the rural livelihood and other important economic sectors cannot be ignored. Hence, with this research paper analyzes the existing challenges and address the issues that needs due attention.

Bhandari, *et al.* (2018) analyzed sustainability of hydro projects. Many rural electrification projects around the world employ micro hydropower plants (MHPs). These installations provide immediate and direct benefits to the local people. However, the sustainability of their operation in the long-run remains a vital issue. Without proper sustainability assessment, the projects may face operational problems. However, to date, only a few empirical studies exist which offer tools to assess sustainability of MHP projects post-implementation. Given that every site has peculiar characteristics that could largely vary from site to site, there is a need to

develop a model that could assess and compare the feasibility of the projects from the sustainability point of view before the project is implemented. For this purpose, a thorough sustainability assessment model was developed for an MHP project in a mountainous region of Nepal. This paper presents a sustainability assessment model for micro hydropower plants. In order to collect the data necessary to run the model, different sets of questionnaires were prepared for all relevant stakeholders. The developed model was used to assess an overall sustainability of a 26-kW plant at Mahadevsthan in Dhading District of Nepal. At this site, 15 community households, a project management committee member, an operator, and 3 policy makers/micro hydro experts were interviewed. The indicator system developed here was finalized with the stakeholder's participation.

2.3 Research Gap

Demand on electricity is growing continuously. It is most important factors on human life. Electricity is most important for our life style to make simple and facilitated on every difficult work. Such as Sankhkhola-2 Micro Hydropower Project, which was established in 2007 with 39 KW capacity, is providing electricity service regularly. Its main objectives is to electrification overall local area. The plant fulfills the objective as all local residents have now electricity service. People in the study area have multiple use of electricity such as lighting, pumping water, cooking, use in small industries and other electric activities. The main purpose is to provide electricity service and it is satisfied to all local residents.

Electricity has multidimensional impacts. Such impacts should be observed by comparing before and after situations on education, health, water service etc. In the study area, the impact of electrification on different services to local residents is absent. This study fills gap in this area.

CHAPTER - III

RESEARCH METHODOLOGY

This chapter explained the methodology to evaluate the socio-economic impact of Micro- Hydro Power on users in Sankhkhola-2 micro hydropower project Musikot Municipality of Rukum west district.

3.1 Study Area

Sankhkhola-2 micro hydropower project is located in Musikot Municipality ward No. 7 of Rukum west district. Musikot Municipality is in Rukum west District in Karnali Province of Nepal. It is also district head quarter of Rukum west district. It was established in 2007 by merging the former Village Development Committees of former Rukum district. These VDCs were Khalanga, Sankh, Chaukhawang, Bhalakcha and Chiwang VDCs and Ward No. 3 and 4 of Syalapakha VDC. The municipality has Sisne and Bhume municipalities in the east, Sanivheri municipality in the west, Vanfikot municipality in the north and Triveni municipality and Rolpa district in the south. It has 14 wards with an area of 136.6 sq. Kms. According to census 2011, it has total population of 35348.

The project area, ward No. 7 has 490 Households with the population of 2919. The population consists of Brahmin, Chhetri, Magar, and Dalit caste and ethnic communities. The main occupation of the residences is agriculture. Maize, wheat, paddy, mustard and millet production are major cereals agriculture product of the area. Vegetable and livestock farming are also popular. The area is rich in natural resources

People of Musikot ward N0. 7, remaining as the most remote local level in the district, were dependent on the local 18-kilowatt Patalkhola micro hydropower project and its operation was stopped as technical errors became frequent. Now some 350 to 400 households of ward no 7 are receiving service from the 39-kw Sankhkhola-2 micro hydropower project. The mini plant was established in 2007.

3.2 Research Design

This study is based on explanatory research design. This study was investigating the socio-economic impact of micro hydro-electricity in rural sector. This study finds out how people are benefitted by project and its impact on people. Besides, the study an attempt to describe the benefits experienced by households of the project affected areas after the installation of micro hydro-electricity such as economic activities, income, information, education etc. Thus, this study is done descriptive, analytical and explanatory.

3.3 Source of Data

This study aims to study explicate the utilization of micro hydroelectricity and socio economic impact of Sankhkhola-2 micro hydropower project on the people of that Musikot Municipality Rukum west district. Therefore, this study is based on qualitative and quantitative from questionnaire though household interview survey. Some key informant interview took from project-introduced people. Thus, the primary data was collect from user and non-user households of the study area.

Similarly, the secondary data was collected from different sources such as economic survey, CBS report and publication of Nepal Electricity Authority (NEA), publication of AEPC, feasibility report, journals, internet and document from individuals, experts and organization related to micro hydro electrify.

3.4 Population, Sample Size and Sampling Procedure

There are 490 households as population in the project area of Musikot Municipality. Out of which 80 households were sampled. According to the ward wise user and non-user household's ratio by using simple random sampling method to fulfill the purpose of the study. This research is based on the information collected from the sample households, selected simple random sampling method.

3.5 Data Processing

A work sheet was prepared through the complete questionnaire incorporating the use of electricity for the purpose. The collected data classified according to its nature and

characters. To make the analysis more reliable and easier, different data sheets have been prepared for different variable. Field questioner is carefully checked for possible errors. The data is carefully edited and processed by computer program state and excel then the required pie-chart, bar diagram and table is generated by using computer software program.

3.6 Data Collection Tools and Technique

For this study, data about the effectiveness of the electrification has been collected through direct personal interview with the help of structured questionnaire among directly Project Affected Families (PAFs) in the society since the installation of Sankhkhola-2 micro hydropower project. The structure questionnaire or unstructured interviews and observation methods was applied to collect the both qualitative and quantities data in the survey.

3.6.1 Questionnaire for Survey

To generate the accurate data from households survey of micro hydro users, structured questionnaire was prepared. The respondents were required to fill up questionnaire. To find out the respondent's attitude the impact of MHP in different sector in the village the questions were provided them to fulfill in their own views.

3.6.2 Field Visit and Observation

Field visit was conducted by collecting the name lists of each household within the month March 2021 who was benefited by this micro hydro-electricity and selection was done by simple random sampling method. To hear the people perception and get the real situation of MHP in village field visit is essential.

3.6.3 Key Information Interview

To know about MHP and its role in the society, key informant was taken from some expertise as well as social man in the study site. Key informant interview was conducted by applying the exploratory method to gather the information about the project and its impact on the affected area.

3.7 Data Analysis Techniques

3.7.1 Descriptive Analysis

The data has been tabulated and analyzed according to the objective to study. The data analysis is descriptive as well as analytical. Data was analyzed with the help of computer programming- SPSS and Excel. Simple statistical tools like Tables; Pie chart was used for data analysis. Descriptive methods have been used for qualitative data.

3.7.2 Paired t-test

The paired sample t-test, sometimes called the dependent sample t-test, is a statistical procedure used to determine whether the mean difference between two sets of observations is zero. In a paired sample t-test, each subject or entity is measured twice, resulting in pairs of observations. Common applications of the paired sample t-test include case-control studies or repeated-measures designs. Suppose you are interested in evaluating the effectiveness of a micro-hydro project. One approach you might consider would be to measure the performance of a sample of households before and after taking the electricity service, and analyze the differences using a paired sample t-test.

Like many statistical procedures, the paired sample *t*-test has two competing hypotheses, the null hypothesis and the alternative hypothesis. The null hypothesis assumes that the true mean difference between the paired samples is zero. Under this model, all observable differences are explained by random variation. Conversely, the alternative hypothesis assumes that the true mean difference between the paired samples is not equal to zero. The alternative hypothesis can take one of several forms depending on the expected outcome. If the direction of the difference does not matter, a two-tailed hypothesis is used. Otherwise, an upper-tailed or lower-tailed hypothesis can be used to increase the power of the test. The null hypothesis remains the same for each type of alternative hypothesis. The paired sample *t*-test hypotheses are formally defined below:

- The null hypothesis (H0) assumes that the true mean difference (μd) is equal to zero.

- The two-tailed alternative hypothesis (H1) assumes that μd is not equal to zero.
- The upper-tailed alternative hypothesis (H1) assumes that μd is greater than zero.
- The lower-tailed alternative hypothesis (H1) assumes that μd is less than zero.

The mathematical representations of the null and alternative hypotheses are defined below:

- H0: $\mu d = 0$
- H1: $\mu d \neq 0$ (two-tailed)
- H1: $\mu d > 0$ (upper-tailed)
- H1: $\mu d < 0$ (lower-tailed)

It is important to remember that hypotheses are never about data, they are about the processes, which produce the data. In the formulas above, the value of μd is unknown. The goal of hypothesis testing is to determine the hypothesis (null or alternative) with which the data are more consistent.

In this study, two pairs of same variable of sources of lightings, sources of cooking energy, microenterprises and other enterprises, wheat production, vegetables production, water lifting, health status, employment opportunity, cost efficiency, time saving and electric home appliances variables were tested. Each variable has two pairs one is before electricity service and other is after consuming electricity service. The results consists of the t-statistics value, standard error and probability of t-statistics. If the probability of t-statistics within 5 percent level of significance, null hypothesis is rejected under two-tailed test i.e. There is significant impact of micro-hydro project to improve in sources of lightings, sources of cooking energy, microenterprises and other enterprises, wheat production, vegetables production, water lifting, health status, employment opportunity, cost efficiency, time saving and electric home appliances.

CHAPTER - IV

DATA PRESENTATION AND ANALYSIS

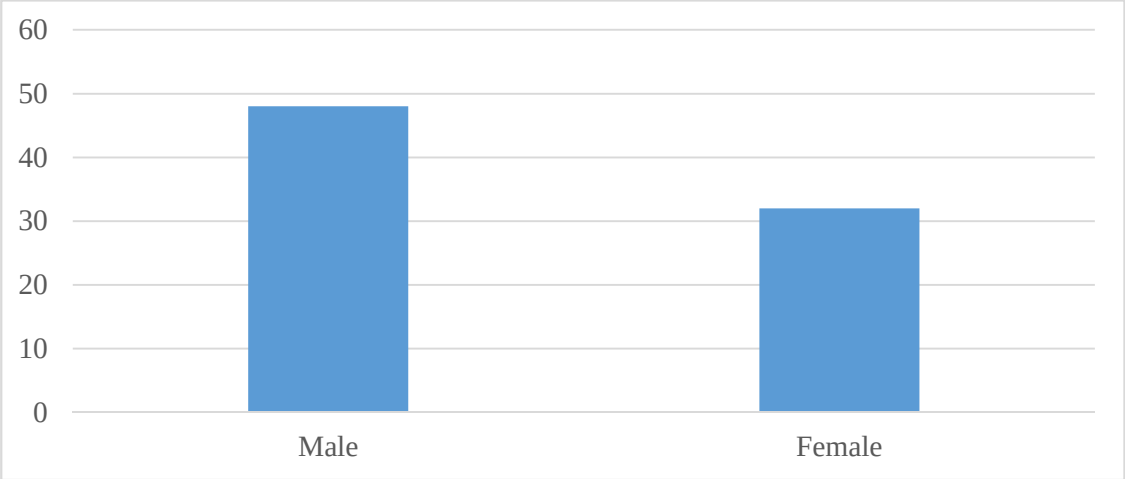
This chapter consists of various calculations and interpretation of data. In this chapter, the relevant data and information necessary for the study are presented and analyzed keeping the objectives in mind. This chapter is categorized in three parts: presentation, analysis and interpretation. The data are analyzed using different statistical tools like mean, percentage, growth rates and paired t test.

4.1 Characteristics of Sample Households

4.1.1 Sex Composition of the Household Heads

Total population of selected household heads were 80. Of them 48 (60.0 percent) were males and 32 (40.0 percent) were males (Figure 4.1).

Figure 4.1: Sex Composition of Household Heads

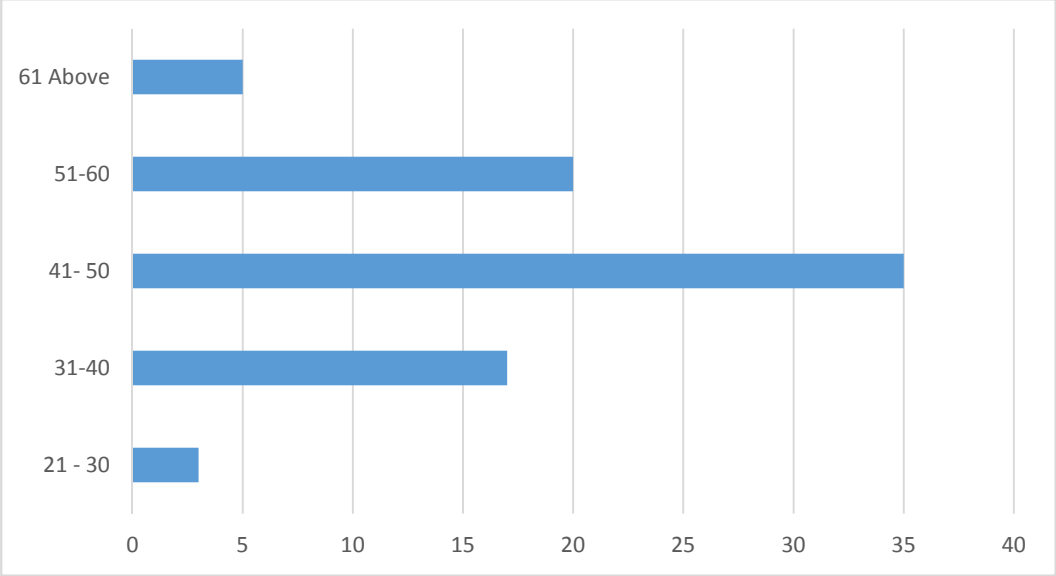


Source: Field Study 2021

4.1.2 Age Structure of Household Heads

The result of sampled household heads on age structure ranged between 21 years to 69 years. The 3 household heads (3.8 percent) aged between 21 to 30 years, 17 household heads (21.3 percent) aged between 31 to 40 years, 35 household heads (43.8 percent) aged between 41 to 50 years, 20 household heads (25.0 percent) aged between 51 to 60 years and 5 household heads (6.3 percent) aged 61 and above years respectively. The results showed that more heads were young. The age structure of the sampled households was presented below (Figure 4.2).

Figure 4.2: Age Structure of Household Heads

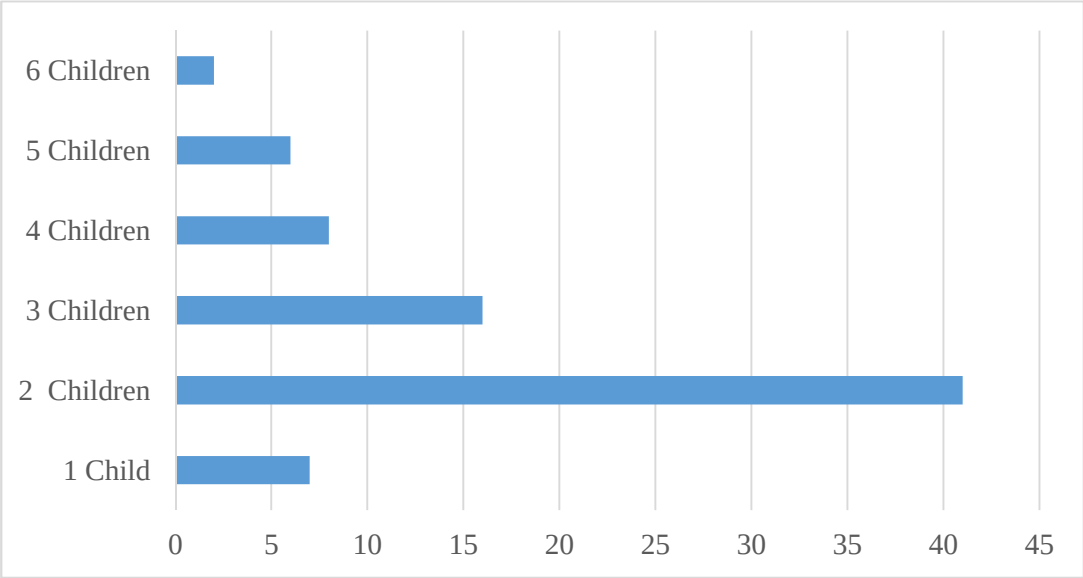


Source: Field Study 2021

4.1.3 Family Size of the Household Heads

Family size directly affects the expenditure and savings of the household. There is inverse relationship between saving and family size but positive relation with consumption expenditure and family size. If the family size was high, there were low chances to get out from poverty level due to lack of resources to generate income. Family size was observed moderate in the study area. The distribution of number of family members of the sampled households was high for the study area (Figure 4.3).

Figure 4.3: Family Size of the Household Heads

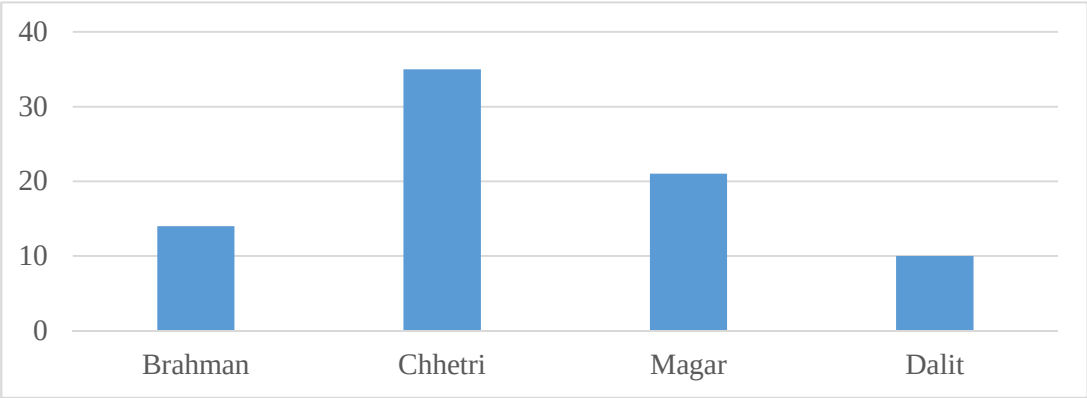


Source: Field Study, 2021

4.1.4 Caste and Ethnicity

Nepal is predominantly rural and agricultural country. Nepal has multi-ethnic society. The population of Nepal consists of several ethnic groups. They vary significantly in terms of socio-economic characteristics. The results showed that the Chhetris are the largest ethnic group followed by Magars. The respective percentage of Brahmins, Chhetris, Magars and Dalits were 17.5 percent, 43.7 percent, 26.3 percent and 12.5 percent respectively (Figure 4.4).

Figure 4.4: Caste of Household Heads

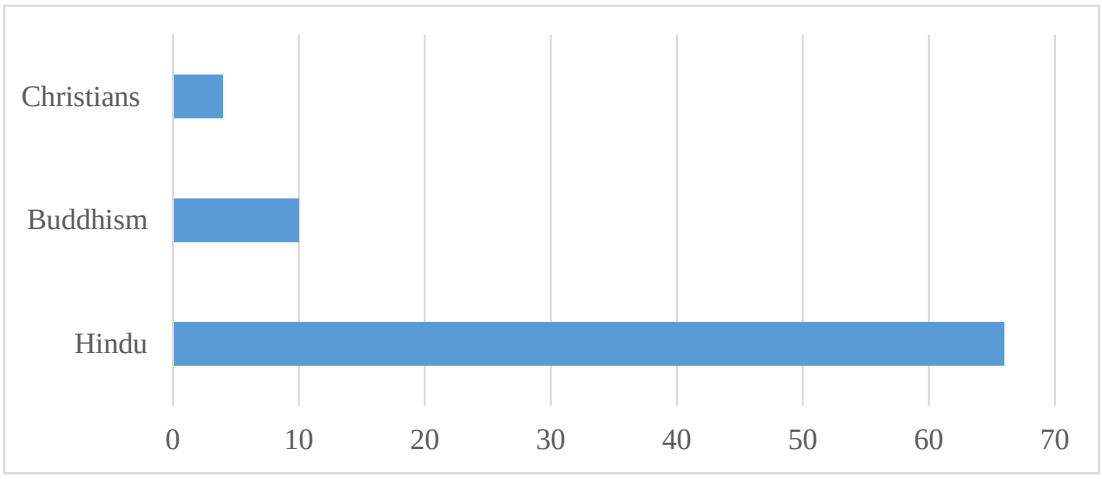


Source: Field Study 2021

4.1.5 Religion of Household Heads

There are three major religions found among the household heads, which are Hindu, Buddhism and Christians and their respective shares were 82.5 percent, 12.5 percent and 5.0 percent respectively (Figure 4.5).

Figure 4.5: Religion of the Household Heads

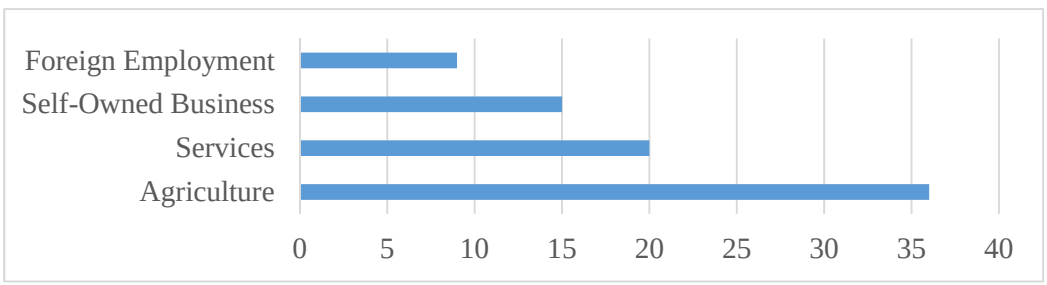


Source: Field Study 2021

4.1.6 Distribution of Sampled Household Heads by Occupation

Agriculture was the major occupation of the people in the study area. About 45.0 percent household heads were farmers. Other occupation were service, own business and foreign employment and their shares were 25.0 percent, 18.8 percent and 11.2 percent respectively. The results indicated that non-farm and farm economic activities provided jobs to the household heads in the study area (Figure 4.6).

Figure 4.6: Occupation Status of the Household Heads

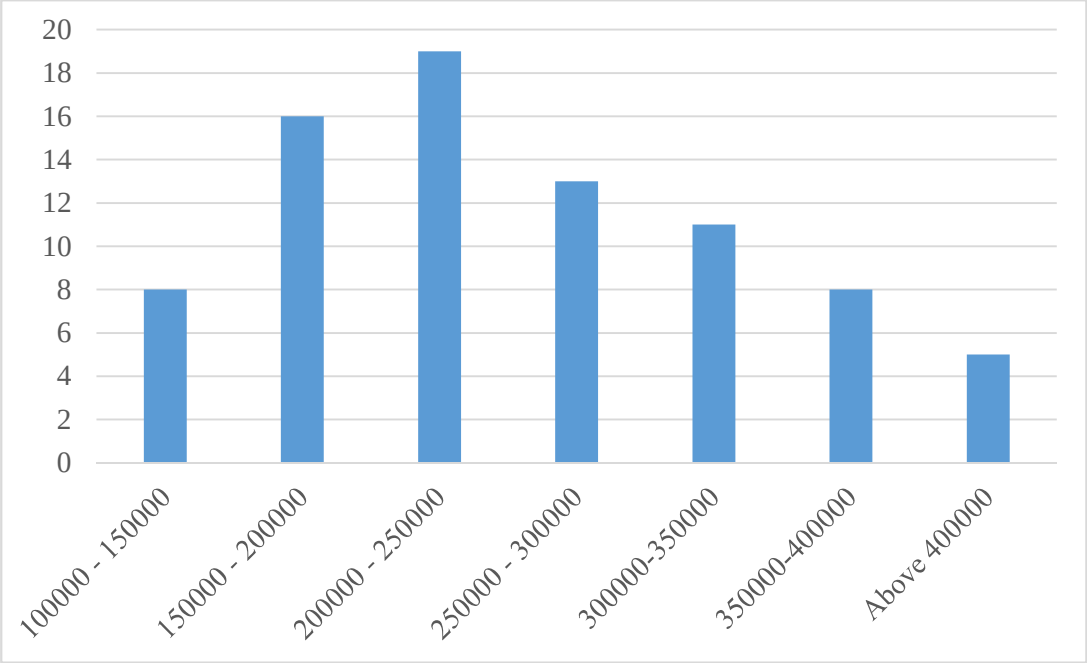


Source: Field Study, 2021

4.1.7 Annual Income of the Household Heads

Micro-hydro service provide electricity services to nearby households for different income generating businesses. The businesses of the households differ according to local resources. In the study area, sources of income by economic activities were highly varied. Most of the economic activities in the area came under primary sector and the remaining activities were to service sector. The activities related to manufacturing were nearly nil. People in the study area have different sources of income such as farming, livestock, poultry farming, daily wages, government service, remittances, business etc. Income levels vary according to households because of variation in income sources and activities. In the study area most of the households' income level was below Rs. 3 lakhs. The study found that average annual income of the households was Rs. 234590.6 (Figure 4.7).

Figure 4.7: Annual Income Distribution of Households



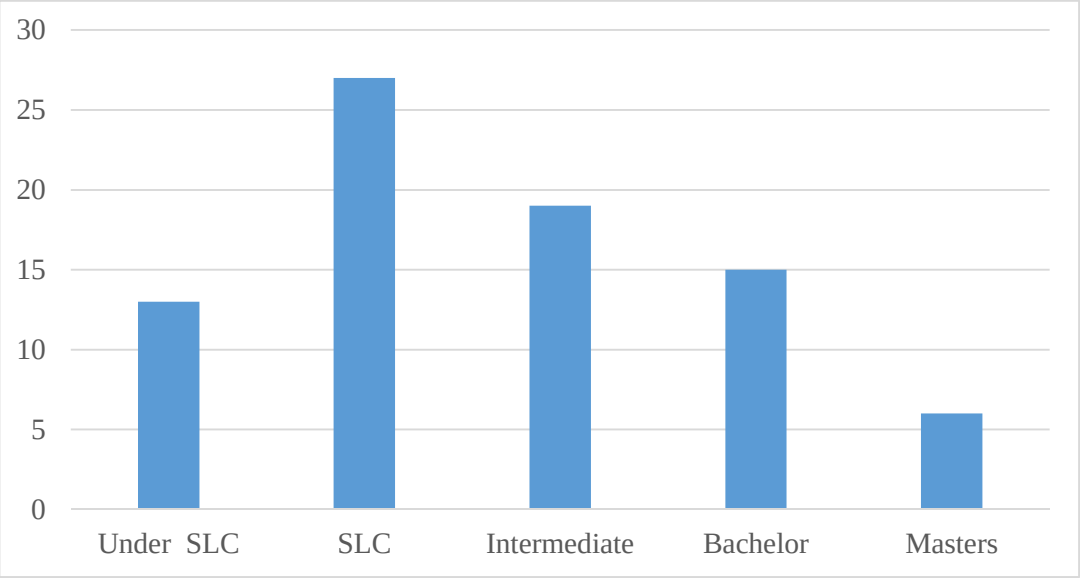
Source: Field Study 2021

4.1.8 Education Status of the Household Heads

In modern age, education is very important in the life of human beings. Education is considered as milestone to each person to increase his/her knowledge. To develop any

country, education plays a vital role. Education is essential to increase participation in the local economic activities. Educated people could take more benefits from micro-hydro projects. Therefore, the educational status of sampled heads was also analyzed. Nevertheless, educated heads run different economic activities with sustainability and the benefit is well distributed to family members even to children of any age and gender (Figure 4.8).

Figure 4.8: Education Status of Household Heads



Source: Field Study 2021

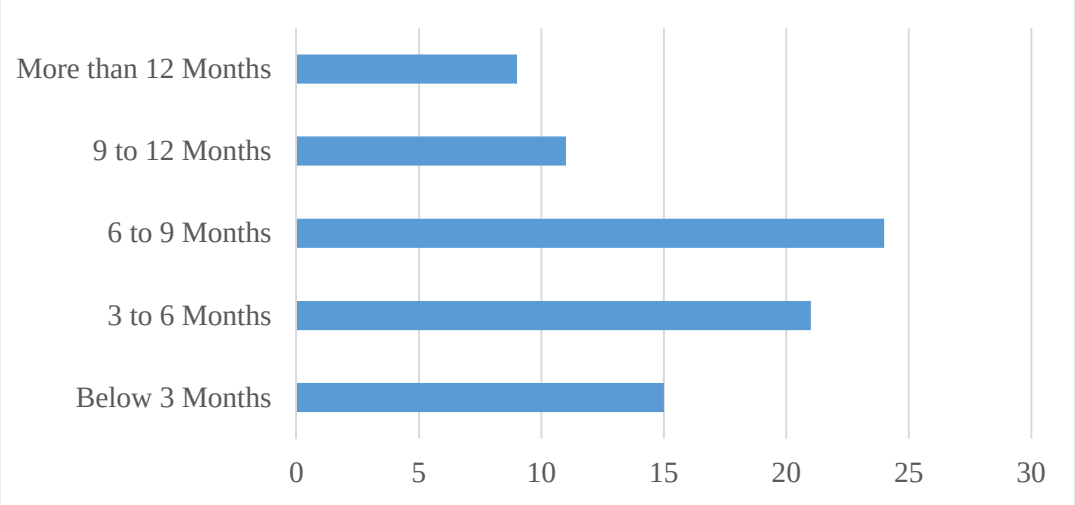
The results on household education showed that in the study area all heads were literate. The percentages for under SLC, SLC, intermediate, bachelor and masters education levels were 16.3 percent, 33.8 percent, 23.8 percent, 18.8 percent and 7.5 percent respectively.

4.1.9 Distribution of Household Heads by Food Sufficiency Status

In the study area, households had agriculture activities. It would contribute to food supply. If that activity supply sufficient food supply for the next harvesting, it was considered that they had meet one of the basic need from their own farming and they had gains from farming. If it is just for meeting food supply for short period, agriculture activities had little contribution to local residents. The results showed that 25.1 percent households have sufficient food from their own agriculture activities,

reaming 74.9 percent household's agriculture output did not meet annual food supply. Food sufficiency of the households is presented in the Figure 4.9 below.

Figure 4.9: Food Sufficiency Status of Household Heads

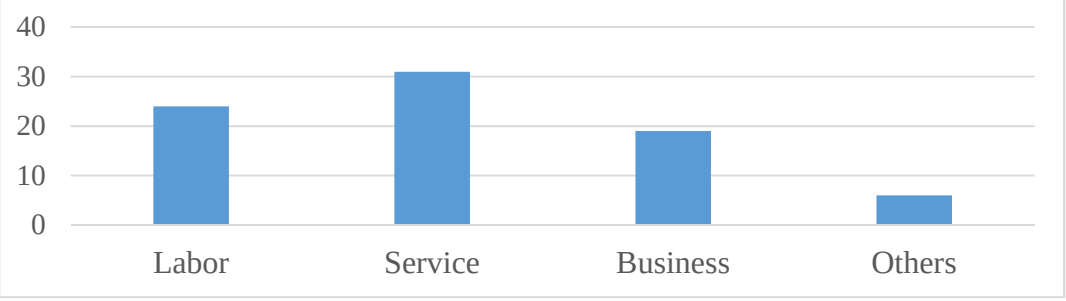


Source: Field Study 2021

4.1.10 Alternative Sources to Recover Insufficiency in Food Supply

As there were 74.9 percent, households had insufficient food supply. In such condition, there should be alternative income resources. Such sources are important in supplying food in the family. Such sources might be labor or daily wages, business, government service, business etc. In the study area, major alternative sources of income that suffice food supply were labor, service, business and others. The respective percentages according to labor, service, business and others were 30.0 percent, 38.8 percent, 23.8 percent and 7.5 percent respectively (Figure 4.10).

Figure 4.10: Alternative Sources of Food Supply for Household Heads



Source: Field Study 2021

4.2 Socio-economic Assessment Related To Sankhkhola-2 Micro HydropowerProject

Micro hydro projects had direct and indirect impacts. This study estimated direct impacts comparing the situation before and after service of electricity. Before and after electricity service, there is significant difference in the use of sources of light, sources of cooking fuel, microenterprises, other enterprises, use of home appliances (TV, rice cooker, grinder, iron etc.), agriculture outputs due to pumping, drinking water sources from pumping/lifting, health improvement due to use of quality energy source, cost efficiency due to saving of time in fetching water and collecting fire wood, employment situation generated from electricity service and chances of working time due to work in the late nights and early mornings. Therefore, under paired t test analysis only those variables were included that were mostly seen in the field study. The key variables under the test were:

i. Sources of lightings

ii. Sources of cooking energy

iii. Increase in microenterprises

iv. Increase in other enterprises

v. Increase in wheat production

vi. Increase in vegetables production

vii. Availability of underground or other lifted drinking water source

viii. Health status

ix. Employment opportunity

x. Cost Efficiency

xi. Save of time (water fetching and fire wood collecting)

xii. Increase in electric home appliances

The study tested these variables based on paired t-statistics. The results were accepted below the 5 percent significance level. The acceptance and rejection of the test result was determined by probability value of t statistics. If the probability of any variable

above 5 percent, null hypothesis is accepted i.e. there is no difference on the said variable after intervention of micro-hydro project. If the probability of the variable appeared below 5 percent, then null hypothesis is rejected or alternative hypothesis is accepted i.e. there is significant difference on the said variable after electrification trough micro-hydro project. The results were presented in the Table 4.1.

Table 4.11: Paired t-statistics Results

Variable	t-Statistics	Standard Error	p-value	Result
Sources of lightings	-23.602	0.847	(0.000)*	Significant
Energy to Cook	-1.628	4.725	(0.316)	Insignificant
Microenterprises	-19.821	0.937	(0.004)**	Significant
Other enterprises	-17.083	0.838	(0.019)**	Significant
wheat production	-3.974	5.964	(0.382)	Insignificant
Vegetables production	-24.882	0.305	(0.000)*	Significant
Water lifting	-5.409	3.958	(0.717)	Insignificant
Health status	19.073	0.582	(0.043)**	Significant
Employment Level	-6.938	4.935	(0.285)	Insignificant
Cost Efficiency	-2.749	3.387	(0.539)	Insignificant
Save of time	-34.735	0.135	(0.000)*	Significant
Electric home appliances	-36.837	0.127	(0.000)*	Significant

Note: * denotes the statistical significance at 0.01% and ** denote the statistical significance at 0.05%
Source: Self-Calculation

The probability value of the variables conformed that all variables were significant except energy to cook, wheat production, vegetable production, cost efficiency and employment level. Therefore, the socio-economic impacts of Sankhkhola-2 Micro Hydropower Project were remarkable.

As the variable sources of lighting was appeared significant. It revealed that local residents of Musikot Municipality now uses electricity instead of traditional sources of lightings such as Tuki, candles, kerosene lamps, bio gas lamps, lights from dry batteries etc. Therefore, it infers that micro-hydro projects have significant positive impact on lightings.

Firewood is traditional source of cooking fuel. In rural areas of Nepal, it is widely used to cook food and fodder for cattle. In the study area, the impact of electrification is inconclusive. Before the micro-hydro project, they use firewood and after the electricity service, they are not using electricity in cooking significantly. This might be high cost of electricity or easy availability of firewood at low or costless condition. Further, households might be using biogas or LPG gas. Nevertheless, the expectation does not exist. It accepts null hypothesis that there is no difference in the use of traditional energy sources in case of availability of its compliments.

Microenterprises or enterprise include local traditional and modern businesses such as mills, spices, cottage industries, crafting, wood work, poultry farming, furniture, saw mill, dairy, agro processing mills, computer official services, internet service, etc. These enterprises utilize power and such power is supplied from micro-hydro projects. Therefore, there was no opportunity to run these businesses before the introduction of electricity. Diesel plants might be used before electrification, however such energy is expensive and very less complement to electricity. Thus, the impact of micro-hydro projects on micro and other enterprises is positive and significant. Hence, micro-hydro projects induce the development of both microenterprises and other enterprises in the nearby areas.

The study expected that in the winter dry season local framers lift water to irrigate wheat fields after the micro-hydro project. Before the project people have no alternative to lift water, however after the project, it appeared insignificant. This might be vegetable production instead of wheat farming. Vegetable farming/production business is more profitable than wheat farming. Hence, the impact of the micro-hydro projects on vegetable farming appeared significant. It infers that after electrification local farmers indulged in vegetable farming.

The impact of the project on health status is significant. It deduces smoke and use of electricity in different uses in the kitchen as well as other applications increased the living standard of people. Thus, micro-hydro projects have boosting impact on health of its service holders.

The impact on employment level is insignificant at 5 percent level. It directs that there is no significant impact of micro-hydro projects on employment generation. Nepal is country of high unemployment forever. Further, the country bears the burden of

disguised unemployment. Unemployment and disguised unemployment is more severe in rural areas. The area of the study is rural and might be employment opportunities would low. Thus, the impact on employment is inconclusive.

Electrification intensifies more and more use of machines. On the one hand, it reduces cost due to savings in time; on the other, it augments productivity of the labor. Thus, the study expected that introduction of micro-hydro project would reduce working time. The results are in line of expectation, as the variable appeared significant. Hence, micro-hydro projects save the time of its service users.

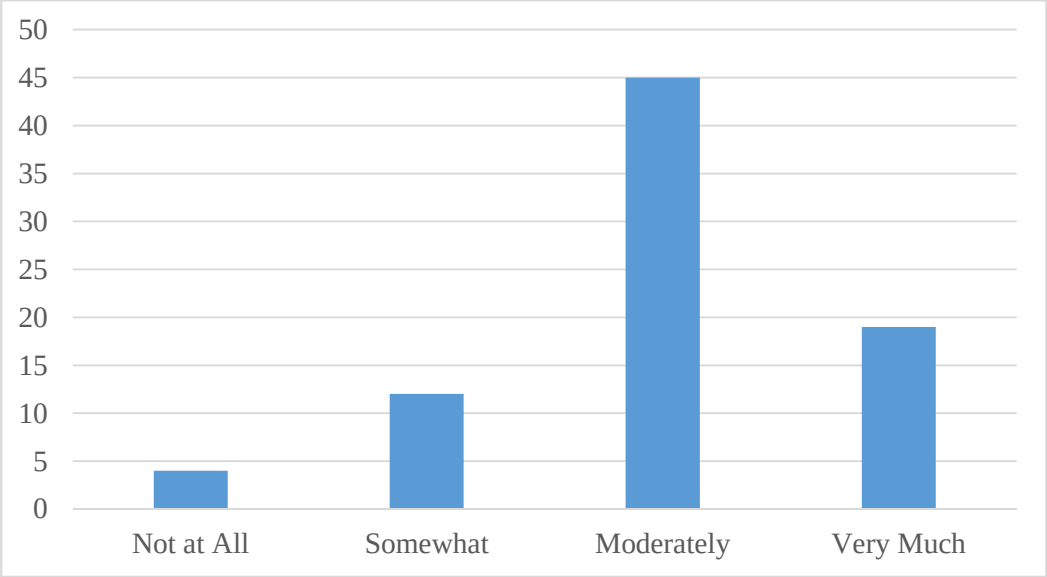
Saving in time reduces cost of any business. Saving time means more time to produce in the same time. Further, electrification intensifies the use of modern machines, equipment. It upsurges production level from the same level of inputs. All these activities finally resulted into cost efficiency or competitiveness. The results showed that the impact of micro-hydro projects on the study area is inconclusive i.e. micro-hydro projects have no significant impact on cost efficiency in the Musikot Municipality.

This the age of electric appliances. Fans, fridges, heaters, TV, iron, rice cooker, grinder, cattle, radio, washing machine, mobile charge and induction stove, etc. These all appliances need electricity. Hence, the study expected that after intervention of the micro-hydro project, the use of electric appliances is increased in the study area and the results comes true. Therefore, micro-hydro projects have significant impact on the use of electric appliances. It means that people use more appliances after the introduction of electricity service.

4.3 Participation of Service Users for Satisfaction of the Project

Responsibility is known as accountability. Everything needs maintenance. For this purpose, someone must be responsible. In the study, it is attempted to find out who is responsible for maintenance, safe guard the project area from unnecessary tensions and helping the staffs of the company. The attitude of local people to the company shows the responsibility of local people. The satisfactory level of households reflects the responsibility of service users (Figure 4.11).

Figure 4.11: Service Rating of Consumers



Source: Field Study, 2021

The results showed that most of the households were well satisfied from the service. The percentages for the categories not at all, somewhat, moderately and very much were 5.0 percent, 15.0 percent, 56.3 percent and 23.7 percent respectively. Therefore, higher level of satisfaction supports responsibility toward the project.

CHAPTER - V

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This chapter is divided into three sections. Findings, conclusions and recommendations interpreted in different sections.

5.1 Summary of Findings

In the absences of infrastructures like road and transmission line, the speed of hydropower development is weakened. Hilly areas with natural waterfalls on the dam-toe or canal drops are suitable sites for micro-hydropower plants. Micro-hydropower plants produce nearly constant input power. Micro-hydropower is easy to operate and there is no need for rigorous maintenance. Micro-hydro technology is electrical energy generation system from water resources with lower installed capacity. The capacity varies according to countries.

This technology has been successful to extend and explains rural electricity in rural areas. At present, the effort of the government of Nepal and Nepal Electricity Authority (NEA) is not adequate to harness the vast power generation potentiality of the country and meet the growing demand in the short run. Recently adopted rural electrification strategy to provide energy and to reduce the socioeconomic disparity by giving the importance in the rural electrifications as mini hydropower projects.

Micro-hydro projects have many positive impacts. Impacts are direct and indirect and such impacts are multidimensional. For this purpose, this study used before and after technique to evaluate the impact of electrification service on sources of lightings, sources of cooking energy, microenterprises and other enterprises, wheat production, vegetables production, water lifting, health status, employment opportunity, cost efficiency, time saving and electric home appliances. Therefore, reliable information has been collected from the local respondents nearby the Sankhkhola-2 Micro Hydropower Project which is located ward no. 7 of Musikot Municipality of Rukum West district. In this context, following specific objectives are fulfilled.

i. To access the impact of Sankhkhola-2 Micro Hydropower Project on household activities, and

ii. To find out consumers satisfaction from electricity service of Sankhkhola-2 Micro Hydropower Project.

This research would help to know externalities for other project and programs and to implement such type of new project. Socio economic impacts of this project inform the role of project in the socio economic uplift of a community. Finding of this research may be valuable information to those institutions that are interested about people of related area.

This study is based on explanatory research design. There are 490 households in the project area of Musikot Municipality of Rukum West. Out of which 80 households are sampled. Samples are purposely selected. The structured questionnaire or unstructured interviews and observation methods was applied to collect the both qualitative and quantities data. Descriptive methods and paired t test were used to analyze data. Results of the study are summarized below:

- From the total population of 480, 80 households were sampled. Of them 48 (60.0 percent) were males and 32 (40.0 percent) were males.
- The result of sampled household heads on age structure ranged between 21 years to 69 years. The 3 household heads (3.8 percent) aged between 21 to 30 years, 17 household heads (21.3 percent) aged between 31 to 40 years, 35 household heads (43.8 percent) aged between 41 to 50 years, 20 household heads (25.0 percent) aged between 51 to 60 years and 5 household heads (6.3 percent) aged 61 and above years respectively. The results showed that more heads were young.
- Family size was observed moderate in the study area.
- The results showed that the Chhetris are the largest ethnic group followed by Magars. The respective percentage of Brahmins, Chhetris, Magars and Dalits were 17.5 percent, 43.7 percent, 26.3 percent and 12.5 percent respectively.
- There are three major religions found among the household heads, which are Hindu, Buddhism and Christians and their respective shares were 82.5 percent, 12.5 percent and 5.0 percent respectively.

- Agriculture was the major occupation of the people in the study area. About 45.0 percent household heads were farmers. Other occupation were service, own business and foreign employment and their shares were 25.0 percent, 18.8 percent and 11.2 percent respectively.
- In the study area, most of the households' income level was below Rs. 3 lakhs. The study found that average annual income of the households was Rs. 234590.6.
- The results on household education showed that in the study area all heads were literate. The percentages for under SLC, SLC, intermediate, bachelor and masters education levels were 16.3 percent, 33.8 percent, 23.8 percent, 18.8 percent and 7.5 percent respectively.
- The results showed that 25.1 percent households have sufficient food from their own agriculture activities, reaming 74.9 percent household's agriculture output did not meet annual food supply.
- In the study area, major alternative sources of income that suffice food supply were labor, service, business and others. The respective percentages according to labor, service, business and others were 30.0 percent, 38.8 percent, 23.8 percent and 7.5 percent respectively.
- The statistical results showed that the variables energy to cook, wheat production, cost efficiency and employment level were insignificant.
- The results infers that micro-hydro projects have significant positive impact on lightings. It reduces traditional sources of lightings.
- The results showed that micro-hydro projects induce the development of both microenterprises and other enterprises in the nearby areas.
- The study infers that after electrification local farmers indulged in vegetable farming.
- Results supports that micro-hydro projects have boosting impact on health of its service holders.
- Results showed that micro-hydro projects save the time of its service users.
- Micro-hydro projects have significant impact on the use of electric appliances. It means that people use more appliances after the introduction of electricity service.

- The results showed that most of the households were well satisfied from the service. The percentages for the categories not at all, somewhat, moderately and very much were 5.0 percent, 15.0 percent, 56.3 percent and 23.7 percent respectively. Therefore, higher level of satisfaction supports responsibility toward the project.

5.2 Conclusions

Lower scale MHP may be most useful in rural and remote areas. There is sufficient feasibility of such types of lower scale MHP. Electricity is the closely related with human life therefore all respondent's living standard have been changed after MHP. After electricity facility most of the respondent's family income is increased. Micro-hydro projects have significant positive impact on lightings as they reduces traditional sources of lightings. The results showed that micro-hydro projects induce the development of both microenterprises and other enterprises in the nearby areas. It also infers that after electrification local farmers indulged in vegetable farming. Results supports that micro-hydro projects have boosting impact on health of its service holders. Results also showed that micro-hydro projects save the time of its users. Micro-hydro projects increases the use of electric appliances. The impact of the micro-hydro projects on cooking energy, wheat production, cost efficiency and employment level appeared insignificant. Local people were well satisfied from the electricity service. Based on the descriptive and analytical results, it revealed that socio-economic impact of micro-hydro projects on the local residents was found satisfactory in the study area. Therefore, service holder appreciate the service.

5.3 Recommendations

Electricity generation is an important part of the infrastructure development of any country. A conductive national strategy should be lunched to enhance and accelerate the electricity generation. To meet the yearly demand and then after export the surplus energy to neighboring countries, which would uplift the economy of the country in the long-run. Due to this conclusion the lower scale MHP is relevance in remote and Hilly areas. The following recommendations are suggested:

i. Electrical energy must be established as fundamental and basic needs of human being. Nepal is rich in water resource but there is not specific vision and policy of state. Therefore, the government should formulate and implement the proper policy. Government should emphasize the development of infrastructures in remote, hilly and mountains districts, which support the development of hydropower.

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

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

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

v. The impact of electrification varies from one place to another because of other socio-economic status. To have positive impacts, government should support other income generating programs to electricity service holding families.

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APPENDIX 1
Household Questionnaire

Socio-Economic information of Respondents

S.N	Questions	Code/Answer
1.1	Name of the village	
1.2	Ward No	
1.3	Name of house head	
1.4	Gender	a. Male b. Female
1.5	Age of Respondent	…… years
1.6	Number of household members	Numbers:
1.7	Caste	a. Brahmin b. Chetteri c. Magar d. Dalit e. Others
1.8	Religion	a. Hindu b. Buddhist c. Christain d. Others
1.9	Main occupation of household members	a. Agriculture b. Services c. Self-Owned Business d. Foreign Employment e. Others
2.0	Annual Income	Rs.:
2.1	Education Level	a. Illiteracy b. Literacy ▪ > Bachelors ▪ > Certificate Level ▪ >SLC ▪ 8-10 ▪ < 8
2.2	Food Sufficiency Month	a. <3 b. <6 c. <9 d. <12 e. >12
2.3	If food sufficiency is <12, what are the alternative source of income	a. Labor b. Business c. Service d. Others

3. What was the situation of electricity before and after MHP?

Periods	Before	After
Electricity (HRS)		
Source of Light		
Source of Cooking Energy		
Electricity Access To Household		
Load shedding (HRS)		
Regularity of Electricity		
Problem of Electricity		
Use of Electricity - Lighting - Watering - Cooking - Others		
Cost of Electricity		
Cost of Household Energy		

Micro enterprise
- Number
- Nature
- Type
- Scale
- Capacity
- Related
  - Agro
  - Service
  - Manufacturing
- Employment
  - Self
  - Employee
  - No
  - Nature
  - Contract
  - Wage
  - Informal		

How many hours' children use electricity in the study at night?		
How many hours your spouse work at night?		
How many hours you work at night?		
Growth of Asset - Radio - Cellphone - No of TV - Rice Cooker - Other Electrical Appliances		
How many hours' time is allocated to use the following instruments? - Radio		

⎫ Cellphone ⎫ TV ⎫ Rice Cooker ⎫ Others		
Do you involve in any Enterprises? ⎫ Poultry ⎫ Furniture ⎫ Saw Mill ⎫ Dairy ⎫ Agro Mill ⎫ Computer ⎫ Others		
How much income have you earned from your enterprises? ⎫ Poultry ⎫ Furniture ⎫ Saw Mill ⎫ Dairy ⎫ Agro Mill ⎫ Computer ⎫ Others		
Is Irrigation available to land? ⎫ Yes ⎫ No		
If Yes, what is the irrigation system? ⎫ Canal ⎫ Rain fed ⎫ Water pumping		
What is its coverage in ⎫ Upper belt of MHP ⎫ Mid belt of MHP ⎫ Lower belt of MHP		
How many months irrigation water is available?		
Do you get it regular? ⎫ Yes ⎫ No		
If yes, do you shift to high value crop? ⎫ Yes ⎫ No		
If yes, what you farm high value crops? ⎫ Vegetables ⎫ Mushrooms ⎫ Others		
Do your family have respiratory problem? ⎫ Yes ⎫ No		

If yes, what are they? ⎫ Respiratory ⎭ Others		
Do electricity service reduce respiratory problems?		
If yes, how much MHP supported to the project?		
What is the effect of MHP on ⎫ Irrigation ⎪ Clean Drinking Water ⎪ Employment ⎪ Infrastructure Development ⎭ Others		
What MHP's special contribution in these areas? a. b. c. d.		
What is your satisfaction on MHP?		
If not, what should MHP do?		