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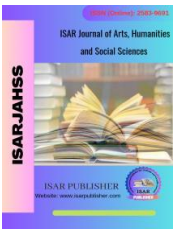

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SOCIO-ECONOMIC IMPACT OF THE ANKHUKHOLA HYDROPOWER PROJECT ON THE RESIDENTS OF TRIPURA SUNDARI RURAL MUNICIPALITY DHADING

Sudip Pandey[1*], Anish Poudel[2]

Department of Economics, Tri-Chandra Multiple Campus, Tribhuvan University, Nepal.

***Corresponding Author**
Sudip Pandey
Anish Poudel

Department of Economics, Tri-Chandra Multiple Campus, Tribhuvan University, Nepal.

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Abstract: *This case study investigates the Ankhukhola Hydropower Project's socio-economic impact on the Tripurasundari Rural Municipality residents in Dhading, Nepal. Utilizing a descriptive research design, the study aims to provide a comprehensive understanding of the multifaceted effects of the hydropower project on the local community. The primary objective is to analyze the socio-economic status and impacts on living conditions. The methodology includes primary data collection through interviews, questionnaires, and data analysis using Excel, ensuring a systematic approach to examining the project's social and economic consequences. The research highlights significant improvements in service delivery, revenue production, tourism, infrastructure development, and technology use post-electrification. Overall, the findings indicate that the Ankhukhola Hydropower Project has substantially benefited residents' economic and social lives in the catchment area.*

Keywords: Ankhukhola Hydropower Project, Socio-economic Impact, Quality of Life, Livelihoods, Infrastructure Development, Electrification.

JEL Classification: Q42, O13, R11, Q56, H54, R58

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I. INTRODUCTION

Hydropower projects represent a significant opportunity for Nepal's economic development, leveraging the country's abundant water resources. Nepal ranks as the second richest country globally and the richest in Asia in terms of water resources. With around 6,000 large and small rivers descending from the Himalayas and high mountains, the perennial nature of these rivers and the stepped terrain create ideal conditions for hydropower development. The total hydropower potential of Nepal's rivers is estimated at 83,000 MW, although the country has yet to fully capitalize on this potential. In response to an energy crisis, the Nepalese government aimed to produce 2,500 MW of electricity by the end of 2015, highlighting the urgency and potential for hydropower expansion.

Energy is a critical driver of national growth and development, with each country relying on its energy reserves to fuel progress. Nepal, endowed with substantial hydropower resources, stands out for its untapped potential in this sector. Despite this natural wealth, Nepal's hydropower development over the past century has not met expectations, leading to severe power shortages. Load-shedding has been a persistent issue, with the country experiencing up to 16 hours of power cuts daily as of 2017. This situation underscores the gap between potential and actual energy production, which continues to hinder economic growth and development.

The increasing demand for electricity in modern societies makes hydropower projects essential, yet their implementation often brings significant lifestyle changes for local populations. These projects impact various socioeconomic aspects, including living conditions, health, education, and income. While the benefits of hydropower include improved infrastructure and increased energy availability, these projects also entail challenges such as community displacement and environmental changes. These disruptions can profoundly affect the local population's quality of life, necessitating a thorough examination of both the positive and negative consequences.

Hydropower projects can lead to improvements in local education systems by providing reliable electricity, which enhances educational infrastructure and resources. However, the execution of such projects can also cause disruptions, such as community displacement and environmental changes, which may negatively impact educational outcomes. Health effects are multifaceted, involving changes in water flow, potential increases in waterborne diseases, and risks associated with construction activities. Additionally, the financial implications for local communities include both job opportunities and potential adverse effects on traditional livelihoods, such as agriculture, forestry, and fishing. The comprehensive understanding and responsible planning of hydropower projects are crucial to balancing the benefits of electricity generation with the broader socioeconomic impacts on local populations.

II. REVIEW OF THE LITERATURE

This literature review explores the socio-economic impacts of hydropower projects globally, emphasizing local communities' livelihoods, socio-economic status, and well-being. Focusing on Tripurasundari Rural Municipality in Dhading, it examines demographic characteristics, economic activities, and social structures. Various research methodologies, including descriptive designs, primary data collection, and data analysis techniques, are analyzed to assess the socio-economic impact of infrastructure projects. Existing studies on the Ankhukhola Hydropower Project are reviewed, identifying gaps and justifying the current research. The review highlights community involvement and stakeholder perspectives in hydropower projects, particularly local communities' participation in decision-making processes. It also discusses environmental and social impact assessments, providing insights into methodologies, key findings, and recommendations, emphasizing the significance of hydropower project impact assessments in rural settings.

Theoretical Review

Hydropower, known for its non-polluting and renewable nature, has become essential for modern living, aiding communication, healthcare, and reducing physical labour. Its viability in remote areas, especially through mini-hydropower (MHP) projects, makes it a preferred energy source in regions with scattered settlements and low investment capacity. MHP projects, which require low investment and have short gestation periods, are particularly suited for countries with abundant small rivers, such as Nepal. The increasing electricity demand, driven by population growth in developing countries, underscores the need for sustainable energy solutions. Hydropower supports rural communities by improving quality of life, education, healthcare, and economic activities.

Historically, hydropower has been utilized since ancient times for various tasks. Modern hydro turbines, developed in the 18th century, revolutionized electricity generation, leading to widespread adoption. Nepal, with an estimated 42,000 MW of economically feasible hydropower potential, has only developed approximately 846 MW. Most power plants in Nepal are run-of-river types, facing seasonal energy availability challenges. The reliance on traditional energy sources, such as fuel wood, contributes to environmental degradation, highlighting the need for increased hydropower development to achieve sustainability goals.

Empirical Reviews

Numerous studies highlight the socio-economic benefits of hydropower in Nepal and globally. For instance, Karki (2010) and Shrestha (2003) emphasized the positive impacts of micro-hydropower plants on health, education, communication, and overall living standards. Similarly, Paudyal (1999) and Sharma (2003) discussed the macroeconomic benefits of hydropower, including regional development and poverty alleviation. Despite these advantages, challenges such as operational and maintenance issues, environmental impacts, and displacement of local communities persist.

Studies like Ing & Genet (2016) and Lamsal (2013) have shown the mixed impacts of hydropower projects, with some highlighting positive socio-economic changes and others pointing out negative consequences, such as land displacement and inadequate compensation. The need for community involvement and robust institutional frameworks to address these issues is emphasized in the literature.

III. METHODOLOGY

This chapter outlines the research methodology used in this study, encompassing the research design, data sources, population and sample size, data collection tools, and data analysis methods.

3.1 Research Design

This study employs a descriptive research design to observe, record, analyze, and describe the characteristics of the phenomenon under study. This design is suitable for understanding the socio-economic impacts of the Ankhu Khola Hydropower project on income, savings, occupation, and other variables.

3.2 Conceptual Framework

The study considers various contextual elements such as project features, demographics, livelihoods, infrastructure, and cultural factors affecting the socio-economic impacts of the hydropower project. These elements can lead to environmental changes, wildlife displacement, relocation, economic effects, infrastructure development, and social and cultural impacts. Community involvement is crucial for effective decision-making and communication. The framework emphasizes the importance of community development plans, social welfare programs, environmental conservation, and capacity-building for sustainable impacts. Data on community opinions and adaptive management methods are collected through surveys to assess project impacts and create adaptive management plans.

3.3 Nature and Sources of Data

The data for this study are predominantly qualitative, complemented by some quantitative insights. Primary data sources provide a comprehensive understanding of socio-economic dynamics. Qualitative data explore community experiences in depth, while quantitative data offer statistical trends for a holistic analysis.

3.3.1 Population Sample Size and Sampling Technique

The study focuses on Tripurasundari Rural Municipality ward no. 4, comprising 602 households (Rural Municipality Record, 2022). A sample of 200 households was selected using a convenience sampling technique, which involves selecting participants based on their availability and willingness to participate.

3.3.2 Tools of Primary Data Collection

Primary data were collected using semi-structured questionnaires developed in line with the study's objectives and research questions. These questionnaires aimed to capture socio-economic impacts such as changes in income, savings, and occupations. Data were collected through observational methods and structured questionnaires.

3.4 Data Analysis

The data analysis process combined both quantitative and qualitative techniques. Convenience sampling and tools like percentages, tables, and graphs were used for quantitative analysis, providing a structured numerical representation of the data. Qualitative data, obtained from observations and open-ended questionnaire responses, were analyzed thematically to offer a deeper understanding of the community's experiences. This qualitative analysis enriched the quantitative findings, adding context and depth to the study.

Convenience Sampling

Convenience sampling, a non-probability sampling method, was used due to its efficiency and simplicity. It allows for quick and cost-effective data collection, which is particularly useful in exploratory research or when resources are limited. However, it also has limitations regarding the validity and generalization of the study results.

Analysis Methods:

Quantitative Analysis: Utilized percentages, tables, and graphs to analyze socio-economic trends, providing a structured numerical view.

Qualitative Analysis: Thematic analysis of narrative information from observations and open-ended responses, offering a richer understanding of community experiences and complementing the quantitative data

IV. DISCUSSION AND FINDINGS

The collected data were analyzed based on objectives and research questions, presented in tables and paragraphs. The analysis covered: project details, respondents' socio-economic and demographic details, the socioeconomic impact of the Ankhu Khola Hydropower Project, its economic contributions, and other advantages of hydropower projects

Table 1: Education Status

S.N.	Education Status	No. of Respondent	percent
1	Illiterate	8	4
2	Secondary	60	30
3	+2 level	48	24
4	Bachelor	52	26
5	Above	32	16
6	Total	200	100

Source: Field Survey, 2023

Table 1 notes the education status of the respondents. Data indicates that 4percent are illiterate, 30percent passed secondary level, and 24percent passed +2 levels. In the same way, 26percent passed the bachelor level and 16percent passed above the bachelor level. The majority of the respondents have only up-to-level education, and only 16percent have higher education. The hydropower project also provides scholarships to students for higher education. Students find it easy to study after electrification, so there is a relationship between electrification and education status.

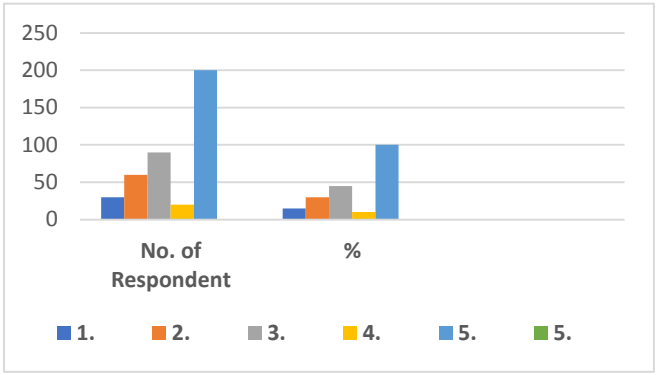
Table 2: Main Family Occupations

S.N.	Occupations	No. of Respondent	percent
1.	Agriculture	140	70
2.	Business	20	10
3.	Service	20	10
4.	Labour	20	10
5.	Total	200	100

Source: Field Survey, 2023

Table 2 notes the family occupations of the respondents. Data shows that 70percent of respondents are involved in agriculture and 10percent are involved in business. Of that, 10percent are involved in business, and 10percent follow in labour like wage labour. In services, there were services like public service, military service, and service in the private sector.

Figure 1: Annual Income



Source: Derivation of Author

A bar diagram representing respondents' annual income is shown in Figure 1, which indicates a general increase following electrification. The majority experienced financial growth, illustrating the positive impacts of electricity on the population's fundamental economic health.

Annual Expenditure

Annual expenditures are not so high for the respondents. Table 3 shows the annual expenditure of the respondents.

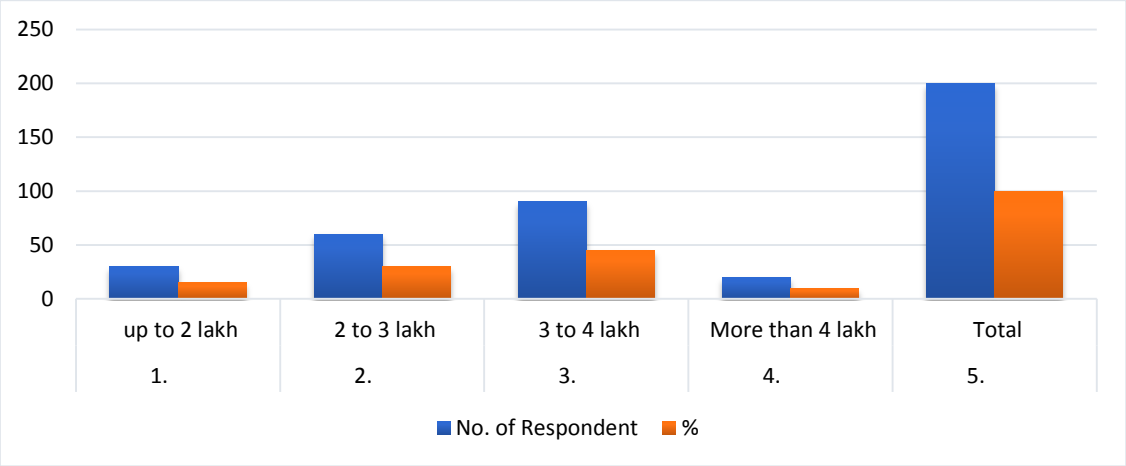
Table 3: Annual Expenditure

S.N.	Annual Expenditure	No. of Respondent	percent
1.	up to 2 lakh	30	15
2.	2 to 3 lakh	60	30
3.	3 to 4 lakh	90	45
4.	More than 4 lakh	20	10
5.	Total	200	100

Source: Field Survey, 2023

Table 3 notes the annual expenditures of the respondents. Data indicates that 15percent spend up to 2 lakhs, and 30percent spend 2 to 3 lakhs. In the same way, 45percent spend 3 to 4 lakhs annually, and more than 10percent spend more than 4 lakhs. Only a few respondents earn more than their annual income.

Figure 2: Annual Expenditure is shown in the Bar graph.



Source: Derivation of Author

Figure 2 shows of respondents' annual expenses, with few savings because of their low income. Most respondents (200 of them) spend all of their income on home costs, which shows the challenges of saving.

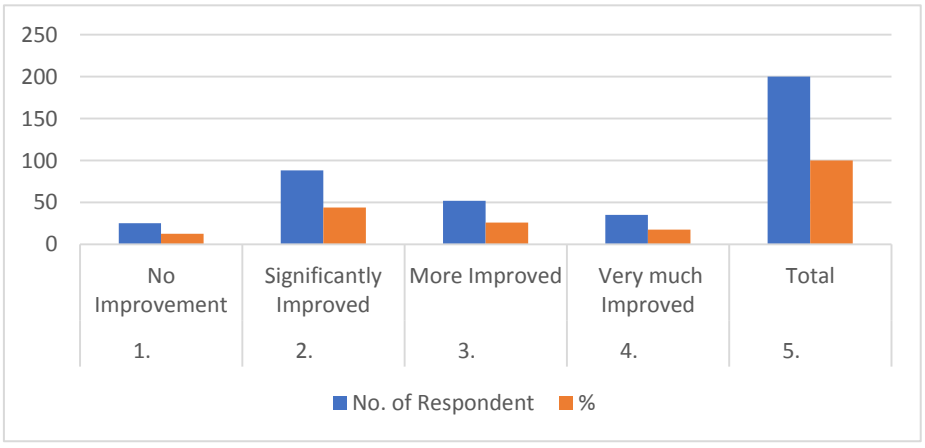
Table 4: Changes in Children's Education After Electrification

S.N.	Improvement In Education	No. of Respondent	percent
1.	No Improvement	25	12.5
2.	Significantly Improved	88	44
3.	More Improved	52	26
4.	Very much Improved	35	17.5
5.	Total	200	100

Source: Field Survey, 2023

Table 4 indicates the changes in children's education. Data shows that 17.5percent feel the change in children's education after electrification from hydropower. 26percent do not feel improved, 44percent feel significantly improved, and 12.5percent feel no improvement because they have no opportunities to connect to electricity at home. The majority of the respondents feel changes after electrification.

Figure 3: Children's Education After Electrification



Source: Derivation of Author

A bar diagram 3 illustrating the positive changes in the education of children after electrification might be found which illustrates the beneficial effects of electricity on children's educational chances.

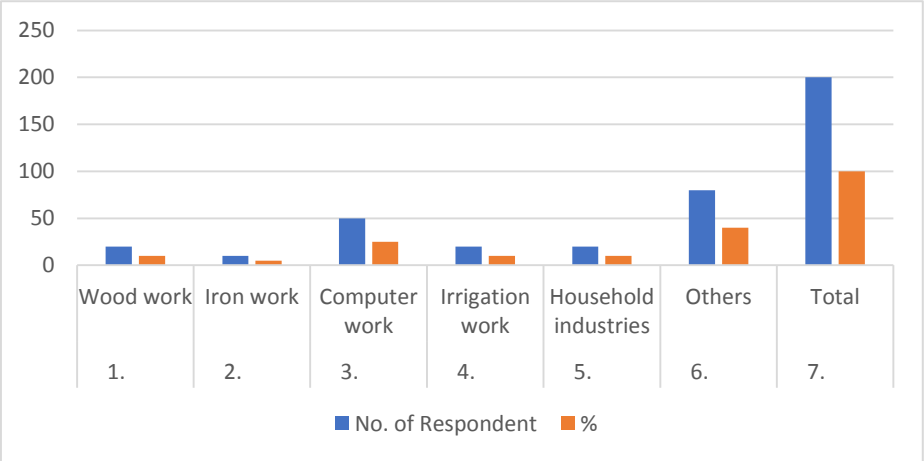
Table 5: Improvement in Productivity

S.N.	Improvement in Productivity	No. of Respondent	percent
1.	Woodwork	20	10
2.	Iron work	10	5
3.	Computer work	50	25
4.	Irrigation work	20	10
5.	Household industries	20	10
6.	Others	80	40
7.	Total	200	100

Source: Field Survey, 2023

Table 5 notes the productivity improvement. Data indicates that 25percent engage in computer work, 10percent engage in woodwork, 10percent engage in irrigation work, 10percent engage in household industries, and 5percent engage in ironwork. 40percent engage in any kind of productive work. The majority of the respondents feel that working is productive

Figure 4: Improvement in Productivity



Source: Derivation of Author

The above bar diagram indicates a productivity improvement. The bar diagram shows a range of preferences; the majority of individuals engaged their working hours in productive areas like woodwork, ironwork, computer work, irrigation work, household industries, and others.

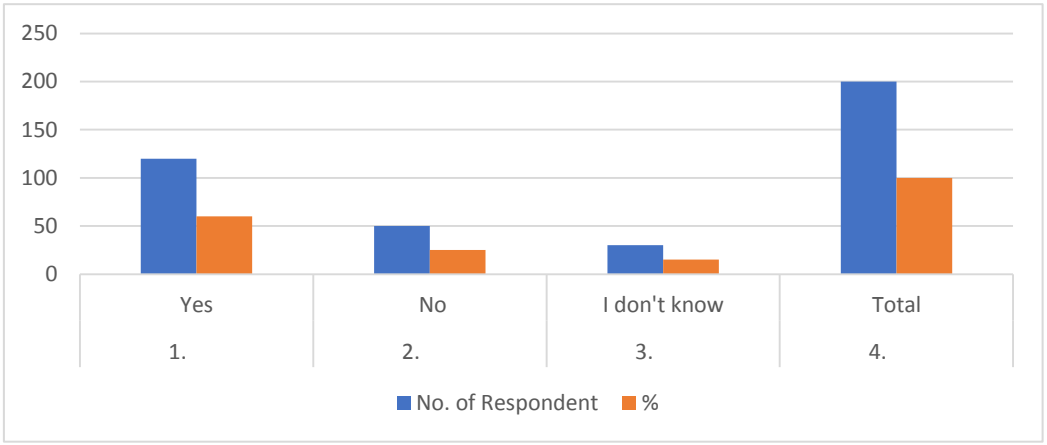
Table 6: Improvements in Health after Electrification

S.N.	Improvement in Health after Electrification	No. of Respondent	percent
1.	Respiratory	66	33
2.	Eye-aching	34	17
3.	Headache	16	8
4.	Heart diseases	8	4
5.	Asthma	42	21
6.	Other	34	17
7.	Total	200	100

Source: Field Survey, 2023

Table 4.16 notes the respondents' feelings about changes in health conditions after electrification in the study area. Data indicates that 33percent feel improvement in respiratory, 17percent feel improvement in eyes aching, 8percent feel improvement in headache, 4percent feel improvement in heart disease, 21percent feel improvement in asthma, and 17percent feel improvement in another disease like skin and hair-related disease.

Figure 5: Improvement in Environment



Source: Derivation of Author

Figure 5 illustrates the impacts on the environment after electrification. This shows most people feel a good environment after electrification.

Table 7 Energy Sources in the Study Area

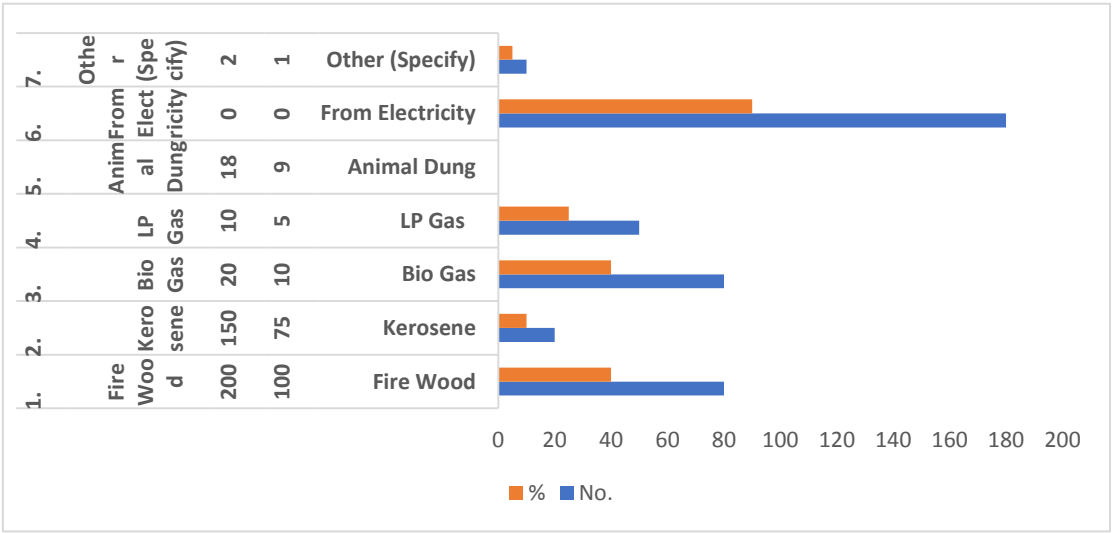
S.N.	Before	No.	percent	After	No.	percent
1.	Fire Wood	200	100	Fire Wood	80	40
2.	Kerosene	150	75	Kerosene	20	10
3.	Bio Gas	20	10	Bio Gas	80	40
4.	LP Gas	10	5	LP Gas	50	25
5.	Animal Dung	18	9	Animal Dung	0	0
6.	From Electricity	0	0	From Electricity	180	90
7.	Other (Specify)	2	1	Other (Specify)	**10**	**5**

Source: Field Survey, 2023

Table 7 notes the before and after use of energy sources in the study area. Data indicates that all the respondents use firewood for fuel, 75percent use kerosene to light at home, 10percent use biogas, 5percent use LP gas, 9percent use animal dung, and 1percent use another source. There were no electricity facilities in the study area before the completed hydropower project.

After completing the hydropower, 90percent use electricity as the main source of energy, 25percent use LP gas, 10percent use biogas, 10percent use kerosene for lighting, and only 40percent use firewood for energy. Almost all of the respondents used electricity as their main source of energy after completing the hydropower project.

Figure 6 Energy Source in Study Area



Source: Derivation of Author

The diagram 6 illustrates the energy source in the study area before and after electrification. Most people use firewood before electrification, but they use electricity after that.

Table 8 Other Advantages of Hydro Power Project

S.N.	Description	No. of Respondent	percent
1.	Improve Health	120	60
2.	Time-Saving	185	92.5
3.	Easy to work at night	45	22.5
4.	Increase in reading habit	60	30
5.	Improve on use of new technology	190	95
6.	Improve health and Time saving	160	80
7.	Improve Health, Time Saving Easy to work at night	150	75
8.	Improve Health, Time Saving Easy to work at night, Increase in reading habit	90	45
9.	Improve Health, Time Saving Easy to work at night, Increase in reading habit, Improve on use of new technology	105	52.5
10.	Total	200	100

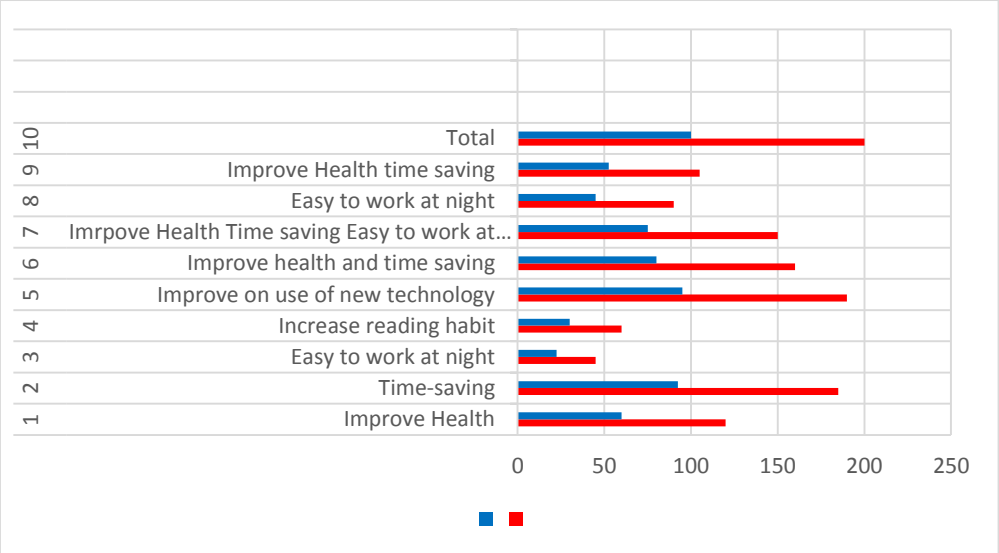
Source: Field Survey, 2023

Table 8 denotes the 200 respondents involved and every question asked about improvement after electrification in the study area. It is shown that 60percent of respondents claimed improvement in health because, after using electricity, smoke-related diseases like eye-aching and respiratory diseases have decreased. For that, 92.5percent noted electrification improved time because people began small industries after electrification in local areas, and 22.5percent felt it was easy to work at night after electrification. Respondents use bulbs for lighting. In the same way, 30percent mentioned that electrification increased the reading habit of the respondents because at night they could easily read books.

After electrification in the study area, respondents used technology like mobile phones, TVs, charging lights, etc. In this context, 52.5percent of respondents improved their health and time savings.

It is easy to work at night, increases reading habits, and improves the use of new technology after electrification in the study area.

Figure 7: Advantages of Hydro Power Project



Source: Derivation of Author

Figure 7 represents the advantages of hydropower projects, in which most people found the benefits of improvements in health, working habits, time savings, the use of new technology, and so on.

Findings

Analyzing the socioeconomic status of respondents revealed that 31 percent are aged 16-45, 39 percent are 45-60, and 39 percent are over 60. Males constitute 55percent and females 45 percent. Educationally, 4 percent are illiterate, 30 percent completed secondary level, 24 percent completed +2 levels, 26 percent have bachelor's degrees, and 16 percent have education beyond bachelor's. Most respondents are Janajati and Chhetri, with 53 percent Hindu, 30 percent Christian, 12 percent Buddhist, and 16 percent other religions.

Regarding occupation, 70 percent are involved in agriculture, 10percent in business, 10 percent in service, and 10 percent in labour. Income data showed that 15 percent earn up to 3 lakhs, 30 percent earn 3-4 lakhs, and 45 percent earn 4-5 lakhs annually. Expenditure patterns indicated that 15 percent spend up to 2 lakhs, 30 percent spend 2-3 lakhs, and 45 percent spend 3-4 lakhs annually, with few respondents saving more than they earn.

Education improved post-electrification: 17.5 percent felt very improved, 26 percent more improved, and 44 percent significantly improved their children's education, though 12.5 percent saw no change due to lack of electricity access. Device usage increased, with 65 percent using more than three devices. Electrification led to changes in occupation by 65 percent, with new businesses such as hotels, wood industries, and iron factories emerging.

Productivity improvements were noted by 25 percent in computer work, 10 percent in woodwork, irrigation, household industries, and ironwork, while 40 percent saw no productivity changes. Post-electrification, 30 percent took on side jobs like woodwork and dairy work, with 180 of 200 respondents engaging in evening or night business activities.

Health improvements included 33percent in respiratory conditions, 17 percent in eye health, 8percent in headaches, 4 percent in heart disease, 21 percent in asthma, and 17 percent in other diseases. Animal husbandry support was noted by 70 percent, with 25 percent using electricity in agriculture and livestock, 30 percent for lighting, 20 percent for business, 10 percent for service, and 5 percent for personal use.

Energy sources shifted significantly post-electrification: 90 percent now use electricity as the main energy source, reducing reliance on kerosene and batteries. Electricity usage patterns showed 50percent using a minimum of 100 units per month, 30 percent using 100-200 units, and 20 percent using over 200 units.

Environmental impacts included deforestation and pollution, with mixed perceptions of improvement. 5 percent felt worse, 20 percent felt no change, 25 percent saw a drastic change, and 50 percent felt sanitation improved. Main occupations were agriculture (10 percent), business (15 percent), service (10 percent), and labor (20 percent). Landholdings were up to 10 ropani (36 percent), 10-20 ropani (41 percent), and over 20 ropani (18 percent). The project allocated 10 percent of shares to affected areas, employing 13 residents. Electrification enhanced income generation, tourism, infrastructure, and technology use.

V. CONCLUSION AND RECOMMENDATIONS

The Ankhu Khola Hydropower Project in Tripurasundari Dhading has significantly impacted the local community through electrification. With access to electricity, respondents have established small industries, hotels, and tourism businesses, increasing their income. The shift from using kerosene, candles, firewood, batteries, and biofuel to electricity has saved them time and money. The project has created numerous local jobs, allowing residents to work on the project site and in local industries.

The majority of respondents noted improvements after electrification, which now supports various domestic and commercial activities. Electricity has enhanced agricultural production through better irrigation and has benefited animal husbandry and poultry farming. Environmental conditions have also improved post-electrification.

Electrification has made public and private service delivery faster and more convenient, boosting overall efficiency. The Ankhu Khola Hydropower Project has facilitated income generation, tourism, infrastructure development, and the adoption of new technology in the catchment area. Overall, the project has positively transformed the economic and social lives of the residents in the region.

The hydropower project aims to ensure the well-being of workers and local communities through strict health and safety protocols, emergency response training, and healthcare facilities. Education and awareness initiatives are crucial, focusing on sustainable energy practices and long-term benefits. Social impact evaluations are conducted to understand the project's effects on local communities, and resettlement plans are developed with fair compensation and adequate housing. Cultural heritage preservation plans are developed in consultation with local communities, and conflict resolution mechanisms are established. Long-term monitoring and evaluation processes are used to assess the project's socio-impact, adjust strategies, and foster a culture of continuous improvement for long-term sustainability.

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APPENDIX

Questionnaire

Name of the Respondent:

Age:

Sex:

Education status:

Caste/ ethnicity :

Religion :

Main family occupation :

Landholding size :

Annual income :

Annual expenditure :

1. Contribution of Ankhu Khola Jalvidut Company Ltd. Tripurasundari Dhading in rural development
   a) . After electrification, can it be easy to study or your children increase their study time (please tick√)

Not improve ( ) Significantly Improve ( ) Improved ( ) Very much improved ( )

2. Do you use electronic devices after electrification in your area?

One Device ( ) two device ( ) Three devices ( ) More than three devices ( )

3. Does Ankhu Khola Hydropower Project Ltd help in your occupation?

new occupation ( ) Old Occupation ( )

4. How much aggregate extra time do you spend in productive activities after the electrification?

a. less than 1 hrs [ ] b. 1 hrs to 2 hrs [ ]

c. 2 hrs to 3 hrs [ ] d. More than 3 hrs [ ]

5. Have you been involved in any kind of side occupation? Yes [ ] NO [ ]

If yes, Specify.....

6. Can you do business work in the evening or night? Yes [ ] NO [ ]

7. If yes, in which business do you work at night

a. saw mill b. Rice mill c. animal firm

d. spice mill e. oil expeller f. small industry g. Small industry Restaurants & Hotel

h. Not involved…….

8. Did you find that involvement in productive work, helps to increase your income level?

a. Yes b. No c. To some extent d. Difficulty to say

9. If yes, how much (approx.) Rs. ……

10. Can this project help with animal husbandry?

a) Support of animal husbandry b) Not supported

11. Does hydropower support in Health Sector?

a) Yes b) No

12. If yes what types of improvements bring after electrification

Respiratory

Eye-aching

Headache

Heart diseases

Asthma

Other

13. Before electrification which source of energy did you use?

a. Firewood b. Kerosene c. Biogas d. LP Gas e. Animal Dung f. From Electricity

g. Other (Specify)…….

14. In which purpose do you use electricity?

a. Agriculture & livestock b. Lighting only c. Business d. Services e. Personal use f. Other (Specify)

15. How many units of electricity do you consume in one month?

.....units, Per unit rate.....

16. How much money do you spend on these energy sources? Specify the total in Rs. Per month

	Before	After
a.	Kerosene	
b.	Battery	
c.	Candle	
d.	Firewood	

e. Electricity

17. Did you feel environmental pollution after the project? Yes [ ] No [ ]

18. If yes, what type of pollution is increasing?

a. Water Pollution b. Air pollution

c. Landslides d. Duets

e. Deforestation Others (Specify)

19. What is the status of sanitary after electricity?

a. improved b. worse

c. Same as before d. Drastic change

20. What advantage of small hydro projects attracted you?

a. Improve health b. Time-saving c. Easy to work at night

d. Increase in reading habits

e. Effective in Agricultural production

f. Improve the use of new technology

g. Other specify (……)

21. What should be done for the sustainability of the project?

From the government site: ……...…….

From the user's site:…….....…….……..