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RESEARCH ARTICLE

Socio-economic Impacts of Hydel Power Project Pahalgam, Anantnag, Jammu & Kashmir India

Naila Nabi, Abdul Rouf Farooqi

Department of Environmental Sciences, S.P. College Srinagar J&K India.

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ABSTRACT

Electricity is the most essential element for the economic growth of a nation. In the past decade or so, throughout the world, hydropower projects have gained much attention regarding the environmental and socio-economic impacts that have arisen from the development of such projects. Though small hydropower projects are generally considered greener and more sustainable options than large ones, the environmental effects of SHP are not 'Small' compared to large ones. The SHPs cause long-term adverse effects on the surrounding environment, such as the construction of reservoirs and power plants causing deforestation, displacement of the local population, water present in the reservoirs for more extended periods causing the leaching of nutrients from the soil and also causes waterlogging and root rot; the stream diversion affects the habitat of aquatic species, risk of fire occurrence in the powerhouse poses a severe threat to the local population, affects the agricultural production, less employment generation, less electricity availability. To mitigate the environmental and socio-economic impacts and maximize the positive effects, a sustainable water resource project is required, and a public meeting should be conducted before such small hydropower projects are installed. This paper refers to the perception of the local public with regard to the socio-economic impacts of the Pahalgam Hydel Power Project and the need for sustainable development to maintain the balance with the hilly and eco-sensitive area.

Keywords: Environment, hydropower, renewable energy, sustainble deelopemnt, water resources

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INTRODUCTION:

Electricity is considered the most essential resource across all human industries everywhere in the world. Small hydropower systems allow for achieving self-sufficiency by using the best possible scarce natural resource, water, as it is decentralized and has a low cost of energy production [1]. Hydropower is the most used renewable energy source, but it has environmental impacts, as hydropower facilities result in changes in the surrounding environment. Due to these changes, both human and wildlife habitats are affected. [2]. Small hydro power plant systems use the energy in flowing water to produce electricity or mechanical energy. The water flows through the penstock or channel to the turbine or waterwheel, where it strikes the bucket of the wheel, due to which the shaft of the waterwheel or turbine rotates [3]. For electricity generation, the rotating shaft, connected to an alternator or generator, is responsible for the shaft's motion conversion into electrical energy. This electrical energy is stored in batteries or used directly or inverted to produce utility-quality electricity [4]. A small hydropower plant requires a proper height for the fall of water (head) and a sizable water flow. Small hydropower plants can be established at existing dams or are to be constructed in connection with river and lake water-level control and irrigation schemes [5].

On 30 September 1882, a 12.5 kW capacity first hydropower plant in the world was commissioned on the Fox River in Appleton (USA) [6]. In India, the first small hydropower project was implemented in the north-eastern state of West Bengal in the hills of Darjeeling in 1897 with an installed capacity of 130 kW [7]. In India, the Ministry of New and Renewable Energy has classified the hydropower plants eight as:

- Micro-hydro: up to 100 KW
- Mini-hydro: 101 kW–2000 KW
- Small-hydro: 2001 kW–25000 KW
- Below 100 KW (Kilowatt) capacity would come under

**Author for Correspondence: nailanabi709@gmail.com*

Pico Hydro

- A capacity of above 25000 KW would come under large hydropower projects.

Nearly about 173 GW is the global small hydropower potential.[8,9] Afghanistan, Bangladesh, Bhutan, India, Iran, Nepal, Pakistan and Sri Lanka have a small hydropower potential evaluated at 18,,077 MW, of which only 3563 MW has been developed so far [9,10]. India ranks among the largest hydropower capacity installations globally and is ambitious to expand [11]. hesitates 46,850 MW of hydropower's installed capacity, which is 11—4% of total installed capacity [12]. Jammu and Kashmir have an estimated hydropower potential of 20,000 Megawatts (M.W.), of which about 16475 MW have been identified so far [13].

General Features of the Pahalgam Hydel Power Project :

The Pahalgam hydel power project is a run-of-river type development located on the bank of Pahalgam West Lidder, a tributary of Jehlem River, in district Anantnag, Jammu and Kashmir, India. The project is situated at a longitude and latitude of 34°-01'N and 75°-19'E, respectively, and is 42 km away from Bijbehara town. The total area of the project is 153kanal. This powerhouse provides electricity to almost the whole of Pahalgam city, including its adjoining villages like Mamal, Laripora, Mondlan, Aru, Frislan, Ganeshbal, etc.

The Jammu and Kashmir Power Development Corporation (JKPDC) runs the project. The hydel power project was installed in May 2005, with a view to supplying power to this tourist destination uninterruptedly.

The Pahalgam Hydel Power Project is not a mini hydel power project as the total power generating capacity of this project is 3×1.5 M.W., so it falls in the category of small hydro as per the hydropower plant classification given by the Ministry of New and Renewable Energy Government of India. 2013, the project was upgraded, and one more unit was added. Presently, the project consists of three turbines for electricity generation. As per employees of the power project, this project's maximum power generating capacity during the summer period is 4.5 MW per hour, and in the winter season is 1MW per hour.

Working on the Project:

The water source to run this hydropower project comes from West Lidder (Fig. 1a), situated at an elevation of 2130.00 meters above sea level. The water is diverted from the West Lidder (Fig.1b) to the forebay tank (Fig. 1d), creating a reservoir. The water from the reservoir is then channelled through a penstock (Fig. 1e), which is a large pipe. The water flows downhill due to gravity and gains speed as it descends through the penstock. The fast-moving water strikes the blades of a turbine (Fig. 1f), causing it to rotate. The turbine's rotation is connected to a generator. As the turbine spins, it turns the generator's rotor,

Fig. 1a: West Lidder

Fig. 1b: Diversion of water

Fig 1c: Water coming to forebay tank

Fig 1d: Forebay tank

Fig. 1e: Penstock

Fig 1f: Turbines

Fig. 1g: Receiving station

Figure 1: Baic components of hydel power project Pahalgam.

surrounded by a stator.

The interaction generates electrical energy through electromagnetic induction. As the turbine spins, it turns the generator's rotor, surrounded by a stator. The interaction generates electrical energy through electromagnetic induction. The generator produces alternating current (A.C.) electricity. This A.C. power is typically at a relatively low voltage, so it goes through a transformer to increase its voltage to levels suitable for transmission. The generated electricity is then transmitted to a substation using high-voltage transmission lines. The voltage may be further increased at the substation for long-distance transmission or stepped down for distribution. The substation is connected to the electrical grid (Gopalpora Grid Station), an extensive network of power lines and infrastructure that supplies electricity to homes, businesses, and factories. The electricity from the grid is then distributed to consumers through local distribution lines, reaching homes and businesses for use.

METHODOLOGY

The survey was carried out in the following four sites, where power is supplied by the project, to know the socio-economic impacts of the project. These are;

1. Ganeshbal (located downstream (west) of the project)
2. Mamal (located on the east side of the project)
3. Mondlan (situated upstream of the project)
4. Laripora (Situated upstream of the project)

The present study is primarily based on primary data. The primary data includes first-hand reports/information collected by visiting various sites near the Pahalgam Hydel power project through detailed discussions with ordinary people and officials. Household socio-economic status is usually collected through questionnaire surveys, interviews, and field observations [14].

The universe of the study covers four villages around SHP. Systematic random sampling was done to choose four villages, of which two villages were situated upstream of the project, one from downstream and the other from the west side of the Pahalgam Hydel Power Project. The criteria were to choose one from a far region and the other from a near-to-project area. Thirty random respondents were selected from each of the villages.

Informal interviews using semi-structured questionnaires were conducted in the selected villages. In order to obtain results and to achieve the objectives of the present study, a well-designed questionnaire based on the literature available on this topic was prepared and distributed among 30 persons from each of the villages. The purpose and method of the study undertaken were explained to people to get their consent. All the questions in the questionnaire were filled out according to the respondents' actual responses.

RESULTS AND DISCUSSION

Most respondents were women (56.7%) compared to men (43.3%) (figure 2), and the age of respondents ranged from 20 years to 70 years (Figure 3). Most respondents (42.90%) belong to the age group of 14-35 years, while 35.70% are 36-55 years old. The majority of respondents were literate (55%); among the literate group, 48.5% were formally educated, 51.5% were educated correctly, and the lowest percentage (45%) of respondents belonged to the illiterate group (Figure 4)

The impact of the Pahalgam Hydel-Power project on the social and economic life of people:

Employment opportunities

Small hydro projects create employment opportunities and save fuel [15]. As shown in the figure below (Figure 5), most respondents (57.1%) agreed that employment is generated from this project. In comparison, 14.3% of respondents strongly agreed with it, but 28.60% of people's perceptions were neutral.

Some of the respondent's responses were that most of the

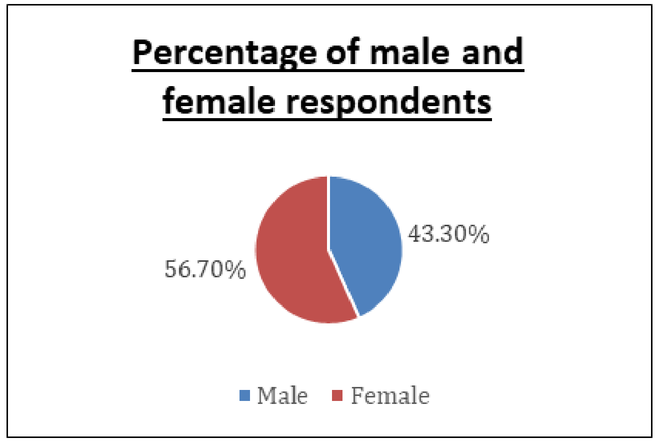

Figure 2: Percentage of male and female respondents.

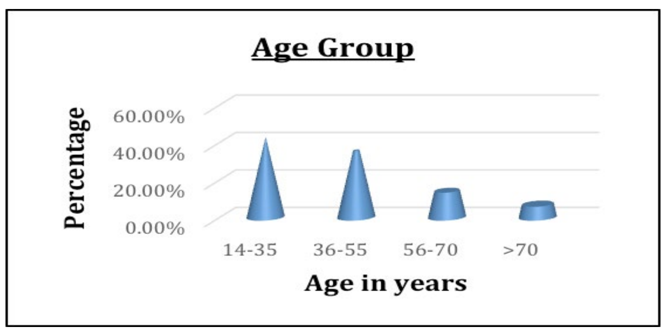

Figure 3: Percentage of age of respondents.

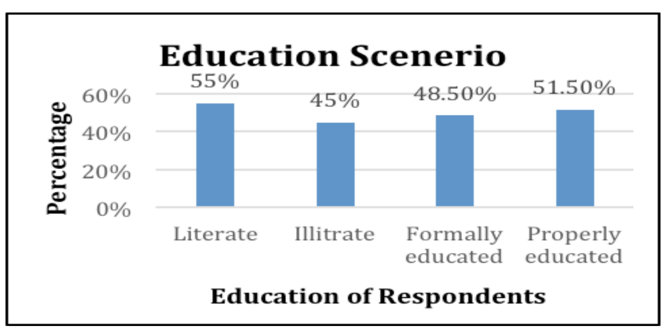

Figure 4: Percentage of literate, illiterate, formally educated and adequately educated respondents.

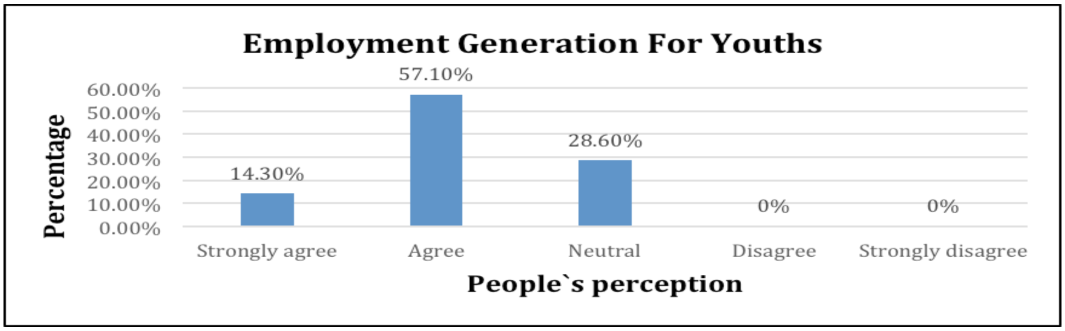

Figure 5: Respondent's perception towards employment generated for youths since after the establishment of the project.

time, discrimination is done by power developers while creating job opportunities, as discrimination is unethical and illegal. They said that most of the employees working on the project are from other districts and outside of the Kashmir valley, other than the residents of the project vicinity. They mentioned that the government should provide jobs in this project to those living in the project vicinity, i.e., these people should be given first preference. As per respondents, there are unemployed graduates and P.G. students in their villages, and only six persons out of 4 surveyed villages are working as employees in this project. As per the national survey conducted from July 2011 to June 2012, based on usual principal status (UPS), J & K has the highest unemployment rate of 4.9% in comparison to its neighbouring States like Punjab (2.8%), Delhi (4.7%), Haryana (3.2%) [16,17].

Tourism attraction:

The Pahalgam region is already home to horse and sheep farmers, and the power project is situated on the bank of the Lidder River, which boosts the tourist experience. As a result, the opinions of different respondents are likely to differ over how a destination's resources should be utilized [18]. As shown in the figure below (Figure 6), the maximum percentage of respondents (57.1%) strongly agree that the installation of the hydel power project had attracted local tourism in the area, which gave rise to the construction of more business establishments and other related infrastructure followed by 35.8% of respondents who agree with it. In comparison, 7.1% of respondents disagree with it.

Electricity availability

A small hydroelectric power system can produce enough electricity for a home, farm, ranch, or village [19]. The maximum percentage (64.3%) of respondents' responses was that electricity is available for less than 4 hours out of 24 hours daily. The lowest rate of respondents who responded that electricity is available only for 8-12 hours daily is 7.1%. At the same time, 14.3% of respondents responded that electricity is available for 4-8 hours or more than 12 hours in a day (Figure 7).

However, the maximum number of respondents (98%) responded that electricity remains available 24×7 during Amarnath Yatra (from June to September) every year.

Deduction of electricity during the winter season as compared to the summer season:

As shown in the figure below (Figure 8), most respondents claim that the electricity supply is deducted more during the winter than in summer.

The deduction of electricity during the winter may be since, in the Western Himalayas, the monitoring of winter precipitation suggests an increase in total rainfall but a decrease in snowfall from 1991 to 2015 [20]. These changes in the cryosphere will alter the spatial pattern and timing of glacier and snow melt [21,22], which may profoundly impact the amount and seasonality of water available for hydropower generation.

Change in cost of vicinity land area of the project after its installation:

As shown in the figure below (Figure 9), 92.9% of respondents' perception was that the cost of the vicinity land area of the project increased after its establishment. In comparison, 7.1% of respondents' perceptions were the opposite.

Residents who live at a minimum distance from the powerhouse stated that the power transformer produces

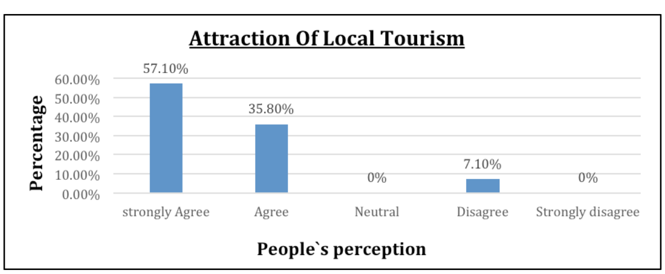

Figure 6: Respondent's perception towards the attraction of local tourism in the project vicinity area due to the installation of the hydel power project.

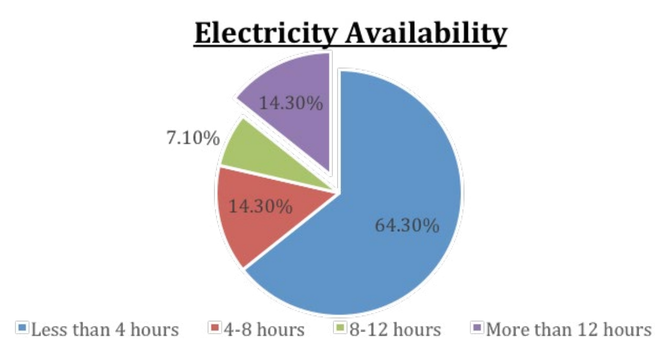

Figure 7: Respondent's perception of how many hours of electricity are available daily.

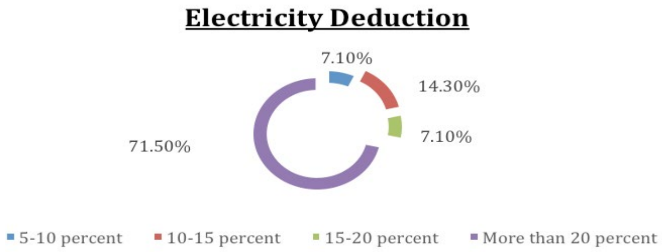

Figure 8: Respondents' perception of the percentage of electricity deduction during winter compared to summer.

unbearable noise. Sometimes, fires occur in the powerhouse, which poses a severe threat to nearby residents due to the potential for explosions, toxic smoke, and power disruption. It's crucial to have proper safety measures and emergency plans in place to mitigate such risks and protect the community.

Apart from the above impacts, some other Impacts of this small hydropower project include;

- 64.3% of respondents said that the land area under the project belongs to the residents of the village Mammal, and the power project establishment resulted in the dislocation of many families to other places. The dislocated families presently reside in Langanbal village, and the government provided little compensation to the affected families, of which the people are not satisfied. They also said that most of the affected people are not compensated yet. At the same time, 28.6% of respondents said that none of the affected families was compensated, and 7.1% responded that they didn't know anything about it.
- 64.3% of respondents responded that the construction of such small hydropower projects in remote areas of J & K is not fruit-full for local residents residing in the project vicinity and impacts the ecological status of the area. They said this project not only resulted in the dislocation of local residents but also disturbed the habitat of both wild and domestic animals. The residents said the river diversion impacts aquatic life, such as trout, which is not now seen in this river but was readily available around the project vicinity before its installation. At the same time, 35.7% of respondents disagree with it.
- Approximately 98% of residents of Mammal village said that they are not allowed by the Govt. to construct new homes. They said 4 to 5 families are living together in only one house. They also said that water present in the forebay tank for longer periods destroyed the habitat of pine and deodar trees found in the project vicinity, as sufficient water can lead to waterlogging in the soil, which can harm the root system of these trees and potentially cause root rot or other diseases. Also, too much water can leach essential nutrients from the soil, making them less available to the trees.
- 75% of respondents were unaware whether EIA was conducted before the project was established. They also said that the government didn't conduct public meetings at all, which resulted in the dislocation of many families, and 25% of respondents responded that they needed to learn about the EIA process. Dominik, S. (2006) indicated that the predominant reason for SHPs not contributing to sustainable development is the lack of public participation [23].
- 35.7% of respondents responded that the hydropower project impacted agricultural production severely, especially for those that resided at minimum distances from the project; they said that they used to cultivate maize plants in the land where the project is now constructed.
- Approximately 95% of respondents stated that the installation of hydropower projects impacted the grazing activities of domestic animals. The shepherds of the locality said they are not allowed to go in the project vicinity with or without a flock.

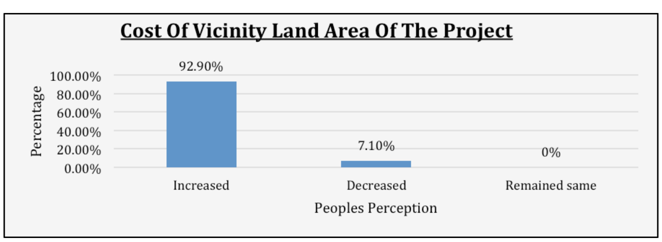

Figure 9: Respondent's perception of change in the cost of vicinity land area of the project since after its establishment.

Though the study is limited to a moderate sample of 120 interviews, the high level of primary data collection improves the reliability of the results. It evaluates the socio-economic impacts of the small hydel power project at Pahalgam. As this project is located in association with Overa-Aru Wildlife Sanctuary and is a popular resort area, it was necessary to evaluate its impacts. As of the results considered, this project provides employment opportunities, but most of the residents are not satisfied with it, as discrimination is done by power developers while creating job opportunities. Electricity is available at most 4 hours a day during the summer period, while in the winter season, residents face more electricity shortages. The project resulted in the dislocation of several families and disturbed the habitat of wild and domestic animals. It also impacted aquatic life, and the forebay tank destroyed the habitat of deodar trees and affected agricultural production. Further research is required to examine the impacts of such individual SHPs in eco-sensitive areas.

CONCLUSION:

Small hydropower technology is one of the most common technologies for electricity generation for rural populations. Analysis of the primary data presented in this study stated that the socio-economic impacts of small hydropower projects are less minor than such. The Pahalgam hydropower project has benefited the local people in several ways. Still, instead of its benefits, the project has more negative impacts, such as affected the habitat of wildlife, the decline in trout species in river Lidder, restricted grazing activities of domestic animals, resulted in a decrease in maize production, reservoir disruption, the growth of deodar and pine trees. The employment generated is of quite a minimum percentage, fire occurrence in a powerhouse poses a severe threat to nearby residents, and restricted access to previously accessible natural resources further increased the local hostility against the SHPs. The lack of expected benefits from the hydropower project and the onset of unexpected adverse impacts led to high dissatisfaction among respondents over the construction of SHPs in the region. Mitigating these impacts is possible to a large extent, provided that people are part of the decision-making process. They are made aware of their rights as most respondents state that the government had yet to conduct public meetings before project installation, resulting in the above impacts and dislocation of residents to other areas without giving them a bit of compensation. Environmental impact assessment should be carried out for such SHPs, significantly since environmental degradation can strongly affect the socio-economic activities of local communities.

Most importantly, to address the adverse effects of SHPs, there is a need to strengthen the policies governing these individual projects. Also, implementing effective monitoring mechanisms and regulations promoting decentralized electricity supply, local employment at working plants, and participatory management practices can enhance compliance with standard baselines and policies.

The present study is not against the installation of small hydropower projects, but these must be eco-friendly and sustainable in nature, and there must be sustainable improvement of human welfare. The study suggests that completely ignoring the environmental impacts of SHPs may not be good practice as far as the ecologically sensitive region is concerned. There is a dire need for further research to understand this project's cumulative economic and social impacts significantly better.

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