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EFFECT OF SMALL HYDROPOWER PROJECTS ON HUMAN DEVELOPMENT INDEX IN AZAD JAMMU AND KASHMIR

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ABSTRACT

This study investigated the impact of rural electrification on the Human Development Index in the Hattian Bala district of Azad Jammu and Kashmir. The 346 of beneficiaries and non-beneficiaries of small hydropower projects was selected randomly from 10 villages. The interview schedule was utilized for the collection of data. Face to face interview schedule consisted of three socio-economic parameters such as income, health and education which are central to Human Development Index (HDI). The HDI of villages using renewable energies from small hydropower appeared 0.412 while for un-electrified it was 0.047. Among the indices of income, health and education it was observed that the index of education was lower (0.236) than the health (0.339) and Income index (0.675) Even though literacy level was high in the area under study but most of the respondent's family members were aged up to 16 years (matriculation level) the weight age for the adult literacy index is 2/3 as compared to the gross enrolment index. Results also point out that the electrification in rural areas makes a great contribution to the development of that area because the availability of energy has a significant impact on different social and economic circumstances in developing countries. Findings of the study recommend that small hydropower projects, particularly in the northern belt of the country are very supportive in improving the living standard of communities.

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INTRODUCTION

Around the world, the larger part of the population is deficient in access to energy. Approximately 1.3 billion people do not have electricity, and 2.5 billion people depend on biomass for cooking purposes (IEA, 2017). Energy characterizes basic elements of socio-economic development. A shortfall of moderate energy services epitomizes a block to human, social, and economic development as well as the achievement of the (MGD) Millennium Development Goals (Zakari *et al.*, 2022). There are many advantages of electricity services in the health sector such as refrigeration of medication. Energy resources have a direct effect on lessening maternal mortality and battling an infection. The use of traditional cooking and heating fuels may prompt genuine medical issues (Holdren *et al.*, 2000).

Furthermore, energy promotes productive activities and financial growth in the agriculture sector development (IISD, 2004). Access to affordable and safe energy has an incredible potential to diminish poverty (Vera and Langlois, 2007). The provision of sufficient, dependable and inexpensive energy for domestic and commercial utilization is vital for the social and economic development of the economy.

Energy is a very important component of daily life such as we need the energy to cook food and keep ourselves warm (Goldenberg and Johansson, 1995), Energy in the form of electricity is required in educational institutions, and hospitals as well as bring social change in the community (Pachauri and Spreng, 2003). Equal provision of energy to all sectors of society is very important. Energy disparities end up in social injustice (United Nations Development Programme, 2005a). The energy crisis has sweeping effects on the well-being of individuals such as access to essential energy services like warm homes. Much time and

Physical energy is expended on simple survival tasks (Karekezi and Kithyoma, 2002), consisting of collecting firewood within neglected communities. Provision of energy improves Socialization for instance; access to modern energy can develop women's position in the community by relieving them from several the troublesome day-by-day tasks (Holdren *et al.*, 2000) Likewise modern energy encourages children's education such that comfortable environment for study in the educational institute as well as in homes (IEA, 2017). Because of energy, we can purify water for drinking, domestic usage and irrigation.

As per the report of the Asian Development Bank (2013), productive execution of renewable energy can pass advantages to individuals regarding health, and the environment. Renewable energy can increase income-generating activities and assist to maintain education, civilizing health circumstances and protect natural resources such as tourism, mining, transit trade, commercial agriculture, employment and small and medium enterprise (SME) development prospects can improve due to the tremendous capability of hydropower advancement.

Hydroelectricity is a type of renewable energy that is produced by machines, powered by moving water. It is usually possible in mountainous regions blessed with streams and rivers. In. those areas' utilization of hydropower on small scale is one of the feasible methods for the decentralized electrification of a rural region (Yah *et al.*, 2017). While instinctive, the connection between energy and development is difficult to quantitatively verify and has no longer been analytically explored in detail in the scientific literature. The purpose of this paper is to highlight factors influencing human development and recommendation of policies to promote human development. To make development comparable and measurable United Nations' Human Development Index (HDI) a composite statistic of life expectancy, education, and income per capita indicators is used

Objectives of the study

This study was designed to examine and quantify the effect of small hydropower projects on HDI in rural areas of Azad Jammu and Kashmir.

MATERIALS AND METHODS

Universe of the study

The study area was the District Hattian of Azad Jammu and Kashmir. The total area of the district is 854 square kilometres with a total human population of 230,529 and a growth rate of population is 1.74 percent (Census Report, 2017). Most valleys of the districts are tired through the Jhelum River and its tributaries. Electricity can be generated through small hydropower stations on rapid flowing streams through high altitudinal variations

Sampling technique and sample size

In different locations of Azad Kashmir, Government has installed many small hydropower projects aiming to provide cheap and reliable energy to rural local communities This research aimed to quantify the effect of small hydropower projects on HDI in rural areas of Azad Jammu and Kashmir. Therefore, the data was collected from district Hattian, where the hydropower projects were functional for at least five years. In this context, the current district was the most suitable selection, where several villages have been electrified through small hydropower projects.

For sample selection, the Multistage sampling technique was followed. In the first stage, from three tehsils namely Hattian Bala, Chakar and Leepa of District Hattean, two tehsils Hattian Bala and Leepa were selected purposively as hydropower projects were functional in these areas. In the second stage, out of 12 union councils, four union councils were purposively selected for collecting the required data. Three union councils were selected which were electrified with Small Hydropower Projects and one which was electrified through the National grid.

In the third stage, from three union councils, six villages were randomly selected. Two from the small hydropower project Sharian, two from the small hydropower project Leepa and two from the small hydropower project Kathai. Four villages were selected randomly from the fourth union council which were not electrified through small hydropower projects.

In the fourth stage, a randomization technique was carried out for a selection of sample. This technique is very useful in prevailing selection biases. For the present study, data were collected from the head of the household. The Head of household is taken as the unit of analysis at the household level. The beneficiaries' and non-beneficiaries households from small hydropower projects were considered as two different populations for the sampling purpose. A total sample size (346) was drawn by using the Sekaran table (Sekeran, 2003).

Finding out the sample size, the proportion allocation method was used for each sample village. For getting the sample required, many researchers and authors have used the proportional allocation technique (Ali *et al.*, 2013) (Table 1).

The formula for the proportion allocation sampling method is as follows:

$$n_i = \frac{N_i}{N} X\, n \ldots \ldots \ldots \ldots \ldots (1)$$

Where:

ni = No. of sampled respondents from each village.

Ni = Total population size in each village.

N = Total population.

n = Total number of respondents selected for the study.

Table 1. Distribution of the sampled respondents in the study area.

	Union councils	Villages	No. of sampled HH	Sample Size
Villages connected to small hydropower projects	Langla	Sharian	290	32
		Goharabad	250	28
	Gujar bandi	Kathai	260	29
		Ghrthama	305	34
	Leepa	Leepa	436	49
		Nakot	256	29
Villages not connected to small hydropower projects	Hattian Bala	Saran	346	39
		Chathea	336	38
		Kaneena	250	28
		Dhanni	355	40
		Total	3084	346

Sources: Hydroelectric Board (District Muzaffarabad, Revenue Department (District Hattian), 2015.

Data Source and Data Collection

The research was based on primary and secondary data. For the gathering of primary data well designed and pre-tested questionnaire was used from households used as a sample through a face-to-face interview schedule.

Analytical framework

HDI is the country's performance measured on three different features such as health, education, and living standard. There is a separate index produced for each aspect and combining these indices, with an equal weightage of 1/3, gives the HDI (Haq and Ponzio, 2008).

The Human Development Index is multiple indexes for measuring the three basic dimensions for achieving human development on average (United Nations Development Programme, 2005a; Bhandari, 2006).

1. A healthy and long life, as measured by life expectancy[1] at birth.
2. Knowledge, as measured by the adult literacy rate[2] and the combined gross enrolment[3] ratio for primary, secondary and tertiary schools.

[1] The life expectancy at birth is defined as the number of years an infant born and would live along with the existing patterns at a time of birth for a specific mortality rates were to remain same throughout the life of a child.

[2] . The adult literacy rate is defined as the percentage of people ages from 15 and above who can, with understanding,

[3] The combined gross enrolment ratio is defined as the number enrollment of students in primary, secondary and tertiary levels of education, regardless of age, as a percentage of the population of official school age for the three levels.

3. A decent living standard, as measured by GDP [4]per capita in purchasing power parity (PPP) US dollars[5]. Before the HDI itself is calculated, a need of index to be created for each of these dimensions. To calculate these indices for dimension, minimum and maximum values (goalposts) were chosen for each underlying indicator shown below:
   - Life expectancy at birth: 25 and 85 years
   - Adult literacy rate: 0 percent and 100 percent
   - Combined gross enrolment ratio: 0 percent and 100 percent
   - Real GDP per capita (PPP$): US$100 and $40,000 (PPP$)

The main steps are then calculated as:

1. The life expectancy index is calculated as follows:
   - $life\ expectancy\ ratio = \frac{LE-25}{85-25} \ldots\ldots\ldots\ldots\ldots (2)$
2. An index for education measures a country's comparative achievements in both adult literacy and combined gross enrolment for primary, secondary and tertiary. First, an index for adult literacy and combined gross enrolment is calculated. Then these two indices are combined to create an index of education, with two-thirds weight given to adult literacy and one-third weight to combined gross enrolment.
   - $Education\ Index = \frac{2}{3} XALI + \frac{1}{3} X\ GEI \ldots\ldots\ldots\ldots\ldots (3)$
   - $Adult\ Literacy\ Index\ (ALI) = \frac{ALR-0}{100-0} \ldots\ldots\ldots\ldots\ldots (4)$
   - $Gross\ Enrollemnt\ Index\ (GEI) = \frac{CGER-0}{100-0} \ldots\ldots\ldots\ldots\ldots (5)$
   - $Education\ Index = \frac{2}{3}(adult\ literacy\ index) + \frac{1}{3}(Gross\ enrolment\ index)$
3. The GDP index is computed by adjusting GDP per capita (PPP US$). In the HDI \ income serves as a proxy for all the dimensions of human development not reflected in a long and healthy life and knowledge. Income is regulated because achieving a respectable level of human development does not require unlimited income. Accordingly, the logarithm of income is used.

$$GDP_{per\ capita} = Income\ Index = \frac{\log(GDPpc) - \log(100)}{\log(40000) - \log(100)} \ldots\ldots (6)$$

4. Once the dimension for indices has been calculated, determining the HDI is straightforward. It is a simple average of the three-dimension indices.

HDI=1/3 (life expectancy index) + 1/3 (education index) + 1/3(income index) ………. (7)

The indicator in this research was designed to get an impression of the impact of rural electrification by comparing electrified rural villages connected to Hydropower projects with those that are not connected to Small Hydropower Projects (SHP). This study used the Human Development Index as an indicator in calculating the HDI of the electrified villages with SHP and the electrified villages without SHP. Data were analyzed through Statistical Package for Social Sciences (SPSS). Data analysis was done by using percentages, frequency distribution two-way tabulation (cross tables) and dummy variable regression analysis was used to compare the Life Expectancy Index, Education Index, Income Index and Human Development Index of electrified villages with SHP and without SHP.

Empirical model

The indexes were compared by using the empirical models as follows:

Comparison of Life Expectancy Index of electrified villages with SHP and without SHP

$LEI = \alpha_0 + \alpha_1 D_1$ (8)

Where;

LEI = Life Expectancy Index

D_1 = 1 if electrified villages with SHP, 0 otherwise

α_0 = Average value of LEI for the village without SHP

α_1 = Differential intercept of LEI for the village with SHP

[4] GDP is the sum of value added by all resident producers in the economy plus any product taxes (less subsidies) not included in the valuation of output. It is calculated without making deductions for depreciation of fabricated capital assets or for depletion and degradation of natural resources.

[5] The purchasing power parity is a rate of exchange that accounts for price differences across countries, allowing international comparisons of real output and incomes. At the PPP US$ rate, PPP US$1 has the same purchasing power in the domestic economy as $1 has in the United States

Comparison of Education Index of electrified villages with SHP and without SHP

$EI=\beta_0 + \beta_1 D_2$ (9)

Where;

EI = Education Index

D_2 = 1 if electrified villages with SHP, 0 otherwise

β_0 = Average value of EI for the village without SHP

β_1 = Differential intercept of EI for the village with SHP

Comparison of Income Index of electrified villages with SHP and without SHP

$II=\partial_0 + \partial_1 D_3$ (10)

Where;

II = Income Index

D_3 = 1 if electrified villages with SHP, 0 otherwise

∂_0 = Average value of I I for the village without SHP

∂_1 = Differential intercept of I I for the village with SHP

Comparison of HDI of electrified villages with SHP and without SHP

$HDI=\Omega_0 + \Omega_1 D_4$ (11)

Where;

HDI = Human Development Index

D_3 = 1 if electrified villages with SHP, 0 otherwise

Ω_0 = Average value of HDI for the village without SHP

Ω_1 = Differential intercept of HDI for the village with SHP

RESULTS AND DISCUSSION

Socio-economic Characteristics

Table 2 shows that sampled households (87%) were headed by a male and only 13 % were female-headed. The average age of the family head was 44 years with a middle school education level. The average household size was up to seven persons with a monthly income of Rs. 25327 (Pakistani rupee). The three primary sources of income of the studied families were agriculture, non-farm and off-farm activities.

Prime agricultural activities included animal husbandry and crop production with maize, wheat, and rice as primarily grown crops. Livestock products such as milk and yoghurt also contribute to the source of income. Off-farm activities include local daily employment at the village or adjacent locations so this form of labour was paid in cash or terms of harvested goods Certain non-farm activities in this sample were natural resource-related activities such as collecting firewood for own use or auction. Non-farm (activities) may also include services in government departments, private Corporations, handicrafts i-e weaving and spinning, carpentry and Small-scale businesses like grain fruit and vegetable trading. The majority (63%) of the households have adopted a non-farm livelihood strategy (NFLS) while 15% have adopted an agricultural livelihood strategy (ALS). However, 11% of respondents were engaged in off-farm livelihood strategy (OFLS) and diversified livelihood strategy (DLS). The average monthly income generated by DLS and NGLS was significantly higher than that

Table 2. Socio-economic characteristics of the households.

Variables	Mean	Std. Deviation
Households' characteristics		
Gender (1 for male and 0 otherwise)	0.87	0.33
Age (in years)	44.68	10.97
Education (years of schooling)	8.33	4.53
Households Characteristics		
Size (in numbers)	7.00	2.67
Total monthly income (Rs.)	25326.88	11502.66
Income sources of households		
Only agriculture (15%)	12615.38	5375.70
Non-farm activities (63%)	27595.87	10694.05
Off-farm activities (11%)	18121.62	6256.42
DLS1 (11%)	38284.62	9057.87
Landholdings (in acres)	1.76	0.77

Comparison of Life Expectancy Index of electrified villages with SHP and without SHP

$LEI = 0.339 + 0.019\, D1$ ……………… (12)

SE = (0.015) + (0.020)

t-ratio = (22.299) (0.932)

A response dummy variable Regression Model was used to evaluate the Income Index of respondents having smal l Hydropower projects and not having small hydropower projects. The empirical results are as follows:

The calculated dummy variables coefficient (D1) is 0.05 which can be defined as being statistically significant at 1% of α. It suggests a significant gap in the national grid electrification between the income indexes of participants in electrification from small hydropower projects, and participants. The income index gap was 0.05. This significant increase in revenue production is attributed to the 24-hour availability of electricity.

The availability of power provides a variety of new aven ues for business establishment. The industrialization has raised peoples ' incomes by generating employment opportunities. These companies created new employment for the study area community. The employment opportunities have contributed to household diversification, thereby rising their income levels.

In addition, most homes indicated that having electricity outside their homes in other regions, such as factories, was also directly proportional to household income. It was evident that industries could generate income eleven times higher than those without electricity. The minds of people were broadened with the continuous supply of electricity to the villages through hydropower projects. Then they looked into many other ideas and ways of using their time. Moreover, it drove many of them into the business sector; rural areas develop local small-scale industries.

Energy is an aspect that is extremely necessary to achiev e social and economic development. Basic operations suc h as lighting, cooking, transportation, heating, telecomm unication, mechanical and mobility power are extremely power-intensive. Rural electrification is directly linked to infrastructure development that generates secondary opportunities for the community. Energy input, for example, electricity, is important for the outputs of income generation, transport, trade and micro-enterprises. Increased access to power, particularly in rural areas that have direct hydropower facilities, results in increased opportunities to build income-producing activities Access to electricity promotes the development of small and medium-sized companies to integrate mechanical equipment into their businesses. That reduces labour costs while at the same time increasing productivity. This eventually leads to local small-scale businesses being developed, thereby increasing business opportunities and household income.

Comparison of Education Index of electrified villages with SHP and without SHP

EI=0.236 + 0.109 D2 …… (13)

SE= (0.015) (0.020)

t-ratio= (15.691) (5.38)

The t-ratio of the estimated coefficient of a dummy variable (D) was found statistically insignificant at 95 percent in this case of life expectancy, since the calculated value is less than the tabulated value (rule of thumb). This implies that the life expectancy index of respondents from villages electrified by small hydropower projects and villages electrified from the national grid is not significantly different. For areas with hydropower projects, advantages grow through increased awareness of health issues through education and promotions on various television programs, advanced indoor environment quality, improved living conditions and efficiency of health centres and clinics, but these advantages did not have a major impact on the life index.

While living conditions in the villages were improved this was not a single life expectancy measure. Birth and death are both natural phenomena, and it is a well-known fact. Therefore, it has no natural limits and electricity, whether from hydropower or the national grid, has not affected this greatly. Although the study findings suggest indirect effects of rural electrification on health facilities, they cannot find a direct effect on people's lives as there is no correlation between life index and electricity supply, whether from hydropower or another source.

According to Valencia and Seppänen (1987), the estimators noticed that health conditions in various households were uninfluenced in research and linked to the results. Nevertheless, the cumulative indirect benefits may include adding equipment to local health centres. In addition, Lipscomb *et al.* (2013) performed similar research and found income and literacy rates significantly higher excluding health and mortality.

Comparison of Income Index of electrified villages with SHP and without SHP

I I=0.675 + 0.050 D3……….. (14)

SE= (0.006) (0.008)

t-ratio= (108.792) (6.175)

For education index, a significant difference between the electrified villages from small hydro power projects and villages from national grid (t=5,38) is indicated by the approximate coefficient of dummy variables (D). This indicates that the education index of participants from villages electrified from small hydropower projects and respondents electrified from the national grid is significantly different. In the homes, electric light allows adults and children to pursue study whether it is formal or informal. Students could study safely at night. The lack of access to energy not only limits the ability of a child to study after dark but also the ability of the teachers to better prepare their lessons.

Fans' availability and improved lighting options provide a comfortable environment for studying in electrified villages. Similarly, Barkat *et al.* (2002) supported this finding that 93 percent of the electrified homes studied showed that students had improved attention span and commitment to learning since the start of electrification.

Furthermore, most households involved in the research found out that electricity helped improve the educational performance of their children. This was attributed directly to students now being able to study after school hours. Energy Sector Management Assistance Program (ESMAP) (2002a) reported similar results, with estimates that children could spend an extra 48 minutes each day in a study.

Comparison of HDI of electrified villages with SHP and without SHP

HDI=0.412 + 0.047 D4…………(15)

SE=(0.009) (0.012)

t-ratio = (46.902) (4.042)

The calculated dummy variable (D) coefficient is 0.047 and is considered statistically significant at the level of significance of 1 percent. The results indicate that the human development indexes of respondents electrified from small hydropower projects and respondents electrified from the national grid are significantly different. In HDI, the difference is 0.047. The HDI of un-electrified small hydropower villages is 0.412 and the small hydropower electrified village is 0.459.

Hydropower villages have a high HDI value compared to non-hydropower villages, suggesting that electrification will bring about improvements in a country's socio-economic conditions. Energy is required not only for economic development but also for improving life quality and increasing human development opportunities. Moreover, there was a positive correlation between human development and infrastructure in the same area. Accordingly, a study suggests that public spending on improving infrastructure also improves human development (Adeyemi *et al.*, 2009; Akram and Khan, 2007; Siddiqui, 2008).

Electrification of rural areas contributes greatly to the growth and development of these rural areas, especially in developing countries and leads to poverty reduction, increased revenue sources and increased levels of literacy.

The prevalent literature reveals a connection between multiple sustainability and growth indicators as expressed by Kanagawa and Nakata (2008) and Modi *et al.* (2005) that the lack of electricity is directly proportional to the high levels of poverty. Electricity makes a big difference in reaching MDGs. The availability of electricity also influences various social and economic conditions in developed nations and highly influences HDI.

Similarly, UNDP has recognized the correlation between energy per capita and the Human Development Index. Nevertheless, the higher the energy used in HDI nations at 0.8 or higher, the lower the chances of causing an HDI increase (United Nation Development Program (UNDP), 2004). This indicates that energy's role in raising standards of living and welfare is particularly detrimental to early development. On the other hand, the later development steps require that economic growth does not highly dependent on the level of energy consumption. Later development stages, for example, require a lower energy usage (Johnson and Lambe., 2009).

For Pakistan, growth and development remained a thrust of the Human Development Index (HDI) and have nearly stagnated over the past five years. For more than five years Pakistan has barely been able to advance its Human Development Index (HDI). Pakistan's 2013 HDI value remained at about 0.537 which falls under the category of low human development. Nevertheless, the country's position was at about 146 out of 187 countries and territories. The study area's HDI was lower than in Pakistan, even for the small Hydropower electrified villages. The HDI of small hydropower-electrified villages is 0.459, and without small hydropower is 0.412.

CONCLUSION AND RECOMMENDATIONS

The study concluded that the HDI in small hydropower-electrified villages is 0.459, and without small hydropower is 0.412. Among the indexes of income, health and education, though the level of literacy was high in the study area, however, the index of education was low., it is because most respondents have family members up to 16 years of age who have education up to matriculation. Similarly, the adult literacy weighing index is 2/3 compared to the gross enrolment index which is 1/3. The major source of electrification in the study area was small hydropower project which is economical and sustainable therefore it is recommended that government must explore energy-based projects in the areas and also try to convert grid station to small hydropower projects so that their Human Development Index may be improved.

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