SOCIO-ECONOMIC EFFECTS OF CONSTRUCTING THE HYDROPOWER PROJECT: A CASE STUDY OF TARBELA 4TH EXTENSION

Saima Tabassum, Pakistan. Email: saima4.tabassum@yahoo.com

Muhammad Imran Khan Pakistan. mimrankhan.pk@gmail.com

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Abstract. *The dams and water reservoirs are built to achieve an integrated set of benefits, yet they have certain effects on the people living in the vicinity. The Tarbela dam is the largest earth-filled dam in the world. The objective of this study is to find out the socio-economic effects of constructing the Tarbela 4th Extension on residents of the area. For this purpose, this study investigates the socio-economic dynamics of the Tarbela 4th Extension Hydropower Project. The design of the study is quantitative, based on the data collected from Tehsil Ghazi and Tehsil Topi (KPK). A sample of two hundred households residing in the area was randomly selected. A specially designed questionnaire was used for the data collection. The results of the study reveal that the project has positively affected the social status of the inhabitants, education, and overall Quality of life. People's economic condition improved as they got contractual and daily wage jobs in the project. Thus currently, their income has been raised. The study found a formal occupation trend, which is govt or private jobs are dominant in the area. The project has played a vital role in the socioeconomic development of the area. The study concludes Tarbela 4th extension has undoubtedly affected the incomes, expenditures, infrastructure, quality of life, health, education, relocation of the people, public safety, and communication system.*

Keywords: Tarbela 4th Extension, Hydropower Project, Socio-economic effects

1. Introduction (Background of the Study)

Dams are one of the key factors for the development of the economy especially for the development of agriculture and infrastructure. Dams also play a vital role in the energy sector to counter the energy crisis. The primary purpose of a dam is to stop or minimize water discharge for financial, communal, and eco-friendly use. It reduces inundations and makes hydel provisions for irrigation, domestic, commerce, and power generation from projects like Tarbela 4th Extension Hydropower. The hydropower project is measured as economical, reliable, and the

effective compared to other power generation sources (Tortajada,2014).

Advantages and disadvantages are proportional to a developmental project, affecting the foreseeable community's socio-economic factors. Hence, conducting a socio-economic and environmental assessment of mega projects like hydropower projects in developed/ established countries is essential. This practice is frequently followed in Nepal, Kenya, India, China, and Pakistan. The latest expansion of mega hydel plants in China, India, Pakistan, and the USA encourages discussion regarding such projects' commercial, communal, and ecological effects (WAPDA, 2011).

The socio-economic effects of such projects have positive as well as negative bearings on the surrounding people/ community (Olana, 2006). Positive impacts include creating new employment opportunities, improving the living standard of the community by increasing domestic incomes and improving infrastructural facilities (medical and residential) for the project's employees, and better access to potable water (Richter and Thomas, 2007). Negative effects include road deterioration due to frequent movement of heavier traffic vehicles, reduced agricultural production, reduction in woodland and fishing incomes, the disorder of the local community's secrecy, and socio-health circumstances of the evacuated people. Ecological effects of the hydel projects modify the biochemical sequences of ecosystems by disturbing the river sequence, altering the nutrient equilibrium, and fluctuating the current of oxygen, warmness, and sediment flow. Moreover, the destruction of the river ecosystem disturbs the relocation of marine species and inundates the bulky zones, and problems with resident biodiversity (Abbasi, 1991; Makombe, 2003). Thus, the study's prime purpose is to assess the beneficial and harmful socio-economic effects of the building of the Tarbela 4th Extension Hydropower Project on the residents of Tehsil Ghazi and Topi. This study is looking at the socio-economic effects of the construction of the Tarbela 4th Extension on Tehsil Ghazi and Topi. It is believed that this research will contribute to considerable policy options, which will help policy-makers to use appropriate measures for the welfare of the project area's community.

Literature Review

Majeed et al., (2008) investigated the part of two large dams i.e., Tarbela and Mangla in the economic development of Pakistan. The study compares irrigation, power, and agricultural patterns pre- and post-construction of the dams. The study finds that these dams have a positive role in the agricultural economy, irrigation supply, power generation, and agricultural patterns.

Ali et al. (2011) examined evaluating the impact of the Ghazi Barotha Hydropower project on re-settlers at Barotha model village district Attock in Pakistan. The study used primary data collected through a questionnaire, focused group discussion, and participant observation. In contrast, the secondary data was collected from donor agencies' technical reviews and project completion reports.

The study found a negative impact on agriculture and livestock. Average livestock per household decreased from 11 to 2 due to the project. In contrast, housing and living conditions in the area have improved due to the project and had a positive impact.

Usman and Ifabiyi (2012) studied socio-economics scrutiny of the functioning effects of the Shiror hydropower dam in Nigeria and examined the socioeconomic impact of the dam on fishing and the public. They collected the information via an open-ended opinion poll from the affected public and follow the principal factor examination technique to verify the impact amongst the variables. The conclusion showed the harmful effects of the Shiroro dam on the nearby public.

Bird (2012) studied the socio-economic effect of Chalillo dam, USA, on the adjacent public. The primary data on a variety (24) of variables related to living standards were collected through a questionnaire. Results concluded the overall adverse effects of the dam on the people of the surrounding area.

Lata et al; (2013) examined the socio-economic effect of the Sorang hydel energy project in the district of Kinnaur India. The nature of the study was descriptive. The researcher collected the basic information through an opinion poll survey, interviews, and field observation. For data collection, the researcher used a random sampling technique. The study found that the dam has a positive effect on people's education and revenue but a negative effect on the environment and livelihood.

Santos et al., (2017) investigated the socio-economic effect of the Ferreira Gomes hydel power project on fishers' pre and post-reservoir filling in Brazil. He collected data through a questionnaire by random sampling technique. The finding of the research showed that the dam badly affected the water quality. The production cost of the fishery and domestic revenue of fishers were reduced. Thus, the total outcome of the research's socio-economic effect because of the dam on the anglers' community was adverse.

To sum up, it is evident from the literature that inadequate research has been conducted on the energy, socio-economic, and environmental impacts of hydropower projects. Generally, studies on medium and large, small, mini, and micro-scale hydropower projects have been conducted to identify various types of impacts created by the development of hydropower projects (Adhikari, 2014; Gurung et al., 2011; Joshi, 2011; Rai, 2014; Raj et al., 2019). However, large dams contribute meaningfully to the socioeconomic growth of countries worldwide. Besides its vast benefits, a large dam has significant disadvantages. It brings significant changes in an ecosystem and physical and social structures. In the case of the Tarbela 4th Extension, the reports are highly superficial without any baseline and follow-up, and measurements of local and regional effects are ignored.

Therefore, the current study covers all the effects of the project in the short as well as long term.

Methodology

Tarbela 4th Extension (T4Extn) project is the study area to complete research work. The overall development objective of the project is to overcome the energy crisis in Pakistan. The construction of the Tarbela Dam was completed in 1976, and the total installed capacity is 3478 MW. The Latitude and the Longitude of the project are 34° 05' 44"N 72° 41' 25" E. It is located on Tarbela dam in District Haripur, Province Khyber Pakhtunkhwa.

This research evaluated the socio-economic effect of the Tarbela 4th Extension on the individuals of the project area (Tehsil Ghazi and Tehsil Topi). Hence, the expressive examination method has been utilized to attain the objectives. Descriptive research is described quantitively or summarizes features of the collection of information. Expressive figures are brief expressive factors that summarize a specified information group, which can signify the whole inhabitants or an example of it.

Data Type and Sources

The current study is based on the expressive study design. This study has investigated the socio-economic effect of the Tarbela 4th Extension project. Primarily, information about Tarbela 4th Extension geographical area, people, and settlements was collected from the Pakistan Bureau of Statistics (PBS) and the Environmental Social Assessment Report of Tarbela 4th Extension. Then, a detailed questionnaire-based examination has been carried out in 6 villages of Tehsil Ghazi and 5 villages of Tehsil Topi. The selection of villages is based on the feasibility report (ESA) of Tarbela 4th Extension, which clearly describes the anticipated project-affected villages of Tehsil Ghazi, District Haripur, and Tehsil Topi District Swabi. Finally, for investigating the impact of the project, a survey was conducted using a specially designed questionnaire from the residents of the area. In addition to the required data from the respondents, their demographic characteristics (gender, age, marital status, education, occupation, income, and family type) were also recorded.

The questions examined include household characteristics, community livelihood profile, socio-economic benefits, and resource potential of the dam. The socio-economic datasets have been analysed using the primary descriptive statistics method of data analysis. The descriptive statistics method, namely means, frequency, and percent ratios, have been used depending on the set-up objectives. Subsequently, the results of the datasets collected have been analysed using SPSS software and presented in tabular form.

Sampling and Sample Size

A sample of 200 households was selected from Tehsils Ghazi and Topi using the following formula (Yamani 1969):

$$n=N/(1+Ne^2)$$

N= total population, e = error

The study used the multistage cluster sampling technique for data collection from two core groups (Tehsil Ghazi and Topi) and then sub-divided into village groups from where data from 200 families were collected. In the final stage, every 27th household was selected as part of the sample. Table 1 shows the sampling design of the study.

Table 1: *Sample Selection*

Tehsil	No. of Villages	Total No. of Households	Selected Households
Ghazi	6	3,587	**132**
Topi	5	1,829	**68**
Total	**11**	**5416**	**200**

Results and Discussions

This study collected data using a structured questionnaire. The questionnaire has four sections. The first section contains information regarding respondents (demographic structure), Gender, age, education, occupation, and income of HHs. Section 2 consists of questions on economic variables (Income, expenditure), section 3 includes information on the Standard of living (Water supply, Housing, infrastructure characteristics), and section 4 is devoted to data on relocation and Quality of Life.

Demographic Characteristics of the Respondents

Gender of respondent analysis

Table 2 stated that out of 200 respondents, 75 % are male household heads, and 25 % are female. This trend confirms that the households are predominantly male.

Table 2: *Gender of the Respondents*

	Frequency	Percent
Male	150	75%
Female	50	25%
Total	200	100%

Age of Respondent Analysis

Table 3 shows the categorization of the respondents into seven age groups for a better understanding.

Table 3: *Age of Respondents*

Age Group	Frequency	Percent
20-24	2	1.0
25-29	7	3.5
30-34	24	12.0
35-39	34	17.0
40-44	35	17.5
45-49	45	22.5
50 & above	53	26.5
Total	200	100

Education Status of Respondent

Table 4 provides details about the education level of the sample respondents.

Table 4: *Education of Respondent*

Education Level	Frequency	Percent
SSC/HSSC	57	28.5
Bachelor	67	33.5
Master	72	36.0
M.Phil./ MS	4	2.0
Total	200	100.0

Respondent monthly income of household status

Table 5 shows the division of respondents based on their monthly income. The field survey identified that the monthly income is very different among the people in the project area.

Table 5: *Respondent Monthly Household Income*

Monthly Income	Frequency	Percent
Less than 15000 PKR	2	1.0
15000 to 25000 PKR	24	12.0
25000 to 35000 PKR	54	27.0
35000 to 45000 PKR	35	17.5
45000 & above PKR	85	42.5
Total	200	100.0

Socio-Economic Effects of the Project

Effect on household income due to this project

Table 6 stated that 25.5% of respondents reported that income has increased due to the Tarbela 4th extension project during the construction phase. They are generally those who got employment in the project.

Table 6: Effect on Household Income Due to Project

Effect on Income	Frequency	Percent
Increase	51	25.5
Decrease	0	0.0
No change	149	74.5
Total	200	100.0

Effect on household expenditure due to the project

Table 7 stated that 10.5 % of respondents responded that expenditure has increased due to the Tarbela 4th Extension project during the construction phase. This shows an increase in the livelihood expenditure of a small group of residents. The main reason for the increase in the cost was renting houses by migrated households.

Table 7: *Effect on Household Expenditure Status*

Effect on Expenditure	Frequency	Percent
Increase	21	10.5
Decrease	3	1.5
No change	176	88.0
Total	200	100.0

Status of household water supply availability

Table 8 show that 74% of respondents responded that water supply sources are available inside houses, while 26.0% reported the availability of water sources outside the home.

Table 8: *Household Water Supply Status*

Source of Water Supply	Frequency	Percent
Inside	148	74.0
Outside	52	26.0
Total	200	100.0

Source of Water Status

Table 9 result on the water source stated that about 55.5% of the respondents are using tape while 28.0 % of respondents claimed the use of hand pumps as the source of water and 16.5% of respondents observed well as a source of water.

Table 9: *Source of Water Supply Status*

Source of Water	Frequency	Percent
Tape shape	111	55.5
Hand pump	56	28.0
Well	33	16.5
Total	200	100.0

Water supply status effected by power channel due to project

Table 10 stated that 9.5% of respondents responded that the water supply had been affected because the underground water level decreased in Ghazi and Kahlo. The water level in wells is down, 90.5% reported that there is no impact on the water supply.

Table 10: *Water Supply Affected by Power Channel Due to the Project*

Response	Frequency	Percent
Yes	19	9.5
No	181	90.5
Total	200	100.0

Water supply status sufficient for household needs

Table 11 stated that on satisfaction with water supply sufficiency in HHs for domestic use, most respondents are satisfied, which is 61.0 %. In comparison, 39.0 % of respondents are not happy, and according to them, the water supply does not fulfil their domestic needs.

Table 11: Water Supply Sufficient for the Household Needs

Response	Frequency	Percent
Yes	122	61.0
No	78	39.0
Total	200	100.0

Housing characteristics

Table 12 describes the community's perception of structural change in houses during the project. Among the respondents, 26.0 % reported structural change in housing, 15% talked about the change in rents, and only 9% reported a decrease in the availability of land for housing.

Table 12: *Housing Characteristics Status*

Question About Housing	Responses			
Any change in housing characteristics	Yes	Percent	No	Percent
Any structure change occurred in the existing housing in your Mohalla due to Project?	52	26.0%	148	74%
Any change in the rent of the houses due to the Project?	30	15.0%	170	85%
Do you feel a shortage of land for housing due to Project?	18	9.0%	182	91%

Infrastructure Status

Table 13 defines community opinion about infrastructure changes or any damages in buildings that occurred during the construction phase of the project. Among the respondents, 19% reported damages to the buildings due to the project, 41% reported damages to the existing roads, and 30% reported developmental activities due to the project.

Table 13: *Infrastructure Status Any Change Due to Project*

Question About Infrastructure	Responses			
	Yes	%	No	%
Is there any damage to the building due to the project?	38	19.0	162	81
Are the roads are affected due to the traffic?	82	41.0	118	59
Do you see any development or new construction due to the project?	61	30.0	139	69

Relocation of People Status Due to Project

Table 14 shows the relocation impact of the project. Among the respondents, 8% have got employment in the project and shifted there while 10% had shifted their families away due to the project.

Table 14: *Relocation of People due to Project*

Question About Relocation	Responses			
	Yes	%	No	%
Have you got employment in the project from out-station	17	8.0	183	91
Did you shift your family due to the project	21	10	179	89

Quality of Life Status

Table 15 describes the impact on the quality of life of the respondents. Among the respondents, 20% had got employment in the project, 30% reported over-crowdedness, and 20% had changed their occupations due to the project.

Table 15: *Quality of Life Status*

Question about Quality of Life	Responses			
	Yes	%	No	%
Have you got employment in the project	40	20.0	160	80
Do you feel that area is overcrowded due to the project	61	30.0	139	69
Is there any change in the occupation of the HHs head	40	20	160	80.0

Existing Facilities' Satisfaction Level Status

The Tarbela 4th Extension has led to an increase in the population of the area. The respondents were asked about the availability of enough education, health, and transport facilities in the area. Table 16 shows that 60%, 55%, and 54% of the respondents were satisfied with the existing education, health, and transport facilities respectively. This reflects the fact that these important areas of quality of life need more concentration.

Table 16: *Existing Facilities Satisfaction Level*

Question About Facilities	**Responses**					
	Education		Health		Transport	
	Yes	No	Yes	No	Yes	No
Are the existing available facilities being enough	120	80	111	89	109	91

Conclusion and Recommendation

Conclusion

This study attempted to explore the various positive and negative effects of the Tarbela 4th Extension project on the residents in the vicinity. This project has changed the project area in many ways. The study randomly selected 200 respondents from the area and interviewed them. In the first section, demographic information was inquired about. 59% of respondents were working in the formal sector, 36% had master's degrees and 60% were satisfied with available education facilities in the area. Among the respondents, 42.5% were earning a salary of PKR 45,000 or above.

There are certain positive and negative impacts of the project on the socio-economic status of the residents. The income of 25.5% of respondents has increased due to the project, 10% have observed an increase in their expenditures mainly due to transportation issues and 20% had observed an increase in employment opportunities due to the project. According to 9.5% of people, the project has negatively affected the water supply in the area. Many respondents (41%) observed a negative effect on infrastructure, mainly the Lawrenspur road. The socio-economic effects revealed that few people benefit or derive livelihoods from the dam. As the project was awarded to a foreign contractor, so the majority of employees were foreigners, therefore, many security restrictions were limiting the movement of local people in the vicinity of the project area. Finally, as the data was collected from two tehsils, the study did not find any significant difference in the results of both areas.

Summarizing all findings shows the socio-economic effects of constructing the hydropower project Tarbela 4th Extension are not negligible. The generation of electricity, especially hydroelectricity, is needed, particularly in Pakistan. Not only

the project is very significant for the country in the prevailing energy crises situation, but also the project has many social and environmental effects on the locality. Certain measures of the project include the right of the local community to employment in the project, settlements of pending issues of the people affected in previous phases of the project, provision of safe drinking water, reduction of traffic load on road, and minimizing the risk of accidents during the construction phase of the project. In addition, renovation of the infrastructure and new construction was included in the project plan.

In the light of present research, some recommendations are proposed to mitigate the adverse impact of the Tarbela 4th Extension and similar projects. To provide job safety to the residents, future dam projects must also be accompanied by support schemes and small-scale economic activities such as industries and handicrafts. These would provide alternative jobs for the community. As observed that the cost of living has increased, so the project-initiated plans to support the local community in this respect such that they should not suffer. Similarly, a job quota should be specified for local people to get jobs and hire the local communities to get benefitted. To reduce the effect on transport, alternative routes should be identified for project endeavors. Finally, a participatory approach should be adopted to involve the local community in the development activities.

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