Socio-Economic Impact of Multi-purpose River Valley Projects: Empirical Investigations by Application of Confirmatory Factor Analysis

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ABSTRACT

In Financial Globalisation, the most of the Govt.of the world has ensured for the socio - economic development of the people so that it could further helped to financial growth of the country. In this context, Dam is the one of the important source for economic empowerment of the people in the state. Hirakud Dam is one of the famous multipurpose Dam which can help people to increase their income. Instead of that, it is the lifeline of the people of Odisha especially for irrigation, fishing and power Generation for overall growth of the state. This dam can also help to the industries in most part of odisha to supply water as per their requirement. The present study is the part of the un published thesis submitted for the evaluation titled "*Socio-Economic Impact of Multi-purpose River Valley Projects,: A case Study of Hirakud Dam in Odisha*" used factor analysis to find out the real factors for policy formulation

Keywords: **Hirakud Dam, Socio-economic environment, Factor Analysis**

I. Introduction:

It is The Rainwater is the only renewable source of water. But, it is subjected to uncertainty, both in respect of time, quality and quantity. Agriculture provides the basic human need of food and industries provide sustainability and economic prosperity. The agricultural development calls for timely and required quantum of water. Industries need water in its pristine form for generation of electricity by burning of fossil fuels or for other industrial use. It may thus be observed that water plays the most important role in the socio-economic condition of human civilization. Therefore, dams are built to preserve the river water when

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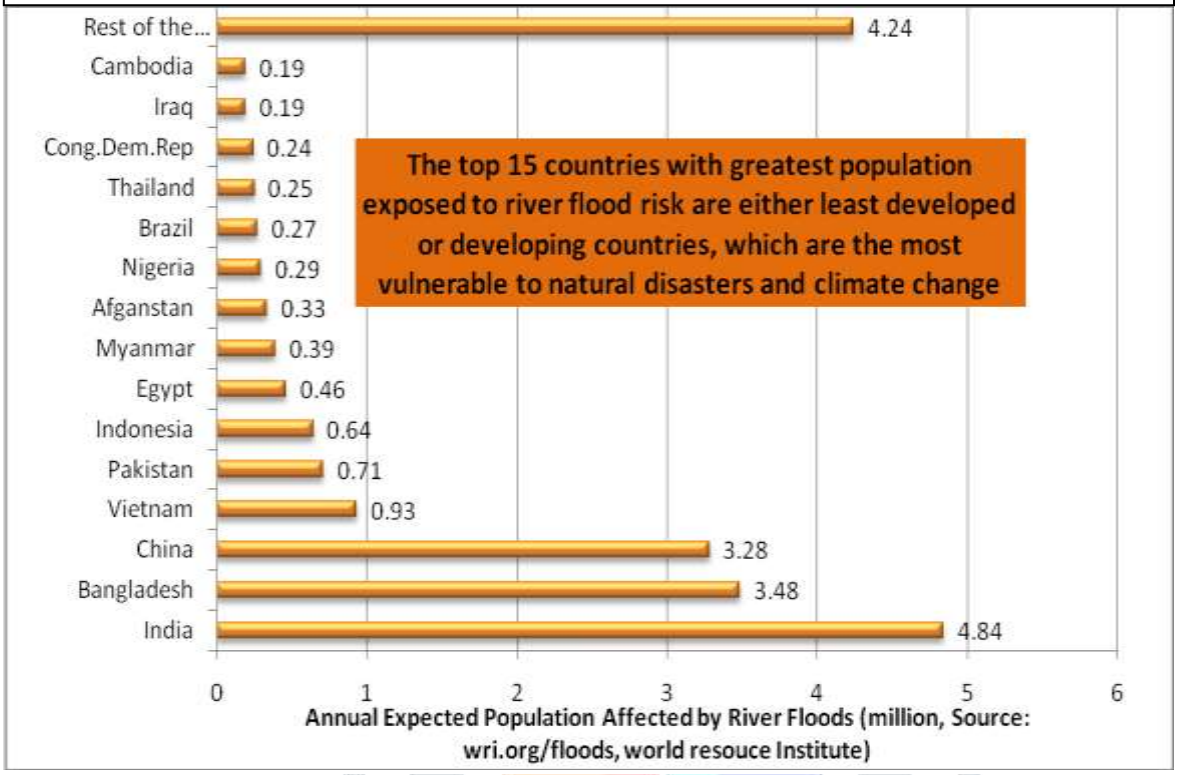
it is available in abundance and utilize the same for productive purpose such as for irrigation, generating hydro-electricity, preventing floods, pisciculture, navigation, etc. (Angel, Gurría.,2017)

Figure: 1.1 15 Countries Account for 80% of Population Exposed to River Flood Risk



1.1. Need for Storage Dams

As per the demand for water, there is an urgent need for mass storage dams. The following are the main reasons for the need of storage dams;

1. **Conversion of Available waters into Utilizable Waters:**

   The plenty of water is stored on both surface and is ground which is obtained from rainfall. In India especially the rain occurs only in a few months of monsoon (June to September) and that too, in a few spells of intense and heavy rains. It obviously cannot be utilized for various purposes over the rest of the year and will go waste, most of the time causing flood damage en route. As such, the conservation of water will mean converting as much water as is available into a utilizable supply. In fact, this is one of the principles enshrined in India's National Water Policy, which was adopted in 1987. It is thus of paramount importance to build as many storages as possible—small, medium and large.

2. **In this context, *Nitin Gadkari, Union Water Resources Minister told*** at the fifth edition of the India Water Week that there is a need large fund required for river-linking. As he told, it has been decided to start five big river connectivity projects costing Rs 50,000 crores within three months. According to the minister, the Centre wants to spend Rs 80,000 crore in five years for irrigation. If a dam is constructed by the state government then the union government will fund it. The aim is to irrigate 80 lakh hectares of land," he added. Gadkari also said the work on the development of inland waterways in the Ganga and

the Brahmaputra rivers is going on. "It will be completed by 2018 with 40 river ports…We are working on inland waterways running across 20,000 kilometers (Report from Financial Express).

3. Drinking Water Supply:

The requirements of drinking and municipal water supply to metropolitan and other important towns in the country have already become critical. For example, the entire water supply of Bombay is dependent on a series of dams such as the Vaitarana, Tansa, and Bhatsa. In fact, there is now a proposal to construct another dam on the Vaitarana to meet the increasing needs of Bombay's water supply. The water demand of Pune town in Maharashtra is met by the Panshet and Khadakwasla dams. Hyderabad is mainly dependent for its water supply on the Manjira and Singur Dams. Delhi, which is situated on the banks of the Yamuna, gets scarcely 25% of its needs from the river. The balance needs are met by releases from Bhakra Dam to the west, and Ramganga Dam to the east. For the future needs of Delhi, it is proposed to obtain water from the Tehri Dam being constructed in the north on the Ganga. This is in addition to a number of tube wells, which contribute less than 10% of Delhi's water supply. The acute scarcity of water supply in Chennai is well known. Since, apart from the storage available in Poondi Reservoir, there was no other possibility of further augmenting the water supply, the states of Andhra Pradesh, Maharashtra and Karnataka agreed to part with their allocated share of Krishna water to provide 430 million m3 of water supply to Chennai city, which will be made available through the stored waters at Srisailam Reservoir in Andhra Pradesh and carried through a 430 km long canal to reach Madras city. A major dam at Bisalpur is now being constructed mainly to provide water supply to Ajmer city in Rajasthan. Warangal town in Andhra Pradesh depends for its water supply on Sriramsagar Dam.

In the same line, there is the difference between Chhattisgarh and Odisha on the Mahanadi river water and dam has been constructed by Chhattisgarh Govt. to fulfill the demand of the scarcity of water in its state. In the same line, as Odisha is concerned, the river Mahanadi is the only river which is considered as the lifeline for entire Odisha. The Odisha agriculture, Industrial units, and rural development purely depend on the river Mahanadi.

4. Apart from that, the major advantages of the dam are to control flood and supply water for industrial houses to increase the individual production of the country. Besides that, the dam is also used for fishing and power generation purposes. In view of the above an attempt has been made t study the "socio-economic impact of Multi-purpose River Valley Projects: A case study of Hirakud Dam in Odisha."

1.2. Aims and Objectives of Present Study

The present study is undertaken with the following objectives;

1. To examine the overall socio-economic status of the people of the 'Catchment' area as well as in the "Command" areas of the Hirakud Dam.
2. To evaluate various contributions of Hirakud Dam Project on different economic indicators.

3. To examine the impact of Hirakud Dam on the socio-economic life of the people in the study area.
4. To probe into reasons responsible for diminishing contributions of Hirakud Dam.
5. To examine the adverse aspects of Dam on mankind in terms of resettlement rehabilitation, environment, and other socio-economic issues.
6. To suggest measure to increase its contribution towards the socio-economic development of the people under study area.

2. Review of Literature

Bureau of Statistics and Economics, Government of Orissa, (1968) undertook an agro-economic survey in the villages of Command area of Hirakud Dam to assess the benefits of Hirakud irrigation. The basic objective of the study, as visualized by the economic adviser in his technical note is "to cover the entire irrigated area of the Hirakud Dam in order to assess the net effect on the economy as a result of the availability of water in terms of growth of prosperity over a period of time.

Further, Abbasi (1991) went on pointing out the overall status of Hirakud Dam as follows. The Hirakud reservoir appears to have catalyzed deforestation in areas surrounding excessive silting which will decrease the life of the dam to 77 years from 111 years. Heavy silting resulted in climatic imbalance, a decrease of rainfall in some areas, increase in humidity, failure in controlling floods the survey highlights.

In the same period, Baboo (1991) proposes to capture the social dimension of the Hirakud Dam project. For this, he documents the history of agitation, dam construction process and finally condition of displaced people in their resettlement colonies, and their method of adjustment to this technological onslaught. With the help of the survey, he spoke about the ill effects on displaced people. It was observed that the 'oustees' have not been rehabilitated properly as yet, and are still in the process of shifting from one locality to other.

Malik, R., (2008) pointed out Water is essential for economic production and human well-being. Securing a reliable supply of water for key economic areas is critical to achieving economic growth. Because water is vital to many other sectors such as agriculture, food, hydropower, navigation, transportation, and flood management, management of and investment in water resources often form the basis for broad regional and national development.

Vogel et. al. (1962) showed that the standardized net inflow and the coefficient of variation of net inflow completely characterize the refill properties of storage reservoirs. They compared the resilience, reliability, yield, and vulnerability of individual storage reservoirs under existing scenarios and one future climate scenario.

Brekke, L. D., et. al. (2009) presented a flexible methodology for conducting climate change risk assessments involving reservoir operations. Using a case study for California's Central Valley Project and State Water Project systems, they showed that assessed risk for a given risk attitude was sensitive to the analytical design choices, namely, the assumption that climate change will influence flood control constraints on water supply operations, and weighting of climate change scenarios.

Li et al. (2009) investigated potential impacts of future climate change on streamflow and reservoir operation performance in a Northern American Prairie watershed.

Freed, J. R., and F. Sussman (2006) pointed out that In developing risk-based planning procedures, managers require information on which of their operational and planning decisions are unlikely to be affected by climate change, which will probably be affected and could benefit from adaptive decision support in the short term, and which will probably be affected but involve adaptive actions that can and probably should be deferred to later dates.

In the case of the Hirakud multipurpose dam project Baboo, B. (1991) points out that none of the resettled colonies got to benefit from the canal irrigation. Further, the displaced people could not buy the costly land in the future command area with the meager compensation received for their acquired land. They suffered untold hardship in the resettlement colonies because they are completely uprooted as they are located in remote areas and were provided with some skeletal needs such as shelter and barren land.

BBC, 2011 went on saying that within this debate is an inherent need for better resource planning and wider recognition of the implications of poor decision-making concerning shared resources. Shifting the food security of 12 million households from heavy reliance on aquatic protein to a more rain fed, the land-based economy has obvious and significant challenges. The resulting political, economic, social and institutional gaps are wide enough to merit further analysis and exploration. The on-going debate over the Xayaburi dam in Laos is a case in point. The USD $3.8 billion dam is the first of 11 planned for the lower main stem: yet continued uncertainties about the downstream impacts to the ecology and livelihoods, as well as food supply have led to the project’s being stalled. If the proposed dams are built, it is not only the impacts on the food supply but also the strategies, investment, and handling of numerous natural resources and social issues which must be considered.

King, P.et al. (2007) pointed out that Many hydropower projects have cross-boundary impacts and contribute to the burgeoning sub-regional power trade. As such, there is an emerging need for harmonized treatment of environmental issues in the GMS. This would help ensure that attempts to attract investment do not unnecessarily lower environmental standards. As the MRC coordinates water resources development in the LMB, ongoing work leading to country approval of a framework for trans-boundary EIA will provide an excellent foundation to ensure that a common approach to environmental criteria for hydropower development can be adopted. MRC has also incorporated SEA procedures into its basin development plan (BDP) to identify priority projects that should be supported. Dam construction has almost always created conflicts between energy supply and related economic interests, versus their social and environmental impacts.

WCD, (2000). Large dams and irrigation projects are a nested set of sub-systems involving the dams as a source of supply, the irrigation system (including canals and on-farm irrigation application technology), the agricultural system (including crop production processes), and the wider rural socio-economic system and agricultural markets.

Potential performance indicators for large dam irrigation projects include:

- Physical performance on water delivery, area irrigated and cropping intensity;
- Cropping patterns and yields, as well as the value of production; and
- Net financial and economic benefits.

3. FEATURES OF HIRAKUD DAM

3.1. Power Generation

Hirakud Dam Project is a multipurpose scheme intended for flood control, irrigation and power generation. This is one of the oldest hydel projects of India, being the first post-independence major multipurpose river valley project in the country. A profile of power generation by Hirakud Dam is presented in Table 3.1

Table 3.1		
Power Generation	**Original**	**Revised**
Installed Capacity, Burla,	4X37.5=150MW	2X49.5=99MW
Turbines	2X24.0=48MW	2X37.5=75MW
		2X32.18=64.34MW
		1X37.5=37.5MW
Total	198.0 MW	275.86 MW
Installed Capacity, Chiplima	3X24 = 72 MW	3X24 = 72.0 MW
Grand Total	270.0MW	347.86MW
Source:http://ohpcltd.com/Hirakud/Index.,https://en.wikipedia.org/wiki/Hirakud_Dam		

The project has benefited 1, 55,635 hectares of Kharif and 1, 08,385 ha of Rabi irrigation in the districts of Sambalpur, Bargarh, Bolangir, and Subarnapur. The water released through the powerhouse irrigates further 4, 36,000 ha of Culturable Command Area (CCA) in Mahanadi Delta. The installed capacity for power generation is 347.5 MW through its two powerhouses at Burla, at the right bank and Chiplima, at about 22 km downstream of the Dam. Besides, the project provides flood protection to 9500 sq. kms of delta area in districts of Cuttack and Puri.

3.2. Distribution System

Three numbers of Head are Regulators provided from the reservoir for Irrigation viz;

- Bargarh Main Canal
- Sason Main Canal
- Sambalpur Distributary

The details of regulators are presented in Table 3.2

Table-3.2			
Distribution System	**Bargarh MC**	**Sason MC**	**Sambalpur D**
Full supply Discharge in Cumecs	108.21	17.84	3.4
Sill Level of Head Regulator in meter	176.98	178.38	176.52
Bed Widths meter	45.7	16.764	4.57
Full m	2.98	1.52	0.98
Source:http://ohpcltd.com/Hirakud/Index.,https://en.wikipedia.org/wiki/Hirakud_Dam			

3.3. Economic Benefits

As stated by Arun Ku. Nayak in his project "Big Dams and Protests in India: A Study of Hirakud Dam" it is evident that through this gigantic dam, the multipurpose objectives have been fulfilled such as flood management, hydropower production, irrigation, navigation, etc. It can help a lot for the socio-economic empowerment of the state especially for the growth of the Industries and irrigation. Apart from that, the dam is enhancing the economic status of people and rural development in the command area. In this regard, the essential infrastructure has been randomly developed and ample water is being provided for irrigation. Various performance indicators of the Hirakud Dam are presented in Table 3.3

Table 3.3				
The Maximum, Minimum and Average Values of the Performance Indicators				
Sl No	**Indicators**	**Hirakud Irrigation System**		
		Minimum	**Maximum**	**Average**
1	Standard Gross Value of Production per unit command area (Rs/ ha)	90496.43	94845.44	92451.5
2	Standard Gross Value of Production per unit cultivated area (Rs/ ha)	103088.29	118077.6	108785.68
3	Standard Gross Value of Production per unit irrigation water delivered (Rs/ m3)	10.41	15.41	11.94
4	Standard Gross Value of Production Per unit Water Consumed (Rs/m 3)	16.3	23.5	19.6
5	Relative water supply(ratio)	3.08	4.69	3.57
6	Relative irrigation supply(ratio)	2.69	4.37	3.28
7	Water delivery capacity(ratio)	0.37	1.1	0.84
8	Annual irrigation water supply per unit command area (m 3/ha)	5878.17	8961.86	7814.2
9	Annual irrigation water supply per unit irrigated area(m 3/ha)	6792.5	10800.82	9149.92
10	Financial self-sufficiency (%)	13.86	49.51	78.76
11	Gross return on investment (%)	102.99	121.04	112.2
12	Total Management operation Maintenance cost per unit cultivated area (Rs/ha)	87.65	154.95	100.13
13	Average revenue per 1000 cubic meter of irrigation water supplied (Rs/ m 3)	191.69	726.6	322.35

14	Fertilizer applied per unit-cultivated area. (kg/ha)	8.73	37	20.68
Source: Hirakud Irrigation System Management using Performance Indicators				

3.4. Land Holding & Farm Economy

Due to the rolling topography of the Hirakud Command Area, the operational land holding is fragmented and small. Operational holdings and District wise distribution of operational areas are presented in Table 3.4

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In addition to the above data, the land value of agricultural land in the command areas as determined as below:

Irrigated Land:

- Fertile Agricultural Land Rs3.0 lakhs per Ha

Table 3.4						
Land Holding and Farmers Economy						
Class in Ha.	**No of operational holding**			**Area Operated in Ha**		
	Sambalpur	**Bargarh**	**Sonepur**	**Sambalpur**	**Bargarh**	**Sonepur**
Marginal upto 1.0 Ha	8867	22790	17810	45910	11569	8166
Small (1.0 to 2.0Ha)	5344	15482	8348	7349	20826	11103
Semi- medium 2 Ha to 4Ha	3381	9394	4589	9231	24471	11903
Medium (4 Ha to 10Ha)	1396	3652	1556	7965	199915	8566
Large (10Ha & above)	163	496	174	2417	7263	2503
Source: Director of Command area Development, Bhubaneswar						

- Normal Agricultural Land Rs 2.0 lakhs per Ha

3.4. Economic Potential Created and Utilized

The Command has created the potential for economic pursuits and has facilitated utilization of the created potential for improving the economic condition of the farmers in the Kharif and Rabi cultivation. This is presented in Table 3.5

Table 3.5							
Economic Potential Created and Utilized							
Year	**Potential created ('000 Ha)**			**Potential Utilized**			**% of**
	Kharif	**Rabi/ Summer**	**Total**	**Kharif**	**Rabi/ Summer**	**Total**	**Utilization**
1987-88	159	103	260	159	110	269	102.6

1988-89	159	111	270	159	111	270	100
1989-90	159	105	264	159	109	268	101.5
1990-91	159	104	263	159	110	269	102.2
1991-92	159	105	264	159	108	267	101.1
1992-93	159	96	255	159	104	263	103.1
1993-94	159	92	251	159	98	257	102.3
1994-95	159	92	251	159	104	263	104.7
1995-96	159	94	253	159	104	263	103.9
1996-97	159	95	254	159	104	263	103.5
1997-98	159	85	244	159	97	256	104.9
1998-99	159	88	247	159	111	270	109.3
1999-2000	159	97	256	159	110	269	105.1
2000-01	159	82	241	159	93	252	104.5
2001-02	159	96	255	159	108	267	104.7
2002-03	159	85	250	159	109	268	107.2
2003-04	159	83	251	159	112	271	107.97
2004-05	159	89	267	159	105	264	98.88
2005-06	159	90	268	159	114	273	101.87
2007-08	159	89	265	159	106	265	100.00
2008-09	159	85	260	159	99	258	99.23
2009-10	159	88	269	159	103	262	97.40
2010-11	159	90	270	159	110	269	99.63
2011-12	159	92	271	159	102	261	96.31
2012-13	159	87	267	159	109	268	100.37
2014-15	159	90	276	159	110	269	97.46
2016-17	159	93	280	159	108	267	95.36
Source: Director of Command area Development, Bhubaneswar							

3.5. Agrarian Relation impacting Socio-Economic Profile

Hirakud Command is all about managing canal irrigation adapting principle or techniques for collection and distribution of water. But, a number of inequities have been marked in the head-reach and tail-end areas. While the water used in the head reach is quite high, the tail-end regions suffer from a multiplicity of problems such as poor availability of water, salinity and lack of drainage. The impact in the lower reaches is manifested in the scarcity of water, unpredictable supply, lower yields and lower cropping intensity. On the contrary, in the head reaches, the productivity of water is low because of its over-use. Solution to low productivity of water in the head area will solve the low agricultural productivity in the tail reaches. This is precisely the philosophy of good water management that plays an important role on the socio-economic profile of the Hirakud Command area.

3.6. Agrarian Structure

The term 'Agrarian Structure' is used by Thorner (1980) and Joshi (1975) as the network of relations among various groups of people connected with or involved in the process of cultivation such as landlord, tenants and agricultural labourers.

Rao(1968) emphasizes the role of natural factors such as fertility of the soil and assured water supply, either in the form of rainfall or irrigation, which gives rise to tenancy relations. Tency is the relationship between the landlord and the tenant. Mollinga (2003, 2010) argues that the social differentiation in terms of the problem of water-sharing between head-end and tail-end assumes a different spatial pattern in the critical debate on irrigation management and agrarian change. The total command area is 1,59,016.55 ha. The actually irrigated area varies from year to year due to a number of reasons such as quantum of rainfall, demand for irrigation, accumulation of sand in the river bed, poor maintenance of canal, etc.

4.1. NEED OF THE STUDY

The people of Odisha especially western part of Odisha has been severe deficiency related to the infrastructure to social backwardness due to the lack of government awareness and economically backwardness. Hence, Hirakud Dam is the only source of a lifeline for the people for their daily business such that irrigation, fishing, and industrial propose. Therefore, I would like to explore the real cause and impact of the Hirakud Dam on the socio-economic impact of the people in the western part of Odisha.

4.2. The motivation for the Study:

Hirakud dam is one of the earliest multipurpose river valley projects in the country and is the world's largest manmade water sheet even today. But, after the review of extant literature, it has been found that it remained one of the least researched projects in terms of its socio-economic benefits to the society at large. Hence, a study to measure the socio-economic impact of multipurpose river valley projects by taking Hirakud dam as the sample is legitimate within the world of social sciences and the present study is an attempt in this direction.

4.3. Research Objectives:

Keeping in view the research problem of the study and the findings from a review of the extant literature, it has been undertaken with the following specific objectives;

1. To bring out reasons responsible for diminishing contribution of Hirakud Dam.
2. To examine the adverse issues of the dam on mankind in terms of resettlement and rehabilitation, environment and other socio-economic issues.
3. To suggest measures to increase its contribution towards the socio-economic development of the people under study area.

4.4. Research Design:

Social researches are always based on data and when it is about the measurement of the socio-economic impact of a river valley project, a handsome amount of data unquestionably can show the solid facts and represent the truth permanently. But, in the present study since (1) the Hirakud Dam project is over six decades old, (2) the Hirakud Dam project has influenced the lives of people in a large geographical area, (3) the Hirakud Dam project had been undertaken with various welfare objectives; data on its socio-economic impact may be elusive and as well as ephemeral. They may be true for a particular person or in a particular time period or for a particular place, but might be quite different for others. It is because the Hirakud Dam project not only brought economic and social prosperity in the region but also it ensured displacement, rehabilitation and environmental degradation. Hence, if exactly the same respondents are asked about the socio-economic impact of Hirakud Dam project in different time intervals then their views may change because of their changing experiences in the interim periods.

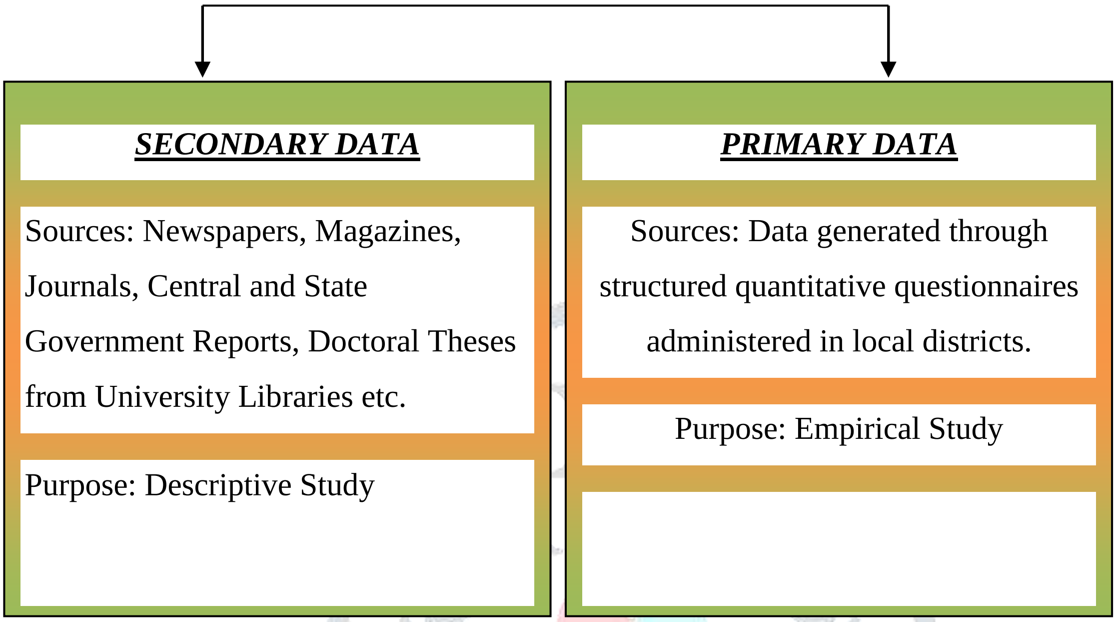
Apart from it, the nature of data in the present study is such that it is corruptible. While measuring the socio-economic impact of any river valley project, biased views clubbed with second-hand reports are often paraded as facts. Since the Hirakud Dam project was undertaken more than sixty years back and it has long-run effects, the far away one gets from the construction period the more likely that inconsistent and inaccurate information is secured. The memory of people fades with time, details of such megastructures are lost gradually and the traditional recording methods almost not allow a full picture. Hence, distortions of interpretations are definitely expected in such a research study.

5. RESEARCH METHODOLOGY:

5.1. Data:

The findings of the present study have been derived from data came from two main forms: secondary data and primary data.

Figure 5.1: Sources of Data: Socio-Economic Impact of Hirakud Dam in Orissa (Source: Researcher's Distillation)



As per the above figure, there are basically two phases of research undertaken under the present study i.e. descriptive phase and empirical phase. In the descriptive study in the present research project, data from secondary sources including newspapers, magazines, journals, central and state Government reports, doctoral theses from university libraries etc. have been considered. In the empirical study in the present research project, data from primary sources i.e. data generated through structured quantitative questionnaires administered in local districts have been taken into account. The first phase of research i.e. descriptive study has been undertaken to discover the dimensions, insights, parameters of the study. Additionally, the significance of research hypotheses so formed has been checked in this phase. And the second phase of research has been undertaken to verify the results and testify the research hypotheses by application of statistical treatments.

5.2. Questionnaire for the proposed study:

The need for developing a structured quantitative questionnaire was felt in order to collect the primary data in the empirical phase of research in the present study.

Figure 5.2: Components of the Questionnaire (Source: Researcher's Distillation)

POSITIVE IMPACTS

1. Purchasing Power of People
2. Up gradation in Living Standards
3. Constant Flow of Income
4. Per Capita Income
5. Employment Opportunities
6. Wealth Creation
7. Increment in Communication and Connectivity
8. Education
9. Healthcare
10. Flood Control
11. Development of Fisheries
12. Tourism Development
13. Hydroelectricity Production
14. Geographical Recognition

NEGATIVE IMPACTS

15. Deforestation
16. Resettlement and Rehabilitation
17. Loss of Wildlife

5.3. Demographic Profile of Sample:

The demographic profile of respondents for the proposed study is presented in

Table 5.1. Demographic Profile of Respondents (n = 299)

Stratification Variables	Category	Frequency	Percentage (%)
Districts	Sambalpur	77	26.0 %
	Bargarh	125	42.2 %
	Jharsuguda	97	32.0 %
Gender	Male	151	50.0 %
	Female	148	50.0 %
Occupation	Agriculture	150	50.0%
	Non Agriculture	149	50.0%

Source: Primary Data

5.4. Final Reliability Analysis:

The test of reliability is generally done through a popular statistical tool 'Cronbach's Alpha' for measuring the degree of consistency among items under consideration. If different variables under consideration are having a high degree of correlation, it means that they are measuring the same construct and they are contributing to the overall construct. When reliability is measured by Cronbach's Alpha, by convention a lenient cut off of 0.6 is acceptable in empirical research. And, in the present study when the data got tested for reliability, it yielded a Cronbach's Alpha score ranging from 0.65 to 0.70 which is much better than the reliability score obtained in the pilot study. The inter-item correlations are also found to be high which means that the items under consideration are measuring the same underlying construct. In Table 5.2 the results of reliability analysis have been shown where it can be seen that the overall reliability of the research instrument in terms of Chronbach's Alpha is equal to 0.709318258 which is much more than the lenient cut off of 0.6. Then the Chronbach's Alpha values for different constructs taken in the questionnaire namely: socio-economic status of people, economic indicators, the socio-economic life of people and adverse effects of the project carrying 3, 3, 8 and 3 items respectively has been taken.

Table 5.2 Reliability Analysis: Chronbach's Alpha (n=299)

Constructs	No. of Items	Cronbach's Alpha	Inter-item Correlation (Mean)
Socio-Economic Status of People	3	0.694015545	0. 532436281
Economic Indicators	3	0.686338042	0. 586869606
Socio-Economic Life of People	8	0.68318461	0.531098786
Adverse Effects of the Project	3	0.694145795	0. 556301555
Grand Total/Overall Reliability & Correlation	17	0.709318258	0.482166626
Source: Primary Data, Compiled from MS Excel Output			

It has been found that the constructs under consideration are having reliability scores of 0.694015545, 0.686338042, 0.68318461, and 0.694145795 respectively which are also more than the generally acceptable cut off of 0.65. It shows overall fitness as well as segment wise fitness of the seventeen items questionnaire.

5.5. Descriptive Analysis:

Descriptive statistics analyzed on interval and ratio scale data generally include the measures of location, variability, and shape. In the present study, arithmetic mean has been taken as a measure of location because it is a rigidly defined average and most suitable for further statistical treatments like hypothesis testing. Then range, standard deviation, and variance have been computed for studying the variability. Additionally, the skewness and kurtosis which are considered extremely useful to understand the nature of distribution have been calculated. Computation of skewness and kurtosis are a must for assessing normality of data.

In Table 5.3, the results of inferential analysis have been given. Since there are three control characteristics, in the table also the computed value of 'F' and the respective p values denoted by 'sig.' are shown for the given three control characteristics: gender, location, and occupation. The level of significance chosen for testing the hypotheses is 0.05. It is so because, in most of the existing literature of a similar type of studies, the level of significance used for testing hypotheses is 0.05. Following the 0.05 level of significance, one can reject the null hypothesis if the p-value would found to be less than 0.05. In other words, we can say that the impact of the chosen control characteristic is significant only if the p values denoted by 'sig.' are less than 0.05 if we are testing the hypotheses at 5% level of significance. In the table, for those items where the impact of the chosen characteristic is found significant has been marked in yellow color. It means for the cells colored in the yellow null hypothesis is rejected and the alternative hypothesis is accepted.

Table 5.3 Inferential Analysis (n=299)

Construct	Variable	Gender		Location		Occupation	
		F	Sig.	F	Sig.	F	Sig.
Socio-Economic Status	1	3.96	0.05	6.99	0.00	9.08	0.00
	2	8.50	0.00	9.03	0.00	21.11	0.00
	3	5.31	0.02	20.96	0.00	32.68	0.00
Economic Indicators	4	6.23	0.01	1.18	0.31	0.14	0.71
	5	0.63	0.43	0.54	0.59	0.31	0.58
	6	2.04	0.15	2.81	0.06	0.10	0.76
Socio-Economic Life	7	17.03	0.00	19.71	0.00	28.40	0.00
	8	18.81	0.00	14.22	0.00	39.69	0.00
	9	12.14	0.00	6.03	0.00	10.67	0.00
	10	0.28	0.60	1.33	0.27	0.00	0.97
	11	0.61	0.44	1.26	0.28	2.96	0.09
	12	9.37	0.00	3.89	0.02	10.69	0.00
	13	11.52	0.00	7.24	0.00	1.03	0.31
	14	1.92	0.17	1.47	0.23	0.94	0.33
Adverse Effects	15	1.63	0.20	0.86	0.42	1.12	0.29
	16	0.01	0.93	1.82	0.16	5.04	0.03
	17	4.29	0.04	2.38	0.09	2.58	0.11

Hypothesis Testified@5% Level of Significance
Source: Primary Data, Compiled from SPSS Output

Now, in order to understand the impact of each of the control characteristics individually, it is very much required that the cross-tabulation values along with the control characteristics should be seen in one go. For this purpose, the Table 5.4, Table 5.5and Table 5.20 have been constructed for the control characteristics gender, location, and occupation respectively. As per gender, the respondents have been classified as male and female. The analysis across gender revealed that there are differences on many of the variables among respondents with the difference in gender (See Table 5.4).

As per the expert reports, there is a high degree of unequal treatment or perceptions of individuals based on their gender especially in Indian context. It is because of differences in socially constructed gender roles as well as biologically through chromosomes, brain structure, and hormones. Wage discrimination, income disparity and also glass ceilings are a few consequences of gender inequality in a labor economy. Hence, in the present study, it was planned to analyze the effect of gender on perceptions of respondents towards components of the socio-economic impact of multipurpose river valley projects like Hirakud dam. Under the construct 'socio-economic status' respondents with different genders have varying perceptions regarding (1) up gradation of living standard and (2) constant flow of income. In both, the cases female respondents are found to be less agreeing with the positive influence of multipurpose river valley project Hirakud dam than their male counterparts. Then under the construct, 'economic indicators' respondents with different genders have varying perceptions only regarding per capita income. Here also female respondents are found to be less agreeing with the positive influence of multipurpose river valley project Hirakud dam on per capita income than their male counterparts.

Table 5.4 Inferential Analysis for 'Gender' (n=299)

Construct	Variable	Male	Female	F	Sig.
Socio-Economic Status	1	4.28	4.04	3.96	0.05
	2	3.89	3.46	8.50	0.00
	3	3.45	3.09	5.31	0.02
Economic Indicators	4	3.75	3.39	6.23	0.01
	5	3.61	3.50	0.63	0.43
	6	3.58	3.34	2.04	0.15
Socio-Economic Life	7	4.07	3.48	17.03	0.00
	8	3.97	3.39	18.81	0.00
	9	3.97	3.47	12.14	0.00
	10	3.95	3.88	0.28	0.60
	11	3.44	3.55	0.61	0.44
	12	4.15	3.76	9.37	0.00
	13	4.13	3.67	11.52	0.00
	14	4.07	3.89	1.92	0.17
Adverse Effects	15	3.82	3.64	1.63	0.20
	16	3.44	3.43	0.01	0.93
	17	3.39	3.66	4.29	0.04

Hypothesis Testified@5% Level of Significance
Source: Primary Data, Compiled from SPSS Output

Under the construct 'socio-economic life' respondents with different genders have varying perceptions regarding (1) increment in communication and connectivity, (2) education, (3) healthcare, (4) tourism development and (5) hydroelectricity production. In all the cases female respondents are found to be less agreeing with the positive influence of multipurpose river valley project Hirakud dam than their male counterparts. Then under the construct 'adverse effects of the project' respondents with different genders are have varying perceptions only regarding the loss of wildlife. Here also female respondents are found to be less agreeing with the negative influence of multipurpose river valley project Hirakud dam on the loss of wildlife than their male counterparts.

The second control characteristic is the location. Under the construct 'socio-economic status' respondents with different locations have varying perceptions regarding the entire three variables (1) purchasing power of people, (2) up gradation of living standard and (3) constant flow of income. In all the three cases first is Sambalpur, second is Bargarh and third is Jharsuguda as per the respondents. Then under the construct, 'economic indicators' respondents with different locations are not having varying perceptions at all.

Table 5.5 Inferential Analysis for 'Location' (n=299)

Construct	Variable	Sambalpur	Bargarh	Jharsuguda	F	Sig.
Socio-Economic Status	1	4.49	4.17	3.90	6.99	0.00
	2	3.99	3.83	3.24	9.03	0.00
	3	3.95	3.31	2.68	20.96	0.00

Economic Indicators	4	3.77	3.51	3.49	1.18	0.31
	5	3.62	3.59	3.45	0.54	0.59
	6	3.77	3.42	3.27	2.81	0.06
Socio-Economic Life	7	4.27	3.93	3.19	19.71	0.00
	8	4.14	3.76	3.23	14.22	0.00
	9	4.00	3.82	3.37	6.03	0.00
	10	4.09	3.91	3.78	1.33	0.27
	11	3.32	3.49	3.64	1.26	0.28
	12	4.21	3.98	3.73	3.89	0.02
	13	4.19	4.00	3.55	7.24	0.00
	14	4.03	4.08	3.82	1.47	0.23
Adverse Effects	15	3.84	3.76	3.61	0.86	0.42
	16	3.34	3.34	3.62	1.82	0.16
	17	3.32	3.51	3.70	2.38	0.09
Hypothesis Testified@5% Level of Significance Source: Primary Data, Compiled from SPSS Output						

Under the construct 'socio-economic life' respondents with different locations have varying perceptions regarding (1) increment in communication and connectivity, (2) education, (3) healthcare, (4) tourism development and (5) hydroelectricity production. In all of the cases, the districts as beneficiaries of the multipurpose river valley project Hirakud dam can be ranked as Sambalpur, Bargarh and then Jharsuguda. Then under the construct 'adverse effects of the project' respondents with different locations is not having varying perceptions at all.

6. CONFIRMATORY FACTOR ANALYSIS

Previous research has demonstrated that the socio-economic impact of multipurpose river valley projects is not a one-dimensional concept but is made up of several "factors" and hence it is considered multi-dimensional even in the present study. For this reason, principal component factor analysis is applied to analyze the variables included in the questionnaire to measure their contribution to the socio-economic impact of the multipurpose river valley project Hirakud dam. In this case, it is called 'confirmatory factor analyses' because we are applying the techniques in order to confirm the contributions of different variables to the given constructs. We are not discovering new components of the socio-economic impact of multipurpose river valley projects in terms of the constructs, instead, we are running factor analysis to cross verify that the variables are actually lying under the respective constructs.

Mathematically, factor analysis is somewhat similar to multiple regression analysis, where each variable is expressed as a linear combination of underlying factors. It is an interdependence technique in which an entire set of interdependent relationship is examined. Factor analysis assumes that underlying dimensions or factors can be used to explain complex phenomena. In the present study, the factors influencing the socio-economic impact of multipurpose river valley projects has been explored by asking the respondents to evaluate their relative importance on each variable or parameters on a semantic differential scale given in the questionnaire. These item evaluations may be analyzed to determine the factors underlying socio-economic impact of multipurpose river valley projects. But, before going for the factor analysis it is always advisable to test the appropriateness of the factor model through the available data.

Barlett's Test (BT) of Sphericity and Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy are two statistics on the SPSS output, which provides information whether the data set is appropriate for carrying factor analysis or not. Table 6.20 below presents the KMO and BT results of the data. Barlett's test of sphericity can be used to test the null hypothesis that the variables are uncorrelated in the population. In other words, the population correlation matrix is an identity matrix (Table 5.5). In an identity matrix, all the diagonal terms are 1, and all off-diagonal terms are 0. The test statistic for sphericity is based on a chi-square transformation of the determinant of the correlation matrix. A large value of the test statistic favors the rejection of the hypothesis. If the hypothesis cannot be rejected, then the appropriateness of factor analysis should be questioned. As the observed significance level in the present study is found to be 0.000 which is small enough to reject the hypothesis, the null hypothesis that the population correlation matrix is an identity matrix is rejected and we can conclude that the strength of the relationship among variables is strong. Hence, it is a good idea to proceed with factor analysis on the data.

Table 6.1 KMO and Bartlett's Test (n=299)		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy:		0.741
Bartlett's Test of Sphericity	Approx. Chi-Square	675.649
	Df	136
	Sig.	0.000
Source: Primary Data, Compiled from SPSS Output		

Another useful statistic is the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. This index compares the magnitudes of the observed correlation coefficients to the magnitudes of the partial correlation coefficients. Small values of the KMO statistic indicate that the correlations between pairs of variables cannot be explained by other variables and the factor analysis may not be appropriate. Generally, a value greater than 0.5 is desirable. The KMO statistic in the present study is also large (>0.5), thus factor analysis would be considered as an appropriate technique for analyzing the correlation matrix.

Once, it is ascertained that factor analysis can be worked out on the present data set, the next step is to actually implement it and explore the factors underlying the socio-economic impact of multipurpose river valley projects like Hirakud dam. The goal of factor analysis is to identify the not-directly-observable or latent factors based on a set of observable or measurable indicators. The process of factor analysis in the following manner: The first step in factor analysis is to produce a correlation matrix for all variables. Variables that do not appear to be related to other variables can be identified from this matrix. The number of factors necessary to represent the data and the method for calculating them must then be determined. Principal components analysis is one method of extracting factors. In principal components analysis, linear combinations of variables are formed. The first principal component is that which accounts for the largest amount of variance in the sample, the second principal component is that which accounts for the next largest amount of variance and is uncorrelated with the first and so on. At this step, it is also necessary to ascertain how well the model fits the data. Coefficients (factor loadings), that relate variables to the identified factors, are calculated. In order for a parameter to belong to a given factor, it is recommended that the loading value be not less than 0.40. The factor model is then rotated to transform the factors and make them more interpretable. The rotation phase transforms a factor matrix in which most factors are correlated with many variables into one in which each factor has non-zero loadings for only some of the variables. The most commonly used method for rotation is varimax rotation which seeks to minimize the number of variables that have high loadings on a factor thus permitting the factors to be differentiated from one another. Following rotation, scores for each factor can be computed for each case in a sample. These scores can then be used in further data analysis, such as analysis of variance, correlation and regression analysis. The results of the factor analysis of the variables considered under the present study are shown in Table 6.2 and Table 6.3.

Table 6.2

Total Variance Explained (n=299)

Components	**Initial Eigen Values**			**Extraction Sums of Squared Loadings**		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.294	26.875	26.875	3.294	26.875	26.875
2	1.441	13.974	40.849	1.441	13.974	40.849
3	1.367	12.544	53.393	1.367	12.544	53.393
4	1.275	9.500	62.892	1.275	9.500	62.892
5	1.231	5.743	68.636			
6	0.980	4.265	72.900			
7	0.935	3.999	76.899			
8	0.834	3.403	80.302			
9	0.823	3.343	83.645			
10	0.782	3.097	86.742			
11	0.717	2.719	89.461			
12	0.663	2.399	91.860			
13	0.591	1.979	93.839			
14	0.586	1.948	95.787			
15	0.538	1.663	97.450			
16	0.493	1.402	98.852			
17	0.450	1.148	100.000			

Extraction Method: Principal Component Analysis
Source: Primary Data, Compiled from SPSS Output

Table 6.2 provides the factorial structure of the behavior of the variables in the sample. In the present sample, a forced four-factor model of socio-economic impact has explained 62.892% of the variance. Based on the factor loadings, the variables of socio-economic impact in the present study can be compressed to four important factors and on the basis of the nature of variables included in different factors, it can be designated as socio-economic life, socio-economic status, adverse effects of the project and economic indicators.

Table 6.3

Rotated Component Matrix (n=299)

		Components

Dimensions	Variables	1	2	3	4
Socio-Economic Status	1	0.115	0.418	0.291	0.180
	2	0.217	0.438	0.342	0.152
	3	0.015	0.575	0.315	0.228
Economic Indicators	4	0.285	0.257	0.111	0.489
	5	0.369	0.066	0.037	0.453
	6	0.026	0.317	0.328	0.477
Socio-Economic Life	7	0.553	0.184	0.329	0.222
	8	0.501	0.099	0.359	0.283
	9	0.412	0.379	0.111	0.066
	10	0.440	0.393	0.007	0.242
	11	0.459	0.306	0.247	0.242
	12	0.486	0.027	0.308	0.303
	13	0.584	0.221	0.150	0.148
	14	0.510	0.229	0.366	0.026
Adverse Effects of the Project	15	0.335	0.020	0.422	0.362
	16	0.010	0.108	0.428	0.139
	17	0.022	0.306	0.577	0.308

Extraction Method: Principal Component Analysis
Source: Primary Data, Compiled from SPSS Output

The first factor i.e. the socio-economic life of people explains 26.875% of variance includes a total of eight variables. The second factor i.e. the socio-economic status of people explaining 13.974% of variance includes three variables. The third factor i.e. adverse effects of the project explaining 12.544% of variance includes three variables. The fourth factor i.e. economic indicators explaining 9.500% of variance includes three variables.

7 CONCLUDING REMARKS

Hence, to summarize the results of factor analysis, it can be said that the respondents place different degrees of priorities to the variables associated with socio-economic impact of multipurpose river valley projects like Hirakud Dam which can be divided into four major categories based on the factors described by the analysis as; socio-economic life of people, socio-economic status of people, adverse effects of the project and economic indicators.

Reference

Angel, Gurría., (2017).“ Putting water at the center of the global agenda”; OECD Secretary-General, 24 April 2017, www. OECD. org / water/ SG-Water-lecture-April-2017. (P-4).

Bijepur lift canal system announced, Outlook,The News Scroll 16 October 2017 Last Updated at 6:48 pm, https: // www. outlookindia.com / newsscroll / bijepur-lift-canal-system-announced/1168850.

Chandra, R. et al. 2011. Monitoring of River Ram Ganga: Physico-Chemical Characteristic at Bareilly. Recent Research in Science and Technology. 3. 16-18.

Characterization of sediments from Tungabhadra reservoir for sustainable development project reference no.: 38s1571, http://www.kscst.iisc.ernet.in/spp/38_series/spp38s/synopsis_seminar/031_38S 157, (PP.3-10)

CHD. (2012) Plan Hidrológico de la Parte Española de la Demarcación Hidrográfica del Duero; Confederación Hidrográfica del Duero: Valladolid, Spain.

Chen, Y., et al. 2011. Desiccation of the Tarim River, Xinjiang, China, and mitigation strategy. Quaternary International, 244(2): 264-271.

Cronbach, L.J. (1951). *"Coefficient Alpha and Internal Structure of Tests, Psychometrika"*, 16(3), pp. (297-333).

Dennis P. Lettenmaier & Thian Yew Gan, 1990, Hydrologic sensitivities of the Sacramento- San Joaquin River Basin, California, to global warming, Water Resources Research, Volume26, Issue1, Pages 69-86. retrived from https://doi.org/10.1029/WR026i001p00069

Dhar, U., et al. 1997. Structural diversity and representativeness of forest vegetation in protected areas of Kumaun Himalaya, India: implications for conservation. Biodiv. and Cons., 6(8): 1045-1062.

Dhembare, A.J. and G.M. Pondhe, (1997), Correlation of ground water parameters of Pravara area. Maharashtra state, India. l2, pp 32-33.

Dvorak, V., J. Hladmy, and L. Kasparek, 1997: Climate change, hydrology and water resources impact and adaptation for selected river basins in the Czeck Republic. Climatic Change, 36, 93–106.

East Flowing Rivers from Mahanadi to Pennar - (NIH), Roorkee, http://nihroorkee.gov.in/rbis/basin%20maps/efrm2p.htm. It is a snapshot of the page as it appeared on 5 Nov 2017 09:32:57 GMT.

Fotedar, A. and Raina, A.K. 2009. Water chemistry about heavies of Sewa river, Kathua district, Jammu and Kashmir State. Indian Journal of Environment and Ecoplan, 16(1): 213-218.

Fotedar, B.K. et al. 1990. Behaviour of trace elements in waters of Chenab River, Akhnoor area, Jammu. All India Seminar on Ground Water Investigation Management and Geophysical Techniques held at Lucknow under the sponsorship of Central Groundwater Board, 11-12 Dec., pp. 18-24.

Fowler, H. J. et al.2003, Modeling the impacts of climatic change and variability on the reliability, resilience, and vulnerability of a water resource system, Water Resources Research, VOL. 39, NO. 8, 1222, doi:10.1029/2002WR001778

Freed, J. R., and F. Sussman (2006), Converting research into action: A framework for identifying opportunities to provide practical decision support for climate change adaptation, Water Resour. Impact, 8, 11 – 14.

Gujarati, Damodar N., (1995). "Basic Econometrics", 3rd Edition, McGraw-Hill, Inc., Singapore, pp. (122-131).

Gupta, S.C. (2011). “Fundamentals of Statistics”, Himalaya Publishing House, Mumbai, pp. (15.29, 16.26-16.33).

Hirakud Dam Project, http:// www. dowrorissa. gov. in / Projects / MajMed / Details Completed Ongoing / Ongoing / CEUMB / Hirakud % 20System % 20% 28 Completed % 29/ SFHirakud, (pp. 1 – 4).

Jain, K. Sharad, et. al. (2007). “Hydrology and Water Resources of India”, published by Spinger, The Netherlands, ISBN No: 1D1-40205179-(HB), (pp. 15 -65).

Kothari, C.R., “Research Methodology”, (2005). New Age International, New Delhi, pp. (184-225).

Leah, Schleifer; (2017). “7 Reasons we’re Facing a Global.” http://www.wri.org/blog/2017/08/7-reasons-were-facing-global-water-crisis. It is a snapshot of the page as it appeared on 23 Nov 2017 02:17:20 GMT. (PP. 1-4).

Levin, R.I. & Rubin D.S. (1991). “Statistics for Management”, (pp.92, 567 – 588). New Delhi:PHI.

Mahanadi water dispute between Odisha and Chhattisgarh: Here's all you need to know about the row, Aug, 16 2016 11:44:38 IST, http://www.firstpost.com/india/mahanadi-water-dispute- etween-odisha-and-chhattisgarh-heres-all-you-need-to-know-about-the-row-2958188.html. It is a snapshot of the page as it appeared on 11 Nov 2017 21:01:58 GMT.

Majhi, Priti., & Khatua, Praful., (2011), “Research Methodology for Management” Concepts, Technologies and SPSS, HPH, pp. (100-103).

Malhotra, N.K. (2005). “Marketing Research - An Applied Orientation”, 5th Edition, Pearson Education Inc., pp. (343-347).

Matt, Williams., (2016) “What percent of earth is water?”, Article written: 1 Dec , 2014, Updated: 31 Oct , 2016, www.universetoday.com/65588/what-percent-of-earth-is-water.

Nayam,K. Arun., (2010). “Big Dams and Protests in India: A Study of Hirakud Dam”, Economic & Political Weekly EPW January 9, 2010 vol xlv no 2,(PP.69-72).

Nitin, Gadkari., (2017). “Five projects connecting rivers will begin in 3 months”, www.financialexpress.com › India news, Sep 7, 2017.

Nunnally, J C (1978). “Psychometric Theory”, New York : McGraw-Hill.

Odisha Hydro Power Corporation Ltd., A Gold rated State PSU (A Govt. of Odisha Undertaking), Powering Green Energy, http://ohpcltd.com/Hirakud/Index, it appeared on 10 Nov 2017 12:05:51 GMT.

Pratim, Ranjan. Bose.,(2017). “Damodar Valley to undertake dam project in Jharkhand,” the Hindu Business Line, published in the Business Line print edition dated May 26, 2005, http:// www. The hindu businessline. com/ todays-paper/tp- corporate/

damodar-valley-to-undertake-dam-project-in-jharkhand /article2178528. ece. It is a snapshot of the page as it appeared on 25 Dec 2017 21:26:06 GMT.

R. B. Shah., (1993). “Role of major dams in the Indian economy,” International Journal of Water Resources Development, 9:3, 319-336, DOI: 10.1080/07900629308722592.