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Study of Water & Air Environment for Impact Analysis of Proposed Bhaurant Dam using Interaction Matrices Approach

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Abstract: *This study presents the findings of Environmental Impact Assessment (EIA) for the proposedBhaurat Dam Project. In this study data pertaining to water and air environment within the study area 10 kms of radius from the dam site has been investigated in the upstream and downstream side of the proposed dam site. On the basis of impact analysis adopting using Matrice and Interaction Matrix approaches and results of the base-line data, it has been found that dam construction activity is more dominant over other aspects. Considered for correlation these aspects are effect on Regional Ecology and Environment, Irrigation Benefits, Forest Loss, Regional Economy, Social Aspects, Geology, Hydrology, Moreover, results indicate that there would be minimal adverse impact on regional ecology and environment following the construction of dam. Instead, it may offer benefit to this region. It may enhance irrigation activity leading to agricultural productivity, increase vegetation and green areas in this semi-arid region of the state.*

I. Introduction

This study was conducted on proposed Bhaunrat Dam in District Lalitpur UP. The Bhaunrat Dam is proposed to be constructed across Jamini River in District Lalitpur, UP. The dam will submerge 1230 hectares of land with an objective to provide estimated culturable command area of about 11699 hectares. The main purpose of the 19.93 m high, with 10 spillways having dam line of 4.2 kms long of Bhaunrat Dam is irrigation.

Man's impact on his environment and his efforts to prevent or mitigate the impact has a long history. There has been a long tradition of land- use planning concerned with the prevention or reduction of detrimental impacts by means of planning permits or denial of such permits In the present modern world, the impact (positive/or negative) is assessed through knowledge and scientific means. The Environmental Impact Assessment (EIA) has become an important tool to gauge the likely impacts of any development projects. Water resources projects like Dam construction has also been considered as a very important activity from environment, economic and social development point of views. The construction new Dam is very critical because of the associated project impact on the environment. The damming of a river will have dramatic consequences on the nature of the environmental both upstream and downstream of the dam and its flow regime. The reservoir water spill out into the surrounding environmental resulting into flooding the natural habitat that existed before the dam's construction. Also, a dam acts a barrier between the upstream and downstream habitat of migratory river animals thus threatening to decrease their reproduction numbers and reduce the species population. The water temperature will also have some effect.

1.2 Construction of Dams for Irrigation Purpose

Water is the vital resource to support all forms life on earth. Unfortunately, it is not evenly distributed over the world by season or location. Some parts of the world are prone to drought making water a scarce and precious commodity, while in other parts of the world it appears in raging torrents causing floods and loss of life and property. Throughout the history of the world, dams and reservoirs have been used successfully in collecting, storing and managing water needed to sustain civilization.

Even today, water remains essential for the survival of mankind and the future development of the world's cities, industries and agriculture. Today there is a significant demand on the world's water. As the world population continues to grow at the rate of over 100 million people each year, so does the demand for water. At the same time, there is a careless use of our natural resources and accelerated pollution of the environment. The fact that a significant portion of the available water in the world is too contaminated for domestic use makes this situation very critical.

One of the most efficient ways to manage water resources for human needs is by the construction of dams that create reservoirs for the storage and future distribution. Currently there are about 45,000 dams higher than 15 meters throughout the world. While some are more than 2,000 years old, about 73% have been built in the last 50 years. The reservoirs formed by these dams store some 3,600 km3 of usable water. The primary benefit of dams and reservoirs in the world is water supply. Other key purposes and benefits include:

- Irrigation for agriculture (food supply)
- Flood control

- Hydropower
- Inland navigation
- Recreation

1.3 Location of project

The proposed dam project where this study has been conducted is located in District Lalitpur. Lalitpur district falls in the Bundelkhand region forming the southern fringe of Uttar Pradesh demarcated by the Vindhyan hills and plateau. It falls under semi-arid climatic zone characterized by rugged undulating terrain, and low soil cover with granitic outcrops. The area with poor soil cover and uncertain rainfall has limited agricultural development for about 5.71 per cent of the total 240,928 km^2 geographic area. Lalitpur district has 11.07 per cent forest cover within its 5039 km^2 of geographic area.

1.4 Geography and Topography:

District Lalitpur is ravenous, undulating and hillocks bounded by Vindhyan Plateau in south, river Yamuna in north, river Ken in east and rivers Betwa and Pahuj in west. While the Yamuna flows from west to east, its first order tributaries viz., Betwa, Ken, Pahuj, Baghain, and Paisuni flow from south to north. Second order tributaries of the Yamuna are Dhasan, Jamini, Birma, Sonar, Katne, Bewas, and Kopra.

The entire system of drainage and stream flows forms a part of Ganga basin. The region generally slopes from south to north. The elevations in the area ranges from 600 m above mean sea level (MSL) in southern part to 150 m MSL near Yamuna River.

1.5 Ground Water Resources

Water aquifer is inadequate and non-dependable largely due to hard rock hydro-geological conditions. Except a belt along the Yamuna river and a few rivers and few pockets here and there already having tube-well, water yield in the remaining part is very low.

1.6 Rainfall Pattern

Rainfall is the ultimate source of surface, ground, green and blue water resources for raising biomass and other utilities. The average annual rainfall of Bundelkhand in Uttar Pradesh is 876.1 mm with a range of 786.6 to 945.5 mm. About 90% of the rainfall is received in the monsoon season of July to September in about 30-35 events or spells.

Rainfall variation within the season is important for crop production and rain in September is crucial for the maturity of Kharif crops and sowing of Rabi crops. Delayed on set of rains, early withdrawal or long dry spells in between also lead to drought like situation. The U.P. part of the region experienced rainfall deficit of 25% in 2004-05, 33% in the year 2005-06 which went up to 45% in 2006-07 and 56% in 2007-08 . Five out of seven districts had more than 50% rainfall deficit. All the districts experienced meteorological drought.

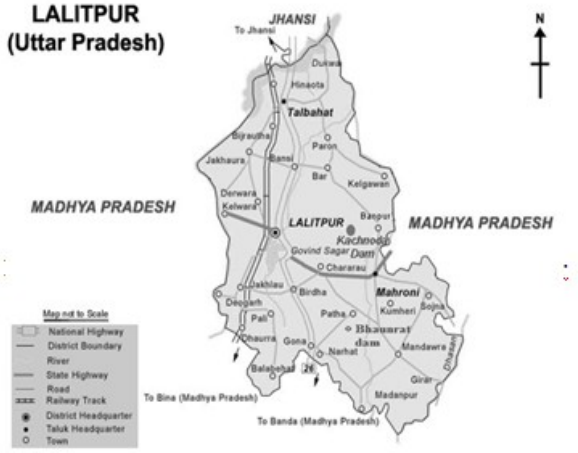


Fig 1.1: Maps of Uttar Pradesh Showing District Lalitpur

II. Dam project detail

The proposed Bhaunrat Dam Project envisages construction of a 4.20 km long and 19.93m high above river bed with a gross storage of 50.44 mcm across Jamini river (a tributary of river Betwa), about 20 km downstream of existing Jamini dam near village Bhaira in Mehrauni Tehsil of District Lalitpur of Uttar Pradesh. A gated spillway of 157m length is proposed to be constructed to pass the maximum flood discharge of 5000 cumecs. It is envisaged to irrigate an area of 1960 ha in rabi& 1960 in kharif.

2.1 Dam characterstics

The Bhaunrat Dam project has the following features

LOCATION	
Tehsil	No
District	Lalitpur
State	Uttar Pradesh
River Basin	Betwa
Nearest Railway Station	Lalitpur
Nearest Airport	Gwalior/Bhopal
Gross catchment area uptoDam Site	335.40 Sq. km
Free catchment area*	358.90 Sq.km
Average annual rainfall	1018 mm
Design flood for spillway	5000 cumec
DAM	
Type	Homogeneous
Max. height above river bed level	19.93 m
River bed level (above MSL)	343.170 m
Elevation of top of Dam	363.1
Length of Dam Line	4.20 Km
Length of Left Flank	1.9715 Km
Length of Right Flank	2.0715 Km
Width at top	6.6 m
Canals	Bhaunrat feeder channel (2.5m3
Freeboard	
SPILLWAY	2.2 m
Type	
Shape	ogee Spillway
RESERVOIR and SUBMERGENCE	354.550
Full Reservoir Level, FRL (above MSL)	
Estimated Culturable Command Area (CCA)	1230 ha of land
No. of villages affected	11699 hectares
No. of families affected	06
ESTIMATED COST	1118
Civil Works	
E and M Works	Rs. 388.52 Crore
Total Basic Cost	Rs. 37 Crore
CONSTRUCTION PERIOD	Rs. 423.45 Crore
Target Year	36 months

III. Study Area of proposed project

As per the EIA requirements, study area has been taken as 10 Kms of from the dam line of the proposed Bhaunrat Dam site. Within the scope of study, the environmental parameters pertaining to water and air as per MoEF guidelines have been studied in the study area. The study area is shown Figure 1.2 (a&b). Photograph showing the site where proposed Bhaunrat dam shall be constructed are given in Figure 3.5. The D/s of Jamini River near the proposed dam site is given in Figure 3.6.

Legend:

ASL : air sampler location
WSL : water sample location
VWSL : village water sample location

Fig 1.2: Proposed Site for Dam Construction

IV. Data Collection and its Analysis

Within the scope of the study, parameters pertaining to water and air, relevant to dam projects have been investigated. These parameters have been investigated for three seasons (summer, Post-Monsoon and winter). The parameters are:

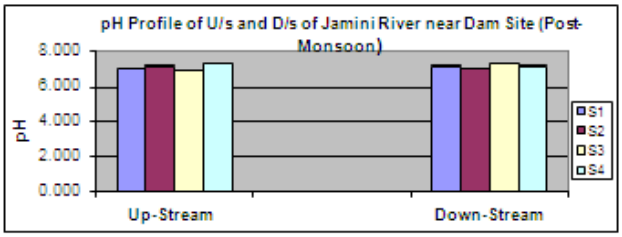
1. Water Environment

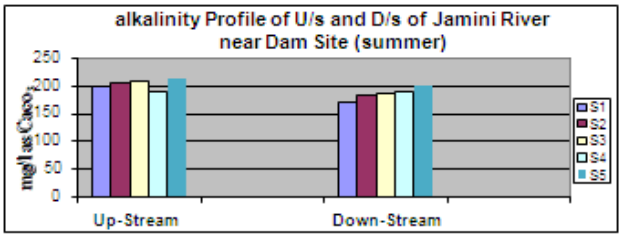
pH
Alkalinity
Hardness
Turbidity
TDS

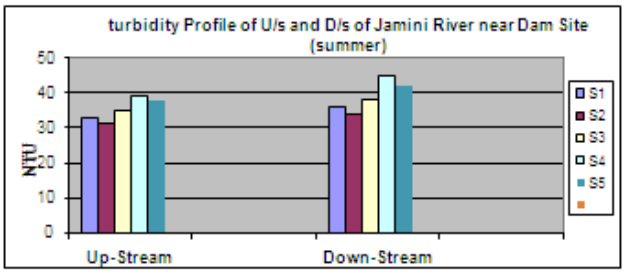
2. Air Environment

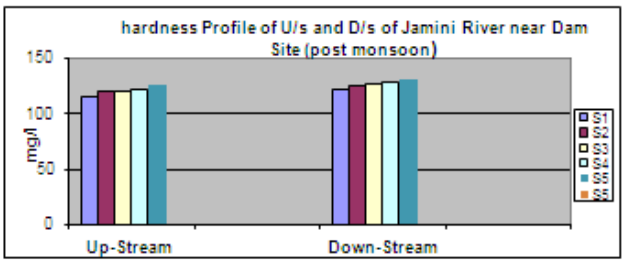
RSPM
SPM

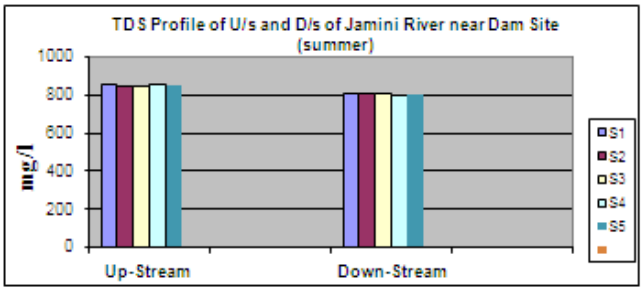
For air sampling, random samples within 10 sq.km of project site has been conducted. Wind-rose analysis and diagram were beyond the scope of this study. There were practical constraints due to which wind-rose analysis could not be carried out. However, due to no industry in this area, air pollution is not an issue.











Data of air sampling at Bhaunrat Dam site

Table 1.1: Air Quality Monitoring Data at U/s of Bhaunrat Dam in Summr Season

Location	RSPM (µg/m^3)	SPM (µg/m^3)
ASL1	71.27	52.32
ASL2	83.49	55.92
ASL3	81.26	54.26
ASL4	79.26	55.12

Table 1.2: Air Quality Monitoring Data at U/s of Bhaunrat Dam in Post-Monsoon Season

Location	RSPM (µg/m^3)	SPM (µg/m^3)
ASL1	82.27	65.45
ASL2	81.94	59.35
ASL3	83.11	62.16
ASL4	81.11	61.31

Figure 2.1: High Volume sampler installed at the proposed site

V. Analysis of Results

Parameters pertaining to water collected and analyzed in this study are pH, Alkalinity, Turbidity, TDS, and Hardness.

The pH value of surface water (Jamini River) ranges in between 6 and 7 (U/s) and 6.3 and 7.0 (D/s). This indicates that there is hardly any variation in the pH during the flow of water of this river from upstream (5kms away from the dam line) to downstream (5 kms away from the dam line). Thus, pH may not have significant role on the agriculture using this water.

In case of alkalinity, similar pattern have been obtained. The alkalinity concentration in the U/s of River ranges in between 200 and 225 whereas in D/s it ranges from 155 to 200 mg/l as $CaCO_3$. This shows that there is not much variation in these samples.

As for turbidity, results show 32 to 39 NTU in U/s of the river and 35 to 44 NTU in D/s of the River. This parameter may also not have any impact.

TDS and Hardness measured at the U/s and D/s of the river and ground water shows very little variation. TDS value ranges from 800 to 900 mg/l at U/s and D/s whereas hardness ranges from 115 to 225 at these two locations. This indicates that these parameter may not have any negative impact after the dam construction

5.1 Results and discussion

On the basis of the field surveys conducted and data collected, impact analysis has been carried out with respect to the environment with other features of the area/components.

1. Interaction Matrices Approach
2. Analysis of data on water, air and noise environment

5.2 Environmental Impact

On the basis of the field surveys conducted and data collected, net environmental impact has been carried out with respect to the Dam construction.

Features likely to be affected		**Construction of dam**
Vegetation	forestry/vegetation	-3P
Wildlife	Birds	-1T
	Fisheries	-2T
	other wildlife/animals	-2T
Sedimentation	sedimentation/erosion	-2P
Hydrology	ground water recharge	+3P
	Floods	-1P
Ecology	land area	-2P
	Climate	Nil
Health	drinking water	+1P

	water quality	-1T
	air quality	-1T
	health and safety	-2T
	historical monuments	Nil
	Communication	+2P
Socio-economic	Development	+3P
	Agriculture	+3P
	food production	+1P
	public revenue income	+2T
	Industrialization	+3T
	Housing	+1P
	Employment	+3T
	scenic views	+1T
	Tourism	+1T

T = Temporary effect
P = Permanent effect

Designated scale

	MILD	CONSIDERBLE	HIGH	VERY HIGH
BENEFICIAL	+1	+2	+3	+4
DETRIMENTAL EFFECTS	-1	-2	-3	-4

5.3 Correlation with Inter-Disciplinary Components
Following major aspects have been considered for correlation matrix

- Effect on Regional Ecology and Environment
- Dam construction
- Irrigation Benefits
- Forest Loss
- Regional Economy
- Social Aspects
- Geology
- Hydrology

These are the respective symbols use for different component

S = Effect on Regional Ecology and Environment
T = Dam Construction
U = Irrigation Benefits
V = Forest Loss
W = Regional Economy
X = Social Aspects
Y = Geology
Z = Hydrology

Compare	With alternatives								SUM
	S	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	
S	-	0.5	0.5	0	1	0.5	0	0	2.5
T	0.5	-	1	1	0.5	1	1	0.5	**5.5**

U	0.5	0	-	0	0.5	0	0.5	0.5	2.0
V	1.0	0	1	-	0.5	0	0.5	0.5	2.0
W	0	0.5	0.5	0.5	-	1	1	0	3.5
X	0.5	0	1.0	1.0	0	-	0.5	0	3.0
Y	1	0	0.5	0.5	0	0.5	-	0.5	3.0
Z	1	0.5	0.5	0.5	0	0	0	-	2.5

In this result all the five alternatives S,T, U, V, W, X, Y, and Z are compared paired wise to each other. In this method First a matrix is drawn with all options listed both horizontally and vertically. Each option is then compared with every other one and a score of 1 assigned to the preferred option or 0.5 to both options if no preference zero is assigned.

On the basis of result it is found that sum of the preference of alternatives W (Dam construction) is three which is greater than other alternatives so conclusion of this result is that dam construction is more preferable option in that region rather than other components. This comparison shows that the dam construction is very beneficial with respect to all other parameters and it produces very less impact on environment that may be mitigated.

VI. Summary and conclusion

On the basis of the study and analysis of data, the following conclusions are made:

1. Study has revealed that proposed dam at Bhaunrat dam, in District Lalitpur UP is more dominant over other aspects considered for correlation without causing any harm to the environment.
2. The proposed Bhaunrat Dam in District Lalitpur, which lies under semi-arid region, is a positive step by the state government as it would increase the Irrigation potential and Culturable Command Area (CCA) of this area.
3. Results pertaining to water and air analysis within the project area indicate that there will not be any adverse impact on ecology and environment following the construction of dam.
4. It is also concluded that the construction of dam shall increase the regional economy, green cover, and vegetation.
5. The dam will also act as a reservoir to recharge the ground water level of this region.

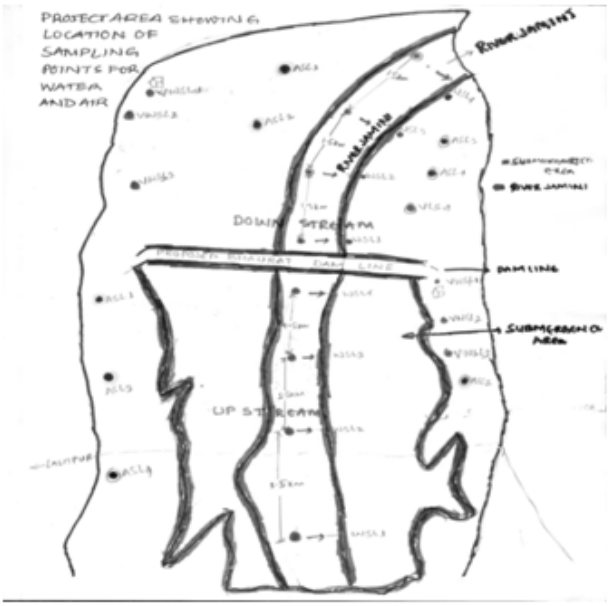


Fig: - Shows Study area and location of sample

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