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SEASONAL VARIATION OF WATER QUALITY AND ITS SUSTAINABLE APPROACH IN LOCAL LIVELIHOOD IN HARABHANGA ABONDONED OCP IN RANIGANJ COALFIELD, WEST BENGAL, INDIA

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ABSTRACT

'Rat-hole' mining method is a primary and conventional process of coal extraction in several parts of India as well as in the world. The study has been done on the basis of samples collected in different seasons to know the nature of dispersion and also human activities have also been considered to know its impact. It has been observed that low dissolved oxygen (DO) and high BOD, high TSS and TH are some of the bio-physical parameters which characterize the degradation of water quality. The inter dependency among different climatic variables and in all cases the correlation value is 1, i.e. <0.5. It is seen that the amount of rainfall is heavy, then excessive amount of waste materials are flow through this runoff and the physical properties of water become affected. So it has been argued that the water bodies of the area are the greatest victims of the coal mining. This work will analyse the various parameters of Harabhanga pit water bodies which can able to show the nature of water quality and will also aiming on the seasonal dependency on the water bodies. OCP water based sustainable developmental strategies that can be useful in mitigation of the environmental problems and rehabilitation of degraded ecosystems and it have also been suggested that these strategies will be prepared on the basis of local needs.

Key words: Abandoned OCP, BOD, Dissolved oxygen (DO), Sustainable development, TSS, TH

INTRODUCTION

The water that runs off the mines can have detrimental effect on the water bodies that are in and around the mining areas. The seepage from ore bodies, mining waste rocks and treatment of effluents pose a great threat to the water bodies and the aquatic life associated with them **[1-3]**. A significant threat to water quality and aquatic organisms comes from eroding soils at abandoned mining sites and deposition of unwanted material in the water bodies. Solids such as fine particles of coal, sand, mud and other mineral particles have been found deposited at the bottom of the water bodies **[4]**. Dissolve oxygen is essential for sustaining higher life forms in water. It is an important parameter to assess water quality. Dissolved oxygen was found to be low in water bodies of coal mining areas, the lowest being 4.24 mg/L in Harabhanga abandoned OCP **[5]**.

In this paper, we propose a comprehensive sustainability assessment method based on community perspectives and expert opinion to examine the local sustainability impacts of abandoned coal mining pits. Our study develops a composite sustainability index that can assess the sustainability impacts experienced by three local communities in Harbhanga village.

Study Area

The present study site, Harabhanga abandoned OCP situated near South of Harabanga Village under Raniganj Block of Paschim Bardhaman, West Bengal. The pit is under the jurisdiction of Tirat gram panchayat. As per coal mining map of our country it is a part of Eastern Coalfield Ltd (Satgram area). Geo-physical information on Harabhanga OCP has been obtained from E.C.L. (Satgram Area), which is shown in **Figure 1 and Table 1**.

METHODOLOGY

For analysis, primary water samples were collected from three consecutive seasonal phases, these are pre monsoon, monsoon and post monsoon season. Surface water was collected from five points of Harabanga abandoned OCP and mixed it thoroughly. After that it was brought to the laboratory to analyse the data using APHA 23rd Edition, 1060 technique. Parameters like temperature, pH, Total Suspended Solid (TSS) i.e. pollutants, Dissolved Oxygen (DO), BOD, COD, Total Hardness as $CaCo_3$, Total Alkalinity as $CaCo_3$ were considered for observation. And metallurgical data was also taken from Panagarh and Asansol weather station to find out the relation between monsoon wise rainfall and humidity.

During sampling and analyses of the mine water, standard protocols and methodologies were maintained strictly for getting accurate result **[6]**. Whereas Correlation method was applied by using

SPSS statistical software version 16.0 for analysing the data set and get better understanding on interrelationship between season wise different variables. ANOVA (single factor) was also computed to analyse the actual impact among different physical properties of pit water. Cartographic methods like bar, line graph were also used to know about the nature of distribution.

Here, the sampling seasons were considered according to the hydrological background, which is mainly depends on the seasonal variations due to rainfall distribution. The most influencing factor for the hydrological regime of the present study area is depends on south-west monsoon, while the whole sampling procedure was undertaken during pre-monsoon, monsoon and post-monsoon season.

RESULTS/ DATA ANALYSIS

Weather data's are taken through using different weather instrument like Maximum Minimum Thermometer, Hygrometer etc. Rainfall data collected from local weather station, i.e. Panagarh, Asansol. After getting this data, these are plotted in Tabular form **(Table 1)**. To get better result ground observation has been done and season wise data taken, especially for monsoon, pre monsoon, post monsoon.

There is a direct dependency observed between air and water temperature and also between rainfall and humidity. Water temperature increases with increases of air temperature and humidity increases with increases of rainfall. Pre monsoon is the hottest season along with moderate humidity and rainfall, monsoon temperature is moderate with high humidity and rainfall and post monsoon experiencing low temperature, humidity and rainfall. As season wise water discharge through surface run off may vary, coming water from land surface may also putting an immense effect on water quality **[7]**. Higher the rainfall causing higher the surface run off and due to sufficient run off, large volume of waste and eroded materials are mixing into pit water. Therefore, water quality may change significantly in monsoon season **(Table 2)**.

Table 1: Overview of Harabanga abandoned OCP

Name	Location	Latitude & Longitude	Altitude	Shape	Length	Width	Depth	Distance from Nearest Railway Station	Distance from Damodar River	Lavelling	Last coal extraction	References
Harabhanga OCP	South of G.T. Road (Nimcha and Sripur more)	Lat: 23º39'52'' Long:87º01'44''	95.71M	Crocodile	450M	140 m	9 to 16 m	1300 m from Kalipahari Station (AIR)	4.05 km	84.43 M	1982	ECL Satgram Area

Figure 1 & 2: Harabhanga OCP (Crocodile Shaped)

Season wise weather parameters are represented in **Figure 3**. It is showing that the air-water temperature and rainfall-humidity is interdependent in nature.

Correlation is also a significant method to determine the nature and magnitude of relationship between different variables. When the variance wise inter crossed value is < 0.5 that means there is positive (+) relationship. Here it is seen that all values are same, i.e. 1. So it may be argued that all the weather elements are inter dependent in nature **(Table 3)**.

Season wise water parameters are plotted in **Table 4**, along with its permissible limit as per MoEF Schedule-VI Standard. The observed parameters are pH (at 25^0C), Total Suspended Solid (TSS) i.e. pollutants, Dissolved Oxygen (DO), BOD, COD, Total Hardness as $CaCo_3$, Total Alkalinity as $CaCo_3$.

From **Table 3**, the data represents in line graph to show season wise variability of water parameters. Monsoon months are shown highest diversity among all seasons.

Water quality may significantly vary in monsoon season. As per analysis the magnitude of seasonal impact is as

Monsoon>Post-Monsoon>Pre-Monsoon

ANOVA **(Table 5)** is a valuable statistical analysis to find out the significant variance level among different components or properties. The result from ANOVA is analysing considering two values, i.e. "F" and "F Critical". When F value is greater than F Critical value, it means there is significant difference among all variables or there is difference in opinions regarding the relationship between said aspects. On the other hand, if F value less than F Critical value, it means there is no such difference in between different variables or parameters and all have same view in respect of showing their opinion regarding inter relationships.

Here, it is seen that F value (0.042034) is less than F Critical value (3.098391). So, it signifies that there no significant difference among all water parameters. Season is the key factor to change water quality.

Table 2: Weather Parameters in Different Seasons

Indicator	Air Temperature (^{0}C)	Water Temperature (^{0}C)	Rainfall (cm)	Humidity (%)
Pre monsoon	**41**	**38**	**2.8**	**34.5**
Monsoon	**36**	**33**	**4.2**	**49.1**
Post monsoon	**31**	**29**	**1.4**	**21.5**

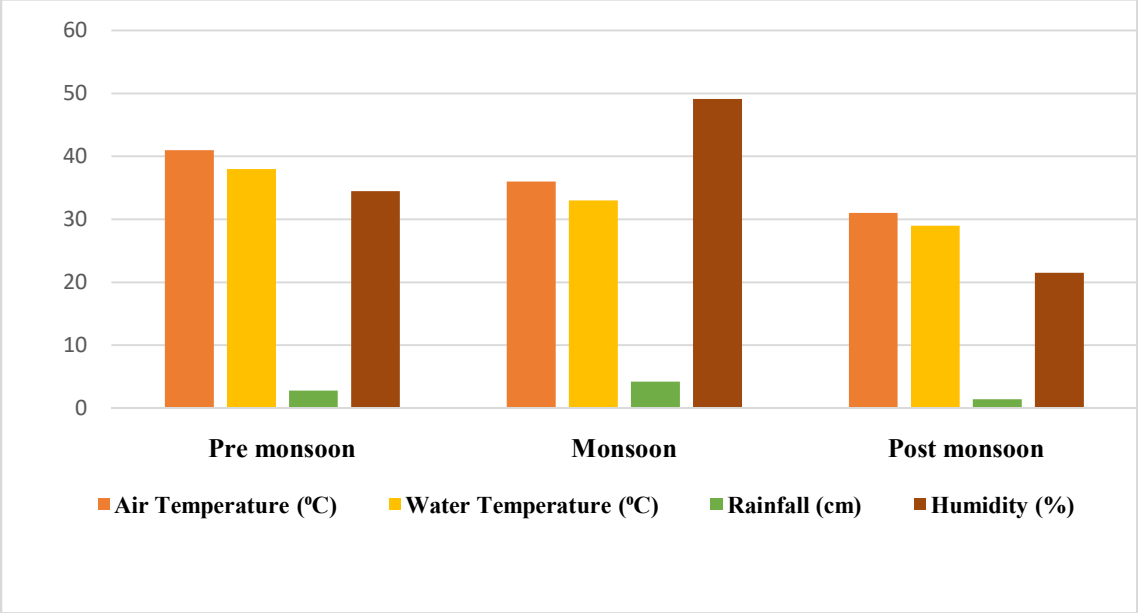

Figure 3: Comparative Bar showing weather condition

Table 3: Correlation between different weather parameters

	A	B	C	D
A	1			
B	1	1		
C	1	1	1	
D	1	1	1	1

Table 4: Physical parameters showing seasonal wise water quality of Harabhanga OCP

Properties	Pre-monsoon	Monsoon	Post-monsoon	Limit as per MoEF Schedule-VI Standard
pH (at 25^0C)	6.34	5.72	6.78	5.5-9.0
Total Suspended Solid (TSS) i.e. pollutants	4.1	7.6	5	100
Dissolved Oxygen (DO)	5.6	6.23	4.07	-
BOD	42.1	60.3	50	30
COD	250.65	232.23	277.76	250
Total Hardness as $CaCo_3$	119.42	139.2	123.76	-
Total Alkalinity as $CaCo_3$	102.7	99.5	106	-

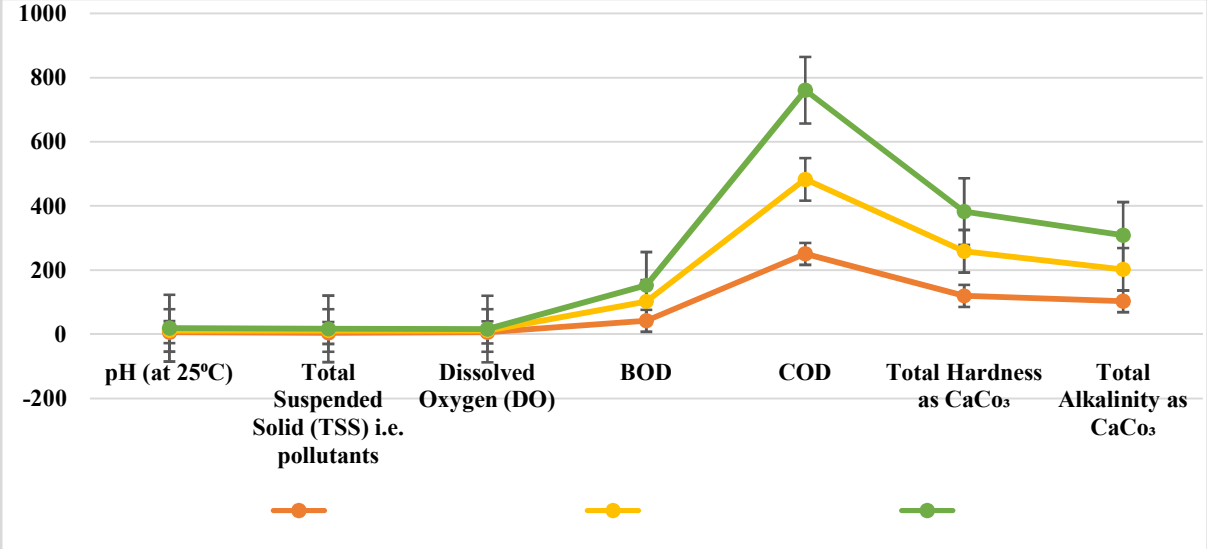

Figure 4: Line graph showing seasonal variation of water quality

Table 5: ANOVA (One way) on water parameters of Harabhanga OCP

ANOVA						
Source of Variation	***SS***	***df***	***MS***	F_{obs}	***P-value***	***F crit***
Between Groups	**1150.54075**	**3**	**383.5136**	**0.042034**	**0.988173**	**3.098391**
Within Groups	**182478.922**	**20**	**9123.946**			
Total	**183629.4628**	**23**				

Notes: SS = Sum of Squares, df = Degree of Freedom, MS = Mean Sum of Squares, F_{obs} = Observed F, P- value = Probality, F_{crit} = Critical F.
Source: Authors

DISCUSSION

Geo climatically the area is under tropical region, where summer season is hot and dry, monsoon season is experiencing huge rainfall and winter season is cold and dry. As per data **(Table 2)** taken from Panagarh and Asansol weather station, we have been seen that there is interdependent weather parameters, which may control all geomorphic process and hydro-climatic condition as well as physical environment of that area. Temperature becomes the highest in summer with an average at 41^0C and gets maximum value at 47^0C. Average humidity is observed 34% approximately. Rainfall volume is 2.8 cm in summer time or pre monsoon. Monsoon season is become hot and humid with excessive rainfall (4.2 cm). Humidity reach at 49% level with an average temperature reach at 36^0C. Due to presence of moderate vegetation cover, humidity will increase with an increase of evapotranspiration. Post monsoon season received less amount of rainfall (1.4 cm on an average) and therefore, it simply indicates the dry winter season. Western disturbance is also occurs during this season.

There is a direct relation in between air temperature and water surface temperature, as we know that both are directly connected with each other. Solar radiation is directly coming through the air and as a result of it, air became heated. It is also heated due to radiation of heat from surface both land and water. As the time span of heat holding and releasing capacity is very low in water, so water takes more time to become heated than air. But water temperature is also high in pre monsoon and low in post monsoon like as air. Correlation **(Table 2)** is also computed to know the inter dependency among different climatic variables and in all cases the correlation value is 1, i.e. <0.5. So, it is showing the positive correlation among several weather parameters. It means that all climatic parameters, like temperature, rainfall and humidity are directly interdependent to each other. When the amount of rainfall is heavy, then excessive amount of waste materials are flow through this runoff and the physical properties of water become affected. Basically, it has been observed that the water quality also season dependent. Due to high evaporation rate in summer season,

large proportion of water will going into the air. The volume of water is also decreases. Therefore, water quality may differ in various season with precipitation rate.

On the other hand, low precipitation rate in post monsoon season is also creating the same condition. But in monsoon, diversity and richness of water quality parameters, become high. So water quality may largely affect during monsoon season. Various physical parameters are analysed in departmental lab after getting the water sample from study site. The major indicators like as TSS, DO, pH, COD, BOD, TH, TA are taken into consideration for analysing water quality. MoEF Department, Govt. of India, has given permissible standard in respect of each different water parameters or indicators. All the parameters are categorised in respect of this standard limit. In case of pH, COD, TA monsoon wise variation is as

Post Monsoon > Pre Monsoon > Monsoon

Whereas TSS, DO, BOD, TH values may vary in different season as

Monsoon > Post Monsoon > Pre Monsoon

Like graph is also showing a clear view on the season wise deviation of different water parameters. In all monsoon COD, BOD, TH, TA rate are high. But pH level, TSS, DO, Level is slightly near about in all seasons. Specifically, it is argued that, the inner deviation rate is low in these cases.

ANOVA is also analysis to know significant level among different water parameters (variable). Through this method it is found that "F" Value is less than "F Critical" value. That means there are no significant differences. It may also be pointed that there is no such differences are observed to find out the interrelationship between seasons and water parameters and between different water properties. This study further shows that water parameters are directly influenced by various seasons. Interrelation among water parameters and seasons are found positive.

Sustainable Measures

Mining activity may create resource and several opportunities of employment in these areas, but simultaneously it's resulting to massive environmental exploitation, disruption and destruction of traditional values in the local society. Here, we are trying to describe some measures to reduce the environment related problems of these areas including the improvement of pit water quality through artificial treatment methods. Massive deforestation, neutralization of acidity, conservation of topsoil has to implement to reduce the problem **[8-12] (Figure 5)**.

The village is extended about 262.7 hectares. Harabhanga has a total population of 1,907 peoples. There are about 348

houses in Harabhanga village. As per 2019 stats, Harabhanga villages come under Asansol Dakshin assembly & Asansol parliamentary constituency **(Figure 6)**.

Figure 5: Fishing activity at Harabhanga OCP

Figure 6: Household activity at Harabhanga OCP

Support for alternative livelihood options can broaden the focus of restoration goals from simple landscape restoration **[13, 14]**. Related to the above, to improve the economic sustainability, supporting agricultural livelihoods and expanding access to portable water could be priority restoration goals. Improving access to new agricultural land (especially in resettled communities), encouraging the youth to go into farming, and improving access to farm input to increase productivity can be some of the possible interventions.

Improving access to farm inputs so as to increase productivity will require the direct provision of seedlings and fertilizer. Enhancing the interest of youth in farming as a means of moving away from mining can be a long-term goal which may require support and the provision of appropriate incentives from the local and national governments. Livelihood diversification can be another important restoration goal needed in all the communities as towards

the end of the mine life cycle, most mine workers are likely to lose their jobs. Alternative livelihood schemes to support ex-mine workers could involve support for livestock rearing activities, cash crop production, and involvement in reforestation support programs.

CONCLUSION

The water bodies in mining areas are facing terrible problems regarding its quality deterioration, which may pose health risks to consumers if there is no reduction in contamination sources or improved the quality of water purification systems **[15, 16]**. Stakeholders such as local communities (basically agricultural labourer, mining worker, fishermen etc.), mining firms, civil society, and the government are key players to tackle the sustainability challenges that mining poses. Like an example, mining firms apart from adopting sustainable production practices during their operation, they can develop restoration goals that consider the complex and multi-faceted damages after their operations are concluded. Mining firms can contribute meaningfully to restoration efforts by moving beyond their narrow adoption of standardized tools such as CSR activities and environmental impact assessments (EIAs), to consider more significant the local environmental, social, economic, and institutional impacts of their operations **[17, 18]**.

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