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STUDIES ON PHYSICO-CHEMICAL PARAMETERS OF THE TWO COAL WASHERIES EFFLUENT NEAR DAMODAR RIVER OF DISTRICT BOKARO, JHARKHAND

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ABSTRACT

The present investigation was carried out to assess the Physico- Chemical properties of two Coal washery effluent named Moonidih Coal washery and Dugda Coal washery of district Bokaro, Jharkhand, India. Water samples were collected on monthly basis from November 2021 to October 2022. A total 1 to 10 parameters were analysed by selecting the most practicable methods available in the Standard Method for examination of water and also waste water as per APHA, 2005. The average value of selected water parameters of Moonidih Coal washery and Dugda Coal washery, the temperature was 23.14°C. -24.51°C, Electrical conductivity (EC) 1035.33-800.6 µs/cm, Dissolved Oxygen (DO) 6.47-6.17mg/L, pH 8.23-7.40, Total Dissolved Solids(TDS) 776.07-656.70 mg/L, Biological Oxygen Demand (BOD) 1.84-1.83 mg/L, Sulphate (So_4) 55.0-56.31 mg/L, Nitrate (No_3) 8.24-7.21 mg/L, Chloride (Cl^-) 78.38-72.49 mg/L, Turbidity 29.55-24.43(NTU), respectively. Pearson's correlation coefficient values show high significant positive and negative relationship ($p<0.05$ level).

According to calculated WQI, 77.59 for Moonidih Coal Washery shows very poor-quality status and 55.19 for Dugda Coal Washery shows poor quality status as per Water Quality Index rating.

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INTRODUCTION

Water, the base of life, constitute about 70% of the body weight in the living beings. (Singh *et al* 2013, Singh and Kamal 2014.). But there is only 1% of out of whole earth's water available in rivers, lakes, streams, reservoirs and groundwater is suitable for living being's consumption 2% locked in polar ice caps and 97% is in the ocean. It is estimated that around 7 billion people out of the projected 5.3 billion in the entire world will face water shortage problem and out of these 40% will suffer acute water crises. In India's case the future is a bit worse. Since we have only 2. 45%of the world's landmass, supporting 16%of the world's population and our fresh water resources doesn't exceeding 4% of the global resources Apart from availability, continuous water pollution due to disposal and other wastes are going on. Damodar river, one of the most important rivers of India, flowing across the Indian states of Jharkhand and West Bengal. It flows through the industrial towns of Chandrapura, Ramgarh, Bokaro, Jharia Dhanbad, Durgapur, etc. (Sen, P K. 1991; Chandra,S. 2003; Bhattacharya, K.2011).This river basin is credited of first Coal Mining in India in 1815(Singh, 1992). The river is quite wide and carries the effluents of several types like coal mines, coal washeries, Coke oven plants, thermal power plants, Bokaro steel plant, cement plant, different types of potential pollutants, adversely affecting the riverine ecosystem and thus degrading the water quality .(Ghosh *et al* , 1984 ;Dhar 1993 , Bell and Karr, 1993) Physico-chemical parameters of river water play vital role in river ecosystem and that are reported in various literatures. An Ecosystem's functional characteristics are determined by the interactions between physical, chemical and biological aspects. Ascertaining the quality is crucial before its use for various purposes such as drinking, agricultural and industrial uses, etc. Sargaonkar & Deshpande 2003, Khan *et al* 2003).

To see the inter relationship among the various parameters, some mathematical analysis would reflect significance of quality of water. (Hardgrave *et al.*,1994; He *et al.*, 2001). The coefficient correlation method is the statistical mathematical tool used to develop to know the relationship between the Physico -Chemical parameters or others (Brown *et al*. 1970; Bhandari and Nayal,

2008.). The coefficient correlation helps in the investigation of the existence and degree of freedom of the relationship between two or more variables (Tripathi *et al.*,2014).

Water quality index (WQI) is another statistical tool and very useful and efficient method for assessing the suitability of water for different purposes, Especially for drinking. It is also very useful method of communicating the information on all over quality of water (Asadi *et al.*2007) to the related authority. Water Quality Index was proposed by Brown and his co-workers. It converts a large number of data into a single value.

MATERIALS AND METHODS

Study area

Bokaro district is located in the Eastern part of India at 23^0 45'38.40" latitude and 86^0 3'10.66" E longitude. It is located in picture square surrounding on the Southern bank of river Damodar. The two coal washeries were selected for Physico-Chemical analysis in which one site is (Moonidih coal washery S_1), with latitude 23.7418^0 N, and longitude 86.2816^0 E and another site is (Dugda Coal washery S_2) with latitude 23.7376^0 N and longitude 86.1512 E.

Sampling and Analysis

Water samples from the two selected sampling sites were collected from November 2021 to October 2022. samples were taken in 2 litre capacity of pre closed bottles. Collection and analysis of samples were done monthly. Samples collection were done between 8 AM to 11 AM. Temperature, pH and Electrical Conductivity were measured by Thermometer, Portable conductivity and pH meter respectively.

Other parameters like Dissolved Oxygen (DO), Total Dissolved Solid (TDS) Biological Oxygen Demand (BOD), Nitrate ($NO3^-$), Chloride (Cl^-), Sulphate ($So4^-$), Turbidity were analysed according to the Standard Methods APHA-2005.

Statistical Analysis

Water Quality Index

An Instrument used to evaluate the general quality of water in a given area is the Water Quality Index (WQI). Water Quality Index (WQI) is defined as a technique of rating that provide the composite influence of individual water quality parameters on the overall quality of water (Sarkar et al 2006). Water Quality Index aims at giving a single value to the water quality of a source on the basis of one or the other system which translates the list of constituents and their concentrations present in a sample into a single value.

Water Quality Index developed by Brown and his co-workers provide an expression for the overall water quality. It is a mathematical equation used to measure and evaluate the water quality and clarify that the water is suitable for drinking and other domestic purposes or not. It takes into account a multitude of water quality parameters with reference to World Health Organisation (WHO) and Indian Standard B I S.

For the present work to fulfil the purpose of calculating Water Quality Index6.Indian standard BIS for drinking water I.S 10500 have been taken into consideration.

Table 1: - showing standards for drinking water as per mentioned BIS of WHO.

Temp		
pH	6.5 - 8.5	7.0 - 8.5
Dissolved Oxygen (DO)	4 - 6 mg/l	--
Total Dissolved Solids (TDS)	500 mg/l	500 mg/l
Electrical Conductivity (EC)	300 µs/cm	180 – 1000 µs/cm
Chlorides (CL^-)	250 mg/l	250 mg/l
Nitrate	45 mg/l	50 mg/l
Sulphate	250 mg/l	250 mg/l
Turbidity	5 NTU	5 NTU

For the calculations of WQI, three steps have been taken.

Step -1 To calculate Wn means unit weight factors for each parameter following equation was used

$Wn=k/sn$

Where

Wn is the unit weight for the n^{th} parameters.

Sn is the Standard Value of the n^{th} parameters

K is the constant proportionality

$k=1/1/s1+1/s2+1/s3+1/s4.....1/sn$

$1/\Sigma 1/sn$

Step-2. To Calculate Sub index (Qn) value, the equation is given below

$Qn=[(Vn-Vi)/(Sn-Vi)]$

Where

Qn is the sub index of n^{th} parameter

Sn is the standard value (I S 10500) for the n^{th} parameter

Vi is the ideal value for each parameter in pure water.

Vi of pH is 7 and Vi of DO is 14.6. Generally, Vi is 0 for other parameters.

Step 3-Finally, WQI is calculated as

$=\Sigma WnQn$

Overall $WQI=\Sigma WnQn/\Sigma Wn$

Where

Wn is the unit weight for the n^{th} parameter.

Qn is the sub index of n^{th} parameter.

Table2: Showing Seasonal variation in physico-chemical parameters of two selected coal washeries effluents near Damodar River during November 2021 to October 2022

	Moonidih Coal washery(S_1)			Dugda coal washery (S_2)		
Parameters	Range (Min-Max)	Mean	Standard Deviation	Range (Min-Max)	Mean	Standard Deviation
Temperature(^{0C})	17.23-33.21	23.14	5.197	17.43-38.04	24.516	4.823
pH	7.21-8.98	8.23	0.412	6.94-8.02	7.401	0.315
EC(µs/cm)	923-1239	1035.33	94.057	589.-1057	800.66	148.690
Sulphate(mg/L)	50.92-64.62	55.001	4.5888	50.21-65.64	56.315	4.553
Nitrate(mg/L)	5.31-12.68	8.247	2.664	3.01-10.98	7.219	2.553
Cl- (mg/L)	62.89-105.96	78.385	12.620	53.01-94.01	72.490	13.873
TDS (mg/L)	551.96-1153.80	776.070	194.639	483.41-916.24	656.70	142.286
Turbidity (NTU)	24.11-34.61	29.555	2.798	18.34-32.43	24.432	4.312

DO (mg/L)	4.01-8.84	6.476	1.621	4.03-8.01	6.179	1.399
BOD (mg/L)	1.46-2.23	1.84	0.237	1.32-2.23	1.834	0.281

Pearson's Correlation Coefficient

Pearson Co efficient Correlation determines the relation between two variables, depending upon the Correlation Coefficient expressed as r. The correlation coefficient values vary from +1 to −1, indicating varying interdependence. The r> 0.7 indicates a strong correlation between the variables (Shil *et al* 2019, Ravi *et al*; 2021) The correlation is perfectly positive if the value (r) is +1 and correlation is perfectly negative If the value (r)is -1 and there is no correlation between the two variables, if the value (r)is 0.(Rodgers &Nice wander, 1998 and Magroliya *et al*; 2018).

The Karl Pearson's Correlation Coefficient (r) was calculated by using this equation (Zaidi and Pal 2015, Karmakar and Singh, 2021).

$r = (n (\Sigma xy) - (\Sigma x) (\Sigma y)) / (\sqrt{} [n \Sigma x2 - (\Sigma x)2] [n \Sigma y2 - (\Sigma y)2)$

Where

r = Pearson Coefficient

n = number of total observations

x& y =Two different variables

Σxy = sum of products of the variables

Σx = sum of the x variable in a sample

Σy= sum of the y variable in a sample

$\Sigma x2$ = sum of the squared x variable

$\Sigma y2$ = sum of the squared y variable

The correlation coefficient analysis was done in the study to know the relationship between the variables means various physico-chemical parameters used to indicate the quality of water (Kumar *et al*. 2005; P.Lilly Florece et al,2012).

In this study, Water Quality Index and Pearson correlation coefficient method were used as statistical tools to examine the physico-chemical parameters of the selected samples.

RESULTS AND DISCUSSION

Various Physico-Chemical parameters were analyzed with the help of statistical tools of two coal washery effluents and got the result.

Temperature

Temperature is one of the most important parameters to analyse the characteristic of waters. It controls the self-purification of water bodies pH and DO has a direct relation with the temperature. Temperature ranged between 17^{0C} to 33.21^{0C} in S_1 and 17^{0C} to 33.04^{0C} in S_2.

Maximum temperature was in the month of June and minimum during December in S_1 and January in S_2.

In S_1, temperature showed high significant positive relationship ($p<0.05$ level) with EC (r=0.97), TDS (r=0.989), SO_4-(r=0.959), pH(r=0.6425), NO_3- (r=0.0656), Cl-(r=0.963), BOD (r=0.606). whereas Turbidity (r=-0.279), DO (r=-0.928) shows negative relationship at $p<0.05$ level.

In S_2, temperature showed high significant positive relationship ($p<0.05$ level) with EC (r= 0.774), TDS (r=0.7262), SO_4-(r=0.877), pH(r=0.8375), NO_3- (r=0955), Cl-(r=0.9634), BOD (r=0.6064). whereas Turbidity (r=-0.902), DO (r=-0.947) shows negative relationship at $p<0.05$ level.

pH

PH means potential of Hydrogen is the parameter of to measure the acidic or basic nature of any aqueous solution. Extremely acidic or alkaline, both are problems to the ecosystem. The pH ranged from 7.21 to 8.98 in S_1 and (Moonidih coal washery) and from 6.94 to 8.02 in S_2 (Dugda coal washery). Maximum pH was recorded during summer and minimum during winter season.

In S_1 pH shows significant positive relationship ($p<0.05$ level) with EC (r=0.659), TDS (r=0.637), SO_4-(r=0.5702),NO_3- (r=0.643) ,Cl-(r=0.697),BOD (r=0.5607), Turbidity (r=-0.279), where pH shows negative relationship with DO (r=-0.6869) at $p<0.05$ level.

In S_1 pH shows high significant positive relationship ($p<0.05$ level) with EC (r=0.8656), TDS (r=0.8185),SO_4-(r=0.8425),NO_3- (r=0.7986) ,Cl-(r=0.97),BOD (r=0.663).whereas Turbidity (r=-0.7271),DO (r=-0.8381) shows negative relationship at $p<0.05$ level.

EC

Electrical conductivity or (EC) shows the ability of the water to conduct electrical current. The quantity of conductive ions presents in the water have significant impact on conductivity. In the present study, EC were found ranging from 923 to 1239 in S_1 and 589 to 1057 in S_2. Maximum EC was recorded during summer season.

In S_1 EC shows high significant positive relationship ($p<0.05$ level) with TDS (r=0.98), SO_4-(r=0.9775), NO_3- (r=0.9011), Cl-(r=0.9906), BOD (r=0.5764). whereas Turbidity (r=-0.362), DO (r=-0.8606) shows negative relationship at $p<0.05$ level.

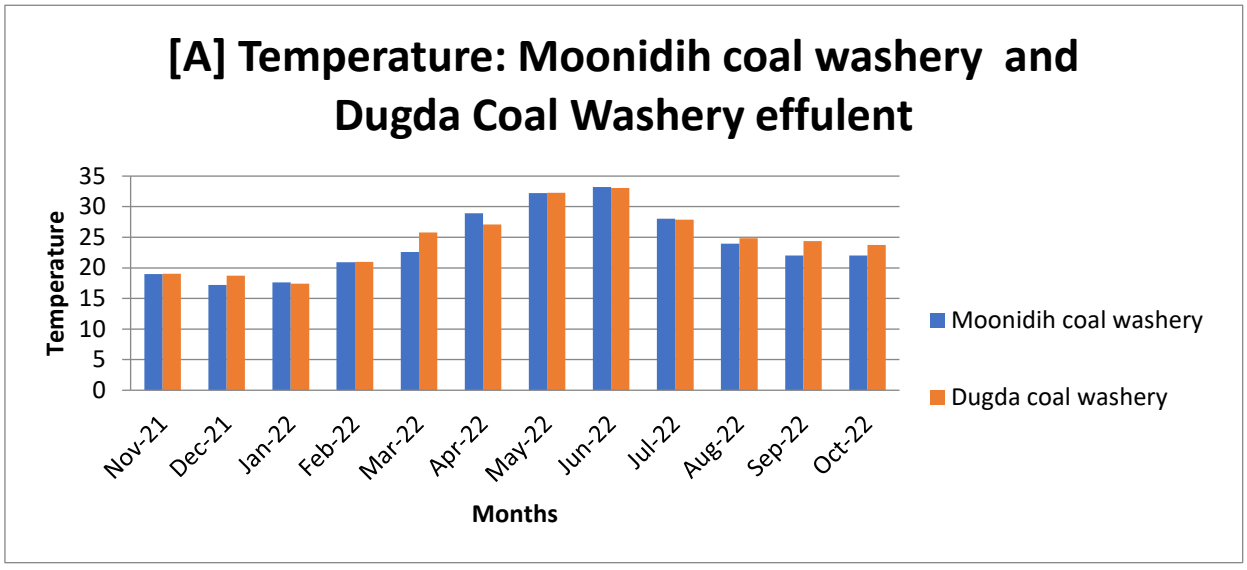
In S_2 EC shows high significant positive relationship ($p<0.05$ level) with TDS (r=0.9517), SO_4-(r=0.9963),NO_3- (r=0.9451) ,Cl-(r=0.9275),BOD (r=0.6535).whereas Turbidity (r=--09379),DO (r=-0.9714) shows high negative relationship at $p<0.05$ level.

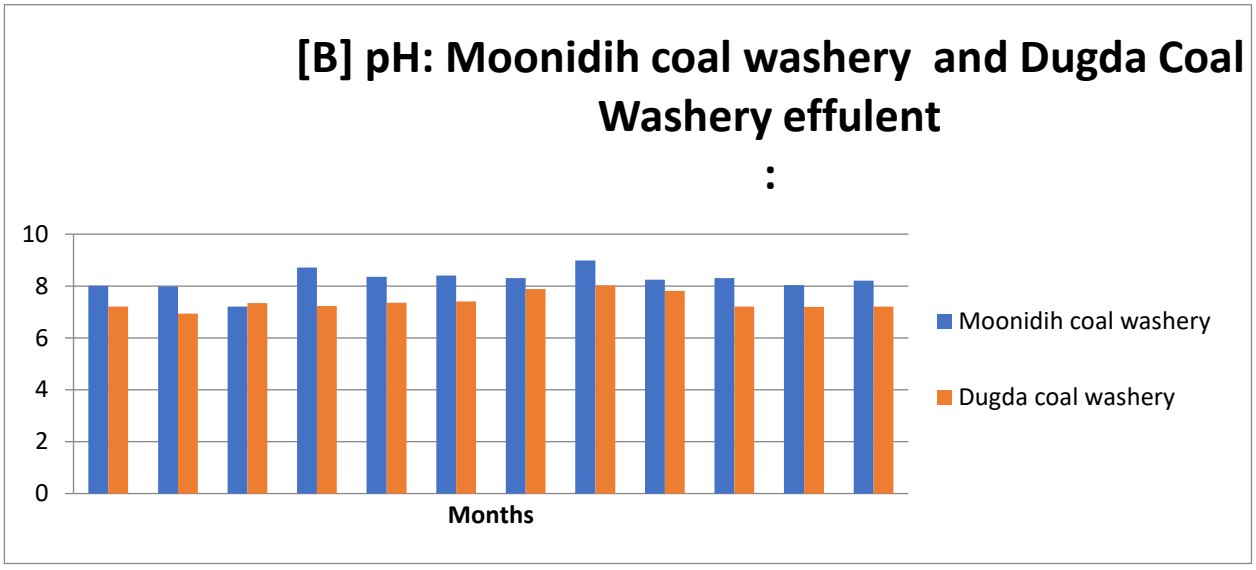
SO_4

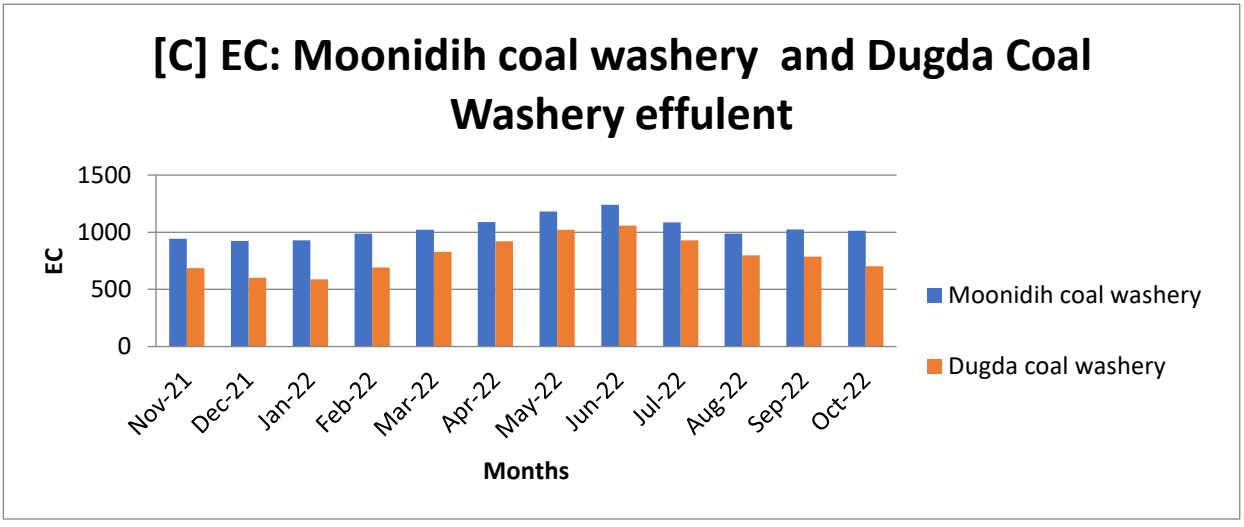
Sulphate occurs in natural water and in waste water. The high concentration of Sulphate in natural water is usually caused by leaching of natural deposits of sodium Sulphate (Glauber's salt) and magnesium Sulphate (Epson Salt). In the present study So4 ranged from 50.74 mg/L to 64.62 mg/L in S_1 and from 50.21mg/L to 65.64mg/L in S2.

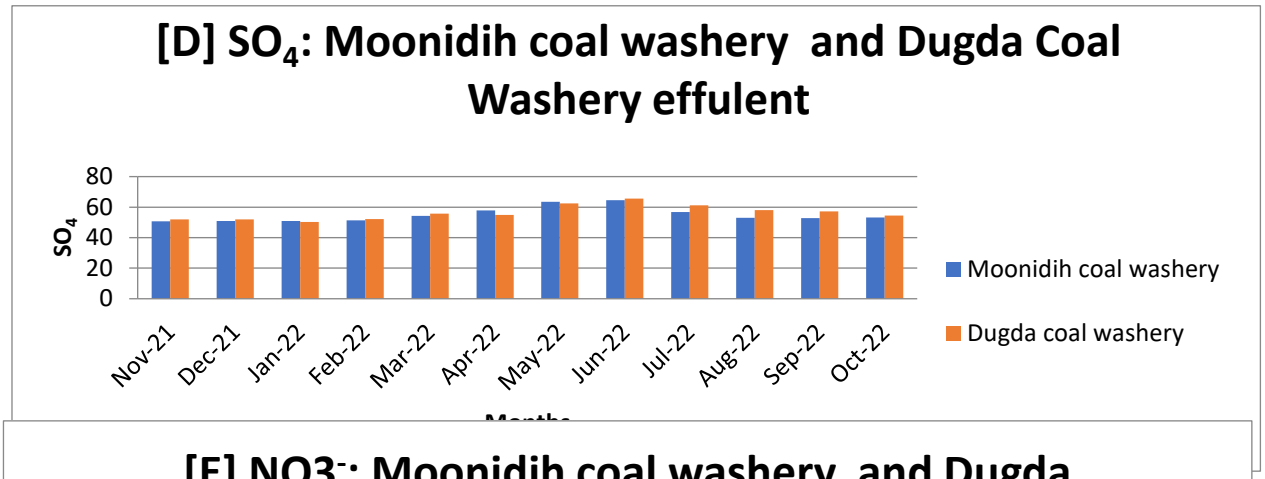
In S_1 So4 shows significant positive relationship ($p<0.05$ level) with EC (r=0.97), TDS (r=005475), No3 (r=0.4397), Cl-(r=0.5869), BOD (r=0.408), Turbidity (r=-0.0763). DO (r=-0.4677) shows negative relationship at $p<0.05$ level.

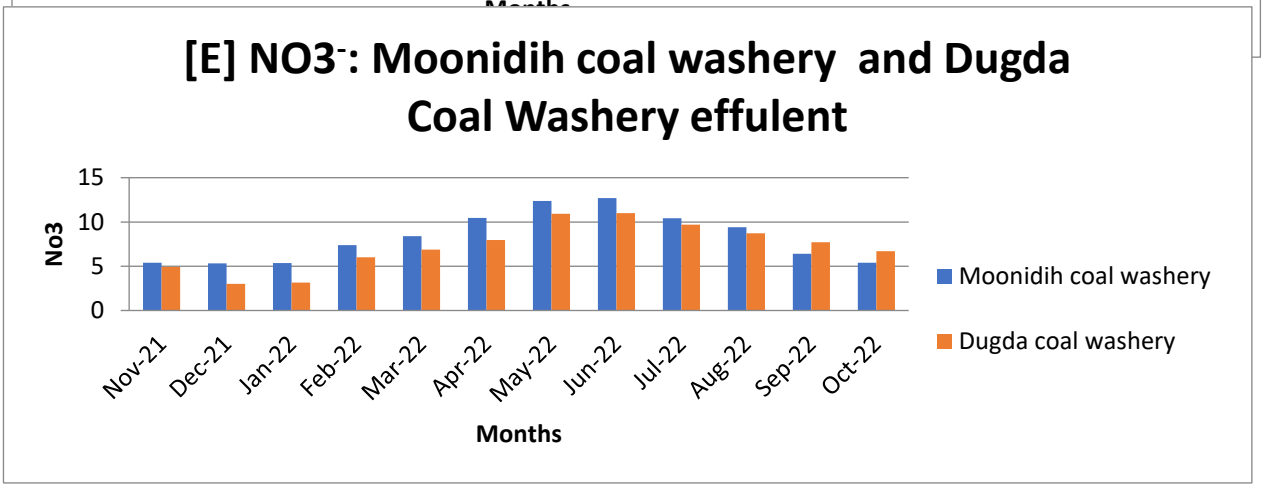
In S_2 So4 shows positive relationship ($p<0.05$ level) with EC (r=0.97),TDS (r=0.9429), No3 (r=0095) ,Cl-(r=0.9474),BOD (r=0.4269).whereas Turbidity (r=-0.8406) DO (r=-0.8293) shows negative relationship at $p<0.05$ leve

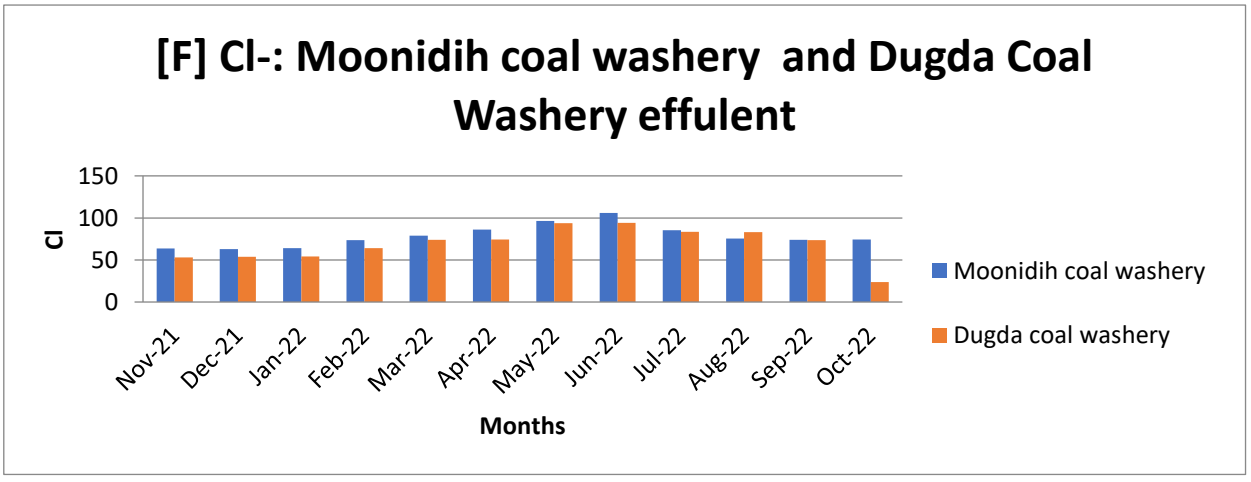

[A] Temperature: Moonidih coal washery and Dugda Coal Washery effulent
Temperature
35
30
25
20
15
10
5
0
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Months
Moonidih coal washery
Dugda coal washery


[B] pH: Moonidih coal washery and Dugda Coal Washery effulent
:
10
8
6
4
2
0
Months
Moonidih coal washery
Dugda coal washery


[C] EC: Moonidih coal washery and Dugda Coal Washery effulent
EC
1500
1000
500
0
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Months
Moonidih coal washery
Dugda coal washery


[D] SO4: Moonidih coal washery and Dugda Coal Washery effulent
SO4
80
60
40
20
0
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Moonidih coal washery
Dugda coal washery


[E] NO3-: Moonidih coal washery and Dugda Coal Washery effulent
No3
15
10
5
0
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Months
Moonidih coal washery
Dugda coal washery


[F] Cl-: Moonidih coal washery and Dugda Coal Washery effulent
Cl
150
100
50
0
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Months
Moonidih coal washery
Dugda coal washery

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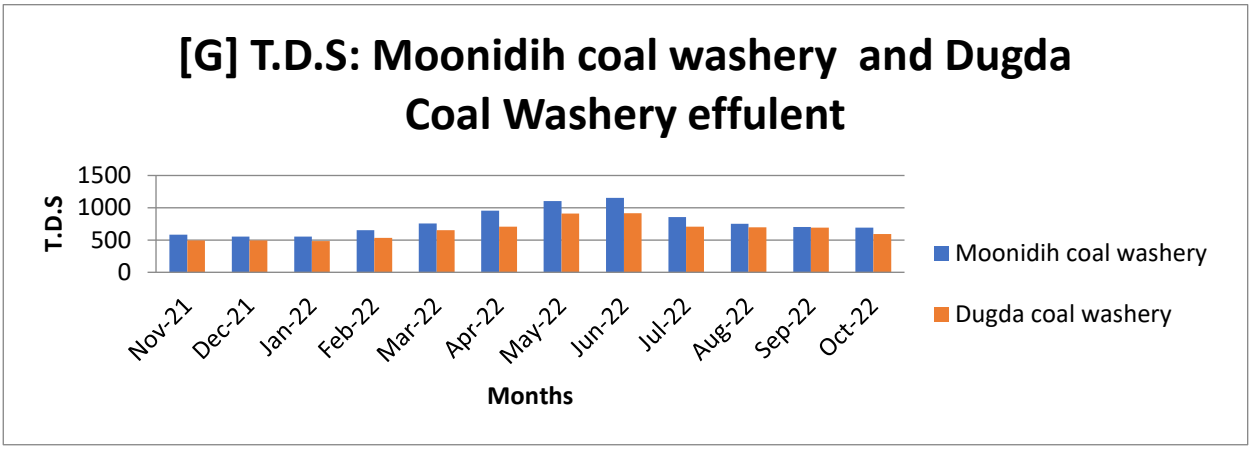
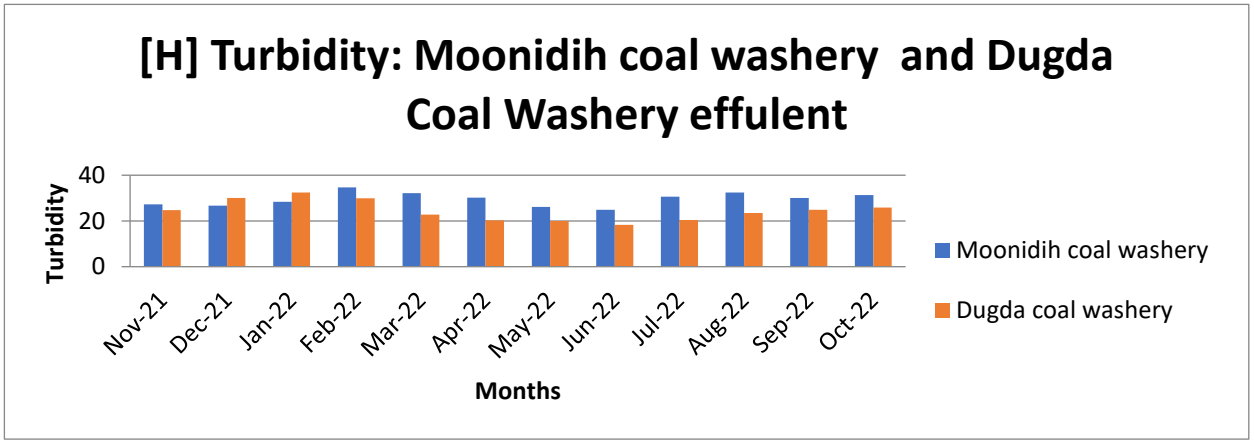
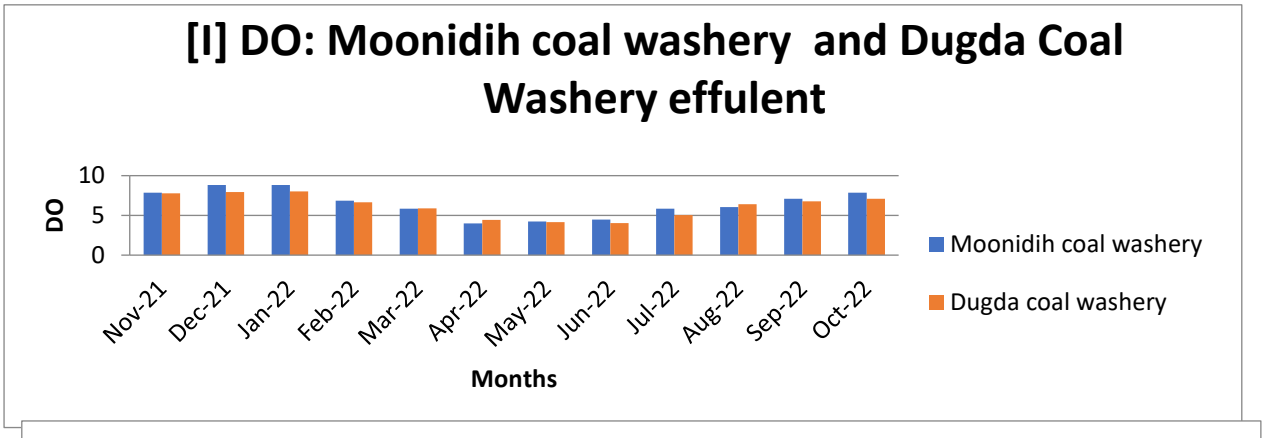

[G] T.D.S: Moonidih coal washery and Dugda Coal Washery effulent
T.D.S
1500
1000
500
0
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Months
Moonidih coal washery
Dugda coal washery


[H] Turbidity: Moonidih coal washery and Dugda Coal Washery effulent
Turbidity
40
20
0
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Months
Moonidih coal washery
Dugda coal washery


[I] DO: Moonidih coal washery and Dugda Coal Washery effulent
DO
10
5
0
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Months
Moonidih coal washery
Dugda coal washery

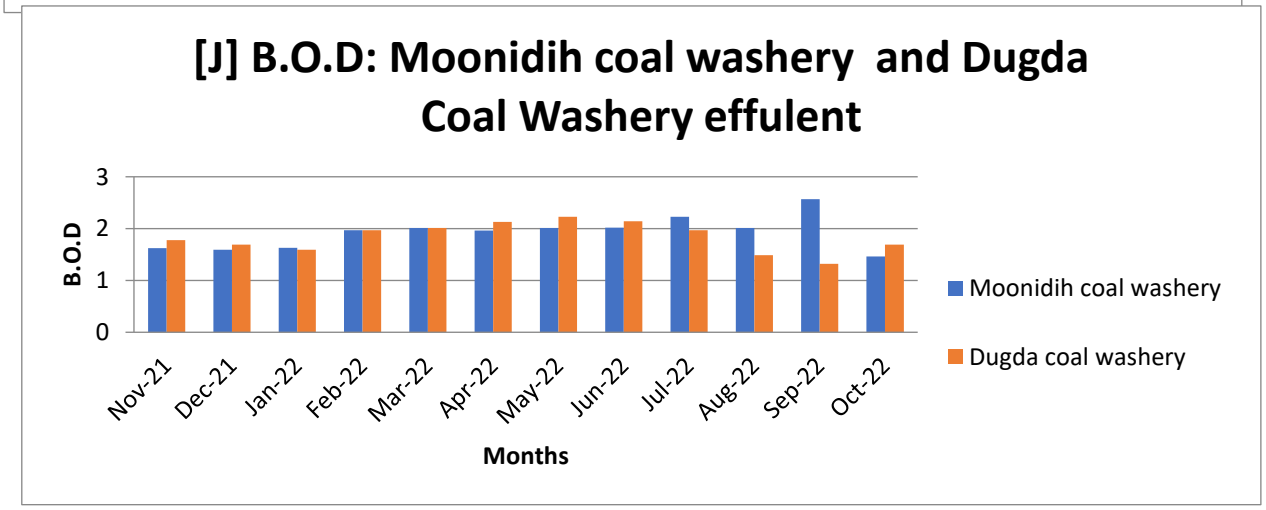

[J] B.O.D: Moonidih coal washery and Dugda Coal Washery effulent
B.O.D
3
2
1
0
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Months
Moonidih coal washery
Dugda coal washery

Figure 1: Comparative graphical represtation of monthly variations in the Physico-Chemical Parameters of two selected Coal Washeries [Moonidih Coal Washery(S1) and Dugda Coal Wahery (S2)] viz., [A] Temperature; [B] pH; [C] Electrical Conductivity (EC); [D] Sulphate (SO_4^-); [E] Nitrate (NO_3^-); [F] Chloride (Cl^-); [G] Total Dissolved Solids(TDS); [H] Turbidity; [I] Dissolved Oxygen(DO); [J] Biochemical Oxygen Demand.

Nitrate is one of the waters contaminates that mainly results from anthropogenic activity. The major resources are human or animal waste, sewage system, industrial waste, fertilizer application etc. In the present study NO_3^- ranged from 5.31 to 12.68 in S_1 and from 3.01 to 10.98 in S_2.

In S_2 NO_3^- shows high significant positive relationship ($p<0.05$ level) with TDS (r=0.9483(, Cl-(r=0.9347(, BOD (r=0.8279). whereas Turbidity (r=-0.2901), DO (r=-0.8882) shows negative relationship at $p<0.05$ level.

In S_2 NO_3^- shows significant positive relationship ($p<0.05$ level) with TDS (r=0.9329), Cl-(r=0.9029), BOD (r=0.4494). whereas Turbidity (r=-0.8657), DO (r=-0.879) shows negative relationship at $p<0.05$ level.

Chloride

Chlorides are widely distributed in nature as salts of sodium (NaCl), potassium (KCl) and calcium (cacl2). Chlorides are leached from various rocks into the soil and water by weathering. The presence of a significant amount of organic matter with both allochthonous and autochthonous origin may be the cause of the elevated chloride concentration.

In the present study cl ranged from 62.89 to 105.96 in S_1 and from 53.01 to 94.01 in S_2.

In S_1 Cl- shows positive relationship ($p<0.05$ level) with TDS (r=0.9832), BOD (r=0.6498) whereas Turbidity (r=-0.2901), DO (r=-0.8882) shows negative relationship at $p<0.05$ level.

In S_2 Cl- shows significant positive relationship ($p<0.05$) with TDS (r=0.9643), BOD (r=0.4542). whereas Turbidity (r=-0.8366),DO (r=-0.8858) shows negative relationship at $p<0.05$ level.

Table 3: Corelation Matrix (Pearson's correlation method) among physico- chemical parameters of Moonidih Coal Washery (S_1).

	Temp	pH	E C	SO_4-	NO_3	Cl^-	T-D-S	Turbidity	D.O	B.O.D
Temp	1									
pH	0.6425	1								
E C	0.97	0.6595	1							
SO_4-	0.9598	0.5702	0.9775	1						
NO_3	0.9561	0.6435	0.9011	0.4397	1					
Cl^-	0.9743	0.6976	0.9906	0.5869	0.9347	1				
T-D-S	0.9897	0.6378	0.98	0.5475	0.9483	0.9832	1			
Turbidity	-0.2792	0.1237	-0.362	0.0763	-0.2094	-0.2901	-0.3447	1		
D.O	-0.928	-0.6869	-0.8606	-0.4677	-0.9386	-0.8882	-0.9216	0.2724	1	
B.O.D	0.6632	0.5607	0.5764	0.408	0.8279	0.6498	0.6288	0.1734	0.0632	1

Table 4: Corelation Matrix (Pearson's correlation method among physico- chemical parameters of Dugda Coal Washery(S_2)

	2	pH	E C	SO_4-	NO_3	Cl^-	T-D-S	Turbidity	D.O	B.O.D
Temp	1									
pH	0.8375	1								
E C	0.9774	0.8656	1							
SO_4-	0.8774	0.8425	0.9063	1						
NO_3	0.9553	0.7986	0.9451	0.95	1					
CT	0.9634	0.7918	0.9275	0.9474	0.9209	1				
T-D-S	0.7262	0.8185	0.9517	0.9429	0.9329	0.9643	1			
Turbidity	-0.9023	-0.7271	-0.9379	-0.8406	-0.8657	-0.8366	-0.5301	1		

D.O	-0.9474	-0.8381	-0.9714	-0.8293	-0.879	-0.8858	-0.9025	0.8763	1	
B.O.D	0.6064	0.683	0.6535	0.4296	0.4494	0.4542	0.5055	-0.5595	-0.74	1

TDS

Total Dissolved Solids demonstrates just the measure of distinct disintegrated solids. It is mainly due to vegetative decay, evaporation and disposal of effluents etc.

In the present study TDS ranged from 551.96 to 1153.80 mg/L in S1 and from 483.41 to 916 mg/L in S_2.

In S_1 TDS shows negative relationship at ($p<0.05$ level) with Turbidity ($r=-0.3447$), DO ($r=-0.9216$) whereas positive relationship with BOD ($r = 0.6288$) at ($p<0.05$ level).

In S_2 TDS shows negative relationship at ($p<0.05$ level) with Turbidity ($r=-0.5301$), DO ($r=-0.9025$) and BOD ($r =- 0.5595$).

Turbiity

Turbidity in water is the reduction of transparency due to presence of particular matter, such as clay or slit, finely divided organic matter etc.

In the present study Turbidity ranged from 24.91 NTU to 32.12 NTU in S_1 and from 18.34 NTU to 32.43 NTU in S_2.

In S_1 Turbidity shows positive relationship at ($p < 0.05$ level) with DO ($r = 0.2724$), BOD ($r = 0.1734$). In S_2 Turbidity shows positive relationship at ($p< 0.05$ level) with DO ($r =0.8763$) and negative relationship at ($p < 0.05$ level) with BOD ($r =-0.5595$).

Table 5: Calculated WQI (Water Quality Index) for the two Coal Washery i.e |Moonidih Coal Washery(S1) and Dugda Coal Washery (S2).

	Parameter	BIS STD (Sn)	K=1/1/Sn	Wn=K/Sn	QN=Vn/Snx100	WnQN
Moonidih Coal Washery (S_1)	pH	8.5	2.463847	0.289864	82	23.768848
	DO	5	2.463847	0.492769	100.84	49.69082596
	EC	300	2.463847	0.008213	345.11	2.83438843
	TDS	500	2.463847	0.004928	155.214	0.764894592
	SO_4	250	2.463847	0.009855	22	0.21681
	Cl-	250	2.463847	0.009855	31.354	0.30899367
	NO_3	45	2.463847	0.054752	18.32	0.0100305664
						WnQn= 77.597817292
Dugda Coal Washery (S_2)	pH	8.5	2.463847	0.289864	26.73	7.74806472
	DO	5	2.463847	0.492769	87.718	43.224711142
	EC	300	2.463847	0.008213	266.88	2.19188544
	TDS	500	2.463847	0.004928	131.34	0.64724352
	SO_4	250	2.463847	0.009855	22.526	0.2199373
	Cl	250	2.463847	0.009855	28.996	0.28575558
	NO_3	45	2.463847	0.054752	16.022	0.8772336544 WnQn=55.194815078

Table 6: Categories for Water Quality Status developed by Brown *et al.*,1972

Water Quality Index	Water Quality Status	Possible application
0-25	Excellent	Drinking, Irrigation and Industrial
26-50	Good	Drinking, Irrigation and Industrial
51-75	Poor	Irrigation and Industrial
76-100	Very Poor	Irrigation
>100	Unfit for consumption	Proper treatment required before use

D O

Dissolved oxygen (DO) plays an important role in the growth, survival, behaviour, dispersion and metabolic process of fishes and other aquatic organism. The desirable limit of DO according to standard method BIS ranges from 4 to 6mg/L.

Here DO ranged from 4.01 to 8.83 mg/L in S_1 and from 4.16 to 8.01 mg/L in S_2.

In S_1 DO shows positive relationship ($p<0.05$ level) with BOD ($r= 0.0632$) and it shows negative relationship with BOD ($r=-o.748$) in S_2.

BOD

It is a measure of the quantity of oxygen consumed by microorganisms during the composition of organic matter.

In the present study BOD ranged from 1.46 to 2.23 in S_1 and from 1.32 to 2.23 in S_2.

RESULTS

WQI

WQI (Water Quality Index), which are used to know the quality status of any aquatic Ecosystem. WQI is computed in a few steps and got the result.

Calculated WQI indicates that both the sampling sites fall under very poor and poor categories at developed by Brown et al, 1972. Moonidih coal washery shows 77.59 WQI value which is higher than Dugda coal washery WQI value that is 55.19.

Water Quality Index is a numerical representation of the overall water quality suitable for various purposes. AS a result, we can see that both the sites (S1-Moonidih Coal washery and S2 – Dugda coal washery effluents) were not suitable for drinking and other purposes. Also, and it is not suitable for aquatic animals to survive. It is necessary to do proper treatment for its use in different purposes.

CONCLUSION

The present investigation provides an overall picture on the water quality status of the two coal washe effluent near Damodar River viz Moonidih coal washery (S1) and Dugda coal washery (S2) with the help of various physico- chemical analysis and statistical tools like WQI and Pearson 's coefficient correlation method.

Analysis of monthly variation sanctioned in the physico- chemical parameters such as Temperature, pH,EC,TDS, So4, No3, Cl-, BOD, DO,Turbidity were found to be in higher concentration compare to permissible limit WHO 2006 in both the sites ,but it was higher in S1 (Moonidih coal washery).

WQI shows very poor to poor quality status of S1 and S2 respectively.

So, on the basis of the above results, it can be concluded that with proper treatment and regular water monitoring by competent authorities can improve the water quality and river water can be utilised for different purposes, and it should be beneficial for the local people living there nearby.

REFERENCES

- APHA.AWWA and WEF,2005 Standard Methods for the Examination of Water and Waste water.,21st ed. *American Public Health Association, Washington*. D.C.
- K Pandit, Freshwater Ecosystem of Himalaya, Parthenon *Publishing,* London, *UK*,1999.
- Bardalo,A.A. W.Nilsumranchit. and K.Chalermwat., water quality and uses of Bangpakong river (Eastern Thailand), *Water Research*, 2013.5(15),3635-3642.
- Bell F C.and Kerr A. (1993). Coal mining and water quality with illustration from Britain page 607 - 614 ., *Env-Management ,Geo - water of Engineering Aspects* .Chaudhary and Shiv Kumar(eds).Balkema, Rotterdam, ISBN 90 54100990.
- Burden F. R., Kelvie M. C.I., Forestner. U.and Guenther A. *Environmental Monitoring Handbook, Mc Grow -Hill Handbooks,* New York, 2002;3.1-3.21.
- Brown, R.M., Mc Clelland, N.I., Deininger,R.A and Tozer,R.G. 1970. A Water Quality Index-Do We Dare?.Water and Sewage Works.339-343.
- Dhar, B B. (1993). Environmental Scenario of Indian Mining industry, Env- Management, Geo water and Engineering Aspects, Choudhary and Shiv Kumar (eds). Balkema, Rotterdem ISBN90 54100990.
- Ghosh S.K,Singh T.P.N. and Tiwary R.K (1984) Quality of mine waters in Jharia Colfield.*IAWPC tech Annual;* xi, 25-28.
- Giri S. Singh A.K (2104) Assessment of surface water quality using heavy metal pollution Index in Subabarekha River,India *Water Quality Expo Health* 5(4):173-182.
- Gurdeep Singh (1988) Impact of Coal mining on Water Quality, *International Journal of Mine Water,*7(3), pp.49-59.
- Horton R. (1965) An Index number System for rating water *quality [J]. Research Journal of Water Pollution Control Federation*. 37,300-305.
- IS :10500, Bureau of Indian Standards, Standards for drinking water ,2012.
- Karmakar B and Singh, M.K.2021. Assessment of water Quality sQureatus of Water Bodies using Water Quality Index and Correlation Analysis in and around Industrial Areas of West District, Tripura, India. *Nature Environment and Pollution Technology,* 20(2): 551-559.
- Kumar,R.,Singh, R.D.,Sharma, K.D.,water resources of India, *Current Science* ,2005,89,794-801.
- Leo M.L.and Dekkar M. *Handbook of Water Analysis Marcel Dekker, New York,* 2000,1-25,115-117,143,175,223-226,26+,273,767.
- Mishra, S and Singh, P. 2021. Studies on the Physico-chemical parameters and Correlation Coefficient of Govindgarh Lake, Rewa (MP.) *International. J.Advanced Academic Studies.* 3(2):34-38.
- Naik.S.and Purohit, K.M., Studies on Water Quality of River Brahmani in Sundargah District, Orissa, *Indian Journal of Environment and Ecoplanning*,200, vol.5(2),397-402.
- Qureshimatva, U.M., Maurya, R.R., Gamit, S. B. Solanki, H.A.2015. Studies on Physico- chemical parameters and Correlation Coefficient of Sarkhej Roza Lake, District Ahmedabad, Gujarat, India. J. *Environment and Analytical Toxicology*.5(4).
- Ramkrishnaiah.S.,and Sri,Y.Babu Rao., Environmental and water quality studies in A P State- A Case Study 1991.
- Ray M and Pal S, (2021) Study of aquatic biodiversity and correlation within physical parameters of Jalangi river. European *Journal of Biological Research* 2021;11(21):212-216.
- Ray M, Ghati A,Pant H, Negi S, and Joshi H. C ,(2021), Comparison of water quality between upper and delta course of river Ganga during winter 2021. *Journal of Science and Technological Researches* 2021, 3(2): 216-221.
- Ray M, (2021) Comparison of physico -chemical parameters of river Bhagirathi, Jalangi and Churni within Nadia, WB during 2020-2021. *Journal of Science and Technological Researcher* 2021,3(3),1-8.
- Saikh N.and Yeragi S.G. Seasonal Temperature changes and their influence on free Carbon Dioxide, Dissolved oxygen and pH in Tansa,Thane District Maharashtra *Journal of Aqua Bio,*2003; 18: 73-75.
- Singh, A.., Mondal,G.C.,Singh, P.K.,Singh ,T.B., Tiwari, B.K .,and Sinha, A.,Aquatic Geochemistry of Dhanbad District ,Coal City of India. Source Evaluation and Quality Assessment *Journal Geological society India*,2007, v69, pp.1088-1102.
- Singh G. Kamal R.K (2014) Application of water quality index for assessment of surface water quality status. *Our world Environ* 9(3)-994-1000.
- Singh, P.K.,Tiwari ,A.K .,and Mahato,M .K.., Qualitative Assessment of surface water of West Bokaro coalfield ,Jharkhand by using Water Quality Index Method .*International Journal of chem Tech Research CODEN* (USA):July-Sep 2013.
- Stambuk-Giljanovic,N., water quality evaluation by index in Dalmatia, *Water Research* 1993,33(6). 3423-3440.
- Subramanian,V.,Water: quantity- quality perspectives in South Asia ,*Kingston International Publishers limited survey* ,(2000), U.K.
- Tiwari, R. K and Dhar B. B (1994). Environmental pollution from Coal Mining activities, damodar river basin,India .*Mine Water and the environment*. June -December, issue 13pp.1-10.
- Tiwary, R. K (2001). Environmental impact of coal mining on water regime and its management. *Water Air Soil Poll* 132:185-199.
- WHO (World Health Organisation) Guidelines for Drinking Water Quality Recommendations,2006;
- Yidana S.M.and Yidana A. (2010) Assessing water quality using index and multivariate analysis *[J]. Environment Earth Science*. 59,1461-1473.