



## **IMPACT ON THE WATER DUE TO INDUSTRIAL CLUSTER OF SAMBALPUR–JHARSGUDA DISTRICT OF ODISHA**

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### **ABSTRACT**

An industrial cluster area of ~706.85 Km<sup>2</sup> of the district of Sambalpur-Jharsguda where in coal-fired thermal power plants and other small water polluting plants are located. The impact of these water polluting plants of cluster area in the surrounding have been studied by evaluating the pH, conductivity, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), total hardness, alkalinity, total coliform (TC), faecal coliform (FC). Our finding on those parameters is that they decrease with respect to distance from Segment-I to Segment-II.

**Key words:** Industrial cluster, Sambalpur-Jharsguda, Odisha

### **INTRODUCTION**

Review of literature shows that several works has been carried out to evaluate the quality of water of the power plants and the region and affected due to it<sup>1-16</sup>. In our earlier communication<sup>17</sup>, we have reported the impact on the air due to industrial cluster of Sambalpur-Jharsguda district of Odisha. In our present communication, we reported the impact on the water due to industrial cluster of Sambalpur-Jharsguda district of Odisha. The Kherual (84<sup>0</sup> 00' 31'' E and 21<sup>0</sup> 47' 00''N) is the center of the cluster, and at a radius of 20 Km from this place is the study area which covers 706.85 Km<sup>2</sup>. This area is divided into two segments.

**Segment-I:** This segment covers ~78.53 Km<sup>2</sup> around the center and in this area all the thermal power plants (10), iron and sponge iron (11) and an aluminium smelter industries (02) are located (~5 Km radius from the centering place, Kherual).

**Segment-II:** This covers the area ~628.32 Km<sup>2</sup> beyond the boundary of the segment-I. In this area only one industry is located. (Ultra Tech cement production unit) (~15 Km radius

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from the centering place, Kherual).

We have identified the location of eight sampling stations in each segment for the collection of surface waters and underground waters, which are denoted as SW and GW, respectively for both segment (Table 1 & 2). We have followed the sampling procedure strictly in accordance with standard method<sup>18,19</sup>. As regard to sampling collection label, spot analyses were also done as per standard method. In order to examine the variation and trends of different parameters over time samples have been collected for a period of two years on monthly basis from January 2011 to December 2012. The values are listed in Table-3 to Table-6.

**Table 1: List of monitoring stations of surface water and ground water in the Segment-I**

Station code	Stations name	Direction and distance from Kherual	
		Direction	Distance
SW <sub>1</sub> '	Pond, behind Collecteriate, Jharsguda	N	11 KM
SW <sub>2</sub> '	Pond, Debadihi, village	NE	9 KM
SW <sub>3</sub> '	Pond, Banjari, village	NE	6.5 KM
SW <sub>4</sub> '	Pond, Katikela, village	SE	8 KM
SW <sub>5</sub> '	Pond, Thelkoli, village	S	3 KM
SW <sub>6</sub> '	Pond, Pandloi, village	SE	12 KM
SW <sub>7</sub> '	Banaharpali, Village School Building,	NE	12 KM
SW <sub>8</sub> '	Pond near Municipality office, Jharsguda	N	8 KM
GW <sub>1</sub> '	Tube well near Collecteriate, Jharsguda	N	11 KM
GW <sub>2</sub> '	Well (6.5 mts), Debadihi, village	NE	9 KM
GW <sub>3</sub> '	Well (6.3 mts), Banjari village	NE	6.5 KM
GW <sub>4</sub> '	Well (6.0 mts), in Katikela in the village	SE	8 KM
GW <sub>5</sub> '	Well (6.5 mts), Thelkoli village	S	3 KM
GW <sub>6</sub> '	Well (5.5 mts), Pandloi village	S	12 KM
GW <sub>7</sub> '	Well (5.0 mts), Banaharpali in the village	SW	12 KM
GW <sub>8</sub> '	Tube well Municipality office, Jharsguda	N	8 KM

**Table 2: Monitoring Stations of Surface water and water in the Segment-II**

Station code	Stations name	Distance and Direction from Kherual	
		Direction	Distance
SW <sub>1</sub> "	Pond, Durlaga, Village	NE	15 KM
SW <sub>2</sub> "	Pond, Arda, Village	NE	17KM
SW <sub>3</sub> "	Pond, Badimal, Village	NE	18KM
SW <sub>4</sub> "	Pond, Raghunathpurvilage	NE	15KM
SW <sub>5</sub> "	Pond, Samasingha Village	E	18KM
SW <sub>6</sub> "	Pond, Katarbaga, Village	SE	19KM
SW <sub>7</sub> "	Pond, Remenda, Village	SW	24KM
SW <sub>8</sub> "	Pond, Chichinda, Village	NW	20KM
GW <sub>1</sub> "	Well (5.5 mts), Durlaga of Village	NE	15 KM
GW <sub>2</sub> "	Well (4.6 mts), Arda, Village	NE	17KM
GW <sub>3</sub> "	Well (4.3 mts), Badimal Village	NE	18KM
GW <sub>4</sub> "	Well (4.0 mts), Raghunathpur Village	NE	15KM
GW <sub>5</sub> "	Well (3.6 mts), Samasingha Village	E	18KM
GW <sub>6</sub> "	Tube well of Katarbaga Village	SE	19KM
GW <sub>7</sub> "	Well (3.0 mts), Remenda Village	SW	24KM
GW <sub>8</sub> "	Well (3.6 mts), Chichinda, Village	NW	20KM

### Analysis of samples

The samples were analysed for the water quality parameters: pH, conductivity, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD) total dissolved solids (TDS), total hardness, alkalinity, total coliform (TC) (MPN/100 mL), faecal coliform (FC) (MPN/100 mL)

## EXPERIMENTAL

### Methods

For the analysis above parameters standard procedure have been followed. pH was determined with the help of ORION ion selective meter, Model No. 720A PLUS.

Conductivity was measured with conductivity meters (SYSTRONICS, Model No 306). Total dissolved solids were determined by the gravimetric method. The total alkalinity was obtained by titrating against sulphuric acid solution using methyl orange as an indicator. Hardness was estimated by using complexometric technique, where known aliquot of water samples were titrated against EDTA with Erichrome black-T indicators. Hardness of water was calculated in terms of mg CaCO<sub>3</sub> per Litre. Dissolve Oxygen was measured by Winkler titrimetric azidomodification (Iodometric) method. Biochemical Oxygen Demand (BOD) was measured by the method which consists of filling with samples, to overflowing, in an airtight bottle of the specified size, and incubating it at 27<sup>0</sup>C for 3 days. Dissolve Oxygen is measured initially and after incubation, and the BOD is computed from the difference between initial and final DO. Because the initial DO is determined immediately after the dilution is made, all oxygen uptake including that occurring during the first 15 minutes is included in the BOD measurement. Chemical Oxygen demand (COD) was measured using potassium dichromate as an oxidant in the presence of sulphuric acid. The excess dichromate remaining after oxidation was titrated against standard ferrous ammonium sulphate solution using ferroin indicators. COD was measured by closed reflux, titrimetric method with the help of HACH COD Reactor Model No. 45600.

In general, the methods recommended by APHA were followed for the analysis of various parameters<sup>18</sup>.

## RESULTS AND DISCUSSION

The analytical data of a few important parameters of surface water and ground water of the industrial cluster area and area beyond the cluster are recorded in Table 3 to Table 6, respectively. The comparative graphical representations of the above data are shown in Fig. 1 to Fig. 4. All the values are in mg/L, except pH, conductivity and total Coliform (TC).

**Table 3: Surface water quality of the Segment-I\***

S No.	Parameters	Concentration of pollutant								
		SW <sub>1</sub> '	SW <sub>2</sub> '	SW <sub>3</sub> '	SW <sub>4</sub> '	SW <sub>5</sub> '	SW <sub>6</sub> '	SW <sub>7</sub> '	SW <sub>8</sub> '	Mean
1	<b>pH</b>	6.1	6.9	8.8	7.8	7.6	6.8	6.2	7.5	7.21
2	<b>Conductivity</b> ( $\mu\text{Scm}^{-1}$ )	200.8	280.2	320.8	315.6	310.5	300.4	280.2	270.6	284.9
3	<b>DO</b>	9.2	7.2	6.1	6.3	6.5	7.1	7.2	7.4	7.13
4	<b>BOD</b>	2.7	3	4.3	4.2	4	3.5	3.1	4.0	3.6

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S No.	Parameters	Concentration of pollutant								
		SW <sub>1</sub> '	SW <sub>2</sub> '	SW <sub>3</sub> '	SW <sub>4</sub> '	SW <sub>5</sub> '	SW <sub>6</sub> '	SW <sub>7</sub> '	SW <sub>8</sub> '	Mean
5	<b>COD</b>	18.5	18.8	22.5	20.2	20.6	20.1	19.4	20.2	20.04
6	<b>TDS</b>	180	186	220	200	190	180	170	175	187.6
7	<b>Total hardness</b>	72.4	75.2	94.6	88.4	87.2	84.2	72.6	83.2	82.2
8	<b>Alkalinity</b>	58.8	61	77.8	65.4	68.2	66.4	68	65.2	66.4
9	<b>TC(MPN/100 mL)</b>	120	115	150	130	135	124	110	125	126.1
10	<b>FC(MPN/100 mL)</b>	75	80	100	90	105	80	70	85	85.6

All values are in mg/L except pH, conductivity, TC and FC.

\*Average data of two consecutive years SW' = Samples of segment-I.

Numerical figure indicates the sampling stations number

**Table 4: Ground water quality of the Segment-I\***

S. No.	Parameters	Concentration of pollutant								
		GW <sub>1</sub> '	GW <sub>2</sub> '	GW <sub>3</sub> '	GW <sub>4</sub> '	GW <sub>5</sub> '	GW <sub>6</sub> '	GW <sub>7</sub> '	GW <sub>8</sub> '	Mean
1	<b>pH</b>	6.3	7.4	8.6	8.3	7.9	8.1	8.3	8.2	7.9
2	<b>Conductivity (<math>\mu\text{Scm}^{-1}</math>)</b>	120.8	160.2	208.8	202.6	200.5	155.4	130.2	140.6	164.9
3	<b>DO</b>	8.2	8	6.5	6.6	6.7	7.2	7.1	7.9	7.3
4	<b>BOD</b>	2.7	2.8	3.3	3.2	3.1	3	2.9	1.8	2.9
5	<b>COD</b>	17.5	19.8	21.5	20.2	20.6	20.1	20.4	19.2	19.9
6	<b>TDS</b>	160	175	223	215	185	170	162	160	181.3
7	<b>Total hardness</b>	52.4	55.2	70.6	68.4	56.2	64.2	62.4	61.2	61.3
8	<b>Alkalinity</b>	50.8	51	70.8	68	60.2	66.4	66	68.2	62.7
9	<b>TC(MPN/100 mL)</b>	120	110	140	130	125	115	120	130	123.8
10	<b>FC(MPN/100 mL)</b>	75	60	75	71	81	65	70	57	69.3

All values are in mg/L except pH, conductivity, TC and FC.

\*Average data of two consecutive years GW' = Samples of segment-I.

Numerical figure indicates the sampling stations number.

**Table 5: Surface water quality of beyond the Segment-II\***

S. No.	Parameters	Concentration of pollutant								
		SW <sub>1</sub> "	SW <sub>2</sub> "	SW <sub>3</sub> "	SW <sub>4</sub> "	SW <sub>5</sub> "	SW <sub>6</sub> "	SW <sub>7</sub> "	SW <sub>8</sub> "	Mean
1	<b>pH</b>	7.6	8.1	8.3	8	7.8	7.8	7.6	7.5	7.8
2	<b>Conductivity</b> ( $\mu\text{Scm}^{-1}$ )	110.8	120.2	140.8	135.6	120.5	105.4	100.2	100.6	116.8
3	<b>DO</b>	10.2	9.3	8.1	8.2	8.8	9.8	9.2	9.8	9.2
4	<b>BOD</b>	2.2	2.8	3	2.4	1.8	1.6	2	1.4	2.2
5	<b>COD</b>	18.5	19.8	20.5	19.2	16.6	15.1	18.4	14.2	17.8
6	<b>TDS</b>	162	180	200	175	125	115	150	110	152.1
7	<b>Total Hardness</b>	50.4	58.2	60.6	48.4	46.2	44.2	52.2	53.2	51.7
8	<b>Alkalinity</b>	66.8	60.8	62.8	71	52.2	51.4	55	55.2	59.4
9	<b>TC(MPN/100 mL)</b>	100	115	120	115	110	95	90	104	106.1
10	<b>FC(MPN/100 mL)</b>	50	55	65	50	48	50	40	50	51

All values are in mg/L except pH, conductivity, TC and FC.

\*Average data of two consecutive years SW" = Samples of segment-II.

Numerical figure indicates the sampling stations number

**Table 6: Ground water quality of Segment-II\***

S. No.	Parameters	Concentration of pollutant								
		GW <sub>1</sub> "	GW <sub>2</sub> "	GW <sub>3</sub> "	GW <sub>4</sub> "	GW <sub>5</sub> "	GW <sub>6</sub> "	GW <sub>7</sub> "	GW <sub>8</sub> "	Mean
1	<b>pH</b>	7.5	7.7	8.0	7.9	7.6	7.4	7.5	7.3	7.61
2	<b>Conductivity</b> ( $\mu\text{Scm}^{-1}$ )	100.8	105.2	106.8	118.2	100.5	96.4	98.2	95.6	102.7
3	<b>DO</b>	11.9	10.5	9.1	8.9	9.8	10.8	10.4	10.9	10.3
4	<b>BOD</b>	1.8	2.2	2.5	2.1	1.5	1.4	1.7	1.3	1.8
5	<b>COD</b>	15.5	16.8	18.5	16.2	12.6	12.1	13.4	12	14.6
6	<b>TDS</b>	145	160	180	150	125	120	136	112	141

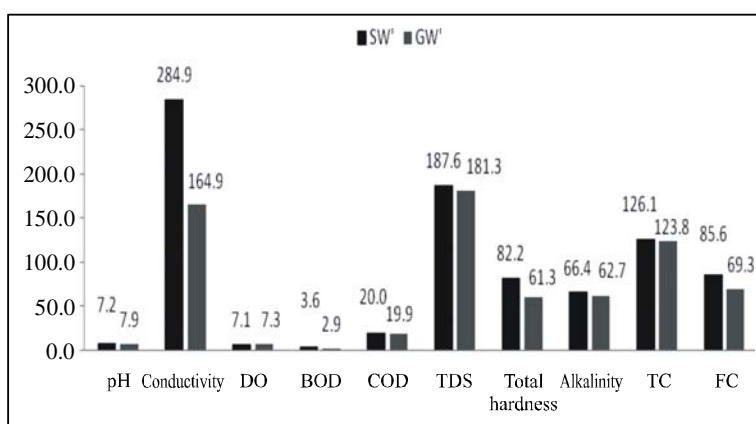
Cont...

S. No.	Parameters	Concentration of pollutant								
		GW <sub>1</sub> "	GW <sub>2</sub> "	GW <sub>3</sub> "	GW <sub>4</sub> "	GW <sub>5</sub> "	GW <sub>6</sub> "	GW <sub>7</sub> "	GW <sub>8</sub> "	Mean
7	<b>Total Hardness</b>	50.2	55.2	60.6	50.4	47.2	44.2	48.4	43.2	49.9
8	<b>Alkalinity</b>	52.8	61	65.8	60	55.2	60.4	60	55.2	58.8
9	<b>TC(MPN/100 mL)</b>	85	90	122	110	105	100	101	90	100.4
10	<b>FC(MPN/100 mL)</b>	60	70	75	70	60	72	73	58	67.3

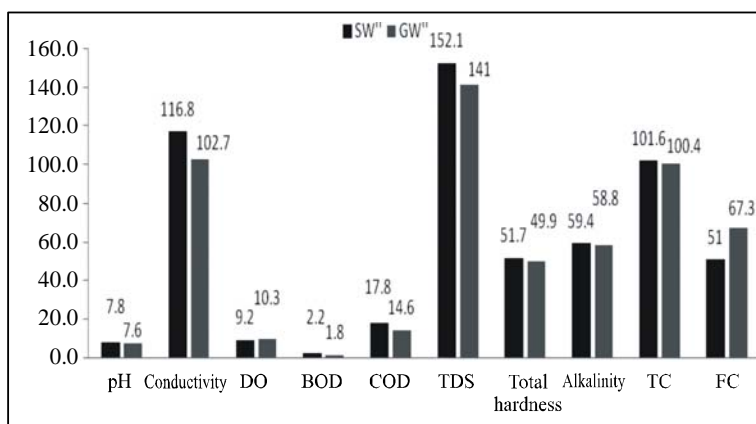
All values are in mg/L except pH, conductivity, TC and FC.

\*Average data of two consecutive years GW" = Samples of segment-II.

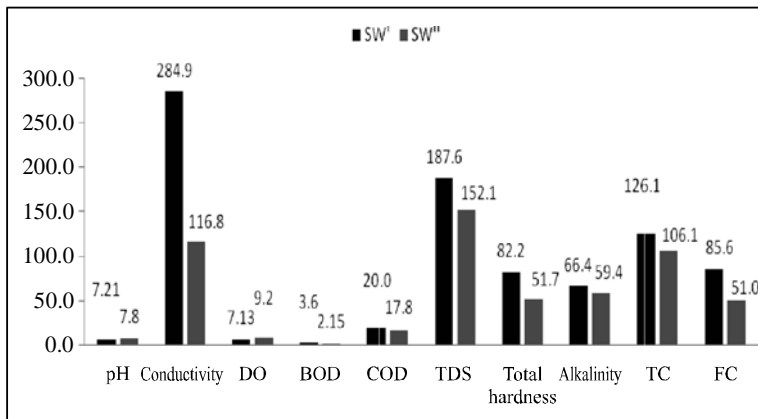
Numerical figure indicates the sampling stations number



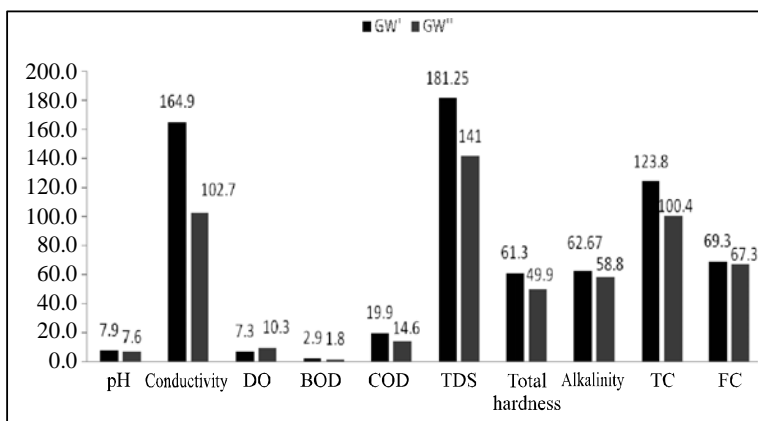
**Fig. 1: Comparative figure of surface and ground water of Segment-I**



**Fig. 2: Comparative figure of surface and ground water quality of Segment-II**



**Fig. 3: Comparative figure of surface water quality of Segment-I and Segment-II**



**Fig. 4: Comparative figure of ground water quality of Segment-I and Segment-II**

The pH values of all the eight surface water samples of the segment-I area is in the range 6.1-8.8 and the average value is 7.21. On comparing these data with the standard data (6.5-8.5) for drinking purpose, the surface water can be used for drinking only after disinfection. However, the water is suitable for outdoor use like bathing, swimming and sports purpose. In case of ground water of segment-I, the pH range of all the eight samples is in the range 6.3- 8.6 and their average value is 7.9. As above the source of ground water of the cluster area need treatment before using it for drinking. However this water of the segment area can be used like surface water for outdoor bathing, swimming etc.

The pH values of water of the segment-II are recorded in Table 5 and 6. The minimum, maximum and average values are 7.5, 8.3, 7.8 and 7.3, 8.0 7.61, respectively. The water of either of sources cannot be used for drinking directly from the sources but can be



done after conventional treatment. But the water can be used for outdoor activities. The analytical data of DO of the sources of water in the segment-II as well as that of segment-I reveals that like pH, the water can be used for drinking with necessary conventional treatment. But the water can be used without treatment for outdoor activities.

The BOD values of surface water and that of ground water quality of the segment-I is in the range 2.7-4.3 with average value 3.6 and 1.8-3.3 and 2.9, respectively. BOD values of both types of water of the segment-II are recorded in Table 5 and Table 6. The minimum, maximum and average values are 1.4, 3.0, 2.2 and 1.3, 2.5, 1.8 respectively. The water either of sources cannot be used for drinking directly from the sources since the BOD values exceeds in all the cases. However, the water can be used for drinking after necessary conventional treatment.

The COD values of surface water quality of the segment-I is in the range 18.5-22.5 with average value 20.04 of all the samples and that of ground water of same area the COD values range is 17.5-20.6 and their average value is 19.9. COD values of both types of water of segment-II are recorded in Table 5 and 6. The minimum, maximum and average values are 14.2, 20.5, 17.8 and 12, 18.5, 14.6, respectively. Since there is no standard data for COD it cannot be told about the quality of the water.

The total coliform (TC) organism for drinking water without conventional treatment should be 50 MPN/100 mL but the values of all the samples in the present study are around 2-3 folds more than the standard values of drinking water. Hence, no water sample of the segment-I area or beyond should be taken directly for drinking. However, after conventional treatment the water can be used for drinking.

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