Pollution Load of River Salandi in Boula Nuasahi Mining Belt, Urban Area at Bhadrak and Its Down Streams In Odisha

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ABSTRACT

An assessment of water quality of river Salandi which originates from the well-known biosphere of Similipal reserve forest of Mayurbhanja district in Odisha passing through the Hadagad dam, Agarpada and Bhadrak town and joins ultimately with the river Baitarani near Akhandalmani, the so called reputed natural spot Tinitar ghat. The river Salandi receives the forest runoff, untreated and semi-treated mining effluents, agricultural discharges, industrial discharges of Ferro Alloys Corporation (FACOR) plant and urban discharges, which are the prime causes of the pollution, as reported in several newspapers. In the present study, the physico-chemical and bacteriological parameters of water were analyzed by collecting the water samples from nine different stations of the river Salandi by using standard procedures during summer(April & May) and during rainy(August) season and highlights the quality of water. The water quality of the river Salandi is contaminated both physically, chemically and bacteriologically measuring the water unfit for human consumption due to mining, industrial and urban discharges. The water of river Salandi is contaminated with chromium, phosphate, sulphate and iron from the mining belt, industries and agricultural lands, which endanger the livelihoods of the dwellers. Besides, the urban waste from the Bhadrak municipality also adds to this pollution which challenges the survival of the ecosystem.

Keywords
Standard limit, Standard procedure, Hexavalent Chromium

INTRODUCTION

Water is life as good quality of water is inhabitable for both micro and macro organisms including the human beings for various biochemical activities. Now-a-days the water is largely polluted due to rapid growth of industrializations, urbanizations and other human activities for which it is a challenge on the part of the living system for its future survival. In the present study, we have taken the river Salandi, originates from well-known biosphere of Similipal forest of Mayurbhanja district in Odisha and join with river Baitarani near Akhandalmani the vary natural spot Tinitar ghat before its confluence with the Bay of Bengal.

A dam was built across the river Salandi at Hadagad in Anandpur Subdivision of Keonjhar district. The brief history of the dam is that it was commenced in 1960 and was completed in 1976 and able to irrigate from 106776 to 123000 acres of land during Kharif seasons and 25000 to 64000 acres of land during Rabi seasons. The total annual irrigation is 113226 to 148000 acres of land. It receives average annual rainfall 1540 mm and average monsoon rainfall 1422 mm.

After Hadagad, the river passes through Boula Nuasahi Chromites mining belt where it receives mining discharges. In the Boula Nuasahi chromites mining belt there are three chromites mines namely Boula Open cast and underground mines, Nuasahi chromites mines and Bangur chromites mines in operation where one lakh tones per year chromite ores and 7 lakhtones over burdens are excavated, where a lot of chromites in the form of total Chromium and hexavalent Chromium are rushing to the river Salandi through surface run off as well as mining discharges and thereby contaminating the water of the river Salandi. Thereafter it passes through Bidyadharpur barrage, Agarpada town and travels through 40 KMs agricultural fields and passes through FACOR industry at Randia and finally Bhadrak municipality where it receives industrial discharges and urban discharges. The aforesaid factors including mining discharges, industrial discharges and urban discharges are the prime causes of pollution. In this paper, water samples have been collected from nine different places of the river Salandi twice during summer(April & May) and rainy(August) season and have analyzed physico-chemical and bacteriological parameters by using standard procedures to highlight the pollutants.

MATERIALS & METHODS

Water samples were collected from nine different stations of the river Salandi, twice in the summer(April & May) and once in rainy(August) season in the plastic bottles and physico-chemical and bacteriological parameters were analyzed according to the method APHA, prescribed in 1995. TDS was measured by gravimetry method and total hardness was measured by complexometric method by...
using EDTA solution with Erichrome black-T as indicator. Sulphate was measured by turbidimetry method. Iron was measured by using Phenolphthalein indicator with the help of spectrophotometer at 510 nm. Total Chromium, Nitrate and Fluoride were measured by spectrometric methods at 540, 275 and 570 nm respectively. Chloride was measured by titration method. Bacteria were examined by H₂S kit method.

Water samples collected from nine different stations have been described briefly in Table-1 and study reports of 16 parameters of samples for the month of April, May & August have been enlisted in Table-2, 3 & 4 respectively. Further, samples collected from different stations have been located in the map of the river Salandi, starting from Hadagada Dam of Keonjhar District to the confluence place at Tinitar, near Akhandalmani of Bhadrak District (map-1).

Table 1

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Name of Stations</th>
<th>Brief Description on Sampling Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Hadgada Dam</td>
<td>It is 40 KM from Bhadrak town and is a hilly &amp; mining area where the river receives mining, agricultural and forest effluents Simlipal Biosphere.</td>
</tr>
<tr>
<td>02</td>
<td>Bidyadharpur</td>
<td>It is nearly 30 KM from Bhadrak town and a barrage is on the river Salandi where it receives mining and agricultural effluents.</td>
</tr>
<tr>
<td>03</td>
<td>Agarpada</td>
<td>It is 20 KM from Bhadrak town where the river receives agricultural wastes &amp; urban wastes primarily.</td>
</tr>
<tr>
<td>04</td>
<td>Randia (FACOR)</td>
<td>At the bank of river Salandi, the village Randia, Ferro Alloys and Charge Chrome Corporation industries are established where industrial effluents and agricultural effluents enter into the river.</td>
</tr>
<tr>
<td>05</td>
<td>Baudpur</td>
<td>It is 02KM from Bhadrak town where the river receives agricultural effluents.</td>
</tr>
<tr>
<td>06</td>
<td>Rajghat</td>
<td>It is situated at the heart of Bhadrak Municipality and nearest to the District headquarter hospital where mainly urban wastes and medical wastes enter into the river.</td>
</tr>
<tr>
<td>07</td>
<td>Satbhauni</td>
<td>It is around 15 KM away from</td>
</tr>
</tbody>
</table>

08 Dhusuri Bhadrak town where the river receives mainly agricultural runoff as it is covered with plenty of agricultural lands

09 Akhandalmani (Tintar) Bhadrak town where the river receives mainly agricultural wastes

It is more than 40 KM from Bhadrak town and is a confluence place of river Salandi & River Baitarani and thereafter the river runs towards Bay of Bengal where the river receives back flow of sea water due to tide and agricultural wastes

Map 1 - Location of sampling stations across Salandi River
### Table 2 – WATER ANALYSIS REPORT OF RIVER SALANDI IN APRIL 2015

<table>
<thead>
<tr>
<th>Place</th>
<th>pH</th>
<th>Turbidity</th>
<th>TDS</th>
<th>TH</th>
<th>Ca²⁺</th>
<th>Mg²⁺</th>
<th>SO₄²⁻</th>
<th>NO₃⁻</th>
<th>PO₄³⁻</th>
<th>Cl⁻</th>
<th>Fe</th>
<th>Total Cr</th>
<th>F⁻</th>
<th>Cr⁶⁺</th>
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<td>&lt;0.01</td>
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</tr>
<tr>
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**Bacteria**
- Positive in all stations

**Standard value of Drinking Water IS-10500**
- 6.5-8.5

### Table 3 – WATER ANALYSIS REPORT OF RIVER SALANDI IN MAY 2015

<table>
<thead>
<tr>
<th>Place</th>
<th>pH</th>
<th>Turbidity</th>
<th>TDS</th>
<th>TH</th>
<th>Ca²⁺</th>
<th>Mg²⁺</th>
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<th>NO₃⁻</th>
<th>PO₄³⁻</th>
<th>Cl⁻</th>
<th>Fe</th>
<th>Total Cr</th>
<th>F⁻</th>
<th>Cr⁶⁺</th>
<th>DO</th>
<th>BOD</th>
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</table>

**Bacteria**
- Positive in all stations

**Standard value of Drinking Water IS-10500**
- 6.5-8.5

**Water Analysis Report of River Salandi in April 2015**

**Units**
- Turbidity: mg/L
- pH: -
- TDS: mg/L
- TH: mg/L
- Ca²⁺: mg/L
- Mg²⁺: mg/L
- SO₄²⁻: mg/L
- NO₃⁻: mg/L
- PO₄³⁻: mg/L
- Cl⁻: mg/L
- Fe: mg/L
- Total Cr: mg/L
- F⁻: mg/L
- Cr⁶⁺: mg/L
- DO: mg/L
- BOD: mg/L
RESULT AND DISCUSSION

pH:
Water samples were measured from the month of April to August, 2015 at nine different stations on the course of river Salandi. It was noticed that the pH is slightly higher during May from Hadagada to Dhusuri in comparison to April due to low flow of water. But at Akhandalmani the pH is fluctuating from 6.9 to 7.3 in different months and slightly higher in the month of April (7.3) which may be due to receiving of unseasonal rainfall run off in the coastal region as because Akhandalmani is closer to seashore (Fig.1) i.e. Bay of Bengal where sea water is entering to river through tide. It is seen that pH value fluctuates due to receiving of different types of pollutants that all the values are within the permissible limit* (fig.-1).

TDS:
The fluctuation of turbidity and TDS is nearly equal. During the month of August i.e. rainy season both TDS and turbidity is higher than the month of April and may due to entering of forest runoff, mining runoff and agricultural runoff to the river Salandi. The dissolved solid flow is nearly same but at the monitoring station Akhandalmani, the TDS is high in both April, May and August due to back flow of sea water to the river as because the station is closure to seashore.

TH, Ca, Mg, NO3, SO4, and PO4 & Cl:-
All the results are within the prescribed limit of drinking water IS-1050018. But at the station Akhandalmani all the results are high in both the time of monitoring because due to back flow of water from sea (Bay of Bengal).But it is marked that the result in May was higher than in the month of April and it was in the ascending order from upstream to downstream which may be due to receiving of mining effluents, industrial effluents and urban wastes. Also the results are high in the rainy season i.e. sample collected in the month of August which is due to entering of agricultural effluents in the form of byproducts of certain fertilizers such as Calcium Ammonium Nitrate (CAN), basic Calcium Nitrate, Calcium superphosphate, etc used by the farmers to the river system11,12. The increase in concentration of Calcium, Sulphate, Phosphate & Nitrate is due to the release of Calcium, Sulphate. Phosphate from aforesaid fertilizers used by the farmers for cultivation purpose during rainy season in large scale. Also during rainy season (August) the river is receiving mining as well as forest runoff which also cause an increase in hardness and calcium as well as magnesium in the river water at different monitoring stations (Fig.2-4).

Fe (>0.3ppm) & Cr (>0.05ppm):-
Iron and hexavalent Chromium are found to exceed permissible level at most of the stations during April, May and August. This is mainly due to the receiving of mining effluents in the Nuasahi chromites belt, industrial sector at Randia (FACOR) and urban effluents of Bhadrapur municipality. Due to mixing of mining effluents, particularly at Bidyadharpur the iron concentration is high during month of August (Fig.5-6).

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Table 4 – WATER ANALYSIS REPORT OF RIVER SALANDI IN AUGUST 2015

Unit - except pH all concentrations are expressed in mg/L

<table>
<thead>
<tr>
<th>Place</th>
<th>pH</th>
<th>Turbidity</th>
<th>TDS</th>
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<th>Ca2+</th>
<th>Mg2+</th>
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<th>NO3⁻</th>
<th>PO4³⁻</th>
<th>Cl⁻</th>
<th>Fe</th>
<th>Total Cr</th>
<th>F</th>
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<td>0.90</td>
<td>&lt;0.01</td>
<td>7.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Dhusuri</td>
<td>7.0</td>
<td>9</td>
<td>100</td>
<td>120</td>
<td>108</td>
<td>5.4</td>
<td>12</td>
<td>5.3</td>
<td>3.5</td>
<td>20</td>
<td>0.30</td>
<td>0.08</td>
<td>0.92</td>
<td>&lt;0.01</td>
<td>7.0</td>
<td>4.9</td>
</tr>
<tr>
<td>Akhandalmani</td>
<td>7.2</td>
<td>10</td>
<td>800</td>
<td>480</td>
<td>460</td>
<td>18</td>
<td>15</td>
<td>5.6</td>
<td>4.2</td>
<td>1760</td>
<td>0.45</td>
<td>0.05</td>
<td>0.95</td>
<td>&lt;0.01</td>
<td>7.0</td>
<td>4.4</td>
</tr>
</tbody>
</table>

Bacteria positive in all stations

Standard value of Drinking Water IS-10500 6.5-8.5

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* pH values are within the permissible limit: 6.5 - 8.5

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The permissible level of hexavalent Chromium is 0.05 ppm (IS-10500). But at Randia, particularly the river water contains more than 0.05 ppm may be due to discharge of chromium effluents from Ferrochrome plant. Presently some private chromite mines are not running due to want of environmental clearances. But earlier reports on pollution control Board revealed that they were discharging the effluents with high concentration of chromium to the river Slandi. Although some chromite mines are presently not running but they have left the mining wastes without proper biological reclamation or have not taken proper environmental management which has resulted in open exposure of chromite mixed soil to the atmosphere. The rain water has washed it and eroded the chromite and other contaminants to the river Slandi which is the only drainage system in the study area. Hence, hexavalent chromium in the month of August is found more from Bidyadharpur to Baudpur due to mixing of mining run off and industrial run off in the river Slandi.

**Dissolved Oxygen:-**

Dissolved oxygen is a crucial parameter of river water system which supports the survival of aquatic life. Due to indiscriminant discharge of industrial, urban, mining as well as agricultural effluents, the dissolved oxygen value is decreasing gradually in the redox reaction process to stabilize the pollutants in the water bodies.

It is seen from the monitoring values of river Slandi from upstream to downstream that the dissolved oxygen values is constantly influenced by the discharge of mining, agricultural, industrial and urban wastes, also, more than the critical value (4mg/lt). The dissolved oxygen value at all the monitoring stations is decreasing from Hadgad dam to downstream to confluence spot (Tintarghat) at Akhandalmani. The lower value of dissolved oxygen from 6.7 to 6.8 in the mining belt and 6.2 to 6.6 mg/lt at Rajghat during April and May which indicates the pollution of river Slandi due to mining and urban wastes. The dissolved oxygen value in the month of August is more than critical value due to dilution as well as aeration in the river system because of high flow of rain water and flood (Fig.7).

**Biochemical Oxygen Demand:-**

Biochemical oxygen demand is an indicator of water pollution. The more the pollution, the more is the biological oxygen demand (BOD) and vice-versa. For river water which is being used for drinking purpose shall contain 3mg/lt BOD. But in the presence study almost all monitoring stations both in April, May and August of 2015 contain either more than limit or touching the limit value of 3 mg/lt. It is also seen that the value of BOD is high at the downstream of mining belt, urban belt and industrial belt which reflects the influence of mining, industries and urban areas to the river Slandi. Comparatively high values of BOD in the month of August than April and May is due to increase of flood and agricultural runoff water as well as runoff from the adjacent forest areas which causes more biological residue from the forest to the river system during rainy season. Hence water quality of river Slandi is constantly deteriorating and will not support the ecosystem if such pollution will continue (Fig.8).

**Bacteriological Test:-**

Bacteriological test were made through H₂S kit method and found that bacteriological test is positive in all the monitoring stations from Hadagada to Akhandalmani station which indicates the contamination of river Slandi and rendering the water unfit for human use.
Fig-2 - Ca\textsuperscript{2+} (for nine sampling stations in the month of April, May and August)

Fig-3 - SO\textsubscript{4}\textsuperscript{2-} (for nine sampling stations in the month of April, May and August)

Fig-4 - PO\textsubscript{4}\textsuperscript{3-} (for nine sampling stations in the month of April, May and August)
Fig-5 – Fe (for nine sampling stations in the month of April, May and August)

Fig-6 - Cr$^{6+}$ (for nine sampling stations in the month of April, May and August)

Fig-7 - Dissolved Oxygen (for nine sampling stations in the month of April, May and August)
CONCLUSION

The river Salandi is originated from hilly areas but flowing after Hadgada dam through Nuasahi chromites mining belt and in downstream Randia industrial belt as well as the urban area of Bhdrak Municipality and ultimately confluence in the Bay of Bengal at Dhamara, just below the Akhandalmani. During the course of flow it receives mining, industry as well as urban effluents. Hence, the water is contaminated with different pollutants. Also, bacteriological test is positive in all samples throughout all monitoring stations. Also, the BOD value is either exceeding the permissible limit or close to the permissible limit in all the monitoring stations. Similarly, the dissolved oxygen (DO) value is also decreasing from upstream to downstream and biochemical oxygen demand (BOD) as well as dissolved oxygen is at alarming stage in the downstream of mining, industrial and urban area.

The present work is an indicative of total water quality picture. However, due to above findings and constant adding of contaminants the water will render unfit for human consumption and not meeting the standard of drinking water quality as per IS-10500. It is high time right now to save the water quality of the river Salandi, otherwise the river system will pose a serious problem to the life line of the dwellers. Hence urgent steps such as disinfection, Electro dialysis and reverse osmosis and particularly for hexavalent chromium reduction with sulphur dioxide in acidic medium followed by lime treatment to precipitate as chromium hydroxide along with other approved modern technology shall be taken to treat the effluents carefully and cautiously by the mining, industries and urban authorities before discharging to the river Salandi.

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REFERENCES


