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Impact of industrial development on surface water resources in Angul region of Orissa

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ABSTRACT

The impact of various industrial developments on water resources may be in the range of minimal to severe. An intensive investigation was conducted in highly industrialized area of Angul to determine the water quality status. The industries such as coal mines of MCL, Aluminium Plant of NALCO and its CPP, Talcher Super Thermal Power Station and Talcher Thermal Power Station of NTPC etc. are situated along with the river stretches. The Brahmani river and their tributaries are the main source of the water for various industries activities within study areas. But at same time the industrial effluents, mine drainage water, untreated sewage from urban settlements, run-off from agricultural field, mining areas and open defecation on the river banks have been contributing the pollution load on the river water. The deterioration of river water quality may give adverse effect on human health and aquatic ecosystem directly or indirectly. This paper attempt to be focused on the overall status of river water resources and their management strategies.

Key words: Surface water, Coal mines, Smelter, Thermal power plant, Water quality

1. Introduction

Water is an essential constituent or intergradient of all the animal and plant life. A river and its tributaries play an important role in industrial and social development. Growing population, accelerating industrialization and intensification of agriculture and also urbanization exert heavy pressure on our vast but limited water resources. Waste water from mining and other related industries are the most common source of water pollution and it is increasing day by day (Reza and Singh, 2010). The effluents from mines and industries have a great deal of influence on the pollution of the water body; these effluents can alter the physical, chemical and biological nature of the receiving water body (Sangodoyin, 1991). The quality of a river at any point reflects major influences, including the lithology of the basin, atmospheric inputs, climatic conditions and anthropogenic inputs. On other hand, river plays a major role in assimilation or transporting municipal and industrial waste water and runoff from agricultural land. Municipal and industrial waste water discharge constitutes a constant polluting source, whereas surface runoff is seasonal phenomenon, largely affected by climate within the basin (Singh, 2004).

The input of waste into water bodies therefore does not always impact negatively on aquatic environment because of the self purification property of the water bodies. However the untreated/partially treated waste water may contain toxic compounds, discharge from industries, mining, domestic and commercial areas enter the surface water body they get dissolved or lie suspended in water or get deposited on the bed (Panda et al., 2006).

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Brahmani river basin along Angul-Talcher region is based on heavy deposit of coal and other minerals. Coal mines and related industries are spreaded over major urban and sub urban areas of that region. Industrialisation is considered the trigger of development strategies due to its significance contribution to the economic growth and human welfare (ICID, 2005). Availability of water and good infrastructure has to conducive for industrialization in the study area. River and other streams are not far from the industries and it contaminate continuously from point as well as non-point source. Waste generation due to the operation and expansion of mining and industrial activity in Angul-Talcher is going to be a serious negative impact on the water resource in near future. The input of waste into water bodies therefore does not always impact negatively on aquatic environment because of the self purification property of the water bodies. However the untreated or partially treated waste water may contain toxic compounds, discharge from industries, mining, domestic and commercial areas enter the surface water body they get dissolved or lie suspended in water or get deposited on the bed.This problem is persisting and cannot be ignored that it can have a serious long-term impact on water resource. The impact of effluent discharge from mining and other industries on water resources may range from minimal through to severe (Reza et al, 2009).

The mines of MCL, Aluminium smelter, NTPC's power plants etc. draw water for their use from the Brahmani and its tributaries and in return they release thousands of gallons of wastewater to the river, which contains obnoxious substances like SS, TDS, ash, oil & grease, heavy metals, fluorides, phosphorus, ammonia, urea and acids . The fly ash generated during these power plant operations and ash ponds in the coalfield area also created environmental hazard particularly in water by increasing the suspended, dissolved and heavy metals concentration. Somewhere the water of river Brahmani including tributaries is not matching the prescribed limits of Indian Standard. The river water samples show that various physical and chemical parameters are not within the class 'C' limits of Indian Standard (CMPDI, 2005).

2. Area Description

The Angul-Talcher area lies between latitudes 20º 37' N to 21º 10' N and longitudes 84º 53' E to 85º 28' E. Angul-Talcher area falls in the "Brahmani River Basin". Brahmani river basin is an inter-state river basin. Angul-Talcher region with 1813 $km^2$of coal bearing area is one of the major industrial zones in the State of Orissa and in India (CMPDI, 2005). Due to the vast mineral deposits in the catchment area, availability of water and good infrastructure conducive for industrialization in the river basin of Brahmani with a catchment area of 4235.38 sq.km in Angul and its tributaries are the Singhara, the Tikra and the Nandira etc.

3. Major Existing Industries/Mines

The availability of coal in Talcher area and water of river Brahmani are responsible for growth of industrial activities. On the average 36 million tons of coal is being extracted annually. Raw water to the extent of about 86.26 million cubic meters/annum is drawn from the river for industry/ mining activity. The industrial activities in Angul-Talcher area is primarily dominated by large scale coal based super thermal power plants established by National Thermal Power Corporation (NTPC) at Kaniha with 3000 MW, TTPS at Talcher

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with 460 MW and National Aluminium Company (NALCO) and its Captive Power Plant (980MW). Availability of good quality coal has also promoted the establishment of other coal based iron steel industries etc. (Sundaray, 2009).

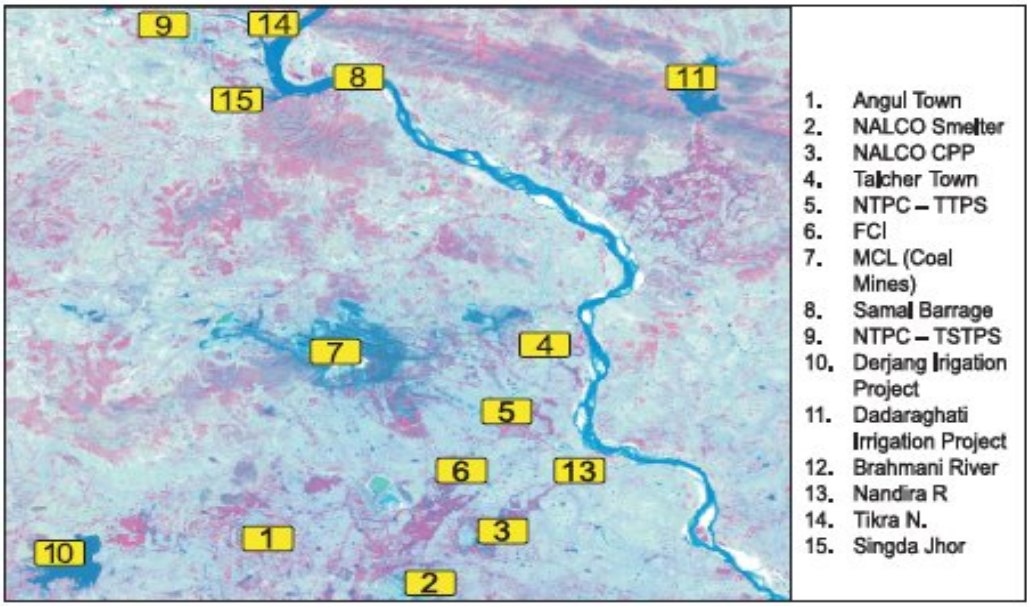

Figure 1: Industries, Mines, River and Streams etc. of study area

Table 1: Major Polluting Industries and their concerned river in Angul Talcher region

Sl. No	Name of Industry	Public/ Private sector	Category	Effluent Recipient	Concerned River
1	NALCO, CPP, Angul (industrial effluent and ash pond over flow, ash pond water is completely reused)	Public Sector	Thermal power	Nandira River	Brahmani
2	NTPC, Kaniha (Industrial effluent)	Public Sector	Thermal power	Tikira River	Brahmani
3	NTPC, Kaniha (Ash pond over flow effluent)	Public Sector	Thermal power	Tikira River	Brahmani
4	TTPS (NTPC), Talcher (Industrial effluent)	Public Sector	Thermal power	Nandira Jhor	Brahmani
5.	TTPS (NTPC), Talcher (Ash pond overflow effluent)	Public Sector	Thermal Power	Nandira Jhor	Brahmani

Source: Environmental Statement (form-V), (2006-07). MCL, Orissa.

Seventy percent of total installed capacity of electricity generation in the country is from coal based thermal power plants. Increased dependence of power sector on the inferior quality of coal has been associated with the emissions from the power plants in the form of particulate

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matter, toxic elements, fly ash, oxides of nitrogen, sulphur and carbon besides large volume of water for cooling and land requirement for ash disposal *(CPCB, 2000-01).*

4. Water Scenario of Region

The major part of the area forms the plains of river Brahmani and its tributaries like Nandira Jhor, Singhara Jhor and Tikra River. The drainage network is controlled by river Brahmani. The rivulet Nandira, which flows centrally from west to east and meets Brahmani near the village Kamalanga. It is highly polluted carrying almost all the industrial effluents and also a sizeable load of domestic effluent from industrial townships, located on other sides of the river. Bangaru Nallah originates from Satyabadi Sagar situated within the lease hold area of Kalinga Open Cast mine project and carries the waste water of different coal mines of Mahanadi coalfields joins Brahmani from north-west. Deojhar nallah flowing to Nandira rivulet carries the run-offs of mining area as well as waste water of South Balanda colliery (ICID, 2005).

Table 2: The Aerial Coverage of Exploration for MCL

Particulars	**Area in sq. km**
Total area of Talcher Coalfield	1,860
Coal Bearing Area	845
Potential Coal bearing area identified for exploration	605
Area explored	171 (28%)
Area under exploration	90 (15%)
Future Exploration	344 (57%)

Source: Environmental Statement (form-V), (2006-07). MCL, Orissa.

Table 3: Consumption of water and discharge of waste water from the major power plant in Angul-Talcher region

Name of the Existing Industry	**Products**	**Water consumption**	**Wastewater generation**
		(1000 Liters/day)	
National Aluminum Company-Smelter Unit	Aluminium	5,066	4,900
Captive Power Plant- NALCO (960 MW)	Electric Power	1,35,000	90,000
ORICHEM Ltd.	Chemicals	170	10
Talcher Thermal Power Station (460MW)	Electric Power	13,227	6,483
Talcher Super Thermal Power Plant NTPC, Kaniha (3000MW)	Electric Power	1,37,099	52,080
Miscellaneous	-----	45,883	16,608
Total		**3,36,445**	**1,70,081**

Source: Environmental Statement (form-V), (2006-07). MCL, Orissa.

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The impacts of surface mining on stream quality result directly from the land disturbance activity. The chemistry of the water is highly dependent on the overburden or earthy materials that were disturbed during the mining process. When disturbed rock and soil is exposed to precipitation (e.g., rainfall, snow, dew, etc.), water running off these materials carries solid particles as well as dissolved constituents such as salts, metals, trace elements, and/or organic compounds that can pollute nearby surface waters.

Talcher coalfield has both the opencast and underground mines and as is well known both the methods of mining severely impact the water quality. Variation in water quality is very much depends upon the modification and alterations in the surface topography affect the chemical characteristics and nature of flow of streams. In coal mining the water is mainly need for dust suppression at haul road and siding, fire fighting, workshop, domestic and other activities but maximum quantity of water (60%) which is used in production, drained back to local water bodies (Konhauser et al, 1997).

Table 4: Production of coal, water consumption and waste water discharge from the various coal mines in Angul-Talcher region

Mines	Area (in Hectare)	Production (MTY)	Water consumption (Kl/day)	Waste water discharge (Kl/day)	Concerned River
Jagannath OC	590.853	5.57	1168.71	701.23	Brahmani
Ananta OC	242.810	12.0	1648.84	989.30	Brahmani
Kalinga OC	117.350	NA	NA	NA	Brahmani
Chendipada OC	24.300	0.28	34.3	20.58	Brahmani
Bharatpur OC	1237.180	9.23	4090.43	2454.26	Brahmani
Lingaraj OC	1248.510	10.82	2263	1357.8	Brahmani
Hingula OC	1063.560	7.88	1290	774.0	Brahmani
Balaram Prsad OC	NA	4.12	1135	681.0	Brahmani
Talcher UG	1140.000	0.20	2420	1452.0	Brahmani
Nandira UG	1785.750	0.22	1751	1050.6	Brahmani
TOTAL	7450.30	50.33	15801.28	9480.78	

Source: Environmental Statement (form-V), (2006-07). MCL, Orissa.

5. Water Quality Issues

The water pollution due to vast expansion of coal mining, thermal power generation and associated industrial activities are expected to increase pollution load to the river system. Coal mines, power plant and other Industries at Angul -Talcher belt had encouraged rapid urbanization of rural landscape and extensive degradation land. The principal sources of water contamination are outlets of industrial discharge and runoff from mining, urban, agricultural etc. Coal and metal ore seams and their associated rock strata contain pyrite (iron sulphide) which oxidises on contact with air and in the presence of bacteria to form sulphuric acid. Consequently, drainage from a mine has very low pH (acidity) and contains high concentrations of sulphur, iron and a range of heavy metals (Envis New letter, 2005).

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Major source of pollution are mining activities, agricultural activities, urban storm and surface runoffs. Runoff from OB dumps and ash ponds contains a high quantity of toxic dissolve pollutant and suspended solids. Non point source (NPS) pollution is typically associated with storm water runoff in either urban or mining areas. Surface runoff can transport significant amounts of contaminants--including sediment, nutrients, pathogens, pesticides, heavy metals, oil and grease from multiple sources into the water body. In India, on the basis of use based water quality standards, CPCB has divide five broad categories.

Table 5: Five broad categories of use based water quality standards

Class	Use
A	Drinking water source without conventional treatment, but after disinfections
B	Organised outdoor bathing
C	Drinking water source with conventional treatment followed by disinfections
D	Fish culture and Wildlife propagation
E	Irrigation, Industrial cooling or Controlled Waste Disposal

The villages located at the downstream to the power plants have been severely affected due to the pollution of their water bodies and streams by the effluents. Even though the NALCO factory has ash pond overflows and effluents are being discharged into the river regularly, this could be because of bad dyke design or a deliberate attempt to dispose off the water without any treatment. Such release of ash pond decant tends to deposit ash all along its path thereby causing fugitive dust nuisance when it dries up. Also when such water mixes with a water body, it increases the turbidity of the water body thereby decreasing the primary productivity. Leakage and overflow of slurry from the ash ponds they give diverse impacts on the chemical composition of water in downstream. NALCO is sometimes providing their treated or untreated water to the villagers on demand. This is not a good practice and it should be discontinued forthwith. OSPCB should look into this matter as no discharge outside factory limits is permitted without the consent of the Board (SCMC, 2006).

The sewage water generated from the colonies is also disposed directly into the water body. Domestic sewage and agricultural run-off also fall in the river through Nallah and Jhor. The domestic animals as well as human beings exposed to such polluted water and may be affected with various types of diseases. But the Committee (SCMC, 2006) was very much impressed by the management of NTPC, one of the PSUs which made the Committee feel proud. The management and staff have taken a lot of initiatives. They monitor surroundings, cleanliness, water management, ash ponds and their discharge, colony management, etc.

6. Water Pollution Problems

The water pollution may affect the quality of stream water in the following ways:

6.1 Change in chemical characteristics

Temperature, turbidity, TSS, TDS, Ammonia, oil & grease and trace metals are the main pollutants come out from coal mines and related industries like Power plant, smelter and other iron & steel industries. It accounts 60% from non-point source of coal mine areas.

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6.2 Toxic pollutants: organics and heavy metals

Organic pollutants (Mostly chemicals manufactured artificially by man) are also becoming an important water quality issue. They enter rivers as point and non-point sources. Uncontrolled discharge of industrial wastewater often causes pollution due to toxic metals. Other sources of metal pollution are leachates from ash ponds, urban solid waste landfills and mining waste dumps.

6.3 Salinisation

Increased mineral salts from industrial effluent, mine water and surface run-off from Open Cast or Over Burden dump areas in rivers may arise from several sources:

- pollution by mining waste waters
- pollution by certain industrial waste waters
- Increased by surface run off from open cast OB dumps area etc., Evaporation however, increases the concentration of all ions.

6.4 Contamination by faecal and organic matter

Due to the large number of coal mine, power plant and other industries, a very dense populated area settled along the Brahmani river. In that case faecal contamination is still the primary water quality issue, especially where human and animal wastes are not adequately collected and treated. The release of untreated domestic or industrial wastes high in organic matter into rivers results the high BOD and feacal concentration and that make the water unfit for drinking, bathing water, as well as ecological health of river.

6.5 Changes in river hydrology

Many industrial and human activities, directly or indirectly lead to modifications of river channels, which can, in turn, induce changes to the aquatic environment. Some major modifications to river Systems include the following:

- Changes to depth and width for navigation creation of flood control ponds.
- Creation of reservoirs for drinking water supply.
- Damming for hydroelectric power generation.
- Diversion for irrigation purposes

All of the above affect the hydrology and related uses of the river system and so have a great potential to affect water quality. It must be remembered, however, that not all such water quality changes are necessarily deleterious.

7. Conclusion and recommendation

1. Above mentioned industries are come under the “Grossly Polluting” industries but instead of that there is no any devastating problem to aquatic or other living being in environment due to the availability of water and presence of enough flow current. They have strong self purifying capacity. But it should not be ignored for long time

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because several large industries are in the pipeline. So the overall management of water system is necessary and CPCB/SPCB rules should be strictly implemented.

2. The wastewater treatment facilities adopted by the thermal power plants are generally sufficient to attain the prescribe standards but water used in the cooling towers is generally disposed off at temperature 4-5^0 C above the prevalent surface water temperature, which can harm the local aquatic biota. In order to avoid such thermal pollution, the power plants dispose off the effluent by means of a long and open channel, due to which the temperature of the effluent comes down to the level of that of the surface water by the time it reaches the receiving body.
3. Carrying capacity study is essential before any new mine or industry comes up in the zones.
4. Each industry should treat their effluents, in accordance with the legal requirements, before discharging these into the streams otherwise 'Polluter pays' principle should be implemented.
5. Old abandoned areas of mines and quarries can be effectively planned for reclamation and converting into forest with water bodies and appropriate form of land use.
6. Educating the urban as well as the rural mass is another major step to put a check on the river water pollution. Masses should be made aware of the drastic consequences of such a situation on their lives, both directly and indirectly.

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