Research Paper

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Impact of Bandel Thermal Power Plant (BTPS) on Hugli River, Hugli, West Bengal

Geography

KEYWORDS : Power plant, Physico-chemical parameters, Thermal effluent, Water quantity, Water quality index

Amit Bera, Department of Geography and Disaster Management, Tripura University, Suryamaninagar, Tripura, India

ABSTRACT

The aim of this research is to study the impact of Bandel Thermal Power Station (BTPS) on River Hugli through measuring physicochemical and microbiological parameters of the BTPS outlet, upstream and downstream water samples. Physicochemical analysis includes Temperature, Dissolved oxygen (DO), pH, Electrical Conductivity (EC), Total dissolved solids (TDS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), trace metals, major anions and cations. Water Quality Index (WQI) of the outlet, upstream and downstream samples were investigated by using National Sanitation Foundation's Water Quality Index (NSF WQI). WQI results showed that those three samples WQI values is under (50-70) Medium water quality rating but BTPS outlet WQI value was slightly decreased compared to the upstream and downstream samples which indicates a slight negative impact of Bandel Thermal Power Plant on river Hugli.

INTRODUCTION

A power plant can affect the environment by its construction and its operation. These effects, or impacts, can be either temporary or permanent [1]. In thermal power stations water is used for generating steam to drive steam turbines, for cooling the exhaust steam and for other operations including ash disposal, emissions control and potable use. This water is consumed, recycled or disposed to the environment [2]. For power plants located on main land, the raw water is generally drawn from fresh water source such as river, lake, canal, reservoir, and barrage [3].

Bandel Thermal Power Station (BTPS) is situated on the western bank of the Hugli River in the district of Hugli, West Bengal. It is a coal based thermal power plant which is operated by the West Bengal Power Development Corporation Limited (WBPDCL). The BTPS has a total installed Capacity of 450 MW with five units.

The major water requirement for once-through cooling purposes is taken from the river Hooghly. Water from the river flows into the individual pumps suction basin through trash rack, inlet gates and travelling water screen [4]. Sometimes numerous fish and macro invertebrates get impinge on intake water screening devices of power plants, culminating in sizeable mortalities [5]. The outlet from the condenser is returned to the downstream side of river through concrete underground tunnel and discharge weir. The water through discharge falls in a short canal of about 70 m long which meets the river Hugli. As the water passes underground in the plant area, there is very little chance of natural cooling due to exposure to atmosphere [4].

The main objective of this paper is to find out the Physio-chemical Observations at the BTPS outlet discharge water, upstream and downstream and to assess the effect of this discharge water on and Hugli River. Water Quality Index model was also applied for the assessment of water quality of upstream, downstream and BTPS outlet water samples on River Hugli.

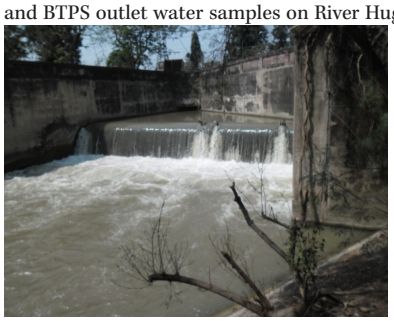

Figure 1: Discharge water outlet of BTPS.

LOCATION OF THE STUDY AREA

Bandel Thermal Power Station is located on the western bank of river Hugli (also called Ganga) near Tribeni town in Hugli District of West Bengal. Its latitude and longitudinal extents are 22°59'N and 88°24'E, respectively. The area is included in the Tribeni Chandrahati Gram panchayat. It is connected to Grand Trunk Road (National Highway No. 2) by Assam Road and then Delhi Road. Nearest railway station is Kuntighat on Bandel - Katwa branch line of Eastern Railway. Area being located less than a degree of the Tropic of Cancer is at the limit of the Torrid Zone. The annual mean temperature is 26.8° C, although maximum temperature often exceeds 38° C. Maximum rainfall occurs during the monsoon in August and average annual Rainfall is 1581mml.

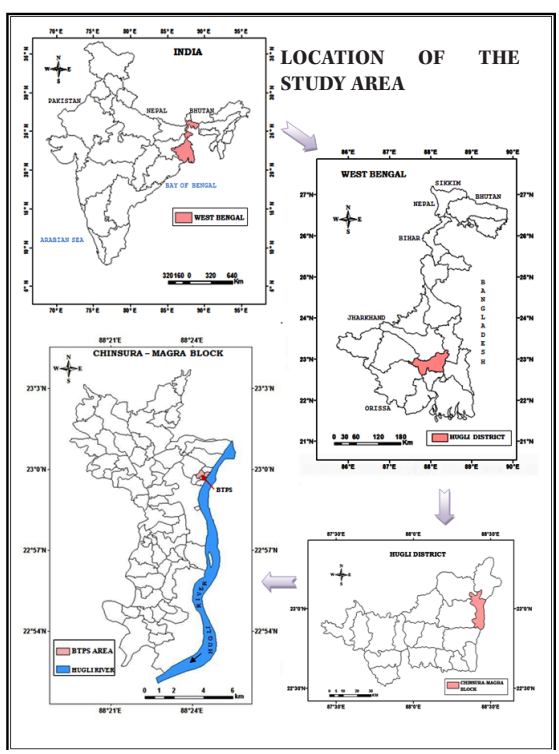

Figure 2: Location map of the study area.

METHODOLOGY

In Pre-field stage some literature concerned with the topic of the study has been collected and reviewed. During Field Survey water samples were collected 8th march 2014 from Hugli river

at upstream (BTPS Battala Ghat), downstream (Tribeni Ghat) and at the Discharge water outlet of BTPS. Water temperatures of Hugli River at these three spots were measured in field using standard Thermometer, 0° –100°C. The post field work is mainly concerned with detail processing of collected samples. Physicochemical analysis of the collected water samples were measured in the Central Laboratory of West Bengal Pollution Control Board (WBPCB), Kolkata and Hooghly Regional Laboratory, WBPCB. After getting these entire water test reports those data are analyzed through statistical tools and technique and represented by suitable diagrams and maps.

Physicochemical analysis includes Temperature, Dissolved oxygen (DO), pH, Electrical Conductivity (EC), Total dissolved solids (TDS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), trace metals, major anions and cations.

Figure 3: water samples Collection from river Hugli.

The water quality index was calculated using National Sanitation Foundation (NSF) information software and compared with standard water quality rating, as shown Table 4.

RESULTS AND DISCUSSION

Impacts on Water Quantity

Thermal-based power facilities, such as nuclear and coal-fired plants, are critically dependent on water for cooling purposes. This enables them to maintain high production efficiencies, but also means that they use tremendous volumes of water every day [6]. The water requirement for BTPS is taken from the River Hugli (31800 cum/hr.) and partly from the Ground water (100 cum/hr.). A portion of the cooling water is used for ash water for carrying the ash to the ash pond. The Quantity of daily Water Consumption from BTPS is tabulated in Table-1.

Table-1: Daily Water Consumption, BTPS.

Nature	water consumption Quantity (m^3/ day)
Industrial cooling	846801
Process water	4265
Domestic	1700
Total water consumption	852766

Source: Final Audit report of BTPS, 2008, World Bank.

Circulating system using Cooling Tower looses a significant amount of continuous loss of water. For BTPS, this will be about 20,000 m3/ day. In a lean season the BTPS cooling water discharge is about 7.6 cusec [4]. Cooling towers evaporate large quantities of water into the atmosphere. The evaporated water is lost to local stream flow or the local groundwater Aquifer. Decreased stream base flow can adversely affect stream morphology, habitat and aquatic plants [1]. The overall per day wastewater generation from BTPS is given in Table-2.

Table-2: Wastewater Generation Per Day Basis, BTPS.

Nature	Source	Quantity [m3/ day]	Place Of Discharge
Cooling water	Plant	846801	River Hooghly
Ash Pond Overflow	Plant	4052	River Hooghly + Irrigation
D.M Plant	Plant	74	River Hooghly
Sullage Pump House	Township	600	River Hooghly

Source: Final Audit report of BTPS 2008, World Bank.

IMPACTS ON WATER QUALITY

Temperature

Thermal discharge may result into the disturbance in physicochemical constituents of water body, affecting species composition [5]. Results illustrated in Figure-4 showed that the BTPS outlet discharge water temperature 27°C was above the upstream and downstream temperature with an average 24°C and 25°C respectively. So it indicates that outlet discharge water temperature 3°C higher than upstream temperature of river Hugli. This heated discharge water can harm the local aquatic biota mainly temperature-sensitive plants, fish, microbial activities and also affecting the chemical and physical reactions in the water where the disposal outlet channel meets the river Hugli.

Because water can absorb thermal energy with only small changes in temperature, most aquatic organisms have developed enzyme systems that operate in only narrow ranges of temperature. These stenothermic organisms can be killed by sudden temperature changes that are beyond the tolerance limits of their metabolic systems [7].

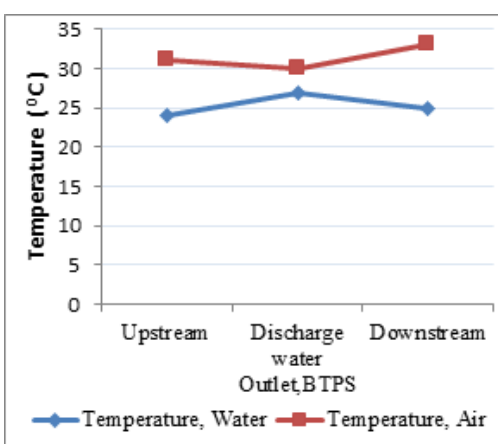

Figure 4: Spatial variation of Water and surface Air temperature on the River Hugli.

Dissolved oxygen (DO)

Dissolved oxygen is essential for most aquatic life and is one of the most important receiving quality parameters. A dissolve oxygen range of surface water 8-10 mg/L is considered good quality of water. Results illustrated in Figure-5 showed that the BTPS outlet discharge water average DO value 1.87 mg/L was very less from the upstream and downstream with an average 9.2 mg/L and 9.1 mg/L respectively and it was also below from the standard limit (BIS: 6mg/L) of DO in surface water. The warm temperature reduces the solubility of oxygen in water and affects the environment of healthy aquatic ecosystem. When DO value less than 2.5 mg/L is very stress full to survive most aquatic organism and create suffocation problem.

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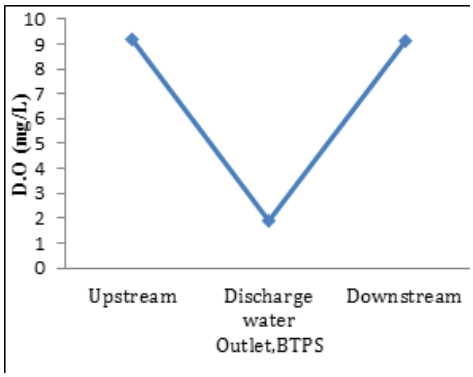

Figure 5: Spatial variation of DO values on River Hugli.

pH

If the pH of water is too high or too low, it can stress for aquatic organisms living and it can also decrease species diversity in freshwater aquatic ecosystem. Figure-6 showed that the average pH value 8.59 at the outlet of BTPS on River Hugli was increased slightly compared to the upstream and downstream samples with an average 8.41 and 8.47 respectively and it was also slightly high from the standard permissible limit (BIS: 6.5-8.5) of pH in surface water. Minor changes of pH levels in water can increase the solubility of elements and compounds. Especially more sensitive Aquatic species are affected by slight changes of pH levels in water.

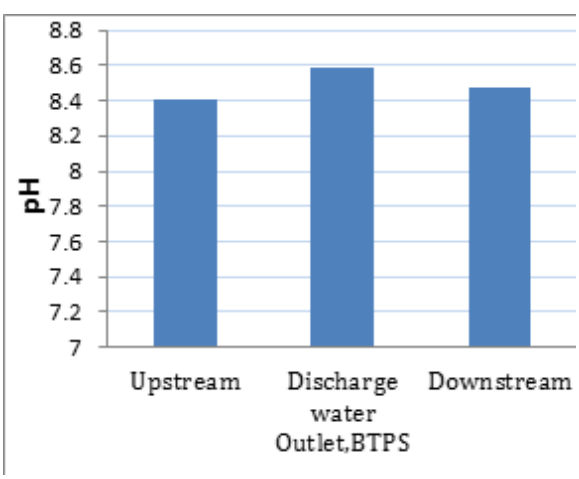

Figure 6: Spatial variation of pH values on River Hugli.

Total dissolved solids (TDS) and electrical conductivity (EC)

Total Dissolved Solid (TDS) is a measurement of inorganic and organic substances and other dissolved materials in water. Electrical Conductivity (EC) is a measure of ability of water to pass an electrical current flow. The total dissolved solid and the electrical conductivity are closely related. The more concentration of ionized solids dissolved in water relates to direct effects of increased rate of electrical conductivity. Results illustrated in Figure-7 showed that the TDS and EC values at the outlet of the power plant on River Hugli sample with an average 240 mg/L and 375 µs/cm were significantly increased compared to the upstream and downstream samples with an average 180 mg/L , 281 µs/cm and 190 mg/L , 297 µs/cm respectively.

The electrical conductivity of the water also depends on the water temperature. The electrical conductivity of water increases by 2-3% for an increase of 1 degree Celsius of water temperature [8]. Davies (1966) showed that cooling tower discharge has lower ammonia level, higher concentration of nitrate and TDS, and lower levels of organic nitrogen [9].

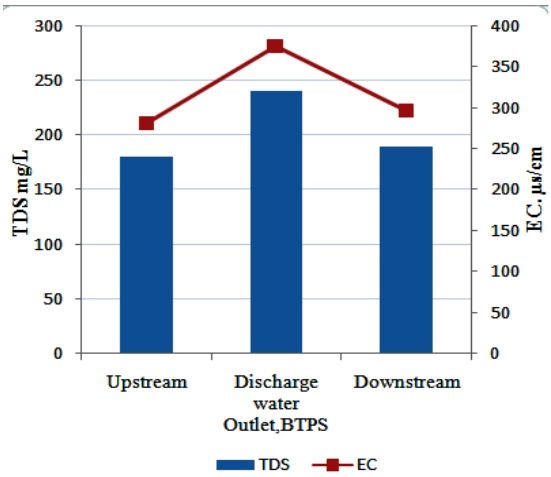

Figure 7: Spatial variation of TDS and EC values on River Hugli.

Biochemical oxygen demand (BOD) and Chemical oxygen demand (COD)

Results illustrated in Figure-8 showed that the BOD at the outlet of the power plant on River Hugli sample with an average 1.2 mg/L was significantly changed compared to the upstream and downstream samples with an average 2.8 mg/L and 2.63 mg/L respectively.

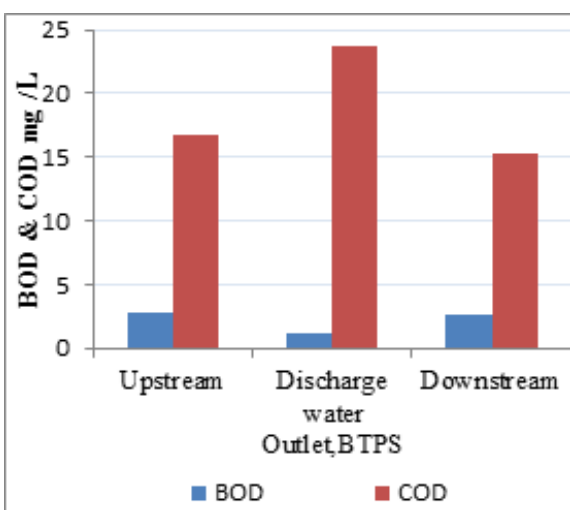

Figure 8: Spatial variation of BOD and COD values on River Hugli.

Figure-8 also showed that COD values at the outlet of the power plant on River Hugli sample with an average 23.77 mg/L were increased significantly compared to the upstream and downstream samples with an average 16.73 mg/L and 15.30 mg/L respectively.

Major cations and anions

Average calculated values of major cations (calcium, potassium, magnesium, and sodium) and major anions (chloride, nitrate, sulphate and fluoride) at BTPS outlet, Upstream and Downstream water samples on River Hugli were tabulated in Table-3.

For major cations, the results showed that the Calcium (Ca) and magnesium (Mg) values at the outlet of the power plant on Hugli River with an average 44.00 mg/L and 14.58 mg/L, respectively. These values were not significantly changed compared to the up-

stream samples. Potassium (K) value at the outlet of the power plant on Hugli River sample was increased slightly compared to the upstream and downstream samples.

Table 3: Average values of the major cations and anions.

Parameters	BTPS outlet	Up-stream	Down-stream
Ca mg/L	44.00	44.00	36.00
Mg mg/L	14.58	14.58	17.01
K mg/L	5.00	4.00	4.00
Na mg/L	21.00	20.00	20.00
NO_3 - N mg/L	0.28	0.32	0.23
SO_4 mg/L	24.60	26.00	24.71
F mg/L	0.128	0.124	0.126
Chloride mg/L	32.26	27.85	36.87

For major anions, the results showed that the average Sulphate (SO_4) value at the outlet of the power plant on River Hugli 24.60 mg/L was decreased slightly compared to the Up-stream sample. Fluoride (F) and Chloride values at the outlet water sample with an average 0.128 mg/L and 32.26 mg/L, respectively. These values were increased slightly compared to the Upstream and downstream sample.

WATER QUALITY INDEX (WQI)

Water Quality Index (WQI) becomes an important parameter for the assessment of the water quality ratings. National Sanitation Foundation's Water Quality Index (NSFWQI) was the WQI model applied for the assessment of water quality of upstream, downstream and BTPS outlet water samples on River Hugli. Nine water quality parameters such as Dissolved Oxygen (DO), Fecal Coliform (FC), pH, Biochemical oxygen demand (BOD), Temperature, Total Phosphate (PO_4), Nitrates (NO_3), Turbidity and Total Solids (TS) are used to calculate the Water Quality Index based on NSF guidelines. The mathematical expression for NSF WQI is given by-

$$NSF,\ WQI = \sum_{i=1}^{n} QiWi$$

Where,

Qi = sub-index for i^{th} water quality parameter;
Wi = weight associated with i^{th} water quality parameter;
n = number of water quality parameters.

For this NSFWQI method, the ratings of water quality have been defined by using following Table-4.

Table 4: National Sanitation Foundation Water Quality Index (NSFWQI) ratings.

WQI Value	Rating of Water Quality
90-100	Excellent water quality
70-90	Good water quality
50-70	Medium water quality
25-50	Bad water quality
0-25	Very bad water quality

NSF WQI is illustrated in Figure 9 and tabulated in Table 5. It was found that the water quality index (WQI) at upstream, downstream and BTPS discharge outlet on River Hugli is about, 68, 66 and 62 respectively. Although those three samples WQI values is under (50-70) Medium water quality rating but BTPS outlet WQI value was slightly decreased compared to the upstream and downstream samples, which indicates a slight negative impact of Bandel Thermal Power Plant on river Hugli.

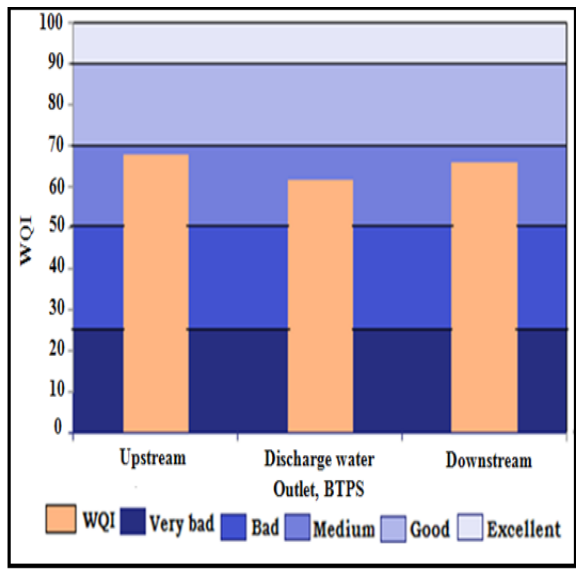

Figure 9: Water Quality Index values in different location on the River Hugli.

Table 5: WQI values for Upstream, Downstream and BTPS Outlet water samples.

Factor	weight factor	Up-stream	Down-stream	BTPS outlet
		Q- value	Q-value	Q-value
DO (% satu-ration)	0.17	97	89	9
FC(MPN/ 100 ml)	0.16	7	7	63
pH (std units)	0.11	69	67	63
BOD (mg/L)	0.11	68	69	93
Change Temp. (^{0}C)	0.10	73	73	56
PO_4 (mg/L)	0.10	100	98	99
NO_3 (mg/L)	0.10	97	97	97
Turbi-dity (NTU)	0.08	41	36	38
TS (mg/L)	0.07	66	67	69
WQI		68	66	62

CONCLUSION

Intake Water from Hugli River plays a vital role in the thermal production cycle of BTPS, where huge volumes of freshwater are drawn every day from Hugli River to serve the cooling needs of Bandel Thermal Power Plant.

The present study showed that the thermal discharge from Bandel Thermal Power Plant is responsible for alteration in physicochemical and microbiological properties of Hugli river water. Increased temperature of discharge water would consequently result in decreased DO and increased TDS and pH.

The resulted Water Quality Index rating reveals that heated discharge water from Bandel Thermal Power Station plays a critical role for a significant *deterioration* of *water quality* in the downstream of River Hugli.

The variability of aquatic ecosystems is highly dependent on physical, chemical and biological parameters of the water body in which they live. Changes to this habitat are reflected by changes in species composition and, consequently, changes in the trophic web in the aquatic ecosystem [10].

Bandel Thermal Power Plant should have improved ecological

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monitoring system for dealing the most serious ecological effects by discharge heated water.

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