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WATER QUALITY MONITORING AND MODELLING OF TALDANDA CANAL, CUTTACK, ODISHA (YEAR-2015)

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INTRODUCTION

Taladanda Canal in Odisha is off-taking from right side of Mahanadi Barrage. Parts of the canal were dug up in 1862 by the East India Company for irrigation purposes as well as for using as a waterway. It was later taken over by the British Government, which completed it in 1869. It was the longest canal of Odisha. The canal was originally designed to provide irrigation and navigation from Bay of Bengal at Paradeep to Cuttack. Subsequently, there was a need to extend the canal to meet the industrial water requirement of number of large industrial units in Paradeep as well as to meet the municipal requirement of the area.

The canal is commanding an ayacut of 72611 Ha with design discharge of 88.42 cum. The total length of the canal is 83.3 km. The area enjoys a subtropical monsoon climate with an average annual rainfall of 1,370 mm and average annual humidity is 78%. The temperature varies from 11.5°C to 44.5°C. Presently the canal is in a dilapidated condition. The deficiency in carrying capacity in the canal is mainly due to discharge of pollutants from municipal sources, hospitals, industries for which its carrying capacity in the canal is mainly due to discharge of pollutants from municipal sources, hospitals, industries for which its carrying capacity is not achieved and has become unsuitable for human consumption. Realising the importance of this problem this study aims to determine the present pollution level of the canal and based on the findings suitable models for prediction of the pollutant behaviour at different locations of Taldanda canal.

WATER QUALITY PROBLEMS

In Taldanda canal water quality survey was carried out at different sampling locations during the year 2015-16. In addition, water quality data collected earlier by different research in Taldanda canal has also been studied in the present work.

Das and Acharya, (2003) collected a total of 120 water and sewage samples from 20 stations over six consecutive seasons in two years in order to study the possible impact of domestic sewage on the lotic water in and around Cuttack, India.

Samantray *et al*. 2009 carried out water quality analysis, and the results are shown in Table 1.

Table 1 : Water quality during different season in Taldanda Canal Samamantray *et al*. (2009)

Loca-tion	Season	pH	Turbidity NTU	[TDS] mg/l	[TH] mg/l	[NO_1] mg/l	[F] mg/l	[BOD] mg/l	[DO] mg/l
T1	Postmonsoon	7.38	5	76	24	8.8	0.32	2.7	6.4
	Winter	7.31	4	81	33	9.9	0.36	2.8	6.2
	Summer	7.16	5	101	48	11.0	0.40	3.0	6.0
T2	Postmonsoon	7.27	3	66	20	4.0	0.22	3.6	6.0
	Winter	7.00	5	85	32	4.5	0.25	3.7	5.8
	Summer	6.85	5	109	46	5.0	0.28	4.0	5.7
T3	Postmonsoon	7.18	4	158	43	3.2	0.32	4.8	5.8
	Winter	7.06	5	167	60	3.6	0.36	4.9	5.6
	Summer	6.92	12	209	87	4.0	0.40	5.0	5.5
T4	Postmonsoon	7.53	4	184	63	5.6	0.24	3.7	6.0
	Winter	7.46	5	194	98	6.3	0.27	3.8	5.8
	Summer	7.31	4	242	140	7.0	0.30	4.0	5.6
T5	Postmonsoon	7.32	4	67	33	12.8	0.33	3.6	5.9
	Winter	7.24	3	88	46	14.4	0.37	3.7	5.7
	Summer	7.09	6	113	67	16.0	0.42	4.0	5.6

In Taldanda canal discharge data were monitored along with various water quality variables under the present study. The discharge is decreasing as we proceed towards Paradeep from Cuttack. The flow is reducing exponentially and upto RD 12 km, half of the water is distributed to command areas through canal.

Following water quality data were collected during the year 2015 from seven locations of Taldanda canal (RD: 0 km, RD: 3.5 km, RD: 70 km, RD: 82 km) four drains (RD: Drain at SCB College; RD: Drain at Naya Bazar; RD: Drain at Matru Bhawan).

Category 1 : pH, Temperature, DO, BOD, COD, turbidity, Conductivity, TDS, TSS, Boron, Hardness.

Category 2 : Total Coliform, Fecal Coliform, E.Coli (MPN), Plankton (phytoplankton and zooplankton), Chlorophyll estimation.

Category 3 : Sodium, Potassium, Calcium, Magnesium, Nitrate, Phosphates, Sulphate, Chlorides, Total Alkalinity.

Category 4 : Iron, Fluoride, Zinc, Copper, Cadmium, Cynide, lead, nickel, Chromium, Mercury, Silica, Pesticides.

Out of these variable, some of water quality variable are not detected and some are found in negligible amount. However, couple of toxic chemicals, metals and bacteriological indicators are found in Taldanda canal. They are discussed in the following section :

It has been found that the Total Dissolved Solids (TDS) are less than 200 mg/l in Taldanda canal which is showing reduced values in comparison to TDS values observed during the year 1996-97 (Das and Acharya, 2003) and 2006 (Samantray *et al*, 2009). Total suspended solids (TSS) are found very high during July and then the values were observed less than 197 mg/l. Turbidity values are found to be on higher side with a maximum of 126 mg/l during July 2015. The values obtained are much higher than the values obtained by Samantray et al (2009). Conductivity is found to be more than 198 (μs/cm) all time, which indicates the presence of ionized substances.

Biochemical oxygen demand (BOD) values are found to be highest 32 mg/l at RD during December 2015. However, all the drains discharge very high BOD in Taldanda canal with highest from drain at Matrubhaban. BOD values obtained by Das and Acharya (2003) are found to be much higher (12-200 mg/l) whereas the values obtained by Samantray (2009) are very low (2.7 – 5.0 mg/l). High values of BOD are alarming in Taldanda canal in all the reaches upto Paradeep. Chemical oxygen demand (COD) is found to be in three folds of BOD, indicating presence of chemical in every sampling point in Taldanda canal. The situation needs to be controlled. The dissolved oxygen (DO) values are within the permissible range most of the times. Only on few occasions and it has gone below 5. Interestingly, DO values has never been zero in any of the drains, which indicated their interaction to atmosphere due to some turbulence. Das and Acharya (2003) also observed low values of DO (1.7 mg/l) in some of their sampling points.

Nitrate (NO_3) and Phosphate (PO_4) values are found to be less than 3 mg/l, but significant amount of PO_4 has been observed from all the drains discharging the water to Taldanda canal. NO_3 can be toxic to certain aquatic organisms even at concentration of 1 mg/l whereas PO_4 may cause algal bloom in Taldanda canal. Sulphate (SO_4) are found to be within the range. They are available in abundance in nature as soium sulphate and magnesium sulphate. Sodium (Na) is present as common salt, which reacts with water to make sodium hydroxide and hydrogen. In the analysis, it is found to be less than 32 mg/l. Magnesium (Mg) indicates hardness in the water and its values were found to be fluctuating in different period of sampling. Potassium are found to be prominent up to RD 35 km, but the less than 16 mg/l. Thereafter its values have been reduced. Calcium is also an indicator for hardness. Its values are found to be below 22.6 mg/l at every location.

The presence of trace metals in Taldanda canal are also found. The traceable metals are Iron (Fe), Zinc (Zn), Copper (Cu) and Silica (Si). Other traces metals are found only on one or two occasions during the sampling. Iron content is very high in amount varying 21 mg/l. The maximum permissible range is 0.50 mg/l. High concentration of iron damages liver. Coagulants or Flocculation is essentially needed to remove iron. Availability of Copper is in high concentration touching the maximum permissible range of 1.8 mg/l. The dissolved copper salts even in low concentrations are poisonous to some biota. It should be less than 0.05 mg/l. Zinc and Silica are found to be within the range at all the sampling locations of Taldanda canal.

Total Coliform, Fecal Coliform and E-Coli are detected in the water at different sampling locations of Taldanda canal. The values are significantly high but have not crossed the maximum permissible range. Traces of phytoplankton, Zoo plankton and Chlorophyll are also found in water at water at different sampling locations of Taldanda canal.

To study the trend, it is found essential to estimate the loads of different ionic elements present prominently in Taldanda canal. For this total load of Calcium, Sodium and Sulphate at different sampling stations were collected and studied. Two types of heavy metals Copper (Cu) and Iron (Fe) are found in alarming situations. Both the metal area par with their permissible limits. The results indicate that their concentration is reducing in the Taldanda canal towards downstream direction slightly. However, the total load in the Canal is reducing exponentially.

Table - II

	Drain at S.C.B College	Drain at Matru Bhawan	Drain at Naya Bazar	R.D. 0 K.M.	R.D. 35 KM	R.D. 70 KM	R.D. 82 KM.
Total dissolved solid (T.D.S) – mg/l	178	182	191	169	197	188	161
Total suspended solid - mg/l	317	315	312	308	250	242	216
Turbidity – mg/l	121	116	126	118	97	92	94
Conductivity - µs/cm	194	198	192	183	116	128	136
Biological Oxygen Demand (B.O.D) –mg/l	30	32	32	32	28	26	24
Chemical Oxygen Demand (C.O.D) – mg/l	88	97	92	91	80	85	85
Dissolved Oxygen (D.O) - mg/l	4.9	4.8	5.1	4.8	3.9	3.7	3.2
Nitrate – mg/l	2.16	2.0	2.35	2.98	2.74	2.56	2.21
Phosphate – mg/l	2.05	2.0	2.1	2.21	1.96	1.74	1.45
Sulphate – mg/l	0.67	0.59	0.48	0.67	0.46	0.49	0.39
Sodium – mg/l	28	32	22	21	22	29	25
Magnesium – mg/l	0.87	0.79	0.87	0.98	0.77	0.84	0.85
Potassium – mg/l	16	16	15	16	11	9	8
Calcium – mg/l	21.4	22.6	22.2	22.3	18	17	17
Iron – mg/l	20.6	21	20.8	21	18	15	13
Zinc – mg/l	0.5	0.53	0.6	0.6	0.49	0.51	0.45
Copper – mg/l	1.69	1.67	1.8	1.8	1.2	1.1	1.0
Silica – mg/l	0.76	0.77	0.8	0.69	0.54	0.51	0.49
Fecal Coliform	860	856	809	854	603	204	205
Total Coiform MPN/100ml	2100	2057	2090	1807	1803	1504	890

Fecal coliform and Total coliform are in very high numbers in Taldanda canal. They are increasing in down stream direction and may cause serious health problems.

Recommendations

1. BOD and COD values are very high. This can be removed by using hydrogen peroxide or oxidation using aerators or coagulants. For BOD and DO simulation at different location, proper water quality modeling approach needs to be applied to find the assimilative capacity and most suitable site for waste disposal with their appropriate quantity.
2. Iron and Copper are present in high amount, which needs to be controlled by effluent management and suitable removal techniques including oxidation, activated carbon,

ion exchange, chemical treatment, membrane or adsorption techniques. Some trace metals such as Zinc, Lead, Chromium, Cadmium, Cobalt, and Boron have been detected, which may be a alarming signal for future water management. Chemical treatment, activated carbon, coagulation, ion exchange, and membrane techniques should be applied.

3. Biological variables (Total coliform, Fecal coliform and E-coli are available significantly), which may cause serious health problem to be people drinking the canal water and using it for drinking purposes. Chlorination, UV technique, membrane techniques are mainly required for pathogen removal. However, Total organic carbon should be checked before injecting chlorine to avoid formation of disinfection byproducts which causes cancer.
4. Turbidity is high, which needs to be reduced to improve the water quality ionic components by chemical treatment, and ion exchange techniques.
5. Regular monitoring of highly toxic variables needs to be done and water quality management should be applied properly.
6. Water quality models developed in the present work are very useful to estimate chemicals, heavy metals, coliform, physical parameters, nutrients, organic matter, etc. at downstream station with high accuracy and correlation statistics.

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