WATER QUALITY ANALYSIS OF MAHANADI RIVER IN CUTTACK CITY

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ABSTRACT-The main objectives of the present study is to access the surface water quality of Mahanadi river in Cuttack city ,Odisha for knowing the suitability of drinking by comparing the primary data with permissible limits for drinking water quality according to World Health Organisation(WHO) and American Public Health Association (APHA).The water samples were collected from different locations of Mahanadi river in Cuttack during winter,summer and rainy seasons.Water quality assessment has been analysed on various physico-chemical parameters like pH,COD(Chemical Oxygen Demand), TDS(Total Dissolved Solids),BOD(Biological Oxygen Demand),TH(Total Hardness),Chloride,Nitrate,Sulphate ,Fluoride and EC(Electrical Conductivity).These are compared to established standards. The obtained results indicate that the quality of water slightly deviates from the potable conditions at some stages.The Mahanadi water is polluted due to the reasons like discharge of domestic effluents,flow of sewage,industrial effluents, biomedical waste,man- made water pollution like immersion waste, Causes of turbidity include soil erosion, waste discharge, urban and algal growth. Turbidity causes the decline in quality of water due to the presence of colloidal particles. Restriction of environmental flows(EFs) affects the healthy water ecosystems. Microbial pollution or contaminated water is believed to be the large single cause of water borne diseases.Realising the importance of this problem, this study aims at determining the present pollution load of the river, EF and based on the findings, suitable models for prediction of the pollution behaviour at different locations of the Mahanadi river and its remedial measures are to be framed.Detailed study is needed to identify the exact reason behind alteration of water quality of the Mahanadi river at different points.

Keywords : *Physico-chemical parameters, Industrial Effluents, Biomedical waste, EF, MC.*

1.INTRODUCTION

The Mahanadi is a major river in East-central India. It drains an area around 141600km^{2}and has total course of 858km.and runs across a number of districts of Odisha. The Mahanadi flows through a vast stretch with numerous perennial and non-perennial streams and enters the Bay of Bengal at false points by several channels.The river traverses Cuttack district in an east-west direction.Water resources have critical importance to both natural and human development. Water is the universal solvent and one of the most abundant compounds of the ecosystem. The healthy aquatic ecosystem is depended on the physico-chemical and biological characteristics of water.The Mahanadi watershed is the most developed and urbanized region in the state of Odisha. The river on its way supports more than a few hydro-electric plants and serves as a key source of irrigation in the state.The assessment of water quality analysis of the river Mahanadi inCuttack city is of utmost importance because of various reasons like rapid urbanization, agricultural and industrial waste, sewage water comprising of domestic, medical and other wastes due to anthropogenic activities.The alarming water pollution not only degrades of water quality but also threatens human health and balance of aquatic ecosystem, and economic development of the state.Due to the construction of barrages and reservoirs on the upstream and interstate disputes, environmental flow of the Mahanadi river water is not sufficient for shielding or maintaining the construction and function of an ecosystem and its dependent species.The slowing down of water would adversely impact on the ecosystem and be a tremendous threat to the environment,ecology and aquatic life.Therefore,a need arises to regulate the reservoirs and barrages for releasing the adequate water in

the river throughout the year. Thus, environmental flows assessment is done in lower Mahanadi sub-basin for providing the Environmental Flow Requirements (EFRs), with a range of low flow requirements (LFRs) and high flow requirements (HFRs) to be ensured at any circumstances to avoid any degradation of river ecosystem.With the increasing awareness in the field of water pollution control, setting up Micro Composing Centers(MCCs) and the willing to maintain high quality level of the river sorroundings. Our approach in this paper will help in evaluating the quality of the river to be utilized for various beneficial uses of Cuttack city.A river quality monitoring programme(RQMP) could be designed on the basis of the information on the existing water quality,standards,anthropological effects and the 'use' criteria.

2.MATERIALS AND METHODS

2.1:Study Area-

Sampling sites of the present study mainly comprises of five locations of Cuttack city i.e Chahata Ghat(L-1),Gadagadia Ghat (L-2), Mata Math(L-3), Jobra Barrage(L-4), Sikharpur Kaliabuda (L-5), covering river water.

Fig-1 Chata Ghata(L-1)

Fig-2 Gadagadia Ghata(L-2)

Fig-3 Mata Matha(L-3)

Fig-4 Jobra Barrage(L-4)

Fig-5 Sikharapur Kaliaboda(L-5)

2.2:Sample Collection and Water Analysis-

The water samples were collected at different locations of the Mahanadi river in Cuttack during Summer-S1,Rainy-S2 and Winter-S3 season in the early hours of the day.Water samples filled in the plastic bottles previously rinsed with distilled water were kept in the refrigerator.The water samples were analyzed in the laboratory following standard method of American Public Health Association(APHA 2017) by various physical-chemical-biological parameters such as-

PARAMETERS	INSTRUMENTS	METHOD NAME
pH	pH meter	Electromeric method
Total Dissolved Solid	TDS meter	Instrumental method
Electrical Conductivity	Conductivity meter	Instrumental method
Total Hardness	Titrimetry	EDTA Titrimetric method
Dissolved Oxygen	DO meter	Electrode method
Chemical Oxygen Demand	COD reactor	COD method
Biological Oxygen Demand	BOD incubator	BOD method
Chloride	UV-VIS Spectrophotometer	Argentometric method
Fluoride	UV-VIS Spectrophotometer	SPADNS method
Nitrate	UV-VIS Spectrophotometer	UV spectrophotometric Screening
Sulphate	UV-VIS Spectrophotometer	Nephelo turbidimetric method

2.3: Statistical Analysis-

The results obtained were subjected to two way ANOVA using MS Excel data analysis tool.

3.RESULT AND DISCUSSION-

TABLE-1 :Physico-chemical parameters showing " mean ±SD" in Summer season(S1)

PARAMETER	SAMPLING LOCATIONS(MEAN±SD)				
	L-1	L-2	L-3	L-4	L-5
PH	6.80 ± 0	6.82 ± 0	6.83 ± 0	6.78 ± 0	6.85 ± 0
EC(mho/cm)	312 ± 0	314 ± 0	316 ± 0	310 ± 0	318 ± 0
COD(mg/I)	62.55±0.587	66.53±0.423	68.32±0.587	58±0.981	78.33
BOD(mg/I)	2.68. ± 0.21	2.74 ± 0.065	2.88 ± 0.049	2.73 ± 0.059	2.89 ± 0.055
TH(mg/I)	40 ± 1	42.38±0.564	45.56±1.153	36.35±0.561	47.59 ± 0.562
TDS(mg/I)	165.54±0.562	185.62±1.228	234.46±0.562	158.64±1.627	254.45±1.164
DO(mg/I)	4.9 ± 0.053	4.7 ± 0.053	4.5 ± 0.053	5.02 ± 0.121	4.1 ± 0.120
CHLORIDE (mg/I)	36±1	39±1	44±1	33±1	48±1
FLUORIDE (mg/I)	0.16±0.01	0.18±0.01	0.23±0.02	0.12±0.01	0.25±0.01
NITRATE (mg/I)	15±1	18±1	20±1	14±1	22±1
SULPHATE (mg/I)	18±1	20±1	23±1	19±1	24±1

TABLE-2 :Physico-chemical parameters showing "mean ±SD" in Rainy season(S2)

PARAMETERS	SAMPLING LOCATIONS(MEAN±SD)				
	L-1	L-2	L-3	L-4	L-5
PH	7.11±0	7.13±0	7.16±0	7.10±0	7.18±0
EC(mho/cm)	287±0	289±0	292±0	285±0	295±0
COD(mg/I)	27.25±1	30.39±1.53	32.62±0.588	25.79±1.17	34.32±0.588
BOD(mg/I)	3.10 ± 0.21	3.12 ± 0.065	3.33 ± 0.049	2.99 ± 0.059	3.35 ± 0.055
TH(mg/I)	22.71±1.623	23.69±0.588	27±1	20±1	29±0.5
TDS(mg/I)	150.74±0.058	152.33±0.052	154.03±0.052	148.98±0.052	156.54±0.051
DO(mg/I)	4.23±0.056	4.25±0.021	4.27±0.058	3.76±0.049	4.29±0.058
CHLORIDE (mg/I)	25±1	27±1	29±0.4	19.34±1	32±1
FLUORIDE (mg/I)	0.19±0.01	0.20±0.01	0.22±0.01	0.17±0.01	0.29±0.01
NITRATE (mg/I)	39±1	40±1	43±1	37±1	42±1
SULPHATE (mg/I)	17±1	19±1	21±1	15±1	27±1

TABLE-3 : Physico-chemical parameters showing "mean ±SD" in Winter season(S3)

PARAMETERS	SAMPLING LOCATIONS(MEAN±SD)				
	L-1	L-2	L-3	L-4	L-5
PH	6.79±0	6.82±0	6.85±0	6.75±0	6.87±0
EC(mho/cm)	296±0	298±0	301±0	294±0	303±0
COD(mg/I)	25.15±1	27.02±1.53	29.34±0.588	23.24±1.17	31.38±0.588
BOD(mg/I)	2.89±0.057	2.91±0.058	2.93±0.059	2.82±0.057	2.94±0.116
TH(mg/I)	19.52±1.623	22.69±0.588	25.32±1	17.12±1	28.04±1
TDS(mg/I)	144.97±0.058	147.42±0.052	149.30±0.052	142.95±0.052	151.24±0.052
DO(mg/I)	5.27±0.058	4.51±0.061	4.26±0.057	5.30±0.044	4.22±0.056
CHLORIDE(mg/L)	29±1	18±1	26±0.4	22±1	27±1
FLUORIDE (mg/I)	0.10±0.01	0.13±0.01	0.15±0.01	0.09±0.01	0.17±0.01
NITRATE (mg/I)	34±1	39±1	41±1	35±1	41±1
SULPHATE (mg/I)	19±1	21±1	23±1	17±1	25±1

pH LEVEL-pH is important to quantify the health of a river since water is used by public for direct consumption.pH of water at all study sites showed a narrow range of variation 6.75 – 7.18 and well within the tolerance limit. pH is recorded high in summer at location L-5 and is due to 'algal blooms'.The low pH in winter was 6.75 at location L-4, may be due to input of raw sewage into the river water.

ELECTRICAL CONDUCTIVITY-Pure water is a poor conductor of electricity. Presence of acids , bases and salts in water make relatively good conductor of electricity. The greater the conductivity ,the greater is the quantum of anions and cations in the water and the greater is the dissolved mater(electrolyte).Electrical conductivity is used as a basic index in judging the suitability of water for potable properties. Present studies revealed that all the samples recorded conductivity values well within the tolerance limit prescribed by ICMR and WHO.EC of water samples of all locations was high in summer in comparison to winter and rainy seasons.EC of location L-5 is high i.e 318mg/L,may be due to inflow of urban waste containing heavy ionic concentrations.EC was low in rainy season and ranged from 295mg/l at location L-5 to 285mg/L at location L-4.

CHEMICAL OXYGEN DEMAND-COD was recorded higher in summer than rainy and winter seasons.COD were ranged from 78.33mg/L at location L-1 in summer to 23.24mg/L at location L-4 in winter.High COD have been reported to be associated with high organic matter content and sewage disposal in the river.High COD value indicate that river water is polluted.

BIOCHEMICAL OXYGEN DEMAND-BOD-The degree of microbially mediated oxygen consumption in water is known as biochemical oxygen demand. This parameter is commonly measured by the quantity of oxygen utilized by suitable micro-organisms during 5 days period at $20^{o}C$ .It is not a pollutant but an indicator to what extent the water is polluted. If it is 6.0mg/l or more in water body, the same is said to be polluted. BOD was more in rainy than summer and winter seasons.The value ranged from 2.94mg/L at location L- 4 in winter to 2.68mg/L at location L-1 in summer season.Higher value of BOD during rainy season was due to organic waste and enhanced bacterial activity.

TOTAL HARDNESS-TH of water samples was found to be higher in summer than rainy and winter seasons.During summer the TH of water samples value ranged between 47.59 mg/L at location L- 5 to 36.35mg/L at location L-4.TH range in rainy was 20mg/L to 29mg/L and in winter was 17.12mg/L to 28.04 mg/L. The permissible limit for total hardness is 300mg/L(IS10500).Hence all the water samples in the present study are were within the permissible limit.The increase in hardness in summer season may be due to washing clothes, bathing animals and servicing vehicles at the river site.

TOTAL DISSOLVED SOLID-. TDS contains different kinds of nutrients and has been proved to be a very useful parameter. Rising of TDS content causes pollution**.**Excess amount of TDS may disturb ecological balance and cause imbalance in osmotic regulation and suffocation in aquatic fauna even in the presence of fair amount of dissolved oxygen.Water containing more than 500 mg/l of TDS is not considered desirable for drinking water supply and normally less palatable and may induce an unfavourable physiological reaction in the transient consumer.TDS was maximum in summer than rainy and winter seasons.Duringsummer,the value ranged from 158.64mg/L at location L-4 to 254.45mg/L at location L-5.TDS value was lowest in winter and ranged from 142.95mg/L to 151.24mg/L and in rainy season was 148.98mg/L to 156.54 mg/L.The values are well within the permissible limit for water.

DISSOLVED OXYGEN-DO-Dissolved oxygen is one of the most important parameters of water quality assessment and reflects the physical and biological processes prevailing in the water and show metabolic balance. A high DO level in a river water sample is good because it makes the water better from drinking as well bathing point of view and friendly for aquatic lives. However, according to Europian Economic Community the standard value of DO is 5mg/l of drinking water. The DO values of water samples from the river at all study locations ranged from 3.76mg/L to 5.30mg/L.The values were nearthe limits of drinking water standards.

CHLORIDE-Public drinking water standards require chloride level not to exceed 250 mg/L. Chloride ions may come into water due to anthropogenic or road salt, oil well wastes, water softeners waste water from industries and sewage contaminations. Chloride content of water samples was recorded higher in summer than rainy and winter seasons. Its value ranged between 33mg/L at location L-4 to 48mg/L at location L-5 in summer season. During rainy season its value ranged between 19.34mg/L at location L-1 to 32mg/L at location L-5 and in winter was 22mg/L to 27mg/L.Thedatas were within the permissible limits.

FLUORIDE-Fluoride level of water in rainy season was higher in summer and winter seasons.The permissible level of fluoride in potable water is 1.5mg/L as recommended by IS10500.During rainy season ,the value ranged from 0.17mg/L at location L- 4 to 0.29mg/L at location L-5.Fluoride content was ranged from 0.12mg/L to 0.25mg/L in summer and 0.09mg/L to 0.17mg/L in winter season.The values of fluoride level at all study locations were well below the permissible limits.

NITRATE-High level of nitrate in potable water may due to manure storage ,excessive use of inorganic fertilizers, rotten vegetables, domestic waste water, septic systems, industrial discharges, inflow and atmospheric precipitation which can cause methemoglobinemia or 'blue baby' disease..Nitrate content recorded higher in rainy than winter and summer seasons. Nitrate was ranged from 37mg/L at location L-4 to 43mg/L at location L-3 in rainy season.During summer nitrate content was ranged from 14 mg/L at location L4 to 22mg/L at location L-5 and in winter was 34mg/L at location L-1 to 41mg/L at location L-5.The permissible limit for nitrate is 45mg/L. All water samples contained nitrate were within the permissible limits.

SULPHATE-Sulphate content of water in rainy season wasrecorded higher than summer and winter.During rainy season the value ranged from 15mg/L at location L-4 to 27mg/L at location L-5,in summer was 18mg/L at location L-1 to 24mg/L at location L-5 and in winter was 17 mg/L at location L-4 to 25 mg/L at location L-5. Sulphate content values in all locations in winter, rainy and summer seasons were under the permissible limits i.e 150 mg/L as recommended by IS10500.

4.CONCLUSION-

The Mahanadi is said to be the life line of the state of Odisha and almost criss-crosses the state during its course and deposits more silt than any river in the Indian sub-continent.Average annual surface water potential of 66.9Km^2 has been assessed in this basin.Culturable area in the basin is about 80,000square kilometers which is 4% of the total culturable area of the country. But the matter of grave concern that the water quality is increasingly deteriorating which is mainly attributed to the uncontrolled and improper disposal of solid and toxic waste from industrial effluents,agricultural runoff and other human activities.Not only the degradation of water qualities but the pollution of the Mahanadi river in Cuttack city threatens the human health and disturbs the balance of aquatic ecosystem, ultimately resulting in hampering the economic development of the state.This is high time that a collective effort should be made to see that the Mahanadi is back to its normal self and be beneficial to all flora and fauna around it.To sustain a healthy water quality of the river and to preserve the aesthetic properties of aquatic systems, a concerted endeavor is to be made for proper management of industrial waste and its disposal system. Care has to be taken to see that the diversion of local drains does not carry effluents from various sources from the city area.The waste could be treated so that the water remains usable.

The approach described in this paper will go a long way to serve as a useful tool in evaluating the quality of the water and making suggestions to improve the same that the river becomes expedient to Cuttack city.This paper also aims at creating a general awareness regarding the pollution that has taken a heavy toll so far as the water of the Mahanadi is concerned.

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