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PHYSIO-CHEMICAL PROPERTIES OF ERAI RIVER AND SUGGESTED TREATMENT GIVEN TO IT BEFORE ITS DISTRIBUTION

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Abstract: Human survival is dependent on five essential components. They are air, water, soil, heat and food, of which water plays a vital role and is linked with other components. Modernization and civilization have given rise to human development, but has ruined the essential and life sustaining components. The river water being only 0.6% in quantity, it has a wide scope. Hence, its quality check is important before use. One such physico-chemical parameter of Erai River during summer season was carried out to compare the quality of river water during monsoon. The results of physico-chemical parameters during monsoon have been already published and in this, we are presenting the results of river water collected during summer. The treatment given to the river water and its quality parameters is presented in this paper along with amendment suggestions for treatment of water before connecting to domestic supply.
Keywords: Human survival; Monsoon; River water quality; Summer.

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INTRODUCTION

The determination of physico-chemical parameters of Erai River was carried out to check the quality of river water during monsoon. The sampling was carried for a period of two months at five different locations of Erai River. The Erai River is the river located in Chandrapur district having a length of approximately 75 km. It is one of the tributaries of the Wardha River which flows from Madhya Pradesh in the north and joins Godavari in the south. The various physico-chemical properties of the Erai River during monsoon have been tested and the results have been recorded and published Shende & Rathoure 2020 and 2021. The water quality index of Erai River has been also calculated (Shende & Rathoure, 2021).

EXPERIMENTAL

Further, the sampling was carried during the summer season to compare the results with that obtained during monsoon. The sampling locations were the same as were in the paper published covering a total distance of 23.3 km. Following are the sampling locations:

Table 1. Sampling locations

Sample Code	Sample Location	Remarks
S1	Datala Road	Upstream
S2	Wadgaon Bridge	Upstream
S3	Bimba Gate	Downstream
S4	Pathanpura Gate	Downstream

S5	Sone chafe Mahadev mandir	Downstream
S6	Village Hadasti	Confluence points of Wardha & Erai River

The sample location (S4) has been added, as the condition of the location was very poor. The water was black in color with scum flowing over it. Also, the algal growth was high indicating high nitrogen and phosphorus content. The river was also polluted due to dumping of burnt ashes and due to open defecation by the people.

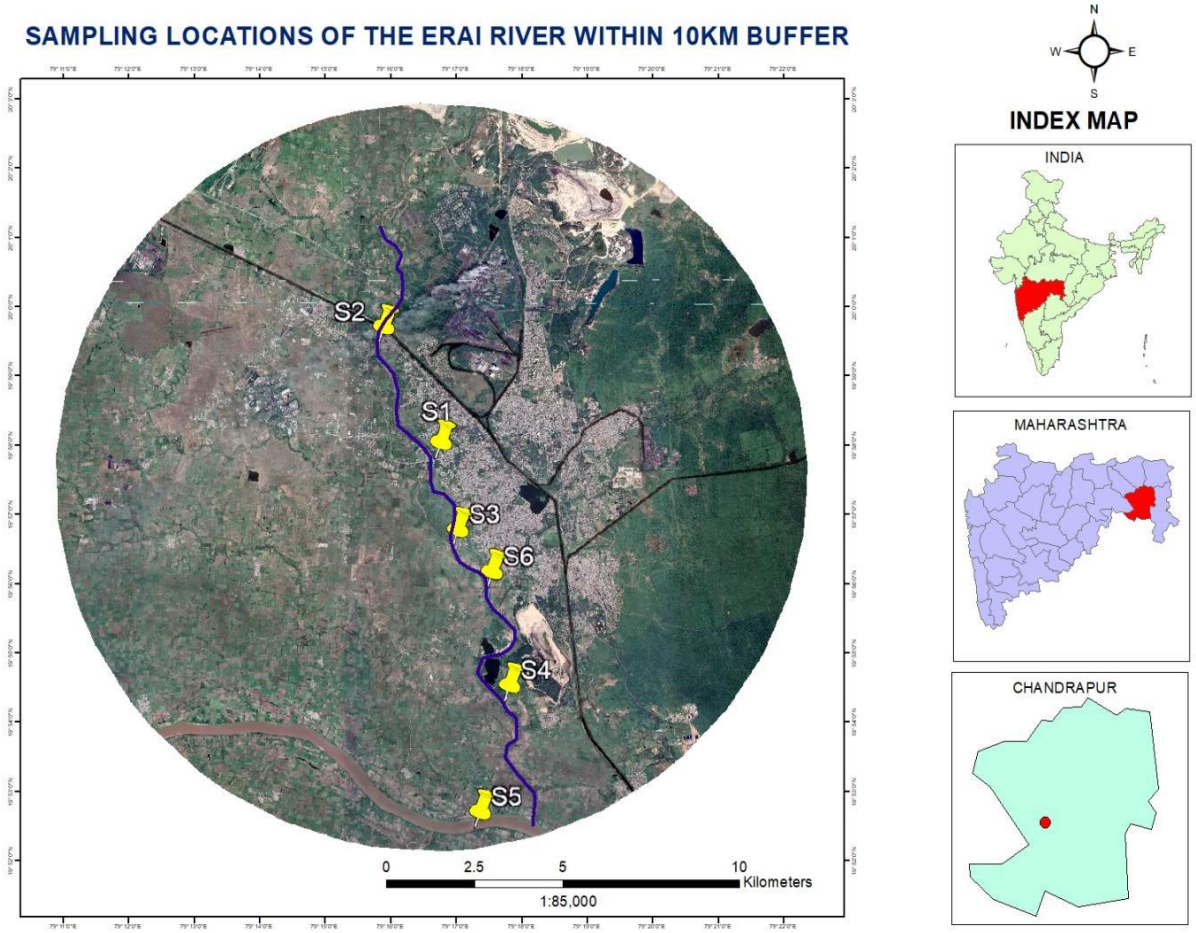

Figure 1. Map showing sampling locations (Erai River)

Showing high nutrient content

Scum formation

Figure 2. Nutrient Rich Water

Datala Road

Wadgaon Bridge

Bimba Gate

Pathanpura Gate

Sone Chafa Mahadev Mandir *Hadasti Village*

Figure 3. Different sampling locations

RESULTS AND DISCUSSION

From the results obtained during monsoon and summer (Table 2), it was estimated that the city requires a well-designed treatment plant to treat the incoming waste before its supply to household connections. Such a plant is under construction at Ramnagar, Chandrapur, Maharashtra. The population of the area, considering future predictions, will be nearly 93000. Due to population expansion, the capacity of existing treatment plants was planned to increase. This increase will help to tackle the problem of domestic water at present and in near future. Further, a modification to the proposed plant was decided by including a recirculation system to the treatment plant. Such modification will decrease the pollution load of the river. The distribution network will cover many areas adjoining the Municipal Corporation area. The existing plant has the capacity of 10 MLD and the proposed plant will be of 15 MLD. The raw water will flow under gravity from the Erai River. The sampling results of the existing 10 MLD water treatment plant is given in table 3.The fifteen parameters were analyzed for river water samples.

Table 2. Results of analysis at sampling locations during summer

S. No	Parameters (unit)	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
1.	Color (Hazen)	Fair	Fair	Fair	Fair	Fair	Fair
2.	Taste	Unobjectionable					
3.	Odor	Unobjectionable					
4.	Turbidity (NTU)	6	7	5	5	7	5
5.	Temperature (ºC)	31	30	31	30	31	35
6.	pH	7.8	7.6	7.5	7.4	7.4	8.4
7.	Alkalinity (mg/l)	79	74	80	98	84	79
8.	Conductivity (µs/cm)	64.5	70.8	63.8	62.2	66.6	58.2
9.	Total hardness (mg/l)	450	366	321	276	256	367
10.	TDS (mg/l)	32.2	35.4	31.6	31.7	33.3	24.1
11.	DO (mg/l)	7	8	6	9	7	9
12.	BOD (mg/l)	12	11	13	7	11	8

13.	COD (mg/l)	33	23	35	19	29	19
14.	Free CO_2						
15.	Chloride (mg/l)	78	89	70	89	96	85
16.	Fluoride (mg/l)	0.76	0.53	0.58	0.65	0.38	0.84
17.	Nitrate (mg/l)	32	35	46	39	42	45

Table 3. Analysis of Old WTP

S. No.	Test Parameter	Irrigation fountain Erai River	From sump well filter plant
1.	Physical Appearance	Yellowish black soily	Yellow soily
2.	Odour	Soily	Soily
3.	Turbidity (NTU)	4.97	1.30
4.	pH Value	7.4	7.0
5.	Chlorides	96	90
6.	Nitrates	36.59	32.07
7.	Total Hardness	260	260
8.	Alkalinity	100	80
9.	TDS	436	449
10.	Iron	0	0
11.	Fluoride	0.76	1.55

The above comparison shows that the total hardness is same before and after testing and also the TDS is very high exceeding its permissible limit. The detailed process of the proposed treatment plant has been mentioned below:

Construction of Water Treatment Plant of capacity 15 MLD with Re-circulation System

Aeration fountain (Cascade aerator): The raw water will enter the unit with the inflow rate of 625 m^3/hr. The total area of the aerator is 19.03 sq. m. The water flows through a cascade aerator to remove staleness or iron content present in the raw water. Four numbers of steps having a tread of 0.5 m and a rise of 0.2 m are provided.

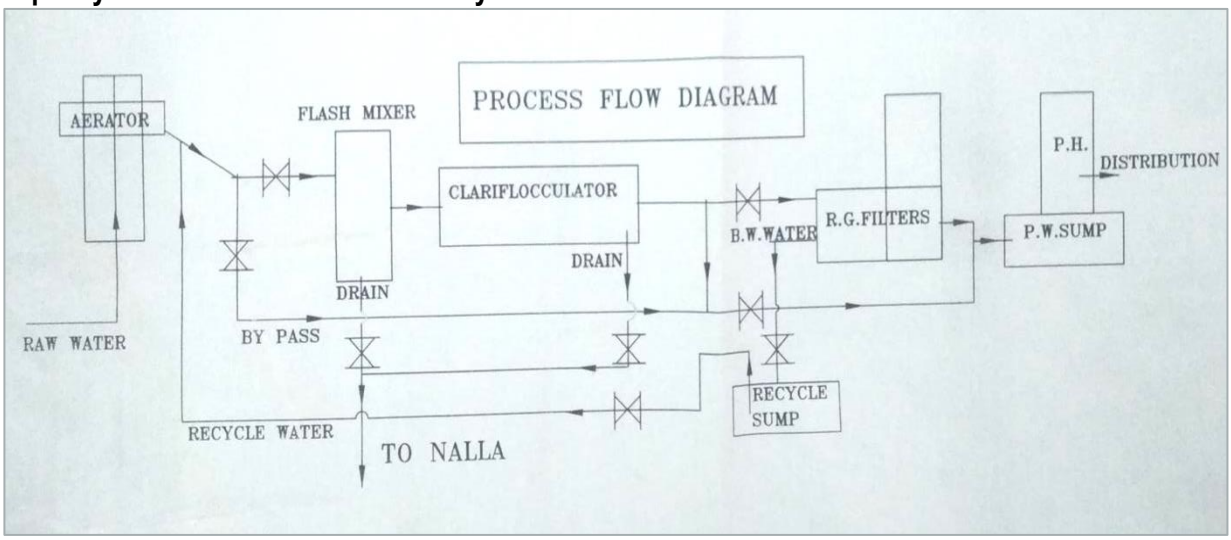

Figure 5. Process Flow Diagram of 15 MLD Water Treatment Plant

Existing

Proposed

Figure 6. Aeration Fountain

Figure 7. Parshall Flume

Raw Water Channel: The purpose of it is to connect the aeration fountain to the flash mixer and bypass chamber. A Parshall flume (venturi meter) is provided at the channel which measures the flow of the water going to the flash mixer. The purpose of it is also to reduce the velocity of the flow before entering into the flash mixer in order to maintain the flow in the flash mixer.

Flash Mixer: The water from the aerator passes to the flash mixer through a raw water channel. The volumetric capacity of the tank is 10.41 m^3. A detention period of 60 seconds is provided and is sufficient to facilitate proper mixing of chemical dose with the incoming water. Alum will be added as a coagulant at the inlet of flash mixture at a rate of 50 ppm. The settled sludge is drained and is sent to the aeration fountain along with the raw water for its treatment.

Clariflocculator: It is the heart of the treatment plant having an area of 538.169 sq. m. The outlet from the flash mixer enters first into the flocculation zone whose velocity is restricted to maintain the flocs. The detention time provided here is 30 minutes. Water further enters the

clarifier zone having a detention period of 2.50 hours for effective sedimentation and removal of the flocs. The settled sludge is scrapped through the scrapper and is periodically passed to the drainage chamber provided.

Bypass Chamber: It is a round shaped chamber having diameter 2 m and height 4.50 m. This unit is designed to bypass the flow from the clariflocculator in case of shutdown. In that case the flow from the aeration fountain is directly passed to the filter bed for treatment.

Filter House: The outlet from the clarifier is sent to the filter house consisting of six beds of twin sections having dimensions of 3.90 m X 2.80 m. The rate of filtration provided for each section is 4.80 $m^3/ m^2/$ hour. The rate is increased to 6.00 $m^3/ m^2/$ hour when one bed is taken for washing. The rate of back washing is provided as 36 $m^3/ m^2/$ hour. The wash water storage tank is constructed at the top of the filter house to store water for back washing filter beds. The filter media will be provided in five layers of sand and gravel having size varying from 0.45 mm to 50 mm with uniformity coefficient of 1.3 – 1.7.

Proposed *Existing*

Figure 8. Clariflocculator

Filter Bed (Proposed) *Filter Bed (Existing)*

Figure 9. Filter House

Chemical House: It is a two storied building constructed for storing chemicals (such as alum, lime and Total Chlorine) sufficient to fulfill requirements for 90 days. Three numbers of tanks each of alum and lime will be provided for dosing at the outlet at the cascade aerator. The maximum dose of alum and lime will be 50 mg/L (10% conc.) and 25 mg/L (5% conc.) respectively with each tank having a capacity of 2500 liters. Both Alum and lime suspensions will be dosed by gravity through a constant head dosing box.

Chlorination: A post chlorination treatment is necessary before discharging it to various pipe networks to destroy the microorganisms (if any) in the treated water. Two numbers of chlorinators will be provided having a capacity of 500 cum/hr. This will help in controlling the contamination in the water, increasing the portability and aesthetic condition of the water. The dose of chlorine will be in gaseous state having a maximum dose of 3 mg/L. Two numbers of chlorinators will be provided as per the design.

Pure water sump and pump house: Water that is filtered through filter beds is sent to pure water sump for its storage. The sump is designed to store water of total capacity 625 m^3. The water is then sent to the Mass Balancing Reservoir (MBR) through the submersible pumps. Centrifugal pumps will be installed for this purpose. Adequate chlorine dosing at a rate of 3 mg/l will be done to kill microorganisms (if any) present after passing the water through filter beds. This treated water is then stored in Pure water sump also named as clear water sump. The stored purified water in MBR will be then distributed at a regular interval to the household pipelines.

Underground sump: The underground sump is provided to store the water that will be sent for washing the filter bed in wash water tank.

Re-circulation sump: The function of it is to store the water that will be used for back washing of filter beds. The stored water will be diverted to the inlet of the aeration fountain for its further treatment. Three numbers of submersible pumps of capacity 72 cum/hr will be installed to draw water.

CONCLUSION

It was found that the river water was of fair quality having dissolved oxygen within permissible limit. The direct consumption could be harmful as the total hardness were not within the range. The aquatic lives could survive here but at some places the scum formation might trouble them. The Total Dissolved Solids were also within the range and hence the pH. Considering the results of the testing carried in summer as compared to that of during winter, the quality of river water is better in summer. The quality of river water during monsoon was average as the various parameters exceeded the permissible range. As discussed in the early paper a suitable treatment is required to treat the incoming water before its distribution at the various locations. Therefore, a new water treatment plant has been designed to treatment the river water. The construction is in process and will treat the 15 million of water per day. The plant has been designed with re-circulation system which will reduce the pollution load of the river *i.e.,* the drained water will be sent along with the incoming raw water instead of discharging it back into the river. Currently the 10 MLD water treatment plant does not have the re-circulation system and hence all the back-washed water goes into the river. This process creates the pollution load into the river and also the solids present in the backwash water increases the friction, thus deteriorating the surface of the pipe material.

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