Octa Journal of Environmental Research
International Peer-Reviewed Journal
Oct. Jour. Env. Res. Vol. 8(3): 067-077
Available online http://www.sciencebeingjournal.com

Jul. – Sept., 2020
ISSN 2321 3655

Research Article

Octa Journal of Environmental Research
(Oct. Jour. Env. Res.) ISSN: 2321-3655
Journal Homepage: http://www.sciencebeingjournal.com

PHYSICO-CHEMICAL PROPERTIES OF ERAI RIVER IN MONSOON NEAR CHANDRAPUR CITY (MAHARASHTRA) INDIA

Shraddha Shende and Ashok K. Rathoure
M/s Akone Services, Lucknow, India
Corresponding Author's Email**: shraddhashende1997@gmail.com**
Received: 1st Sept. 2020 **Revised:** 10th Sept. 2020 **Accepted:** 15th Sept. 2020

Abstract: The environmental aspects of the earth are interlinked naturally of which water is the essential component in the sustenance of the living organism. Water occurs on earth in various forms, one of which is liquid. The purest form being rain makes its way towards water bodies increasing their level when falls on the earth and provides moisture to the crops for cultivation. The study was carried out during monsoon for a period of two months (July-August) of the Erai River in the Chandrapur district of Maharashtra, to determine the quality of river water. Various Physico-chemical parameters such as rainfall, pH, turbidity, color, TDS, DO, etc., were determined and the final result was evaluated from the average determined from a period of two months. The samples were collected from five different locations of Erai River. Erai River is the tributary of the Wardha River which meets to Erai River at Hadasti village. The turbidity was found greater and Dissolved oxygen was found almost negligible in the water. This indicates the river was polluted during monsoon which is a serious threat to aquatic life.
Keywords: Aquatic life, July, Monsoon, Wardha River, Water Pollution.
Postal Address: Shivaji Nagar, LCH Qtr. No. F10, Behind UCO Bank, Ghugus. Dist.- Chandrapur (MS) India

INTRODUCTION

Water, as always, has played a major part in survival of living organisms. Despite the geographical location, size, population, source, etc., its quality and quantity always remain a question. Due to rapid increase in industrialization and urbanization, the need and demand for water has been increased, making it the most valuable resource. As there is no substitute to water, it must be utilized and consumed effectively. India being the sub-tropical country has a very hot summer climate. Relatively, the climate of Chandrapur district is mostly tropical. Summer months are mostly hot and humid while the rainy season is moderate and pleasant. During summer season, the level of the water in the river decreases making the city water scarce. Rainfall is the major backbone for agricultural as well as industrial production besides the important component for living organisms to thrive. A major population of the world receives water from river for their daily domestic purposes. There are some areas in the world that receive huge precipitation whereas other areas do not even receive sufficient rainfall to satisfy their thirst. The purest form of water is rain which ultimately deteriorates when falls on the earth as it flows towards the water bodies finding its path. Hence, it is important to conserve, preserve and utilize the water.

The Chandrapur district is blessed with many rivers, one of which is Erai River. It is located at latitude of 19°57'31.67"N and longitude of 79°16'37.18"E at its center. It is a tributary of Wardha River and is a main river in Chandrapur. The Erai River originates near Kasarbodi village of Chimur taluka and meets Wardha River near Hadasti village. It has a total length of 78 km and lies entirely within Chandrapur district. The river has a dam built on it called Erai Dam. The dam has a height of

30 m and a length of 1620 m. The volume content of the dam is 985 km^3 and gross storage capacity is 226,500.00 km^3. The Municipal council in Chandrapur district supplies drinking water to the local public from Erai river dam. The Maharashtra State Electricity Board (MSEB) had built this dam across the river for industrial operations. The Erai River is the lifeline for the people residing in and around Chandrapur city. It primarily supplies water to the Chandrapur city and Chandrapur Super Thermal Power Station (CSTPS). After the establishment of major industries such as M/s CSTPS and Western Coalfields Limited (WCL), the river started to get polluted and is now gasping for breath. When the drinking water supply scheme from the Erai was initiated, the population of Chandrapur was approx. 50,000 and now, it is more than 3 Lakhs.

Erai River Profiling

Erai River, which is the backbone of the Chandrapur Super Thermal Power Station (CSTPS), lifts 304 MLD of water daily from the river for its operation. Further, 54 MLD of whole water is supplied to the city and surrounding villages for domestic activities. A part of it is also used by commercial institutions and religious establishments. As the city does not possess any treatment plant to treat the incoming sewage, a large amount of effluent has been discharged into the river, making the river most polluted and contaminated for aquatic life as well as for local people. The whole of the domestic waste and a part of the treated waste from CSTPS is discharged into the river. Besides this, other M/s WCL opencast mines consume river water. During summer season, the industries mainly CSTPS have to limit their water usage to ensure enough drinking water for the city. The water is used for irrigation purposes and activities such as bathing of animals and washing of clothes also takes place. Due to agricultural run-off, the river water has been polluted and hence the quality of water has deteriorated.

Source of Pollution

The major source of pollution in the river is due to direct discharge of domestic and industrial effluent. Domestic pollution due to human settlement, local residence and municipal council located surrounding the river, discharges large amount of effluent into the river at various locations. The city does not have a sewage treatment plant to treat the waste, and hence it receives about 7385.25 BOD/ kg/day from rural and urban habitation and about 751.3 BOD/kg/day of domestic sewage from industries. The dam is constructed and is situated at latitude of 20.16773810 N and longitude of 79.30480960 E respectively. The storage capacity of the dam was reduced from 193.003m (in the year 1983-85) to 144.796m (2007-08) in mm^3 due to siltation, and was estimated as the difference between original capacity and present capacity. The study found out the quality of Erai dam was suitable for aquatic life. The sample was collected monthly from five different stations for a period of one year *i.e.* from August 2007- July 2008. Various physico-chemical parameters were tested and most results were within the limits as prescribed by the BIS. The physical parameter such as temperature was observed highest during summer and lowest during winter. The investigation showed temperature ranged from 22 ºC to 30 ºC which was suitable for the fish culture and the results were similar to those obtained earlier in 2000 (by Borse and Bhave). The water was found to be highly turbid in the monsoon season due to siltation. The presence of clay increases turbidity of water. Also turbidity restricts light penetration, which directly affects bio-productivity. The results for turbidity were in between 1 - 6 NTU. The pH was in the range of 7 to 9 making water quality good for aquatic culture. The conductivity ranged from 114 to 200mho/cm in the summer season and during summer the total volume of water decreases and the conductivity increases. The presence of salt content increases conductivity. Due to high temperature during summer, water evaporates leaving behind salt content. The conductivity value of Erai dam was favorable to the biological productivity. According to Swingle (1967) more than 15mg/L, CO_2 range is detrimental for fishes. The study showed that the range of CO_2 was between 0.014 to 1.22 mg/L. The chloride range was also observed

high in the summer season. Presence of chloride in the water source is used as an indicator of pollution. Total alkalinity was between 62-90 mg/L. Alkalinity and pH are so closely related. High alkalinities are able to shift pH. Water is more alkaline when the concentrations of hydroxyl ions are present in large quantities. It was observed that phenolphthalein indicator was significantly absent. D.O. is another vital parameter regulating survival of aquatic life. Higher D.O indicates good water quality. Colder water possesses high D.O than warmer water. The D.O. ranged from 3 to 5 mg/L. In the month of December and January, the D.O was observed to be higher and therefore good for production. The total hardness was within the standard limit and ranged between 44-67 mg/L. Calcium was found in the range of 30-80 mg/L. Magnesium ranged between 10-25 mg/L. A positive correlation was found between calcium, magnesium and total hardness. Phosphorus is a vital factor for fertility of soil. Its content less than 0.5mg/L is unfavorable for fish growth. The phosphorus ranged between 0.10 to 0.70 mg/L and was favorable for fish growth.

Causes of Pollution

a) Domestic sewage
b) Industrial effluent
c) Agricultural run-off
d) Hospital waste
e) Storm water
f) Commercial and religious establishments

The major water receiving sources apart from household domestic supply are as follow: Chandrapur Railway Station, collector office, Police station, Swad café, Head Post office, Hotel Sushilkaa, District court, Hotel Sidharth, Chanda Fort Railway Station, Babupeth Railway Station, WCL Area Hospital, City Police Station, Tandoor Restaurant and Bar, Hotel Palace Bar & Restaurant, Adivasi Vidyarity Vastigruh, Christ Hospital, Hotel Blue Paradise, Government Hospital, Pazare Nursing Home, Chandrapur District Jail, Hotel Motimahal, Chandrapur Super Thermal Power Station, Hotel Green Park, CTPS Hospital, WCL Durgapur Hospital, Mayur Hotel. Some minor water receiving sources are: BSNL office, Dr. Baba Saheb Ambedkar College of Art and Science, Azad Garden, Jubliee Junior College, TES Girls College, Badri Masjid, RGCERT, Nagar Parishad School, Nagar Parishad High School, Narmel High School, Government Engineering College, Paramount High School, SP College, Industrial Training Institute, Jainuddin Zaweri Polytechnic, SP Law College, INSIGHT Coaching classes, ACS College, Nehru Jr. College, Little Flower English, FES Girls College, Murlidhar Bagala High School, Shri Sai Polytechnic. Thus, by carrying out profiling of river helped to determine the quality of water during monsoon. It helped to predict the silt and clay content mixed with the river water through run-off. The water carried soil and mud along with the sewage making the water more polluted and aesthetically miserable. Moreover, the potability of water was evaluated by determining the physico-chemical properties of water and suitable treatment could be carried out if the parameters are not within permissible limits.

EXPERIMENTAL

a) Physico-Chemical parameters:

The following properties of Erai River were evaluated:

• Rainfall	• Temperature
• pH	• Calcium
• Alkalinity	• Color
• Conductivity	• Turbidity
• Hardness	• Taste
• TDS	• Odor
• Chlorides	• DO
• Nitrates	• BOD
• Phosphates	• COD
• Sulphate	• Free CO_2
• Fluoride	

b) Sampling Site and Sample Collection:

Sampling Sites

The samples were collected from five different places at five different locations of Erai River. The tests were performed using standard methods of APHA and Indian Standard. The sampling stations were selected based on the criteria of incoming load in to the river due to population density, industrial areas as well as anthropogenic activities such as mining and also ease of collection of water samples. Many regions within 10 km buffer zone were dense

forest and there was also no human settlement and hence less discharge. The total path traced for all sampling stations was 23.3 km. Hence, the first sampling station (S1) was the starting point of the path upstream and located near Datala road, approx. 6.7 km from Erai River. The second station (S2) was near Wadgaon Bridge and located 2.9 km from Erai River. The third sampling station (S3) was 7.9 km downstream of Erai River near Balaji Ward (Bimba Gate), the fourth station (S4) was taken near son chafa mahadev mandir (charwat gaon) 12.3 km downstream, and the last and fifth station (S5) was at the Hadasti village 16.6 km from Erai River and was the location from where the Wardha river flows towards Erai River. The Google earth image of study area map is depicted in figure 1. The latitudes and longitudes of stations are mentioned in table 1.

Sample Collection

The samples were taken from five different locations and were collected during day time for a time period of 2 months. The method of collection was as per APHA. The method used for sample collection and testing is listed in table 2.

Table 1. Latitudes and Longitudes of Sampling Stations

Stations	Latitude	Longitude	Remarks
S1	19°57'47.84"N	79°16'40.65"E	Upstream
S2	19°59'27.64"N	79°15'48.44"E	Upstream
S3	19°56'32.25"N	79°16'56.46"E	Downstream
S4	19°54'17.81"N	79°17'43.85"E	Downstream
S5	19°52'28.33"N	79°17'16.98"E	Downstream
Wardha & Erai River	19°52'31.24"N	79°18'10.30"E	Confluence point at village Hadasti

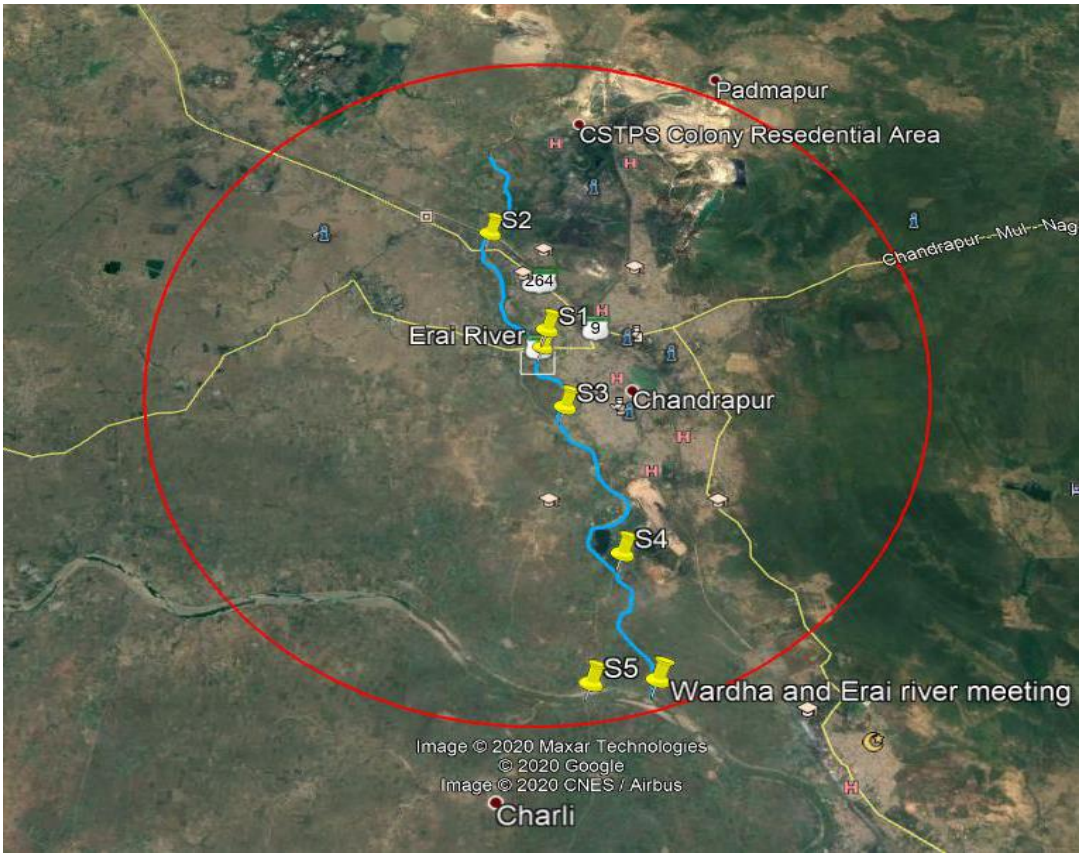

Figure 1. Study Area map shown over Satellite Imagery (Source- Google Earth Pro)

Figure 2. Sampling Locations along Erai River

Table 2. Parameters and Test methods

#	Parameters (Units)	Methodology	Method of Test	Equipment Used	Detection Limit
1.	Rainfall (mm)	Physical Method	IS 4986: 2002	-	-
2.	Color (Hazen)	Visual comparison	IS 3025 (Part 4)	Platinum cobalt	-
3.	Taste	Physical Method	IS:3025 (Part 7&8)	-	-
4.	Odor	Quantitative Human Receptor	IS:3025 (Part 5)	-	-
5.	Turbidity (NTU)	Nephelometric	IS:3025 (Part10)	Nephelo turbidity meter	0.1
6.	Temperature (°C)	Mercury Thermometer	APHA	Thermometer	0.001
7.	pH	Potentiometric	IS:3025 (Part 11)	pH meter	0.1-12
8.	Alkalinity (mg/L)	Titrimetric	IS:3025 (Part 23)	Burette	1.0
9.	Electrical Conductivity (µs/cm)	Conductivity cell potentiometric	APHA	Conductivity meter	10
10.	Total hardness (mg/L)	EDTA titrimetric	IS:3025 (Part 21)	Burette	1.0
11.	TDS (mg/L)	Gravimetric method	IS:3025 (Part 16)	Desiccator	1.0
12.	Dissolved oxygen (mg/L)	Winkler's titrimetric method	IS:3025 (Part 38)	Burette	0.1
13.	BOD (mg/L)	Bottle incubation at 27°C	IS:3025 (Part 44)	Incubator	0.1
14.	COD (mg/L)	Open Reflux	IS:3025 (Part 58)	Digester	0.01
15.	Free CO2	Titration	APHA	Conical flask	0
16.	Chloride (mg/L)	Argentometric Titration	IS:3025 (Part 32)	Burette	1.0
17.	Fluoride (mg/L)	Electrochemical probe method	IS:3025 (Part 60)	Millivolt meter	0.001
18.	Sulphate (mg/L)	Gravimetric method	IS:3025 (Part 24)	Desiccator	1.0
19.	Phosphate (mg/L)	UV Spectrophotometric	APHA	Visible spectrophotometric	0.1

#	Parameters (Units)	Methodology	Method of Test	Equipment Used	Detection Limit
20.	Nitrate (mg/L)	UV Spectrophotometric	IS:3025 (Part 34)	Colorimeter	0.001
21.	Calcium (mg/L)	EDTA titrimetric	IS:3025 (Part 40)	Hot plate	1

c) Test Analysis

Sampling was carried out for a period of two months *i.e.* July and August 2020 and results were obtained concerning each parameter in order to evaluate the final result based on the average calculated for the respective time period. The water analysis was done in the laboratory for selected parameters and precautions were taken such as addition of preservatives during transit of samples.

RESULT AND DISCUSSION

The results from data analysis showed that the water quality is suitable for aquatic life. This study involves determination of physicochemical parameters of water for different stations and is summarized in table 3. The detailed discussion about individual parameters given in next section.

Table 3. Analysis Result of Surface Water at 5 stations

#	Parameters (unit)	Station 1	Station 2	Station 3	Station 4	Station 5
1.	Rainfall (mm)	37.1	35.6	68.1	71.9	119.9
2.	Color	Turbid	Turbid	Turbid	Turbid	Turbid
3.	Taste	Objectionable	Objectionable	Objectionable	Objectionable	Objectionable
4.	Odor	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable
5.	Turbidity (NTU)	40	45	50	50	55
6.	Temperature (ºC)	30	30	29	29	28
7.	pH	7.82	7.83	7.85	7.84	7.86
8.	Alkalinity (mg/L)	128	129	130	130	131
9.	Conductivity (µs/cm)	0.45	0.46	0.47	0.48	0.49
10.	Total Hardness (mg/L)	152	155	156	157	157
11.	Total Dissolved Solids (mg/L)	158	138	172	183	196
12.	Dissolved Oxygen (mg/L)	0.4	0.4	0.5	0.5	0.6
13.	BOD (mg/L)	9.8	9.2	10	9.5	8.6
14.	COD (mg/L)	29	31	30	32	35
15.	Free CO2	2.25	2.50	2.50	2.75	3.25
16.	Chloride (mg/L)	119	120	120	121	122
17.	Fluoride (mg/L)	0.2	0.2	0.3	0.5	0.5
18.	Sulphate (mg/L)	56	56	57	58	58
19.	Phosphate (mg/L)	1.2	1.2	1.3	1.4	1.5
20.	Nitrate (mg/L)	1.9	2.0	2.1	2.1	2.2
21.	Calcium (mg/L)	36	37	38	38	39

Rainfall: Rainfall is one of the factors which are essential for all forms to sustain life. Rain water is the purest form of water but as it comes down and finds its way towards the water bodies, it carries many impurities such as sand, clay, etc. with it, thus deteriorating the quality of the water bodies. It is the important source for agriculture and for daily domestic activities. Hence it is important to measure the quality and quantity of rainfall. During the study, the rainfall in the month of July was found in the range of 0 – 71.9 mm, 71.9 mm being the maximum precipitation recorded on 14th July, 2020. Whereas another highest precipitation was recorded on 3rd August, 2020 as it ranged between 0 – 119.9 mm. The graphical representation of rainfall for the month of July and August is depicted in figure 3.

Color: Color is one of the physical parameters in determining the quality of water. It ranges from 5-20 mg/L. It was observed that the color of water samples at all sample locations was turbid due to presence of more clay and silt content during monsoon.

Taste: Taste in water is due to presence of dissolved minerals and dissolved inorganic salts. It is essential to maintain the temperature of laboratory and free from other disturbing odors while determining the taste of water. From the result, it was found that the taste of all water samples was objectionable due to high turbidity.

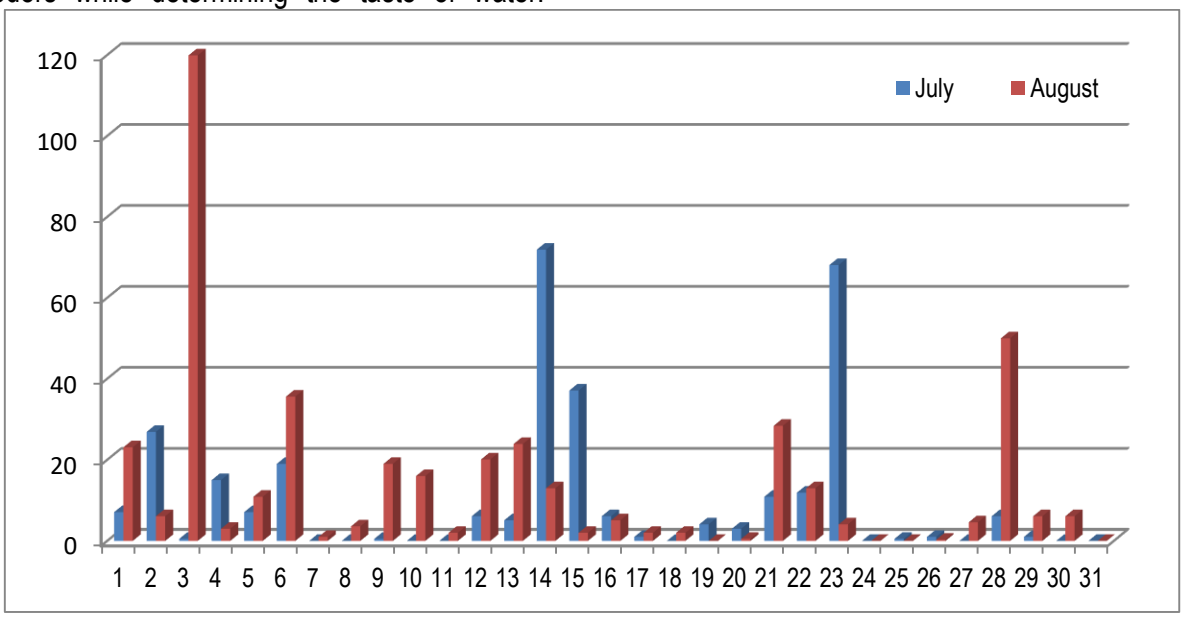

Figure 3. Precipitation in the month of July and August

Odor: Odor in water bodies is due to dissolved gases like H_2S, CO_2, and NH_3 and can also be due to the presence of decayed vegetation matter or aquatic organisms. The type of odor should be described by judging the degree of sweetness, pungency, smokiness and rottenness of the odor such as rotten egg, burnt sugar, soapy, fishy, septic, aromatic, chlorinous, alcoholic odor or any other specific type. Hence, the odor of water samples was quite unobjectionable as a large quantity of rain water had been mixed with it.

Turbidity: Turbidity in the water is due to presence of suspended solids like clay, silt, etc. and also due to presence of decayed vegetational matter. It is expressed in NTU. The instrument used to measure turbidity is Nephelometers and it is very precise method, and measures turbidity up to 0-1 NTU. This method is based on principle of scattering of light. The results for turbidity were beyond the desirable limit as prescribed by the BIS. The turbidity of water samples ranged from 40-55 NTU and was very high.

Temperature: Temperature is one of the factors influencing physico-chemical parameter of water. The temperature of water should be in the range of 20-35 ºC for adequate biological growth. An increase in temperature of 10 ºC doubles the biological activity. Temperature also affects the amount of oxygen that can be dissolved in water, rate of photosynthesis of plants, metabolic rates of animals, and the sensitivity of organisms to toxic wastes, parasites and diseases. The temperature was within the range of BIS *i.e.* from 28 – 30°C and was suitable for aquatic life.

pH: The pH is one of the most important parameters to be determined and is defined as the negative logarithmic of hydrogen ion concentration. For aquatic organisms to thrive, the pH of water should be in the range of 6.5-8.2. The permissible limit given by BIS is also from 6.5-8.2. Low pH indicates high acidity which causes corrosion in pipes and increases solubility of certain heavy metals. High pH indicates high alkalinity; they induce formation of tri-halomethanes which are toxic. The results of pH were observed within range *i.e.* 7.82-7.86 as prescribed by the BIS. Hence, the water was suitable for aquatic life to survive.

Alkalinity: Alkalinity is defined as ability of water to neutralize acid without change in pH. The pH and alkalinity are closely related. High

alkalinity shifts pH to the right and helps to remove dissolved carbon dioxide from water. Alkalinity in water is due to presence of carbonate, bicarbonate, silicate, phosphate and hydroxyl ions in water. If alkalinity of carbonate ion is present in water, then it is known as carbonate alkalinity and alkalinity of HCO_3^- is present then it is bicarbonate alkalinity and if OH^- is present, then it is caustic alkalinity. The presence of alkalinity in water causes incrustation of pipelines and formation of white deposits. When CO_2 reacts with water, it forms carbonic acid (H_2CO_3). The reaction obtained is reversible. Alkalinity is measured in terms of calcium carbonate due to presence of minerals in water. The results of alkalinity were desirable *i.e.* from 128 – 131 mg/L which indicates water is good for aquatic life.

Conductivity: Electrical conductivity indicates the amount of ions or dissolved solids present in water. More is the salinity of water, higher is the conductivity. It is expressed in micromoles/cm. It is related to the sum of the cations or anions, and is correlated, with the total salt concentration. Electrical conductivity is a rapid and precise method and is always expressed at a standard temperature of 25°C to enable comparison of readings taken under varying climatic conditions. The conductivity of water samples was observed very low i.e., from 0.45 – 0.49µm/cm. This is because the study was conducted during monsoon and rainfall dilutes the water.

Total Hardness: Hardness is defined as the soap consuming capacity of water. It has two types: Temporary hardness and Permanent hardness. Temporary hardness is mainly due to presence of bicarbonates and carbonates salts of calcium and magnesium which can be removed through boiling whereas Permanent hardness occurs due to presence of sulphates and chlorides of calcium and magnesium ions which cannot be removed by boiling and requires treatment processes such as ion exchange resin method for their removal. The permissible limit for hardness is 600 mg/L and consumption above the limit can cause diseases such as heart attack and scaling in water distribution pipes. The study found that the amount of total hardness was in the range of 152 – 157 mg/L which indicates that water can be used for domestic purposes.

Total Dissolved Solids (TDS): It is due to presence of solids in water which changes color of the water, and is the sum of cations and anions concentration. A high content of dissolved solids elevates the density of water, influences osmoregulation of fresh water organism, and reduces solubility of gases like oxygen and also utility of water for drinking, irrigation and industrial purposes (Maiti, 2004). High levels of TDS results in excessive scaling in pipes and low levels may be unhealthy for plants and fish. A large number of solids are found dissolved in natural waters, the common ones are carbonates, bicarbonates, chlorides, sulphate, phosphate and nitrates of calcium, magnesium, sodium, potassium, iron etc. The test results obtained from the experiment predicts that water was rich in solids *i.e.*, from 138 – 196 mg/L. This was due to the heavy precipitation in the month of July and August which influences surface run-off.

Dissolved Oxygen (DO): DO is the presence of oxygen that is dissolved in water and which helps aquatic plants and animals to grow and breathe. Due to presence of sewage in water, microorganisms consume that oxygen to breakdown organic content in wastewater. As a result, its amount decreases leaving aquatic animals devoid of it. For water to be fresh, DO should be above 5 mg/L. From the study, it was observed that the results of the DO were very low i.e. from 0.4 – 0.6 mg/L. These indicate that the water is almost devoid of oxygen which increases threat to aquatic life.

Biochemical Oxygen Demand (BOD): It is defined as the amount of oxygen required by the microorganisms such as bacteria to completely decompose organic matter under aerobic condition. It is most important parameter in determining the water quality. A BOD value between 4-6 mg/L is recommended. More the BOD more is the pollution. The incubation period for this test is generally 5 days starting from day 0 to day 5 at 20ºC. From the study, it was observed that the BOD values were high, and ranged from 8.6 to 10 mg/L which indicates the water was not healthy

for aquatic life to survive and it could cause fish death.

Chemical Oxygen Demand (COD): It can be defined as the amount of oxygen required to oxidize organic and inorganic matter in presence of strong oxidizing agent such as $KMnO_4$. It is expressed in mg/L and is time efficient process. COD values should always be 2.5 times greater than BOD values because COD measures the total matter decomposed. The permissible limit is 10 mg/L for domestic purposes. As the BOD and COD are co-related, the COD of water samples was also high and beyond permissible limit as it ranged from 29 – 35 mg/L.

Free CO_2: Carbon dioxide is readily soluble in water and is present in the water bodies in dissolved gas form. Free CO_2 is the major dominant acid present in the water bodies and its quantity above 15 mg/L is the indicator of pollution in the water bodies. The ratio of the carbon dioxide to carbonate and bicarbonate ions acts as a major control for pH in the water bodies. At a temperature range of 0-30°C, the solubility of CO_2 is 200 times more than that of oxygen. This increased level of CO_2 makes aquatic life difficult to utilize the limited amount of O_2 and make their survival strenuous. Hence, it is important to determine the quantity of free CO_2 in water. The amount of free CO_2 in the water samples was within the range of 2.25 – 3.25 mg/L and was low.

Chloride: Main sources of chloride in river water are from industrial effluents, agricultural run-off, pesticides, insecticides, etc. if present. Excessive chloride concentration increase rates of corrosion of metals in the distribution system, and can lead to increased concentration of metals in the supply (WHO, 1996). It may be injurious to some people suffering from diseases of hearts and kidneys. Taste, indigestion, corrosion and palatability are affected. The permissible limit is 1000 mg/L and desirable limit is 250 mg/L. The results from the study showed that the chloride content in the water was within desirable limit *i.e.* from 119 – 122 mg/L.

Fluoride: Fluoride is present naturally in all water bodies and ingestion of excess fluoride, most commonly in drinking-water, can cause fluorosis which affects the teeth and bones. Moderate amounts lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems. The desirable limit of fluoride is 1.0 mg/L and permissible limit is 1.5 mg/L as per Indian standards. The study found that the results of fluoride were within desirable limit and ranged from 0.2 – 0.5 mg/L which indicate fluoride content was low in water.

Sulphate: The desirable limit for sulphate is 200 mg/L and permissible limit is 400 mg/L according to Indian standards for drinking. Beyond the desirable limit may cause gastrointestinal irritation when Mg or Na is present. The sulphate content in drinking water exceeding the 400 mg/L impart bitter taste and may cause gastro-intestine irritation and catharsis (Kakar 1989). The sulphate ranged from 56 – 58 mg/L in the water sample and was within desirable limit.

Phosphates: The major sources of phosphate are domestic sewage, detergents, agricultural runoff with fertilizers and industrial waste water. High concentration of Phosphate may cause vomiting and diarrhea and can stimulate secondary hyperthyroidism and bone loss. Its higher concentration indicates pollution and is due to industrialization and urbanization. The desirable limit for phosphate is 0.5 mg/L and permissible limit is 1.0 mg/L according to Indian standards for drinking water. Beyond the desirable limit eutrophication and kidney stone with calcium may take place. The results of the phosphates from the study showed that it was beyond permissible limit *i.e.* from 1.2 – 1.5 mg/L and is the cause of eutrophication in the water body.

Nitrates: The desirable limit for nitrate is 45 mg/L and permissible limit is 100 mg/L. Presence of nitrate is the main cause of water pollution. Excessive amount of nitrate can lead to methemo-globinemia. The nitrate ranged from 1.9 – 2.2 mg/L in the water sample which indicates it is within permissible limit and was low.

Calcium: Calcium is present on earth's crust in abundance and occurs in various forms some of which are calcium carbonate, calcium sulfate, calcium fluoride, etc. It is one of the

important sources of mineral and is also important for human body. Excessive amount of calcium make water hard and unfit for drinking. A desirable limit of up to 60 mg/L is considered good for consumption. The calcium ranged from 36 – 39 mg/L in the water sample and was not hard for consumption.

Interpretation of Surface Water Quality

The study shows that the turbidity of the water samples is very high, maximum at village Hadasti. Here, the Wardha River meets Erai River; Wardha River being the major river of Chandrapur city is greater in wide and length. Also the study was carried during monsoon, when there is an increase in the level of the River water due to precipitation falling directly into the river. When the precipitation occurs on land, the rain water finds its way to the water bodies mixing with the surface pollutants and deteriorating the quality of the river. The DO level was extremely low and almost negligible which present a serious threat to aquatic life. The study also found that the phosphate range is beyond permissible limit as prescribed by the BIS. Thus, from the present study it can be concluded that the water cannot be used directly for domestic activities and also for irrigation due to large phosphate content and BOD values. These may contaminate the agricultural soil making it uncultivable.

CONCLUSION

As Chandrapur city is surrounded with many industries, it is certain that there will be increase in population in the coming decades. The supply and demand for water will increase, leading to consumption of good quality of water for drinking purpose. There is a need to design a suitable treatment plant and sewerage system to treat the incoming waste will help to reduce the pollution load of the river. The rainy seasons are usually moderate and hence the water need be conserved through designing a rainwater harvesting. There is very less possibility of floods in the city or around, but provision of dams could help to protect the city. Also many industries lift water from the river making it the most valuable water resource. Thus, the design could be done through the results obtained from testing.

REFERENCES

APHA (1992). Standard method for the Examination of water and waste water. APHA AWWA, WPET Washington DC, U. S. A. 18th edition, 1992.

APHA (1999). Standard Analytical Procedures for Water Analysis APHA, AWWA, WEF. Laboratory manual. 19th edition. 1999.

APHA, AWWA, AND WEF (1995). Standard methods for the Examination of Water and Wastewater, 19th Ed., Washington, DC, American Public Health Association, 1995.

Bhatadi OC Expn. Project of WCL. (2014). Application for environmental clearance. Available online at http://environmentclearance.nic.in/writereaddata/EIA/51122121121612014_5_20_May_2014_1457489531151-2014.pdf

Erai & Zarpat River Action Plan (2016). Maharashtra Pollution Control Board, Available online at https://www.mpcb.gov.in/sites/default/files/focus-area-reports documents/Erai_&_Zarpat_River_Action_Plan-Revised.pdf

Irai dam (2019). Specification. Available online at https://en.wikipedia.org/wiki/Irai_Dam

IS 3025-5 (1983): Methods of sampling and test (physical and Chemical) for water and waste water Part 5 Odor

IS 3025-8 (1984): Methods of sampling and test (physical and Chemical) for water and waste water Part 8 Taste

Jadhao, R. G. and Dhage, D. M. (2015). Physicochemical parameters of Erai dam, Chandrapur (MS) India, *Int. J. of Life Sciences,* 3(4):387-391

Kharat, S. J. Pagar, S. D. (2009). Determination of Phosphate in Water Samples of Nashik District (Maharashtra State, India) Rivers by UV – Visible Spectroscopy. E-Journal of Chemistry, 6(SI):S515-S521

Kumar, A. Joshi, V. D. Bisht, B. S. and Singh, A.K. (2011). Determination of Physicochemical Pollutant Indicators in Solid and Liquid waste (leachate). International Journal of Research in Environmental Science and Technology, 1(1):1-6

Tambekar, P. Morey, P. Batra, R.J. and Weginwar, R.G. (2012). Quality assessment of drinking water: A case study of Chandrapur District (M.S.) Journal of Chemical and Pharmaceutical Research, 4(5):2564-2570

Tambekar, P. Morey, P.P. Batra, R.J. and Weginwar, R.G. (2013). Physico-chemical parameter evaluation of water quality around Chandrapur District Maharashtra. Journal of Chemical and Pharmaceutical Research, 5(5):27-36

Telkapalliwar, N.G. and Shende, B. B. (2011). Analysis of some physico-chemical parameters of ground water in Gondpipri Region, Chandrapur District (Maharashtra). J. Chem. Pharm. Res., 3(1):176-179

The tragic tale of Erai. (2018). Indian Water Portal, Available online at https://www.indiawaterportal.org/articles/tragic-tale-erai

Warhate, S. R. and Patel, P. R. (2016). Effect of Coal Mine Effluents on Population of Fishes in River Erai. Research Journal of Chemical Sciences, 6(4): 44-46

Western Coalfield Limited. (2018). Environmental Clearance. Available online at http://www.westerncoal.in/sites/default/files/userfiles/ENV-CR-DURGAPUR%20OC.pdf

Yeul, V. Dafade, M. S. Gutte, M. B. Shiwankar, D. M. Dange, C. M. Borkar, V. R. and Ghuge, R. S. (2019). Chandrapur Super Thermal Power Station Environment Management Perspectives. Journal of Indian Associations for Environmental Management, 39:1-4

Source of Financial Support: Nil.
Conflict of Interest: None, Declared.