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HYDROLOGICAL PROFILE OF KATHANI RIVER,GADCHIROLI (M.S.)

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ABSTRACT: *The present study was conducted for the time period of 12 months (June 2013-May 2014) aiming to find out the physicochemical parameters of Kathani river water, Gadchiroli at different sites. Four sample sites were selected for the study and the samples were collected on monthly basis. The samples thus collected were analyzed for physicochemical parameters like water temperature, pH, electrical conductivity (EC), total dissolved solids (TDS), total hardness (TH),* Ca^{2} *and* Mg^{2} *hardness, total alkalinity (TA), free* CO_2*, dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD),* Cl^{-}, SO_4^{2-}, NO_3^{-}, PO_4^{3-}, F^{-} *and* Fe^{2} *concentration. The results were compared with standards prescribed by WHO (World Health Organization). All the physico-chemical parameters were found to be in the prescribed permissible limit except* Fe^{2} *. Monthly and seasonal variations of parameters were prominently studied. The correlation matrix was also calculated for different parameters to get correlation coefficient (r) and to establish relationship among different parameters. Highest positive correlation was observed between EC and TDS, EC and Hardness (TH), TA and TH, etc. Inorganic ions exhibited positive correlation amongst themselves. DO showed negative correlation with majority parameters.*

Key words: *Hydrological, Correlation coefficient, Kathani river, Gadchiroli.*

INTRODUCTION : Water is the commonest fluid yet the most precious resource on blue planet without which there would be no life on earth. It is the vital resource for agriculture, industry and other human activities. Pollution is the serious concern as almost 70% of the Indian water resources and a growing number of its water resources have been contaminated by biological, organic and inorganic pollutants [1]. In urban areas the careless disposal of industrial effluents and other wastes in rivers and lakes may contribute greatly to the poor quality of river water [2-5]. The expansion of agriculture and industrial development has not only increased water utilization but has also affected adversely the water quality. The problem of water quality deterioration is mainly due to human activities such as disposal of dead bodies, discharge of industrial and sewage waste and agricultural run-off which are major cause of ecological damage and pose serious health hazards. It is estimated that community wastes from human activities account for four times as much waste water as industrial effluents, most of which is discharged untreated/partially treated into the water courses in India.[6] The Wainganga river receives numerous tributaries on either banks and drains the western, central and eastern regions of Chandrapur, Gadchiroli and Nagpur district. The present investigation is related to study hydrological profile of kathani river, Gadchiroli, Maharashtra for 12 months i.e., from June 2013-May 2014. The physico-chemical parameters like water temperature, pH, conductivity (EC), total hardness (TH), total dissolved solids (TDS), calcium and magnesium, total alkalinity (TA), dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), chloride , free CO_2, sulphate, phosphate, nitrate, iron and fluoride were analyzed.

STUDY AREA : Gadchiroli town, a district place of eastern Vidharbha of Maharashtra State is located on 20.10 N latitude and 80.0 E longitude. The Kathani river originates in the Dhanora Pendhri hills, flows about 4 km away from Gadchiroli town westwards and merges Wainganga river near Bormala village about 6km away from Gadchiroli town. It is a shallow river and a main tributary of Wainganga and often gets flooded during monsoon season and overflow of Gosikhurd dam project on Wainganga.

MATERIALS AND METHODS

Sample collection: The present study is aimed at analyzing physical and chemical parameters of Kathani river, Gadchiroli, Maharashtra,India, from four sampling sites and the results are compared with standards given by WHO/IS:10500 to determine the quality of water. Water samples were collected from four different sampling sites of Kathani river in between 9.00 am to 11 am for the period of one year from January 2014 to December 2014. Water samples were collected in precleaned, sterilized polythene containers of two liter capacity. Temperature, pH, EC and TDS were measured immediately on the spot using a thermometer, pH meter, conductometer and TDS meter respectively. The various physico-chemical parameters like total hardness (TH), free CO_2, total hardness (TH) free CO^2 alkalinity (TA), chloride (CL^-), sulphate (SO_4^{2-}), nitrate (NO_3^-), iron and fluoride (F^-) were analyzed by standards procedures described in APHA (1998,2012)[7-8] and Trivedi and Goel (1990) [9].

The main objectives of research is :

- To evaluate the physico-chemical parameters of Kathani river water.
- To compare the results with WHO standards.
- To find out correlation coefficient between physico -chemical parameters.

Sampling locations are given in table 1 :

Table 1 : sampling sites of Kathani river,Gadchiroli.

Sampling sites	Location
K1	Near Bormala site
K2	Near bridge on Gadchiroli-Armori highway
K3	Near Adpalli – Gogaon village
K4	Near Kharpundi bridge

Satellite imagery showing locations of Kathani river.

K1

K1

K2

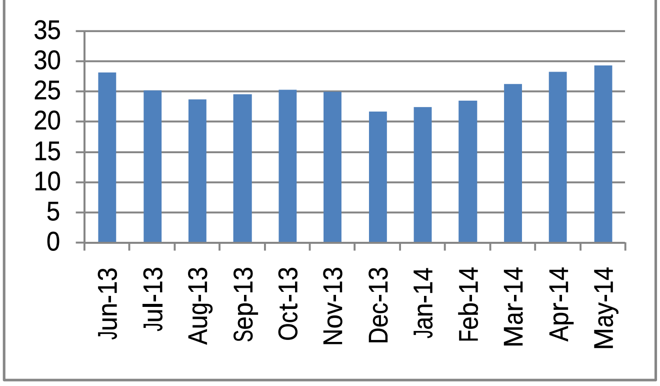
K3

K4

RESULTS AND DISCUSSION : The analysis of **various physico-chemical parameters of four** sampling sites (K1 to K4) of Kathani river was carried out for 12 months from June 2013 to May 2014 and the results were presented as monthwise and seasonal variation in the table 2 and table 3 and graphically presented in the figures. The physico-chemical parameters were examined in the light of WHO [10] and BIS [11] standards.

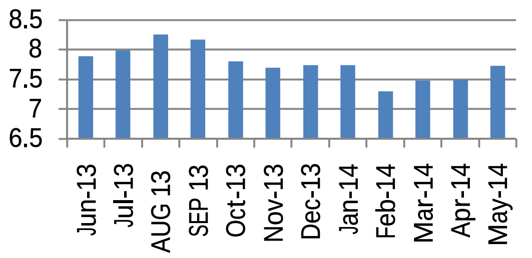
Temperature: The water temperature depends on geographical location and meteorological condition. Hutchinson, (1957)[12] suggested that meteorological conditions are responsible for seasonal changes in temperature. In an aquatic ecosystem , this parameters affects chemical and biological parameters such as solubility of oxygen, CO_2, carbonate and bicarbonate equilibrium, increase in metabolic rate and metabolic reaction of organisms etc. In the present investigation the water temperature was ranged between 21.75^{0}c to 29.4^{0}c. The minimum temperature was recorded in the month of December and maximum in the month of May. Seasonally minimum temperature was recorded during winter as 23.64 ± 1.78 while maximum temperature was recorded during summer season as 26.88 ± 2.59 mg/L. High water temperature during summer might be due to low water level, higher temperature and clear atmosphere. Similar results were reported by Jayabhaye et al (2006)[13], Salve and Hiware (2008)[14].

Fig-1 Monthly variation in temperature



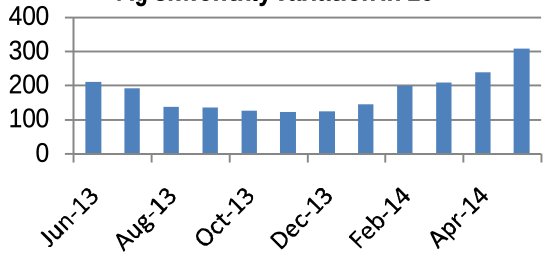
pH: According to George (1997)[15], pH is an important parameter of water, since most of the aquatic organisms are adapted to average pH and do not withstand abrupt changes. Present study revealed that pH values from all the sampling sites were slightly alkaline throughout the study period which ranged from 7.31 to 8.26. Minimum mean pH was recorded in the month of February while maximum pH was recorded in the month of August. Seasonally the minimum value of pH observed was 7.51 ± 0.18. In the summer season and the maximum value of pH recorded was 8.08 ± 0.17 in the monsoon season. Bobdey (2002)[16] recorded the pH value between 7.0 to 8.50 in the river Wainganga at Pauni, Maharashtra. Prakash et al (2009)[17] recorded the pH ranging from 6.90 to 8.80 in the river Cauveri, India. Gangwar and Joshi (2007)[18] in the Ganga river at Haridwar, Saksena et al (2008) [19] in the Chambal river, Asati, S. R. (2012)[20] in the Wainganga river for Tirora town also recorded parallel findings. Relatively minimal values of pH in summer might be due to reduced water level, concentration of organic matter with subsequent rise of CO_2 but intense sunlight accelerate photosynthetic activities of algae and macrophytes which in turn enhance carbohydrates intake and thereby decrease pH during summer. (Bobdey et al, 2007)[21]. The maximum values of pH during monsoon might be due to sewage reception containing carbonates and bicarbonates and flooded situation thereby pouring bicarbonates in the river.

Fig-2 Monthly variation in pH



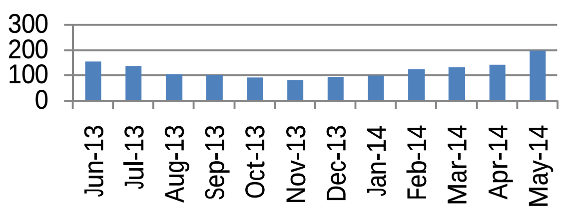
Electrical conductivity (EC): Electrical conductivity (EC) is a measure of water capacity to convey electric current. It signifies the amount of total dissolved salts. Therefore increased conductivity of river water indicates contamination of ionic pollutants (Shrivastava 1993)[22] has observed that high value of EC indicate water rich in electrolytes. Electrical conductivity during study period was ranged between 123 to 308 µs.cm^{-1}. The minimum mean EC and maximum mean EC recorded were in the month of November and May respectively. As far as seasonal variation, minimum EC as 130.25 ± 10.63 while maximum EC as 239 ± 48.93 in summer were observed. Low value of EC during winter is probably due to low temperature and reduced rate of decomposition thereby lowering ionic concentration in water. Summer maxima of EC might be due to less flow of river water, high rate of evaporation through solar radiation and higher TDS. Similar results were reported by Thomas et al (2001) [23] in the Kutlanad wetland ecosystem, Bobdey (2002)[16] in the river Wainganga, Dahegaonkar (2008)[24] in the rivers Wardha, Erai, Zarpat at Chandrapur (M.S.) and Chavan A.W. (2009)[25] in river Wainganga. Yadav R.C. and Srivastava V.C. (2011)[26] have reported high EC in rainy season and lowest in winter in the river Ganga at Ghazipur.

Fig 3:Monthly variation in EC



Total Dissolved Solids (TDS): Total dissolved solids indicate the salinity behaviour of river water. The TDS value during the period of investigation was ranged between 81.6 and 199.4 mg/L, the minimum being in the month of November and the maximum in the May. Seasonal variation of TDS revealed minimal value during winter as 91.08 ± 6.98 mg/L and maximum during summer season as 149.92 ± 33.82 mg/L. The entire range of TDS was found to be within the permissible limit of WHO. Srinivas rao et al (2007)[27], reported maximum TDS value in summer and minimum in winter and stated that seasonal variation in conductivity and TDS was due to factors such as rainfall, biota causing changes in ionic concentration and the nature of bottom deposit. Dahegaonkar (2008)[24] reported high value of TDS during summer due to intake of large quantities of domestic effluents whereas lower values during winter due to sedimentation in river Wardha, Erai and Zarpat Chandrapur (M.S.). Yadav and Srivastava (2011)[26] reported lower TDS in river Ganga at Gazipur in winter and highest in rainy season. Jagtap (2014)[28] reported lower TDS in monsoon and highest during summer in Bhima river. The minimal TDS in monsoon may be due to addition of fresh rain water during monsoon period. (Narayan Raj et.al. 2007)[29].

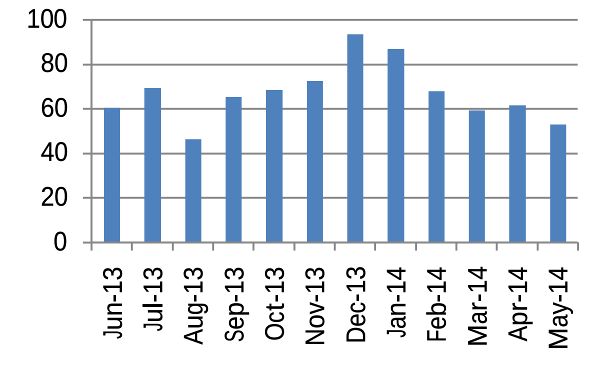
Fig 4:Monthly Variation in TDS



Total Alkalinity (TA) : Alkalinity is the measure of buffering capacity of the water. It is generally imparted by the salts of carbonates, bicarbonates, phosphates, nitrates etc. (Yellavarthi, 2002)[30]. In the present study TA was ranged between 46.5 mg/L – 93.8 mg/L having minimum TA in August and maximum in December. Seasonal variation in TA showed that minimum TA of 60.50 ± 10.03 mg/L was recorded during monsoon season and maximum TA of 80.65 ± 11.80 mg/L during winter. Range of TA was found within the permissible limit of WHO. During monsoon low decomposition of organic matter by microorganisms and higher respiratory activity by microbes. Monsoon minima might be due to dilution effect as large quantity of rain water dilutes the decomposed organic matter to the greater extent. Similar results were reported by Bobdey (2002)[16] in the river Wainganga. values of TA was possibly due to dilution of river water with rain water. The results were found to be in concurrence with the observation of Tiwari (1983)[31], Sikandar (1987)[32], Chopra et. al (1983)[33] and Chavan, A.

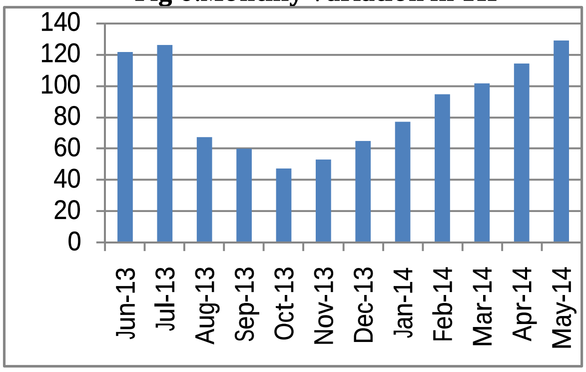
(2009)[25].

Fig 5:Monthly Variation in TA



Total Hardness (TH): Total hardness (TH) is the property of water which prevents lather formation with soap and increases the boiling point of water. (Trivedi and Goel, 1986)[9]. Hardness of water mainly depends on the amount of calcium or magnesium salts or both. During the study period TH varied between 47.3 – 129.1 mg/L which lies within the permissible limit of WHO. Seasonally minimum TH value was reported during winter as 60.65 ± 13.27 mg/L and maximum in during summer as 109.92 ± 15.17 mg/L. higher TH in summer might be due to rising temperature thereby increasing solubility of calcium and magnesium salts. (Garg 2003)[34]. Pande and Sharma (1998)[35] reported high value of hardness during summer and low during winter and rainy season in the river Ramganga at Moradabad. Mohanta and Patra (2000)[36] reported seasonal fluctuation in hardness, minimum values recorded during monsoon and maximum during summer.

Fig 6:Monthly Variation in TH



Calcium (Ca^{2}) and Magnesium (Mg^{2}): Calcium and magnesium together operate the carbonic buffer system and complement each other in the seasonal average. Ca and Mg exist in surface and ground water mainly as carbonates and bicarbonates. In summer, decomposition of organic materials that released CO_2 brings calcium into solution. (Jayadevi 1985)[37]. In the present study Ca^{2} value varies from 28.4 to 73.3 mg/L which lie within the permissible limit of WHO. The minimum Ca^{2} value was recorded in October while the maximum in July. Similarly minimal Mg^{2} value was reported in September and maximum in May. Therefore seasonally minimum and maximum Ca^{2} and Mg^{2} were reported during winter and monsoon or summer. Similar results were observed by Mohanta and Patra (2000)[36].

Fig 7:Monthly variation in ca^{2+}

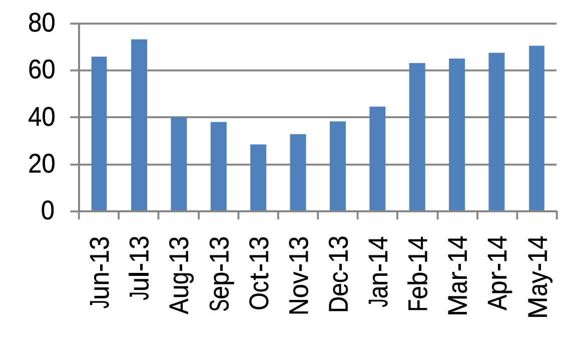
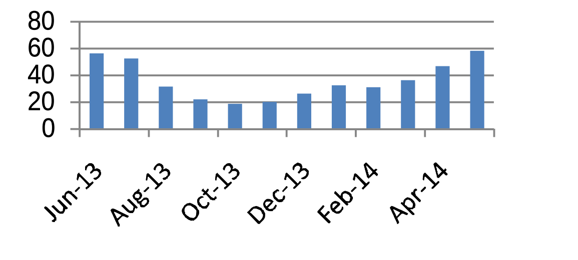
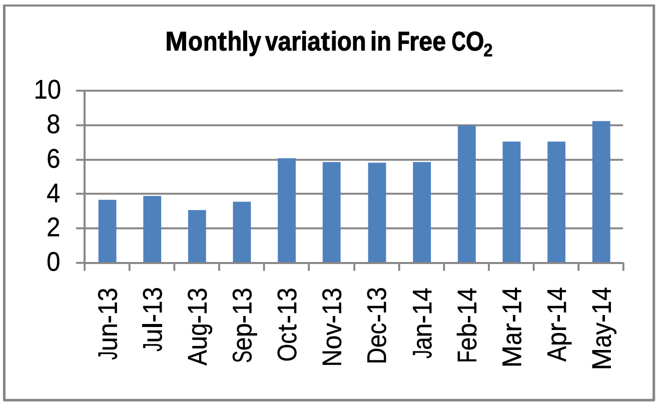


Fig 8:Monthly variation in Mg^{2+}



Free CO_2: Carbon dioxide is the end product of both aerobic and anaerobic bacterial oxidation; therefore its concentration is not limited by the amount of dissolved oxygen. The CO_2 content of water depends upon the temperature of water, depth of water, rate of respiration, decomposition of organic matter and chemical nature of the bottom. According to Hanifa et al (1993)[38], concentration of CO_2 increases at polluted sites, due to low photosynthetic activity and high bacterial decomposition of organic matter. In the present study, free CO_2 value varied from 3.07—8.25 mg/L, the minimum being in the month of August and maximum in the month of May. Seasonal variation shows that minimum free CO_2 was reported during monsoon as 3.55 ± 0.35 mg/L and maximum as 7.60 ± 0.62 mg/L during summer season. Monthly and seasonal variation of free CO_2 was found in the permissible limit of WHO. Summer maxima might be due to higher rate of decomposition of organic matter by microorganisms and higher respiratory activity by microbes. Monsoon minima might be due to dilution effect as large quantity of rain water dilutes the decomposed organic matter to the greater extent. Similar results were reported by Bobdey (2002)[16] in the river Wainganga.



Monthly variation in Free CO_2

Dissolved Oxygen (DO): Dissolved oxygen (DO) is a regulator of metabolic activities of organisms and thus governs metabolism of the biological communities as a whole and also acts as an indicator of trophic status of water body. (Saksena and Kaushik, 1994)[39]. In the present investigation DO was ranged between 5.2—7.8 mg/L, lowest being in the month of September and highest in the month of December, and lying within the permissible limit of WHO. As far as seasonal variation of DO winter maxima in DO might be due to clear zone, fall in temperature, increase in the solubility of oxygen, slightly more photosynthetic activities and high aeration rate whereas monsoon minima of DO might be due to increased organic matter of surface run-off. S. Zafar Javeed (1991)[40] in the river Godavari, Maharashtra, Chugh(2000) [41] in the river Ganga at Hardwar however reported higher concentration of DO in winter and lower in summer. Bobdey (2000) [16] in the Wainganga river at Pauni (M.S.) recorded minimum DO in summer which might be due to higher concentration of organic matter and increased rate of decomposition due to more temperature of river water.

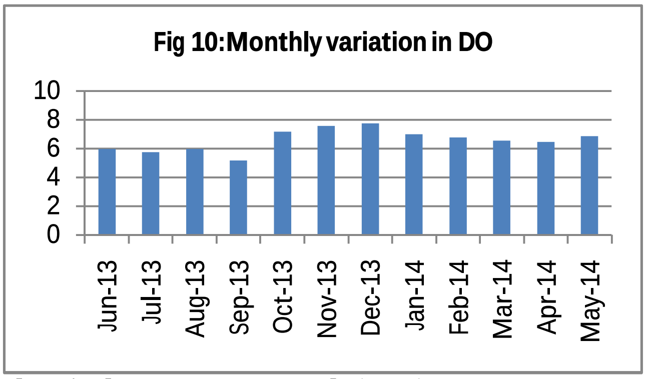


Fig 10:Monthly variation in DO

Chemical Oxygen Demand (COD): Chemical Oxygen Demand is a measure of the oxidation of reduced chemicals in water. It is commonly used to indirectly measure the amount of organic compounds in water. (Kumar et al 2011) [42]. The measure of COD determines the quantity of organic matter found in water. This makes COD useful as an indicator of organic pollution in surface water. (Faith 2006) [43]. In the present study, COD values varied from 4.69—12.10 mg/L, minimum being in the month of November and maximum in the month of May. Seasonal variation showed the minimum COD value as 4.80 ± 0.09 mg/L during winter and maximum COD value as 10.51 ± 1.53 mg/L during summer. Values of COD are within the permissible limit of WHO. Similar observations were reported by Srinivasrao et al (2007) [44]. However Thomas et al (2001) [23], recorded higher value of COD in the month of June, July and August and indicate the presence of organic load carried to the system by the river during monsoon months in the Kutlanad wetland ecosystem, Kerala, India.

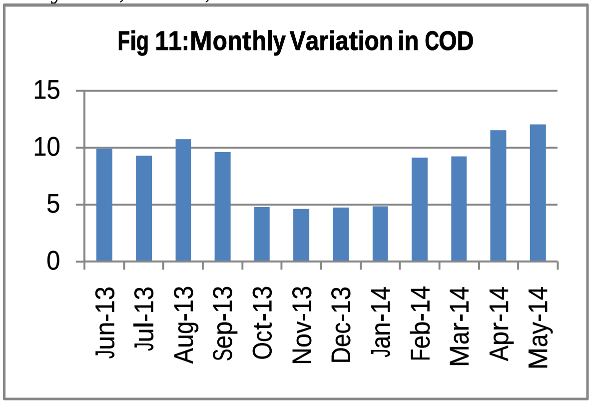


Fig 11:Monthly Variation in COD

Biochemical Oxygen Demand (BOD):
Biochemical Oxygen Demand (BOD) is a measure of the oxygen in the water that is required by the aerobic organisms for the decomposition of organic matter. High BOD indicates high scale contamination of organic matter in water. Biodegradation of organic material exerts oxygen tension in the water and increases the BOD. (Abida, 2008) [45]. In the present investigation, value of BOD varied from 1.99—2.91 mg/L, minimum being in the month of December and maximum in May. BOD range was well within the permissible limit of WHO. Seasonal variation of BOD showed minimum value as 2.05 ± 0.074 mg/L during winter and maximum as 2.73 ± 0.13 mg/L during summer. Similar results were reported by Arvind Kumar et al (2002) [46], in Mayurakshi river (Jharkhand State).

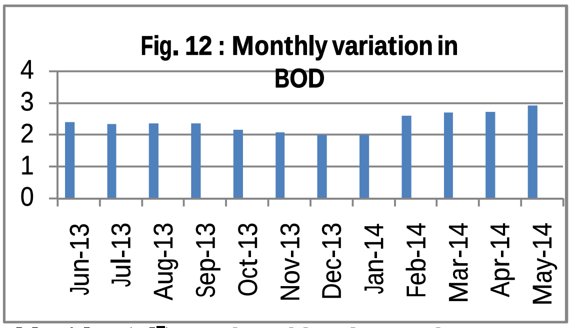
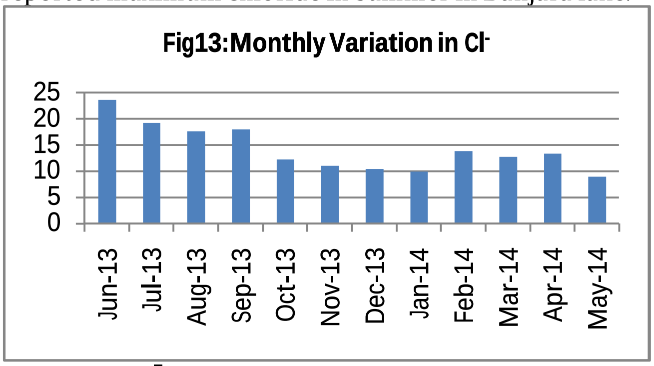
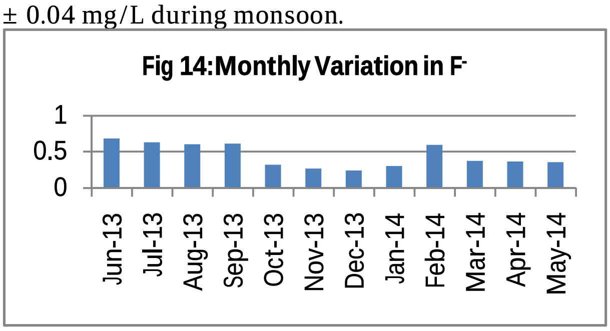


Fig. 12 : Monthly variation in BOD

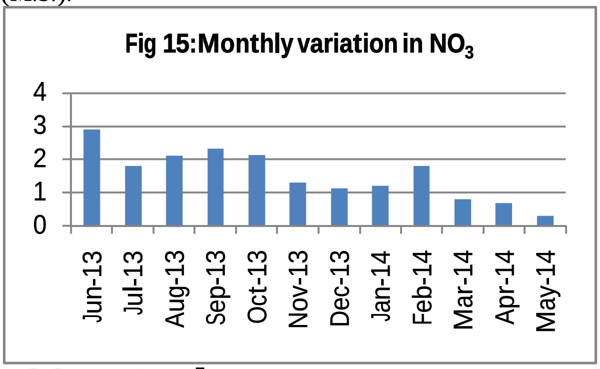
Chloride (Cl^-) : The chloride in the water is generally due to salts of Na, K and Ca. The high chloride ion concentration is considered to be an indicator of pollution due to organic wastes of animal and industrial origin. High values of chloride are troublesome in irrigation and also harmful to aquatic life. (Venkatesharaju K. et al) [47]. In the present study, Cl^- concentration varied from 9.0-23.6 mg/L, minimum being in the month of May and maximum in the month of June and ranged within the permissible limit of WHO. Seasonal variation of chloride indicate lower value during winter as 10.88 ± 0.99 mg/L and higher as 19.62 ± 2.75 mg/L during monsoon season. Higher value of chloride during monsoon is eventually due to receiving high amount of domestic and other organic wastes along with surface run-off whereas lower value of chloride during winter is due to dilution effect of post monsoon period. Similar results were reported by Dahegaonkar (2008) [24] in Zarpat river. Manjare S.A. et al (2010) [48] in Tamdalge Tank, (M.S), Swarnalatha and Narsingrao (1998) [49] however reported maximum chloride in summer in Banjara lake.



Fluoride (F^-): Fluoride occurs as fluorspar, rock phosphate, triphite, phosphorite crystals etc. in nature. Probable source of high fluoride in Indian water seems to be that during weathering and circulation of water in rocks and soils, fluorine is leached out and dissolved in ground water. Fluoride, as dissolved constituents of drinking water, is perhaps the only substance producing divergent health effects as the consuming depending on their relative proportion. Concentration of fluoride between 0.6 to 1.0 ppm in potable water protects tooth decay and enhance bone development (Kundu N. et al 2001) [50], while higher level greater than 1.5 ppm in drinking water pose a threat to human health. (Mayer, B. et al 2007) [51]. In the present study F^- concentration varied from 0.25 - 0.69 mg/L showing minimum value in the month of December and maximum in the month of June. F^- content was within the permissible limit of WHO. Seasonal variation of fluoride showed minimum value as 0.29 ± 0.04 mg/L during winter and maximum as 0.64 ± 0.04 mg/L during monsoon.

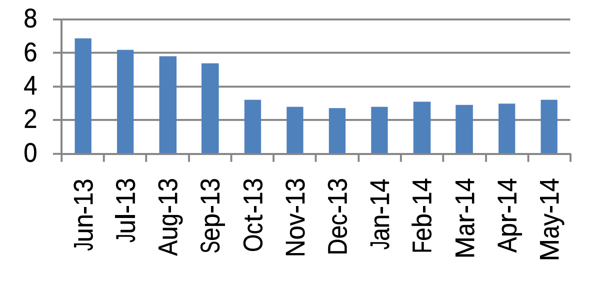


Nitrate (NO_3^-) : Nitrate is an excellent parameter to judge organic pollution and it represents the higher oxidized form of nitrogen. Higher concentration of nitrates in potable water cause serious condition to young ones; it reduces nitrates in their intestinal tract which may lead to metahaemoglobinaemia. In the present investigation NO^- concentration was ranged from 0.30 – 2.91 mg/L showing minimal value in the month of May and maximum in the month of June. Monthly and seasonal variations of NO_3^- concentration were within the permissible limit of WHO. Summer minima of nitrate might be due to activity of denitrifying bacteria, utilization of nitrate by phytoplankton and macrophytes as an evidence of high photosynthetic activity. Monsoon maxima of nitrate is probably attributed to influx of nitrogen rich flood water bringing contaminated sewage water, runoff from agricultural fields. Similar reports were observed by Arvind Kumar and Singh (2002) [46] in Mayurakshi river. Jagtap P.B. (2014) [28] reported maximum value of nitrate during summer and minimum during monsoon season in Bhima river water at Tulapur, (M.S.).



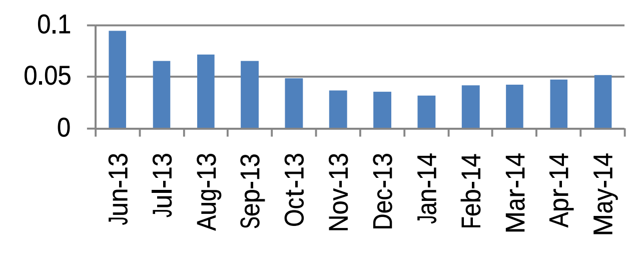
Sulphate (SO_4^{2-}): In all natural waters the sulphate is contributed from weathering of rocks, domestic sewage and industrial effluents. Therefore the level of sulphate is an indicator of pollution from organic matter. Decomposition of organic matter containing proteinaceous sulphur and anaerobic reduction of sulphate in water contribute to alter the condition that markedly affect the cycling of nutrient productivity and bottom sediments. (Thomas et al 2001) [23]. Under aerobic condition the reduction of sulphate is an assimilatory process (Killaharn et al 1981) [52]. Present study revealed that sulphate concentration varied from 2.7 – 6.9 mg/L having minimum concentration in December and maximum in June. Seasonal variation showed the minimum sulphate concentration during winter as 2.88 ± 0.22 mg/L and maximum during monsoon as 6.08 ± 0.64 mg/L and lying within the permissible limit of WHO. Monsoon maxima might be due to bringing high input of sulphate from catchment area and discharge of domestic wastes from nearby village. Minimum value of sulphate during winter might be due to not having any appreciable organic input. Similar observations were also reported by Kulshrestha et al (1992) [53] in Manasarovar reservoir.

Fig 16:monthly variation in SO_4^{2-}



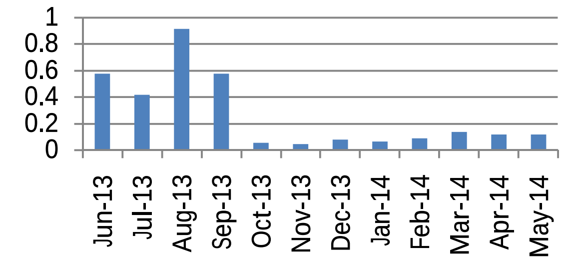
Phosphate (PO_4^{3-}) : The major source of phosphate are domestic sewage, industrial effluents, agricultural runoff, detergents and soap etc. Phosphates are normal constituent of human excreta. (Koshy and Nayar, 1999) [54]. Though phosphate pose problems in surface waters, it presence is necessary for biological degradation of waste water. (NEERI,1986) [55]. In the present study, phosphate concentration recorded was varying from 0.032-0.095 mg/L. Minimum concentration was recorded in January where as maximum concentration was recorded in June. Seasonally minimum phosphate concentration as 0.038 ± 0.007 mg/L was observed during winter and maximum concentration as 0.075 ± 0.014 mg/L during monsoon, having variation within the permissible limit of WHO. Higher phosphate values during monsoon might be due to rainwater bringing in high input of phosphate from the bank of river containing ashes of funeral, nutrient soil deposited from catchment areas and agricultural runoff. Minimum phosphate values during winter might be due to its rapid utilization by aquatic plants and assimilation by phytoplankton. Similar results were reported by Arvindkumar (1995) [56].

Fig 17:Monthly Variation in PO_4^{3-}



Iron (Fe^{2}): Iron is also important to human and other organisms, as it is partially responsible for transporting oxygen through the bloodstream. Iron gets easily dissolved in water and can be found naturally occurring in water bodies. Iron is an essential element for human nutrition and metabolism. But in large quantities it results in toxic like haemochromoitosis in tissues due to accumulation. In the present investigation iron concentration in water varied from 0.04 – 0.94 mg/L with minimum value in November and maximum in August. As far as seasonal variation, iron concentration remained within the permissible limit of WHO during summer and winter whereas it was beyond the permissible limit during monsoon season as 0.612 ± 0.023 mg/L monsoon maxima especially during monsoon might be due to presence of iron ores in the vicinity of river. Therefore excess value of iron is due to rainwater and flooded situation in monsoon bringing in high input of iron from Dhanora-Pendhri hills.

Fig 18:Monthly Variation in Fe^{++}



Correlation analysis : In the present study, correlation matrix was prepared to find out the relation between different parameters as presented in table 4. The study of correlation reduced the range of uncertainly associated with decision making. The correlation co-efficient 'r' was calculated using the equation [57].

$$r = \frac{\Sigma(\quad) - (\Sigma\quad)(\Sigma\quad)}{[\ \Sigma\quad - (\Sigma\quad)\ ][\ \Sigma\quad - (\Sigma\quad)\ ]}$$

Where, Xi and Yi represented two different parameters.
N= Number of total observations.

The correlation coefficient will have a value from -1 to + 1. In the present research the highest positive correlation is observed between EC and TDS (0.969), EC and Hardness (0.884), TDS and TH (0.908), TDS and BOD (0.827), and pH with SO_4^{2-} and iron (0.716) and (0.801).

Majority of inorganic ion concentration have shown positive correlation with each other. DO shows negative correlation with most of the parameters except TA and CO_2.

Conclusion :

The physico-chemical parameters of Kathani river water were examined in the light of WHO standards with a view to detect extent of deterioration of water quality and its impact on the ecological system.

In the present research it has been observed that most of the parameters were within the permissible limit of WHO except iron concentration. Iron ore reserves in Gadchiroli district accounts for 178 million tones out of total estimated reserves of 260.824 million tonnes of iron ore in Maharashtra. Increase in iron concentration in monsoon might be due to its high input along the flooded river. Therefore water of Kathani river should be treated to make it free of iron before consumption as it may pose health problems such as haemochromoitosis to the inhabitants of near villages.

Therefore it seems to be high time to create awareness among people to maintain water quality, proper water management schemes and to make them aware of not using unethical practices.

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Monthly Mean values of Physico-chemical parameters of Kathani River at Gadchiroli during June 2013 - May 2014

Table No.2

Month	Temp	pH	EC	TDS	TA	TH	Ca^{2+}	Mg^{2+}	CO_2	DO	BOD	COD	Fe^{2+}	Cl^-	F^-	NO_3^-	SO_4^{-2}	PO_4^{-3}
Jun-13	28.2	7.9	212	156.3	60.5	121.5	66	56.1	3.68	6	2.4	9.94	0.58	23.6	0.69	2.91	6.9	0.095
Jul-13	25.25	7.99	192	137.8	69.5	126.1	73.3	52.7	3.89	5.8	2.34	9.32	0.42	19.3	0.64	1.81	6.2	0.066
Aug-13	23.75	8.26	139	103.9	46.5	67.5	40	31.5	3.07	6	2.36	10.8	0.92	17.6	0.61	2.12	5.8	0.072
Sep-13	24.62	8.18	136	101.3	65.5	60.2	38	22.1	3.57	5.2	2.35	9.66	0.58	18	0.62	2.34	5.4	0.066
Oct-13	25.32	7.81	127	90.6	68.8	47.3	28.4	18.9	6.09	7.2	2.15	4.82	0.06	12.2	0.33	2.14	3.2	0.049
Nov-13	24.98	7.7	123	81.6	72.8	53.1	32.9	20.2	5.87	7.6	2.07	4.69	0.05	11	0.27	1.32	2.8	0.037
Dec-13	21.75	7.75	125	94.2	93.8	65	38.4	26.6	5.85	7.8	1.99	4.8	0.08	10.4	0.25	1.14	2.7	0.036
Jan-14	22.5	7.75	146	97.9	87.2	77.2	44.7	32.5	5.86	7	2	4.9	0.07	9.9	0.31	1.22	2.8	0.032
Feb-14	23.5	7.31	200	124.6	68.1	94.5	63.4	31.1	8.01	6.8	2.6	9.18	0.09	13.9	0.6	1.82	3.1	0.042
Mar-14	26.3	7.49	209	132.8	59.5	101.8	65.2	36.6	7.06	6.6	2.7	9.26	0.14	12.8	0.38	0.82	2.9	0.043
Apr-14	28.3	7.5	239	142.9	61.8	114.3	67.6	46.8	7.07	6.5	2.71	11.59	0.12	13.4	0.37	0.69	3	0.048
May-14	29.4	7.74	308	199.4	53.2	129.1	70.7	58.4	8.25	6.9	2.91	12.1	0.12	9	0.36	0.3	3.2	0.052
MIN	21.75	7.31	123	81.6	46.5	47.3	28.4	18.9	3.07	5.2	1.99	4.69	0.05	9	0.25	0.3	2.7	0.032
MAX	29.4	8.26	308	199.4	93.8	129.1	73.3	58.4	8.25	7.8	2.91	12.1	0.92	23.6	0.69	2.91	6.9	0.095
WHO 2011	-	6.5-8.5	1000	600	500	500	100	100	-	7.5	6	10	0.3	250	1.5	50	250	0.1
MEAN	25.3225	7.781667	179.6667	121.94167	67.2667	88.133	52.38	36.125	5.689	6.6167	2.3817	8.42167	0.26917	14.2583	0.4525	1.5525	4	0.0532
MEDIAN	25.115	7.75	169	114.25	66.8	85.85	54.05	32	5.865	6.7	2.355	9.29	0.12	13.1	0.375	1.565	3.15	0.0485
S.D.	2.37154773	0.276827	57.3099	33.985196	13.1711	30.001	16.64	14.083	1.774	0.7638	0.2999	2.82142	0.28605	4.44388	0.1642	0.76586	1.576	0.0184

(All parameters are in mg/L except pH and EC. EC is in microsiemens.)

Seasonal variation in physico-chemical parameters of Kathani River during June 2013 - May 2014

Table - 3 :

parameter	monsoon	winter	summer	Annual
TEMP	25.46 ± 1.93	23.64 ± 1.78	26.88 ± 2.59	25.32 ± 2.37
pH	8.08 ± 0.17	7.75 ± 0.04	7.51 ± 0.18	7.78 ± 0.28
EC	169.75 ± 38.14	130.25 ± 10.63	239 ± 48.9	179.67 ± 57.31
TDS	124.82 ± 26.77	91.08 ± 6.98	149.92 ± 33.8	121.94 ± 33.98
TA	60.50 ± 10.03	80.65 ± 11.80	60.65 ± 6.16	67.27 ± 13.17
TH	93.82 ± 34.79	60.65 ± 13.27	109.92 ± 15.2	88.13 ± 30
Ca^{2+}	54.32 ± 17.96	36.10 ± 7.04	66.72 ± 3.16	52.38 ± 16.64
Mg^{2+}	40.60 ± 16.45	24.55 ± 6.28	43.22 ± 12	36.12 ± 14.08
CO_2	3.55 ± 0.35	5.92 ± 0.12	7.6 ± 0.62	5.69 ± 1.77
DO	5.75 ± 0.38	7.40 ± 0.36	6.7 ± 0.18	6.62 ± 0.76
BOD	2.36 ± 0.03	2.05 ± 0.074	2.73 ± 0.13	2.38 ± 0.299
COD	9.93 ± 0.63	4.8 ± 0.09	10.53 ± 1.53	8.42 ± 2.82
Fe^{2+}	0.625 ± 0.21	0.06 ± 0.01	0.12 ± 0.02	0.27 ± 0.29
Cl^-	19.62 ± 2.75	10.88 ± 0.99	12.28 ± 2.23	14.26 ± 4.44
F^-	0.64 ± 0.04	0.29 ± 0.04	0.43 ± 0.12	0.45 ± 0.16
NO_3^-	2.30 ± 0.46	1.46 ± 0.46	0.91 ± 0.65	1.55 ± 0.77
SO_4^{2-}	6.08 ± 0.64	2.88 ± 0.22	3.05 ± 0.13	4 ± 1.58
PO_4^{3-}	0.075 ± 0.014	0.038 ± 0.007	0.046 ± 0.01	0.05 ± 0.02

(All parameters are in mg/L except pH and EC. EC is in micro-Siemens.)

Correlation Coefficient (r) between the Physico-chemical parameters of Kathani River Water at Gadchiroli during June 2013 - May 2014

Table No.4

	Temp	pH	EC	TDS	TA	TH	Ca^{2+}	Mg^{2+}	free CO_2	DO	COD	BOD	Cl^-	F^-	No_3^-	SO_4^{-2}	PO_4^{-3}	Fe^{2+}
Temp	1.000																	
pH	-0.126	1.000																
EC	0.794	-0.371	1.000															
TDS	0.796	-0.184	0.969	1.000														
TA	-0.644	-0.221	-0.5	-0.52	1.000													
TH	0.661	-0.245	0.884	0.908	-0.362	1.000												
Ca^{2+}	0.595	-0.357	0.865	0.858	-0.357	0.978	1.000											
Mg^{2+}	0.695	-0.057	0.846	0.911	-0.39	0.962	0.886	1.000										
Free CO_2	0.227	-0.873	0.504	0.622	0.096	0.212	0.284	0.045	1.000									
DO	-0.248	-0.549	-0.154	-0.259	0.542	-0.316	-0.321	-0.316	0.601	1.000								
COD	0.648	0.091	0.746	0.761	-0.801	0.699	0.704	0.682	-0.002	-0.654	1.000							
BOD	0.734	-0.325	0.886	0.827	-0.721	0.704	0.752	0.616	0.45	-0.327	0.864	1.000						
Cl^-	0.182	0.5	-0.021	0.138	-0.386	0.276	0.253	0.315	-0.747	-0.785	0.411	0.057	1.000					
F^-	0.124	0.421	0.126	0.257	-0.493	0.346	0.365	0.335	-0.571	-0.846	0.573	0.258	0.894	1.000				
NO_3^-	-0.198	0.532	-0.046	-0.306	-0.104	-0.251	-0.273	-0.188	-0.74	-0.498	-0.072	-0.363	0.794	0.704	1.000			
SO_4^{-2}	0.174	0.716	-0.004	0.194	-0.422	0.274	0.205	0.375	-0.828	-0.799	0.429	0.021	0.938	0.869	0.738	1.000		
PO_4^{-3}	0.412	0.606	0.172	0.359	-0.574	0.348	0.263	0.464	-0.682	-0.742	0.544	0.202	0.908	0.815	0.69	0.94	1.000	
Fe^{2+}	0.014	0.801	-0.128	0.035	-0.545	0.041	-0.006	0.155	-0.829	-0.77	0.477	0.036	0.78	0.771	0.626	0.873	0.819	1.000

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