CHAPTER 3

Physico-Chemical Analysis of East Kolkata Wetlands and its future aspects

[1]inderjeet Tyagi, [1]vikas Kumar, [1]koamud Tyagi, [2]rakesh Bhutiani, [2]faheem Ahamad, [1]nitish Kumar & [1]kailash Chandra

[1]Zoological Survey of India, M-Block, New Alipore, Kolkata-700 053, West Bengal
[2]Department of Environmental Science, Gurukul Kangri Visvavidyalaya, Hardwar-249 404, Uttarakhand
Email: indertyagi011@gmail.com, vikaszsi77@gmail.com

PHYSICO-CHEMICAL ANALYSIS OF EAST KOLKATA WETLANDS AND ITS FUTURE ASPECTS

ABSTRACT

Physico-chemical analysis of wastewater from different significant sites of East Kolkata Wetlands (EKWs) namely Bantala Sewage Distribution Unit (BSD), Captain Bheri (CB) pilot fisheries pond, Nalban Food (NB) food park and its adjoining areas was carried out in the light of important water quality indexing parameters. Physical analysis includes parameters like turbidity, temperature, TSS, TDS, TS and electrical conductivity while the chemical analysis includes parameters like BOD, COD, DO as oxygen indicators; TH, CaH, MgH as hardness indicators and pH, acidity, alkalinity, chloride ion (Cl-) and nitrate ion (NO_3-) as essential indicators. All the parameters i.e. physical and chemical was investigated keeping in view the IS and APHA standards methods in order to report the water quality of sewage fed fisheries ponds. An alarming rise in several important parameters with reference to prescribed limits was observed, which indicates towards the rapidly deteriorating health of sewage fed aquatic ponds and it may lead to several water borne diseases which in turn results into severe health hazards as well as faunal diversity change i.e. macrobiome and microbiome.

Keywords
Sewage water, Fisheries ponds, Physico-chemical analysis, Aquaculture, Water Quality.

INTRODUCTION

East Kolkata Wetlands (formerly known as East Calcutta Wetlands) is one of the most complex natural and man-made wetland with an area of 12500 ha geographically located at 22°0'27"N latitudinal and 88°0'27"E longitudinal angles in the east of Kolkata (Strauss, 1997). As per article 8, Ramsar bureau list under Ramsar Convention it is designated as a Ramsar Site on 19th August 2002 and thus making it "wetland of international importance". It is economically important as approximately 10915 million tons of fishes have been produced from these wetlands, which is approximately 11.4 % of total fishes has been transported to different parts of India (Adhikari *et al.*,2009; Chatterjee *et al.*, 2006; Mukhopadyay *et al.*, 2007). EKWs is a combination of aquatic ponds flooded with salts i.e. salt marshes/ salt meadows, and sewage fed aquatic ponds i.e. receiving the wastewater mainly in the form of household waste i.e. solid waste, vegetable peelings, polythene, plastics from the resident societies of Kolkata and partially as toxic effluents i.e. metal ions, tanneries, textiles, dyeing, pesticides etc., from different industries (Mandal *et al.*, 2015). Noxious impurities like metal ions, dyes, pesticides, PAHs, organohalogens, polythene and micro- as well mesoplastics wastes gets accumulated in different sites including water, soil and aquatic organisms (Chatterjee *et al.*, 2016; Subramanian *et al.*, 2015). Some reports on bioaccumulation of metal ion in the different body organs of fishes like tilapia, Indian major carps, *Poecilia reticulate*, *Oreochromis niloticus*, *Labeo bata* was also available in the literature (Aich *et al.*, 2017; Adhikari *et al.*,2009; Talapatra *et al.*, 2007; Chatterjee *et al.*, 2016). This phenomenon of accumulation of noxious impurities in different aquatic sites results in the deterioration of health of aquatic ecosystem as well as its water quality. Keeping in view the rapidly deteriorating water quality and aquatic ecosystem health Central Pollution Control Board (CPCB) in relation to the BIS and WHO standards released the guidelines for the propagation of wildlife and fisheries, the details of the same are present in Table 1.

Categories of water	Prescribed limits of the parameters
Propagation of wildlife and fisheries	1. pH: 6.5 - 8.5
	2. Dissolved Oxygen (DO): 4 mg/l or more
	3. BOD_{5days} at 20°C: 2 mg/l or less

Table 1: Prescribed limits of water quality parameters for propagation of wildlife and fisheries (CPCB Report on Water quality management, 2008)

In the present work, an effort has been made to index the total seventeen (17) water quality parameters (including physical and chemical) of different economically important aquatic sites like Bantala Sewage Distribution Unit (BSD), Captain Bhery (CB) pilot fisheries pond, Nalban Food (NF) park and its nearby areas of East Kolkata Wetland in order to predict the health of aquatic ecosystem.

MATERIAL AND METHODS

Sampling sites collection of samples

Water samples were collected from four (4) different sites, namely BSD, CB, NB Food Park and its adjoining areas. The samples were collected in triplicate, samples collected from BSD unit is numbered from KW1 to KW7; while the samples collected from CB are numbered from KW8 to KW11 and in the end samples collected from NB and its nearby areas has been numbered as KW12 to KW20. Fig. 1 demonstrated the sampling sites while Table 2 comprised of all the details including, month of collection, latitude and longitude for better accessibility of reader. The prescribed Indian standard (IS) and the American Public Health Association (APHA) standard (APHA 2012) was used for carrying out the analysis of water quality parameters (Alam and Pathak, 2010; Khanna and Bhutiani, 2011).

Table 2: Details of Sampling sites and its coordinates

Sl. No.	Sampling Site(s)	Sample Code	Month of Collection	Latitude	Longitude
1.	BSD	KW1-KW7	May, 2019	22°31' N	88°26' E
2.	CB	KW8-KW11	May, 2019	22°33' N	88°24' E
3.	NB	KW12-KW20	May, 2019	22°34' N	88°25' E

Fig. 1: Sampling sites (A) Bantala pumping station and nearby areas; (B) Nalban (NB) food park and nearby areas; (C) Captain Bhery (Image Source: Google Earth)

A

B

C

Water sampling was carried out using HDPE 500 ml autoclavable bottles with the help of water sampler and the sampler was sterilized before each sampling location using a standard solution available in the market. As per standards, some parameters like pH, DO, and the temperature was analyzed on site during the sample collection while the rest of the physical-chemical parameters like TDS, TSS, TS, TH (EDTA titration method), CaH, MgH, total alkalinity (by simple titration method) DO, BOD (5 days incubation method), COD (by the dichromate titration method), electrical conductivity, along chloride ion (Cl-) and nitrate ion (NO_3-) were calculated in the lab.

RESULTS AND DISCUSSION

Analysis of physical parameters of samples collected from BSD unit, CB, NB Food park and its adjoining areas

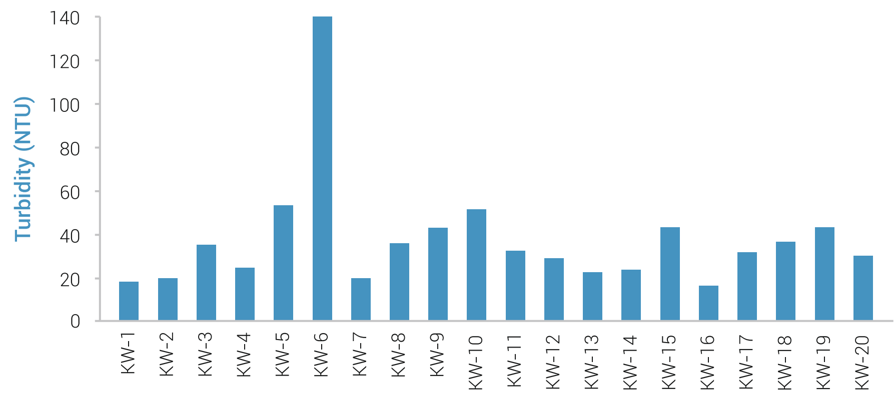
The results of physical parameters like turbidity, total suspended solids (TSS), total dissolved solids (TDS), total solids (TS) and conductivity has been discussed in detail under different subsections.

Turbidity

It is an important factor that determines the opaqueness of water and interference with the passage of light due to suspended matter (clay and silts), chemical precipitants (Mn, Fe), organic particles (plant debris) and organisms (*WHO, 2017*). In addition to this, turbidity also plays a significant role in maintaining the energy relationship at different tropic levels of the aquatic ecosystem. It is generally expressed as nephelometric turbidity units (NTU). As per WHO and BIS standard for drinking water, the turbidity of water samples must lie in the range of 5 -10 NTU, but above 5 NTU customer acceptance is not recommended. The results obtained from different samples, i.e. KW1-KW20 (Table 3 and Fig. 2) lies in the range of 15-140 NTU which was approximately 3 times higher in the case of minimum value obtained and 14 times higher in case of maximum value obtained.

Fig. 2: Turbidity analysis of different samples (KW1-KW20)

Turbidity analysis



Smapling Sites

The maximum value of turbidity was observed in the sample obtained from KW 6 sampling site (Table 3), it was due to the fact that t[illegible]e the largest stock fisheries fed pond and organic content was high due to fish feeds and excrete waste, this pond was used by the local resident for feeding the larger size fishes of 8-10 different species. While the result from rest of sampling sites, i.e. KW1-KW20 except KW6 lies mainly in 15-50 NTU which was due to the sewage water that they are using for the fisheries practices in EKWs. The exponential high value of turbidity with respect to prescribed limits of WHO and BIS standards will act as harboring factor for the growth of pathogenic microbial organisms i.e. it protects the microorganisms from the disinfectants and results in the stimulation of bacterial growth (WHO, 2017).

Table 3: Physical parameters of different sampling sites

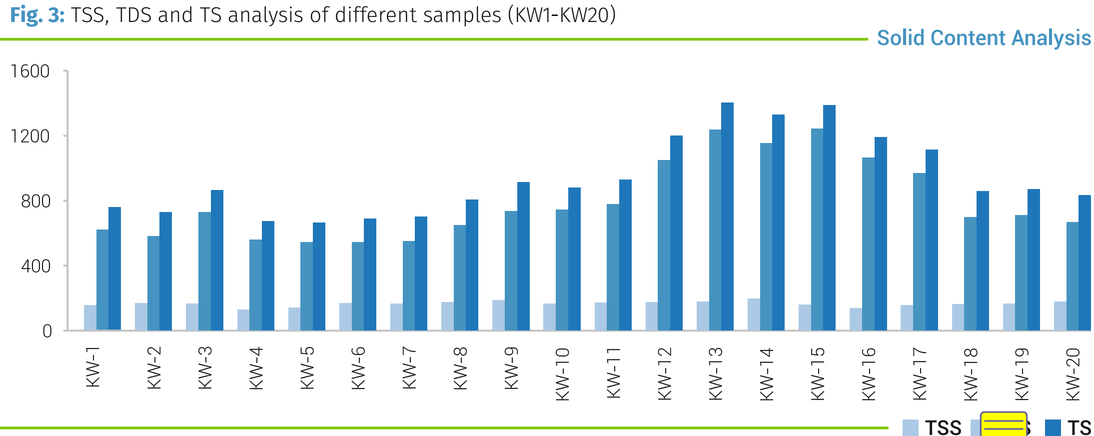
Sampling Sites	Physical parameters Temp. (°C)	Turbidity (NTU)	TSS (mg/l)	TDS (mg/l)	TS (mg/l)	Electrical Conductivity (µS/cm)
KW-1	25.6	15	142	615	757	759
KW-2	24.5	18	150	575	725	839
KW-3	25.2	32	140	725	865	996
KW-4	25.2	25	115	551	666	624
KW-5	25.3	51	125	535	660	703
KW-6	25.4	140	146	540	686	7.7
KW-7	25.5	19	152	540	692	822
KW-8	25.4	35	160	645	805	995
KW-9	25.6	42	175	735	910	958
KW-10	25.2	50	142	736	878	917
KW-11	25.2	28	148	778	926	893
KW-12	25.3	27	152	1052	1204	1462
KW-13	25.3	21	170	1240	1410	1655
KW-14	25.2	23	178	1158	1336	1448
KW-15	25.4	42	145	1249	1394	1402
KW-16	25.6	15	126	1065	1191	1352
KW-17	25.4	32	145	971	1116	1310
KW-18	25.3	38	159	695	854	925
KW-19	25.4	42	158	710	868	910
KW-20	25.3	30	170	665	835	886

Total Suspended solids (TSS), total dissolved solids (TDS) and total solids (TS)

Total suspended solids (TSS) was formerly known as non-filterable residue (NFR), it is a measure of suspended material of different origin i.e. soil, inorganic impurities in the form of metal ions, organic materials and debris present in the water body. It generally includes particles of size larger than 2 microns and it was one of the significant factors in deciding the health and clarity of the aquatic ecosystem, higher the value of TSS, lesser will be the clarity of water. The results obtained were shown in Fig. 3 along with TDS and TS. It was observed that the value lies in the range of 115-170 mg/l (Table 3). The higher values indicate the poor water quality which will lead to severe problems like formation of a coating on the aquatic microorganisms, organisms and eggs; this coating act as a barrier for the oxygen transfer and leads to the death of aquatic organisms. Furthermore, due to its higher concentration, the effectiveness of disinfection agents towards microorganisms also decreases because pathogens are often aggregated or adherent to suspended solids in water (WHO, 2017).

Total dissolved solids (TDS) is defined as the solids that can pass through the filter paper of 0.45 µm and get dissolved in water, it usually comprises of inorganic salts like Ca, Mg, K, Na, HCO_3^{2-}, Cl- and SO_4^{2-} etc. Basically, it signals towards the load of inorganic pollutants that is altering the health of aquatic ecosystems. From results obtained (Figure 3), it was observed that the value of TDS lies in the range of 550 to 1250 mg/l. The maximum permissible limit of TDS for the palatability of the water 2000 mg/l and the desirable limit of TDS is 600 mg/l. The enhanced value of TDS was due to the excessive use of sewage water in fisheries ponds and leaching of inorganic salts from surface to these aquatic ponds. The enhancement in value of TDS results in the laxative effect, bad taste due to the presence of mineral ions; it may get bio accumulated in the different organs of fish, reduced water clarity, decreased metabolic processes, high water hardness etc. Hence, enhanced value of TDS in the present study indicates towards the unpalatability of water to humans as well as aquatic organisms i.e. the aquatic sites are polluted and possess high inorganic content.

Fig. 3: TSS, TDS and TS analysis of different samples (KW1-KW20)



Total Solids (TS) represents the total matter i.e. it is the sum of total suspended solids (TSS) and total dissolved solids (TDS). It is calculated by using the formula mentioned below and expressed as mg/l

TS= TSS +TDS

From results (Fig. 3 and Table 3) obtained, it was observed that the value of TS lies in the range of 660-1410 mg/l with maximum value of 1410 for sample KW 13 which is obtained from the NB food bhery commercial fisheries pond, the reason behind this high value for this sample is mainly due to the inorganic salts present in that pond. As discussed in the TSS and TDS section high value of TS may lead to ineffectiveness of disinfectants which in turn causes difficulty in the wastewater treatment. From Table 3, it was observed that the high value of TS is due to high value TDS which represents the high inorganic salts concentration i.e. metal ions which possess a high tendency to get accumulated in the organs of fishes of that particular aquatic ecosystem. In addition to this some reports of ecological imbalance due to the technical abrasive action of TS are also found in literature (Bhutiani *et al.*, 2018).

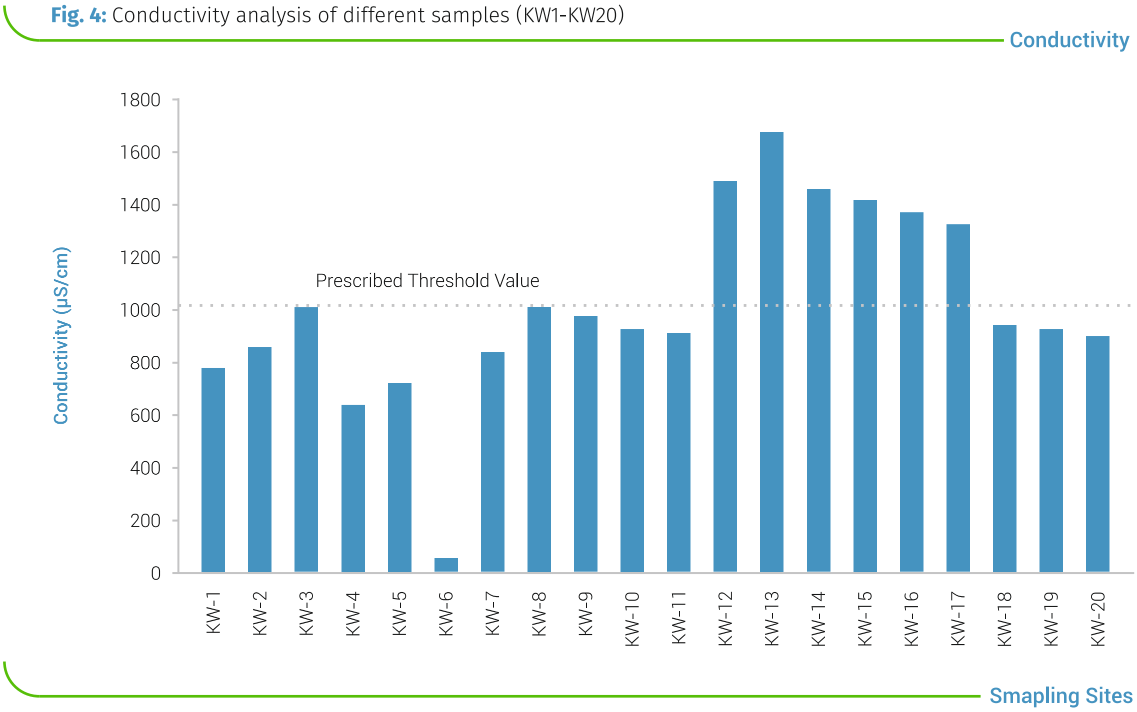
Temperature

According to Brown (Brown, 1999), it is defined as the measurement of the average thermal energy of the substance. JR Brett (Brett, 1971) in one of his studies termed it as "abiotic master factor" due to its significant effect on the life of aquatic organisms. From results obtained (Table 3), it was observed that the temperature for the all the samples i.e. KW1-KW20 lies in the range of 24.5°C - 25.6 °C, which is normal temperature. Wilde, 2006 designated temperature as one of the most significant factors that plays a major role in changing water quality parameters like DO, conductivity, salinity, pH, water density, alkalinity and compounds toxicity.

Conductivity

It is defined as the ability of the water to pass electrical flow and it is directly related to the concentration of ions in the aquatic ecosystem under study. It acts as an early indicator to report any change in the water quality parameter as it changes frequently with changing the water quality. From the results obtained (Fig. 4), it was observed that the value of conductivity lies in the range of 7.7-1655 µS/cm. The lowest value of conductivity (7.7 µS/cm) was for the sample KW6, it was due to the low salt concentration of commercial stock pond of fishes containing up to 8-10 species. The same can also be verified from the value of TDS which was 540 mg/l i.e. near to the acceptable limit. The maximum value of conductivity (1655 µS/cm) was reported in the NB food park bheri sample i.e. KW 13, the same can also be verified from the value of TDS i.e. 1410 for sample KW 13. The prescribed threshold value of conductivity according to surface water regulations in EPA was 1000 µS/cm. The value of most of the samples is below the prescribed limit i.e. 1000 µS/cm, but for samples KW12 to KW17 the value is above the prescribed limit of surface water regulations but below the prescribed limit i.e. 2500 according to drinking water directives (EPA, 2001; Rai *et al.*, 2012).

Fig. 4: Conductivity analysis of different samples (KW1-KW20)



Analysis of chemical parameters of samples collected from BSD unit, CB, NB Food park and its adjoining areas

The results of chemical analysis parameters like BOD, COD, DO as oxygen indicators; TH, CaH, MgH as hardness indicators and pH, acidity, alkalinity, chloride ion (Cl-) and nitrate ion (NO_3-) as essential indicators has been discussed in detail under different subsections. The results obtained from different chemical parameters are tabulated in Table 4.

Table 4: Chemical parameters of different sampling sites

Sampling Sites	Chemical Parameters									
	pH	Cl	TH	CaH	MgH	Acidity	Alkalinity	DO	BOD	COD	No_3-
KW1	6.87	163.3	230	200	7.32	256	310	0.9	42	600	12.3
KW2	6.86	184.6	210	180	7.32	255	321	0.5	35	745	14.2
KW3	7.14	291.1	320	190	31.72	245	325	0	125	5440	11.2
KW4	6.8	213	170	100	17.08	281	290	0	112	1360	10.5
KW5	6.61	213	160	100	14.64	240	295	0	115	1480	9.8
KW6	6.88	213	180	90	21.96	240	295	0	102	1120	15.8
KW7	6.86	220.1	170	100	17.08	255	315	0.1	85	985	11.8
KW8	7.01	234.3	280	180	24.4	225	312	0.1	80	1240	13.6
KW9	6.88	333.7	270	140	31.72	259	298	0.2	81	1040	18.9
KW10	6.89	319.5	290	140	36.6	275	295	0.5	71	440	8.2
KW11	6.82	333.7	310	180	31.72	282	295	0.5	70	450	8.1
KW12	7.31	433.1	610	350	63.44	220	298	0.2	89	1040	6.5
KW13	6.9	560.9	560	260	73.2	225	280	0.1	95	1310	14.5
KW14	6.93	532.5	470	280	46.36	223	290	0.2	85	1240	13.7
KW15	7.41	489.9	520	310	51.24	215	310	0.1	92	1050	11.2
KW16	7.12	411.8	520	310	51.24	215	315	0.2	90	950	8.1
KW17	7.51	333.7	580	380	48.8	230	260	0.2	100	880	8.2
KW18	6.99	319.5	260	120	34.16	231	245	0.2	105	840	7.9
KW19	7.06	319.5	250	110	34.16	225	256	0.3	86	995	10.8
Kw20	7.1	305.3	250	120	31.72	210	245	0	110	1240	11.5

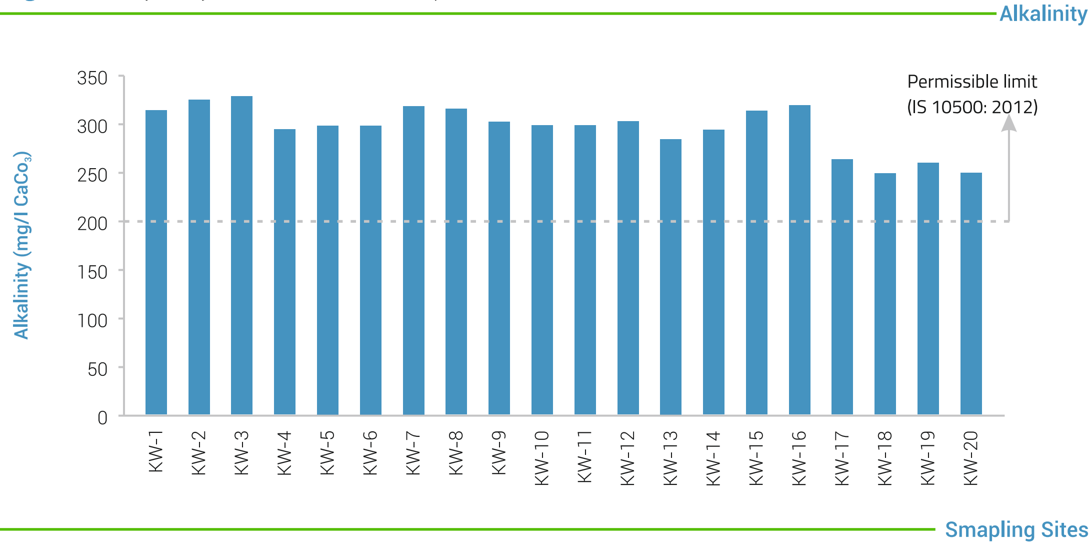
pH

It is one of the most significant chemical parameters to determine the water quality of the particular habitat. From the results obtained (Table 4), the pH of the samples collected i.e. KW1-KW20 lies in the range of 6.6-7.51 which was well within the prescribed limits of the EPA, WHO and CPCB values for fisheries i.e. 6.5-8.5 (EPA, 2001; WHO, 2017; CPCB, 2008). Although the value was in prescribed limit, but the effect of pH on the aquatic organisms specially fishes was discussed by the several researchers (Evans et al., 2006). According to their findings, the value of pH above (more alkaline) or even below (more acidic) the prescribed limits leads to stress induction, reduced reproductive rates, metabolic activity change, and sometimes death when it reached to minimum pH of 4, this was due to fact that extreme pH values increases the solubility rates of noxious pollutants like toxic chemicals, metal ions etc. which enhances their tendency to get accumulate with the vital organs of the aquatic organisms (Chambers *et al.*, 2012). Two important parameters that play the significant role in the maintaining the pH of the aquatic system are alkalinity and acidity, out of which former plays a significant role in resisting the rapid change in pH due to the actions of acids while later plays a significant role in resisting the rapid change in pH due to action of bases. The details of both the parameters are as under:

Alkalinity

It is defined as the capacity of water to neutralize the acid or it is defined as the ability of water to resist the pH change. Alkalinity content was mainly due to the presence of carbonates and bicarbonates, and generally expressed as mg/l $CaCO_3$. From the results obtained (Table 4 and Fig. 5), it was observed that the alkalinity of water samples, i.e. KW1-KW20 lies in the range of 245 to 325 mg/l $CaCO_3$, which was within the permissible and the maximum limit of IS 10500: 2012 i.e. 200 and 600 mg/l $CaCO_3$. This factor was important for the fishes and aquatic life, as alkalinity was directly related to the maintenance pH i.e. it provides the ability to the aquatic habitat to resist the rapid pH change due to factors like acid rain and wastewater, it was well known that rapid change in pH of any aquatic habitat alters the metabolic and the survival rate of fishes and aquatic organisms (Patel and Vashi, 2015).

Fig. 5: Alkalinity analysis of the different samples (KW1-KW20)



Acidity

It is defined as the ability of water to neutralize bases i.e. play a significant role in maintaining the pH of the aquatic ecosystem against the action of bases. According to EPA, it is the due to the presence of weak or strong acids or certain inorganic salts (EPA, 2001). From the results obtained (Table 4), it was observed that the value of acidity was in the range of 210-282 mg/l $CaCO_3$ for different samples i.e. KW1-KW20. The maximum of acidity, i.e. 282 mg/l $CaCO_3$ was observed for the sample KW11 which was obtained from the NB food park. There was no prescribed or permissible limit for the value of acidity found in the literature, but high acidity value affects the wastewater treatment methodologies and as it's directly related to pH change, which in turn affects the aquatic life (Evans *et al.*, 2006).

Hardness of water

Hardness of water is generally due to the presence of bivalent ions mainly calcium (Ca) and magnesium. When these divalent ions, i.e. Ca and Mg combine with bicarbonates (HCO_3-) it is termed as temporary hardness which can be removed simply by boiling it off and when these divalent ions combine with sulfates (SO_4^{2-}) or chlorides (Cl^-), it is termed as permanent hardness, which requires proper treatment of water. In the present work we had calculated the calcium and magnesium hardness due to bicarbonates, and termed it as calcium hardness (CaH) and magnesium hardness (MgH). In the end, total hardness (TH) of the water was calculated which is the sum of temporary hardness and permanent hardness. The details are as under:

Calcium hardness (CaH)

It was calculated as the hardness present in the form of calcium bicarbonate ($Ca(HCO_3)_2$) which was a type of temporary hardness. It is expressed as mg/l $CaCO_3$. From results obtained (Table 4) it was observed, that the value of CaH for the samples i.e. KW1-KW20 lies in the range of 90-350 mg/l $CaCO_3$ which was greater than the tolerance value of 75-200 mg/l as per drinking standards. The maximum value of CaH was observed for the sample KW12 which was obtained from the NB Food bheri. The higher value of CaH results in the corrosive action and cloudiness of water.

Magnesium hardness (MgH)

It is measured as the hardness present in the form of magnesium bicarbonate ($Mg(HCO_3)_2$), which was a type of temporary hardness. It is expressed as mg/l $CaCO_3$. From results obtained (Table 4), it was observed that the value of MgH for samples i.e. KW1-KW20 lies in the range of 7.32-51.24 mg/l $CaCO_3$, which was within the range of tolerance value of 50-100 mg/l as per drinking standards.

Total Hardness

It is the sum of total temporary hardness (calcium and magnesium bicarbonates) and permanent hardness (calcium and magnesium sulfates or chlorides) generally, calcium contributes more towards the hardness of water.

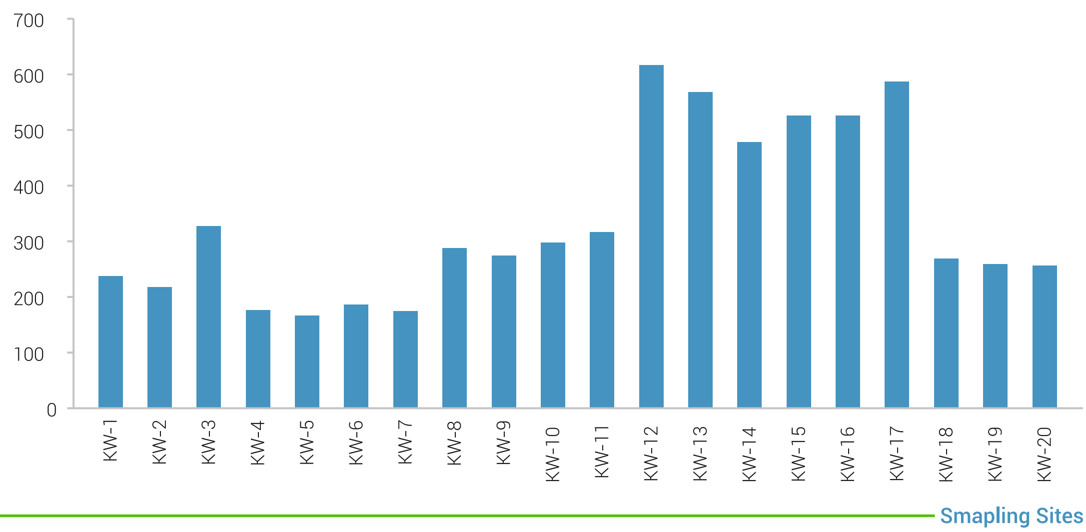
TH = Total temporary hardness + Total permanent hardness

According to EPA (EPA 2001), the classification of hard water was carried out as follows:

Concentration (in mg/l CaCO3)	Category of water
0-50	Soft
51-100	Moderately Soft
101-150	Slightly hard
151-250	Moderately hard
251-350	Hard
351 & above	Excessively Hard

From results obtained (Table 4 and Fig. 6), it was observed that the value of TH for the samples i.e. KW1-KW20 lies in the range of 160-610 mg/l CaCO3, out of which 8 samples i.e. KW1, KW2, KW4, KW5, KW6, KW7, KW19 and KW20 come under the category of moderately hard water, while 6 samples i.e. KW3, KW8-KW11, and KW18 comes under the category of hard water. The rest of the samples i.e. KW12-KW17 lies in the category of excessively hard water.

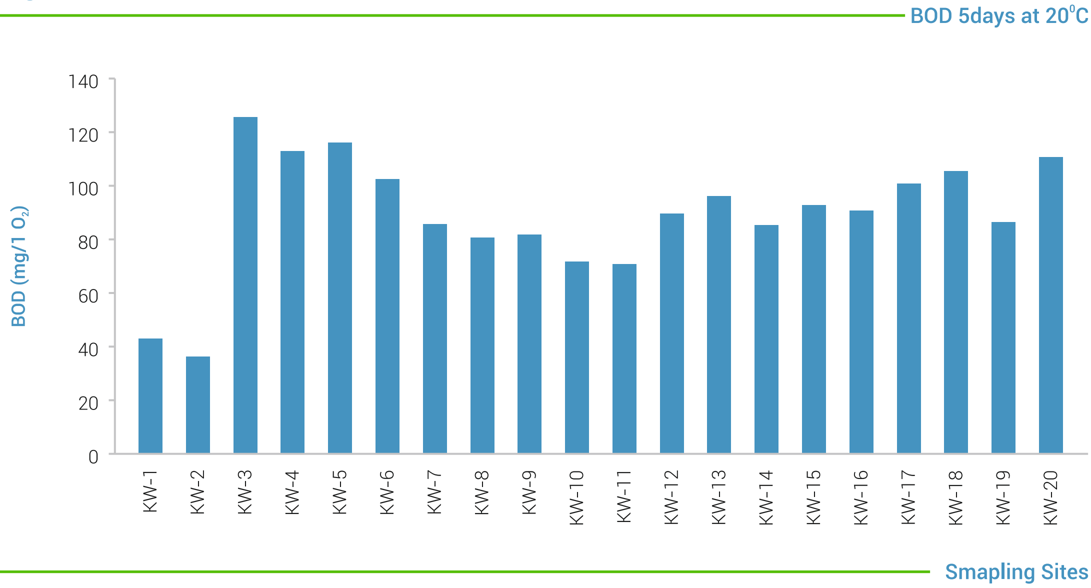
Fig. 6: Total hardness analysis of different samples



Biochemical Oxygen Demand (BOD)

It is defined as the amount of oxygen required by the aerobic microorganism for the degradation of the biodegradable organic or carbonaceous waste in water. It is one of the important parameters that play a significant role in water quality index and it gives us generalize an idea about the extent of organic pollution in aquatic ecosystems. It is generally measured using the Winkler method after 5 days of incubation in the dark at 20°C. From the results obtained (Table 4 and Fig. 7), it was observed that the value of BOD_{5days} at 20°C lies in the range of 35-125 mg/l [illegible]hich was approximately 17 times higher in terms of minimum value obtained and 62 times higher in terms of maximum value obtained. As per data available in Table 1, the permissible limit for the propagation of fisheries in water is 2 mg/l or less, but in present study the values of BO[illegible]ys at 20°C are exponentially high and high values of BOD_{5days} at 20°C will lead to low values of dissolved oxygen (DO) which in turn effects the fisheries growth and propagation. Higher values of BOD_{5days} at 20°C also indicate towards the high organic pollution load at the sampling sites.

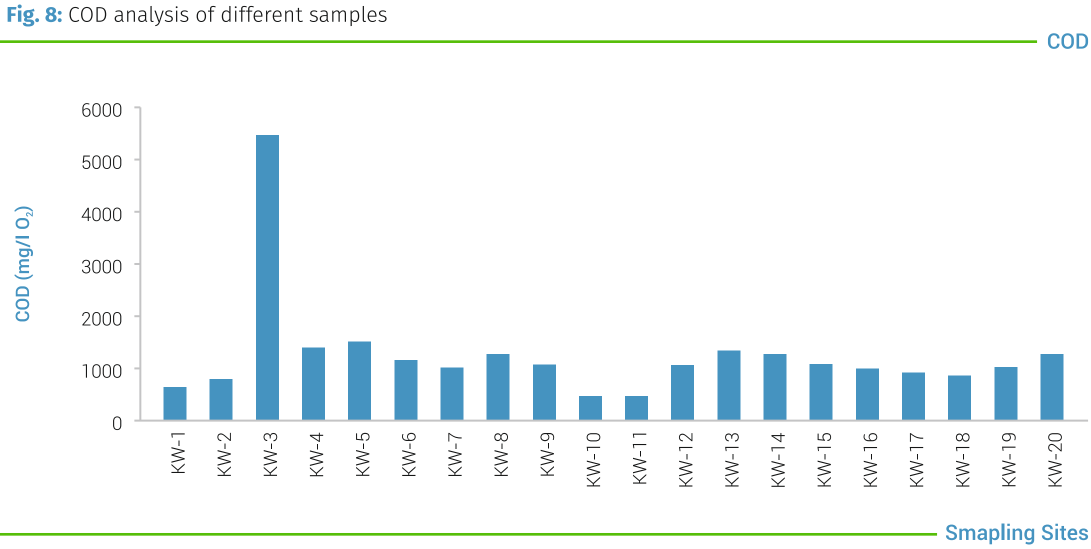
Fig. 7: BOD analysis of different samples



Chemical Oxygen demand (COD)

It is defined as the oxygen required to decompose the biodegradable as well as non-biodegradable organic or carbonaceous matter. It is expressed as mg/l O_2. As per EPA (EPA, 2001), BOD_{5days} at 20°C for biodegradable corresponds to the 65% oxidization of TOM (total organic matter) and in order to oxidize the full i.e. 100% organic content COD method was used and hence the COD/BOD ratio should be 100:65 i.e. 1.54:1. This ratio is very useful for the analyst to assess the water quality and ideas about the non-biodegradable organic pollutant load. This test is generally carried out for the heavily polluted water i.e. sewage water etc. From results obtained (Table 4 and Fig. 8), the value of COD lies in the range of 440-5440 mg/l. The maximum value was for the sample KW3 which was obtained from the bantala sewage distribution unit and having high algal bloom. As per CPCB standard for effluent water quality, the permissible value of COD for inland surface water is 250 mg/l, the standard permissible value of COD for sewage water was still not defined, but if we compare it with permissible limit of inland surface water, the values of COD obtained are very much higher.

Fig. 8: COD analysis of different samples



Dissolved oxygen (DO)

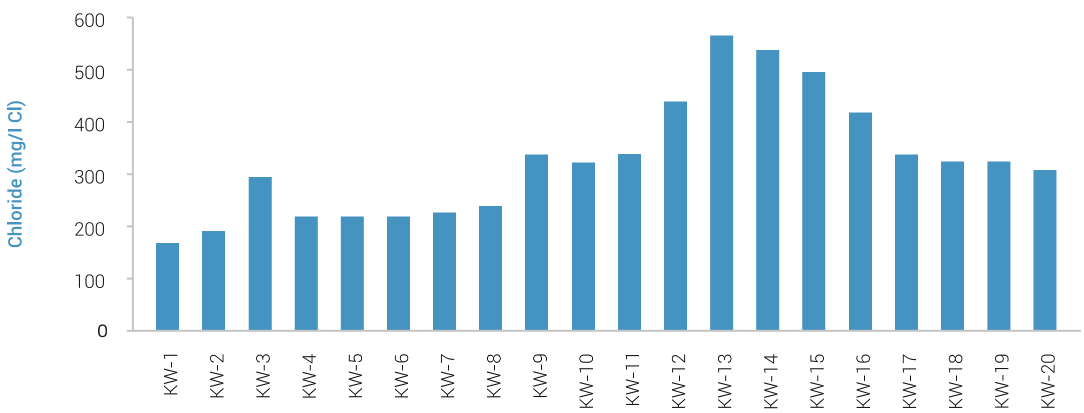
It is defined as the amount of freely available, non-compound oxygen present in the water for the respiration purposes of aquatic animals and organisms. It is expressed as mg/l O2. Its value depends on the certain factors like temperature, BOD, salinity, altitude etc. As evident in section 3.3.3, high values of the BOD will lead to less value of DO because the oxygen was used in the aerobic degradation of organic matter and hence freely available oxygen was less as evident from the results obtained (Table 4). The value of DO for different samples lies in the range of 0-0.9 mg/l O_2, which was less than the prescribed value of DO for the propagation of fisheries (Table 1). This was a severe issue which needs to be addressed as per literature low value of the DO will affect the fisheries propagation and will lead to their death due to asphyxiation (*EPA*, 2001).

Chloride content

Chlorine content in water doesn't possess any health impact, but it refers to the suitability of water in terms of palatability and irrigation purposes. From the results obtained (Table 4 and Fig. 9), the value of chloride content in different samples, i.e. KW1-KW20 lies in the range of 163-560.9 mg/l. The acceptable limit of chloride content in water as per IS 10500: 2012 is 250 mg/l above this value its use for drinking and irrigation purpose may affect.

Fig. 9: Chloride content of different samples

Chloride Content



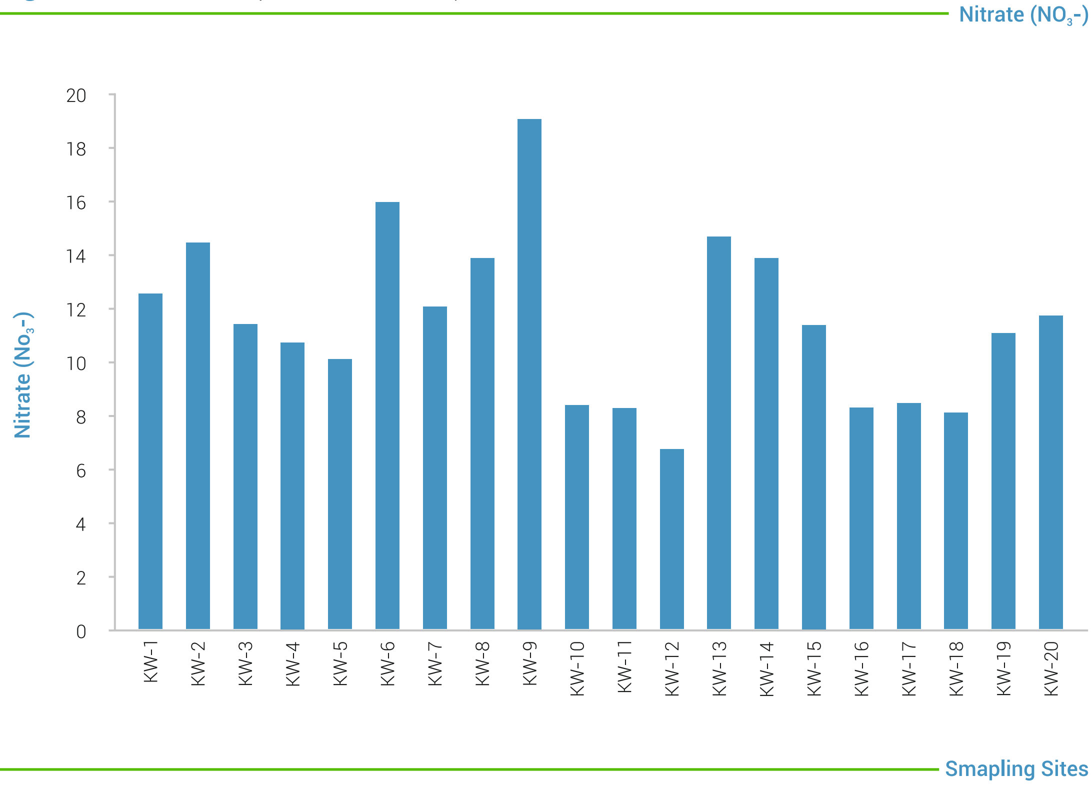
Smapling Sites

The values of chloride content for some samples like KW1-2, KW4-KW8 was within the acceptable limit while for the rest of the samples i.e. KW3, KW9-KW20, it was higher than the prescribed acceptable limit, hence making this water unpalatable and improper for irrigation use.

Nitrate (No_3-)

It is used to estimate the amount of Nitrate (NO_3-) in water as above certain limit it will be toxic to aquatic as well as human health. The sources of nitrate in water are sewage effluent discharges, artificial fertilizers, surface runoff etc. The highest concentration of nitrate is toxic as it converts to nitrite, which leads to blue baby syndrome (methaemoglobinaemia) upon drinking. From results obtained (Table 4), it was observed that the value of Nitrate (NO_3-) in different samples, i.e. KW_1-KW20 lies in the range of 6.5-14.2 mg/l, which was below the acceptable limit of 45 mg/l (*IS 10500:2012*) but for infant's concentration drinking of water having nitrate (NO_3-) greater than 11 mg/l is hazardous (EPA 2001).

Fig. 10: Nitrate (NO3-) analysis of different samples



FUTURE SCOPES

The physico-chemical analysis of the different sampling sites i.e. KW1-KW20 provides us the idea about the water quality that was used by the local residents for various purposes like fisheries, irrigation and other day to day activities. The data obtained indicates towards the poor water quality which in future leads to severe health issues like skin diseases, respiratory and renal disorders in local residents. In addition to this, it will hamper the aquatic ecosystem health by delaying the reproduction rate, low survival rate and high mortality in fishes. Based on the above analysis certain issues which need to be addressed immediately are as follows:

1. Macrobiome and microbiome assessment is essentially required using advanced NGS technique as the poor water quality may lead to the generation of pathogens which are the sources and carriers of deadly diseases.
2. Toxicity studies of heavy metals, dyes, tanneries effluents on the sewage fed fish ponds is essentially required as these noxious impurities possess an ability to get bio accumulate in different organs of the fishes.
3. Spatial distribution of several nutrients is needed to be checked, as above certain permissible limit they are harmful to the aquatic as well as human organisms.
4. Thorough heavy metal analysis of sewage fed aquatics farms with the help of advanced instrumental techniques like AAS, ICP-MS is essentially required.
5. SOP on the basis of point to point sources regarding proper treatment of sewage water before its supply to aquatic ponds is essentially required.
6. Sustainable material development that can lead to improvement of water quality is essentially required and time to time cleaning of ponds with this material can address most of the issues of this sewage fed aquatic farms.

CONCLUSION

Physico-chemical analysis of economically important sewage fed fisheries ponds at different sampling sites is well elucidated and investigated. Based on the above finding following conclusion can be drawn:

1. An alarming increase in chemical parameters like BOD, COD indicates towards high organic pollution load in sewage fed fisheries ponds which in turn results in the decrement of DO value below acceptable limit.
2. The COD/BOD ration of all the samples i.e. KW1-KW20 fails the standard criteria of 1.54:1, it shoots exponentially in all the samples.
3. Low values of DO will have negative impact on the rate of fisheries propagation and survival, i.e. high mortality rate of fisheries can be observed in future.
4. Enhanced value of TDS indicates towards the non-palatability of water to humans as well as aquatic organisms i.e. the aquatic sites are polluted and possess high inorganic content.
5. High value of TDS indicates towards the presence of high inorganic materials and it may toxic heavy metals or other mineral impurities.
6. The water quality of the samples i.e. KW1-KW20 on the basis of physical and chemical parameters comes under the category of poor and it may not be used for irrigation and other day to day activities.

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