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Article

Study Of Physico-Chemical Water Quality Parameters And Irrigation Analysis From Buckingham Canal, Near Manali, Chennai, Tamil Nadu, India

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ABSTRACT: The Buckingham Waterway is a lengthy freshwater route trench, which runs lined up from Andhra Pradesh to Tamil Nadu state. The waterway ties the vast majority of the normal backwaters along the shore to Chennai port. It is one of the main waste and water wellsprings of the Tamil Nadu. A large portion of individuals dwelling in metropolitan regions along the banks of the Buckingham Trench are reliant upon this water hotspot for home grown, water system and different purposes. A sum of 10 surface water tests gathered from Channel and assess the situation with physico-substance boundaries like pH, EC, TDS, TH, CO3, HCO3, Na, K, Ca, Mg and Cl for both Pre Rainstorm and Storm season and the qualities were contrasted with(WHO 2011) standard values. Based on their analysis, some irrigation parameters like SAR, RSC and percentage of Na were calculated.
Keywords: Buckingham Canal, Physico-Chemical parameters, Surface water, SAR, RSC.

INTRODUCTION

Water is considered to be one of the most essential substances for supporting life on Earth, second only to air. Water is crucial for human survival because of its many practical, everyday applications, including drinking. (1). Water's high solubility and status as a renewable resource come at the cost of an increased vulnerability to pollution. Water has the potential to experience alterations in its condition or composition, which can occur either through natural processes or as a consequence of human actions, which can lead to its contamination and make it less suitable for various purposes such as drinking, irrigation, agriculture, industrial use, recreational activities, wildlife habitats, in addition to other applications for which it was appropriate in the original or unaltered state. Toxins can be traced back to when they were found in occurrences of nature on Earth, resulting from the arrangement, alteration, and combination of many natural chemicals, both in their original form and through manmade processes.

The contaminations might emerge normally to shape part of the foundation fixations in the climate. A few toxins can be shaped via fixation and change of normally happening compounds during their home-grown, rural or modern use(2).Numerous synthetic compounds don't happen in the nature, and contamination brought about by them is altogether artificial. A significant proportion of these organisms transition between aerial, aquatic, and terrestrial environments in a continuous manner. However, it should be noted that the primary cause of significant water pollution can be attributed to the processes of urbanization, industrialization, and the rapid growth of the human population witnessed during the past century and a half. Ground water won't be quickly dirtied when contrasted with surface water. Be that as it may, when dirtied the rebuilding is conceivable however undeniably challenging, tedious and might be costly.

EXPERIMENTAL

Material and Methods Sample collection

Five water level tests have been gathered from the Buckingham Trench, the minimum distance maintained between the two areas was 2 kilometers. The water samples were obtained using plastic bottles having a capacity of 2.0 liters. These bottles were meticulously cleaned and filled with purified water before being brought to the designated testing location. The jugs were emptied and rinsed multiple times using the water that was intended for collection. In a similar manner, the sample containers were partially filled with water collected for the purpose of analysis, and thereafter agitated vigorously to ascertain the presence of any discernible odour. After the items were arranged in a specific order, the bottles provided as examples were securely sealed, and the ambient temperature was documented. Subsequently, the specimens were transferred to a cooler maintained at a temperature of 4 degrees Celsius in order to mitigate the activity and reactivity of bacteria and substances. The entirety of the gathered specimens were appropriately marked and thereafter delivered to the designated research facility for the purpose of conducting thorough analysis. The samples underwent physico-substance analysis. Every boundary was dissected utilizing APHA's usual technique (1995).

RESULTS AND DISCUSSION

The table (2 & 3) presents the findings derived from the physicochemical examination conducted on surface water samples acquired from five distinct locations chosen along the Buckingham Canal.

pH analysis
Water's acidity or alkalinity can be determined by its pH level, which is a reflection of the concentration of hydrogen ions in the liquid. (Arya et al., 2011)[3]. Carbonates and bicarbonates, which are alkaline, may be responsible for the pH (Abdul Jameel et al., 2006)[4].Pre-monsoon surface water samples have pH values between 7.1 and 7.9, while Monsoon samples have pH values between 7.6 and 8.4.

The pH levels are within the safe range as defined by WHO 2011 (6.5-8.5) for channel water samples in all sampling stations (Sharma et al., 2004).When comparing the two seasons. pH values showed no much variation. The detected modest alkalinity in samples of water may be attributed to the reaction between carbon dioxide and dolomite rock, resulting in the formation of bicarbonates. This reaction has the potential to impact the pH of the water. The process of partial dissociation of carbonic acid (H_2CO_3) yields hydrogen ions (H^+) and bicarbonate ions (HCO_3). The seasonal variations in pH levels that are observed during the monsoon season can be ascribed to the dilution effect that ensues from these changes.

Electrical conductivity
Water's electrical conductivity demonstrates its capacity to transport electric current. Several factors, such as the number of ions, their ability to move, valence, and temperature, affect how well this process can be done. The amount of absorbed total ions has a big effect on how well water conducts electricity. (Pradeep et al., 1998)[5]. The metric serves as an indicator pertaining to the mineral concentration intrinsic to water. Surface samples of water taken before and after the monsoons have electrical conductivities (EC) ranging from 1078 to 1326 micro mho cm-1 and 1825 to 5448 micro mho cm-1, respectively. The surface water samples exhibit elevated levels of electrical conductivity (EC) throughout the before monsoon and monsoon seasons, surpassing the World Health Organization's 2011 allowable thresholds (600 micro mho cm-1) across all seasons. An observed significant rise in electrical conductivity (EC) values at the S5 station prior to the monsoon season could potentially be attributed to the discharge of sewage, effluents, and additional impurities into the waterway.

Total dissolved solids
The overall amount of dissolved solids in water is affected by both inorganic and organic substances. The solid substances encompass a range of elements including iron, manganese, magnesium, potassium, sodium, calcium, as well as compounds such as carbonates, bicarbonates, chlorides, phosphates, and various other minerals. Consumer generally exhibits a preference for drinking water that contains low levels of dissolved solids (Baruah and Sengutappa, 2003)[6]. The total dissolved solids (TDS) values for water's surface samples in the before monsoon and the monsoon periods fall within the ranges of 1045-1850 ppm and 552-774 ppm, respectively. This investigation has shown that all samples of canal water have higher

levels of total dissolved solids (TDS) than the level set by the World Health Organization in 2011 (500 ppm). This happens because too much sewage, agricultural waste, and uncontrolled drainage residues are dumped into the canal, which has caused the total dissolved solids (TDS) levels to rise. At the S5 monitoring station, large amounts of total dissolved solids (TDS) can be found before the monsoon season starts. The observed phenomenon can be attributed to the process of mineral dissolution, which is influenced by temperature. Additionally, the evaporation effect contributes to development in the ionic concentration. Total dissolved solids (TDS) exhibit a direct relationship with electrical conductivity (EC). An elevated concentration of Total Dissolved Solids (TDS) might result in an aesthetically displeasing experience when engaging in activities such as bathing and washing. (Sirajudeen, 2005)[7].

Total Hardness
The concept of hardness is a quantitative measure used to assess the concentration of both calcium and magnesium salts present in water. The assessment of drinking water quality is contingent upon this crucial component. Mostly, they show up as bicarbonate and carbonate salts. The trait of water that stops soap from making lather is TH (Manivaskam, 2005)[8]. TH levels in surface water samples are found to be between 530 and 642 ppm before the monsoon season and between 500 and 660 ppm during the monsoon season. All surface water tests have TH levels above the safe level set by WHO in 2011 (500ppm). At the same time, during the monsoon season, very high TH readings are seen at station S5. The frequent addition of large amounts of sewage to the channel is to blame for this, as is the rising ionic effect, which causes TH to rise. Heart disease and kidney stones would form because of the high total hardness (Sirajudeen et al., 2013)[9].

Alkalinity (carbonate and Bicarbonate)
Water's alkalinity is measured by how well it can neutralise the acidity of another substance and raise its acidity to a certain level (Edokpayi, 2005). We don't fully understand what alkalinity means for human health, but it is important to note so high alkali fluids are unpleasant and can also make the clotting process less effective. It was found that there were no carbonates in canal water samples during either the pre-monsoon or monsoon seasons. The recorded bicarbonate concentrations for water surface samples are within the bounds of 275 - 405 ppm and 219 - 682 ppm. The bicarbonate values observed in surface waters were generally Within the limit set by the World Health Organization in 2011, except for station S5 during the monsoon season. This phenomenon could perhaps be attributed to the process of atmospheric carbon dioxide (CO_2)

interacting with water. Carbon dioxide (CO_2) is introduced into the system and undergoes a transformation into H_2CO_3. This resulting compound then proceeds to react with primary minerals, leading to an increase in bicarbonate alkalinity. Elevated alkalinity levels impose physiological strain on aquatic creatures, perhaps culminating in a decline in biodiversity (Lawso, 2011)[11].

Calcium
Calcium is a crucial ingredient for the promotion of optimal bone development. It is commonly observed to possess alkaline properties. Calcium is derived from natural sources, such as granitic terrain, which harbours significant concentrations of this element. The calcium (Ca) concentrations were measured within the range of 336 - 502 ppm and 357 - 471 ppm for surface water samples between the early monsoon and the monsoon seasons. The calcium concentrations in all surface water tests consistently surpass the maximum allowable level set by the WHO 2011, which is 100 parts per million, across all seasons. High calcium levels in the canal water may be caused by the discharge of sewage from homes and factories. Station S2 has higher calcium levels before the rainy season. This is mostly because minerals are being leached out of granitic rocks more quickly (Verma et al., 2010)[12].

Magnesium
Magnesium typically exhibits lower concentrations relative to calcium. The relatively slow breakdown of magnesium-rich minerals and the greater abundance of calcium in the Earth's crust contribute to this phenomenon. Exceeding the allowed limit of magnesium and the presence of high levels of solutes in drinking water leads to the emergence of an undesirable flavour in the water. Magnesium (Mg) concentrations were found to vary between 158 and 198 (ppm) in pre-monsoon Channel water samples, while during the monsoon season, the observed range was between 144 and 172 ppm. The magnesium (Mg) concentrations in all the water samples exceed the maximum allowable limit set by the WHO of 150 (ppm). Elevated levels of Mg can potentially be attributed to the contamination of surface water, which occurs when wastewater containing sewage, detergent residues, and industrial effluents is released into water channels. The potential causes for the minimal magnesium content include a reduction of salts that are soluble or increased leaching of minerals from granitic terrain rocks.

Sodium
Sodium is a prominent cation that is naturally present in surface water, holding significant importance. The majority of sodium salts exhibit high solubility in water, however they do not actively participate in chemical reactions (Sarala and Ravi Babu, 2011)[13]. The ranges of sodium contents in samples of surface water during the initial monsoon and monsoon seasons have been reported 118-125 ppm and 102-128 ppm, respectively. In the current investigation, the salt levels in all surface water samples during all seasons were found to be within the acceptable threshold set by the WHO 2011, which is 200 (ppm). The presence of low sodium levels can be attributed to the process of cationic exchange involving potassium ions.

Potassium
Potassium is a significant chemical element that is found in water and serves a crucial function in the metabolic processes of freshwater ecosystems. Potassium has similarities to sodium in terms of its presence in water, albeit with a lower concentration in groundwater compared to sodium (Sathish Kumar T, et.al 2007)[14]. The potassium values for water surface samples in the early monsoon season range from 30 to 51 ppm, whereas in the monsoon season, they range from 39 to 96 ppm. In all seasons, the potassium levels in the channel water samples consistently surpass the permitted limit set by the WHO (12ppm). Elevated levels of potassium are impacted by the process of cationic exchange. The primary origin of potassium cations can be attributed to the process of rock weathering. Station S5 exhibits elevated levels of potassium during the monsoon season, primarily attributed to the discharge of wastewater and agricultural runoff. The observed modest decrease in potassium concentrations may be attributed to the dilution effect caused by seasonal factors.

Chloride
Sodium chloride is present in the groundwater in the form of chlorides. The chloride concentration is significantly influenced by soil porosity and permeability (Ombaka et al., 2013)[15]. The chloride concentrations in surface water samples during the early monsoon season range from 237 to 560 (ppm), while the monsoon season, they range from 88 to 116 ppm. During the monsoon season, the chloride concentrations were observed to be below the permitted range set by the World Health Organisation (250ppm). During the pre-monsoon season, surface water samples S1, S3, S4, and S5 exhibit the highest chloride values simultaneously. Station S5 has exhibited elevated chloride levels during the before monsoon season, which can potentially be ascribed to the introduction of chloride salts with high solubility, as well as the combination of intense evaporation and reduced surface water flow.

IRRIGATION WATER QUALITY ANALYSIS

The primary factors influencing the appropriateness of water irrigation are the composition, concentration, and characteristics of dissolved salts and components. The suitability of water for irrigation is influenced by various chemical parameters, including the overall concentration of soluble salts and the proportions of sodium, calcium, and magnesium present (Arumugam and Elangovan, 2009)[16]. Surface water suitability for irrigation can be evaluated by figuring out a value utilizing sodium adsorption ratio (SAR), ratio of dissolved sodium (RDS) as %Na, or residual sodium carbonate (RSC). These parameters serve as indices for assessing the suitability of surface water for agricultural irrigation purposes (Shaki and Adeloye, 2006)[17].

Sodium Adsorption Ratio (SAR)
The metric known as the Sodium Adsorption Ratio (SAR) assesses the potential risk of sodium in proportion to the amounts of calcium and magnesium. The purpose of this index is to quantitatively measure the ratio of sodium (Na) ions to calcium and magnesium (Mg) ions present in a given sample. The assessment of water suitability for irrigation applications involves the consideration of sodium concentration as a significant factor. It is possible to guess the amount of sodium will build up in soil by using the Sodium Adsorption Ratio (SAR). This happens when sodium water is used again and again. The calculation of SAR is determined using the following formula (Venkateswaran et al., 2013)[18].

SAR = [Na+] / {[(Ca2++Mg2+)/2]1/2}

Where the concentrations of all ions are in meq/l.

The surface samples exhibited SAR values ranging from 1.18 to 1.35. Based on the SAR value classification established by Richards [40] (Table 4), all of the surface samples fall within the excellent group. The Soil Adsorption Ratio (SAR) is a parameter utilized to quantify the inclination of irrigation water towards participating in cation-exchange processes occurring in the soil. The replacement of adsorbed calcium and magnesium by sodium poses a threat due to its detrimental effects on soil structure, resulting in compaction and reduced permeability.(Todd,D.K., (2001)[20].

Percent Sodium (% Na)
The sodium content of water utilized for irrigation has an effect on its classification, given that high levels of sodium can hinder plant growth and impair soil permeability. The sodium content of groundwater is commonly acknowledged as a significant driver in determining that it can be used for watering. The quantification of sodium content is typically conveyed in the form of a sodium percentage, which is determined using the following formula:

%Na = [Na+] X 100 / [Ca2+ + Mg2+ + Na+ + K+]

Percent sodium, commonly known as the soluble-sodium percentage (%Na), is another method for determining the salt concentration of irrigation waters. The total salt concentration of all surface water samples is shown in Table 5. All five samples of surface water fall below the acceptable salt concentration range for use in irrigation (Subba Rao et al., 2002)[19]

CONCLUSION
Drainage and source water samples were analyzed for their physicochemical characteristics and water quality in this study. The pre-monsoon and monsoon seasons exhibit distinct variations in numerous physico-chemical properties. The findings of the aforementioned study indicate that prior to the initiation of the monsoon season, a majority of the Physico-Chemical parameters, including EC, TDS, TH, PO4, Ca, Cl, and K, exhibit levels that surpass the maximum limits suggested by the WHO. The results showed that the Channel was tainted with pollutants from factories, hospitals, and private homes. Most of the channel water samples taken for this investigation were deemed unfit for human consumption due to the presence of high amounts of many physicochemical characteristics. Additionally, in some cases, these water samples may not be appropriate for irrigation purposes due to their potential to alter soil permeability. The consumption of untreated water for drinking purposes poses potential risks to human health. Therefore, it is recommended that water obtained from these sources undergo pretreatment before to use.

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Table.1: Details of Sample code and Sample location

Sample Code	Sample Location
S1	Burma Nagar
S2	Amulaivoyal
S3	Manali –Ex Road- Vaikadu HK puram
S4	Old Washernmen CPCL
S5	MFL II – Salai Ma Nagar

Table 2: Physico-Chemical Parameters of the Surface water samples collected from Buckingham canal in different Stations during Pre Monsoon season

S.No.	Parameters	Limit as per WHO guidelines	Water samples				
			S1	S2	S3	S4	S5
1	pH	65-8.5	6.2	6.7	7.2	7.5	7.7
2	EC	600	2247	1842	2865	2853	2414
3	TDS	500	1128	1457	1512	1573	1850
4	TH	500	347	376	354	301	455
5	CO_3	500	ND	ND	ND	ND	ND
6	HCO_3	500	103	251	201	188	168
7	Ca	100	170	202	156	133	268
8	Mg	150	177	174	198	168	187
9	Na	200	124	125	124	121	128
10	K	12	131	113	118.6	52.9	107
11	Cl	250	259	237	252	257	316

Except for pH and EC, all other variables are given in ppm (micro mho cm-1)

Table 3: Physico-Chemical Parameters of the Surface water samples collected from Buckingham canal in different Stations during Monsoon season
Except for pH and EC, all other variables are given in ppm(micro mho cm-1)

S.No.	Parameters	Limit as per WHO guidelines	Water samples				
			S1	S2	S3	S4	S5
1	pH	65-8.5	8.0	8.7	7.6	7.6	6.9
2	EC	600	1052	1295	1145	1232	2613
3	TDS	500	595	614	514	552	635
4	TH	500	247	284	325	362	363
5	CO_3	500	ND	ND	ND	ND	ND
6	HCO_3	500	250	219	360	245	682
7	Ca	100	103	116	157	180	171
8	Mg	150	144	168	168	182	192
9	Na	200	115	102	126	116	128
10	K	12	89	65	60	96	101
11	Cl	250	104	118	188	106	147

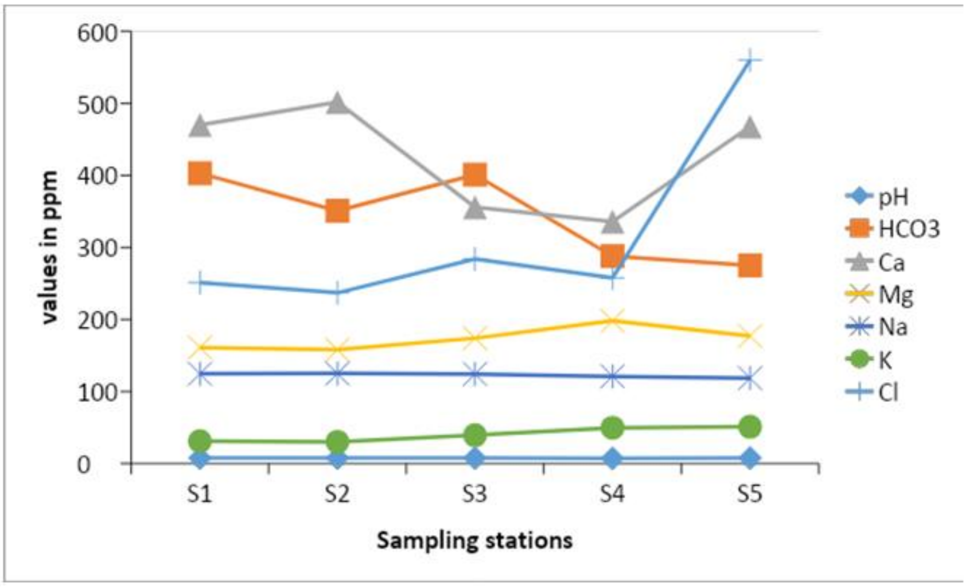

Fig. 1: Graphical depictions of pH, HCO3, Ca, Mg, Na, K and Cl for all sampling points at Pre monsoon season

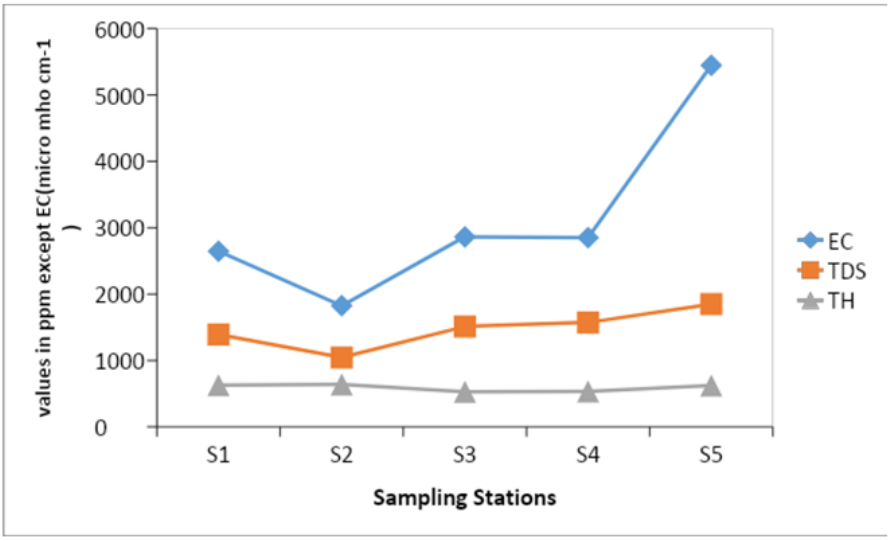

Fig. 2: Graphical depictions of EC, TDS and TH for all sampling points at Pre monsoon season

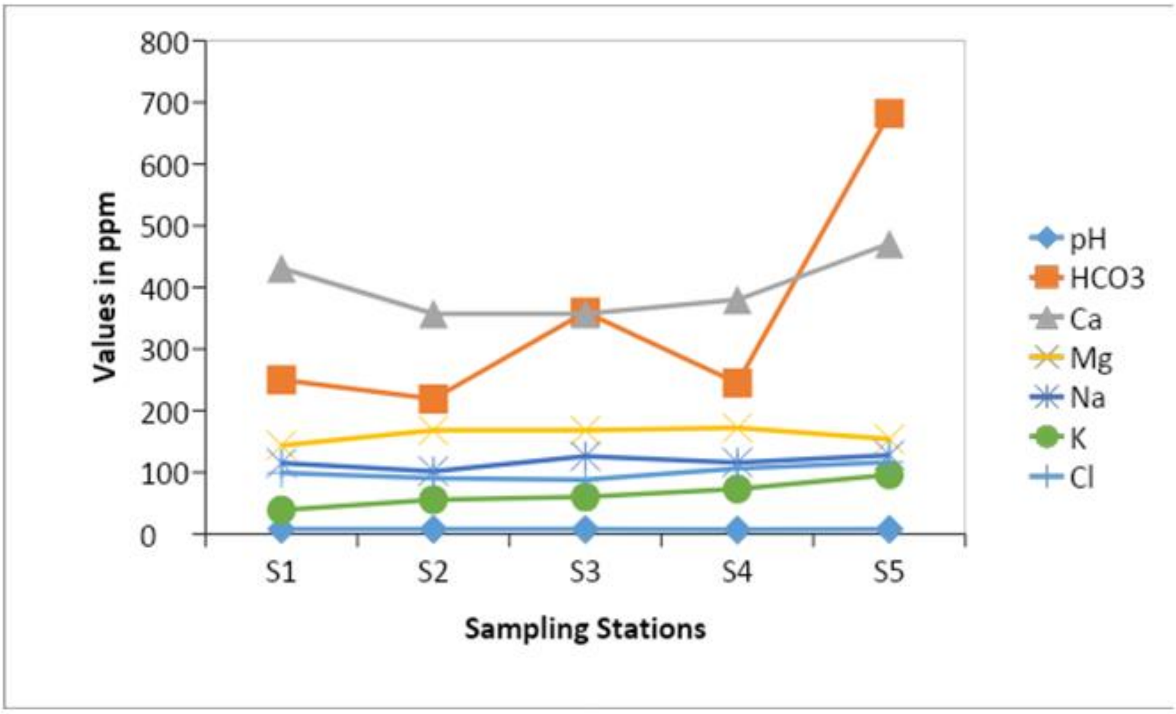

Fig. 3: Graphical depictions of pH, HCO3, Ca, Mg, Na, K and Cl for all sampling points at Monsoon season.

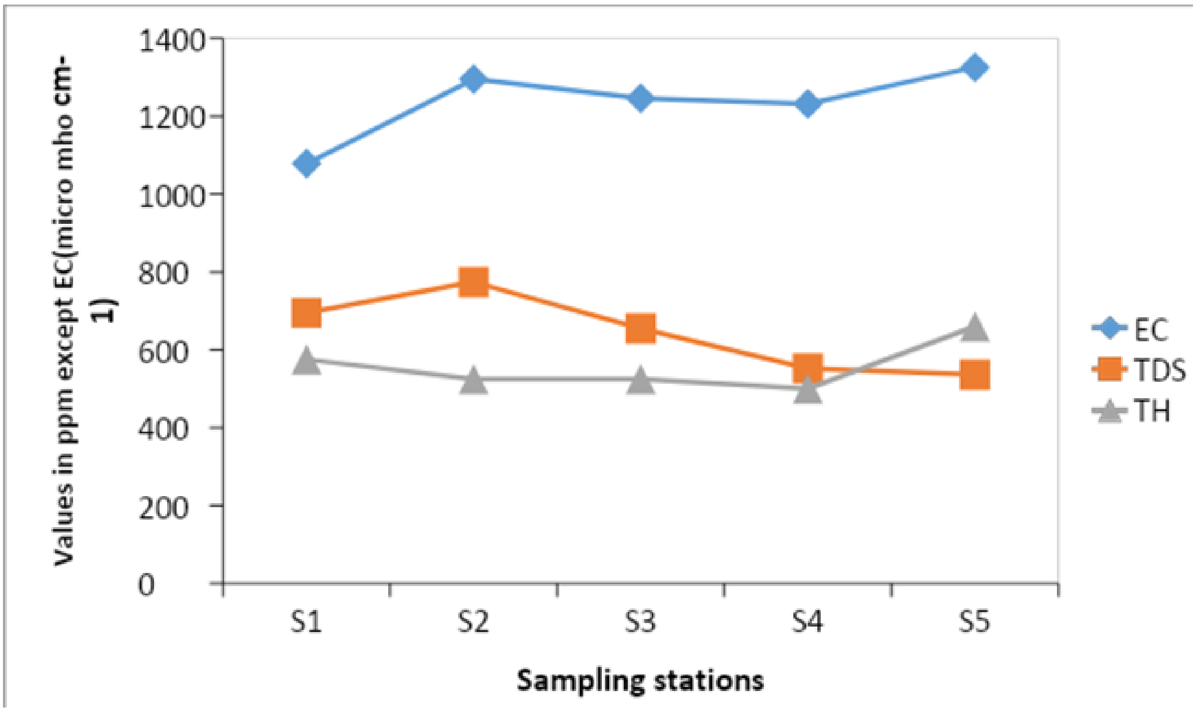

Fig. 4: Graphical depictions of EC, TDS and TH for all sampling points at Monsoon season

Table.4. Sodium hazard classes

SAR (equivalents per mole)	Remark on quality	Electrical conductivity (µmhos cm -1)
<10	Excellent	<250
10-18	Good	250-750

18-26	Doubtful	750-2250
>26	Unsuitable	>2250

Table 5 Irrigation quality of ground water based on sodium percentage

Na%	Water Classification	Observed values
		Surface Waters
<20	Excellent	Nil
20-40	Good	Nil
40-60	Permissible	5 samples
60-80	Unsuitable	….