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Advances in Applied Science Research, 2012, 3 (6):3587-3592

ISSN: 0976-8610
CODEN (USA): AASRFC

Monitoring the quality of groundwater on the bank of Cooum River at Chennai City, Tamil Nadu, India

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ABSTRACT

The groundwater quality of the bank of Cooum River at Chennai was studied. Two groundwater samples were taken near the bank of Cooum River on both sides at eight stations. The study was carried out in pre-monsoon period. The samples were subjected to physico-chemical analysis. The results showed that most of the physico-chemical parameters were in higher concentrations at most of the groundwater stations.

Key Words: Groundwater, Cooum River, Total Hardness, Pollution, WHO

INTRODUCTION

Groundwater in ultimate most suitable fresh water resources with nearly balanced concentration of the salts for human consumption. Over burden by means of population pressure, unplanned urbanization, unrestricted exploration policies and dumping of the polluted water at inappropriate place enhance the infiltration of harmful compounds to the groundwater [1]. Human needs are growing rapidly and the need for water is also growing. Much of the current concern with regards to environmental quality is focused on water because of its importance in maintaining the human health and health of the ecosystem [33]. Earth surface is acting as an effective filtrate to filter out particulate matters like leaves, soils, bugs, dissolved chemicals and gases. Above matters also occur in large concentrations to change the physico-chemical properties of groundwater [2]. The use of fertilizers and pesticides manure, lime, septic tank, refuse dump, etc, are the main sources of bore wells water pollution [31]. Water quality is based on the physical and chemical soluble constituents due to weathering of parent rocks and anthropogenic activities [32]. Groundwater begins with precipitation that seeps into the ground. Contaminated drinking water is believed to be the cause of various diseases which is on raise of heavy metals in the groundwater. Most patients, including children are admitted to the city's government hospital with the symptoms of diarrhoea and vomiting from certain parts of Chennai especially during summer or in rainy seasons. So, basic monitoring of groundwater has necessitated observing the demand and status of groundwater quality. An understanding of the chemical quality of the groundwater is essential in determining its usefulness for domestic, industrial and agriculture purposes. Chennai is one of the most important industrial cities in Tamil Nadu. Industries of diverse fields such as tanneries, pharmaceuticals, pesticides, and huge industries. Cooum River, the urban river of Chennai, starts from 'Coovum' or 'Koovam' 70 kms from the city in Thiruvallur district adjoining Chennai district. The length of the river is around 65kms and flows in three corporation zones of Nungambakkam, Triplicane, and Kilpauk which covers about 16kms. The River Cooum, once a fresh water source is today a drainage course collecting surpluses of 75 small tanks of a minor basin. Hence, the present study has been undertaken to investigate the physico-chemical analysis on the bank of Cooum River at Chennai.

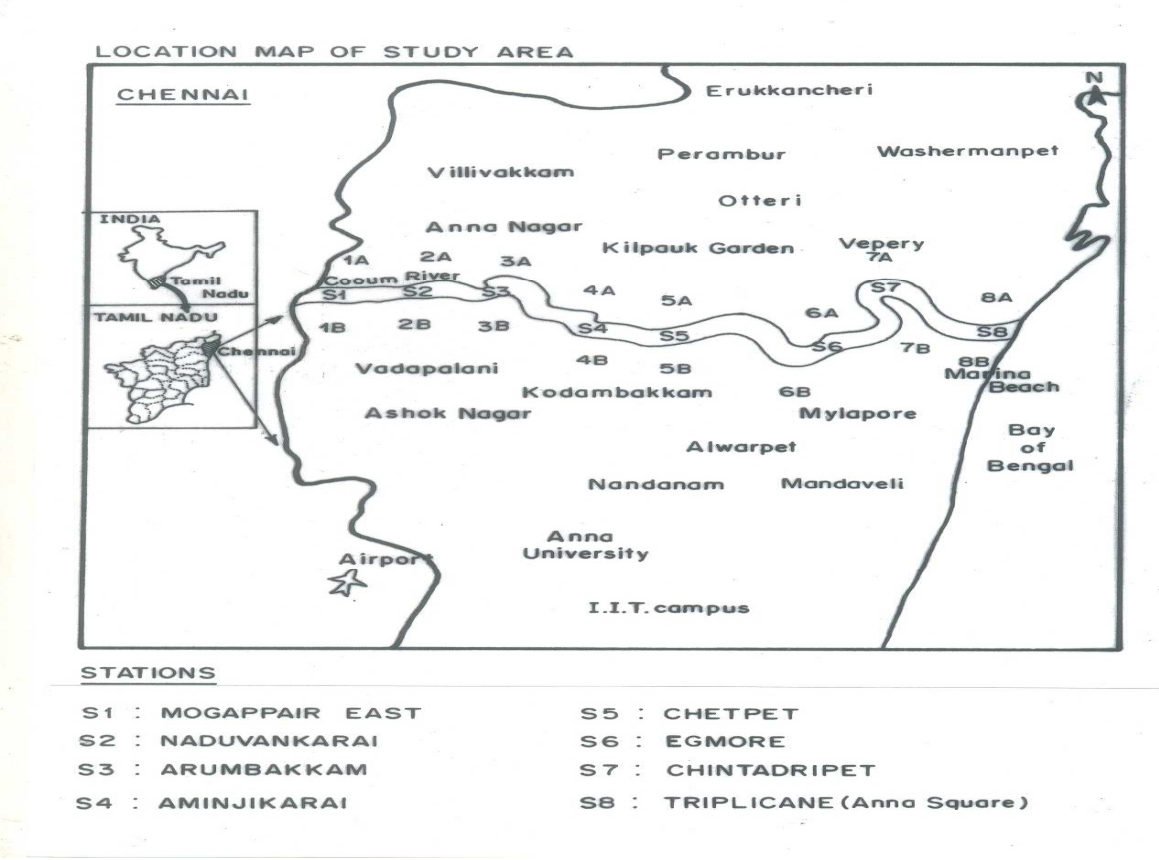
Today water pollution is the biggest problem for human beings characterization by deterioration of the water quality as a result of various human activities which makes water unfit for drinking and domestic use purposes. The main sources of water pollution are chemical fertilizers and pesticides getting in an untreated sewage and industrial effluents into rivers and streams running close to the cities and to the low lands [29].

MATERIALS AND METHODS

Sampling Stations:

The place of study at which water samples were collected is referred to as "Stations". The study pertains to the quality of Cooum River and its impact on the groundwater. Experiments were carried out for the water collected in the pre monsoon season. Eight sampling stations were selected. They are represented as Mogappair East (S1), Naduvankarai (S2), Arumbakkam (S3), Aminjikarai(S4), Chetpet (S5), Egmore (S6), Chintadripet (S7), Triplicane (Anna Square)(S8). The groundwater samples were taken from the bore wells on either side of the bank of Cooum River [1A-8A, 1B-8B] of each station.

The location of the study area map on the sampling stations is shown in the below figure.



The samples were collected in plastic cans. Prior to use, cans were cleaned thoroughly and rinsed with distilled water. They were dried, cooled and labelled. For the estimation of dissolved oxygen (DO), Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), well-sterilized BOD bottles were used. All necessary precautions were taken during sampling analysis and transportations of water samples to the laboratory [4]. The samples were subjected to physio-chemical analysis using standard procedure. [3]

RESULTS AND DISCUSSION

The obtained results are tabulated in table 1. The results are discussed and compared with standard values.

pH

pH value is an important factor in maintaining the carbonate and bicarbonate levels in water. pH is a term used to indicate the alkalinity or acidity of a substance [30]. The pH values are recorded are within the range of 7.5-7.9 for groundwater samples (Table 1). The pH values are found to within the permissible limit of 6.5-8.5ppm [5] in all the sampling stations for groundwater samples. There are no abnormal changes in groundwater samples. The slight alkalinity may be due to the presence of bicarbonate ions, which are produced by the free combination of CO_2 with water to form carbonic acid, which affects the pH of the water [6]. Carbonic acid (H_2CO_3) dissociates partly to produce (H+) and bicarbonate ions [7]. The pH values increase slightly for groundwater samples in some of the stations. The mild alkalinity indicates the presence of weak basic salts in the soil [8]. The low pH does not cause any harmful effect [8].

Electrical conductivity

The importance of electrical conductivity (EC) is its measure of salinity, which greatly affects the taste and has significant impact of the user acceptance of the water as potable [10]. The higher the ionisable solids, the greater will be the EC [11]. The EC values are within the range of 740-3276 μmho cm^{-1} for the groundwater samples. The EC values are well above the permissible limit of 600 μmho cm^{-1} for groundwater samples. The groundwater samples which are very near to the river have maximum EC and values decrease in Egmore. Percolation of channel water containing high ionisable salts and intrusion of domestic sewage enhance the EC level [9]. High EC values encountered at station 3B may be due to the higher rate of pollution of groundwater by flushing and leaching action of rain, which transfers the surface contamination. The same result was inferred by [12].

Total dissolved solids (TDS)

Total dissolved solid is an important parameter which imparts a peculiar taste to water and reduce its potability [30]. The total dissolved solids values are found within the range of 1093-1484 ppm for groundwater samples. All the groundwater samples show that the value of TDS values that are well above the permissible limit of 500ppm [5]. The maximum TDS values are observed at station at 7B. It is noted that all these groundwater stations are located nearer to the Cooum River. The River water along with domestic sewage may percolate into the groundwater, which may lead to increase in TDS values. The high content of dissolved solids increases the density of water and influences osmoregulation of fresh water organisms [13]. The same result was inferred by [14, 15].

Total Hardness

The total hardness values are within the range of 156-286ppm for groundwater samples. Total Hardness values are all in the permissible limit of 300 ppm in all the stations. According to some classifications, water having hardness up to 75ppm is classified as soft 76-150ppm is moderately soft. 151-300 ppm as hard [16] and more than 300ppm as very hard. On this basis, the result shows that all the samples were moderately soft [17].

Bicarbonate

The values of bicarbonate are recorded within the range of 360-1037 ppm for groundwater samples (Table 1). The maximum value of bicarbonate (1037ppm) is recorded at station 6B (Table 1). Since the observed pH value is below 8.5, the carbonate values are not detectable for groundwater samples [9]. The same result was inferred by [18]. Even though the carbonate alkalinity is absent, the total alkalinity is found, which may be due to the accumulation of bicarbonates. The high values are found for groundwater samples near to the river. Bicarbonates are produced from the decomposition and oxidation of organic pollutants [19] and to the frequent exchange of atmospheric CO_2 with water to form H_2CO_3

Chloride

The values of chloride are found in the range of 328-1509 ppm for groundwater samples. Chlorides are one of the major inorganic anions present in natural water. Chloride results from agriculture activities, domestic sewage and chloride-rich rocks. Human body releases vey high quantity of chloride [20]. High concentration of chloride is considered to be the indicator of pollution by high organic wastes of animal or industrial origin [9].

Sodium (Na)

The values of sodium are in the range of 153.9-203.1 ppm for groundwater samples. The sodium values exceed the permissible limit of 200ppm [5] in the sample 3B. The sample 3B which has maximum sodium values. Percolation of River water containing high ionisable salts and the intrusion of domestic sewage probably enhances the sodium

concentration sodium, is found in association with high concentration of chloride resulting in salinity. Sodium concentrations are also influenced by the cation exchange mechanism [18].

Potassium (K)
The values of potassium are recorded between 108.9-176.6 ppm for groundwater samples (Table 1). The values of potassium exceed permissible limit of 12 ppm in most of all the groundwater samples. The values of potassium in groundwater samples vary station wise. Feldspars, micas, clay minerals, etc are responsible for the availability of potassium in groundwater by weathering. Lower value of potassium in groundwater is due to greater resistance to its weathering and fixation in the formation of clay minerals. High concentrations of potassium (> 3.0 mg/l) in ground water result from fertilizing with potassium nitrate and manure near the River. High concentration in groundwater is due to the presence of silicate minerals from igneous and metamorphic rocks [22].

Calcium and Magnesium (Ca & Mg)
The values of Calcium and Magnesium are recorded in the range of 147-199ppm and 133-181ppm respectively in groundwater samples (Table 1). The Magnesium values are more than the permissible limit of 150ppm [5] for most of the groundwater samples. However, the station 5A has maximum values of Calcium which may due to the cationic exchanges with sodium. The low values may be due to the reverse cationic exchanges with sodium. (i.e.) Sodium ions replace Calcium and Magnesium ions thereby reducing their concentrations [9, 23].

Nitrite (NO_2)
The values of Nitrite are recorded in the range of 0.01-0.08 ppm. All the values are less than the permissible limit of 45ppm [5]. Thus the samples are near to the river have maximum nitrite values and the values taken away from the river has minimum nitrite values. Percolation of river water dumping of garbage, sewage leakage of septic tanks and the open toilet of human beings and animals enhance nitrite values [9].

Sulphate (SO_4)
The values of sulphate are found in the range of 36.71-94.91 ppm for groundwater samples (Table 1).The values of sulphate are within the permissible limit of 250 ppm[5]. High concentration of sulfate is due to the accumulation of soluble salts in soil, anthropogenic activity, and addition of excessive sulfate fertilizer [10]. The present study indicates that there is no harmful effect by sulphate.

Phosphate (PO_4)
The values of phosphate are within the range of 0.01-0.09 ppm for groundwater samples (Table 1). In the present investigation, the values of phosphate are found to be within the permissible limit of 0.10ppm in all the sampling stations for groundwater. There is no fluctuation of phosphate values to increased solar radiations that encourage the biological degradation of organic matter [9,24].

Bio Chemical Oxygen Demand
The values of BOD are between the ranges of 0.4-12.5 ppm for the groundwater samples (Table 1) are exceeds the permissible limit of 5.0ppm. In the present investigation the values are high. Hence, the high values may be attributed to the maximum biological activity at elevated temperatures where as the lowest BOD may indicate lower biological activity. There is an inverse relationship between DO and BOD [25, 26]. High values of total dissolved solids are responsible for higher BOD [9, 27].

Chemical Oxygen Demand (COD)
The COD values are found within the range of 0.2-92 ppm for groundwater samples (Table 1). High COD values may cause oxygen depletion on account of decomposition by microbes. The COD values exceed the permissible limit of 10ppm [5] in most of the sampling stations for groundwater, which indicate the pollution by biodegradable and chemically degradable organic matter. The maximum values of COD are recorded for the groundwater stations 4B, 5A, 8A and 8B are located adjacent to the River. The usages of fertilizers and other agricultural utilizable organic and inorganic matters may lead to high COD [28]. Heavy pollution load with the dumping of garbage and other wastes increase the COD values [9].

Dissolved Oxygen
The values of DO are recorded in the range of 6.5-8.5 ppm for all the groundwater samples. (Table.1). Low values of Dissolved Oxygen obtained in the station 5A and High values are obtained in 2B and 7B. This may due to reflect

the physical and biological process prevailing in the natural water. The general trends of changes in DO concentration in different stations are directly or indirectly governed by fluctuations of temperature and BOD. This may be due to the fact that the solubility of dissolved oxygen increases with decrease in water temperature [9]. Thus same was referred by [28]. Further DO content of water is enhanced by the decomposition of organic matter by the microorganisms [26].

CONCLUSION

Table 1. The values of physico-chemical parameters of groundwater concentrations during pre-monsoon period.

Station	pH	EC	TDS	TH	HCO_3	Cl	Na	K	Ca	Mg	NO_2	SO_4	PO_4	BOD	COD	DO
1A	7.5	1,924	1246	207	360	497	184	119	187	174	0.06	94	0.28	1.5	64	7.5
1B	7.8	1,437	1119	157	381	485	182	110	177	165	0.06	86	0.38	4.2	72	8.5
2A	7.5	963	1295	158	538	756	176	119	168	157	0.07	62	0.32	3.4	48	7.1
2B	7.7	1,654	1293	174	415	702	180	164	152	143	0.04	57	0.23	8.5	88	8.5
3A	7.9	1,934	1093	186	471	485	169	176	147	133	0.05	63	0.23	0.8	32	7.9
3B	7.8	3,276	1427	284	636	644	203	123	186	175	0.08	64	0.35	12.5	60	7.6
4A	7.8	1,272	1368	263	782	325	184	135	159	143	0.05	70	0.22	0.4	92	6.3
4B	7.7	1,694	1330	286	672	461	182	108	173	167	0.06	65	0.42	2.5	44	7.5
5A	7.9	2,141	1208	212	406	485	190	151	199	181	0.06	87	0.35	8.5	56	6.5
5B	7.6	1,990	1286	183	446	150	166	126	187	163	0.08	60	0.25	1.8	82	8.3
6A	7.6	1,689	1223	156	675	143	187	125	165	142	0.03	61	0.26	2.4	46	7.9
6B	7.8	740	1276	249	1037	579	175	126	179	166	0.02	65	0.23	0.6	94	7.2
7A	7.5	1,192	1278	174	453	440	153	112	185	179	0.01	56	0.34	6.5	84	7.1
7B	7.8	1,263	1484	209	612	539	165	110	176	163	0.01	36	0.37	4.5	42	6.8
8A	7.5	1,634	1435	273	485	674	188	125	188	173	0.04	74	0.25	0.6	38	8.5
8B	7.8	1,531	1218	176	695	685	159	136	173	168	0.07	73	0.42	0.8	56	7.2

** All the values are expressed in ppm except pHEc μmho/cm*

The groundwater samples were taken at the bank of Cooum River on both sides of each station. The water samples were subjected to physico-chemical analysis. The results of the above work show that most of the physico-chemical parameters are falls within the permissible limit of [5]. The result shows that the most of the groundwater sampling stations are polluted by the intrusion of river water, dumping of waste, and percolation of domestic sewage by inhabitants. The groundwater samples are much polluted in the Cooum river areas. This may be polluted due to the heavy pollution load, domestic sewage and other waste by thickly populated inhabitants will become unfit for drinking and other purposes. It is high time to preserve and protect this valuable ground source. Based on the results and analysis of water samples, it is recommended to use water only after boiling and filtering or by Reverse Osmosis treatment for drinking purpose by the individuals. Hence, dumping of waste polluted material should be avoided and they should not be let into the river.

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