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Agricultural activities impact on groundwater of Cauvery River belt in Papanasam taluk, Tamilnadu, India

Moscow S.,[1] Jothivenkatachalam K.,[1*] and Subramani P.[2]

[1]*Department of Chemistry, Anna University of Technology, Tiruchirappalli, Tamil Nadu, India*
[2]*Department of Engineering Chemistry, Annamalai University, Chidambaram, Tamil Nadu, India*

ABSTRACT

The study of ground water assessment can help to identify and improve predictions of contaminant fate and transport in groundwater systems. The People of Papanasam taluk, Thanjavur District, Tamil Nadu, mainly depend on ground water for drinking and agricultural purpose. The water quality of ground water has been altered due to modern agriculture practice. The present study is undertaken to investigate extent of pollution, to determine the ground water quality in and around Papanasam area due to usage of fertilizers and make awareness among the people about the quality of ground water by taking water samples from 20 different locations for analysis. Water quality assessment was carried out for the various Physico-chemical parameters like as pH, Electrical Conductivity, Cl, Na, K, Ca, Mg, Fe, and Cu etc. The overall quality of groundwater of this area is safe for drinking, domestic purposes, and suitable for irrigation purpose.

Keywords: Cauvery River, Physico-chemical, modern agriculture, irrigation, Papanasam.

INTRODUCTION

The importance of water for sustenance of life cannot be overemphasized and groundwater being a part of the hydrologic cycle needs attention for its proper evaluation and management not only to meet our need for the present but also for the future generations to come. Water is a boon to man by nature. It is acting as medium for most of chemical, biochemical reactions and highly essential for all human activities. Water is not only a vital environmental factor to all form of life, but also it has a great role to play in socio-economic development of human population [1] Water is invariably polluted in all countries, India is no exception to this phenomenon[2-5]. Adequate drinking water quality is essential for the well being of all humans who use water not only for drinking but also at homes, industry, agriculture, recreation, etc [6,7].

Ground water is in general, is clean, fresh and pollution free and has high mineral content. Today, due to some kind of activities like industrial and agricultural practice the ground water are involved to customary pollution. So, now days the management of ground water quality has come to light as great public concern in our country. Quantitative availability and chemical quality of groundwater is influenced by various natural environments such as geology, topography, geomorphology, rock type and extent of weathering, landforms types, drainage density, soil type and land cover are some of the generally used parameters in deciding the suitability of an area for groundwater development. [8,9] The extent of ground water pollution depends on rainfall pattern, depth of water level, distance from the source of contamination, and soil properties such as permeability [10]Water quality also depends on chemical, physical and bacterial constituents [11]. The presence of any toxic substance in water that degrades the quality to constitute a hazard or impair its usefulness [12].

Human health is threatened by most of the agricultural development activities particularly in relation to excessive application of fertilizers. In the face of increasing food demand of the burgeoning population, efficient fertilizer use in crops and the prevention of groundwater pollution are critical [13]. Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from the source. It therefore becomes imperative to regularly monitor the quality of groundwater and to device ways and means to protect it. Water quality index is one of the most effective tools [14-17]

With this knowledge the present study attempts to evaluate the quality of ground water in Papanasam taluk in Thanjavur district. Papanasam taluk is one of the most important agricultural based areas in Tamilnadu, which is lying in Cauvery river deltaic region. It extends latitudinally from 10^0.93' to 11^0 02' N and longitudinally from79^0.05'to 79^0 20'. The water quality of this area has been altered, due to modern cultivation. This area is advanced in agricultural but backward in industries. But, this misuse of fertilizers and the high order of pesticides usage, the ground water expected to have been contaminated. The branch of cauvery, Coleroon River around this area receives litres of sewage, domestic wastage, weeds, pesticides, fertilizers, manure and heap. Such information is essential to ensure water quality assurance in future and for effective management. So the present paper attempts to evaluate and improve the quality of ground water in this study area and thereby to analyse the various related aspects and create an awareness to the people for proper usage of fertilizers to preserve the quality of ground water in future.

MATERIALS AND METHODS

In the present investigation ground water samples were collected from 20 locations in Papanasam taluk, Thanjavur District by using plastic container with necessary precautions [10,18]. Samples containers were prepared to collect the water samples to meet prerequisites of chemical analysis. Each sample was poured into sample bottles after rinsing it twice or thrice with the same water and covered with lid. These containers were labeled with respect to collecting points, date and time in order to avoid any error between collection and analysis. The collected samples were stored in an icebox and brought to laboratory for determining both physical and chemical parameters. All the chemicals used were AR grade of pure quality. Double distilled water was used for the preparation of all the reagents and solutions.

The pH and Electrical Conductivity were measured by using Elico digital pH meter [model L1-12T] with an accuracy of ± 0.01 and Elico digital Conductivity meter [model CM 180] with an accuracy of ± 0.01 respectively. Total Hardness, Calcium, Magnesium were measured by EDTA titration method [11]. Chloride was measured by volumetrically by silver nitrate titrametric method using potassium chromate as indicator and was calculated in terms of mg/L [19]. Sodium and Potassium were measured by flame photometry [Elico model CL 22 D] method and Ca, Mg, Fe, and Cu were analyzed by Atomic Absorption Spectrophotometer [AAS 400 Perkin Elmer].

RESULTS AND DISCUSSION

In the studied area, water used for drinking purposes should be colourless, odourless and free from slight turbidity and excess salts. The taste of the water is slightly brackish at some of the locations. The temperature of the water is in the range 28° C - 38° C. The important physico-chemical characteristics of analyzed water samples and the values are compared with standard like USPH, WHO, ICMR, BIS etc are shown in Table- 1 and 2.

pH: The pH value of drinking water is an important index of acidity or alkalinity. A number of minerals and organic matter interact with one another to give the resultant pH value of the sample. In the present study, the pH ranges from 7.14-9.14 which is exhibit slightly alkaline it may be due to presence of Hydroxide and carbonate sediment [20,21].

The pH value of 7.0 to 8.0 usually indicates the presence of carbonates of calcium and magnesium, and a pH of 8.5 or above shows appreciable exchangeable sodium [22]. The result of the study was supported by the normal recommended pH range for irrigation water is from 6.5 to 8.4 [23]. Moreover the location of the study area being an agricultural area, due to the influence of organic fertilizers the pH of the ground is slightly alkaline.

Dissolved Oxygen: Dissolved oxygen is necessary and needed for good water quality. Oxygen is a necessary element to all forms of life. DO in water is great importance to all aquatic organisms and is considered to be the factor that reflects the biological activity taking place in a water body which are brought about by the aerobic or anaerobic organisms [24].

The result of analysis reported that the Dissolved Oxygen in these areas is found to be in the range of 1.8-3.8 mg/L. Drinking water has a Dissolved Oxygen of less than 500 mg/L it's considered fairly pure as per BIS [25] standard index. As dissolved oxygen level drop below 5.0 mg/l, aquatic life is put under stress. The lower the concentration the greater the stress [26].

Electrical Conductivity: The measurement of electrical conductivity is an useful parameter of water quality for indicating salinity hazard. As per present report, the electrical conductivity is ranges from 100 to 180 μ mho/cm and its found to be within permissible range [27]. The trend of conductivity generally reflects the chloride concentration available in ground water [28] and enriched by the discharge ions of sodium, calcium and magnesium [29].

The significant of electrical conductivity values, due to the fact that a large part of the leaching or washing out of solutes in the soil [30]. The higher values of electrical conductivity are always

predominant with sodium chloride ions [31]. The present analysis report is also line with the above statement and safe for drinking purpose as per USPH recommended permissible limit for electrical conductivity is 300 μmhos/cm.

Calcium: Generally Calcium in the ground water is derived from minerals like limestone and dolomite [32]. The total hardness is relatively high in water due to the presence of calcium, magnesium, and chloride and sulphate ion. Hence, the water is not suitable for potable purpose and also leads to heart, kidney related diseases [33] and constipation effects [34]**.**

The distribution of calcium in the studied area is found to be highly fluctuating from station to station it may be due to the supply of calcium through sandy materials, mixed up with calcareous constituents without any uniform distribution. The drastic shift in concentration of calcium might be due to the presence of limestone in the aquifers at depth of collection. Most of stations show the Calcium concentration is below the prescribed limits, which is evidenced by the WHO [35] standard.

Magnesium: The distribution of magnesium in the studied area ranges from 31 to 162 ppm. Magnesium concentration is below or nearest to the prescribed limits for all the stations. But in station 4&5 observed high values of magnesium is probably due to closeness of the stations to nearby Vennar River. This is possible since magnesium would have been supplied in the form of chloride along with sodic salt in the form manure into the water. Moreover Goldschimt [36] has also indicated the possibility of enrichment of calcium, magnesium & sodium in black sediments.

High loading of Mg ions is related to the weathering of ferro magnesium mineral and anthropogenic sources [37-40]. Too high magnesium causes nausea, muscular weakness and paralysis in human body when it reaches a level of about 400mg/L [35]. Maximum permissible limit of calcium and magnesium in drinking water is 50mg/L as suggested by ICMR [41], thus the status of ground water is not hazards except few stations.

Chloride: The chloride concentration in the studied area displays a more or less uniform except station 5 where it is more than 1000 ppm. It may be probably due to the percolation of chloride ions into the ground water from the adjacent rivers. Soil porosity and permeability also has a key role in building up the chlorides concentration [42] and generally reflects the electrical conductivity of ground water [28].

The chloride ion content in station 5 is high to the tune of 1539 ppm this value is found be higher than the tolerable level for irrigation given by Environmental Geology standard which is 75 – 200 ppm [43]. Hence, the water quality of station 5 is noticed to be neither useful to drinking nor useful to irrigation. High chloride indicates the saline nature of water it may be due to the percolation through this soil bed has enriched saturation of more sodic alkalinity in the water. The WHO [35] emphasized the chloride concentration in excess of about 250 mg/L can give rise to detectable taste in water.

Sodium: The presence of sodium, a naturally occurring metal in drinking water varies from 130 - 350 ppm. Minerals of the bed rock are subjected to weathering and subsequently affected by

leaching, which contribute sodium salts to groundwater [37]. Based on the present survey the sodium concentration in ground water may be considered suitable for domestic purposes except station 5.

As per WHO [35] the permissible sodium content in drinking water is 200 ppm. Very large sodium content is considered to be harmful for people suffering from hypertension. Higher concentration of sodium could be related to cardiovascular diseases as well as toxemia associated with pregnancy [44]. The enrichment of sodium probably accounted by the location of this station close to the Cauvery river flow, it may have led to the increased of sodium content in the ground water.

Potassium: The allocation potassium in the studied area ranges from 1.0- 12.9 ppm. The distribution of Potassium establishes higher order of flocculation, it is possible that in the form of chloride, as water moves further down decreasing the chloride concentration. Potassium enters into a drinking water system from natural geological sources, detergents, mining and agricultural wastes.

The increased use or misuse of fertilizers had frequently been cited as the cause of water quality deterioration [45]. Nitrate leaching can occur in intensively cultivated areas with a shallow water table [46]. Thus, the excess amount of potassium present in the water sample may lead nervous and digestive disorder [47].

Iron: Iron is the most commonly available metal on planet earth. The Iron content in the present study ranges from 0.01 – 2.17 ppm. The maximum iron concentration is found at stations 5, 10 and 17, while other stations display lower iron concentration. The reason behind considerable iron concentration they are in depth levels is probably due to the same kind of sediment that is common in these stations. The black soil, black clay present in soil, it must have been encouraging the presence of iron [48].

Excess amount of iron [more than 10 mg/L] causes rapid increase in respiration pulse-rate and coagulation of blood vessels, hypertension and drowsiness. The shortage of iron causes a disease called “anemia” and prolonged consumption of drinking water with high concentration of iron may lead to liver disease called as haermosiderosis [49]. The ground water used for drinking should not exceed the maximum permissible limit of 0.3 ppm. In the present study, except three stations such as 5, 10 and 17 the iron content is not hazardous.

Copper: Copper is the principle component in metal alloys, preservatives for food and some fungicides, sewage, fertilizers and pesticide residue [50]. The presence of copper in the studied area is found to be nil except in station 12, it may be due to, such concentration in water is generally, expected to the zone of copper sulphate associated in the sediment. Further Goldschmidt [36] pointed out the possibility of higher copper in highly oxygenated sandy beds. Incidence of higher copper content may also be a phenomenon of localized nature, probably due to the type of fertilizers impregnated with $CuSO_4$, being used much commonly in the particular field. Excess of copper in human body is toxic and causes hypertension and produces pathological changes in brain tissues. Excessive ingestion of copper is responsible for specific disease of the bone [51].

Table 1: Physiochemical Parameters

BDL - Below Detectable Limit*

Sl No	Station Names	DO (mg/L)	EC (µmho/cm)	pH	Cl (ppm)	Na (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Fe (ppm)	Cu (ppm)
1	Dalavapalayam	2.2	120	9.14	142	160	1.6	43	33	0.04	BDL*
2	Janbagapuram	2.4	120	8.32	142	160	1.6	34	31	0.11	BDL
3	Poondi	1.8	110	8.62	156	170	2.5	0	41	0.0	BDL
4	Kalancheri	2.0	140	8.14	170	200	4.7	76	38	0.06	BDL
5	Eadaiyaruppu	3.3	180	8.03	1539	350	12.9	38	162	0.69	BDL
6	Milattur	3.6	100	7.14	177	210	3.1	37	162	0.04	BDL
7	Kattukurichi	3.0	130	7.26	319	174	3.0	71	51	0.0	BDL
8	Kothangudi	2.6	140	9.15	213	180	6.9	63	45	0.0	BDL
9	Manalur	2.6	120	8.06	205	180	5.6	46	47	0.01	BDL
10	Papanasam	2.0	140	6.52	248	180	5.2	63	38	2.17	BDL
11	Alavanthipuram	3.1	140	9.10	128	130	1.0	42	46	0.02	BDL
12	Nadupadugai	3.0	140	8.69	324	135	1.1	80	46	0.01	5.13
13	Sathiyamangalam	2.8	140	9.11	248	160	1.7	71	53	0.01	BDL
14	Sarukkai	2.2	140	7.69	262	220	3.9	76	40	0.05	BDL
15	Ganapathi Agraharam	2.4	110	8.7	142	150	1.8	59	32	0.0	BDL
16	Rajagiri	3.3	120	8.32	177	160	2.2	50	39	0.05	BDL
17	Valuthur	2.0	110	7.36	369	140	1.0	46	45	0.86	BDL
18	Sulamangalam	3.1	130	8.62	170	190	4.4	38	47	0.01	BDL
19	Agramangudi	3.8	140	9.00	198	210	5.0	38	49	0.08	BDL
20	Vaiyachari	2.6	140	9.05	191	195	3.7	42	53	0.05	BDL

Table 2: Status of Potable water with reference to standard

Parameters	USPH	WHO	ICMR	BIS	Present Report
pH	6.0-8.5	6.5-9.2	6.5-8.5	6.5 – 8.5	7.14 – 9.14
DO			500	500	1.8 – 3.8
EC, µ mho/cm	300	300			1.0 1.6
Calcium	100	75	75	75	38 - 76
Magnesium	30	50	50	30	31 - 162
Sodium		200			135-350
Potassium		8.0			1.0 – 12.9
Chloride	250	200	250	250	142 - 1539
Iron		0.3		0.3	0.01 – 2.17
Copper		1.0		0.05	0 – 5.13

USPH - United States Public Drinking water Standard
WHO - World Health Organisation
ICMR - Indian Council of Medical Research
BIS - Bureau of Indian Standards

CONCLUSION

In the present study, reveals that most of the ground water samples at Papanasam taluk were found less polluted in physiochemical profile. The ground water samples from Papanasam taluk have been collected from 20 station, the physiochemical parameters of water like DO, Chloride, pH, EC, Ca, Mg, Na, K, Fe and Cu, using titration, Flame photometer, UV spectrometer and Atomic Absorption Spectrometer has been studied.

The whole area of the people depends on ground water for their essential usage like drinking, bathing and irrigation. From the study, it can be seen that all the values are within permissible

limit in most of the stations apart from station 5 according to WHO. The variation in parameters is ascribed to either depth of lithology or fertilizers or the soil type prevalent in the area.

Now, the people of these area are used ground water for their utilization without the treatment in present but in future care must be needed to control the usage of fertilizers for modern agriculture activity and is also essential to understand the ground water pollutant impact on human being. The periodically analysis required for every six months in view of social concerned with human health and wealth cannot be ignored for extensive time.

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