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A STUDY ON PHYSICO- CHEMICAL STATUS AND SPATIAL DISTRIBUTION OF POLLUTANTS IN GROUND WATER PROXIMITY TO UYYAKONDAN CHANNEL USING MODELING SOFTWARE - GIS

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Abstract

Tiruchirappalli is one of the most important industrial cities in Tamil Nadu and situated on the river bank of the Cauvery. Uyyakondan channel is about 65.5 km long, running through the heart of Tiruchirappalli as a tributary of river Cauvery. The channel water is used for domestic and irrigation purposes. A total of 40 ground water and 5 surface water samples were collected from in and around Uyyakondan channel. The water samples were analyzed for physico-chemical parameters like pH, EC, TDS, TH, DO, COD, BOD, Cl, PO_4 and K as prescribed by APHA, using standard techniques and compared with WHO (2009). The ground water quality information maps of the entire study area were prepared by using software GIS for all the above parameters. The results obtained by this study will be helpful for identifying the spatial distribution of pollutant in the study area.

Keywords: Physico-chemical parameters, Uyyakondan Channel, Spatial distribution-GIS

1. INTRODUCTION

Water is the most precious natural resource available to mankind. The quality of water is of vital Concern for mankind since it is directly linked with human life[1]. Groundwater is ultimate and most essential suitable fresh water resources for human consumption in both urban as well as rural areas. The importance of groundwater for existence of human society cannot be over emphasized [2]. Groundwater is a source used for agricultural and industrial sector now a day. In recent years, an increasing threat to groundwater quality due to human activities has become of great importance. The adverse effects on groundwater quality are the over burden of the population pressure, unplanned urbanization, unrestricted exploration, unintentionally by domestic, agriculture and industrial effluents and dumping of the polluted water at in appropriate place enhance the infiltration of harmful compounds to the groundwater [3]. There are several ways as groundwater is contaminated in urban and rural areas such as municipal sewage disposal to nearby water bodies, disposal or seepage of effluent from industries and use of inorganic fertilizers in agricultural farming. Most of the industries discharge the effluent without proper treatment into nearby open land or pass them through unlined channels, resulting in a deterioration of the groundwater resources. The groundwater pollution is highest in urban areas than rural areas where large volumes of waste concentrated and discharged near to the urban lakes. The increasing demand of water from fast growth of industries has put pressure on limited water resources. Groundwater assessment has been based on laboratory investigation, but the advent of Satellite Technology and Geographical Information System (GIS) [4], we can predict the spatial distribution of pollutants around the study area.

2. Materials and Methods

2.1. Study area

The Base map of Tiruchirappalli city was drawn from Survey of India Topo sheets Nos. 58 J/9, 10, 13 and 14 and satellite imagery (IRS -1C and LISS III) is lies between 10°48'18" North: 78°41'7" East. The general topology of Tiruchirappalli is flat and lies at an altitude of 78 m above sea level. Tiruchirappalli is fed by the rivers Cauvery and Kollidam.Uyyakondan Channel**,** a tributary of river Cauvery, is one of the most important drainage and water source for the southern part of Tamil Nadu. The channel starts from Pettavathalai which is a residential area, as well as fertile area located 35 km from the heart of the Tiruchirappalli city and continues via small villages and some parts of Trichy cities. This channel receives water for irrigation for about seven to nine months of a year. The channel starts from Petavaithalai located about 25 km from the heart of Trichy and flows across many villages. The channel water is used for domestic and irrigation purposes and it irrigates around 35000 hectares. It receives enormous amount of effluent from industries and domestic sewage. Most of the people residing along the banks of the channel depend upon this water for bathing, domestic irrigation and other purposes. The typical sewage comprising of domestic and other waste are discharged directly in to the channel without any proper treatment. Dumping of all these wastes into and near this channel not only pollute the water source, but also poses serious health hazards. Hence the present investigation has been attempted to study of various physico-chemical parameters in and around Uyyakondan channel.

2.2. Collection of samples

A Five surface water samples and forty ground water samples were collected from on either side of Uyyakondan channel in Tiruchirappalli district. The distance between one station to another station was maintained about 0.75 kilometers. Samples were collected in a clean and dry polyethylene cane from bore wells after running it for 3 mins. All the samples were collected during the year May 2010- Aug 2013. In the present study, various physico- chemical parameters such pH, EC, TDS, TH, DO, COD, BOD, Cl, PO_4 and K of both surface and ground water samples were analyzed for physico-chemical parameters as prescribed by APHA, using standard

techniques and the results were compared with the values of World Health Organization (WHO 2003).

GIS technology proved to be very useful for enhancing the accuracy. We obtained the Location of the well by using the GPS and Arc GIS software. The IDW was applied to find out the spatial distribution of groundwater quality. In interpolation with the spatial analyst method of IDW, a weight is attributed to the point to be measured. The amount of this weight is dependent on the distance of the point to another unknown point[5]. These weights are controlled on the bases of power of ten. With increase of power of ten, the effect of the points that are farther diminishes. Lesser power distributes the weights more uniformly between neighboring points. In this method the distance between the points count, so the points of equal distance have equal weights[6]. The advantage of IDW is that it is intuitive and efficient. This interpolation works best with evenly distributed points. Similar to the SPLINE functions, IDW is sensitive to outliers. Furthermore, unevenly distributed data clusters result in introduced errors [7].

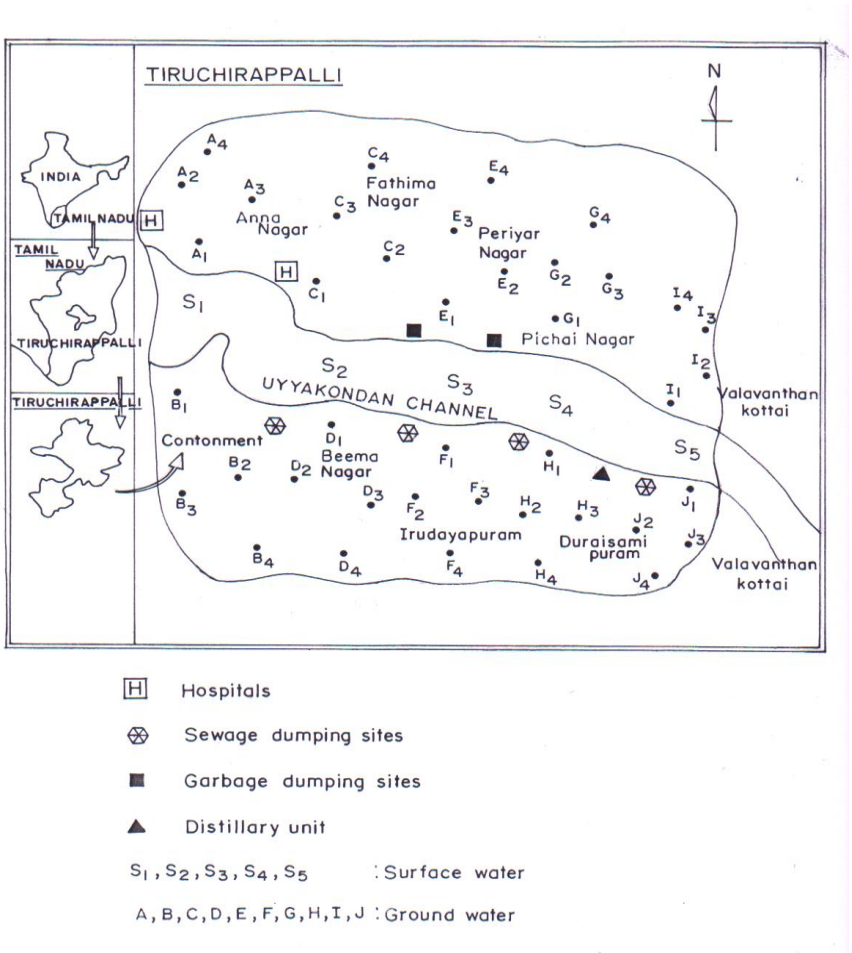

Fig: 1 Location map of the study area

3. Results and discussion

The mean results of the physico-chemical parameter for water samples in and around Uyyakondan channel are presented in table 1,2,3,4 and 5 respectively.

Tables: The Mean values of physico chemical characteristics of surface and Ground water samples collected in and around Uyyakondan channel (STATION 1 Cantonment)

Stations	Parameters									
	pH	EC	TDS	TH	DO	BOD	COD	PO_4	Cl	K
S1	7.8	1629	901	325	6.1	5.3	24.1	1.0	245	28.8
Towards Left from Surface water(S_1)										
A1	7.8	1760	1043	425	7.3	4.9	16.1	0.9	282	51.8
A2	7.7	1505	957	408	8.0	5.9	20.0	0.7	263	48.8
A3	7.9	1748	850	426	8.4	4.9	21.9	1.0	225.8	48.0
A4	7.6	1924	1185	383	7.0	4.1	21.0	0.4	272	46.4
Towards Right from Surface water(S_1)										
B1	7.9	2020	1121	398	8.1	4.6	23.4	0.6	211.6	35.4
B2	7.9	2513	978	375	8.4	5.3	18.3	0.7	186	37.1
B3	7.7	1690	937	435	7.8	4.6	22.4	0.5	203	37.0
B4	7.7	1846	900	536	8.0	3.7	16.4	0.6	210	38.8

Table: 2 The Mean values of physico chemical characteristics of surface and Ground water samples collected in and around Uyyakondan channel (STATION II Fathima Nagar)

Stations	Parameters									
	pH	EC	TDS	TH	DO	BOD	COD	PO_4	Cl	K
S2	7.8	1485	679	342	4.6	5.7	32.8	0.8	120.3	39.1
Towards Left from Surface water(S_2)										
C1	7.3	1654	784	384	6.9	4.5	32	0.6	193	59
C2	7.3	2275	951	431	6.7	4.0	33.7	0.7	197	66.1
C3	7.6	1924	904	435	7.8	8.2	32.0	0.9	178	63.7
C4	7.3	2239	952	407	7.9	5.9	32.1	1.1	205	60
Towards Right from Surface water(S_2)										
D1	7.6	1988	934	447	7.2	5.6	29.4	0.4	167	42.2
D2	7.5	2058	880	450	7.3	6.5	26.3	1.1	159	52.6
D3	7.5	2337	1075	369	7.6	9.3	28.9	0.5	195	54.2
D4	7.5	2156	1187	455	6.6	4.9	31.2	0.4	250.5	52.9

Table: 3 The Mean values of physico chemical characteristics of surface and Ground water samples collected in and around Uyyakondan channel (STATION III,Palakkarai)

Stations	Parameters									
	pH	EC	TDS	TH	DO	BOD	COD	PO_4	Cl	K
S3	7.8	1642	951	420	6.1	4.1	24.0	0.2	262.3	35.2
Towards Left from Surface water(S_3)										
E1	8.1	2152	1315	596	6.2	3.8	20.1	0.3	260	60.3
E2	8.2	2443	1425	483	7.1	3.9	21.2	0.2	211	62.3
E3	7.8	2573	1665	519	7.4	6.2	23.2	0.2	250	61.9
E4	7.9	2491	1521	459	8.1	5.9	23.5	0.2	233	59.5
Towards Right from Surface water(S_3)										
F1	7.9	2408	1479	483	6.7	5.6	23.6	0.3	274	58.6
F2	7.9	2584	1406	409	7.1	8.0	21.3	0.6	232	56.9
F3	7.9	2453	1535	384	6.2	4.1	9.0	0.4	330	54.1
F4	7.8	2285	1460	412	5.7	3.9	21.1	0.39	255	53

Table: 4 The Mean values of physico chemical characteristics of surface and Ground water samples collected in and around Uyyakondan channel (STATION IV Duraisamipuram)

Stations	Parameters									
	pH	EC	TDS	TH	DO	BOD	COD	PO_4	Cl	K
S4	7.5	1946	870	393	6.8	5.9	25.4	0.4	198	53.0
Towards Right from Surface water(S_4)										
G1	7.5	2239	1017	469	6.7	6.0	33.8	0.5	217	64.4
G2	7.4	2842	1277	337	8.3	7.2	31.8	0.7	270	62.5
G3	7.3	3113	1342	607	6.6	6.3	32.2	0.8	379	66.9
G4	7.4	2629	1306	612	7.7	6.6	30.7	0.5	357	73.6
Towards Right from Surface water(S_4)										
H1	7.8	2593	1234	512	7.0	5.8	32.0	0.6	203	60.2
H2	7.4	3085	1061	560	6.0	6.6	31.6	0.7	357	61
H3	7.3	3645	1889	601	3.6	5.1	30.6	18.4	266	54.2
H4	7.5	3392	1826	591	7.2	6.0	25.6	1.1	283	54.7

Table: 5 The Mean values of physico chemical characteristics of surface and Ground water samples collected in and around Uyyakondan channel (STATION V valavanthankottai)

Stations	Parameters									
	pH	EC	TDS	TH	DO	BOD	COD	PO_4	Cl	K
S5	7.9	2915	1348	493	6.8	4.0	17.7	0.7	327	38.3
Towards Left from Surface water(S_5)										
I1	7.7	2170	1480	497	7.4	5.5	25.9	0.1	305	50.1
I2	7.7	3552	2144	922	11.8	3.8	29.3	0.1	391	57.4
I3	7.7	2741	1493	465	7.6	3.4	25.6	0.1	160	65.0
I4	7.3	2710	2306	824	6.9	4.8	25.4	0.2	309.3	44.6
Towards Right from Surface water(S_5)										
J1	6.9	5736	4101	2089	6.9	6.1	29.7	0.1	785	45.9
J2	7.1	4558	3245	978	6.0	3.3	22.2	0.2	416	45.9
J3	7.1	2413	3912	1258	6.7	3.1	22.0	0.2	519	45.3
J4	7.5	3984	2824	844	5.1	4.9	22.6	0.2	796	46

All the values are expressed in ppm except pH and EC (micro mho cm^{-1})

3.1.pH

pH is the measure of the intensity of acidity or alkalinity and the concentration of the hydrogen ion in water[8].The pH values of water samples varied between 6.2 to 8.2 and were found below the limit prescribed by WHO (6.5-8.5). Fig 1

3.2. Electrical conductivity

Electrical conductivity is a measure of water capability to transmit electric current and also it is a tool to assess the purity of water [9] . EC values were in the range of 1505 micro-ohms/cm to 5736 microohms/cm. High EC values were observed for all surface and ground water samples when compared to WHO values (500 micro-ohms/cm),indicating the presence of high amount of dissolved inorganic substances in ionized form. High EC values may cause carcinoma and mortality problem [10]. Fig 2

3.3. TDS

Total dissolved solids indicate the salinity behaviour of groundwater. Water containing more than500 mg/L of TDS is not considered desirable for drinking water supplies, but in unavoidable cases 1500 mg/L is also allowed [12] .TDS values varied from 679 ppm to4101ppm.

In our study all the water samples show higher TDS values that are well above the permissible limit of WHO (500ppm), except some stations. This may due to the infiltration of excess of sewage wastes from the sewage canals and unprotected drainages and chemical weathering of rocks. High TDS may cause lung cancer and cardiovascular diseases [13] .Fig 3 . The same is observed in the study area.

3.4. Total Hardness

Hardness the lather formation with soap and increases the boiling points of water [14]. Hardness of water mainly depends upon the amount of calcium or magnesium salts or both. The hardness values are found in the range from 325 ppm to 2089ppm mg/L. TH values for all samples found below the permissible limit prescribed by WHO(500ppm), except some stations, [E1,E3,G3, G4,H3,H4,I2, I4,J1, J2, J3 and J4] due to evaporation. High hardness is mainly due to the contamination by industrial effluents and regular addition of large quantities of sewage and large scale human. High TH may cause Kidney stone formation[15]. Fig 4.

3.5. Dissolved Oxygen.

Dissolved oxygen (DO) reflects the physical and biological process prevailing in the water which indicates the degree of biological pollution in the water bodies[16]. DO values were in the range of 3.6 ppm to 11.8 ppm. The Do values are recorded above the permissible limit of (WHO), except the station H3. Low DO may due the domestic sewage contain high organic contamination. It is unsuitable for fish and fauna. Fig 5.

3.6. Biological Oxygen Demand

Biological oxygen demand is a test of great value in the analysis of sewage industrial effluents and polluted water. It provides an indirect measure of total amount of unstable organic matter contained in a waste [17]. The test is a basis for assessing the effect of the discharge of the waste water on the oxygen balance of natural water receiving it. BOD refers to the quantity of oxygen required by bacteria and other micro organisms in the biochemical degradation and transformation of organic matter under aerobic conditions. BOD values varied from 3.1ppm to

8.0ppm. In our study the all the surface and Ground water samples are found within the limit prescribed of WHO. Fig 6.

3.7. Chemical oxygen demand (COD):

COD is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface and ground water [18].COD Values were in the range of 16.1ppm to 25.6ppm.COD values of all Surface and Ground water samples found beyond the limit of WHO. High COD may be due to Contamination of water with industrial effluents containing high volatile solids and affect the aquatic life. Fig 7.

3.8. Phosphate.

Phosphate enters into ground water from phosphate containing rock, fertilizers and percolation of sewage and industrial waste [19].The phosphate content in the study area was found in the range of 0.1ppm to 18.4ppm. In the present study all the phosphate values are found above the permissible limit of WHO. High phosphate may due to agricultural runoff from irrigated lands containing phosphatic fertilizers cause hyperphosphatemia. Fig 8.

3.9. Chloride

Chloride occurs naturally in all types of water. Chloride in natural water may results from Agricultural activities, industries and chloride rich rocks [19].The chloride values ranged from 160ppm to796ppm. In our study the Chlorides values found within the limit prescribed by WHO, except some of the stations. High value of Chloride may due to increased rate of percolation of domestic wastes and industrial wastes are increased the chloride level cause Stomach discomfort and eye irritation. Fig 9.

3.10. Potassium

Na and K are the most important minerals occurring naturally. The major source of both the cations may be weathering of rocks besides the sewage and industrial effluents[20.] Potassium values varied from 28.8 ppm to73.6ppm. In present study all the Potassium values are found above the permissible limit of WHO. High values of potassium are attributing to the possible contamination by domestic sewages and effluents. Fig 10.

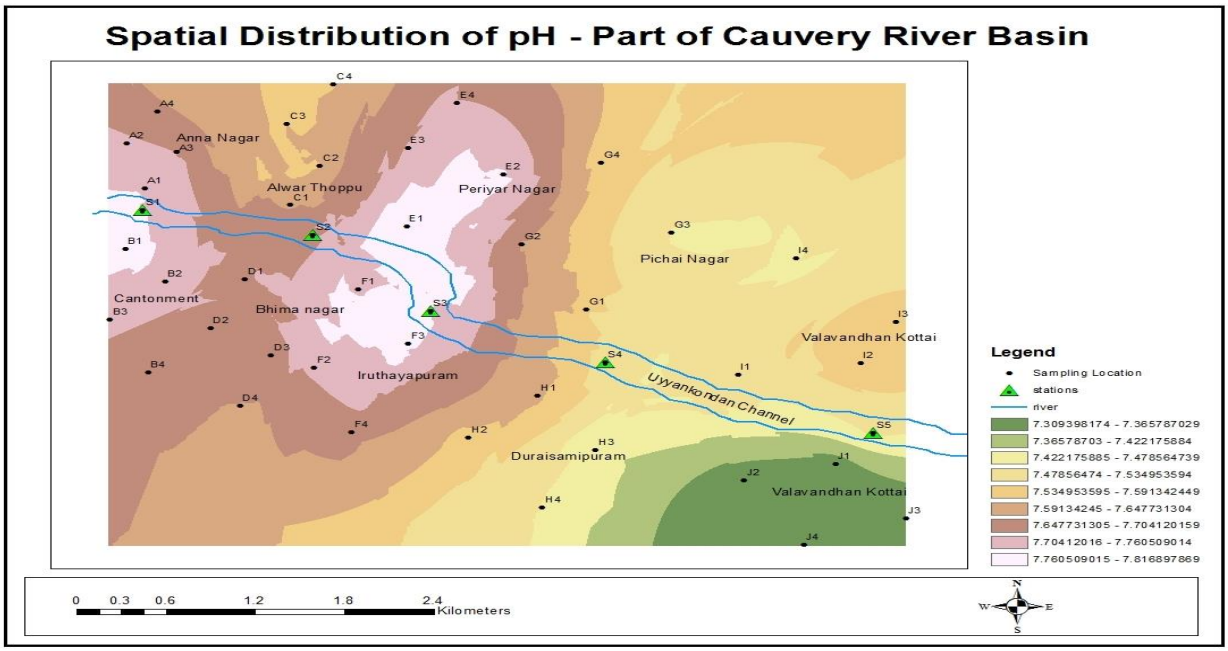

Fig: 2 Mean spatial variation of pH in the study area

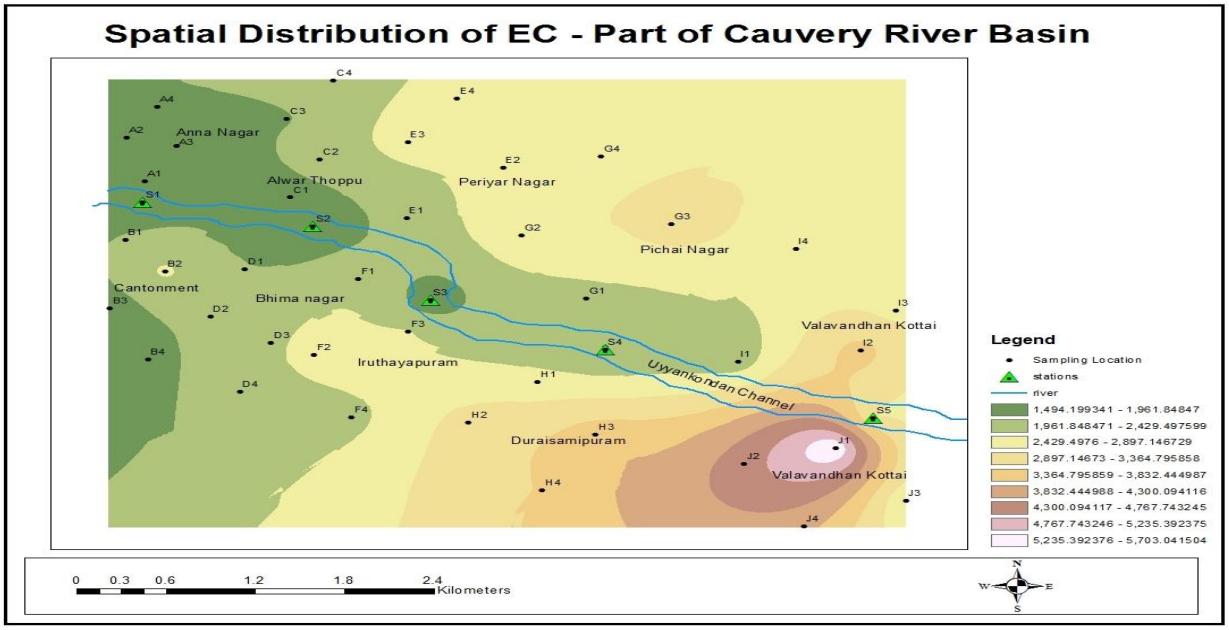

Fig: 3 Mean spatial variation of EC in the study area

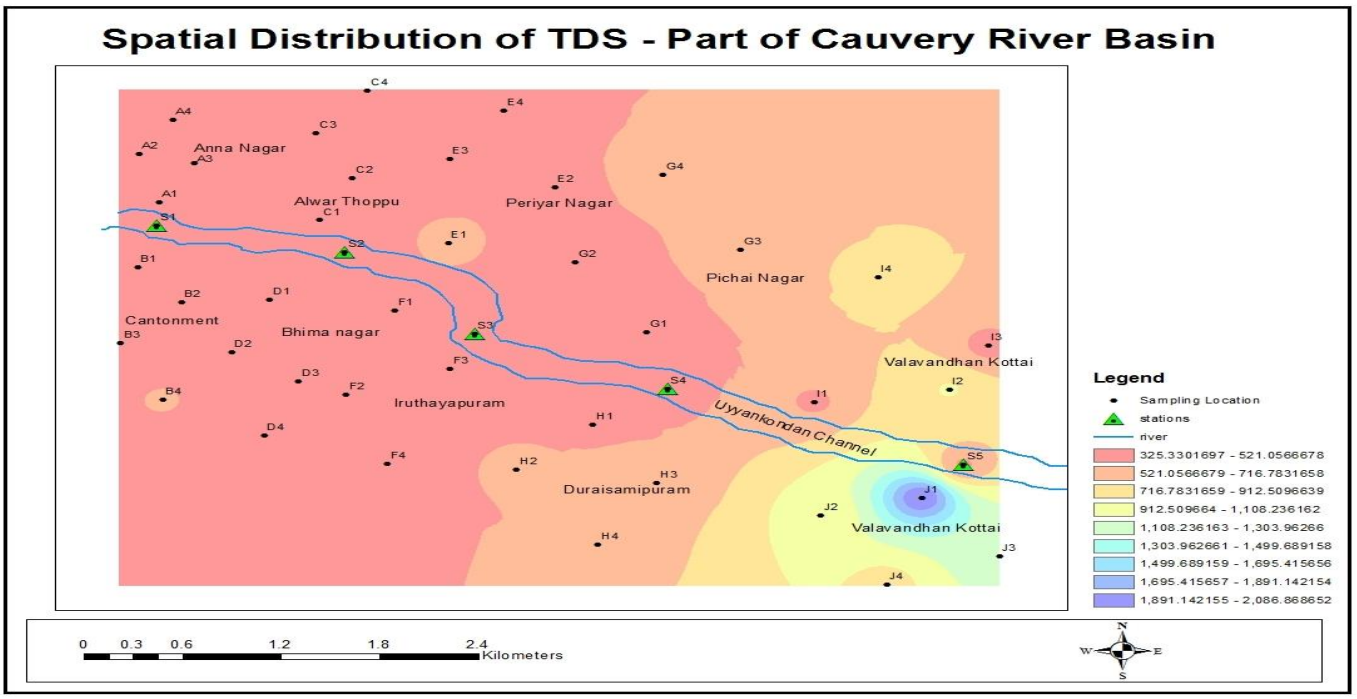

Fig:4 Mean spatial variation of TDS in the study area

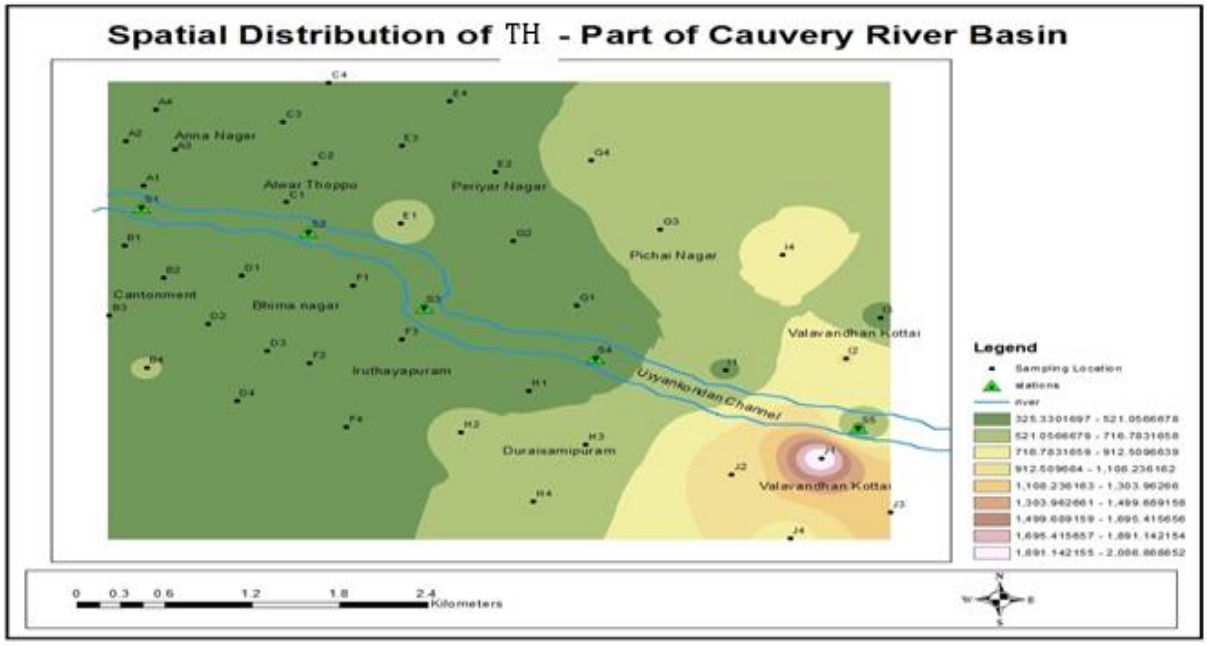

Fig:5 Mean spatial variation of TH in the study area

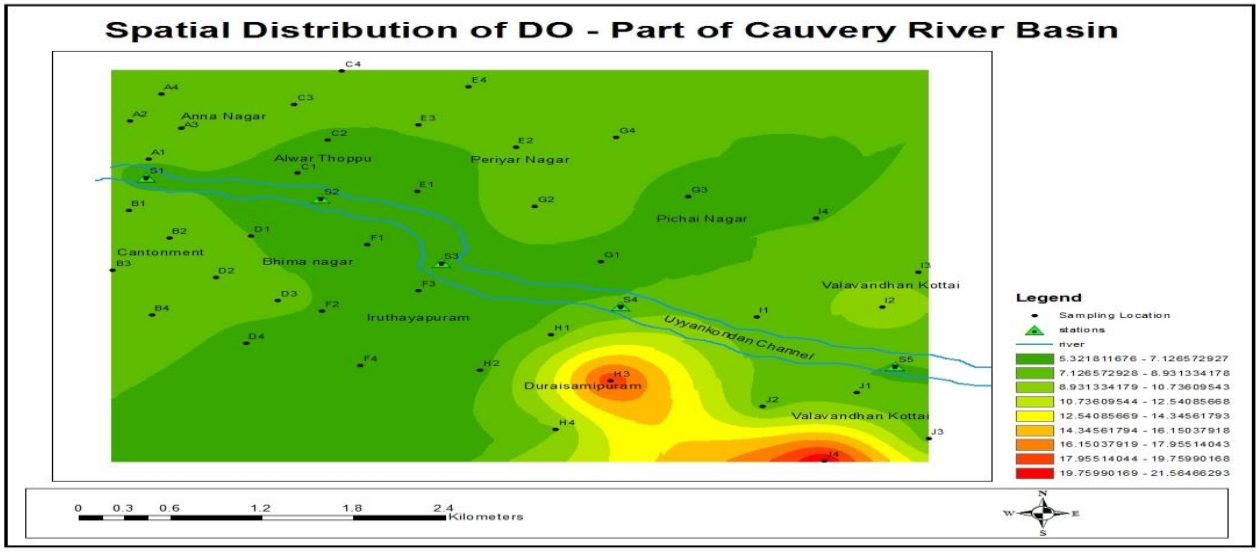

Fig: 6 Mean spatial variation of DO in the study area

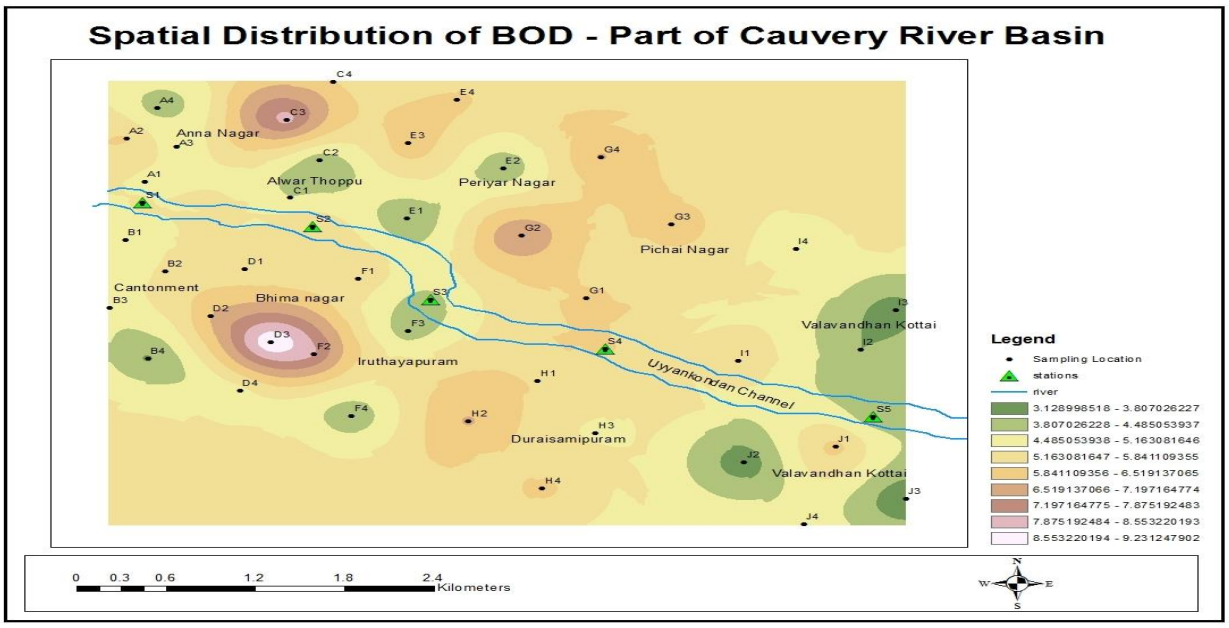

Fig: 7 Mean spatial variation of BOD in the study area

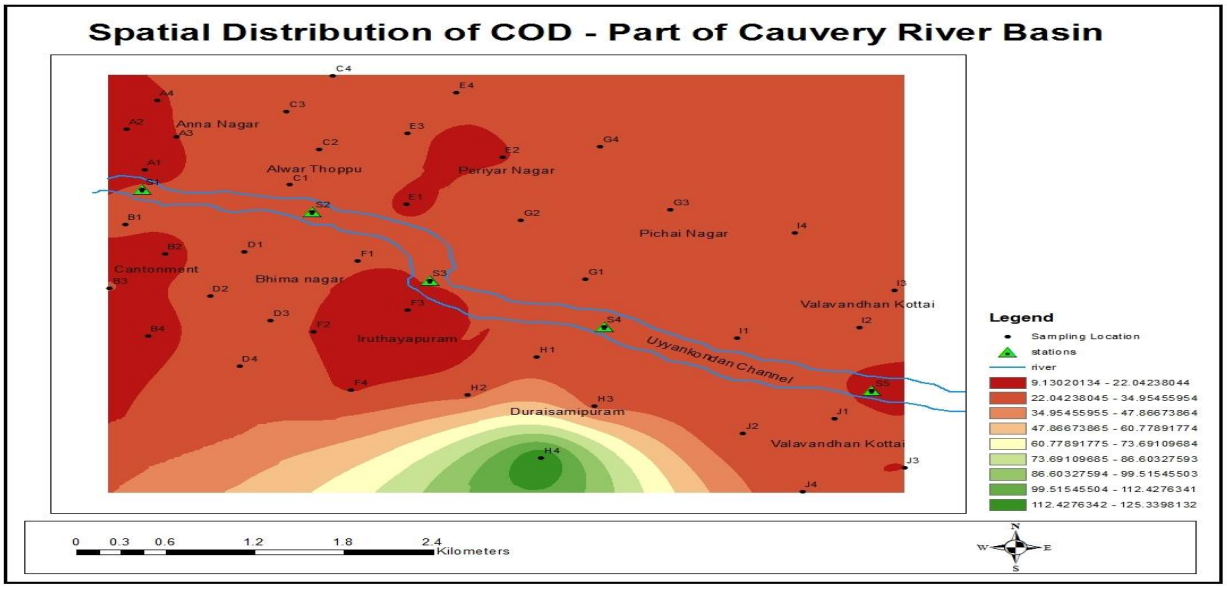

Fig: 8 Mean spatial variation of COD in the study area

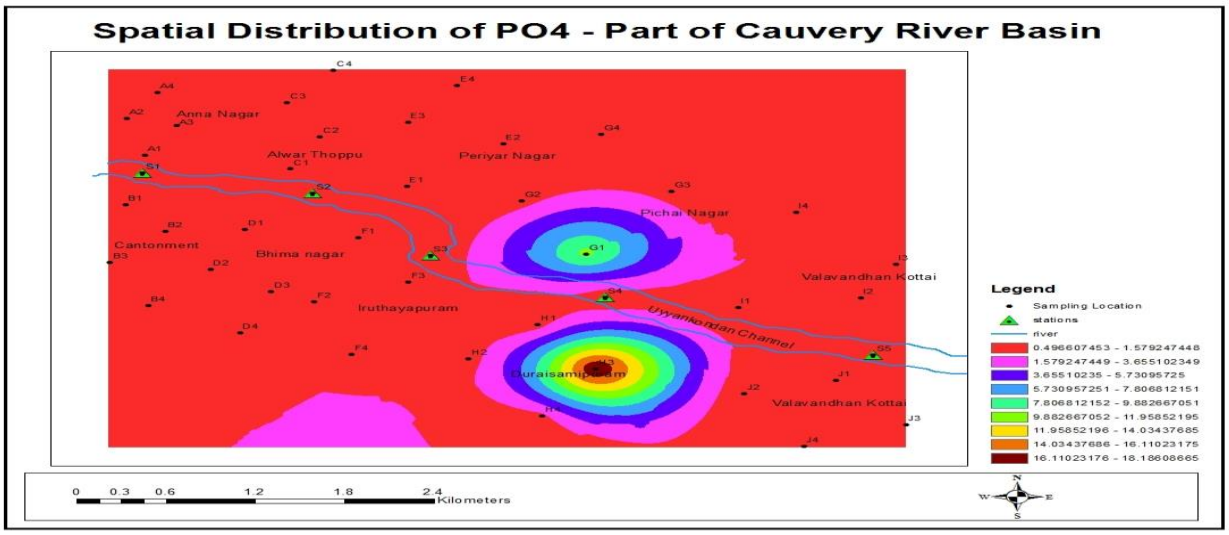

Fig: 9 Mean spatial variation of PO_4 in the study area

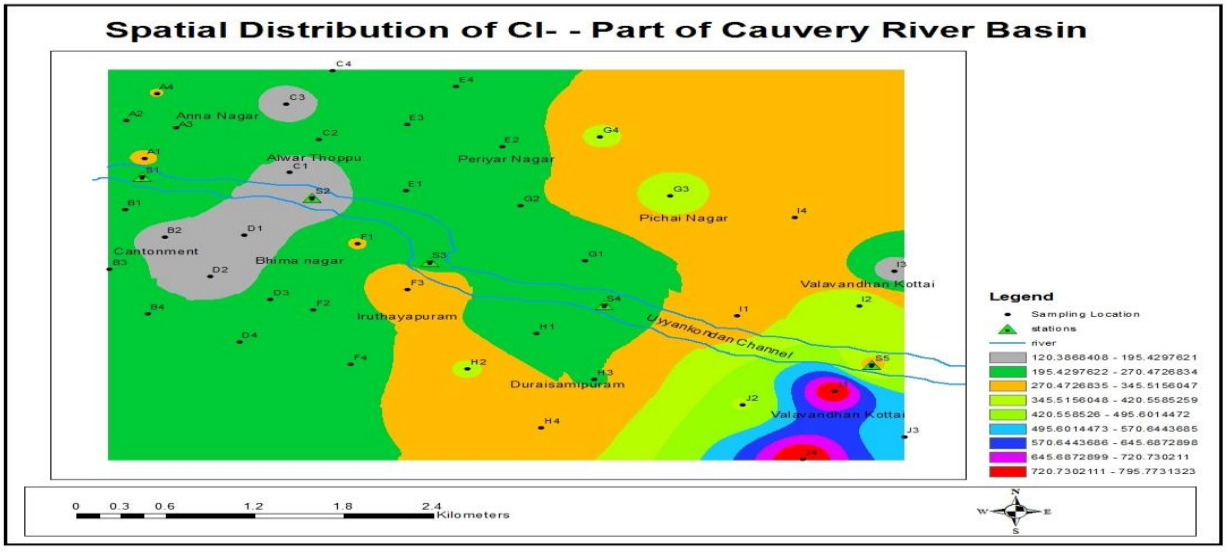

Fig: 10 Mean spatial variation of Chloride in the study area

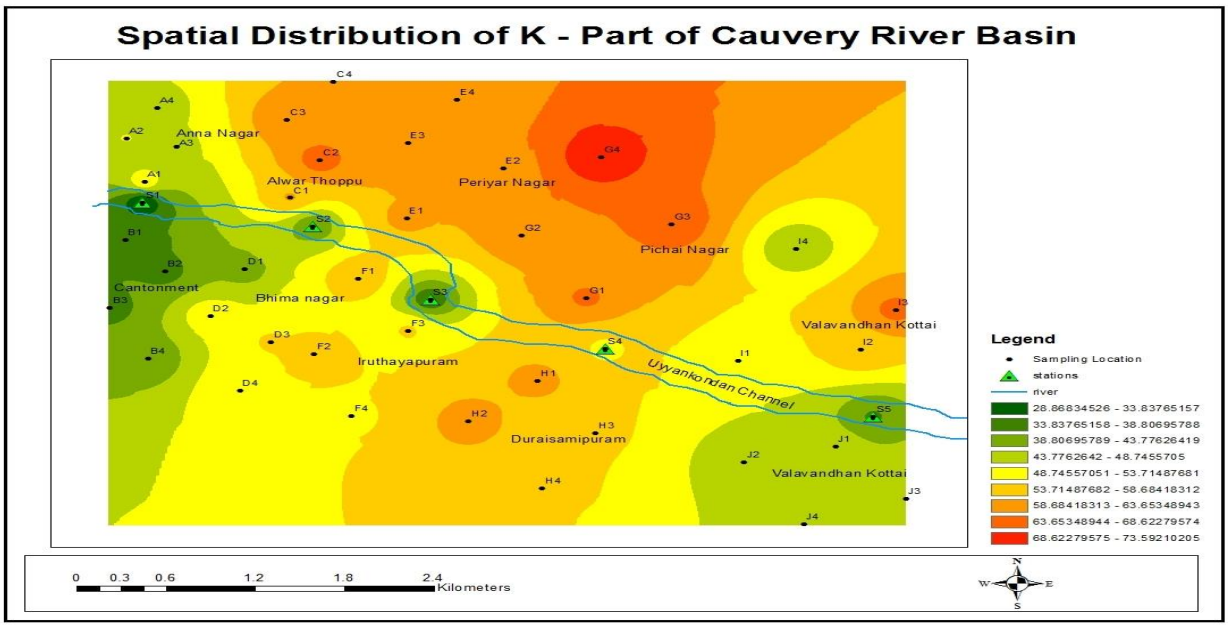

Fig: 11 Mean spatial variation of Potassium in the study area

4. Conclusions

The results of the above work show that most of the physico-chemical parameters like EC, TDS, TH, PO_4, COD, Cl and K are well above acceptable limits of WHO. The major sources of pollution are agricultural wastes, industrial effluents, hospital wastes and domestic sewage disposals. All these are disposed to pollute the channel water which in turn polluted the ground water source of this area in their own way. The slope nature of the land also plays some role in this respect. TDS and EC are the directly related. If TDS increases, the EC values also increases simultaneously. Both the parameters are very high in all sampling sites. High TDS in urban site may due to the both agricultural and effluent intrusion around the sampling sites results high values. High phosphate in all sampling sites including surface water sample showed the usage of phosphoric fertilizer and potash fertilizer in order to get high agricultural yield. Hence the groundwater in the study area is not suitable for drinking. Rapid urbanization has lead to deterioration of the water quality in the study area. There is a need of sustainable measures to be taken by governing authorities to mitigate continuous deterioration of ground water quality. The present work was designed to pictorially represents spatial distribution of physico chemical parameters in ground water in the study area by using geographic information system (GIS).

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