



Trace Elements Concentration In Groundwater of South Chennai, Tamil Nadu, India

KEYWORDS

Groundwater, Trace elements, AAS, and South Chennai.

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ABSTRACT Trace element analyses were carried out in South Chennai coastal area, and its concentration (Fe, Mn, Cu, Cr, Zn, Pb, Ni, Co) in groundwater were quantified. Totally, fifty groundwater samples were collected during pre and post-monsoon of the year 2014-2015 and analyzed in Atomic Absorption Spectroscopy (AAS). The analytical results were compared with Bureau of Indian Standards (BIS, 2012). The Cu concentrations were above permissible limit in Puthupakkam, Sathankuppam, Vanuvampettai, Chromepet, Vengadamangalam, Sirucher, Palavakkuppam and Chinnadikuppam during both seasons. In Thiruvanmiyur, Guindy, Sathankuppam and Pallavaram locations Cr value was observed to be above permissible limit. The Fe concentrations were observed to be above permissible limit in Palavakkam, Sathankuppam, Vanuvampettai and B.V. Nagar locations. In Kumenan Nagar, and Besant Nagar locations Mn concentration were above the permissible limit. Health hazards that are related to Cu, Cr, Fe and Mn are given. The other trace elements concentrations in groundwater of the study area were within the permissible limit.

INTRODUCTION

Trace element studies are very useful in varied branches of scientific discipline. Concentration of trace elements in water helps in the circulation and distribution of minerals in rock and waters. Trace elements are contributed to groundwater from a variety of natural and anthropogenic sources (Ramessur 2000; Newcombo et al., 2002; Abollino et al., 2004; Leung and Jiao 2006). A large number of researchers have also worked on trace element contents of groundwater in the Indian subcontinent along its coastal area. Ramesh et al., (1995) revealed that the toxic element (As and Se) and other trace elements in the groundwater of Madras city are due to anthropogenic activities and salt-water intrusion. The present study was carried out to determine concentrations of the trace elements namely, Fe, Mn, Cu, Cr, Zn, Pb, Ni, and Co in groundwater.

STUDY AREA

The study area lies between 12°51' to 12°56'30" N latitude and from 80°3'30" to 80°14'30" E longitude and covers an area about 270 km². The rainfall in the study area is mainly controlled by northeast monsoon (October, November and December) with an average annual rainfall of 1200 mm. The study area is having a tropical climate with annual temperature from 24.3° to 32.9° C. The major part of the area has flat topography with gentle slope towards east. Geologically, the coastal aquifers underlain by ancient Archaean rocks up to Recent alluvium. The major part of the study area covers alluvium formations and it consists of sand, silt and clay. The study area and sample locations are shown in fig.1.

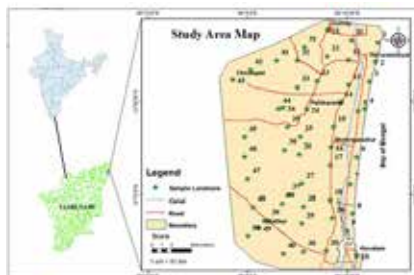


Figure 1: Study area with sample locations

METHODOLOGY

Totally, fifty groundwater samples were collected from dug and bore wells during pre and post monsoon of the year 2014-2015. Water samples were collected in 100 ml clean polyethylene bottles and they were properly labelled for indicating the source, date, time of collection and other records. The trace elements were analyzed using Atomic Absorption Spectroscopy (AAS). The analytical procedures followed as per the American Public Health Association (APHA, 1995). The base map of the study area was prepared using the survey of India toposheets (66 D/1 and 66 D/5) and digitized using Arc GIS 9.3 software. The spatial distribution map of the each trace element concentrations were plotted using surfer 9 software.

RESULTS AND DISCUSSION

Groundwater in the study area is generally have pH ranging from 6.63 to 8.04 during In the study area, EC ranges from 644 to 41200µS/cm during pre-monsoon, while in the post-monsoon it ranges from 514 to 12070 µS/cm. TDS

range from 451 to 28840 mg/l during pre-

monsoon season, whereas, during post-monsoon it ranges from 333 to 7850 mg/l. According to BIS (2012) TDS is above permissible limit in both the seasons only along the coastal tracts within 4 km from the coast. The sample numbers and their respective locations are given in Table.1.

Copper

The Copper concentration in the groundwater of the study area during pre monsoon season ranges from 0.004 to 0.113 mg/L with an average value of 0.066 mg/L. During post monsoon season, it varies from BDL to 0.128 mg/L with an average value of 0.039 mg/L. In premonsoon season Pudhupakkam, Sathankuppam, Vanuvampettai, Chromepet, Vengadamangalam and during post monsoon season it is above the permissible limit in Sirucheri, Palavakkakuppam and Chinnadikuppam. An over dose of copper may lead to neurological complication, hypertension, liver and kidney dysfunctions (Krishna and Govil, 2004; Khan et al., 2010). The spatial distribution of Cu concentration in groundwater is shown in Fig.2 for pre and post monsoon.

**TABLE-1
THE SAMPLE NUMBERS AND THEIR RESPECTIVE LOCATIONS**

Sample.no	Location name
1	Besant Nagar
2	Thiruvanmiyur
3	Palavakka kuppam
4	Chinnadi kuppam
5	Inchamppkkam
6	Panaiurkuppam
7	Olive Beach
8	Karikattukuppam
9	Nepmd
10	Kovalamkuppam
11	Indira Nagar
12	Tharamani
13	Perungudi
14	Mettukuppam
15	Karrappakkam
16	Sholinganallur
17	Kumenan nagar
18	Navalur
19	Padur
20	Kelampakkam
21	Guindy
22	Velachery
23	Thiruvalluvar nagar
24	Pallikarani
25	Perumpakkam
26	Nukkampalayam
27	Ambedkar nagar
28	Sirucheri
29	Pudupakkam
30	Sathankuppam
31	Adampakkam
32	Vanuvampettai
33	Kilkattalai
34	Vadakupattu
35	Ranganathapuram

36	Sittalapakkam
37	Malaicherry
38	Polachery
39	Mambakkam
40	Velichai gramam
41	B.V.Nagar
42	Pallavaram
43	Chromepet
44	Nanmangalam
45	Madampakkam
46	Paduvanchery
47	Vengadamangalam
48	Kilkottiyur
49	Kulathur
50	Panagattupakkam

The results of the trace element analysis are presented in Table. 2 for the study area during pre and post monsoon of the year 2014-2015.

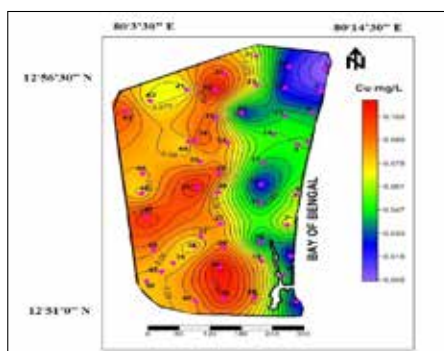
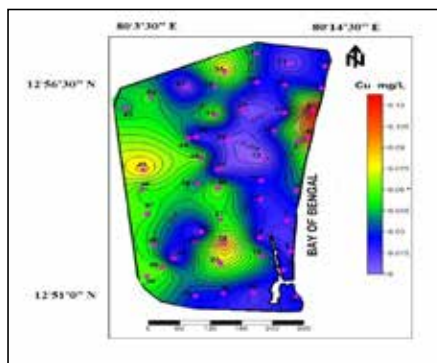


Figure 2: Spatial Distribution of Cu Concentration during Pre and Post Monsoon Seasons



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Chromium

Chromium usually present in the less toxic trivalent form Cr (III) in the effluents. But, when this effluent is discharged into the soil, due to varying environmental conditions, Cr (III) is oxidized to toxic hexavalent form, which seldom remains Cr (VI) (Anderson 1999; Govil et al., 2004; Gowd et al., 2005). The chromium concentration in groundwater of the study area during pre monsoon ranges from 0.229 to 0.971 mg/L with an average value of 0.780 mg/L.

During post monsoon, it ranges from 0.363 to 1.484 mg/L with a mean value of 1.109 mg/L. In Thiruvanmiyur, Guindy, Sathankuppam and Pallavaram locations Cr value is observed to be above permissible limit during both seasons.

An overdose of Cr may lead to skin disorder and cancer in respiratory track. The spatial distribution of Cr concentration in groundwater is shown in Fig. 3 for both seasons.

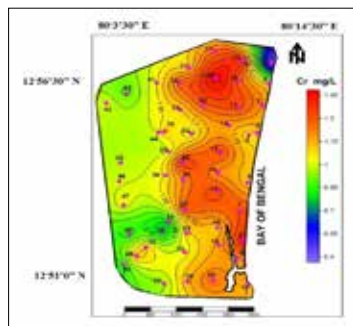
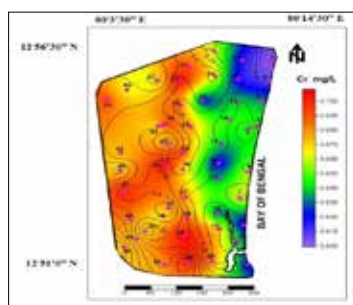


Figure3: Spatial Distribution of Cr Concentration during Pre and Post Monsoon Seasons



Cobalt

The Cobalt concentration in pre monsoon period ranges from 0.085 to 0.696 mg/L with an average value of 0.352 mg/L. In post monsoon period, it ranges from 0.273 to

0.932 mg/L with a mean value of 0.642 mg/L. The spatial distribution of Co concentration is shown in Fig. 4 for pre and post monsoon. The concentration of Co in both seasons is within permissible limit of BIS (2012).

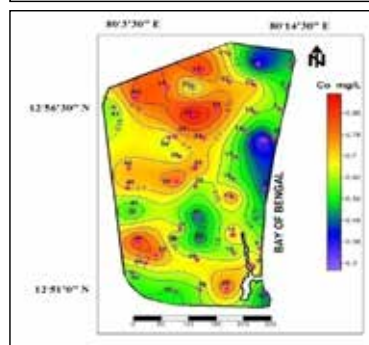
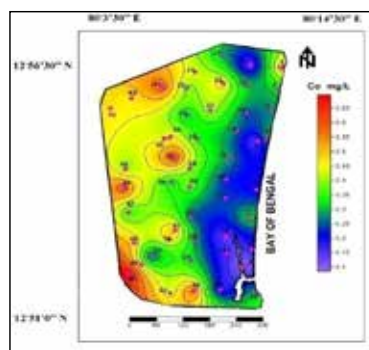


Figure4: Spatial Distribution of Co Concentration during Pre and Post Monsoon Seasons

TABLE -2
MINIMUM AND MAXIMUM VALUES FOR TRACE ELEMENTS OF THE STUDY AREA DURING PRE AND POST MONSOON SEASONS

Trace Elements mg/L	Pre Monsoon		Post Monsoon		BIS (2012)	
	Min mg/L	Max mg/L	Min mg/L	Max mg/L	Highest Desirable Limit (mg/L)	Maximum Permissible Limit (mg/L)
Cu	0.004	0.113	BDL	0.128	0.05	1.5
Cr	0.229	0.971	0.363	1.484	0.05	No relaxation
Co	0.085	0.696	0.273	0.932	-----	-----
Fe	0.001	0.846	0.006	1.994	0.3	No relaxation
Pb	0.112	0.596	0.031	0.806	0.01	No relaxation
Mn	0.01	1.518	0.02	1.276	0.1	0.3
Ni	0.025	0.549	0.001	0.695	0.02	No relaxation
Zn	0.003	0.149	0.001	1.944	5	15

Iron

Iron is an essential element in human body. Anemia caused by lack of iron is the commonest nutritional deficiency in the world (Raju, 2006). In the study area, during pre monsoon period Fe is from 0.001 to 0.846 mg/L and during post monsoon period it ranges from 0.006 to 1.994 mg/L. In post monsoon period, Palavakkam, Sathankuppam, Vanuvampetti, and B.V.Nagar locations, iron concentrations is above BIS (2012) permissible limit. Higher concentrations of iron cause bad taste, discoloration, staining, turbidity, aesthetic, and operational problem in water supply systems (Dart, 1974; Vigneshwaran and Viswanathan, 1995). The spatial distribution diagrams of the iron concentration in both seasons are shown in Fig. 5.

Manganese

The Mn concentration ranges between 0.01 and 1.518 mg/L and from 0.02 to 1.276 mg/L during pre and post monsoon of the study area, respectively. In Kumenan nagar, Besant Nagar, and Chinnadikuppam locations Mn concentration is above the permissible limit for both seasons. Manganese is regarded as one of the least toxic elements but its excess amount in the human body may cause growth retardation, fever, fatigue and eye blindness and may affect reproduction. The spatial distribution diagrams of the Mn concentration in both seasons are shown in Fig. 6. Higher concentrations are related to the geology of the area (Tiwari and Dubey, 2012).

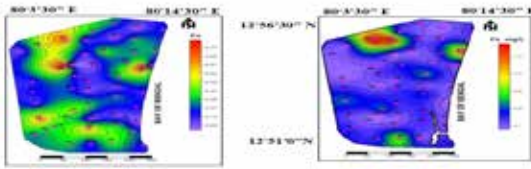
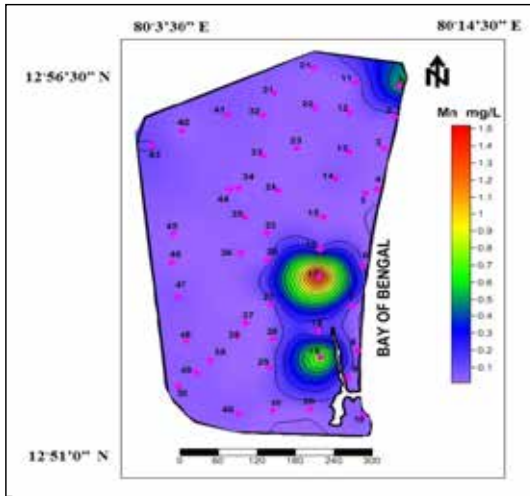


Figure5: Spatial Distribution of Fe Concentration during Pre and Post Monsoon Seasons

Pre-monsoon



Post-monsoon

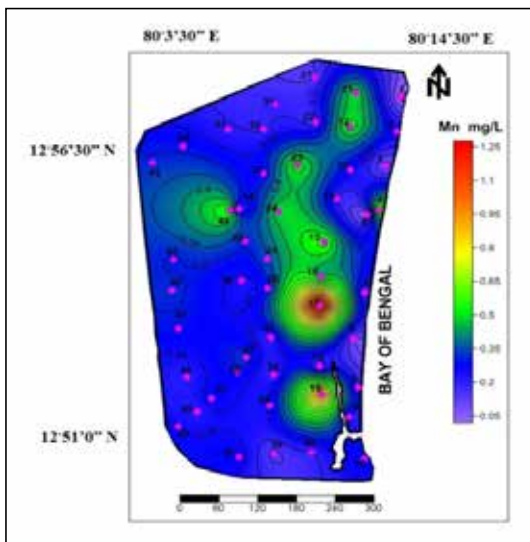
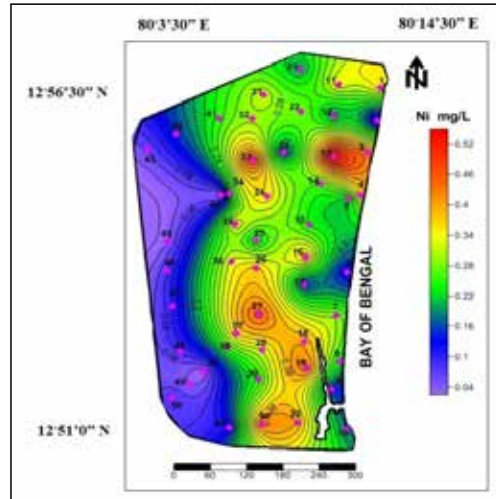


Figure 6: Spatial Distribution of Mn Concentration during Pre and Post Monsoon seasons

Nickel

During premonsoon period, it ranges from 0.025 to 0.549 mg/L and during post monsoon period it is from 0.001 to 0.695 mg/L, respectively. In pre monsoon period Palavakkakuppam, Perungudi and post monsoon season Kumenan Nagar, Adambakkam locations Ni concentrations is above the permissible limit. Acute exposure of nickel in human body is associated with a variety of chemical symptoms and signs such as nausea, vomiting, headache, giddiness etc. (Barzilay, 1999). Spatial distribution of Ni is shown in Fig.7.

Pre-monsoon



Post-monsoon

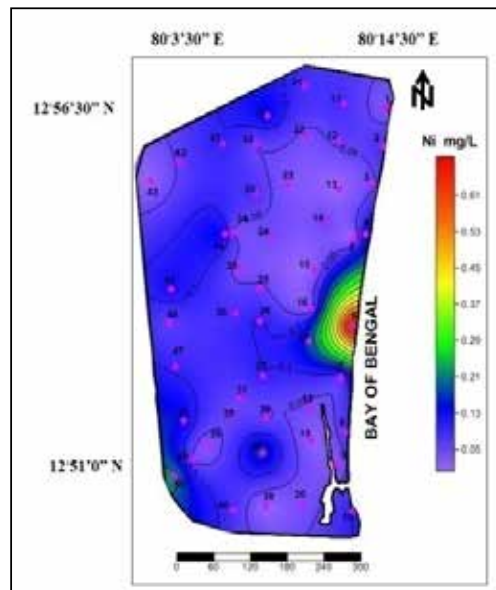


Figure 7: Spatial Distribution of Ni Concentration during Pre and Post Monsoon Seasons.

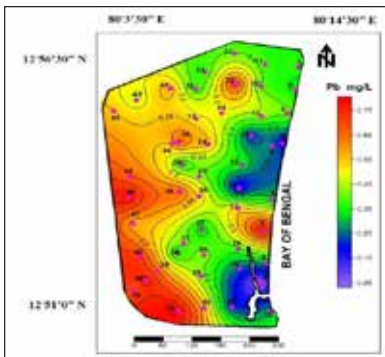
Lead

Lead (Pb) concentration in natural waters increases mainly through anthropogenic activities (Goel, 1997). Lead concentration varies from 0.112 to 0.596 mg/L and from 0.031 to 0.806 mg/L during pre and post monsoon seasons, respectively. Palavakkakuppam, Kumenan nagar and Vanuvampettai locations, Lead concentrations is above the permissible limit in both seasons. The consumption of lead in higher quantity may cause hearing loss, blood pressure, and hypertension. The spatial distribution map of the study area in both seasons is shown in Fig. 8.

Zinc

The Zn concentration ranges from 0.003 to 0.149 mg/L and from 0.001 to 1.944 mg/L during pre and post monsoon, respectively. The maximum permissible limit of the Zn concentration in groundwater is 15 mg/L (BIS, 2012). In study area, Zn concentrations are within the permissible limit for both seasons and are shown in Fig. 9.

Pre-monsoon



Post-monsoon

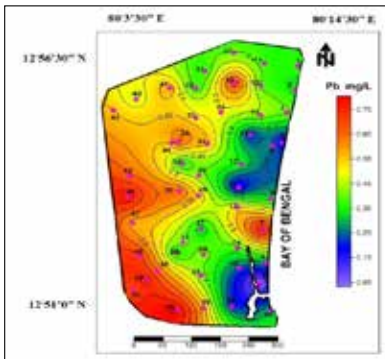
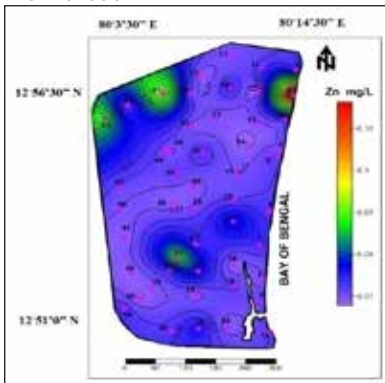


Figure 8: Spatial Distribution of Pb Concentration during Pre and Post Monsoon Seasons

Pre-monsoon



Post-monsoon

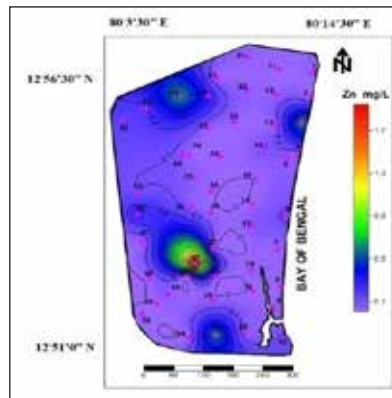


Figure 9: Spatial Distribution of Zn Concentration during Pre and Post Monsoon Seasons

CONCLUSION

Groundwater is alkaline in nature during both seasons. Trace elements, namely Ni, Co, Pb, and Zn are within the permissible limit. The Cu concentrations is above the permissible limit in Pudhupakkam, Sathankuppam, Vanuvampetti, Chromepet, Vengadamangalam, Sirucher, Palavakkuppam and Chinnadikuppam during both seasons. In Thiruvanmiyur, Guindy, Sathankuppam and Pallavaram locations Cr value is observed to be above permissible limit. Fe concentration in Palavakkam, Sathankuppam, B.V. Nagar, and Vanuvampettai locations are above the permissible limit. In Kumenan Nagar and Besant Nagar locations Mn concentration is above the permissible limit. Health hazards, namely, neurological complication, hypertension, liver and kidney dysfunctions, skin disorder and cancer in respiratory track, bad taste, discoloration, staining, turbidity, aesthetic, and operational problem in water supply systems, growth retardation, fever, fatigue and eye blindness are warranted.

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