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Research Article

ASSESSMENT OF FLUORIDE CONCENTRATION DUE TO THE DEVELOPMENT OF SUB-SURFACE INFRA STRUCTURE

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ABSTRACT

The work aims to compare the spatial distribution of fluoride concentration due to the development of sub surface infrastructure in Chennai metro rail. Ten observation wells are identified in and around Chennai metro rail corridor to access the concentration of fluoride before the opening of tunneling. Data of fluoride concentration are collected for a period of 1995-2014. These observation wells are identified along the sub surface opening to determine the fluoride concentration. The spatial distribution mapping are compared to predict the variations of the water quality fluoride concentration in ground water before and after the construction of the metro rail corridor.

INTRODUCTION

Ground water quality problems are difficult to detect and hard to resolve. Majority of ground water quality problems are caused by contamination, over-exploitation, or combination of the two. Urbanization leads to the development of large number of infrastructures above or below the earth's crust. Sub structures which are built very deep into the ground changes the characteristic of geological formations of the sub strata below the ground. The intensive use of natural resources and the large production of wastes in modern society often pose a threat to ground water quality and have already resulted in many incidents of ground water contamination.

Tunneling is one of the Sub structure which facilitates the pollutants get added to the ground water system associated with the natural processes. The percolating water picks up a large amount of dissolved constituents and reaches the aquifer system and contaminates the ground water. Hence the assessment of ground water quality plays a the real world scenarios. Variation of groundwater quality in an area is a function of physical and chemical parameters that are generally influenced by geological formations and anthropogenic activities (Kwang-Soo, *et al*., 1997). Geographical Information System (GIS) based groundwater studies were concentrated on the preparation of hydrogeomorphological maps, interpretation of lineaments and integrated terrain analysis (Roveda, *et al*., 2010).

LITERATURE REVIEW

(Subramani, *et al*., 2012) studied the Groundwater Quality with GIS Application for Coonoor Taluk in Nilgiri District. In this study, the water quality was analysed using GIS mapping. The Lab Test Procedure was done as per Indian standard code of Practice. The water quality parameters are given in the data base to GIS. The Coonoor map was scanned and digitized. Digitization was done by Surfer – 8. Using ARC GIS 9.3 the spatial interpolation was done on the basis of attribute values such as pH, TDS, TH, Sulphate,

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Chloride, Calcium, Turbidity, Temperature, etc. GPS – Garmin and Water Quality Field Kit instruments were used. It provided a guideline for solving water quality problem in Coonoor Taluk.

(Shahid, *et al*., 2014) generated a water quality index map of the Rawal Town and identify the relationship between bacteriological water quality and socio-economic indicators with gastroenteritis in the study area. Water quality and gastroenteritis patient data were collected by surveying the 262 tubewells and the major hospitals in the Rawal Town. The collected spatial data was analyzed by using ArcGIS spatial analyst (Moran's I spatial autocorrelation) and geostatistical analysis tools (inverse distance weighted, radial basis vital role in the development of a sub structure.

Spatial data analysis is carried out for the purpose to understand, describe and to predict function, kriging, and cokriging). The WQI results showed that more than half of the tubewells in the Rawal Town were providing "poor" to "unfit" drinking water.

(Thangavelu, 2013; Loganathan, *et al*., 2011) mapped the quality of groundwater using Geographical Information System (GIS) software. Thematic maps were generated from Survey of India (SOI) toposheets on 1:50,000 scale using ArcGIS. Physio-chemical parameters of the groundwater samples were collected at predetermined locations., spatial distribution maps of water quality parameters such as pH, EC, TDS, Ca, Mg, Total Hardness (TH), Alkalinity, Cl_2, Na, SO_4^{2-} and K of North Coimbatore were prepared using ArcGIS 9.3. and estimated the risk prone levels in Coimbatore.

From the above literature study GIS software founds to be effective tool to display the Spatial distribution of the parameters, which in turn identifies the risk prone areas in the study area.

Study Area

Chennai formerly known as Madras is the capital city of Tamil Nadu state and is the fourth largest metro city in India. The city is widely spread in about 180 Sq. Kms. It is located with the latitude of 13.0827°N, and longitude of 80.2707°E. The average rainfall of the city is 1272 mm. The current population of chennai was 8.2 million.

The area around Chennai Metro rail corridor was selected as study area. To assess the water quality parameters eleven observation wells are identified from the secondary datas collected over a period of 19 years (1995-2014) from Centre Ground Water Board and Institute of Water Studies, Chennai. The identified wells are located as points using GIS software. The study area with the well locations and the metro rail stations are given below (Fig. 1). The mapping also differentiates the elevated and underground corridors and the path of rivers like Adyar river and Coovam river are located.

METHODOLOGY

The construction of Chennai metro rail was started in

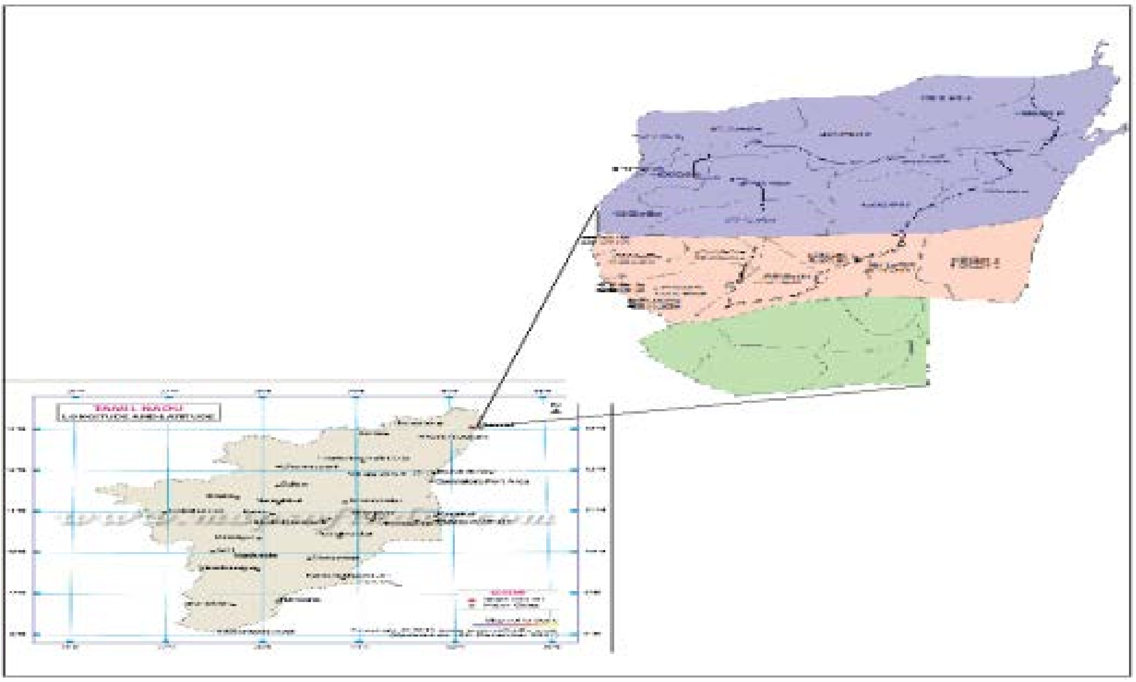

Fig. 1 Base map of study area of Chennai Metro Rail Corridor, Tamilnadu, India.

the year 2008, the spatial distribution analysis using Geographical Information System (GIS is carried out in two phases before (1995-2008) and after (2009-2014) the construction. Table 1 shows the calculated means values of water quality fluoride during (1995-2008) and (2009-2014) at different locations of Chennai Metro Rail Corridor.

(Fig. 2) clearly shows the comparison between the mean value of the fluoride concentration before and after the construction of Chennai Metro Rail Corridor. The concentrations shows higher value after the construction of the tunneling work. The variations in the concentrations are related to the Tunneling process, rainfall and runoff.

Spatial Analysis Using GIS

The spatio-temporal behavior of the groundwater quality using GIS was carried in the study area. The spatial analyst module of Arc GIS 9.3 was used for this analysis. The data base was created in the Excel spread sheets for the mean value of the fluoride concentration from 1995 to 2008 and 2009-2014 separately. Inverse distance weighted (IDW) interpolation technique was used in the analysis. IDW is an algorithm for spatially interpolating or estimating values between measurements. Each value estimated in an IDW interpolation is a weighted average of the surrounding sample points. Weights are computed by taking the inverse of the distance from an observations location to the location of the point being estimated.

Table 1. Comparison of mean values of water quality fluoride concentration

Place	Latitude	Longitude	F	
			1995-2008	2009-2014
Tandiarpet	13˚07'38"N	80˚17'24"E	0.00	0.87
Vepery	13˚05'07"N	80˚15'38"E	0.56	1.16
Chepauk	13˚03'48"N	80˚16'52"E	0.34	0.57
Lights	13˚03'32"N	80˚15'05"E	0.62	0.62
Saidapet	13˚01 '20"N	80˚13'10"E	0.38	0.32
Guindy	13˚ 0' 37"N	80˚12'56"E	0.38	0.52
Aminjikarai	13˚04'12"N	80˚13'28"E	0.34	0.49
Tirumangalam	13˚05'00"N	80˚11'40"E	0.80	0.50
Vadapalani	13˚03'16"N	80˚12'41"E	0.34	0.25
K.K.Nagar	13˚01'47"N	80˚12'47"E	0.76	0.72
Airport	12˚59'38"N	80˚10'19"E	0.30	0.72
Mean value			0.48	0.61

DISCUSSION

In a comparison of several different deterministic interpolation procedures, using IDW with a squared distance term yielded results most consistent with original input data. This method is suitable for datasets where the maximum and minimum values in the interpolated surface commonly occur at sample points (ESRI 2002).

The comparison of spatial distribution of parameters was analyzed in two phases, i.e., 1995-2008 and 2009-2014. The factors considered to compare the water quality parameters are the average value of the rainfall, and the tunneling techniques (Shelton, 1997; Thomas, 1986).

Fluoride

Fluoride Concentration should be less than 1.0 mg/L in many waters. Concentration greater than 2.0 mg/L can cause dental flurosis, a staining and pitting of the teeth. The Fluoride distribution was found to be 0.69- 0.80 in the North-West axis and 0.60- 0.69 range distribution in the North-East axis (Fig. 3). The distribution range was found to be higher in the North-East axis as 1.04 -1.16 and of 0.82 -0.93 after the construction (Fig. 4).

CONCLUSION

Spatial distribution mapping shows the variation in concentration of fluoride parameter in the map. Fluoride occurrence in ground water is naturally

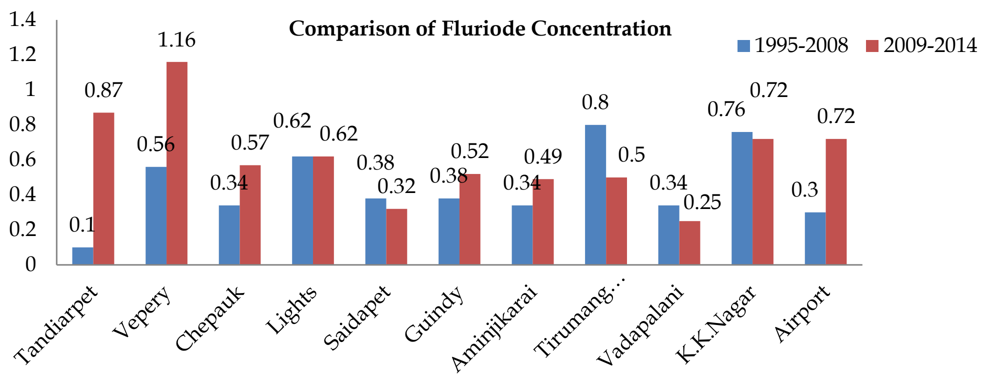

Fig. 2 Comparison of mean value of parameters.

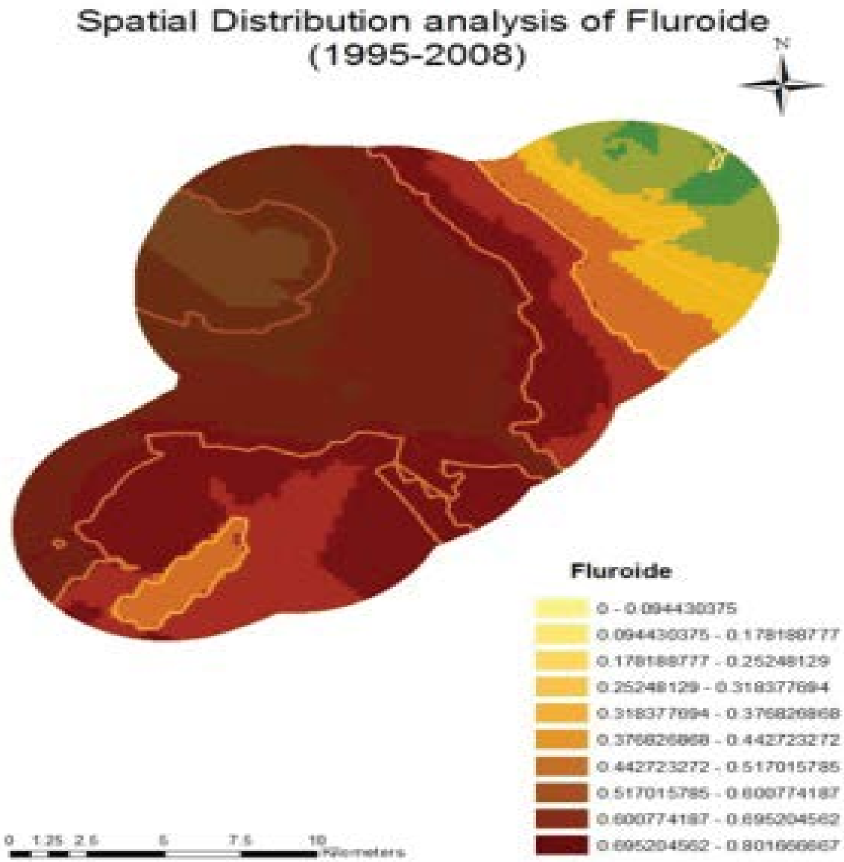

Fig. 3 Spatial distribution analysis of fluroide value for 1995-2008 using GIS.

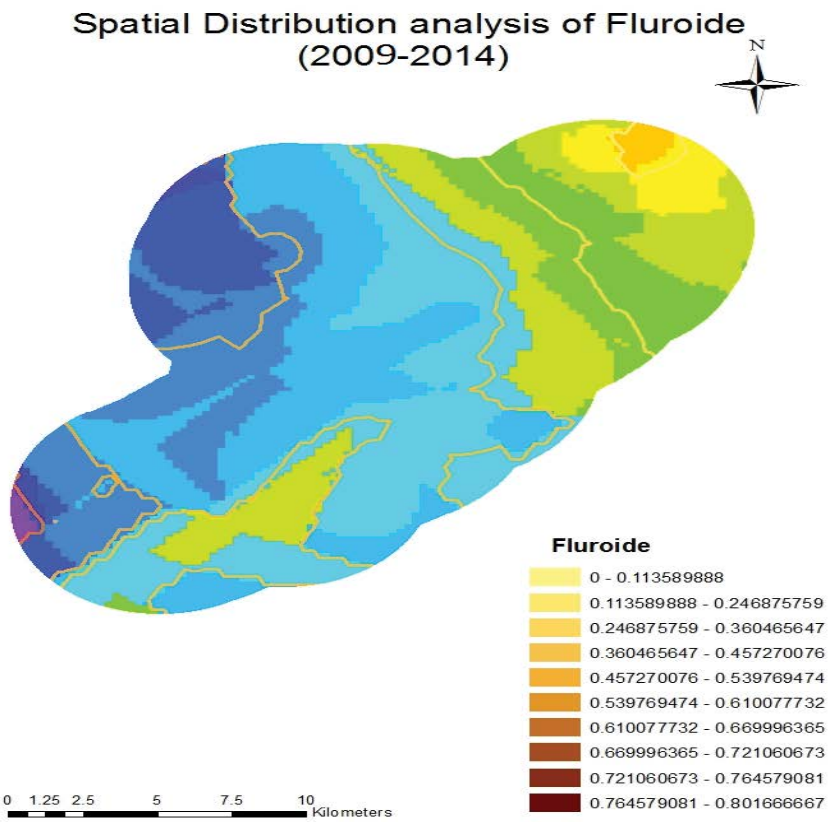

Fig. 4 Spatial distribution analysis of fluroide value for 2009-2014 using GIS.

occurring from the breakdown of rocks and soils. Fluoride concentration founds to be 20% more in the tunnelled area than before construction and the mapping clearly shows the distribution around the corridors. This clearly shows that the fluoride concentration has aggressively increased due to the artificial weathering of the sub surface development.

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