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Assessment of Groundwater Quality Scenario in Respect of Fluoride and Nitrate Concentration in and around Zahirabad mandal, Sangareddy District, Telangana.

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Abstract

Hydrogeochemical studies were carried out in and around the Zahirabad Mandal of Sangareddy district, Telangana state, India to find out the high fluoride and nitrate concentration in groundwater. 49 groundwater samples are collected from sugarcane growing areas of bore wells and dug wells in pre and post monsoon sessions and analyzed for major ions. The fluoride concentration in groundwater ranges from 0.3 to 2.7 mg/l with a mean of 1.2 mg/l in pre-monsoon and 0.1 to 1.8 mg/l with a mean 0.6 mg/l in post-monsoon. About 20.4% and 8.1% of samples in pre- and post-monsoon containing fluoride concentrations that exceed the permissible limit of 1.5 mg/l. The Nitrate concentration in groundwater ranges from 24.5 to 390.9 mg/l with a mean of 156.6 mg/l in pre-monsoon and 28 to 395 mg/l with a mean 158.1 mg/l in post-monsoon. About 89.7% of samples in pre- and post-monsoon containing nitrate concentrations that exceed the permissible limit of 45 mg/l. The results clearly show that the fluoride concentration in the study area was controlled by geogenic process, whereas the nitrate concentration in the samples was due to the excess use of fertilizers, pesticides, and organic matter.

Keywords: Groundwater,Zahirabad, Sugarcane, Nitrate and Fluoride

Introduction

Water is one of the most valuable and essential natural resources for sustenance of life on earth and for any developmental activity. Water resources, being exploited from time to time, may become short of supply or may not be easily available at any site. Groundwater is commonly present with different degrees of availability and distribution in the sub-surface of the earth. There has been an increase in groundwater management and utilization for agriculture, domestic, industry and rural supply schemes for the development of nations. Increasing consumption of water resources due to anthropogenic influences on urban, industrial and agricultural needs and erratic precipitation due to metrological changes greatly degrade water sources (**Carpenter et al. 1998; Jarvie et al. 1998).** Agriculture can flourish in some deserts, but only with water either pumped from the ground or imported from other areas. Civilizations have flourished with the development of reliable water supplies and then collapsed as the water supply failed **(Fetter et al, 1994).** Fluoride and Nitrate are important in terms of public health. It is estimated that approximately one third of the world's population uses groundwater for drinking purposes **(UNEP1999).**

A small amount of fluoride is sufficient for normal bone strengthening and formation of dental enamel **(WHO 2006**). However, if it exceeds more than requirements (> 1.5 ppm) it causes bone deformation. The concentration of F^- in water is mainly controlled by geogenic sources of fluoride-bearing minerals such as fluorite and apatite **(Saxena and Ahmed 2001, 2003)**. Nitrate typically occurs in both surface and subsurface water,and derives from the different sources such as domestic wastes, animal wastes, industrial waste waters, leaching of solid wastes, fertilizers used in agriculture, irrigation return runoff, washing of atmospheric nitrogen by rainfall and this leads to the enhancement of groundwater pollution **(Hem1985; Fogg et al. 1998; Ritter and Chirnside 1984; Lawrance 1983; Saxena et al. 2015; Sakram et al. 2014, 2015; Vishnu Bhoopathi et al. 2014)**. The recommended nitrate concentration is 45 mg/l **(WHO 2004).** Higher concentration of nitrate (> 45 mg/l) in drinking water causes methemoglobinemia especially in infants **(Fewtrell 2004; Lahl et al.1983; McDonald and Kay 1988).**

The present study is carried out with the objective of understanding the trend of distribution of these ions and their probable sources.

2. Location, Geology and hydrogeology of the area

Study area is located at $77^0 25^1$E-$77^0 55^1$E and $17^0 28^1$N -$17^0 55^1$N in the western part of the Indian state of Telangana **(Fig. 1**). The major crop type is sugarcane activity in Nyalkal Raikode, Jharasangam, Zahirabad, Kohir and Mogudampally mandals of the Sangareddy district. Sugarcane is cultivated mainly by using groundwater. The entire study area is covered by Basalts with Intertrappean of Cretaceous age and Laterite rocks of Cenozoic**. (Fig. 2).** the dug wells and bore wells are tapping the groundwater. In the plateau regions, the edges are not favorable for groundwater exploitation. Interior parts of the plateau can give moderate yields from the weathered zones. Such parts are suitable for deep dug wells/bore wells. Fault/fractures zones act as potential areas for groundwater harvest. The groundwater occurs in the soil of weathered Basalts, in the decomposed Basalts and the fractured solid bedrock under the groundwater table and in semi-confined conditions the groundwater occurs in the soil of weathered Basalts, in the decomposed Basalts and the fractured solid bedrock under the groundwater table and in semi-confined conditions**.**

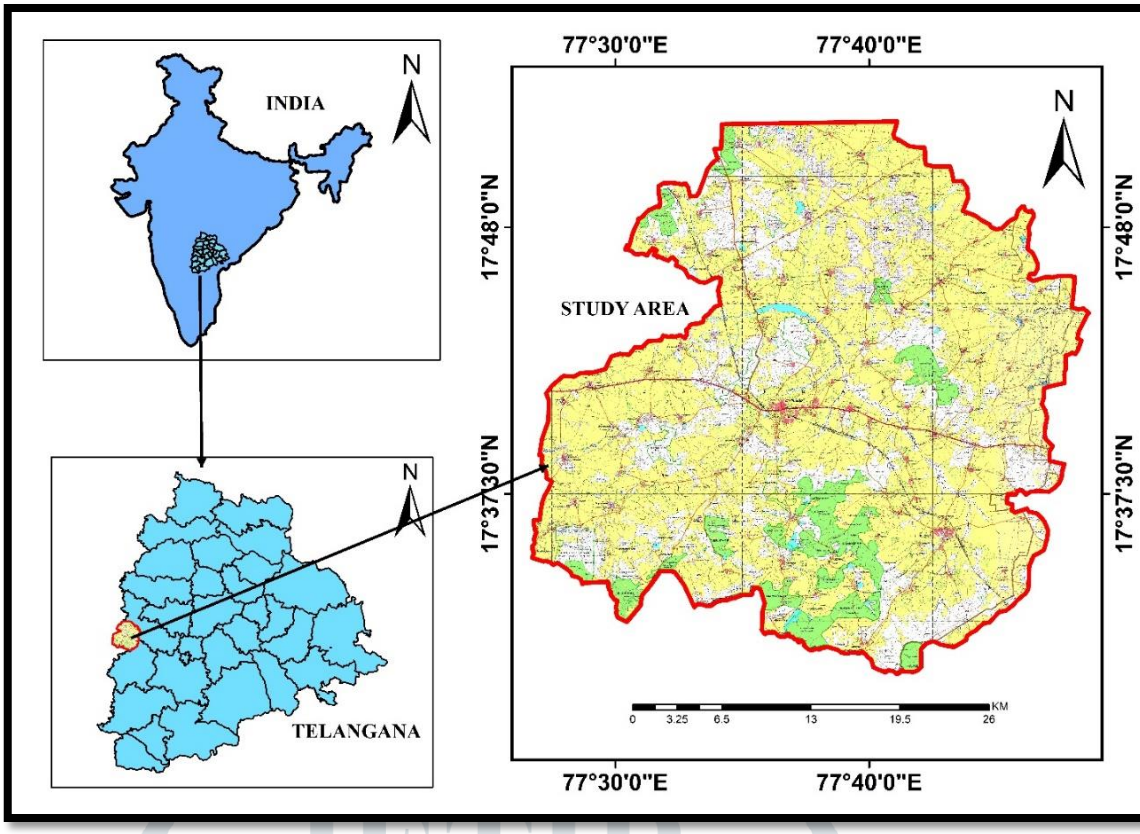

Fig 1. Location map of the study area

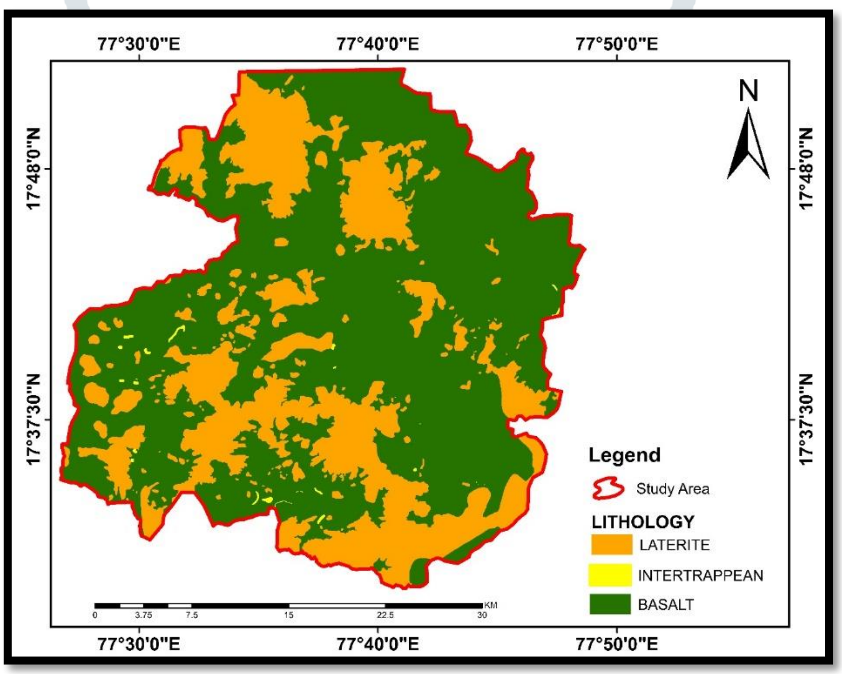

Fig 2. Geology map of the study area

3. Materials and Methods

Hydrogeochemical study was undertaken by randomly collecting forty-nine groundwater samples in sugarcane growing areas from dug wells and bore wells in April (Pre-Monsoon) and November (Post Monsoon) for year 2018. One liter polyethylene bottles were rinsed with distilled water followed by deionized water and samples were collected after pumping out water for about 10 min to remove stagnant water from the well. The pH and Electrical conductivity were measured immediately after sampling in the field using portable pH/EC meter. The sampling locations are shown in **(Fig.3)**. Samples were analyzed in the wet chemical laboratory in the C-MET, Hyderabad and Applied Geochemistry Department, Osmania University using standard methods recommended by APHA. NO_3^- is determined by colorimetry with an UV–Visible spectrophotometer. Fluoride concentration in water was determined electrochemically, using fluoride ion-selective electrode **(APHA 1985).**

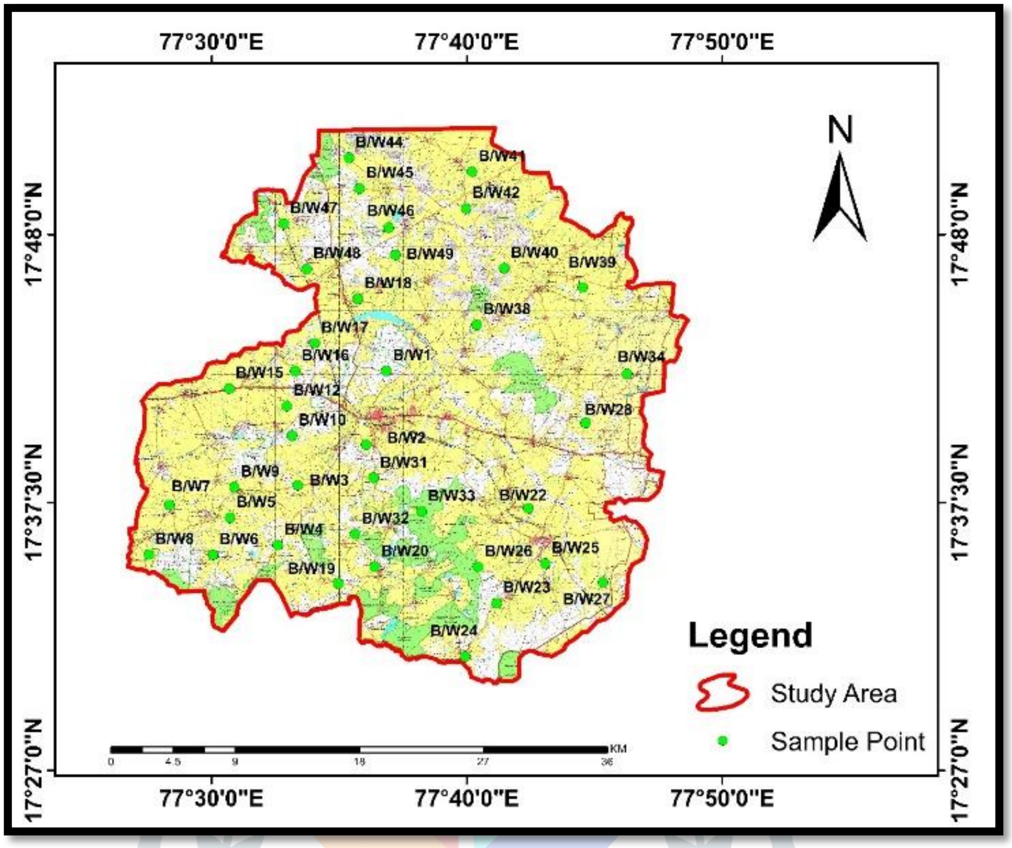

Fig 3. Sample location map of the study area.

4. Results and Discussions

4.1. Fluoride distribution in groundwater

Fluoride levels ranges from 0.3 to 2.7 mg/L and 0.1 to 1.8 mg/L with a mean of 1.2mg/L and 0.6 mg/L in both the monsoons. Fluoride concentration values in the study area are given in **Table No- III.**

The world health organization (WHO) has specified the desirable limit of fluoride in drinking water to be from 0.5 to 1.5 mg/l. accordingly, the groundwater samples of the study area are classified based on their fluoride concentration as shown in **Table I**

Table No:I Abstract of fluoride distribution in and Zhirabad mandal

No.of Villages/Samples	Season	Minimum	Maximum	Average	<1.0 mg/l	1.0 - 1.5 mg/l	<1.6 mg/l
49	**Pre monsoon**	0.3	2.7	1.3	20 (40.82%)	19 (38.78%)	10 (20.40%)
49	**Post monsoon**	0.1	1.8	0.6	44 (89.80%)	1 (2.0%)	4 (8.16%)

This study shows that out of the total samples analyzed 20.4 % of the samples in pre monsoon and 8.1% samples in post monsoon have fluoride concentration more than permissible limit

High fluoride content in groundwater can be attributed to the continuous water–rock interaction during the process of percolation with fluoride-bearing minerals present in rocks under arid, low-precipitation, and high-evaporation Conditions from the study area. The basement rocks provide abundant sources of F− in the form of amphibole, biotite, fluorite, and apatite. **(Sakram et al., 2019)**

Spatial distribution of fluoride concentration is shown in **(Fig.4 and Fig 5)**.From the figure it is very clear that there is no specific trend of fluoride distribution in the area under study.

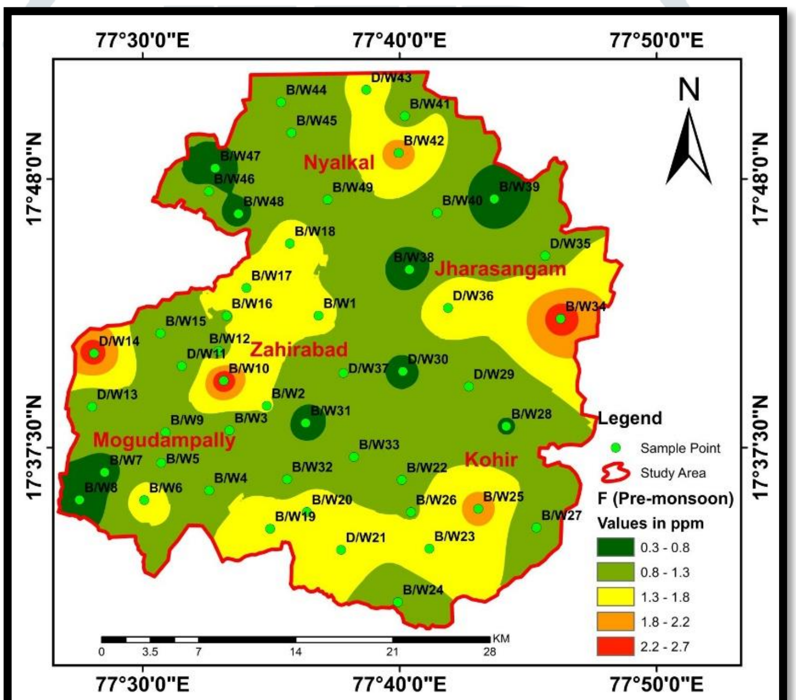

Fig. 4 Spatial distribution map of Fluoride in pre-monsoon

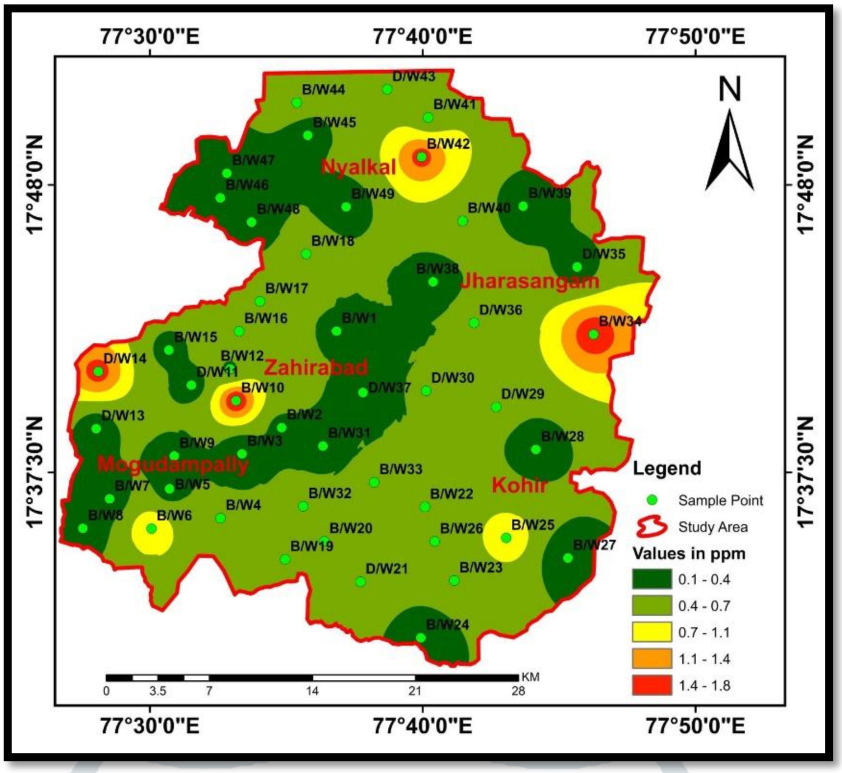

Fig. 5 Spatial distribution map of Fluoride in post-monsoon

4. 2.Nitrate distribution in groundwater

Nitrates are extremely soluble in water and can move easily through soil into the groundwater. Fertilizers wastes are the main sources of nitrogen –containing compounds and its concentration may be further affected by complex hydrochemical processes such as nitrification or denitrification **(Arnade, et al 1999).**The statistical summary of the results of nitrate concentration in the groundwater samples analyzed is given in **table II.**

Table No:II Abstract of Nitrate distribution in and Zhirabad mandal

No.of Villages/ Samples	Season	Minimum	Maximum	Average	<45 mg/l	46-50 mg/l	51-100 mg/l	101-150 mg/l	>150 mg/l
49	**Pre monsoon**	24.5	390.9	158.6	5 (10.20%)	0	4 (8.16%)	18 (36.74)	22 (44.90%)
49	**Post monsoon**	28.0	395.0	160.2	5 (10.20%)	0	4 (8.16%)	17 (34.70%)	23 (46.94)

Nitrate in the groundwater samples of the study area is varying from 24.5 to 390.9 mg/L with an average of 156.6 mg/L in pre-monsoon and 28 to 395 mg/L with an average of 158.1 mg/L,(Nitrate concentration values in the study area are given in **Table No- III)** in post-monsoon which can be attributed to the agricultural activities in the study area. Formers are using fertilizers for sugarcane crop growth and yield. Spatial distribution of nitrate is the study area is given in **(Fig. 6 and Fig 7)**.

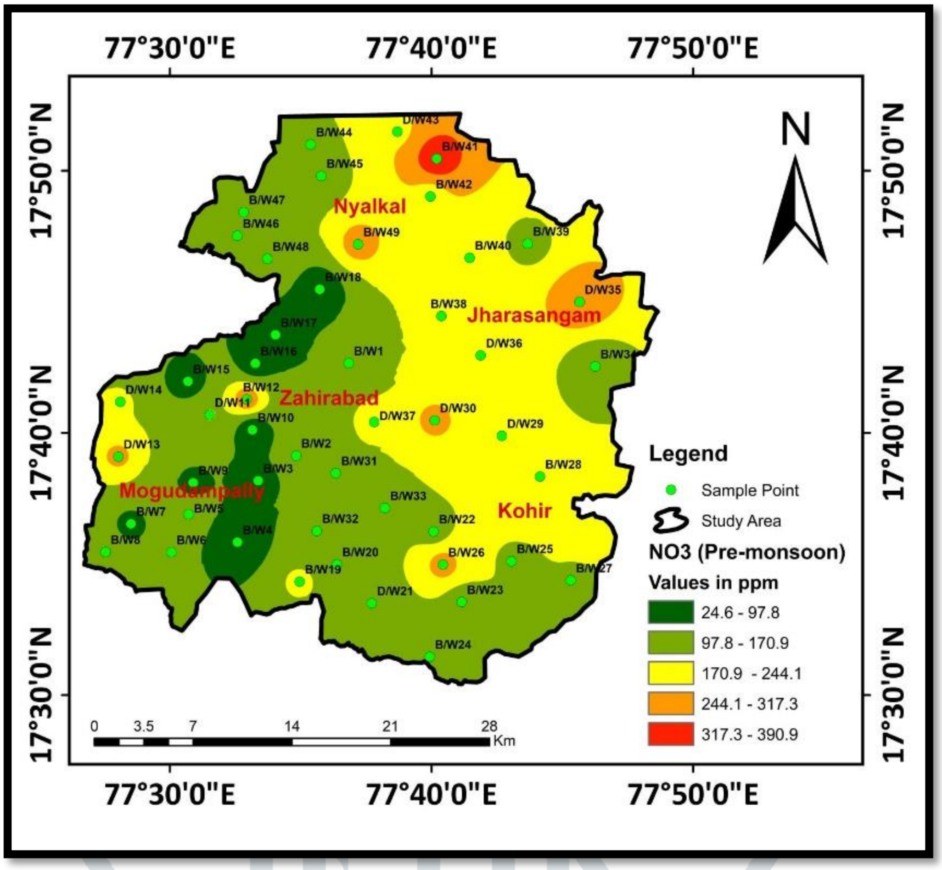

Fig.6 Spatial distribution map of Nitrate in pre-monsoon

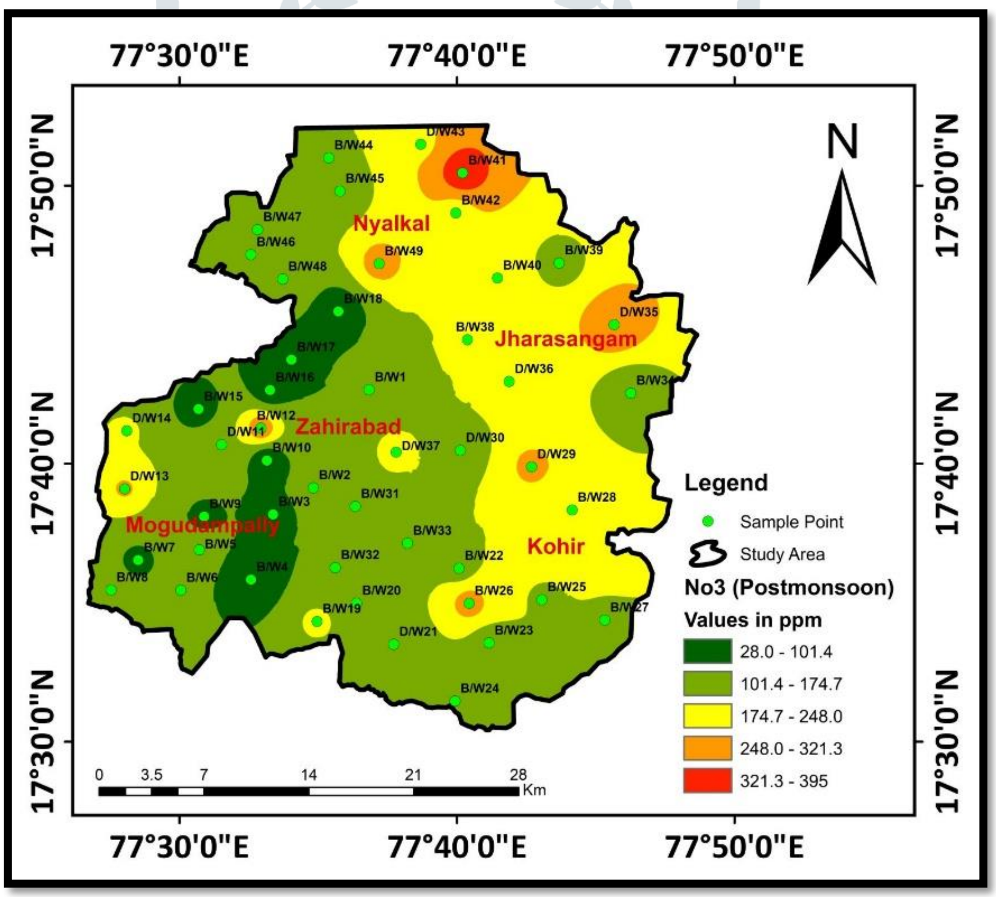

Fig.7 Spatial distribution map of Nitrate in post-monsoon

Table No-III Fluoride and Nitrate concentration in villages of in and around zahirabad mandal,sangareddy District, Telangana

ID	Village Name	Pre-monsoon		Post-monsoon	
		F - mg/l	NO3 - mg/l	F - mg/l	NO3 - mg/l
B/W1	Chinna Hydrabad	1.4	117.2	0.4	120.0
B/W2	Hoti B	1.4	121.9	0.4	125.0
B/W3	Govindpur	1.0	71.9	0.1	76.0
B/W4	Upparpalli Thanda	1.2	24.5	0.5	28.0
B/W5	Mugudampalli	1.3	145.5	0.4	150.0
B/W6	Mandhagubbdi Tanda	1.5	108.9	1.1	116.0
B/W7	Gudipalli	0.7	84.9	0.3	88.0
B/W8	Gousabad Tanda	0.3	115.3	0.2	121.0
B/W9	Mannapur	0.9	78.4	0.3	82.0
B/W10	Gotgaripalli	2.5	30.8	1.6	34.0
D/W11	Gopanpalli	0.8	174.8	0.3	178.0
B/W12	Kasimpur	1.2	317.9	0.4	321.0
D/W13	Dhanseri	1.1	263.5	0.3	258.0
D/W14	Madgi	2.7	176.9	1.8	180.0
B/W15	Satwar	0.9	50.1	0.4	53.0
B/W16	Buchinehalli	1.3	43.5	0.5	45.0
B/W17	Burdhipad	1.6	39.2	0.8	43.0
B/W18	Malkapur	1.6	29.7	0.7	32.0
B/W19	Gudimalkapur	1.8	190.3	0.7	194.0
B/W20	Malchalma	1.6	133.8	0.7	138.0
D/W21	Gotgaripalli	1.5	126.7	0.7	128.0
B/W22	Badampet	1.3	142.8	0.6	146.0
B/W23	Billapur	1.5	132.4	0.5	135.0
B/W24	Manyarapalli	1.0	113.3	0.2	118.0
B/W25	Kohair	2.1	166.5	1.0	172.0
B/W26	Paidigummal	1.3	287.4	0.6	293.0
B/W27	Nagireddypalli	1.0	170.7	0.2	174.0
B/W28	Kavelli	0.8	186.4	0.2	190.0
D/W29	Digwal	1.0	190.5	0.5	268.0
D/W30	Huggelli	0.8	264.9	0.5	124.0
B/W31	Ford naik Tanda	0.6	122.7	0.2	126.0
B/W32	Anjigunta	1.0	120.2	0.5	107.0
B/W33	Shekapur	1.1	124.9	0.6	126.0
B/W34	Sarjapur	2.5	104.8	1.7	108.0
D/W35	Pichiregadi	1.2	317.9	0.3	320.0
D/W36	Machnoor	1.8	209.7	0.6	213.0
D/W37	Alipur	1.0	199.6	0.3	204.0
B/W38	Pottipalli	0.6	180.7	0.2	182.0
B/W39	Rumapur	0.4	137.2	0.2	140.0
B/W40	Raikode	1.2	208.7	0.7	212.0

B/W41	Nayalkal	1.2	390.9	0.6	395.0
B/W42	Mungi	2.1	216.7	1.6	219.0
D/W43	Atunur	1.4	233.7	0.6	238.0
B/W44	Waddi	1.3	148.5	0.5	152.0
B/W45	Hassalli	1.0	113.5	0.3	116.0
B/W46	Mamdgi	0.9	152.6	0.4	156.0
B/W47	Mamdgi	0.7	139.1	0.4	144.0
B/W48	Metalkunta	0.8	170.2	0.2	173.0
B/W49	Matlampadu	1.1	283.4	0.2	285.0

6. Conclusions

Groundwater quality studies have been carried out with the aim of determining the groundwater suitability for drinking in and around Zahirabad Mandal, Sangareddy district, Telangana state.

With respect to fluoride, 79.6 % of sample s in pre and 90.0% of sample in post monsoon groundwater samples are within the range of fluoride and hence they are suitable for drinking. However, 24.4 % of sample s in pre and 8.1% of sample in post monsoon groundwater samples are above 1.5 mg/l of fluoride and unsuitable for drinking. . Excess fluoride concentration (>1.5 mg/l) is found at Gotgaripalli, madgi, burdhipad, malkapur, gudimalkapur, malchalma, kohir, sarjapur, machnoor villages and Gotgaripalli, madgi, sarjapur, mungi villages in pre and post monsoon. 89.7% of groundwater samples are exceeded the acceptable limit of nitrate is 45 mg/L (WHO, 2011) in pre and post monsoon. High concentration of Nitrate is observed at Nyalkal village (BW41) in pre-monsoon and post-monsoon.

The most effective way of reducing the nitrogen content of groundwater in the areas where agriculture is the main occupation is to reduce the application of fertilizers in consultation with agriculture scientists and change the cropping pattern by going in for irrigated dry crops which consume less water and fertilizers. It is suggested that frequently modifying the cropping.

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