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MONITORING OF FLUORIDE AND NITRATE CONCENTRATIONS IN THE GROUND WATER OF HYDERABAD, A.P, AND INDIA.

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Abstract:

Hyderabad is the capital city of Andhra Pradesh and the fifth largest city in India. It is located in the Central Part of the Deccan Plateau. This area experience severe degradation of ground water quality due to various industries, canals and anthropogenic activities. An attempt was made to study the quality and suitability of ground water in these areas for drinking and irrigation purpose and to investigate the concentration of fluoride and nitrate levels in the ground water. Groundwater samples were collected from various locations of Hyderabad during the pre monsoon and post monsoon period for the years 2005 to 2008. These samples were analysed for **Fluorides and Nitrates.** This analysis reveals that some of the water samples in the study area evidenced excess fluoride concentrations and were not meeting the water quality standards. The excess fluoride concentration in the study area has be attributed to the geological formation of that particular area and rapid ground water depletion. Further, reveals that some of the water samples are high concentration of nitrites and this water is not suitable for domestic consumption without prior treatment.

Keywords: Groundwater, fluorosis, Fluoride, Nitrates, Hyderabad.

Introduction

Water quality the only generally accepted adverse effect of fluoride at levels used for water fluoridation is dental flurosis, which can alter the appearance of children's teeth during tooth developemnt. This is mostly mild and not usually of aesthetic concern compared to un-fluoridated water. Fluoridation to 1 mg/L is estimated to cause fluorosis in one of every 6 people (range 4–21) and to cause fluorosis of aesthetic concern in one of every 22 people (range 13.6–∞). Here, "aesthetic concern" is a term used in a standardized scale based on what adolescents would find unacceptable, as measured by a 1996 study of British 14-year-olds. Other adverse effects may be possible at fluoride intake levels above the recommended dosage and de fluoridation is recommended in these cases. In 1993 the WHO guidelines for drinking water quality, set up in Geneva 1993 are the international reference point for standard setting and drinking water safety, established maximum contaminant level (MCL) for fluoride at a concentration of 1.5 mg/L. Consumption of fluoride at levels beyond those used in fluoridated water for a long period of time causes skeletal flurosis. In some areas, particularly the Asian subcontinent, skeletal fluorosis is endemic. It is known to cause irritable-bowel symptoms and joint pain. Early stages are not clinically obvious and may be rheumatoid arthritis ankylosing spondylitis.

Excess fluoride consumption has been studied as a factor in the following:

A weakening of bones, leading to an increase in hip and wrist fracture. At the level used in fluoridated water, decreased fractures are expected but the U.S. National Research Council found the overall evidence "suggestive but inadequate for drawing firm conclusions about the risk or safety of exposures at 2 mg/L, but states that fractures do seem to increase as fluoride is increased from 1 mg/L to 4 mg/L suggesting a "continuous exposure-effect" dose response relationship at these levels. Adverse effects on the kidney, within the recommended dose, no effects are expected, but chronic ingestion in excess of 12 mg/day are expected to cause adverse effects and an intake that high is possible when fluoride levels are around 4 mg/L. Those with impaired kidney function are more susceptible to adverse effects .Little research has been done on possible liver damage, although some studies suggest negative effects at chronic ingestion of 23 mg/day. Chromosomal damage and interference with DNA repair overall, the literature from in vitro and rodent studies does not indicate genotoxicity, but the in vivo human studies are inconsistent .Fluoride's suppressive effect on the thyroid is more severe when iodine is deficient and fluoride is associated with lower levels of iodine. Thyroid effects in humans were associated with fluoride levels 0.05-0.13 mg/kg/day when iodine intake was adequate and 0.01-0.03 mg/kg/day when iodine intake was inadequate. Its mechanisms and effects on the endocrine system remain unclear.

Nitrate toxic in humans occurs through enterohepatic metabolism of nitrates to ammonia with nitrite being an intermediate. Nitrites oxidise the iron atoms in hemoglobin from ferrous iron (2^+) to ferric iron (3^+), rendering it unable to carry oxygen. This process can lead to generalized lack of oxygen in organ tissue and a dangerous condition called methemoglobinemia. Methemoglobinemia can be treated with methylene blue which reduces ferric iron (3^+) in affected blood cells back to ferrous iron (2^+). Infants in particular are especially vulnerable to methemoglobinemia due to nitrate metabolizing triglycerides present at higher concentrations

than at other stages of development. Methemoglobinemia in infants is colloquially known as "blue baby syndrome". Initial exposure is most often caused by high levels of nitrates in drinking water. However, nitrate exposure may also occur if eating for instance vegetables containing high levels of nitrate. Lettuce may contain elevated nitrates under growth conditions such as reduced sunlight, undersupply of the essential micronutrients molybdenum (Mo) and iron (Fe) or high concentrations of nitrate due to reduced assimilation of nitrate in the plant. High levels of nitrate fertilization also contribute to elevated levels of nitrate in the harvested plant. Some adults can be more susceptible to the effects of nitrates than others. The methemoglobin reductase enzymes may be under produced or absent in certain people who have an inherited mutation . Such individuals cannot break down methemoglobin as rapidly as those who do have the enzyme, leading to increased circulating levels of methemoglobin (the implication being that their blood is not as oxygen-rich). Those with insufficient stomach acid (including some vegetarians and vegans) may also be at risk. Ironically, the increased consumption of green, leafy vegetables that typically accompanies these types of diets may lead to increased nitrate intake. A wide variety of medical conditions, including food allergies, asthma, hepatitis and gallstones may be linked with low stomach acid. These individuals may also be highly sensitive to the effects of nitrates.
Drinking water with high nitrate concentrations is a potential health risk, particularly for infants. Elements are essential nutrients for aquatic plants. However, in high concentrations, they can cause excessive growth (eutrophication) that chokes stream channels. Nitrates in drinking water as such are not toxic to health and about 85% of ingested nitrates are rapidly adsorbed from gastrointestinal tract in normal healthy individuals and adsorbed nitrates are excreted by the kidneys. But, if the nitrates are converted into nitrites which occur commonly, then toxic effects are encountered and may cause potential health hazards.

Study Area

Hyderabad is the capital city of Andhra Pradesh and the fifth largest city in India. This city located at 17° 26' 58'' of the Northern Longitude and 78° 28' 34'' of the Eastern Longitude. The total population of the Greater Hyderabad district is above 60 lakhs and the area of the city is 650 sq km. . According to 2001 Census, the total population of the District is 35, 75,064 about 54.20% of which live in urban areas. The major sources of employment are industries. There are 497 large and medium scales and 23642 small scale Industries in the District. The major sources of employment are industries, agriculture, horticulture and animal husbandry, which engage almost 80% of the workforce. The major industries are that of chemicals, oil, cotton, tools, lead batteries, food processing, pharmaceuticals, asbestos, foam, coir and stone crushing. Occurrence, movement and storage of groundwater are influenced by litho logy, thickness and structure of rock formations. Ground water in the study area occurs under water table conditions in the weathered and fractured granite, Gneisses in Greater Hyderabad. The Fluorides and Nitrates of groundwater of Hyderabad have not been studied earlier, so that an attempt to make to study the consontration levels of Fluorides and Nitrates of ground water of Hyderabad. The study area location is shown in fig1.

Figure 1: The study area location map

Methodology

Groundwater samples (272 samples) were collected from various locations of Hyderabad during the pre monsoon and post monsoon period from 2005 to 2008 (Fig. 1). The collected water samples were transferred into pre cleaned polythene container for analysis. Water samples collected from different locations using the standard procedures recommended by APHA-1994 for **Nitrates.** Fluoride (F^-) was determined by SPANDS regent method using colorimetric.

Results and Discussion

2008 registered a highest peak of rainfall (fig.2) at all the stations comparatively, low rainfall was observed during the year2005, 2006 and2007.

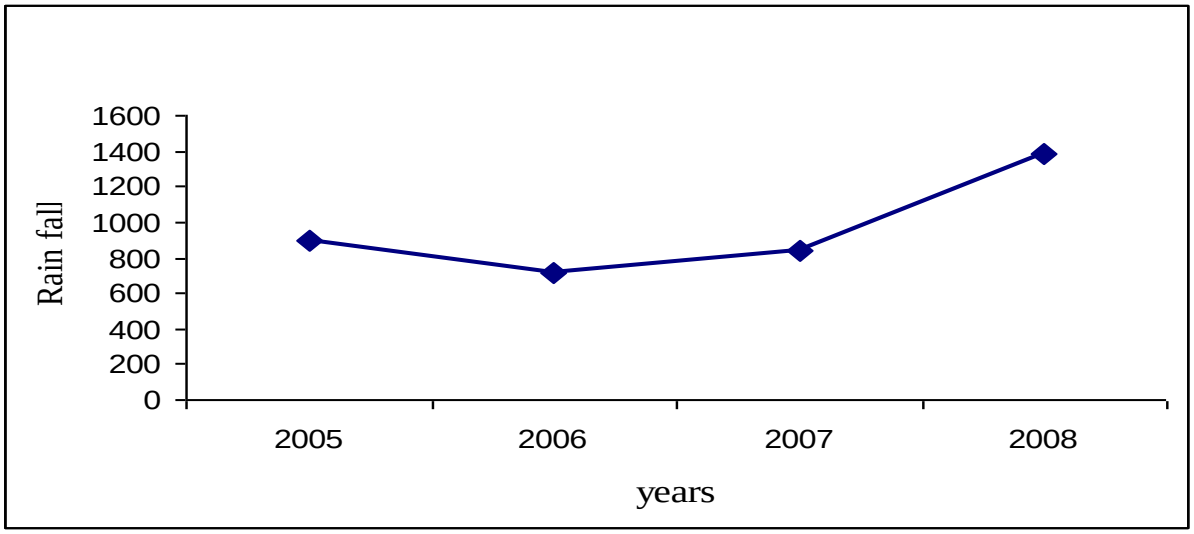

Figure 2:

Total rainfall (mm) at the sampling stations in Hyderabad during 2005 to 2008

The data obtained after analysis of all the samples was compiled and presented in Fig3 to Fig 6 considering various parameters wise.

Season	**Fluoride mg/L <1.50 mg/L (W.H.O Limit)**	**Fluoride mg/L >1.50mg/L**
Pre monsoon May-05	0.23-1.45 (32 samples)	1.70-1.75 (02 samples)
post monsoon Nov-05	0.12-1.50 (29 samples)	1.65-1.90 (05 samples)
Pre monsoon May-06	0.20-1.40 (27 samples)	1.80-2.60 (08 samples)
post monsoon Nov-06	0.21-1.40 (31 samples)	2.25- 3.20 (03 samples)
Pre monsoon May-07	0.23-1.28 (30 samples)	1.65-4.55 (04 samples)
post monsoon Nov-07	0.21-1.40 (33 samples)	3.20 (01samples)
Pre monsoon May-08	0.33-1.50 (25 samples)	1.66-2.46 (09 samples)
post monsoon Nov-08	0.34-1.46 (19 samples)	1.53-2.82 (14 samples)

Table 1: Classification of Fluoride mg/L as per W.H.O Limit

Month/Year	Sampling area	Fluoride mg/L
May-2005	Trirumalagiri	1.75 mg/L.)
	Maraedpally	1.70 mg/L
May-2006	Mushirabad	2.60 mg/L.
	Picket	2.30 mg/L.
	Bollaram	2.10 mg/L.
	Kishenbagh	2.10 mg/L.
	Nacharam	2.00 mg/L.
	Maredpally	2.00 mg/L.
	Agapura	1.80 mg/L.
	Alwal	1.80 mg/L.
May-2007	Nacharam	4.55 mg/L.
	Golconda	2.13 mg/L.
	Bhadurpura	1.84 mg/L.
	Malkagigiri	1.65 mg/L.
May-2008	Malkajigiri	2.46 mg/L.
	Gachibowli	2.42 mg/L.
	Golconda	2.10 mg/L.
	Malkajigiri	1.98 mg/L.
	Sanjeevareddy Nagar	1.96 mg/L.
	Picket	1.88 mg/L.
	Shaikpet	1.72 mg/L.
	Bhadupura	1.66 mg/L.
	Uppal	1.66 mg/L.

Table.2 concentration of fluorides above the permissible limit during the pre monsoon seasons for the year 2005 to 2008

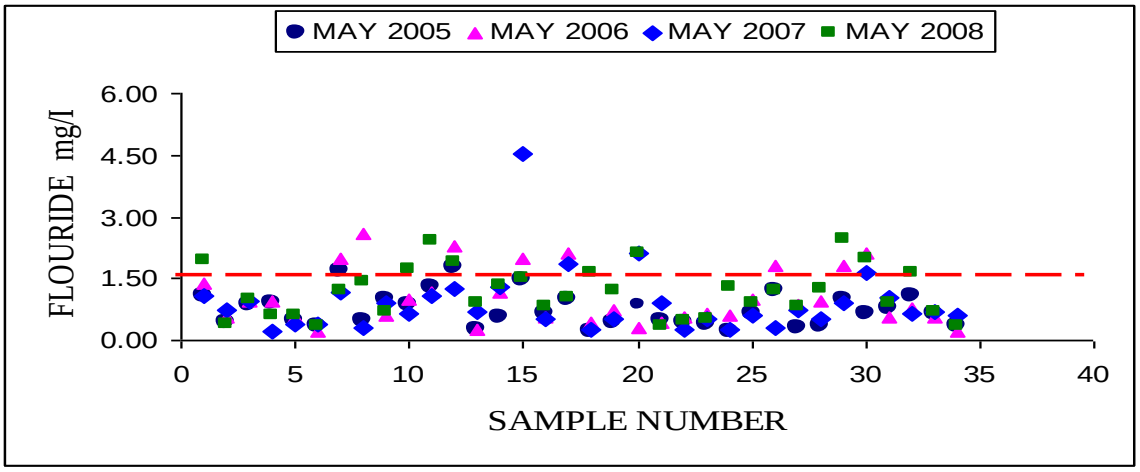

Fig.3: Fluoride concentrations during pre monsoon seasons for the years 2005 to 2008.

The study area with respect to Fluorides minimum and maximum concentrations were represented in Table 1. As per the W.H.O the permissible limit for fluoride in drinking waters is 1.5 mg/L. During pre monsoon are depicted in Fig 3. The analysis results reveal that the concentration of fluorides Maximum of the water samples during the pre monsoon seasons for the year 2005 to 2008 is shown in Table. 2

Month/Year	Sampling area	Fluoride concentration mg/L
November-2005	Bollaram	1.90 mg/L.
	Musheerabad	1.80 mg/L.
	Uppal Khalan	1.80 mg/L
November -2006	Charminar	3.20 mg/L.
	Mushirabad	2.75 mg/L.
	Nacharam	2.25 mg/L.
November -2007	Bhadurpura	3.20 mg/L.
November -2008	Golconda	2.82 mg/L.
	Bollaram	2.77 mg/L.
	Maredpally	2.77 mg/L.
	Alwal	2.64 mg/L.
	Gachibowli	2.47 mg/L.
	Picket	2.00 mg/L.
	Sanjeevareddy Nagar	1.96 mg/L.
	Youufguda	1.87 mg/L.
	Agapura	1.80 mg/L.
	Shaikpet	1.70 mg/L.
	Uppal Khalan	1.66 mg/L
	Charminar	1.64 mg/L.
	uppal	1.53 mg/L.

Table.3 concentration of fluorides above the permissible limit during the post monsoon seasons for the year 2005 to 2008.

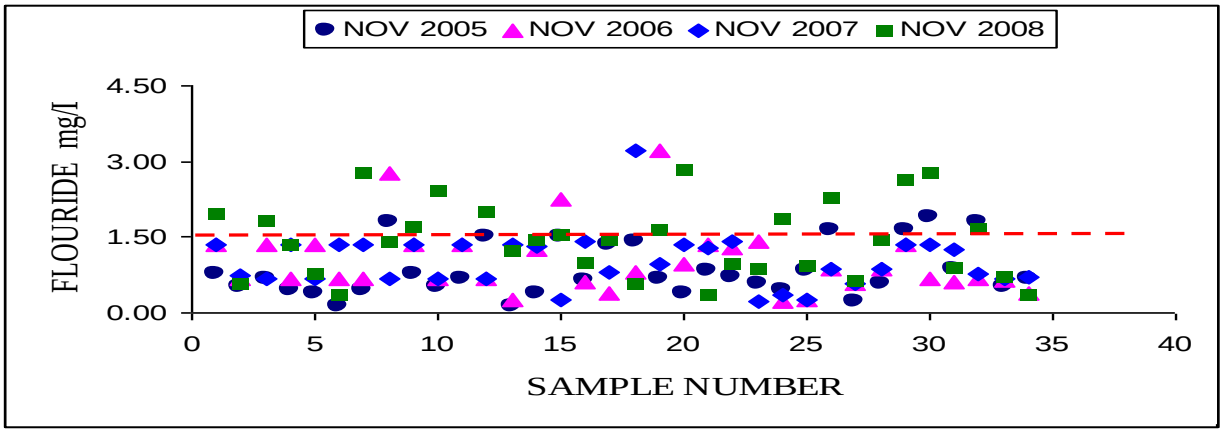

Fig.4: Fluoride concentration during post monsoon seasons for the years 2005 to 2008.

The study area with respect to Fluorides minimum and maximum concentrations were represented in Table 1. As per the W.H.O the permissible limit for fluoride in drinking waters is 1.5 mg/L. During post monsoon are depicted in Fig 4 Fluoride concentrations in the study area shown in table .1.The analysis results reveal that the concentration of fluorides Maximum of the water samples during the post monsoon seasons for the year 2005 to 2008 are shown in Table. 3

Nitrates as No_3

Table 4: Classification of Nitrates as No_3 as per W.H.O

Season	**Nitrates as No_3 <45 mg/L As per W.H.O**	**Nitrates as No_3 >45 mg/L**
Pre monsoon May-05	0.37-39.45 (32samples)	70.50-138 (02 samples)
Post monsoon Nov-05	0.07-42.25 (25 samples)	47.7-141 (09 samples)
Pre monsoon May-06	0.07-30 (30 samples)	47-137 (04 samples)
Post monsoon Nov-06	0.42-33 (31 samples)	72.5-138 (03 samples)
Pre monsoon May-07	0.44-43 (30 samples)	47.50-111 (04 samples)
Post monsoon Nov-0	0.50-33 (30 samples)	47-75.2 (04 samples)
Pre monsoon May-08	0.35 -42 (30 samples)	47-100 (04 samples)
Post monsoon Nov-08	0.20-45 (33 samples)	50 (01 samples)

Month/Year	Sampling area	Nitrates as No_3 mg/L
May-2005	Uppal Khalan	70.50 mg/L
	Gudimakapur	120.00 mg/L.
May-2006	Gudimakapur	137.00 mg/L.
	Kulsan pura	47.00 mg/L.
	Uppal Khalan	48.50 mg/L
	Lower Tank Bund	47.00 mg/L.
May-2007	Gudimakapur	111.00 mg/L.
	Mushirabad	51.50 mg/L.
	Uppal Khalan	47.50 mg/L
	Saidabad	43.00 mg/L
	Shaikpet	42.75 mg/L
May-2008	Gudimakapur	100.00 mg/L.
	Mushirabad	40.00 mg/L.

Table.5 concentration of Nitrates as No_3 above the permissible limit during the pre monsoon seasons for the year 2005 to 2008

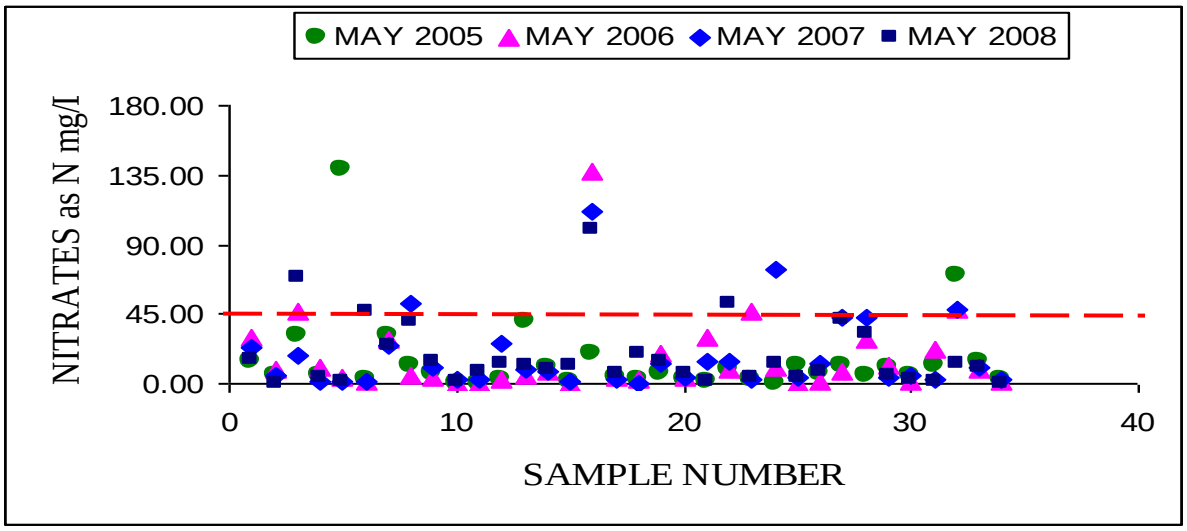

Fig.5: Nitrate concentrations during pre monsoon seasons for the year 2005-2008

The study area with respect to Nitrates, minimum and maximum concentrations were represented in Table 4. As per the W.H.O the permissible limit for Nitrates in drinking waters is 45 mg/L. During post monsoon are depicted in Fig 5. Nitrates concentrations in the study area shown in table .4.The analysis results reveal that the concentration of Nitrates Maximum of the water samples during the post monsoon seasons for the year 2005 to 2008 are shown in Table. 5.

Month/Year	Sampling area	Nitrates as No_3 mg/L
November-2005	Daruru Sharif	141.00 mg/L.
	Gudimakapur	130.00 mg/L.
	Kulsan pura	58.5 mg/L.
	Charminar	47.7 mg/L.
	Shaikpet	89.75 mg/L.
	Maredpally	63.5 mg/L.
	Nampally	49.5 mg/L.
	Yousuf Guda	42.25 mg/L.
	Padmaraonagar	53.5 mg/L.
November -2006	Gudimakapur	138.00 mg/L.
	Kishan Bagh	98.00 mg/L
	Yousuf Guda	72.50 mg/L.
November -2007	Gudimakapur	56.50 mg/L.
	Lower Tank Bund	72.50 mg/L.
	Yousuf Guda	75.20 mg/L.
	Uppal Khalan	47.00 mg/L
November -2008	Alwal	50.00 mg/L.

Table.6 concentration of Nitrates as No_3 above the permissible limit during the pre monsoon seasons for the year 2005 to 2008

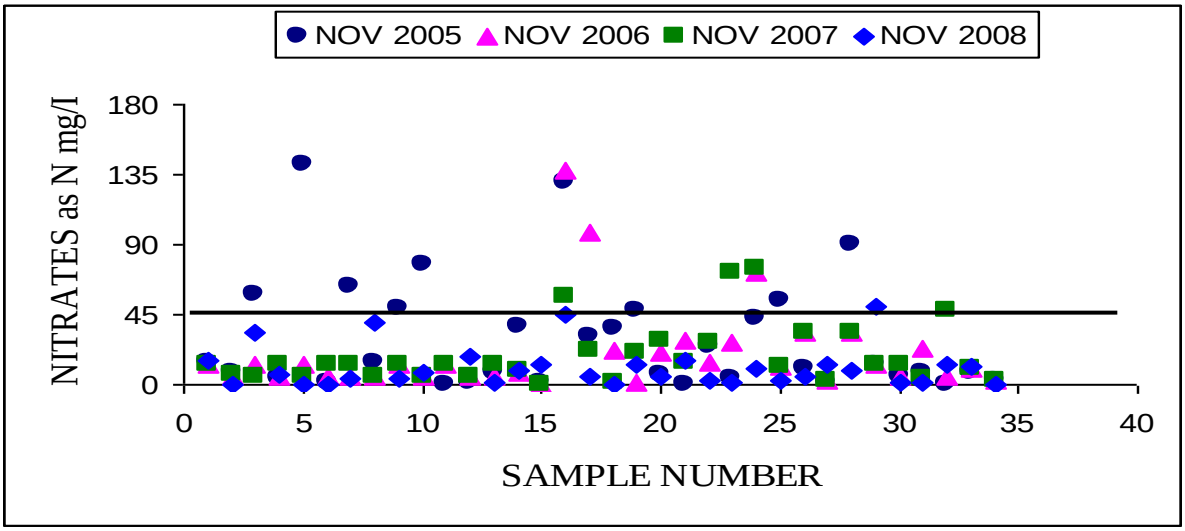

Fig.6: Nitrate concentrations during post monsoon seasons for the year 2005-2008

The study area with respect to Nitrates, minimum and maximum concentrations were represented in Table 4. As per the W.H.O the permissible limit for Nitrates in drinking waters is 45 mg/L. During post monsoon are depicted in Fig 6. Nitrates concentrations in the study area shown in table.1.The analysis results reveal that the concentration of Nitrates Maximum of the water samples during the post monsoon seasons for the year 2005 to 2008 are shown in Table.6.

Conclusions

Some of the water samples in the study area evidenced excess fluoride concentrations and were not meeting the water quality standards. Ground water samples in particular showed high fluoride concentrations. During 2005 to 2008, Total 272 (pre monsoon, post monsoon) samples were analysed, 15% samples were more than the permissible limits of fluorides. The excess fluoride concentration in the study area may be attributed to the geological formation of that particular area and rapid ground water depletion Excess of fluoride mainly due to the geology of the area which comprises igneous rocks of crystalline nature vast volcanic basalt beds of the Deccan Plateau. *Another reason for high concentration fluorides,* Septic *and sewage treatment system discharges in communities with fluoridated water Supplies and* Liquid waste from industrial sources.

Some of the water samples are identified high concentration of nitrites 11 % samples were more than the permissible limit. Nitrate and nitrite are naturally occurring ions that are part of the nitrogen cycle. Nitrates may occur in both shallow and deep well supplies, but they are most common in water from shallow wells. Nitrate nitrogen can result from the seepage of water through soil containing nitrate-bearing minerals. The nitrate concentration in groundwater and surface water is normally low but can reach high levels as a result of leaching or runoff from agricultural land or contamination from human or animal wastes as a consequence of the oxidation of ammonia and similar sources. The sources of nitrates pollution in groundwater are in urban areas are drainage systems, animal husbandry, and increased urbanization.

Due to the detrimental biological effects, treatment and prevention methods must be considered to protect groundwater aquifers from nitrate leaching and high concentrations. Treatment through ion-exchange and other processes can rehabilitate already contaminated water. The water in the study area is not suitable for domestic consumption without prior treatment.

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