Analytical study of Nitrate and Fluoride concentration in ground water: A case study of a central region of Ahmedabad district, Gujarat.

Ajay K Bhanat[1*], Mukesh A Modi[2**], Dr. V M Patel[3*]
[1]Research Scholar, ME Water Resources Engg.,L.D. College of Engineering, University Area, Ahmedabad.
[2]Assistant Professor, Civil Engineering Dept.,**Faculty of Tech.and Engg.,M S University of Baroda
[3]Associate Professor, Civil Engineering Dept.,*L.D. College of Engineering, University Area, Ahmedabad.
ajaybhanat@gmail.com, mamodi-ced@msubaroda.ac.in, vmpatel@ldce.ac.in

Abstract

Groundwater is chief resource of water for household, agronomic and industrial use in India. Ground water quality has become major concern due to health and agricultural problems. Ahmedabad district consist of both rural and urban area. It is highly contaminated by nitrate and fluoride contamination. In this study, data of nitrate and fluoride concentration above permissible limit as per IS-10500-2012 from NWRDP reports have been spatially distributed using ArcGis. Study uses IDW method of interpolation and mapping of both concentrations was obtained. Study shows high concentration of nitrate and fluoride in certain region due to excess use of fertilizers, industrial effluent wastages and sewage waste.

Index Terms —Ground water, ArcGis, IS10500-2012, Fluoride, Nitrate

1 Introduction

According to the U.S. Geological Survey, It is hard to believe that less than three per cent of Earth's water is fresh water. More than 68 per cent of the fresh water on Earth is unearthed in frozen conditions, and just over 30 per cent is found in ground water. Ground water is one of the most valuable resources of the earth. India utilizes greater amount of water from groundwater for the domestic, agricultural and industrial purposes. In recent years, degradation of groundwater quality due to human activities is a major problem which arises due to overexploitation of groundwater, natural and man-made action or a combination of both. Rigorous agricultural commotions have amplified groundwater demand in India. Water quality is subjective to geo-genic and anthropogenic consequences which include local climate, geology and irrigation procedures and increase in small scale industries in the area.

Ground water is major source of water for Ahmedabad district. Frequent assessment of ground water quality is important which influences public health and agriculture. In this study analysis of ground water quality and spatial distribution of results is carried out using Geographical information system (GIS).

2 Literature Review

Study on Groundwater Quality Assessment was carried out Using Water Quality Index and GIS Technique in Modjo River Basin, Central Ethiopia(Nafyad Serre Kawo et al, 2018). They have assessed water quality based on water quality index and they have done spatial distribution of water quality parameters using IDW method of interpolation in GIS. They Concluded that the main reasons behind water quality deterioration in the area was strong water intrusion urban sewage and the use of excessive fertilizers. Higher amount of salt modifies osmotic pressure in root zone. This leads to limited absorption of water in root zone, which effects the growth of the crop.

Study was carried out on Groundwater Nitrogen Pollution and Assessment of Its Health Risks: A Case Study of a Typical Village in Rural-Urban Continuum, China.(Yang Gao et al, 2012) They assessed nitrates and other forms of nitrogen contamination. They found that average nitrogen concentration was five to seven times higher in rural ground water than that in forest covered areas. They have concluded that drinking high amount of nitrate can cause disease like enlargement of thyroid gland, increased incidence of fifteen types of cancers, two birth defects and hypertension.

Study was done on Groundwater quality analysis of quaternary aquifers in Jhajjar District, Haryana, India: Focus on groundwater fluoride and health implications.(Ruchi Gupta et al, 2016) In this study they have analysed ground water quality based on water quality index. They have found that the water is very unsuitable for drinking purposes in those areas. Major source of fluoride and other salts were the availability of salt rich geographical formation.

3 Study area and Data Exploration

Ahmedabad district is located in the central part of Gujarat state. Ahmedabad lies at 23.0225° N latitude 72.5715° E longitudes in western India at 53 meters above mean sea level.Geographical area of Ahmedabad is approximately 8087 sq. km. The study area consists of tehsils such as Bavla, Daskroi, Dholka, Sanand of Ahmedabad district.

Table 1: Geographical area of the study area

SR.NO.	TEHSIL	AREA (SQ. KM)
1.	Bavla	75185.7
2.	Ahmedabad City	5367.14
3.	Daskroi	62416.55
4.	Dholka	101195.95
5.	Sanand	74410.43

(C.G.W.B, 2014)

Ahmedabad has special economic zones and GIDC for the industrial development. It is an industrial hub for textiles. Textiles and Apparel cluster including chemicals & dyes, Drugs and Pharmaceuticals, Agro and Food Processing, Automobiles, Engineering, and Electronics, Biotechnology, Information Technology, Tourism are major industrial sectors in Ahmedabad.(iINDEXTb) INDEXTb journal reports suggest that the dholka , sanad, bavla, daskroi and ahmedabad city consist of high industrial area as shown in figure2. Hence this litrarature helped in narrowing down study region in above tehsils.

Sabarmati River is the chief river of the district. Rivers like Vatrak, Khari, Meshwo, Bhogavo, Bhadar, Rodh, Shelwa also a part of the district. Based on Geomorphology area can be divided into two zones, Flat Alluvial Pen plain and Low hills. This area consists of porous formations

(sedimentary) and fissured formation (Hard Rock). Porous formations hold the 93.5% part of the district. Ground water in this area occurs in unconfined as well as in confined aquifer.

Figure 1Gujarat state Map

Figure 2 Study Area (Central region of Ahmedabad)

Figure 3 Ahmedabad district industrial map (iINDEXTb)

Table 2 **Depth to water Level during 2011-12** (C.G.W.B, 2014)

Depth to water Level during 2011-12				
Period	**Phreatic Aquifer (DTW)**		**Semi-confined Aquifer (PZ head)**	
	Min.	Max.	Min.	Max.
Pre 7 Monsoon	3.11 (Viramgam)	22.32 (Vastrapur Lake-II)	6.62 (Bagodara)	105.14 (Kankariya PZ-I)
Post Monsoon	1.34 (Paccham)	22.87 (Vastrapur-II)	5.27 (Bagodara)	107.35 (Vastrapur-I)

Table 3 **Long Term (10 Years) Water Level Trend (2001-10)** (C.G.W.B, 2014)

Long Term (10 Years) Water Level Trend (2001 to 2010)		
Trend	**Pre-Monsoon**	**Post- Monsoon**
Rise (m/Yr)	0.025 (Ranpur) to 0.58 (Barvala)	0.16 (Ranpur) to 1.08 (Barvala)
Fall (m/Yr)	0.016 (Viramgam) to 0.50 (Dholka)	0.30 (City Daskroi) to 0.95 (Dholka)

Ahmedabad district consist of cultivatable area of 527 ha and forest area of 13 ha. Ground water quality parameters were collected from National Water Resource Development Project (NWRDP) website.The data was collected based on permissible limit defined as per IS 10500 (2012).

Table 4 Nitrate Concentration

2010-11					
Sr. No.	**Block Name**	**Village Name**	**Latitude**	**Longitude**	**AboveP (mg/l)**
1	SANAND	FANGDI	24.501154	71.4568753	301.24
2	SANAND	NANI DEVTI	22.9223598	72.3769962	299.02
3	SANAND	SOYLA	22.9647945	72.3709344	299.02
4	BAVLA	ROHIKA	22.6524941	72.2174003	110.75
5	BAVLA	BAGODARA	22.6318555	72.1807983	97.46
6	SANAND	TAJPUR	22.9088998	72.4466201	97.46
7	BAVLA	DEV DHOLERA	22.768854	72.1648604	95.25
8	SANAND	NANI DEVTI	22.9223598	72.3769962	93.03
9	SANAND	VANALIYA	22.8397491	72.1100104	93.03
10	BAVLA	SHIYAL	22.6877359	72.1529889	79.74
11	DASKROI	GERATPUR	22.9196501	72.6485671	79.74
12	SANAND	SOYLA	22.9647945	72.3709344	73.1

13	DASKROI	BHAVDA	22.978934	72.7562453	70.88
14	DASKROI	BAREJDI	22.8938222	72.6749793	64.45
15	DASKROI	KANBHA	23.0116452	72.7220142	62.02
2012-13					
Sr. No.	**BlockName**	**VillageName**	**Latitude**	**Longitude**	**AboveP(mg/l)**
1	SANAND	SOYLA	22.9647945	72.3709344	161.7
2	SANAND	SOYLA	22.9647945	72.3709344	161.7
3	DHOLKA	VIRDI	22.6200014	72.5011558	139.88
4	DASKROI	ISTOLABAD	22.9052748	72.6634602	133.34
5	DHOLKA	SIMEJ	22.615259	72.4040035	133.34
6	DHOLKA	KHATRIPUR	22.7094497	72.4772501	124.04
7	SANAND	MOTI DEVTI	22.9386733	72.4005997	124.04
8	SANAND	MOTI DEVTI	22.9386733	72.4005997	124.04
9	BAVLA	CHHABASAR	22.804059	72.2449854	119.61
10	DASKROI	BHUVAL	22.9195248	72.7504403	115.18
11	DASKROI	HIRAPUR	22.9216577	72.7097013	95.25
12	DASKROI	BIBIPUR	22.9686649	72.6809627	94.93
13	DASKROI	PARDHOL	23.0903897	72.7179352	93.3
14	DASKROI	KANIAL	22.968714	72.8115454	93.09
15	DHOLKA	RAMPUR	22.714684	72.4579954	93.09
2014-15					
Sr. No.	**BlockName**	**VillageName**	**Latitude**	**Longitude**	**AboveP (mg/l)**
1	SANAND	BOL	22.9900814	72.2634101	293.5
2	DASKROI	MAHIJDA	22.8272851	72.5397742	90.82
3	DASKROI	BHUVALDI	23.0330691	72.7053796	75.3
4	DASKROI	ASLALI	22.9170042	72.5860544	73.1
5	DASKROI	ASLALI	22.9170042	72.5860544	66.45
6	DASKROI	VASAI	22.847709	72.5357854	66.45
7	SANAND	CHEKHLA	24.0831047	71.9316603	65.25
8	DASKROI	ODE	22.9078898	72.5499003	62.02
9	DHOLKA	BHETAWADA	22.6639203	72.4273023	62.02
10	SANAND	CHEKHLA	24.0831047	71.9316603	60
11	DASKROI	BHUVALDI	23.0330691	72.7053796	58.5
12	BAVLA	KESRANDI	22.742509	72.2005704	58.1
13	DASKROI	BADODARA	22.925289	72.6637353	57.69
14	DASKROI	ASLALI	22.9170042	72.5860544	57.59
15	DASKROI	DHAMATVAN	22.9522819	72.7233231	57.5

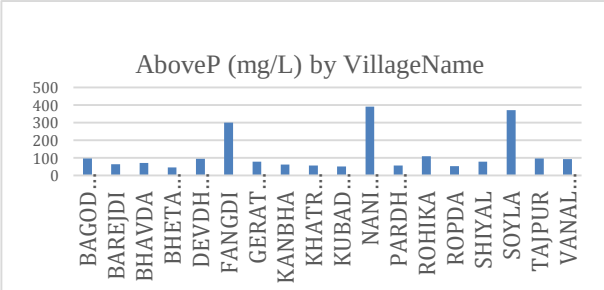

Figure 2 Nitrate Concentration (2010-11)

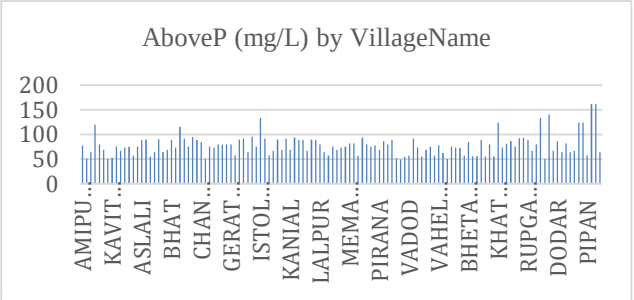

Figure 3Nitrate Concentration (2010-11)

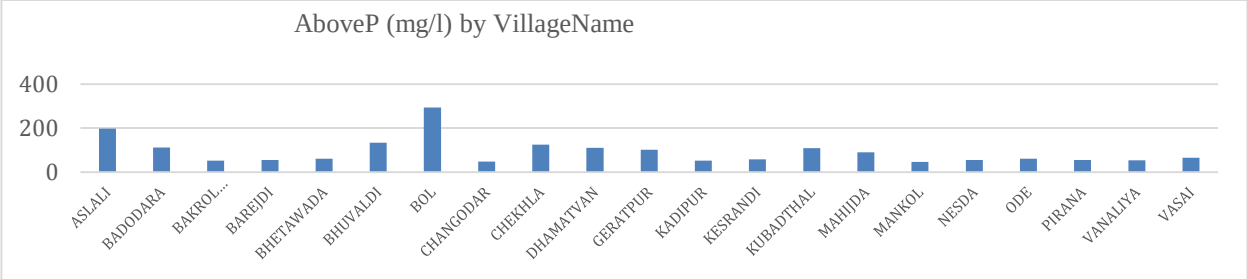

Figure 4 Nitrate concentration (2014-15)

Table 5Fluoride concentration

2010-11					
Sr. No.	**Block Name**	**Village Name**	**Latitude**	**longitude**	**AboveP (mg/l)**
1	BAVLA	DEVDHOLERA	22.768854	72.1648604	2.01
2	BAVLA	ROHIKA	22.6524941	72.2174003	4.23
3	BAVLA	ROHIKA	22.6524941	72.2174003	2.78
4	DASKROI	BAREJDI	22.8938222	72.6749793	2.27
5	DASKROI	KANBHA	23.0116452	72.7220142	2.95
6	DASKROI	PARDHOL	23.0903897	72.7179352	1.84
7	DHOLKA	AMBARELI	22.6498112	72.4093564	2.06
8	DHOLKA	KHATRIPUR	22.7094497	72.4772501	2.04
9	DHOLKA	RANODA	22.766564	72.4193203	1.85
2011-12					
Sr. No.	**BlockName**	**VillageName**	**latitude**	**longitude**	**AboveP(mg/l)**
1	DHOLKA	BEGVA	22.6557748	72.2948901	1.62
2012-13					
Sr. No.	**BlockName**	**VillageName**	**latitude**	**longitude**	**AboveP(mg/l)**
1	DHOLKA	KHANPUR	23.0335164	72.5741651	2.93
2013-14					
Sr. No.	BlockName	VillageName	latitude	longitude	AboveP (mg/l)
1	DHOLKA	SIMEJ	22.615259	72.4040035	1.55
2	SANAND	MORAIYA	22.9207609	72.414528	2.2
3	SANAND	RETHAL	22.8883078	72.1831507	2.33

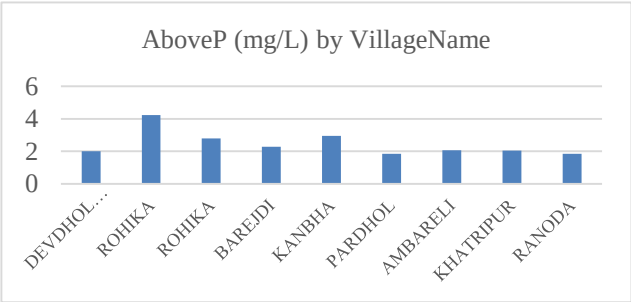

Figure 5 Fluoride Concentration (2010-11)

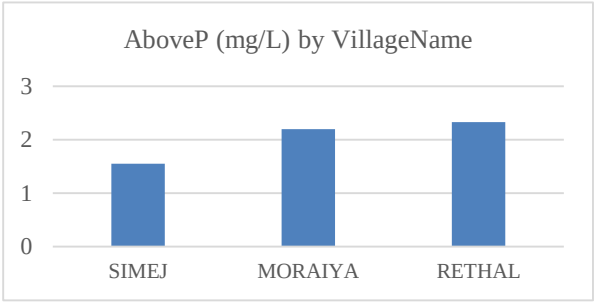

Figure 6Fluoride Concentration (2013-14)

4 Methodology

The nitrate and fluoride concentration data in ground water was collected from NWRDP reports. After collection of this ancillary data, analysis and graphical representation was carried

out using ArcGis 10.2.2.The data collected was above permissible limits defined by IS 10500 (2012). All the quality parameters were expressed in terms of mg/L.

Shape file of the study area was added to the ArcGis 10.2.2. Spreadsheet prepared which shows latitude longitude and the collected data. This file is converted in to text file and then it is added in ArcGis 10.2.2 and file created which shows point concentration in different area. This file is than converted in to a shape file. By using geo processing the boundary of the study area is defined.

Spatial distribution is than carried out by inverse distance weighing (IDW) technique of interpolation-IDW assumes that each measured point has a local influence that diminishes with distance.(ArcGis, n.d.) It utilizes the known values of location and predicts values for surrounding area.

5 Analysis And Result Discussion

IDW technique analyzes the data and gives the result which shows spatial distribution of the contamination in the form of a map.

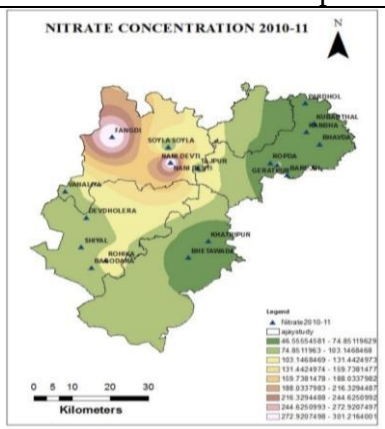

Figure 7 IDWNitrate Concentration (2010-11)

Above figure shows nitrate concentration is highest in the range of 300mg/l in fangadi and nanidevti villages. Above results suggests that sanand tehsil is highly contaminated by nitatre. In sanand city bhadreti lake is main source of nitrate contamination. Waste from market and from other activities are dumped in to the lake. Decomposition of vegetation produces nitrate which further infiltrates in to the ground water and deteriorates it's quality.

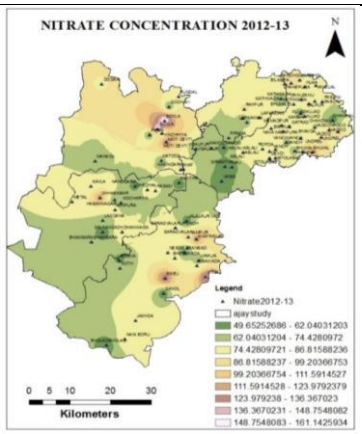

Figure 8 IDW Nitrate Concentration (2012-13)

Above figure shows the sanand, dholka,Ahmedabad tehsils are highly contaminated by nitrate up to range of up to 160mg/l. Highest concentration was found in soyla village of sanand. Near bhagirathlakecity of soyla there is a huge lake. Most of the waste is dumped in that lake. Which again pollutes the water and this waste is responsible for increase in nitrate concentration in ground water.

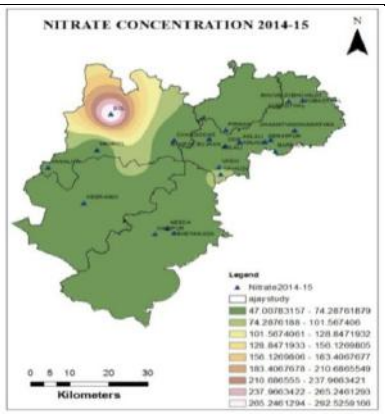

Figure 9 IDW Nitrate Concentration (2014-15)

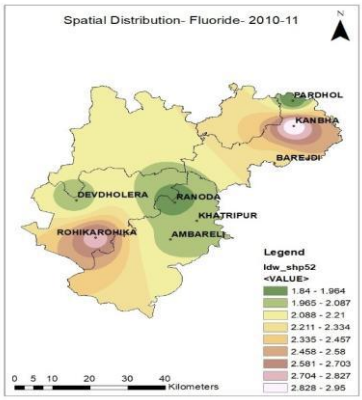

Figure 10 Fluoride Concentration (2010-11)

The above figure shows that the nitare concentration was found highest in bol village of sanand. Based on above study we can say that the nitrate concentration has found higher in the sanand tehsil throughout the year 2010-2015. Other tehsils of Ahmedabad are also highly contaminated by the nitrate concentration. Study shows that nitrate concentration sprayed in the district over a period of time.

Above results shows that the fluoride concentration is found highest as 4.23mg/l in rohika village of bavla. Daskroi,bavla, sanand are the region of higher fluoride concentration. After the analysis of the Fluoride Concentration (2011-12) the spatial distribution is made. The highest concentration was found as 2.33mg/l in rethal village of sanand. Sanand and bavla tehsil are highest contamination region of Ahmedabad district.

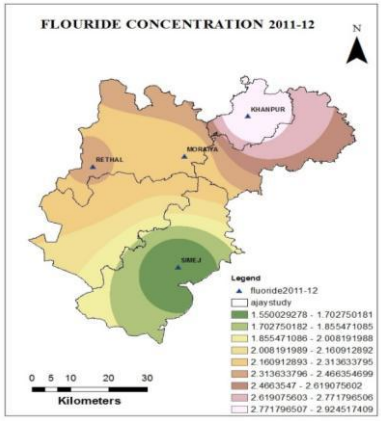

Figure 11 Fluoride Concentration (2011-12)

The nitrate concentration was found in higher amount in sanand, bavla, daskroi, dholka and Ahmedabad tehsil. This all area consist of industrial estate and GIDC. At the initial stage of industrial development in Ahmedabad regulations for effluent treatment and disposal were not provided due to which the industries did not treated the waste water and disposed the waste water nearby localities. This leaded to infiltration of this chemicals to the ground which further contaminates ground water.

Smaller industries dispose their effluent by landfill, which causes infiltration of effluent in ground over a period. Pollution in the form of aerosols present in the atmosphere reacts with the precipitation is exposed to ground. This contamination further infiltrates in the ground water and deteriorates the quality of water.

6 CONCLUSION:

In this research, spatial distribution of ground water contaminants with the help of geo informatics has been performed which gives better understanding to ground water quality in central region of Ahmedabad.

Nitrate concentration more than 45mg/l suggests nitrate pollution in ground water Study shows that high nitrate concentration in the central region of the Ahmedabad district exists.. This excess nitrate in ground water occurs due to use of nitrogen containing fertilizer, domestic and agriculture waste and manmade anthropogenic activities.(CENTRAL GROUND WATER BOARD, 2014-2015). Denitrification increases nitrate concentration in the soil, which deteriorates the quality of ground water.

Water with nitrate concentration higher than 45mg/l is hazardous to human kind.(B.I.S., 2012) Nitrate in higher concentration leads to diarrhea, stomach irritation and skin diseases. If infants and elders consume it, it can cause blue baby disease.

Most of the fluoride found in groundwater is result of the breakdown of rocks and soils or weathering and deposition of atmospheric particles. Most of the fluorides are slightly soluble and are present in groundwater in small amount. Main reason behind fluoride concentration in Ahmedabad district is due geogenic conditions.(CENTRAL GROUND WATER BOARD, 2014-2015)

Water conservation and management techniques can be used to improve the groundwater quality and prevention of water table depletion. Proper management of sewage waste and industrial effluent should be organized before disposal. Excessive use of fertilizes should be avoided.

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