



ASSESSMENT OF FLUORIDE IN GROUND WATER OF BULDHANA DISTRICT, MAHARASHTRA

Pradnya P. Jangle

Rahul V. Patil

Abstract

Quality of ground water in the study area is influenced by geological formations and anthropogenic factors. The changes in the quality of ground water respond to variation in physical, chemical and biological environment through which it passes (Mandeep Sing, 2003). The study area belongs to the drought prone area. Therefore ground water is the main source of drinking water. The presence of fluoride in drinking water at some places in the Buldhana district is beyond the permissible limit, it adversely affects the human body. The present study is based on the physiochemical analysis of ground water in which the correlation between fluoride and other physiochemical parameters has been done. The correlation matrix is prepared for showing the relationship between physical and chemical parameters of ground water.

Keywords: *Physiochemical, Fluorides, Concentration, Correlation.*

Introduction:

Water resources are an essential component of life on earth. As the history shows, these water resources are becoming more limited throughout the world. And consequently the demand for water is increasing with increasing population, as it is specially observed in the developing countries like India. In most of the parts of India, ground water is widely used for farming as well as drinking purposes. Especially in drought prone areas, it is the important source of drinking water. Today there is a need for good quality of water. Water quality is good when all the contents in it are present within the permissible limit. These contents may be deficient or above the permissible limit at different places. The quality of ground water is generally affected by the geology or naturally occurring rock minerals while some man-made causes like soil pollution and urban pollution also affect it. Hence, it is essential to analyze the quality of ground water to study mineral contents and quality parameters. Fluoride is one of the elements present in ground water. It is also beneficial to human health, but only when it is present in a standardized quantity. While fluoride becomes toxic when present in higher quantities and observed beyond its permissible limits. In this study, analysis of fluoride content in ground water of Buldhana district has been studied. Water samples from 31 places covering each tehsil in Buldhana district have been taken into consideration. The correlation analysis between fluoride (F⁻) and other physiochemical parameters like PH, EC, TDS, TH, Ca²⁺, Mg²⁺, Na⁺, K⁺, HCO₃⁻, Cl⁻, SO₄⁻, NO₃⁻ has been done for each of the 31 samples. Correlation & effect of fluoride content on each physiochemical parameter has been observed and a conclusion has been made accordingly.

Study Area:

Buldhana district is located between 19.510 to 21.170 N latitudes and 75.57 to 76.590E longitudes. It is bounded on the north by Madhya Pradesh state, to the east by Akola and Washim districts, to the south by Parbhani and Jalna districts, and to the west by Jalna and Jalgaon districts. Buldhana district is divided into 13 tehsils and covers an area of 9,640 sq. km.



Database and Methodology:

In this study, physiochemical data of ground water samples from Buldhana district has been studied. Data of 31 ground water samples from various parts of Buldhana district containing concentration of different chemicals such as fluoride (F⁻), Calcium (Ca²⁺), Magnesium (Mg²⁺), Sodium (Na⁺), Potassium (K⁺), Bicarbonate (HCO₃⁻), Chloride (Cl⁻), Sulfate (SO₄⁻), Nitrate (NO₃⁻) and other physiochemical parameters like pH, Electrical Conductivity (EC), Total Hardness (TH), Total Dissolved Solids (TDS) has been acquired by secondary sources like Groundwater Surveys and Development Agency (GSDA) and Central Ground Water Board (CGWB), Buldhana. Correlation has been made between fluoride and all above mention physiochemical parameters in order to understand their concentrations & relationship. Consider x and y are the two different variables, in this case physiochemical parameters, then coefficient of correlation (r) between these two variable can be represented by following formula:

$$r = \frac{\text{Cov}(x, y)}{\sqrt{s_x^2 * s_y^2}}$$

..... (1)

Where Cov(x, y) is the covariance of x and y while S²_x and S²_y are the simple variance of x and y, defined as

$$\text{Cov}(x, y) = \frac{\sum(X - \bar{X})(Y - \bar{Y})}{n - 1}$$

..... (2)

$$s_x^2 = \frac{\sum(X - \bar{X})^2}{n - 1} \quad \text{and} \quad s_y^2 = \frac{\sum(Y - \bar{Y})^2}{n - 1}$$

..... (3)

Where,

$$\bar{X} = \frac{\sum X}{n} \quad \text{and} \quad \bar{Y} = \frac{\sum Y}{n}$$

..... (4)

Linear relationship between above variable can be represented by:

$$Y = a + bX$$

(5)

Simple regression analysis has been done for establishing linear relationship between different physiochemical parameters.

Results and Discussion:

According to the study, pH value in samples ranges from 7.2 - 8.6, where highest pH 8.6 has been observed in Malkapur suburb and lowest pH 7.2 was at Sirsgaon village. According to Indian standards (IS) desirable limit for pH is in between 6.5-8.5. Positive correlation ($r=0.01$) has been observed between pH and fluoride (F^-) ions shown in figure 1. Electrical conductivity (EC) is the ability to conduct electricity of water, it is observed highest 6,400 $\mu\text{mhos/cm}$ at Malkapur suburb while lowest 550 $\mu\text{mhos/cm}$ at Washali village. According Bureau of Indian Standards (BSI) tolerable limit of EC is in between 1500-2000 $\mu\text{mhos/cm}$, and it is above tolerable limit at Malkapur suburb. In the study, Electrical Conductivity (EC) has shown positive correlation ($r=0.89$) with TDS, while no correlation with fluoride (F^-) ions has observed. Total dissolved solids (TDS) in samples are highest 3854 mg/l observed at Malkapur suburb and lowest seen 285 mg/l at Washali village, according to Indian Standards, permissible limit for TDS is in between 500-2000 mg/l. While it is above permissible at Malkapur suburb. TDS showed positive correlation with chloride (Cl^-) ions ($r=0.94$) and fluoride (F^-) ions ($r=0.04$) shown in figure 2. Total Hardness (TH) is the amount of salts present in water such as calcium and magnesium. TH is found highest 1135 mg/l at Chikhali suburb and lowest 55 mg/l at Bibi village of Lonar tehsil. According to BIS, permissible limit for TH is in between 300-600 mg/l. Water hardness is above permissible limit at Chikhali suburb. The amount of calcium (Ca^{2+}) is more 264 mg/l observed at Chikhali suburb and lowest 10 mg/l at Bibi village. While BIS permissible limit for Calcium is in between 75-200 mg/l. Calcium showed positive correlation ($r=0.60$) with Mg^{2+} and negative correlation with Fluoride. Magnesium ion (Mg^{2+}) is more 115 mg/l observed at Chikhali suburb and lowest 4 mg/l observed at Buldhana suburb. The BIS permissible limit for magnesium is 30-100 mg/l and it is above permissible limit at Chikhali suburb. Magnesium showed more positive correlation ($r=0.47$) with Nitrate (NO_3^-) and negative correlation ($r=-0.40$) with fluoride (F^-) shown in figure 3. Concentration of sodium ion (Na^+) is observed maximum 1150 mg/l at Malkapur suburb and minimum 29 mg/l found at Nimkhed village of Sangrampur tehsil, according to WHO health standard, presence of sodium should not exceed above 200 mg/l. And it was above permissible limit at many places in study area. Sodium (Na^+) showed positive correlation with chloride ($r=0.82$) as well as with fluoride (F^-) ions ($r=0.19$) shown in figure 4. Concentration of potassium (K^+) ions has been observed maximum 28 mg/l at Dhamangaon Bonde village of Motala Tehsil and no concentration at Bhendwad and Allewadi villages. Potassium (K^+) showed positive correlation ($r=0.66$) with Nitrate and negative correlation ($r=-0.03$) has observed with Fluoride (F^-). Concentration of Bicarbonates (HCO_3^-) has observed more 1074 mg/l at Allewadi village of Buldhana Tehsil while less observed 31 mg/l at wadi village. Bicarbonates (HCO_3^-) showed positive correlation ($r=0.31$) with Nitrate (NO_3^-), while it showed negative correlation ($r=-0.36$) with Fluoride (F^-). Chloride (Cl^-) concentration 1060 mg/l was highly observed at Malkapur suburb and it was lowest 11 mg/l at Nimkhed village. According to BIS permissible limit for chloride in drinking water is 250-1000 mg/l. Chloride showed positive correlation with Sulfate ($r=0.69$), Nitrate ($r=0.59$) and Fluoride ($r=0.16$) shown in figure 5. Concentration of sulfate (SO_4^{2-}) in study area was more 490 mg/l found at Palaskhed Chakka village of Sindkhed Raja tehsil and less observed at 7 mg/l at Nimkhed village. The BIS permissible limit for SO_4^{2-} is in between 200-400 mg/l. Sulfate (SO_4^{2-}) showed positive correlation ($r=0.43$) with Fluoride shown in figure 6. Concentration of Nitrate (NO_3^-) was maximum 580 mg/l at Malkapur suburb and no concentration of NO_3^- has observed at Washali, Amsari, Sangrampur, Bhendwad and Allewadi villages. BIS permissible limit for NO_3^- in drinking water is in between 200-400 mg/l. It showed negative correlation (-0.20) with fluoride. Concentration of fluoride (F^-) in the ground water of study area was highest 11.20 mg/lit observed at Shingaon Jahngir suburb and there was no fluoride concentration in some villages. Correlation coefficients between all the physiochemical parameters are shown in the table 1. And Fluoride (F^-) concentration in ground water

from all the villages in study area has been shown in table 2.

Village	Fluoride (mg/l)	Village	Fluoride (mg/l)
Jawla	0.99	Bibi	0.69
Sirsgaon	0.62	Gundha	0.84
Devthana	0.66	PalskhedChakka	9.60
Washali	0.45	Bharosa	0.27
HingnaKaregaon	0.55	JambulDhaba	0.55
Nimkhed	0.57	Pimapgaon Devi	0.80
Wadi	0.00	DhamangaonBodhe	0.55
Amsari	3.60	Deolgaon (Mahi)	4.76
Mohegaon	2.60	Shingaon Jahngir	11.20
Urha	1.07	Chikhali	0.32
Malkapur	1.30	Brahampuri	0.39
Buldhana	2.07	Sangrapur	0.00
Dhad	0.87	JalgaonJamod	2.00
Anjani Bk.	0.63	Bhendwad	0.00
Sakharkherda	0.25	Allewadi	0.00
Kalyanan	0.79	79	

Conclusions:

1. Study reveals that fluoride concentration is associated with pH, TDS, Sodium, Chloride and Sulfate as it showed positive correlation with all these parameters and it showed negative correlations with Total Hardness, Calcium, Magnesium, Bicarbonates and Nitrates (table 1).
2. In the study area, fluoride concentration was observed above 1.5 mg/l in some places like Amsari, Mohegaon, Urha, Buldhana, Palsakhed Chakka, Deolgaon, Shingaon Jahngir and Jalgaon Jamod and it is above its permissible limits set by Bureau of Indian Standards (BIS).
3. Other physiochemical parameters in ground water like EC, TDS, Chloride, Sodium, Calcium and Nitrate was also above its permissible limits at several places in the study area.
4. A water harvesting plan is suggested in order to dilute the water, for minimize the excess concentration of fluoride and fluoride related health issues.

References:

1. Mandeep singh, Samanpret Kaur, S. S. Sooch, J. IPHE (2003)
2. IPCS (1984) Fluorine and fluorides. Geneva, World Health Organization, International Program on Chemical Safety (Environmental Health Criteria 36)
3. Kaminsky, L.S. et. al. (1990) Fluoride: benefits and risks of exposure (review) Critical review in oral biology and medicine, 1:261:-281.
4. Murry J.J. [Ed] (1986) Appropriate use of fluorides for Human Health, World Health Organization (WHO), Geneva.
5. US DHHS (1991) Review of fluoride. Benefits and risks. Report of the Ad Hoc committee on Fluoride of the committee to coordinate Environmental Health and Related Programs. Washington DC, US Department of health and Human Services, Public Health Service.
6. US EPA (1985a) Drinking water criteria document on fluoride. Washington DC, US Environmental Protection Agency, Office of Drinking Water (TR – 823-5).
7. WHO (1993) Guidelines for drinking water quality, 2nd ed. Vol. 1.
8. WHO (1994) Fluoride and oral health, Report of WHO Expert Committee on oral health status and fluoride use. Geneva World Health Organization

Table.1: Fluoride Content in Ground water samples of villages in study area

Parameters	pH	EC	TDS	TH	Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺	HCo ₃ ⁻	Cl ⁻	So ₄ ⁻	No ₃ ⁻	F ⁻
pH	1.00												
EC	0.11	1.00											
TDS	0.12	0.97	1.00										
TH	0.12	0.55	0.54	1.00									
Ca ⁺⁺	-0.32	0.62	0.64	0.93	1.00								
Mg ⁺⁺	-0.19	0.32	0.26	0.87	0.60	1.00							
Na ⁺	0.35	0.81	0.84	0.02	0.19	-0.20	1.00						
K ⁺	0.18	0.48	0.48	0.32	0.17	0.27	0.35	1.00					
HCo ₃ ⁻	0.31	0.40	0.40	0.24	0.14	0.34	0.37	0.08	1.00				
Cl ⁻	0.05	0.91	0.94	0.45	0.59	0.13	0.82	0.44	0.18	1.00			
So ₄ ⁻	-0.22	0.54	0.58	0.11	0.32	-0.21	0.60	0.13	-0.19	0.69	1.00		
No ₃ ⁻	0.18	0.72	0.70	0.62	0.62	0.47	0.45	0.66	0.31	0.59	0.13	1.00	
F ⁻	0.01	0.00	0.04	-0.29	-0.16	- 0.40	0.19	-0.03	-0.36	0.16	0.43	-0.20	1.00

Table.2: Correlation Coefficient of physiochemical parameters at different places.

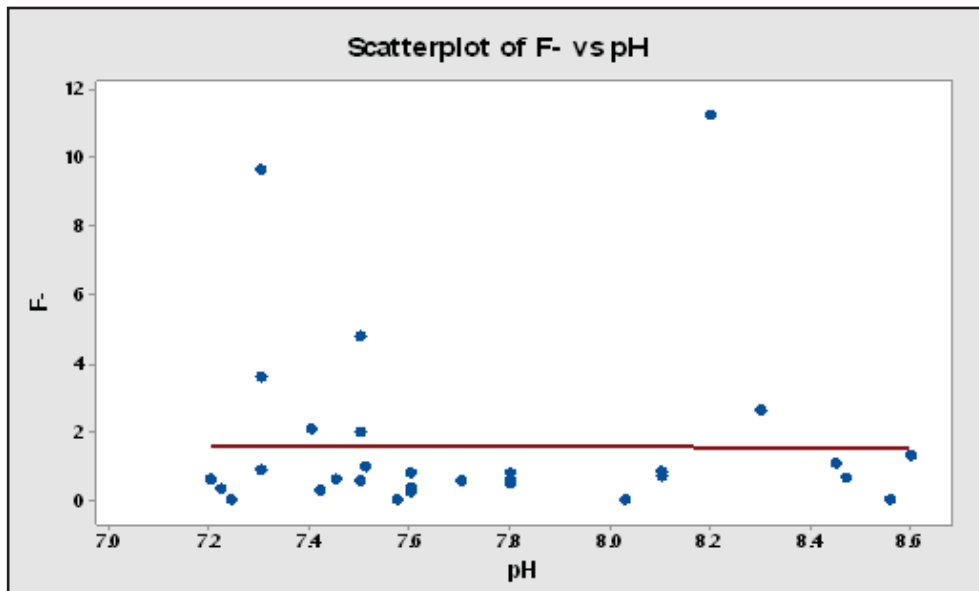


Figure.1

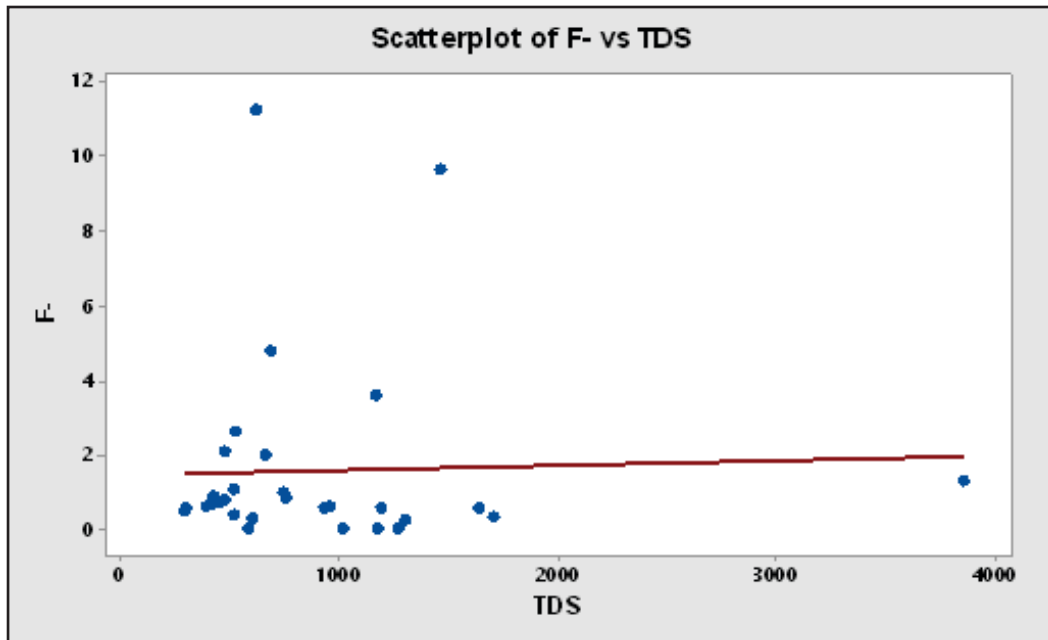


Figure.2

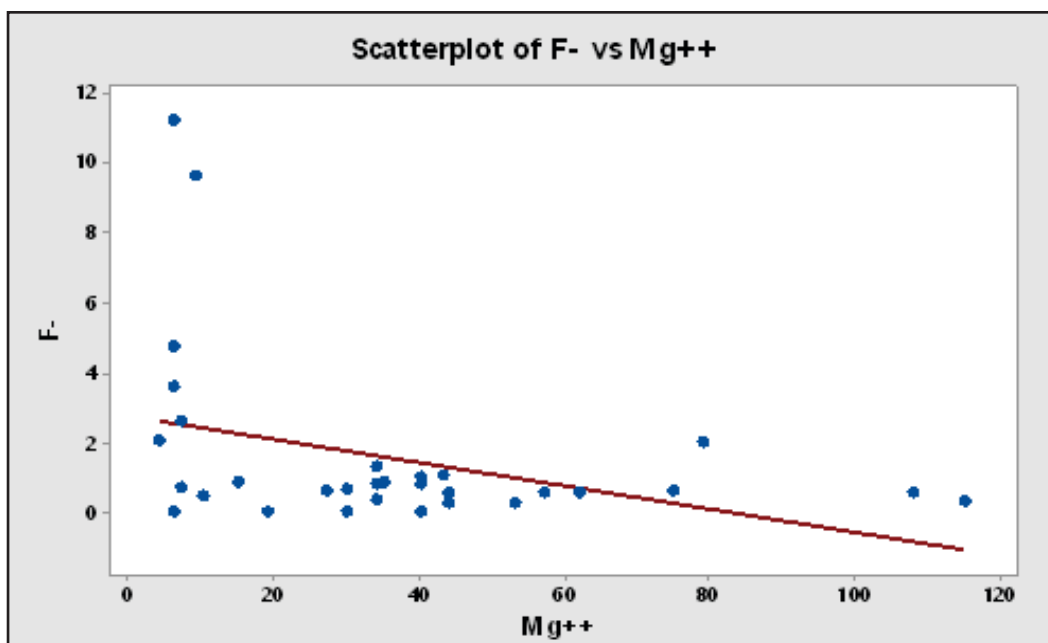


Figure.3

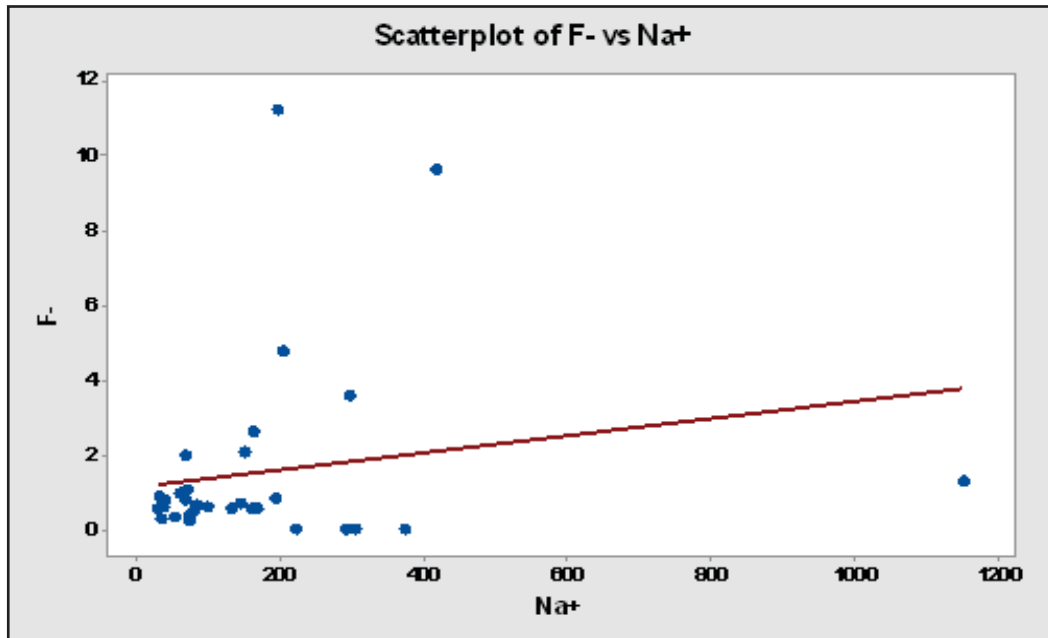


Figure.4

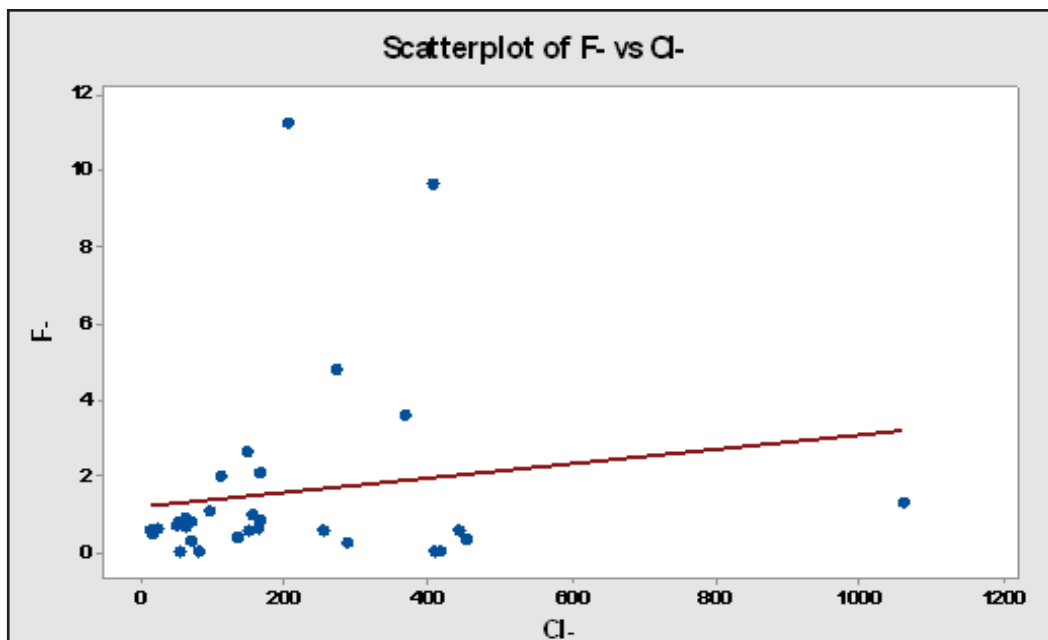


Figure.5

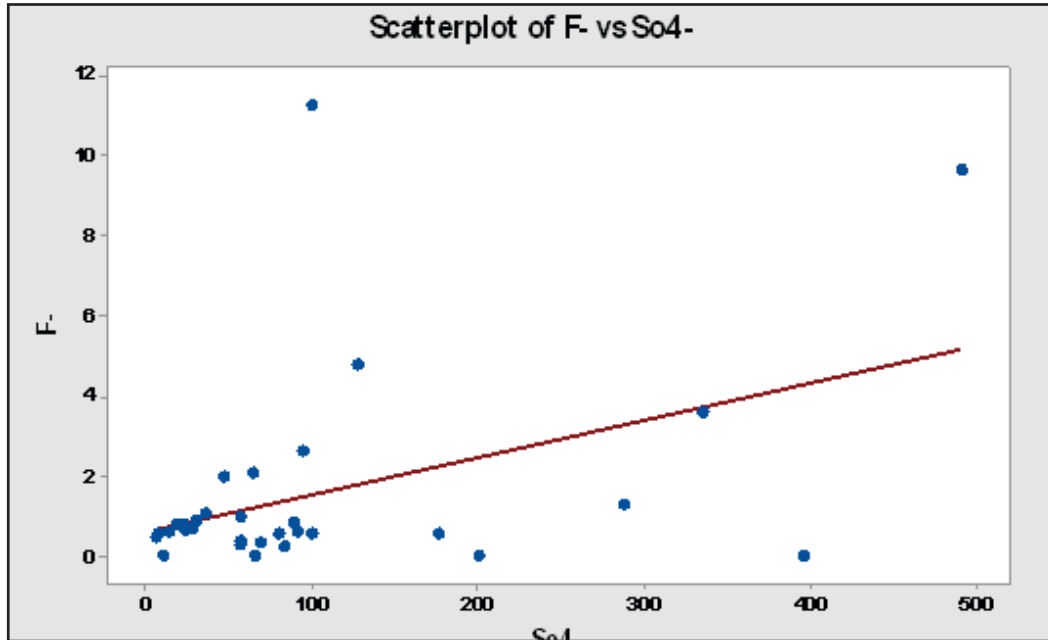


Figure.6

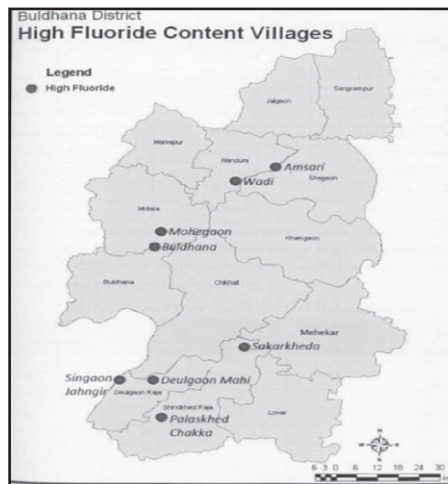


Figure.7

***Dr. Mrs. Pradnya P. Jangle**
Head & Associate Professor,
PG & Research Dept. of Geography,
M. J. College, Jalgaon, MS.

****Mr. Rahul V. Patil**
Dept. of Geography,
PSGVM'S College, Shahada,
Dist. Nandurbar, MS.