

# Fluoride Contamination in Ground Water in Parts of Barmer District, Rajasthan, India

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**ABSTRACT:** Fluoride is an element which has a significant effect on human health. Fluoride is essential for teeth at low concentration as 1 mg/L. It prevents and reduces the tooth decay. Its concentration should not be less than 0.5mg/L. It may cause of tooth decay. High concentration of fluoride in water is also harmful because it causes dental fluorosis, skeletal fluorosis and osteoporosis. Fluoride concentration has been a big problem all around the world. The continuous use of high concentration of fluoride water is toxic to human plants and animals. Ground water is a main source of fluoride. The sources of fluoride in ground water are natural rocks, minerals etc. In hotter climate like Barmer the intake of water is very much so intake quantity of fluoride is also very much. This paper provides a survey of fluoride concentration in different regions of Barmer. Most of the people of this area suffer from dental and skeletal problem due to using water of high fluoride concentration. The fluoride concentration in this region varies between 0.1-20 mg/l. So its need to aware people about harmful effects of using water of high concentration of fluoride, rain water harvesting and defluoridation techniques of water.

**KEYWORDS:** Fluoride, ground water, fluorosis, Barmer.

## I. INTRODUCTION

Water is very important for living organisms without it life is not possible. We always thought that it is available in abundance in nature. But all available water is not useful for us. It depends on the physical, chemical and biological characters of water that for which purpose it can be used like for industrial, domestic or drinking purpose. Percentage of ground water found in nature is very less. Surface water and ground water are the sources of fresh water. But in rural areas the source of drinking water is ground water. Groundwater may contain excessive amount of fluoride which may not be used for drinking purposes. [1] The desirable limit of fluoride in drinking water is 0.5-1.5 mg/L. [2] But now a day's fluoride contamination increases in the ground water. Due to this problem of dental and skeleton problems also increase. The many states of India like Andhra Pradesh, Rajasthan, Bihar, Gujarat, Madhya Pradesh, Tamil Nadu and Uttar Pradesh are facing these problems. In this paper, Fluoride concentration in ground water of Barmer district is studied.

There are many intrusive rocks are present at the basement of this district. It consists of Jalore and Siwana Granite and Malani rhyolite and granite followed by Mesozoic and tertiary formation consisting of sandstone, shale, and conglomerate. These formations are overlain by Pleistocene to recent alluvium consisting mainly clay, sand and silt. The paper contains four sections. Section II gives a view of related work while Section III describes methods and materials followed by section IV and V explaining result and discussion with prevention and control. Finally, section VI concludes the findings.

## II. RELATED WORK

Subba Rao, N (2003) classified of  $F^-$  concentrations for drinking water as: Low:  $<60 \text{ mg l}^-$ ; Moderate -  $0.60\text{-}1.20 \text{ mg l}^-$  and high-  $>1.20 \text{ mg l}^-$ . WHO guidelines for drinking water have fixed 1.5 mg/l fluoride as the higher limit. However, India reduced it to a range of 1.0 to 1.2 mg/l with a rider that less is better (Bureau of Indian Standards [BIS] 10500,

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2012). It was attributed to extreme climatic conditions and deficient in essential nutrients (calcium, vitamins C, E, and antioxidants) deficient diet in rural India. Fluoride in drinking water is known for both beneficial and detrimental effects on health. The intake of fluoride in permissible limits of 0.5–1.0 mg/l is known to be beneficial in production and maintenance of healthy teeth and bones, (WHO, 2005), while excessive intake of fluoride causes dental and skeletal fluorosis.

The situation in Rajasthan is a cause of concern as 3280 Villages in almost all districts have  $F^-$  concentration  $> 3.0$  mg/l much above set standards of WHO as well as India. Considering health impact associated with high fluoride intake, villages have been categorized into following categories:

- (1) Safe: Fluoride  $< 1.5$  mg/l,
- (2) Less problematic: Fluoride  $> 1.5$  to  $3.0$  mg/l,
- (3) Problematic: Fluoride  $> 3.0$  to  $5.0$  mg/l, and
- (4) Highly problematic: Fluoride  $> 5.0$  mg/l.

Studies also indicate that higher fluoride concentration decreased hardness in ground water samples while an increase in alkalinity was observed.

### III. METHODS AND MATERIALS

Study area:

Barmer is located in the western part of Rajasthan and forms a part of desert. The total area of Barmer district is 28,387  $km^2$ . It is located between the 24, 58' to 26, 32'N latitude and 70.05'to 72, 52' E longitude. The temperature difference is very high in various seasons. In summers temperature reaches up to  $46^{\circ}C$ - $51^{\circ}C$ .In winters temperature drops to  $0^{\circ}C$ .The average rainfall of Barmer district is 277mm. So this area feels deficiency of ground water. (Figure 1)

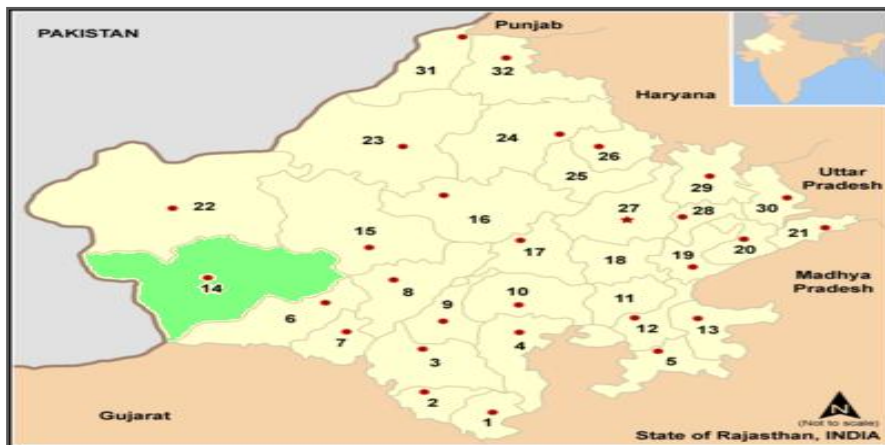


Fig.1 Location of Barmer District, Rajasthan, India

Sampling & Analytical Methods:

80 water samples are collected from different areas of Barmer district. All are from tube wells locating different locations of the Barmer district. After taking samples they are collected in polyethylene bottles. Then they are filtered through whatman filter paper 42. Fluoride was determined by using ion selective electrode. [3] pH is determined by using digital pH meter. Carbonate, Bicarbonate, Calcium and Magnesium ions are determined by using titration method.

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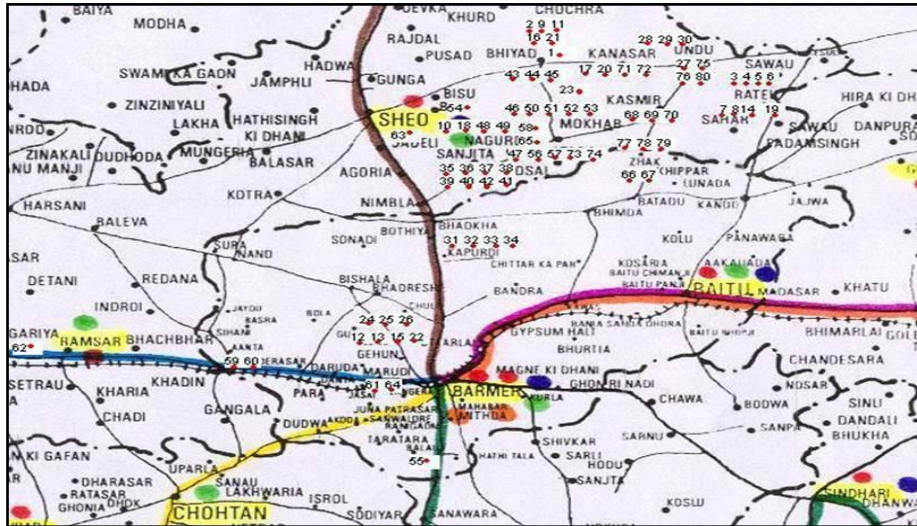


Fig.2 Location of samples, Rajasthan, India.

Samples of ground water were collected from various locations of Barmer district of Rajasthan and are available in figure 2.

## IV. RESULT AND DISCUSSION

All the ground water samples collected from the Barmer district were clear without any visible colour, odour and turbidity. The fluoride concentration in ground water varied greatly in different sampling sites of study area.

Table 1 Physico-Chemical Parameters of Ground water samples of Barmer District, Rajasthan

S.No.	Location	F <sup>-</sup> mg/L	pH	EC (µS/cm)	S.No.	Location	F <sup>-</sup> mg/L	pH	EC (µS/cm)
1	Gudothal TW1	2.3	7.0	6380	41	Sajintada TW7	1.8	8.6	2350
2	Budatala TW1	1.3	7.7	2340	42	Sajintada TW8	0.9	8.6	2910
3	Ratadi TW1	2.9	7.5	2420	43	Bhiyand TW1	0.8	8.6	2740
4	Ratadi TW2	2.1	7.7	3480	44	Bhiyand TW2	10.05	8.6	2620
5	Ratadi TW3	1.4	7.2	2750	45	Bhiyand TW3	40	8.6	2820
6	Ratadi TW4	20.10	7.4	5740	46	Mokhab TW1	0.8	8.6	2300
7	Ratadi TW5	1.7	7.9	1600	47	Nagarda TW3	0.9	8.6	2200
8	Ratadi TW6	20.10	7.4	6150	48	Nagarda TW4	0.7	8.4	5300
9	Budatala TW2	1.4	7.9	2080	49	Nagarda TW5	10.05	8.6	2800
10	Nagarda TW1	1.5	7.7	4330	50	Mokhab TW2	0.1	8.3	4000
11	Budatala TW3	1.4	7.8	2130	51	Mokhab TW3	10.05	8.4	3300
12	Gehum road TW1	0.8	7.2	2240	52	Mokhab TW4	10.05	7.4	2000
13	Gehum road TW2	0.7	7.4	1990	53	Mokhab TW5	0.9	8.7	2200
14	Ratadi TW7	1.4	7.8	3300	54	Visukalla TW1	0.9	8.7	2700
15	Gehum road TW3	0.6	7.1	1960	55	Balai TW1	10.05	8.5	2900

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16	Budatala TW4	1.2	7.7	1320	56	Nagarda TW6	0.5	7.7	3400
17	Kanasar TW1	1.5	7.9	4910	57	Nagarda TW7	0.9	8.4	3300
18	Nagarda TW2	20.10	7.6	3110	58	Nagarda TW8	2.6	7.8	1800
19	Ratadi TW8	2.4	7.9	1610	59	Hathma village TW1	0.9	8.0	2300
20	Kanasar TW2	1.5	7.8	3920	60	Hathma village TW2	0.9	8.6	2300
21	Budatala TW5	1.4	7.5	3650	61	Gov.well marudi	10.05	7.0	4300
22	Gehum road TW4	0.7	7.1	1810	62	Gagaria HP	2.9	7.8	3900
23	Semusar TW1	1.6	7.6	5190	63	Shiv pond	1.9	7.5	5100
24	Gehum road TW5	0.8	7.2	1820	64	Joshiyon Ka bass HP	2.4	7.8	3900
25	Gehum road TW6	0.7	8.0	2200	65	Naya Nagarda Pond	10.05	7.0	4300
26	Gehum road TW7	0.7	7.2	1830	66	Jhakh TW1	20.10	8.0	5300
27	Undu TW1	10.05	8.4	3340	67	Jhakh TW2	1.1	8.1	2500
28	Rajebera TW1	20.10	8.6	2040	68	Kashmir TW1	1.4	8.4	3300
29	Rajebera TW2	3.3	8.5	2850	69	Kashmir TW2	1.7	8.4	2800
30	Rajebera TW3	2.1	8.5	5320	70	Kashmir TW3	0.4	8.6	2800
31	Bhadka TW1	1.2	8.6	2620	71	Kanasar TW1	20.10	8.7	2700
32	Bhadka TW2	1.3	8.6	1960	72	Kanasar TW2	0.1	7.2	4200
33	Bhadka TW3	2.4	8.4	4070	73	Nagarda TW9	10.05	8.5	2900
34	Bhadka TW4	1.1	8.7	2690	74	Nagarda TW10	0.6	8.0	5300
35	Sajintada TW1	10.05	8.7	2220	75	Undo TW2	0.6	7.8	3900
36	Sajintada TW2	0.9	8.6	2280	76	Undo TW3	0.3	8.4	3300
37	Sajintada TW3	1.1	8.6	2470	77	Ratau TW1	0.4	7.6	4500
38	Sajintada TW4	1.2	8.6	2310	78	Ratau TW2	0.3	7.5	1600
39	Sajintada TW5	10.05	8.6	2660	79	Ratau TW3	0.3	7.8	1000
40	Sajintada TW6	1.1	8.6	2970	80	Undo TW4	30	7.4	3600

The results of fluoride ion concentration, pH, EC in ground water are presented in Table 1 and 2.

Table 2 Statistical values of different Parameters in various locations of Barmer District, Rajasthan

Parameter	maximum	mean	Average	Standard Deviation	Range
Fluoride	20.1	4.33	4.71	7.54	0.1-20.1
pH	8.7	7.2	8.01	0.54	7.0-8.7
EC	6380	2517.5	3093.75	1188.44	1000-6380

Table 1 gives details of actual values of fluoride ion concentration, pH, EC in ground water of the area while Table 2 describes mean, average and standard deviation values of these parameters.

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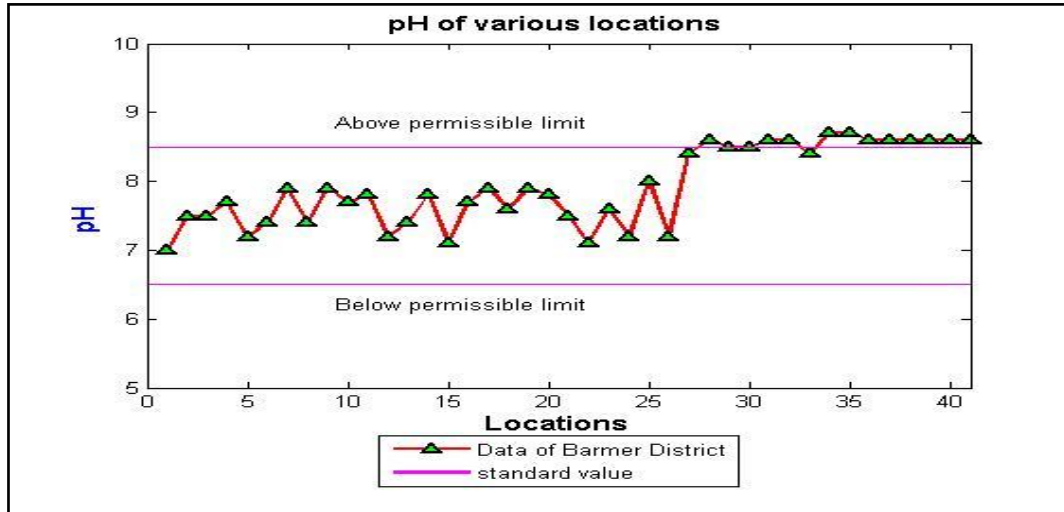


Fig. 3 pH Concentrations of Barmer District, Rajasthan

Hydrogen ion concentration (pH) of the ground water is varying from 7 to 8.7 with an average value of 8.01. These values are within the permissible limit prescribed by ICMR (as 7.0-8.5) and WHO (as 6.5-9.5). (Figure 3)

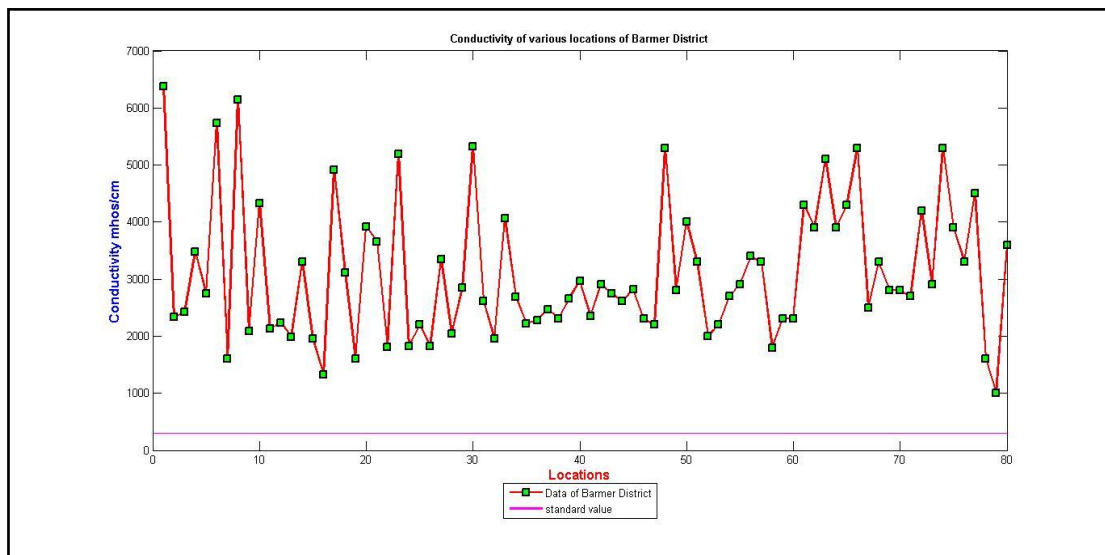


Fig. 4 EC at different locations of Barmer District, Rajasthan

Electrical conductivity values are observed between 1000 and 6380  $\mu\text{S}/\text{cm}$  with a mean of 3093.75  $\mu\text{S}/\text{cm}$ . The EC values of samples exceed to the permissible limit prescribed by WHO as 1400  $\mu\text{S}/\text{cm}$ . (Figure 4)

In this study area fluoride concentration was determined and it was also found that fluoride contamination is natural here due to fluoride containing rocks. The fluoride concentration in study area varies between 0.1mg/l to 20 mg/l. According to Indian Standard specification [4] the desirable range of fluoride concentration in drinking water is from 0.6-1.2 mg/l.



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Table 3 Classifications of ground water in Barmer District, Rajasthan

S. No.	Categories	F Range (mg/L)	Effect on human health	Representing samples	Percentages
1.	Low	0.1-0.5	Dental caries	50,70,72,76,77,78,79	15%
2.	Permissible	0.5-1.5	Prevents tooth decay	2,5,9,10,11,12,13,14,15,16,17,20,21,22,24,25,26,31,32,34,36,37,38,40,42,43,46,48,49,53,54,56,57,59,60,67,68,74,75	45%
3.	High	1.5-4.0	Dental fluorosis	3,4,7,23,29,30,33,41,58,61,62,63,64,69	18%
4.	Very high	>4.0	Pain in neck bones and back and crippling fluorosis	1,6,8,18,19,27,28,35,39,44,45,51,52,55,65,66,71,73,80	22%

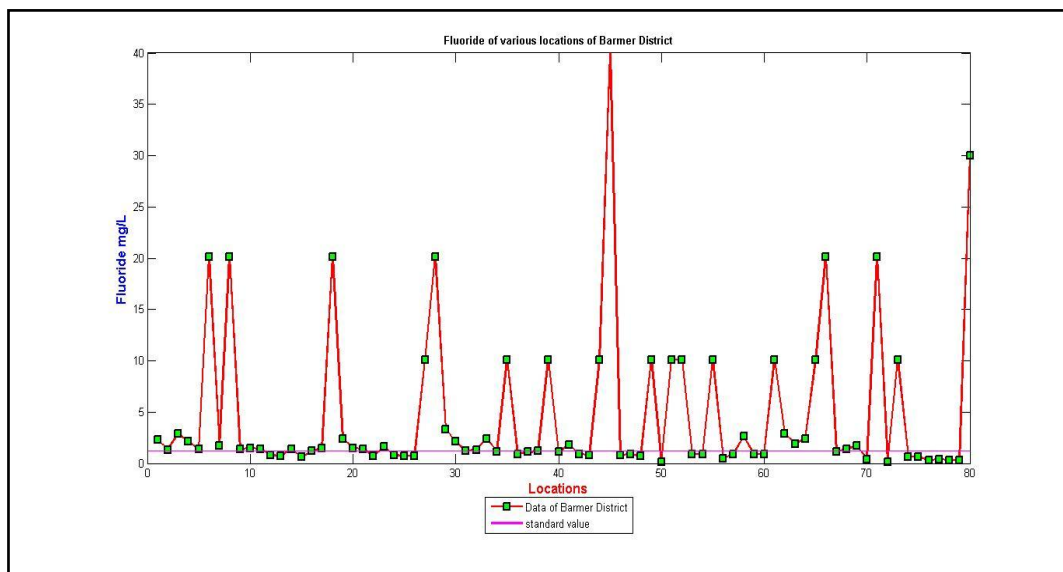


Fig. 5 Fluoride concentrations of different locations of Barmer District, Rajasthan.

Water of fluoride concentration below 0.6mg/l and above 1.2 mg/l is not permissible. But according to BIS the maximum limit can be extended up to 1.5 mg/l. So water samples can be classified in four groups low (0.1-0.5 mg/l), permissible (0.5-1.5 mg/l), high (1.5-4 mg/l), very high >4.0 mg/l. [5] (Table 3, Figure 5)

### Pie Graph Analysis:

By analysis of result it was found that 45% water samples were fit for use as a drinking purpose. 15% water samples have fluoride concentration below 0.6 mg/l so they were unfit for use as a drinking water and 22% of water samples have very high value of fluoride concentration so they cannot be used for drinking purposes. [6] So we can say that on the basis of fluoride concentration only 45% water samples are suitable for drinking purpose and 55% not because of very low or very high fluoride concentration. So in this area treatment of water as defluoridation is urgently required. A government attention is also necessary in this field. (Figure 5)

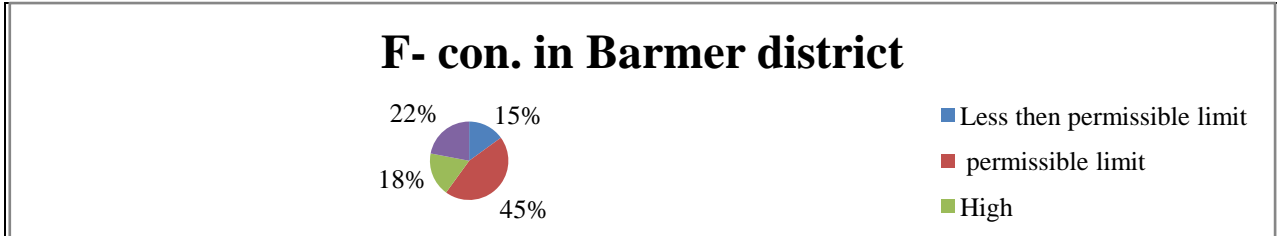


Fig 6 Pie Graph Analysis of Fluoride Ion concentration in Barmer District

The negative correlations were found in between pH & EC and the positive correlations were found in between pH & F<sup>-</sup> and F<sup>-</sup> & EC. (Figure 6)

**Correlation Matrix:**

The correlation study has been used for the measurement of the strength and statistical significance of the relation between two or more water quality parameters and is helpful tool for the promotion of research activities [7]. The correlation coefficients (r) were calculated and correlation matrix was obtained. The values of correlation coefficients are listed in Table 4.

Table 4 Correlation matrix (Spearman's Rank Correlation Coefficient)

Parameters	F <sup>-</sup>	pH	EC
F <sup>-</sup>	1	.031	0.184
pH		1	-0.209
EC			1

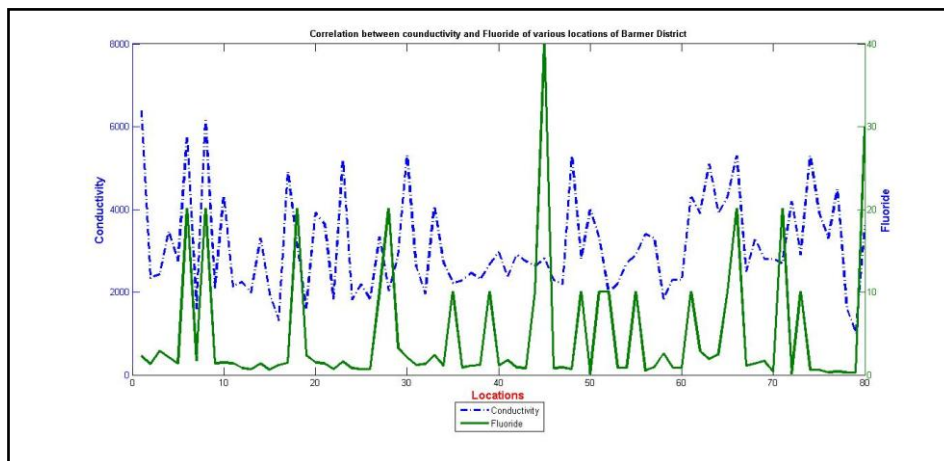


Fig 7 Correlation between EC and F in Barmer District, Rajasthan.

Strong positive correlation was found between conductivity and fluoride which is shown in figure 7 which indicates conductivity effects the fluoride concentration in ground water.

**V. PREVENTION AND CONTROL**

Villagers of fluoride affected areas are advised to this water for drinking and cooking purposes. It is advised to administration that they should defluoridate the water before supply in these areas using standard techniques like

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Nalgonda technique [8] and Nagpur technique [9]. Villagers may use domestic defluoridation filter to minimize fluoride level in drinking water. Consumptions of high concentration of fluoride contaminated water, hot climate, illiteracy, lack of awareness about the quality of water are some causes of diseases in these areas. It is recommended to supply water from other sources or treated water to the affected areas by the government agency. The villagers should be educated through awareness camps on health, sanitation food nutrition and water supply.

### VI. CONCLUSION

Most 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. The excess fluoride concentration in the study area may be attributed to the geological formation of that particular area and rapid ground water depletion. The fluoride concentration in this region varies between 0.1-40 mg/l. So its need to aware people about harmful effects of using water of high concentration of fluoride, rain water harvesting and defluoridation techniques of water. The water in the study area is not suitable for domestic consumption without prior treatment.

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