

## **Challenge of Fluorosis**

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### **ABSTRACT**

Complications attached with existence of fluoride above permissible limits in drinking water, a burning issue in many parts of India, is well reported. There is beneficial as well as harmful effect of Fluoride on human health. Skeletal or dental fluorosis or both can be the result of sustained intake of fluoride above 1.5mg/l for a prolonged duration by means of water, food or air. Disastrous impact, like permanent crippling for entire life, can also be the result of fluoride presence in markedly high concentration in drinking water. Fluorosis is an irreversible and incurable ailment, the only remedy for which is prevention only. Present day it has threatening impact on health in numerous parts of India as well as the world. In the paper, an attempt has been made to identify sources of fluoride, effect on human health and to develop an approach to deal with fluorosis in the Rae Bareli District.

Keywords: Ground water, SPADNS method, Fluoride, Fluorosis.

### **INTRODUCTION:**

Water covers nearly three-fourth of our Earth's surface and is the most vital component for existence of all living beings. Although present in abundance, not all the water is fit for drinking hence there arises the problem of paucity of drinking water. The existence of excessive fluoride ion, above permissible limits, is a matter of great concern from public health point of view. Natural, as well as man-made causes<sup>1</sup> are responsible for occurrence of fluoride pollution.

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Fluoride, the lightest member of halogen family, displays unique properties much varied as compared to other halogens. Fluoride is present as a common element in the earth's crust, in the form of rocks and minerals. Calcium fluoride ( $\text{CaF}_2$ ) is considered as a minor ingredient of natural waters, but it is one of the most important constituents in determining the appropriateness of water for drinking purposes. For healthy growth of teeth, consumption of 1mg/l per day is very much essential, but level exceeding the permissible limit of 1.5mg/L can prove fatal to health<sup>2</sup>. A major geo-environmental problem, these days, in many parts of the world is definitely the Fluoride contamination of ground water and its toxic effects observed even if consumed in minute quantities. Most of the states in India are facing severe problems due to fluoride in ground water<sup>3,4</sup>

Fluoride can have both constructive and destructive impact on human health depending on its intake quantity as a constituent in food and water. The major source for fluoride ingestion is generally the drinking water, which caters to 75-90 % of the day to day consumption.<sup>5</sup> The amount of fluoride in potable water is the major source for monitoring daily fluoride ingestion. Besides the fluoride concentration in drinking water, sum of other sources for all ingested fluoride also contribute towards ill effects on health. Therefore, consumption of water with 1.0 mg/L fluoride in a warm climate, due to larger water intake, might have negative impact on health, while the same concentration in a temperate climate might show positive effect.

Fluorine, being highly electro-negative, easily binds with the positively charged calcium ions present in bone and teeth. Therefore, if taken in excess, fluoride adversely affects the bones and teeth. In large quantities fluoride can also affect the thyroid gland and kidneys and even cause death in extreme cases.<sup>6</sup>

### **Positive health effects**

Micro quantity of fluoride can have a boosting effect on our health. According to WHO, drinking water should preferably contain 0.5-1.0 mg/L fluoride, because it assists in preventing dental caries. This intake limit is specifically very effective for children who are at the stage of developing their teeth.<sup>8</sup> Fluoride will still help to shield the completely developed teeth. Teeth that have been attacked by dental caries can be repaired with the help of fluoride which dissolve in saliva. Fluoride can also bind to the surface of the teeth and when needed, be

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released to help and protect the teeth. With the assistance of fluoride, the metabolism of the bacteria that attack the teeth is retarded and the surface tension is lowered, making it more difficult for plaque, colonies of bacteria, to bind themselves.<sup>9-11</sup>

Bones become very delicate, brittle and break easily in a disease known as Osteoporosis. Fluoride affects the enzyme that controls the formation and degradation of bone, therefore can be used to treat this deadly illness, which would result in quicker production than degradation finally leading to less fragile bones.<sup>12</sup>

### **Negative health effects:**

Fluoride, like any other substance, is harmful in too large doses and the extent of severity depends on the amount ingested over a long and continuous period of time leading to chronic fluoride poisoning or fluorosis. The initial symptom of fluorosis is usually mottling of teeth, starting with white spots which turn to yellowish and finally brownish with passage of time and greater exposure to fluoride. These are the common symptoms appearing on consumption of water containing 1.1-2.0 mg/L fluoride. In case of fluoride concentration exceeding 2.5 mg/L, rough enamel with dark brownish mottling will start spreading throughout the teeth. Deformation of bones, skeletal fluorosis, can be observed in extreme cases, when potable water has a fluoride concentration of 3 to 6 mg/L. The enzymes controlling bone formation and degradation are affected by fluoride and the balance is perturbed. This leads to a situation where the bones start hardening and their density increases. In severe cases excess bone tissue will be deposited, leading to difficulties in bending joints as well as the spinal column, which is a very painful situation.<sup>12</sup>

When the fluoride concentration in drinking water reaches 50 mg/L there is a risk of thyroid changes, at 100 mg/L there is risk of growth retardation, values above 125 mg/L leads to a risk of kidney changes and an acute dose of 2.5-5.0 g will lead to death (Table 1).

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**Table 1: Effect of different doses of fluoride.<sup>7</sup>**

<b>Concentration or dose of fluoride</b>	<b>Medium</b>	<b>Effect</b>
2 parts per 1000 million	Air	Injury to vegetation
1 ppm	Water	Reduction of Dental caries
2 ppm or more	Water	Mottled enamel
5 ppm	Water	No osteosclerosis
8 ppm	Water	Osteosclerosis 10%
20 to 80 mg/day or more	Air or Water	Fluorosis (Crippling)
50 ppm	Water or Food	Thyroid changes
100 ppm	Water or Food	Retardation in Growth
More than 125 ppm	Water or Food	Kidney changes
2.5 to 5.0 g	Acute dose	Death

\* ppm equals to the mg/l.

**Table 2: Number of Districts in various States of India known for widespread cases of Fluorosis**

<b>State</b>	<b>No. of Districts</b>
<b>Assam</b>	<b>02</b>
<b>Andhra Pradesh</b>	<b>17</b>
<b>Bihar</b>	<b>09</b>
<b>Delhi</b>	<b>04</b>
<b>Gujarat</b>	<b>All Except 1</b>
<b>Haryana</b>	<b>12</b>
<b>Jammu &amp; Kashmir</b>	<b>01</b>
<b>Karnataka</b>	<b>03</b>
<b>Kerela</b>	<b>03</b>
<b>Maharashtra</b>	<b>10</b>
<b>Orissa</b>	<b>03</b>
<b>Punjab</b>	<b>13</b>
<b>Rajasthan</b>	<b>All except 1</b>
<b>Tamil Nadu</b>	<b>08</b>
<b>Uttar Pradesh</b>	<b>07</b>
<b>West Bengal</b>	<b>04</b>

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### **STUDY AREA:**

The district from Uttar Pradesh taken for study is Rae Bareli having population 28, 72,330 according to 2001 census. Height of Rae Bareli District from mean sea level is 120.4 meter.

### **Morphometric feature of Rae Bareli:**

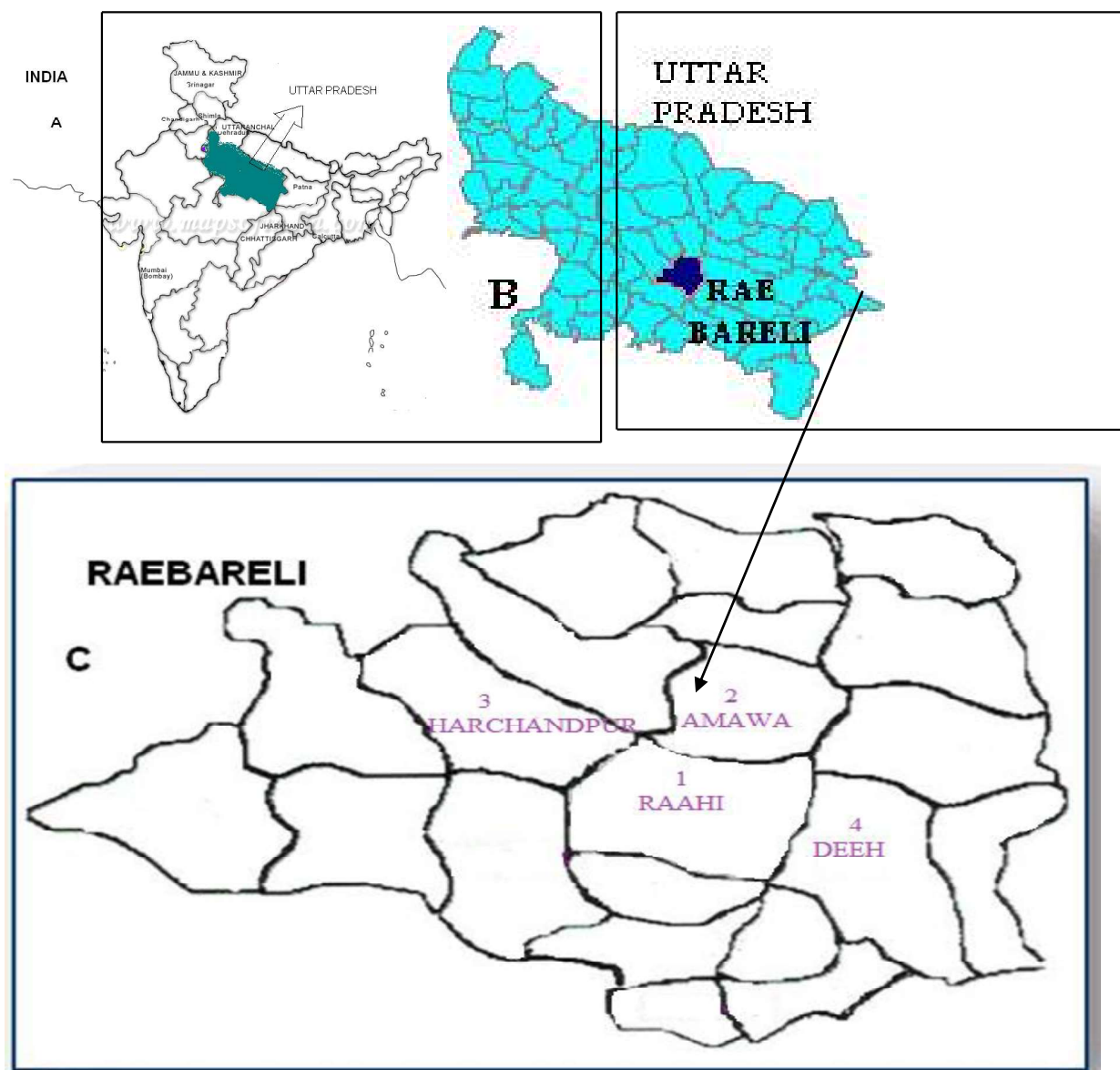
- Altitude                      1082.30 m (1350 feet)
- Latitude                      25° 49' 00''
- Longitude                    81° 34' 00''

### **Meteorological data:**

- Rainfall                      1200mm
- Humidity                      48%

**Rock Type**                      Basalt

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**Figure 1: Location of selected block for Fluoride Estimation**

Rae Bareli is divided into 7 Tahseels namely Rae Bareli, Salon, Unchahar, Dalmau, Maharajganj, Tiloi and Lalganj. These 7 Tahseels are with 21 Blocks out of which 4 Blocks have been selected for sampling. From each blocks 3 villages are randomly selected for the present study.

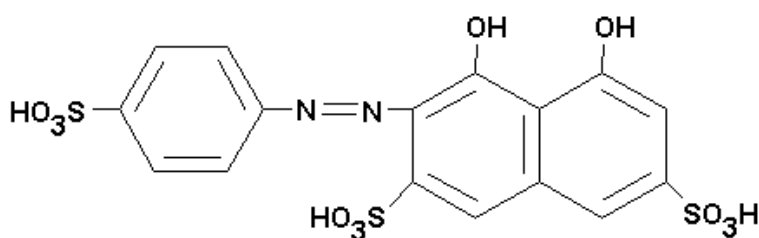
### **MATERIALS AND METHOD:**

Total 36 ground water samples of Hand pump and Tube well from 12 selected villages (using ground water for potable and agriculture use) of Raebareli district were collected using pre-

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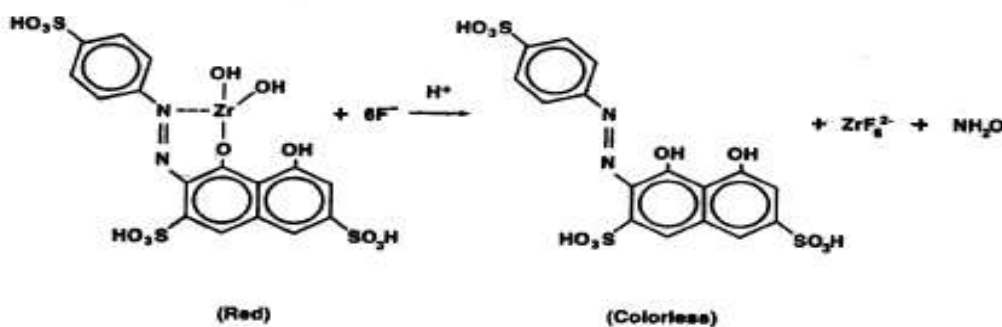
cleaned plastic bottles during Summer (April to May), Rainy (July to August) as well as Winter (November to January) during the period December 2015 to November 2016. Locations are selected in a way that major part of the districts are engulfed and true representation of overall ground water quality of the district in the study area is done.

The collected samples of water were taken to the laboratory for analysis. Fluoride level in ground water is measured by SPADNS method.<sup>13</sup>(SPADNS is Sodium- 2- (para sulphophenyl azo) -1, 8 di hydroxy -3, 6 - naphthalene disulphonate).



### SPADNS

The colorimetric method of SPADNS involves the reaction between zirconium dye-lake and fluoride, resulting in formation of a colourless complex between the dye and anion. With increase in amount of fluoride, the colour produced becomes progressively lighter and lighter.<sup>9</sup>



Standard solutions of fluoride were prepared in the concentration range of 0 to 1.50 mg/L and were further diluted to 50 ml with double distilled water. 5 ml of each SPADNS and zirconil acid

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reagent are mixed with each standard solution and spectrophotometer is set to zero absorbance with respect to the reference solution. UV-Visible spectrophotometer is used to measure Absorbance spectrophotometrically at a wavelength of 570 nm. With the help of standard curve, amount of Fluoride present in each of the water samples were determined.

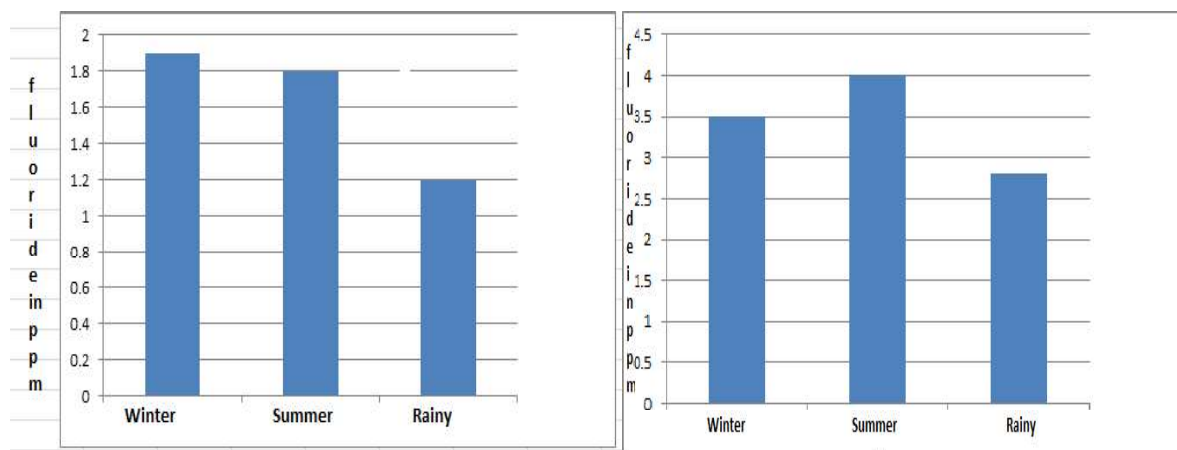
### OBSERVATION TABLE:

**Table 3 : Values of fluoride concentration during summer, winter and Rainy seasons of the year from December 2015 to November 2016.**

S. N.	Selected Villages	Seasonal Readings (mg/lit)		
		Winter	Summer	Rainy
1	Bastepur	1.70	1.80	1.20
2	Jayas	1.30	1.45	1.15
3	Fursatganj	1.90	1.70	0.90
4	Poore Paturia	3.50	4.00	2.80
5	Sankaraha	1.85	1.80	0.90
6	Khairahana	1.40	1.60	1.00
7	Kodra	2.20	2.10	1.80
8	Rohania	1.90	1.80	1.50
9	Pahadpur	2.35	2.50	2.00
10	Poore Narayana	4.20	4.20	3.70
11	Tekari	0.70	0.90	0.60
12	Matiagadar	1.30	1.60	1.00

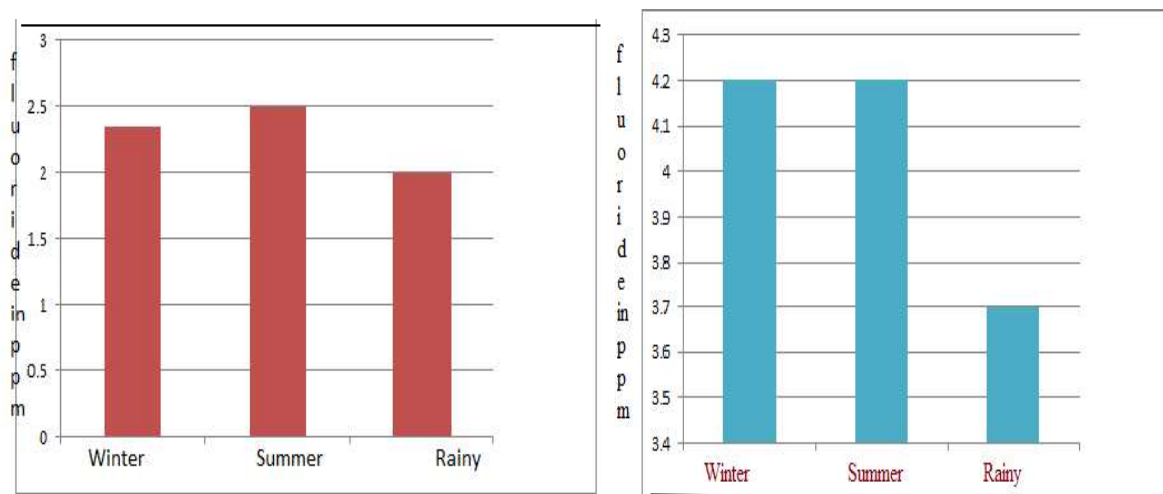


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1. Seasonal variation of fluoride in Raahi

2. Seasonal variation of fluoride in Amaawa



3. Seasonal variation of fluoride in Harchandpur

4. Seasonal variation of fluoride in Deeh

**Figure 2: Seasonal Variation of Fluoride Concentration in Selected Block of Rae Bareli District U.P.**

### RESULTS AND DISCUSSION:

After analysis of each of the samples from 12 villages of 4 Blocks in Rae Bareli District, the following results have been observed:

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- Poore Narayana from Deeh Block and Poore Paturia from Amaawa Block show a value beyond 4 mg/lit.
- Jayas and Tekari show that the value for Fluoride concentration is below standard limit of fluoride level.
- Amaawa, Raahi, Deeh and Harchandpur Blocks are at verge of fluoride contamination.
- When the concentration of naturally occurring fluoride level exceeds recommended limits then defluoridation becomes necessary. Continuous monitoring and water quality analysis by Government should be frequent, to keep the people safe from the problem of fluoride pollution.
- Dissolved fluoride in drinking water is effortlessly taken up by gastrointestinal tract and the interfering elements like Al, Mg and Ca are unable to intervene. This is propagated fully through the direct bioavailability of soluble fluoride ingested with water.
- The lethal effects of excess fluoride intake through water are abrasion, browning and mottling of teeth. Decreased milk production and lameness can be the result of very high fluoride levels in bone and urine
- The aim of water defluoridation is to avoid the occurrence of this chronic illness which may particularly have drastic effect on the poor and the children.
- The present position in the Rae Bareli district is such that only urgent measures will prevent a crisis situation.

### **RECOMMENDATIONS:**

- The present research in hydro geological area portrays that a methodical and careful survey of delineating fluoride vulnerable zone should be made prior to setting up of hand pumps and tube wells. This process needs sustainable management of the accessible water resources.
- Population, residing nearby, should be educated regarding the lethal impact of ground water polluted with fluoride and also the simple techniques which can be implemented for removal of fluoride.

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- Organization of awareness campaign regarding fluorosis should be done and curative methods may be carried out in the villages and schools using various aids like distributing pamphlets and showing some audiovisual clips.
- It is, in fact, the need of the moment that a much stronger regional co-operation of organizations such as local N.G.O., Government and other related stakeholders should be sought.
- Immediate short term mitigation programs should be organized in fluoride related water contamination affected areas.
- Some of the critical institutional, policy and technological difficulties are to be met promptly.

### **CONCLUSION:**

This study for the first time spotted high fluoride in the underground water and wells of various places in Rae Bareilly district. Future horrifying outcomes of fluoride pollution can be minimized beneficially through frequent monitoring and Defluoridation. Awareness Programme through communication, Demo, fieldwork can encourage hygiene and health promotions particularly in the remote areas of the region. Awareness should be also given regarding the fact that boiling of water for disinfection does not help in removing fluoride, but consequently result in increasing the concentration of fluoride in water. Frequent water quality analysis by the Government and regular monitoring should be done to keep the people safe from the problem of fluoride contamination. Areas having high fluoride content should be mapped carefully and ensured that drinking water is fetched from safe low fluoride areas.

### **Prevention of fluorosis**

- a. Detection at an early stage
- b. Tracing the source of Fluoride
- c. Identifying the aspects responsible for fluorosis and its intensity
- d. Assimilating the programmes of fluorosis prevention in Health-care missions
- e. The spreading of fluoride induced disease may be prevented by initial removal of the source of fluoride and providing safe drinking water.

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- f. Quick supplementation of diet with essential nutrients, vitamins and anti-oxidants should be promoted.

### **Fluorosis is not treatable but it is preventable**

- i. Fluorine is the most electro-negative element spread as fluorides in the environment. The key means of fluoride intake by humans is water.
- ii. Fluoride is dispersed in skin, erythrocytes, liver, cardiac and skeletal muscles. It can cross the cell membrane promptly.
- iii. Fluorosis, a major health problem, is the consequence of consuming water with high fluoride levels for a long period of time.
- iv. Fluorosis is specifically categorized by skeletal manifestations and dental mottling such as osteoporosis, osteosclerosis, crippling deformities etc.

### **REFERENCES:**

1. Rao, Nagendra, C.R. "Fluoride And Environment- A Review" in Martin J. Bunch, V. Madha Suresh and T.Vasanth Kumaran, eds., Proceedings of the Third International Conference on Environment and Health, Chennai, India, 15-17 December, Chennai: Department of Geography, University of Madras and Faculty of Environmental Studies, York University. Pages 386 – 399 (2003).
2. Indian Standard Specification for Drinking Water, ISI. (1991).
3. Murulidharan, D., Nair, A.P. and Sathyanarayana, U., Curr. Sci., 2002, 83, 699- 702.
4. Susheela, A. K., A Treatise on Fluorosis, Fluorosis Research and Rural Development Foundation, Delhi, p. 15, (2001).
5. Meenakshi, V.K. Garg, Kavita, Renuka, Anju Malik. "Ground water quality in some villages of Hariyana, India: focus on fluoride and fluorosis". Journal of Hazardous Materials 106B, 85 – 97(2004).
6. Tomas Blom & Elin Cederlund "Fluoride Contaminated Ground Water in Palakkad and Alappuzha Districts Of Kerala, South India" TRITA-LWR Master Thesis 06-09, ISSN 1651-064X, LWR-EX-06-09(2006).
7. Adler, P., Armstrong, W.D., Bell, Muriel E., Bhussry, B.R., Büttner, W., Cremer, H.-D., Demole, V., Ericsson, Y., Gedalia, I., Hodge, H.C., Jenkins, G.N., Jolly, S.S., Largent,

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- E.J., Leone, N.C., Ludwig, T.G., Martin, A.E., Minoguchi, G., Muhler, J.C., Schlesinger, E.R., Siddiqui, A.H., Singer, L., Singh, A., Smith, F.A., Stookey, G.K., Taves, D.R., Venkateswarlu, P., Weatherell, J.C., Weidmann, S.M. & Zipkin, I., Fluorides and Human Health. World Health Organisation. 364p (1970).
8. WHO. Fluoride in Drinking-water. WHO/SDE/WSH/03.04/96. 9 p. URL: [http://www.who.int/water\\_sanitation\\_health/dwq/chemicals/fluoride.p](http://www.who.int/water_sanitation_health/dwq/chemicals/fluoride.p). (2004b).
  9. Karlsson, M. & Nandorf, A. "Limitation of High Fluoride Ground Waters in Southern India". Höskolan Kalmar Examination Project Work 1994:M12. 44p. (1994).
  10. Sheila Srivastava & Shiv kumar "Screening High Fluoride Drinking Waters and Surveying Endemic Fluorosis in Sadar Block of Rae Bareli District" Rasayan Journal of Chemistry, vol. 3, No.3, 411-414(2010).
  11. Shiv Kumar & Sheila Srivastava "Assessment of fluoride Content in Ground Water and its Environmental Impacts at all the Blocks of Rae Bareli Tehsil District Rae Bareli, Uttar Pradesh, India Proceeding of "International conference on Sustainable Water Resource Management and Treatment Technologies" NEERI Nagpur, WT&M/Water 2011:844-852(2011).
  12. Lundell, L. & Rennel, S., High Fluoride Groundwaters in Rajasthan, India. KTH TRITA-IMA EX 1996:3 38p. (1996).
  13. Lenore SC, Arnold EG, Andrew DE, editors, Standard methods for examination of water and waste water. 20<sup>th</sup> ed. Washington DC: American Public Health Association (APHA); (1998).

### **Bio-sketch of Dr. Sheila Srivastava**



- I am Dr. Sheila Srivastava Associate Prof. & Head, Department of Chemistry, Feroze Gandhi College, Raebareli, U.P. (Affiliated to University of Lucknow)

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- 20 students awarded Ph.D. under my supervision
- Published more than 150 research papers in International and National journals of repute.
- Completed 6 major and 4 minor research projects sponsored by UGC, CST
- Authored three books