



## Research Article

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### Toxicity of Fluoride from Ground Water Resources of Bagalkot District, Karnataka State, India

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#### Abstract

A systematic Physico-Chemical analysis of Ground water in 27 different locations in Bagalkot district of Karnataka State has been taken up to evaluate its suitability for drinking purpose in the year 2013 – 2014 in both Monsoon and Post-Monsoon seasons. The parameters such as pH, EC, TDS, Total Alkalinity, Chloride, Sulphate, Nitrate and Fluoride ions of Ground water were studied. In the present investigation water samples were collected from Bagalkot, Badami, Ilkal and Hunagund locations during the above said two seasons. The values were compared with the standard values of World Health Organization. The present study is to bring an acute awareness among the people about the quality of Ground water by taking water samples from specific locations. It is asked the public about the consumption of Fluoride containing water which leads health hazards. The contamination of drinking water due to fluoride is a severe health hazard problem. Excess of fluoride more than 1.5 ppm in drinking water is harmful to the human health.

**Keywords:** Bagalkot District, Physico-Chemical analysis, ground water, fluoride contamination, health hazard.

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### 1. Introduction

Water is essential for life, drinking water is never pure, naturally contains minerals and microorganisms from soil and air. Human activity can add many more substances to water. But, drinking water does not need to be pure and not to be safe. In fact, some dissolved minerals in water can be beneficial to health. It is documented that trace elements are essential and beneficial to human health in minute concentrations. As they play a significant role in many metabolic processes and act as co-factors. Excess intake is known to be toxic and adverse effects on body

metabolism. One such trace element which is easily distributed in soil, earth and water is Fluoride. This element is either naturally occurring or added to the water supply<sup>1,2</sup> ( U.S. specifies the optimum level of Fluoride to range from 0.7 to 1.2 ppm). fluoride is beneficial to young children when it is present within the permissible limit (0.5 ppm to 1.5 ppm) for the calcinations of dental enamel and bone formation, more concentration of fluoride not only affects teeth and skeleton but also cause several neurological damages.

Fluoride is a natural occurring in all water sources and is also one of the most commonly used industrial chemicals. The low concentration of fluoride found in water and foods. But, water with underground sources is more likely to have higher levels of fluorides, where as the concentration in seawater averages 1.3 ppm<sup>3</sup>. Fresh water supplies generally contain between 0.01 – 0.3 ppm, while the ocean contains between 1.2 and 1.5 ppm<sup>4</sup>. Higher concentration of fluoride is found in alkaline, volcanic sedimentary and other rocks derived from highly evolved hydrothermal solutions<sup>5</sup>. The amount of fluoride occurring naturally in ground water is governed principally by climate, composition of host rock and hydrogeology. Areas with semi-arid climate, crystalline rocks and alkaline soils are mainly affected<sup>6,7</sup>. Fluorosis is a slow, progressive, crippling malady, which affects every organ, tissue and cell in the body and results in health complaints. The primary adverse effects associated with Chronic, excess fluoride intake are dental and skeletal fluorosis<sup>8</sup>. It is also adversely affects the foetal cerebral function and neurotransmitter.

Keeping in the view of the above and increased interest in recent periods in Fluoride concentration in ground water and various adverse effects on human health, an extensive study was undertaken in and around the Bagalkot district of Karnataka State by estimating fluoride level in drinking water, identification of exact geographical locations which are having high concentration of fluoride in water, intake and toxicity of fluoride due to the consumption of drinking water. This investigation work may be helpful to perform remedial measures and useful to give awareness about Fluorosis diseases to the villagers residing in the affected area.

## 2. Materials and Methods

Water samples from 27 locations were collected, stored at 25°C and analyzed by using a Fluoride selective electrode (thermo Scientific Arion, Combination Fluoride Electrode No. 9609 BNWP). The method for fluoride estimation as described in the standard methods for the examination of water and waste water<sup>9,10</sup>. All the Physico-Chemical parameters were measured in accordance with standard methods as APHA<sup>11</sup> (1995), while collection the temperature of these water samples was noted by 110<sup>th</sup> thermometer. All the chemicals and reagents such as Sodium fluoride, zirconyl Chloride, 3-alizerin sulphuric acid sodium salts used were of analytical grade. Doubled distilled water was used for preparing the reagent solutions. Nitrate was measured by Ion selective Electrode (ISE) method using digital Ion-pH meter of Elico equipments pvt. Ltd., Hyderabad, India. A known volume (25ml) of water sample was taken in 100 ml beaker and equal volume of buffer solution, for total ionic strength adjustment was added and stirred for 1 minute. The electrode was immersed and reading was recorded when stable. Similarly pH, Ec, TDS, of water samples were also measured by electrode method (Elico India pvt, ltd., Hyderabad). Chloride, Alkalinity and Sulphate were determined in ground water samples by titrimetric methods, and turbidity methods.

All the parameter values were recorded in Table 1 to 3 of Monsoon season, Table 4 to 6 of post monsoon season during 2013-2014. These values were compared with the drinking water standards (Table 7) of Bureau of Indian Standards and World Health Organization for evaluation of physico-Chemical parameters, nitrate and fluoride concentration in the water samples of the study area.

## 3. Results and Discussion

It was observed that in many locations of the Bagalkot District, the water table depth found approximately in between 08 – 10 meters (based on the enquiry from the local people). All the 27 water sources which are using for domestic purposes by the public were analyzed their quality parameters such as pH, EC, TDS, Alkalinity, Chloride, sulphate, nitrate and fluoride concentration. Village Budangud of Badami taluk drinking water is supplying by the municipal / panchayat committee, through water storage tanks, addition to this the public of this area is also depended upon bore wells. But, in all water resources the maximum fluoride concentration were recorded throughout the monitoring periods.

### Temperature:

The study area of Hungund, Ilkal is covered by granite. The area is semi-arid with subtropical climate conditions. The temperature varies in these locations 27.9°C to 29°C. The ground water samples were collected from the residential colonies situated in Bagalkot, Badami during monsoon and post monsoon the temperature ranges in between 28°C to 29°C and 27.7°C to 28.7°C respectively. Temperature of water is an important parameter because it effects bio-chemical reactions in aquatic organisms. Increase of temperature leads to speed up chemical reactions in water body, as the temperature of water increase it reduces the solubility of gases and amplifies the tastes and odours, during summer the water body temperature reaches up to 29.80C.

**Potential of Hydrogen (pH):**

The pH values in one of the most frequently used water quality parameters. The pH values of ground water of sampling spots of Bagalkot locations during monsoon season found in between 6.7 to 6.9 and 6.6 to 6.9 in post monsoon season; all are within the permissible limit. pH values 6.5 to 7.6 and 6.8 to 7.5 of Badami locations found during monsoon and post monsoon seasons respectively. Whereas the water samples of Hunagund and Ilkal pH values ranges in between 6.5 to 7.6 during monsoon and pH values found in between 6.6 to 7.3 during post monsoon of the same locations. pH is an important ecological factor and used to express the intensity of the acid and alkaline condition of the water or solution. Most of the ground water of study area were slightly alkaline due to the presence of  $\text{CO}_3^{2-}$  and  $\text{HCO}_3^-$ . But, all the values found in between prescribed ranges of International standards. The pH values more than 7.0 in water samples reflect contamination of bases like sodium hydroxide and calcium hydroxide<sup>12</sup>.

**Electrical Conductivity (EC):**

Electrical conductivity is a measure of water capacity to convey electric current. It signifies the amount of total dissolved solids. The higher Ec values in water samples indicates the presence of high amount of dissolved inorganic substances in ionized state. EC value is always correlated with TDS found in water and EC is an indicator of degree of mineralization of water. In the present investigation the EC values ranged in between 1.36 m mhos/cm to 1.710 m mhos/cm in Bagalkot areas during monsoon. Whereas in post monsoon EC values of the same locations were found in between 1.368 to 1.720 m mhos/cm, except few locations the EC values found slightly more than the permissible limit (1.4 m mhos/cm) indicates the presence of total dissolved solids in ground water samples. The EC values of Badami and Hunagund sampling spots during monsoon were found in between 1.46 m mhos/cm to 1.96 m mhos/cm and during post monsoon EC values found in between 1.52 m mhos/cm to 1.98 m mhos/cm. The more EC values in Badami sampling spots may be due to content substantial amount of dissolved  $\text{CO}_2$ ,  $\text{CO}_3^{2-}$ ,  $\text{HCO}_3^-$  and hydroxides. These constituents are the results of dissolution of minerals in the soil and atmosphere<sup>13</sup>. The EC values of Hunagund sampling spots found within the legal limit except few locations.



**Figure 1. Budangud Village (Badami Taluk) water supply through tanks (resource-Bore well) Nitrate 11 ppm and Fluoride 3.34 ppm during post monsoon.**

**Total Dissolved Solids (TDS):**

Dissolved solids are one of the desirable parameters of water for drinking purpose. TDS values of water samples were measured by using Elico TDS meter. TDS indicates the salinity behavior of ground water. Water containing more than 500 ppm of TDS is not considered desirable for drinking water supplies, but in unavoidable cases 1500 ppm is also allowed<sup>14</sup>. In the present investigation the TDS values of Bagalkot sampling spot during monsoon and post monsoon seasons found in between 634 ppm to 790 ppm and 698 ppm to 821 ppm respectively, all values were found more than the permissible legal limits, Beyond 500 ppm of dissolved solids, the palatability of water in drinking decreases and may cause gastro intestinal irritation<sup>15</sup>. Thus, the same trends in the TDS values of water samples found in Badami and Hunagund regions (beyond 500 ppm). Hence, the observations indicate that people of the area of the Bagalkot district may have some gastro intestinal problems related with drinking water.

**Total Alkalinity (TA):**

Alkalinity of water affects its taste for human consumption, it is observed that the water samples collected from various locations of Bagalkot and Hunagund regions found more than 200 ppm in both monsoon and post monsoon seasons. Alkalinity in water samples beyond 200 ppm imparts unpleasant taste, although in absence of alternate source, the permissible limit has been extended up to 600 ppm. This indicates that although the water samples are safe from public health point of view in most part of Bagalkot district. Water samples collected from Badami taluk

during both seasons of monitoring periods found the alkalinity values slightly more or equal to 200 ppm. As per the Indian standard, the desirable limit of alkalinity in water for drinking purposes is up to 200 ppm. The present investigation showed the water samples found safe for public use for both drinking and cooking purposes.

#### **Chloride (Cl):**

Chloride concentration serves as an indicator of pollution by industrial effluents and sewage. Chloride occurs in all 27 ground water samples widely in varying concentration in both monsoon and post monsoon seasons. Excessive Chloride in potable water is not particularly harmful. Chloride in excess (more than 250 ppm) impacts a salty taste to water. People accustomed to higher chloride in water are subjected to Laxative effects<sup>16</sup>. In the present investigation the Chloride values of Bagalkot region during monsoon season and post monsoon season ranged in between 21 ppm to 61 ppm and 38 ppm to 78 ppm, all are less than the permissible legal range. The same trend found in the regions of Badami and Hunagund, the Chloride value in the water samples found less than the legal limit. The tolerance of Chloride by human being varies with climate, exertion and loss through perspiration, (WHO and BIS limit: 250 ppm to 1000 ppm decreases portability salty taste and corrosion).



**Figure 2. Shivappa Madar of Budangud village depended of bore water since 20 years Decay and Missing teeth (Dental Fluorosis) Location: Badami Taluk, Budangud –Village.**

#### **Sulphate (SO<sub>4</sub>):**

In the present investigation Sulphate concentration of Bagalkot locations during monsoon season found in between 28 ppm to 62 ppm, whereas during post monsoon ranged in between 36 ppm to 78 ppm. All values found within the permissible limits. Water samples of Badami region during monsoon lies in between 25 ppm to 62 ppm; and 33 ppm to 78 ppm found during post monsoon season. The same trends were found in the water samples of Hunagund and Ilkal during the monitoring periods, i.e., 31 ppm to 65 ppm and 23 ppm to 75 ppm respectively, all are less than the permissible legal limit. It is known that the Sulphate concentration in water samples around 1000 ppm; it has Laxative effect and causes gastrointestinal irritation<sup>17</sup>. Excess sodium sulphate in water causes Cathartic action. High concentration of Na and MgSO<sub>4</sub> is associated with respiratory illness.

#### **Nitrate (NO<sub>3</sub>):**

The analysis of Nitrate concentration in water samples collected from locations of Bagalkot area found in between 13 ppm to 21 ppm and 21 ppm to 36 ppm for monsoon and post monsoons respectively. Similarly water samples from Badami region showed Nitrate concentration below 45 ppm which is desirable and lower permissible limit for Nitrate concentration in water for drinking purpose.

A closer analysis about the Nitrate concentration in the region of Hunagund and Ilkal were beyond 12 ppm and below 31 ppm during monsoon and found in between 11 ppm to 32 ppm during post monsoon. The water having Nitrate concentration below 22.5 ppm is said to be safe for agriculture uses, but higher than 22.5 ppm showed increasing problems<sup>18</sup>. Thus, water from various locations whose Nitrate concentrations more than 22.5 ppm will be appeared to have gone in the increasing problem zone for agricultural purposes with regard to Nitrate concentrations. This is possibly due to unrestricted use of nitrogenous fertilizers in agricultural practices in the areas.





**Figure 3. Bhimanagouda Gyanappanavar of Yerigonal village (Dental & Skeletal Fluorosis) Fluorosis affected every organ, tissue and cell in the body and results in health complaints (Location: Hunagund region).**

#### **Fluoride (F):**

The major sources of Fluoride in ground water are Fluoride bearing rocks such as Fluorspar, Cryolite, Fluorspatite and Hydroxyl apatite. In the present investigation of water samples of Bagalkot, Badami, Hunagund and Ilakal out of 27 water samples 16 samples contained more Fluoride concentrations during monsoon period so far recorded<sup>19</sup>. During post monsoon the Fluoride concentration of above said regions, the 17 water samples contained more than standard prescribed legal limit [1.50 ppm]. The Fluoride concentration in water samples of the villages Kalligund (Spot HND1) and Kelur (Spot HND3) showed 1.48 ppm during monsoon, from the same spots the Fluoride concentrations found more than 1.5 ppm during post monsoon. This indicates that the Fluoride concentration decreased in the area due to the natural purification and dilution factor during monsoon. In addition to this it is noticed that there will be decrease of Fluoride concentration in water sample of Hire Singanagutti village of Hunagund taluk (Spot HND12) during post monsoon was 1.41 ppm thus, during monsoon it was 1.52 ppm. the maximum Fluoride concentration 2.23 ppm to 2.32 ppm found in Semikeri village (Near Govt. School campus) of Bagalkot taluk during monitoring period. Budangud village of Badami taluk showed maximum Fluoride concentration in all three spots (BD7, BD8, BD9) in between 2.68 ppm to 3.21 ppm during monsoon and found in between 2.29 ppm to 3.34 ppm during post monsoon season.

The maximum Fluoride concentration found in the areas of Hunagund and Ilakal of Bagalkot District. The water samples of Yerigonal (Bore1) and (Bore2) showed maximum Fluoride concentration 5.29 ppm and 3.72 in monsoon season respectively. Where as in post monsoon the Fluoride concentration found to be 5.71 ppm and 3.27 ppm of the same spots. Yerigonal (5.71 ppm), Hire Adapur (5.30 ppm), Hire Malagavi (3.22 ppm) and Gorabal (3.14 ppm), Ilakal town (3.59 ppm) and Kudalasangum (2.17 ppm to 2.58 ppm). all are the hazards problem zones for human health with regards to Fluoride concentrations.



**Figure 4. Yerigonal-Village Bore1. Maximum Fluoride content found in the Bagalkot District. Nitrate 33 ppm and Fluoride 5.71 ppm during Post Monsoon (Location: Hunagund)**

Higher concentration of Fluoride which is characterized by molting of teeth enamel, nervous and skeletal disorder. Ground water with high Fluoride contents are generally Bicarbonates, Sodium mixed water, particularly poor in Calcium content. Rocks which are rich in Fluoride minerals contributed enriched Fluoride contents of ground water. The content of Fluoride is related to depth of the wells and water sources. In these areas, there are no any chemical industries of any human activity that can cause anthropogenic contamination of the ground water with Fluoride and in such area high levels of Fluoride are due to geogenic sources. It has been observed that the study area showed the variation in Fluoride concentration may be presence of Fluoride bearing minerals in the host rocks and their interaction with ground water.

Regular intake of Fluoride rich waters seems to be the main cause for Fluorosis in the study area. These results will be helpful to prepare Fluorosis mitigation plan for the affected population of the study area. Fluoride has widely been in the focus of public and scientific interest of their important physiological role in the health of a man. It is high time that an affordable solution should be found to minimize the Fluoride concentration for maintaining the good health of the large population of the study area of Bagalkot District. There is urgent need to carry out studies on hydro-chemical and hydro-geological aspect of occurrence of Fluoride which can be useful to mitigate Fluorosis in the study area. Defluoridation tanks should also be installed in the villages like Budangad, Yerigonal, Hire Adapur, Hire Malagavi and Kudalsangum villages which are having high exposure of Fluoride concentration in drinking water, the possibilities of bringing safe water from nearby villages e.g., Nagur villages of Hunagund region has less than 1.4 ppm Fluoride concentration in water sources. But, nearby village called Yerigonal (1.2 km) possesses maximum Fluoride concentration (5.71 ppm), it is better to bring safe water from Nagur to Yerigonal village through pipe line. Villagers can also be planned with neighbor village people and local authorities. Government has to be taken part in this connection by providing financial support for getting safe water drinking purposes. Otherwise, It is quite necessary to install defluoridation tanks in such area which is having higher concentration of Fluoride in ground water.



**Figure 5. Abdul Rahaman of 15 years old (Dental Fluorosis) found some neurological damages (Location: Kudalsangum (Near Urdu School))**

**Table 1. Physico-Chemical parameter and Fluoride content in Ground Water.**

**Location: Bagalkot Taluk Monsoon Season 2013.**

Sampling Spot	Location	Temp in °C	pH	EC in mhos/cm	TDS ppm	TA ppm	Cl ppm	SO4 ppm	NO3 ppm	Fluoride ppm
BK1	Tulasigeri near Temple	28.3	6.7	1.510	790	233	21	28	13	1.50
BK2	Semikeri near School	28.1	6.6	1.683	786	215	52	36	21	2.23
BK3	Muchandi village	28.4	6.8	1.360	634	242	48	62	20	0.47
BK4	Sirur village	28.7	6.7	1.570	723	215	36	42	18	0.48
BK5	Mannikeri	29.0	6.9	1.710	634	298	61	61	19	0.72

**Table 2. Physico-Chemical parameter and Fluoride content in Ground Water.****Location: Badami Taluk Monsoon Season 2013**

Sampling Spot	Location	Temp in °C	pH	EC in m mhos/cm	TDS ppm	TA ppm	Cl ppm	SO4 ppm	NO3 ppm	Fluoride ppm
BD1	Agasanakoppa	28.0	7.1	1.51	778	182	28	25	21	0.34
BD2	Kerur town	28.2	7.0	1.95	821	215	82	62	23	0.53
BD3	Badami Rly. Station	28.3	6.7	1.96	839	232	62	58	18	0.14
BD4	Kyad Village	28.5	6.7	1.82	820	215	88	52	31	0.53
BD5	Maradi Village	28.3	7.6	1.46	925	192	67	32	26	1.80
BD6	Guledgudda	28.4	6.5	1.72	790	208	52	48	25	0.75
BD7	Budangad Bore1	28.7	7.5	1.61	900	235	95	42	18	2.80
BD8	Budangud Bore2	28.3	7.1	1.58	898	241	89	71	12	2.68
BD9	Budangud Bore3	28.1	7.4	1.72	791	190	62	52	26	3.21

**Table 3. Physico-Chemical parameter and Fluoride content in Ground Water.****Location: Hunagund Taluk Monsoon Season 2013**

Sampling Spot	Location	Temp in °C	pH	EC in m mhos/cm	TDS ppm	TA ppm	Cl ppm	SO4 ppm	NO3 ppm	Fluoride ppm
HND1	Kalligud Village	28.5	6.5	1.22	835	272	41	57	21	1.48
HND2	Aihole Village	29.2	6.6	1.13	891	260	52	56	22	0.59
HND3	Kerur Village	29.3	6.8	1.15	869	234	72	52	12	1.48
HND4	Hunagund Town	29.4	6.7	1.20	790	252	68	42	20	0.49
HND5	Ilakal Town (studio)	29.5	7.0	1.13	956	298	92	62	31	3.36
HND6	Ilakal Town Ward 4	29.1	7.1	1.42	872	272	102	31	18	1.41
HND7	Amingad (Gudur Cro)	29.0	7.1	1.25	786	299	92	45	29	1.75
HND8	Yerigonal Bore1	29.4	7.2	1.25	742	300	71	37	30	5.39
HND9	Yerigonal Bore2	29.5	7.1	1.65	700	342	68	39	18	3.72
HND10	Gorabal Village	28.7	7.3	1.8	720	351	52	52	32	3.41
HND11	Hire Adapur	28.9	7.2	1.72	798	310	61	31	29	5.45
HND12	Hire Sanganagutti	28.5	7.4	1.61	590	308	58	41	20	1.52
HND13	Kudalsangam Village	28.2	7.6	1.81	680	299	89	65	30	2.31
HND14	Kudalsangam (Urdu)	28.3	7.5	1.95	671	301	58	58	31	2.25
HND15	H.Malagavi Village	28.5	7.2	1.48	612	286	71	44	28	5.32

**Table 4. Physico-Chemical parameter and Fluoride content in Ground Water.****Location: Bagalkot Taluk Post Monsoon Season 2013.**

Samplin g Spot	Location	Temp in °C	pH	EC in m mhos/cm	TDS ppm	TA ppm	Cl ppm	SO4 ppm	NO3 ppm	Fluoride ppm
BK1	Tulasigeri near Temple	28.1	6.6	1.480	821	210	38	36	22	1.61
BK2	Semikeri near School	28.0	6.7	1.518	792	200	69	43	36	2.32
BK3	Muchandi village	28.2	6.8	1.689	712	200	55	78	25	0.51
BK4	Sirur village	28.3	6.9	1.368	798	201	54	38	21	0.49
BK5	Mannikeri	28.7	6.7	1.720	698	317	78	71	24	0.78

**Table 5. Physico-Chemical parameter and Fluoride content in Ground Water.****Location: Badami Taluk Post Monsoon Season 2013.**

Sampl ing Spot	Location	Temp in °C	pH	EC in m mhos/cm	TDS ppm	TA ppm	Cl ppm	SO4 ppm	NO3 ppm	Fluoride ppm
BD1	Agasanak0p pa	27.7	7.2	1.52	820	160	38	33	23	0.48
BD2	Kerur town	27.9	7.1	1.98	842	210	101	78	27	0.72
BD3	Badami Rly. Station	28.0	7.0	1.84	859	201	92	68	28	0.29
BD4	Kyad Village	28.1	7.2	1.52	841	198	98	62	33	0.72
BD5	Maradi Village	27.9	6.8	1.68	898	190	43	50	24	2.01
BD6	Guledgudda	28.1	6.9	1.64	798	207	110	40	22	0.82
BD7	Budangad Bore1	28.2	7.3	1.62	900	214	98	68	15	2.29
BD8	Budangud Bore2	28.1	7.5	1.66	912	234	72	48	11	3.34
BD9	Budangud Bore3	28.0	7.2	1.64	918	265	88	38	27	2.55

**Table 6. Physico-Chemical parameter and Fluoride content in Ground Water.****Location: Hunagund Taluk Post Monsoon Season 2013.**

Sampl ing Spot	Location	Temp in °C	pH	EC in m mhos/cm	TDS ppm	TA ppm	Cl ppm	SO4 ppm	NO3 ppm	Fluoride ppm
HND1	Kalligud Village	27.9	6.6	1.31	853	263	32	67	18	1.51
HND2	Aihole Village	28.2	6.8	1.20	889	250	45	61	32	1.01
HND3	Kerur Village	28.5	6.8	1.25	912	214	88	48	11	1.53
HND4	Hunagund Town	28.4	6.9	1.30	812	245	82	34	20	0.55
HND5	Ilakal Town (studio)	28.4	7.1	1.24	929	305	140	75	27	3.59
HND6	Ilakal Town Ward 4	28.5	7.0	1.52	910	265	130	23	20	1.61
HND7	Amingad (Gudur Cro)	28.7	7.2	1.38	876	300	100	58	27	2.02
HND8	Yerigonal Bore1	29.0	7.3	1.48	812	305	68	47	33	5.71
HND9	Yerigonal Bore2	28.7	7.2	1.47	810	364	52	31	16	3.27
HND10	Gorabal Village	28.0	6.9	1.36	762	360	40	68	30	3.14



HND11	Hire Adapur	28.2	7.0	1.64	792	316	52	21	29	5.30
HND12	Hire Sanganagutti	28.5	7.1	1.31	801	290	70	39	18	1.41
HND13	Kudalsangam Village	27.9	7.2	1.50	912	301	92	72	32	2.58
HND14	Kudalsangam (Urdu)	28.1	7.3	1.48	928	310	69	63	31	2.17
HND15	H.Malagavi Village	29.0	7.1	1.36	871	295	82	42	29	3.32

Table 7. Prescribed legal limits and guidelines

Parameter	WHO	ISI	ICMR
pH	7.0 – 8.5	6.5-8.5	6.5-9.2
EC	1.4 ds/m	1400µs/cm	250
TDS	500	500	1500-3000
BOD	5.0	5.0	---
COD	10.0	10.0	---
DO	5.0	5.0	5.0
Cl <sup>-</sup>	250	250	1000
Calcium	75-100	45-75	200
Magnesium	30-150	30	50
Sodium	200	200	---
Potassium	1.4	1.4	---
Sulphate	150-250	150-200	400
TH	300	300	600
TA	120	200-600	200-600
Zinc	0.75	---	---
Copper	0.60	---	---
Iron	<1	0.3	---
Manganese	2.0	0.3	---
Nitrate	40-100	40-100	40-100
Fluoride	1.0-1.5	1.0-1.5	1.0-1.5
Color	5 HU	5 HU	5 HU
Odour	Unobjectionable	Unobjectionable	Unobjectionable
Turbidity	5 NTU	5 NTU	5 NTU

#### 4. Conclusion

The present study has attempted to identify the are affected by Fluoride contamination in ground water resources of Bagalkot, Badami, Hunagund and Ilakal taluks. The study has focused more on both Urban and rural area of the Bagalkot district in order to supplement the data base in this direction, the following conclusions can be drawn from the present study:

1. Fluoride concentrations can be diluted by inducing ground water recharges techniques, i.e., construction of percolation tanks, flooding of ground water by mixing surface water by promoting rain water harvesting.
2. Defluoridation tanks should be installed in such area which is having high concentration of Fluoride in ground water.
3. The possibilities of bringing safe water from nearby villages can also be planned.

#### Suggestions:

1. Monitoring system is to be established to be established to periodically evaluate the prevalence of Fluorosis and dental carries in the affected areas.
2. A registry of water fluoride concentration may be kept in municipalities / panchayats for the benefit of public Health Providers, health professionals and the public with regard to Fluoride consuming from drinking water.

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