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Arsenic and Fluoride levels and its Health hazards in the Ground water samples of Bagepalli Taluk, Chikkaballapur District, Karnataka

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Abstract

The present study deals with the arsenic , fluoride levels in relation to few physical parameters in the ground water samples of Bagepalli taluk, Chikkaballapur District, Karnataka. In this study, the water temperature varied from 25°C during November 2010 and a maximum of 35°C, May-2011 at all the sites. pH concentration varied from 7.0 during January-2011 at S_7 to a maximum of 8.8 in September 2010 at S_1 sites, indicating neutral to alkaline nature of water. The electrical conductivity values are found to be in the range of 302 to 2718 µmhos/ cm. In the present study, high fluoride content recorded with 5.9 mg/L at S8. Peak arsenic content recorded 0.05 mg/L at S_1 and low 0.01 mg/L at S_6. No seasonal variations observed in arsenic content. In many samples, the fluoride is exceed the permissible limits of WHO and BIS standards. It is concluded that the ground water quality is mainly affected by seepage of sewage, waste water and urban runoff into the ground waters, due to lack of sewerage facilities. Dental fluorosis is recorded in the study area.

Water is the essential ingredient of all life on earth and it is one of the most important resource for potable propose. Water has no alternative - it is known as 'life'. In fact the water has been rightly described as the very basis of life. It is essential for the sustenance of all living organisms including plants, animals and man. All plants, insects, animals and men have 60-95% water in their bodies. Therefore, all living beings require lot of water daily. Further, much water is also needed for body growth and nutrition. Therefore, it is absurd to think of life without water. But our usable water resource like any other natural resource is finite and is likely to be exhausted within a century.

Water occurrence in chemically pure form is very rare. It is a good solvent and the quality of water depends on hydrological, physic- chemical and biological factors. Chemical parameters are the most important indices, which characterise the quality of water. Some chemical substances, if present

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more than the permissible limit in drinking water may constitute danger to the health.

Ground water is the major resource of drinking water in both urban and rural India. On the other hand, ground water system receives the soluble inorganic and organic pollutants through the percolation of vast domestic sewage and industrial effluents. If is now generally recognized that the quality of ground water is just as important as its quantity. Since quality of public health depends to a greater extent on the quality of drinking water, it is imperative that in depth information about a quality of drinking water should be systematically collected and monitored.

Water related diseases are divided into two categories, first category is disease caused by a biological agents and second category is due to some chemical substances in water.

The first group is called is the water related infections and include some of the greatest causes of diseases and death in many countries including India (for instance diarrhoea). Excreta related diseases in one related to human excreta (urine & faeces), which, includes nearly 50 infections. The spread of major infections and parasitic dieses such as cholera, typhoid, dysentery, hepatitis, guinea worm infection *etc.*, are due to poor drinking water quality which manifest as acute diarrhoea.

The second group include diseases such as fluorosis (due to high fluoride in drinking water), arsenical keratosis and lung and liver cancer (due to high concentration of arsenic in water) blue baby diseases (due to high nitrate in drinking water) and development of bacteria causing odour, bad taste, frothing and undesirable colour in water due to presence of excess of iron in water. The toxic effects of pesticides, lead and metals have a times led to various physiological disorders. Industrial wastes from paper and textile mills, tanneries, petroleum industries, sugar and refinery factories also contaminate ground water and cause serious diseases if such water is used for domestic purposes.

Fluorosis is a well-defined clinical disorder generally caused by ingestion of excessive amounts of fluoride through potable water. It is a serious health problem in India. Excessive intake of fluoride during pre-eruptive stage of teeth leads to dental fluorosis and continued ingestion over years and decades causes skeletal fluorosis, In its advanced stages, fluorosis crippling deformities and neurological complications. Dental fluorosis mainly involves enamel and mottling is one of the most easily recognizable features. Pitting and chipping are other marks of dental fluorosis. Brown or black pigment is deposits on the defective enamel and once established tends to remain there permanently. Dental fluorosis does not obviously occur when there has been no exposure to fluoride in first decade of life. Skeletal fluorosis is generally characterized by severe pain and stiffness in the back. Stiffness increases steadily and leads to restriction of back movements. Soon stiffness spreads to various joints of the limbs. With the increasing immobilization of the joints due to contractures, flexion deformities may develop at hips, knees and other joints, which make patient bedridden. Neurological stage is a late stage of skeletal fluorosis where in spinal nerves and spinal cord is compressed by deforming bones. This leads to paralysis and

sensory defects affecting touch, vibration, position and joint sense.

Fluorosis is endemic to at least 20 states in India and 23 countries throughout the world. As per WHO's report 20% of the fluoride affected villages in the world are in India and over 50% groundwater have excess of fluoride. Fluorosis affects more than 25 to 30 million people in India[9]. However 17 states in the country have a sizable number of people with high fluoride content in their blood[27]. Now the fluoride is affecting 18 districts in the state. In Unnao district Uttar Pradesh high percentage of fluoride in the groundwater has wrought havoc in a cluster of village[12, 16] but no thorough analysis has been done in this regard. Therefore, an attempt has been made to investigate the fluoride content of groundwater and prevalence of dental, skeletal and neurological stage of fluorosis in Tehsil Purwa of district Unnao.

Arsenic is a natural element which behaves like a metal (a member of the nitrogen family). It is present in the environment both naturally and also by certain human activities. It has different forms. It can exists either in inorganic or organic form. Inorganic arsenic being generally considered as more toxic.

Arsenic is found in the natural environment in some abundantly in the earth's crust and small quantities in rock, soil, water and air. Due to natural geological contaminations, high level of arsenic can be found in drinking water that has come from deep drilled wells. Industrial processes such as mining, smelting and coal-fired power plants contributes to the presence of arsenic in air, water and soil.

If large amount of arsenic is swallowed by humans can cause rapid poisoning and mortality. The symptoms of arsenic poisoning are thickening and discoloration of the skin, stomach ache, sickness, vomiting, diarrhoea, lack of feeling in hands and feet, partial paralysis, and blindness. Long term exposure to high level of arsenic in drinking water can cause cancers of skin, lung and kidney. It also cause a disease called 'black foot disease' in which blood vessels of the leg and foot becomes damaged resulting in coldness, loss of feeling and eventually gangrene in the foot[26,31].

Objectives of the study :

- To analyze the physical characteristics of water samples with special emphasis on fluoride and arsenic contents.
- To assess the suitability of water for human consumption and irrigation.
- To find out the source of pollution.
- To create awareness about health hazards from flouroide and arsenic content in drinking water.
- Recommendation for better management of ground water and suggestion for the scope of further study.

Study area :

Bagepalli is a one of the Taluk in Chikballapur District within the State of Karnataka, India. Bagepalli is located 100 km north of Bangalore at the Bangalore - Hyderabad National Highway. The area is simply beneath the southern border of the Rayalaseema in Andhra Pradesh, South India. It is semi-arid and drought prone with 560 mm of erratic and spatial rainfall. Bagapalli is placed at 13.78°N 77.79°E. It has an average elevation of 707

metres (2319ft). For the preparation of the manuscript, relevant references were consulted[1-31].

The place is a semi arid drought inclined one with low, erratic and spatial rainfall. The dust brown rocky terrain is significantly undulating, with small hill stages and outcrops that stud the topography. There is no mineral wealth and handiest a totally thin and fragile soil cowl.

An unfavourable land : individual ratio creates a robust thirst for cultivable land for the reason that much less than one-1/2 of the overall land is match for cultivation, with the remaining taken over through the hills and rocky fields. Hardly five% of the cropped lands are irrigated through an age vintage network of rain-fed tanks (small lakes), every irrigating 2 to 10 hectares of wet land. The low water table is tapped thru bore-wells drilled to greater than 100 meters intensity. Even those dry up within the summer months, from April to September every 12 months, while temperatures rise to a dry warmth of 38°C.

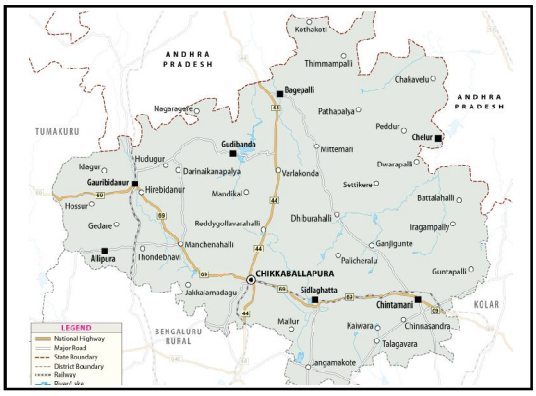

Figure 1. Location of the study area Methodology

A total of 10 water samples (S1 to S10) were collected from selected villages borewells of Bagepalli Taluk, Chikkaballapur District during June -2010 to May-2011. The temperature as recorded at the time of sampling by using mercury thermometer. The pH was measured with pH meter. All the other parameters were measured as per the standard methods[4].

Monthly fluctuation of physical parameters, Fluoride and arsenic contents are given in the Table 1- 5. The BIS standards given in the Table-6.

Table 1. Monthly analysis of Water Temperature in different villages of Bagepalli Taluk

Sites	June 2010	July 2010	August 2010	Sept. 2010	Oct. 2010	Nov. 2010	Dec. 2010	Jan. 2011	Feb. 2011	Mar. 2011	April 2011	May 2011
S1	33	31	30	27	28	25	26	27	30	31	32	35
S2	33	31	30	27	28	25	26	27	30	31	32	35
S3	33	31	30	27	28	25	26	27	30	31	32	35
S4	33	31	30	27	28	25	26	27	30	31	32	35
S5	33	31	30	27	28	25	26	27	30	31	32	35
S6	33	31	30	27	28	25	26	27	30	31	32	35
S7	33	31	30	27	28	25	26	27	30	31	32	35
S8	33	31	30	27	28	25	26	27	30	31	32	35
S9	33	31	30	27	28	25	26	27	30	31	32	35
S10	33	31	30	27	28	25	26	27	30	31	32	35

Table-2. Monthly analysis of pH in different sampling sites of some selected villages of Bagepalli Taluk

Sites	June 2010	July 2010	August 2010	Sept. 2010	Oct. 2010	Nov. 2010	Dec. 2010	Jan. 2011	Feb. 2011	Mar. 2011	April 2011	May 2011
S1	7.8	7.1	8.1	8.8	7.4	7.6	7.6	7.4	7.4	7.8	7.6	7.6
S2	8.2	8.5	8.6	8.6	8.1	7.9	7.8	8.1	7.9	8.1	7.7	7.9
S3	7.7	8.0	8.1	8.6	7.7	7.8	7.9	7.4	7.5	8.2	7.9	7.7
S4	8.1	8.2	8.4	8.6	7.5	7.8	7.8	8.1	8.1	8.2	8.1	8.1
S5	7.9	8.2	8.1	8.3	7.8	7.6	7.6	7.5	7.9	7.5	7.6	7.6
S6	7.9	8.1	8.3	8.6	7.9	7.7	7.7	7.8	8.3	8.1	7.8	7.8
S7	8.2	8.1	7.9	7.7	7.6	7.4	7.7	7.0	7.3	7.3	8.1	8.2
S8	8.1	8.0	7.8	7.6	7.5	7.3	7.2	7.1	7.3	7.6	7.9	8.1
S9	8.3	8.1	8.0	7.9	7.7	7.5	7.3	7.1	7.4	7.6	7.9	8.1
S10	8.2	8.1	7.9	7.8	7.6	7.4	7.3	7.1	7.3	7.5	7.9	8.2

Table-3. Monthly analysis of Electrical Conductivity (µmhos/cm) in different sampling sites of selected villages of Bagepalli Taluk

Sites	June 2010	July 2010	August 2010	Sept. 2010	Oct. 2010	Nov. 2010	Dec. 2010	Jan. 2011	Feb. 2011	Mar. 2011	April 2011	May 2011
S1	1900	2050	2100	2110	2122	2125	2100	1991	1786	1790	1802	1812
S2	720	1010	1020	1120	1140	1132	1202	1226	1043	1080	1025	1052
S3	1415	1495	1550	1535	1600	1632	1620	1642	1540	1311	1300	1381
S4	480	435	460	459	482	500	485	452	302	383	242	382
S5	1490	1545	1520	1531	1526	1640	1680	1542	1342	1311	1490	1346
S6	1490	1500	1520	155	1572	1620	1650	1650	1300	1352	1401	1451
S7	1137	1134	1132	1330	1128	1125	1123	1121	1106	1117	1128	1139
S8	1315	1312	1310	1307	1304	1302	1299	1296	1280	1292	1305	1318
S9	1900	2050	2100	2110	2122	2125	2100	1991	1786	1790	1802	1812
S10	720	1010	1020	1120	1140	1132	1202	1226	1043	1080	1025	1052

Table-4. Monthly analysis of Fluoride (mg/L) in different sampling sites of selected villages of Bagepalli Taluk

Sites	June 2010	July 2010	August 2010	Sept. 2010	Oct. 2010	Nov. 2010	Dec. 2010	Jan. 2011	Feb. 2011	Mar. 2011	April 2011	May 2011
S1	1.2	1.1	1.2	1.2	1.1	1.1	1.3	1.0	1.1	1.2	1.0	1.1
S2	1.6	1.8	1.5	1.4	1.6	1.2	1.2	1.3	1.2	1.4	1.5	1.4
S3	3.8	3.9	3.6	3.5	3.6	3.5	3.6	3.8	3.9	4.0	4.2	4.4
S4	1.0	1.1	1.2	1.1	1.0	1.0	0.9	0.9	0.9	1.0	1.1	1.2
S5	5.5	5.4	5.3	5.1	5.1	5.0	5.1	5.2	5.4	5.4	5.3	5.4
S6	3.1	3.5	3.6	3.4	3.2	3.4	3.4	3.2	3.5	3.8	3.6	3.9
S7	4.2	4.1	4.0	3.8	3.8	3.9	3.8	3.6	3.5	3.8	3.9	4.0
S8	5.3	5.5	5.9	5.8	5.7	5.6	5.6	5.5	5.4	5.4	5.7	5.9
S9	1.2	1.2	1.1	1.0	1.0	1.1	1.2	1.2	1.0	1.2	1.2	1.3
S10	1.8	1.9	1.8	1.9	1.5	1.4	1.4	1.5	1.6	1.8	1.8	1.7

Table -5. Monthly analysis of Arsenic (mg/L) in different sampling sites of some selected villages of Bagepalli Taluk

Sites	June 2010	July 2010	August 2010	Sept. 2010	Oct. 2010	Nov. 2010	Dec. 2010	Jan. 2011	Feb. 2011	Mar. 2011	April 2011	May 2011
S1	0.04	0.03	2.02	0.02	0.03	0.02	0.03	0.04	0.04	0.04	0.05	0.05
S2	0.03	0.03	0.02	0.01	0.01	0.02	0.03	0.03	0.03	0.04	0.04	0.04
S3	0.03	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03
S4	0.04	0.03	0.04	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.04	0.04
S5	0.03	0.04	0.03	0.03	0.02	0.02	0.01	0.02	0.02	0.03	0.03	0.04
S6	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03
S7	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.03	0.03	0.04
S8	0.04	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.02	0.02	0.03	0.04
S9	0.04	0.03	0.03	0.02	0.02	0.01	0.02	0.02	0.03	0.03	0.03	0.04
S10	0.04	0.03	0.02	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.04	0.05

S1-Bagepalli Village S2- Devaragudi palli S3-Pathapalya S4- Cheluru
S6-Kothakota S7-Thimmampaiii S 8-Guluru S9-Yellampalli
S10-Mettemeru

Temperature of groundwater is largely dependent on atmospheric, terrestrial heat, exothermic and endothermic reaction in rocks, infiltration of surface water, insulation, thermal conductivity of rocks, rate of movement of ground water and interference of man on the ground water. Temperature of water is one of the most important physical characteristics and it is well know that the water temperature exerts direct and indirect influences on many abiotic and biotic components of any aquatic system[11]. During the study period water temperature varied from a minimum of 25°C during Nov-2010 and a maximum of 35°C, May-2011 at all the sites (S_1 to S_{10}).

In most natural water, the pH value is dependent on corbondioxide-carbonete-bicarbonate equilibrium. Presence of phosphates silicates, borates, fluorides and other salts in dissociated form may also affect the pH. In presence study pH concentration varied from a minimum of 7.0 during Jan-2011 at S_7 to a maximum of 8.8 in Sept. 2010 at S_1 sites, indicating circum neutral to alkaline nature of water. The recorded values are within stipulated limits for potable waters recommended as per CPCB norms. pH has no direct adverse effects on health although values below 4.0 are known to produce some taste and higher values (>8.5) hasten the scale formation in water heating apparatus and also reduce the germicidal potential of chlorine. It is discernible from the above observation that the pH value are dependent on local soil conditions. The significant correlation of pH was observed with total hardness ($r = -0.62$, $p < 0.06$), magnesium hardness ($r = 0.68$, $p < 0.06$) and potassium ($r = 0.6$, $p < 0.05$).

Electrical conductivity is the function of concentration of dissolved solids salts. Conductivity is the capacity of water to carry an electrical current. In present findings the electrical conductivity values are found to be in the range of 302 to 2718 μmhos/cm (Table -4). It is found to be mole in southwest and northeast monsoon season, however lower

value were observed during summer season. EC showed direct relationship with total hardness, sulphate and total dissolved solids P<0.01).

Table-6. BIS (1990) Standards for the drinking water quality, *mg/L*

Parameter	Permissible limit	Excessive limit
Colour, hazen	5	50
pH	7 - 8.5	6.5- 9.2
Turbidity, NTU	5	25
EC (µmhos/cm)	1000	2250
Chloride	200	1000
Total hardness	200	600
Dissolved Oxygen	4.0	6.0
BOD	2.0	3.0
Fluoride	1.0	1.5
Calcium	75	200
Magnesium	30	150
Sulphate	200	400
Nitrate	45	45
Alkalinity	200	400
iron	0.1	1.0
Manganese	0.05	0.5
Copper	0.05	1.5
Zinc	5.0	15
Phenolic Compound	0.0001	0.002
Arsenic	0.05	0.05
Cadmium	0.01	0.01
Lead	0.1	0.1
Cyanides	0.05	0.05
Selenium	0.01	0.01
Mercury	0.001	0.001

SOURCE: Central Pollution Control Board

Fluoride is fairly common that does not occur in the elemental state in nature because of its high reactivity. It occurs for about 0.3 g/kg of the earth's crust and exists in the form of fluorides in a number of minerals, of which fluorspar, cryolite and fluorapatite are the most common. The fluoride found naturally water are probably derived principally from the meteorites, unites, high calcium, granite, alkali rocks, sandstones *etc.*, The most important fluoride containing mineral, fluorspar many have a variety of tints (blue, yellow or green). Calcium fluoride is of major important since in its naturally occurring form, as fluorspar, it is primary source fluoride[18]. Fluoride has a considerable impact on human physiology causing a disease called fluorosis. Dental fluorosis is present in the areas where the fluoride content of drinking water exceeds 1.5 mg/L, while crippling skeletal fluorosis is present when it exceed 5 mg/L. In the present study high fluoride content recorded 5.9 mg/L at 58. No seasonal variations observed in fluoride content.

Arsenic is an element & present everywhere in the earth crust. As in the earth's crust it is 1.8 ppm, in solids it is 5.5 to 13 ppm, in streams it is less than 2 µg/L and in ground water it is generally less than 100 µg/L. It occurs naturally in sulphide minerals such as pyrite. Arsenic is used in alloys with lead, in storage batteries, and in ammunition. Arsenic compounds are widely used in pesticides, glass manufacture and in wood preservatives. It can exists in both inorganic and organic forms, inorganic arsenic being generally considered more toxic. Concentrations of less toxic organic arsenic are particularly high in sea living animals and therefore in seafood especially in fishes.

However inorganic arsenic can be present as either arsenate or arsenite, in these arsenite is more toxic. The main source of contamination of inorganic arsenic from industrial discharges, pesticides. It also highest in groundwater where containing volcanic rock or arsenic-rich mineral deposits, and deep bore wells. Arsenic in soil and sediment increases if there are natural or manmade source of arsenic contamination present. The peoples of this area are suffered from dental fluorosis (Figure 2).

High arsenic exposure can cause skin cancer, liver cancer, lung cancer, kidney cancer[8,25-29]. In the present study high arsenic content recorded 0.05 mg/L at S_1 and low 0.01 mg/L at S_6. No seasonal variations observed in arsenic content during the present study.

Figure 2: Dental fluorosis in younger peoples

The present investigation has been made to evaluate the quality of ground water of Bagepalli Taluk area. A total of 10 representative underground water samples were collected from different locations. Water samples were analyzed for few physico-chemical parameters to evaluate their suitability for human consumption and domestic applications. In many samples the values of fluoride is exceed the permissible limits of WHO and BIS standards[8,31]. It is concluded that the ground water quality is mainly affected by seepage of sewage, waste water and urban runoff into the ground waters, due to lack of proper sewerage facilities. Open drains are prevalent in study area. Further, lime nature of lithology and lack of rainfall due to the deforestation are also responsible for the degradation of ground water quality. Hence, it is recommended to the Karnataka state and Indian government to take care of ground water quality and to safeguard for the residents and tourists of Bagepalli Taluk, India. Thus to maintain the quality of ground water, preventive measures have to be taken to control the above parameters within the permissible limit.

However, we could suggest that this water could be used for drinking after proper treatment (defluoridation, reverse osmosis *etc*.) and induced ground water recharge techniques, that is construction of percolation tanks, flooding of ground water by mixing surface water by promoting rainwater harvesting.

Recommendations and suggestions :

In nutshell, the groundwater quality of Bagepalli Taluk and surrounding area is getting deteriorated at an alarming rate due to increased human interferences with natural resources. Based on the above results and discussion of various physico-chemical parameters tested for the water samples collected from the study area, the following recommendation and suggestions are made to

reduce further deterioration and conserve the ground water quality for the benefit of human welfare in future.

Recommendations :

Most of the bore-wells of in the study area contain high degree of carbonate hardness (Temporary). Hence, people must be advised to use boiled and cooled water for drinking.

People must be educated regarding ill effects likely to be caused by the excess iron and bacteriological organisms.

The study revealed that in sampling locations fluoride concentrations is more than the standards fixed by BIS for drinking water. Disease fluorosis has no remedy only the way is prevention. Hence, a defluoridation plant based on Nalgonda technique may be practiced for drinking water.

There should be a check on the use of phosphatic fertilizers as they also contribute for high fluoride concentrations which are being leached down to main groundwater body through irrigation practices.

The residents in the village sector should be educated on the militating effects of calcium-rich diet like Ragi, Milk and Vitamin-C which effectively reduce the impact of fluorosis.

An artificial recharge of groundwater may be adopted to reduce higher concentration of parameters wherever it is necessary. Construction of percolation tanks, ponds, check dams, irrigation tanks and bunds across the major and minor perennial or non-perennial streams at geologically ideal locations recommended to help the aquifer recharge and also surface storage. Further, concerned authorities should be directed to maintain the existing ponds, lakes, reservoirs in Megadi taluk to increase the ground water table.

Some of the bore wells are liable to bacterial (*E. coil*) contamination due to the disposal of septic tank effluent in improper manner. Hence, for drinking purposes, water must be treated by boiling permanganate solution.

Proper treatment of water is required before using the water for drinking purpose specially to reduce the iron content of water by the following methods.

- By adding alum, so that there will be sedimentation.
- By adding calculated amount of lime which is stirred properly so that the iron will be precipitated and separated.
- Restrict further drilling through bringing legislation.
- Groundwater is treat as property of the State or Nation.
- Drip and sprinkler irrigation techniques must be adapted for water saving.
- Concerned district authorities should take necessary steps to create health awareness among the people with regard to the ill effects of fluorosis and water borne diseases.
- Proper sanitation and drainage system should be provided to avoid contamination of drinking water therefore, concerned authorities should take appropriate steps.
- Safe disposal of solid wastes should be undertaken as it also severely contaminates

the ground water. Farmers must be advised to use the chemical fertilizers in a judicious way.

- Production of environmentally compatible cropping practice, bio-fertilizer and bio-pesticides should be encouraged.

Suggestions :

There is much scope for further study in the field of ground water quality assessment and that is as follows.

- Assessment of ground water recharge potential.
- Estimation of pesticidal residual contamination.
- Survey and follow up action in areas where fluoride concentration is reported to be above the permissible limit.

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