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# A Study on Fluoride in Drinking Water of Government Kallar Higher Secondary Schools in Madurai, Tamil Nadu, India during Pre-monsoon and Post-monsoon seasons of years 2010 to 2012

**Amutha[1*] and Prakash[2]**
[1]V.V. Vanniaperumal College for Women, Virudhunagar, INDIA
[2]Thiagarajar College, Madurai, INDIA

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## Abstract

*School is a socializing institution which stimulates learning environment and positive changes. Government Kallar Higher Secondary Schools started since 1969 for Piramalai Kallar Community People in Tamilnadu, India. These schools are spread over three districts such as Madurai, Dindigul, and Theni. The drinking water sources of these schools are analyzed for the Physico-Chemical parameters such as Temperature, pH, TDS, Major ions, Fluoride, BOD, COD, DO and heavy metals. The objective of the study is to analyses the above parameters and finds the impact of Fluoride in pre and post monsoon seasons of the year 2010-12. Multi statistical approach showed the pollution potential for Government Kallar Higher Secondary Schools. In this study, the important Physico-Chemical parameter, Fluoride and seasonal variations of drinking water of Madurai Government Kallar Higher Secondary Schools have been reported.*

**Keywords:** Drinking water quality, fluoride parameters, maximum admissible limit, world health organization, Kallar school, groundwater, health-risk, preventive measures.

## Introduction

Madurai is located at 9.93°N 78.12°E. It has an average elevation of 101 meters. The city of Madurai lies on the flat and fertile plain of the river Vaigai, which runs in the northwest-southeast direction through the city, dividing it into two almost equal halves. The Sirumalai and Nagamalai hills lie to the north and west of Madurai. The land in and around Madurai is utilized largely for agricultural activity, which is fostered by the Periyar Dam. Madurai lies southeast of the Western Ghats, and the surrounding region occupies the plains of South India and contains several mountain spurs.

The city experiences a moderate climate from August to October, tempered by heavy rain and thundershowers, and a cool and climate from November to February. Fog and dew are rare, occurring only during the winter season. Being equidistant from mountains and the sea, it experiences similar monsoon pattern with Northeast monsoon and Southwest monsoon, with the former providing more rain during October to December. The average annual rainfall for the Madurai district is about 85.76 cm.

Temperatures during summer generally reach a maximum of 40°C and a minimum of 26.3°C, although temperatures up to 42°C are not uncommon. Winter temperatures range between 29.6°C and 18°C. A study based on the data available with the Indian Meteorological Department on Madurai over a period of 62 years indicate rising trend in atmospheric temperature over Madurai city, attributed to urbanization, growth of vehicles and industrial activity. The maximum temperature of 42°C for the decade of 2001 – 2010 was recorded in 2004 and in 2010.

This paper makes an attempt to focus on the environmental impact of water pollution on the rural communities in general and on human health, and particularly on students of the Govt. Kallar Hr. Sec Schools of Tamil Nadu. Nearly forty thousand students are studying in Kallar Reclamation Department School. It is given in the table - 1. Hostels are also attached with the twelve higher secondary schools. Fortunately the drinking sources of all the schools are ground water. These sources have been polluted by geogenic and anthropogenic factors. In higher secondary schools, the chemical and non-biodegradable wastages from laboratories, food wastages from noon meal kitchen impart a lot percentage of its polluting factors.

The primary source of water for all these schools are only ground waters from bore well, hand pump and Panchayat union supplied over tank water through pipes. There are thirty hydro chemical parameters have been analyzed. The village people are also used the sources as their drinking purpose. The prevalence of Fluoride during pre and post monsoon seasons is given in the table - 3. During our study period School code 4 and School code 10 are highly affected by the Fluoride contamination. The acceptable limit of Fluoride in drinking water is 1.5mg/l. But the polluted areas show somewhat higher concentration than acceptable limit. These schools need a special attention to produce a pure drinking water to the school

students. The analyzed parameters were subjected to Pearson correlation analysis which is a statistical technique used to analyze the impact of fluoride with other Physico-Chemical parameters, space and seasonal variations. The occurrence of high fluoride (F–) in groundwater has drawn considerable attention the world over, since ground water is the main source of F– intake[1]. F– in drinking water has both beneficial and harmful effects on human health[2–8]. According to the Indian standards for drinking water[9], the acceptable (or desirable) limit of F– in drinking water is 1.0 mg/l; however, in the absence of any alternate source, maximum permissible limit is1.5 mg/l. Whereas low F– content (< 0.60 mg/l) in drinking water can cause dental caries and poor development of bones[10], high F– content (> 1.0 mg/l) can lead to dentaland skeletal fluorosis[6]. The source of F– in groundwater is primarily geogenic, i.e. from dissolution of fluorine bearing minerals in the rocks transmitting groundwater, and occasionally anthropogenic[2,10–12]. India is among the 23 nations wherein a large population suffers from dental and skeletal fluorosis due to high F–concentration in groundwater[13–20].

**Table-1**
**Details of the Students' Strength of Kallar Reclamation Schools**

| Sl.No | Category of Schools | Number of Schools | Boys | Girls | Total |
|---|---|---|---|---|---|
| **1** | Higher Secondary Schools | 24 | 9,087 | 6,592 | 15,679 |
| **2** | High Schools | 21 | 2,804 | 2,484 | 5288 |
| **3** | Middle Schools | 28 | 2,198 | 2,080 | 4278 |
| **4** | Elementary Schools | 212 | 7,391 | 6,918 | 14,309 |
| | **Total** | **285** | **21,480** | **18,074** | **39,554** |

The name of the study area is given in the following table-2.

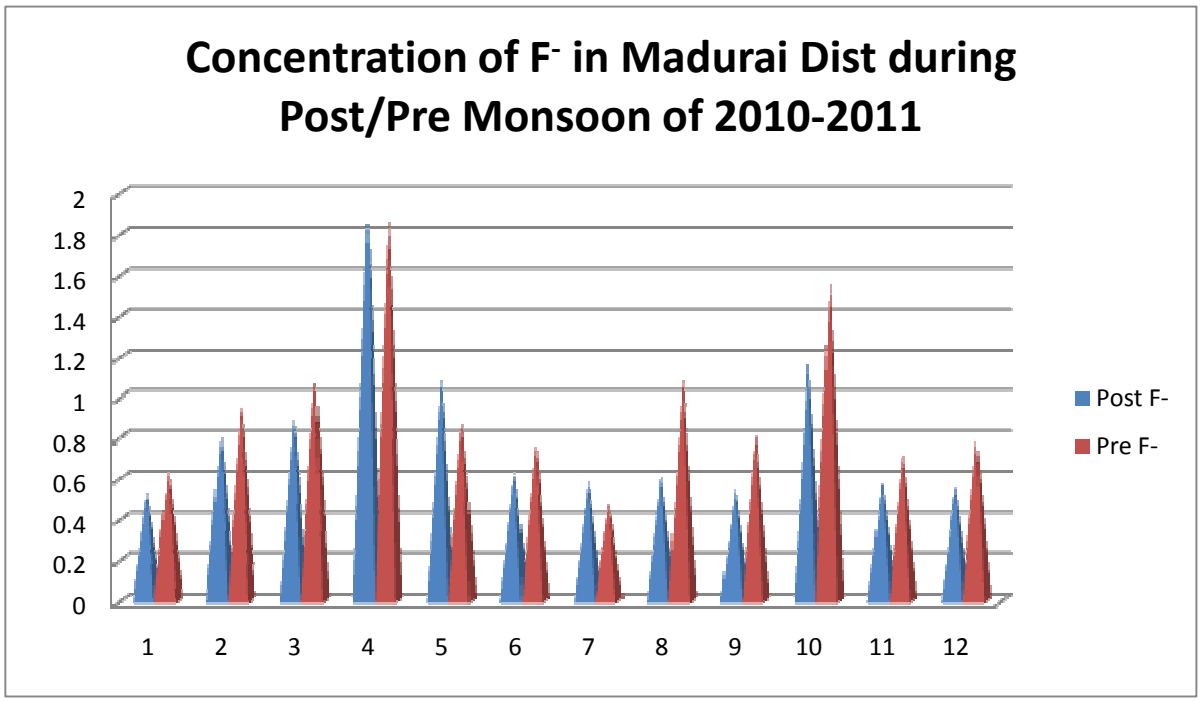
**Table-2**
**Name of the study area**

| School Code | Name of the Schools |
|---|---|
| S1 | Government Kallar Hr.Sec School at Checkanurani |
| S2 | Government Kallar Hr.Sec School at Melaurappanur |
| S3 | Government Kallar Hr.Sec School at Kappalur |
| S4 | Government Kallar Hr.Sec School at Nattamangalam |
| S5 | Government Kallar Hr.Sec School at Papapatti |
| S6 | Government Kallar Hr.Sec School at Vikkiramangalam |
| S7 | Government Kallar Hr.Sec School at Vellaimalaipatti |
| S8 | Government Kallar Hr.Sec School at Vadakkampatti |
| S9 | Government Kallar Hr.Sec School at Thummakundu |
| S10 | Government Kallar Hr.Sec School at Thadayampatti |
| S11 | Government Kallar Hr.Sec School at Melakkal |
| S12 | Government Kallar Hr.Sec School at Ayyappanaickanpatti |

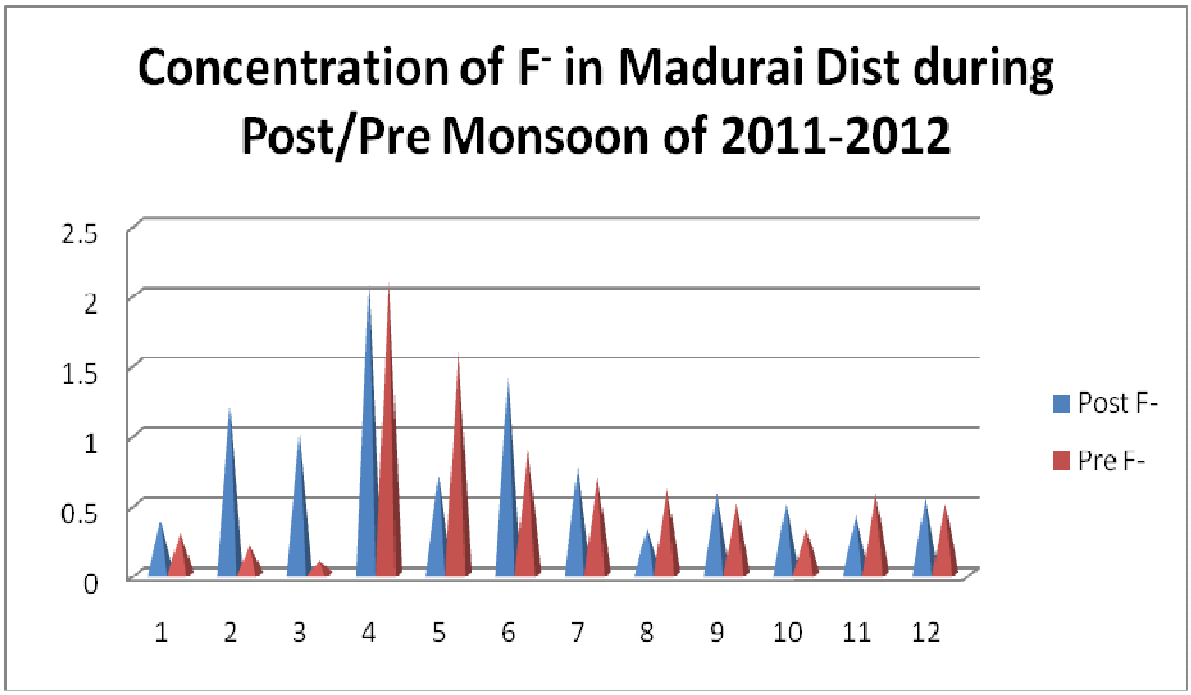
**Table-3**
**Seasonal effects on the prevalence of Fluoride**

| Sampling Sites | Year 2010-2011 | | Year 2011-2012 | |
|---|---|---|---|---|
| | Post Monsoon $F^-$ | Pre Monsoon $F^-$ | Post Monsoon $F^-$ | Pre Monsoon $F^-$ |
| S1 | 0.54 | 0.64 | 0.38 | 0.3 |
| S2 | 0.83 | 0.97 | 1.2 | 0.21 |
| S3 | 0.92 | 1.1 | 1 | 0.1 |
| S4 | 1.9 | 1.9 | 2.08 | 2.1 |
| S5 | 1.1 | 0.9 | 0.71 | 1.6 |
| S6 | 0.63 | 0.79 | 1.41 | 0.9 |
| S7 | 0.59 | 0.48 | 0.77 | 0.7 |
| S8 | 0.63 | 1.1 | 0.33 | 0.61 |
| S9 | 0.56 | 0.83 | 0.58 | 0.51 |
| S10 | 1.2 | 1.6 | 0.51 | 0.33 |
| S11 | 0.59 | 0.74 | 0.42 | 0.58 |
| S12 | 0.57 | 0.8 | 0.55 | 0.51 |


**Figure–1**
**Madurai Map in Tamilnadu [India Map]**




**Figure–2**
**Concentration of $F^-$ in Madurai Dist. during Post/Pre Monsoon of 2010-2011**




**Figure–3**
**Concentration of $F^-$ in Madurai Dist. during Post/Pre Monsoon of 2011-2012**

If we take excess fluoride in drinking water, it may lead to a weakening of bones, leading to an increase in hip and wrist fracture, adverse effects on the kidney[21-24]. The high-fluoride areas studied need a safety defluoridation process.

## Material and Methods

**Fluoride ions ($F^-$)** concentration in water was measured using an ion-selective electrode (Eutech, Singapore) by a standard method APHA.

**Table-4**
**Correlation factor – Statistical analysis**

| | | TH | Cl | TA | Ca | Mg | SO | Na | K | HCO | F |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TH | Pearson Correlation | 1 | .984** | .451 | .982** | .996** | .894** | .609* | .943** | .450 | .291 |
| | Sig. (2-tailed) | | .000 | .141 | .000 | .000 | .000 | .036 | .000 | .142 | .358 |
| | N | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Cl | Pearson Correlation | .984** | 1 | .464 | .970** | .979** | .898** | .698* | .913** | .463 | .260 |
| | Sig. (2-tailed) | .000 | | .129 | .000 | .000 | .000 | .012 | .000 | .130 | .415 |
| | N | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| TA | Pearson Correlation | .451 | .464 | 1 | .404 | .469 | .605* | .834** | .255 | 1.000** | .869** |
| | Sig. (2-tailed) | .141 | .129 | | .193 | .124 | .037 | .001 | .424 | .000 | .000 |
| | N | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Ca | Pearson Correlation | .982** | .970** | .404 | 1 | .962** | .827** | .575 | .918** | .403 | .220 |
| | Sig. (2-tailed) | .000 | .000 | .193 | | .000 | .001 | .050 | .000 | .194 | .492 |
| | N | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Mg | Pearson Correlation | .996** | .979** | .469 | .962** | 1 | .915** | .619* | .942** | .468 | .323 |
| | Sig. (2-tailed) | .000 | .000 | .124 | .000 | | .000 | .032 | .000 | .125 | .306 |
| | N | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| SO | Pearson Correlation | .894** | .898** | .605* | .827** | .915** | 1 | .745** | .790** | .604* | .525 |
| | Sig. (2-tailed) | .000 | .000 | .037 | .001 | .000 | | .005 | .002 | .038 | .080 |
| | N | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Na | Pearson Correlation | .609* | .698* | .834** | .575 | .619* | .745** | 1 | .424 | .834** | .578* |
| | Sig. (2-tailed) | .036 | .012 | .001 | .050 | .032 | .005 | | .169 | .001 | .049 |
| | N | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| K | Pearson Correlation | .943** | .913** | .255 | .918** | .942** | .790** | .424 | 1 | .254 | .175 |
| | Sig. (2-tailed) | .000 | .000 | .424 | .000 | .000 | .002 | .169 | | .426 | .587 |
| | N | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| HCO | Pearson Correlation | .450 | .463 | 1.000** | .403 | .468 | .604* | .834** | .254 | 1 | .869** |
| | Sig. (2-tailed) | .142 | .130 | .000 | .194 | .125 | .038 | .001 | .426 | | .000 |
| | N | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| F | Pearson Correlation | .291 | .260 | .869** | .220 | .323 | .525 | .578* | .175 | .869** | 1 |
| | Sig. (2-tailed) | .358 | .415 | .000 | .492 | .306 | .080 | .049 | .587 | .000 | |
| | N | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| **. Correlation is significant at the 0.01 level (2-tailed). | | | | | | | | | | | |
| *. Correlation is significant at the 0.05 level (2-tailed). | | | | | | | | | | | |

During Post Monsoon 2010-11, Fluoride is positively correlated with Total Alkalinity, Sodium, and Bicarbonate at 0.869, 0.578, and 0.869 respectively and significant at the 0.05 level (2-tailed). And Fluoride is not correlated with Total Hardness, Chloride, Calcium, Magnesium, Sulphate, and Potassium. This shows that the physical chemical properties of ground water quality within the captured area under study were contaminated by Fluoride at minimum level.

## Results and Discussion

During this study the highest concentration of Fluoride during the Post Monsoon of Year 2010-2011 is found at station S4 and the lowest concentration of fluoride is found at station S1. The highest concentration of Fluoride during the Pre Monsoon of Year 2010-2011 is found at station S4 and the lowest concentration of fluoride is found at station S7.

The highest concentration of Fluoride during the Post Monsoon of Year 2011-2012 is detected at station S4 and the lowest concentration of fluoride are found at station S8.And also the highest concentration of Fluoride during the Pre Monsoon of Year 2011-2012 is observed at station S4 and the lowest concentration of fluoride is found at station S3. These variations may be due to geogenic and anthropogenic factors of the school locations.

## Conclusion

Scientific evidence supports the fluoridation of public water supplies as safe for the environment and beneficial to people. Reports at the local, national, and international levels have continued to support this most important public health measure. Our future plan of this study is to implement a novel deflouridation technique and improve the water quality supply for the students of Government Kallar Higher Secondary Schools.

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