

**IN THE NAME OF GOD**



our research subject is :

# **Fluoride level in urban water distribution network in Sari & Noshahr & Tonekabon and Ramsar cities in 2011-2012**

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my associates Ms. Moradi, Mr. Abadi and Mojdeh ; and I did the mentioned research .

**Naturally fluoride occurs in low concentration of food or water.**

**Such as :**

**Fluoride con. Milk and milk products (0.01 – 0.8 mg kg<sup>-1</sup>)**



# Fluoride

- Fluorine is a common element that is widely distributed in the earth's crust and exists in the form of fluorides in a number of minerals, such as:

- fluorspar

and

- cryolite



- **Traces of fluorides are present in many waters, with higher concentrations often associated with underground sources.**
- **Fluoride is one of the drinking-water contaminants regulated by Environmental Protection Agency (EPA)**



Fluoride is the only chemical added to drinking water for the purpose of medication (to prevent tooth decay).

- **Fluoride may be found in drinking water as a natural contaminant or as an additive intended to provide public health protection from dental caries ( artificial water fluoridation )**



- **Fluoride is abundant in the environment and the main source of fluoride to humans is drinking water.**



- **It can also have an adverse effect on tooth enamel and may give rise to mild dental fluorosis at drinking-water concentrations between 0.9 and 1.2 mg per liter, depending on drinking-water intake and exposure to fluoride from other sources .**





Higher levels of fluoride have been found in barley and rice ( about 2 mg per kg ) .



In general , the levels of fluoride in meat ( 0.2 - 1.0 mg per kg ) and fish ( 2-5 mg per kg ) are relatively low.



# Materials and methods

- **This is a descriptive and sectional study.**



The Sari city is the capital of the Mazandaran province

Mazandaran province is in north of IRAN

Ramsar ,  
Tonekabon and  
Noshahr are  
other cities of  
Mazandaran  
province in north  
of Iran, on the  
coast of the  
Caspian Sea.



## Location of studied cities

This four cities were selected for this study.

- **It is done according to the number of water sources and by urban water and wastewater department consultation sampling was done according to the standards during Sept and Oct of 2011.**



### Sari City

- **The Covered Population : 313528** (three hundreds thirteen thousands five hundreds twenty eight)
- **Number of water resources (well water): 20**

### Ramsar City

- **The Covered Population : 50559** (fifty thousand five hundred fifty-nine)
- **Number of water resources (well water):12**

### Tonekabon City

- **The Covered Population : 208890** (two hundred and eight thousand eight hundred and ninety)
- **Number of water resources (well water):30**

### Noshahr City

- **The Covered Population : 48214**(forty-eight thousand two hundred and fourteen)
- **Number of water resources (well water):1 spring**

In this Slide the Covered Population and Number of water resources ( well or spring) of these cities are shown. For Example:

# **Sari City**

- **The Covered Population : 313528**
- **Number of water resources (well water): 20**

- **... of Sari City is 313528 People**
- **(three hundreds thirteen thousands five hundreds twenty eight)**
- **and .... is 20.**

- **Then samples have been taken applied Geological research Center (GRCIR) in Karaj and fluoride concentration has been measured through 9056A EPA method.**



**(= Anion Chromatography Method)**





# Fluoride concentrations (ppm) in urban water distribution network

This Table shows

in Sari & Noshahr & Tonekabon and Ramsar cities separately

Fluoride Con . (ppm) in ...City												
Noshahr		Ramsar			Tonekabon				Sari			
0.16	0.10	0.10	0.12	0.09	0.16	0.19	0.11	0.09	0.28	0.28	0.26	0.49
0.18	0.18	0.10	0.12	0.12	0.12	0.18	0.09	0.10	0.27	0.26	0.27	0.36
0.19	0.08	0.10	0.11	0.11	0.12	0.21	0.12	0.07	0.26	0.25	0.26	0.49
0.16	0.19	0.10	0.26	0.20	0.09	0.11	0.10	0.09	0.26	0.27	0.27	0.30
0.17	0.00	0.09	0.1		0.10	0.09	0.07	0.07	0.23	0.25	0.26	0.30
0.01	0.20	0.10	0.13		0.16	0.08	0.15		0.20	0.23	0.25	0.29
0.16	0.00	0.10	0.12		0.16	0.07	0.06		0.28	0.27	0.25	0.31
0.17	0.15	0.09	0.18		0.16	0.17	0.09		0.22	0.23	0.25	0.24
0.16	0.10	0.24	0.11		0.16	0.11	0.11		0.27	0.28	0.20	0.47
0.16	0.08	0.08	0.11		0.13	0.100	0.08		0.25	0.26	0.27	0.31
0.19	0.02	0.11	0.11		0.16	0.16	0.09		0.24	0.26	0.29	0.49
0.17	0.10	0.10	0.11		0.12	0.18	0.06		0.25	0.27	0.47	0.37
0.18	0.04	0.12	0.10		0.11	0.16	0.07		0.25	0.27	0.28	0.48
0.21	0.21	0.11	0.11		0.09	0.16	0.12		0.23	0.29	0.30	
0.12	0.01	0.12	0.11		0.19	0.1	0.11		0.25	0.28	0.23	
0.11	0.01	0.12	0.10		0.08	0.08	0.12		0.25	0.26	0.46	
0.20		0.11	0.25		0.13	0.09	0.08		0.26	0.32	0.30	

**This table shows that the maximum , minimum and mean levels of fluoride (mg per liter) in drinking water source in Noshahr City :**

<b>Noshahr City</b>	<b>Max</b>	<b>0.21</b>
	<b>Min</b>	<b>0.00</b>
	<b>Mean</b>	<b>0.13 ± 0.07</b>
	<b>Number of Sample</b>	<b>33</b>

That max and min levels of fluoride were 0.21 and zero also mean level of fluoride (mg per liter) in drinking water source was 0.13 ± 0.07= zero point one Three Plus–minus zero point zero Seven and the Number of Samples in the city was 33.

**The results of the study has shown that the maximum , minimum and mean levels of fluoride (mg per liter) in drinking water source were:**

<b>Ramsar City</b>	<b>Max</b>	<b>0.26</b>
	<b>Min</b>	<b>0.08</b>
	<b>Mean</b>	<b>0.12 ± 0.04</b>
	<b>Number of Sample</b>	<b>38</b>

Also this table shows that the max level of fluoride in Ramsar city was 0.26 and min level was 0.08 and mean level of fluoride (mg per liter) in drinking water source was  $0.12 \pm 0.04$  . the Number of Samples in the city was 38

**The results of the study has shown that the maximum , minimum and mean levels of fluoride (mg per liter) in drinking water source in Tonekabon City according to the following table :**

<b>Tonekabon City</b>	<b>Max</b>	<b>0.21</b>
	<b>Min</b>	<b>0.06</b>
	<b>Mean</b>	<b>0.12 ± 0.04</b>
	<b>Number of Sample</b>	<b>56</b>

**The results of the study has shown that the maximum , minimum and mean levels of fluoride (mg per liter) in drinking water source were in Sari City :**

<b>Sari City</b>	<b>Max</b>	<b>0.49</b>
	<b>Min</b>	<b>0.20</b>
	<b>Mean</b>	<b>0.29 ± 0.07</b>
	<b>N of Sample</b>	<b>63</b>

**max and min levels of fluoride were 0.49 and 0.20 also mean level of fluoride (mg per liter) in drinking water source was 0.29 ± 0.07= zero point twenty-nine Plus–minus zero point zero Seven and the Number of Samples in the city was 63.**

- **According to information from urban water and wastewater of Mazandaran and Water laboratory in the health center of Mazandaran province.**
- **Fluoride concentration in samples had measured by DR2000 and SPADNS Fluoride Reagent Solution.**

# Fluoride Con. (ppm) in underground water sources in Sari city (2011-12)

in different seasons

Season No	Spring		Mean	Summer		Mean	Autumn		Mean	Winter		Mean
1	0.23	0.34	0.29	0.22	0.48	0.35	0.47	0.23	0.35	0.46	0.46	0.46
2	0.30	0.33	0.32	0.30	0.32	0.31	0.30	0.32	0.31	0.30	0.31	0.31
3	0.40	0.40	0.40	0.40	0.40	0.40	0.45	0.40	0.43	0.31	0.40	0.36
4	0.31	0.30	0.31	0.30	0.31	0.31	0.30	0.32	0.31	0.30	0.31	0.31
5	0.42	0.41	0.42	0.40	0.41	0.41	0.40	0.40	0.40	0.40	0.40	0.40
6	0.38	0.39	0.39	0.24	0.25	0.25	0.28	0.29	0.29	0.27	0.27	0.27
7	0.30	0.26	0.28	0.30	0.25	0.28	0.25	0.30	0.28	0.30	0.25	0.28
9	0.42	0.41	0.42	0.40	0.41	0.41	0.40	0.40	0.40	0.46	0.47	0.47
10	0.35	0.36	0.36	0.39	0.40	0.40	0.35	0.36	0.36	0.36	0.36	0.36
11	0.35	0.35	0.35	0.35	0.36	0.36	0.35	0.35	0.35	0.34	0.34	0.34
12	0.51	0.51	0.51	0.50	0.51	0.51	0.52	0.50	0.51	0.49	0.50	0.50
13	0.56	0.57	0.57	0.55	0.55	0.55	0.54	0.54	0.54	0.52	0.51	0.52
14	0.36	0.36	0.36	0.35	0.36	0.36	0.34	0.34	0.34	0.32	0.33	0.33
15	0.55	0.56	0.56	0.55	0.55	0.55	0.52	0.51	0.52	0.51	0.51	0.51
16	0.28	0.30	0.29	0.36	0.37	0.37	0.35	0.35	0.35	0.36	0.36	0.36
17	0.30	0.31	0.31	0.26	0.27	0.27	0.28	0.29	0.29	0.28	0.28	0.28
18	0.29	0.33	0.31	0.49	0.50	0.50	0.47	0.47	0.47	0.29	0.30	0.30
19	0.64	0.65	0.65	0.62	0.63	0.63	0.61	0.60	0.61	0.60	0.61	0.61
20	0.50	0.51	0.51	0.50	0.51	0.51	0.50	0.52	0.51	0.42	0.42	0.42
21	0.46	0.47	0.47	0.45	0.45	0.45	0.45	0.47	0.46	0.42	0.43	0.43
<b>Mean</b>	<b>0.40</b>	<b>0.41</b>	<b>0.40</b>	<b>0.40</b>	<b>0.41</b>	<b>0.41</b>	<b>0.41</b>	<b>0.40</b>	<b>0.40</b>	<b>0.39</b>	<b>0.39</b>	<b>0.40</b>
<b>S D</b>	<b>0.11</b>	<b>0.11</b>	<b>0.11</b>	<b>0.11</b>	<b>0.11</b>	<b>0.11</b>	<b>0.10</b>	<b>0.10</b>	<b>0.10</b>	<b>0.10</b>	<b>0.10</b>	<b>0.11</b>
<b>Min</b>	<b>0.23</b>	<b>0.26</b>	<b>0.28</b>	<b>0.22</b>	<b>0.25</b>	<b>0.25</b>	<b>0.25</b>	<b>0.23</b>	<b>0.28</b>	<b>0.27</b>	<b>0.25</b>	<b>0.23</b>
<b>Max</b>	<b>0.64</b>	<b>0.65</b>	<b>0.65</b>	<b>0.62</b>	<b>0.63</b>	<b>0.63</b>	<b>0.61</b>	<b>0.60</b>	<b>0.61</b>	<b>0.60</b>	<b>0.61</b>	<b>0.64</b>

Also this Table shows

## Fluoride Con. (ppm) in underground water sources in Ramsar city (2011-12)

in different seasons

<b>Season No</b>	<b>Spring</b>	<b>Summer</b>	<b>Autumn</b>	<b>Winter</b>
1	0.41	0.40	0.03	0.03
2	0.05	0.01	0.05	0.04
3	0.17	0.19	0.17	0.16
4	0.18	0.20	0.16	0.15
5	0.11	0.11	0.02	0.02
6	0.20	0.26	0.20	0.19
7	0.06	0.38	0.02	0.02
8	0.14	0.30	0.14	0.13
9	0.21	0.15	0.15	0.14
10	0.13	0.11	0.10	0.09
11	0.12	0.20	0.18	0.18
12	0.04	0.09	0.09	0.08
<b>Mean</b>	<b>0.15</b>	<b>0.20</b>	<b>0.11</b>	<b>0.15</b>
<b>S D</b>	<b>0.10</b>	<b>0.12</b>	<b>0.07</b>	<b>0.10</b>
<b>Min</b>	<b>0.04</b>	<b>0.01</b>	<b>0.02</b>	<b>0.04</b>
<b>Max</b>	<b>0.41</b>	<b>0.40</b>	<b>0.20</b>	<b>0.41</b>



# Fluoride Con. (ppm) in underground water sources in Tonekabon city (2011-12)

in different seasons

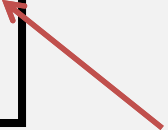
Season No	Spring	Summer	Autumn	Winter	Season No	Spring	Summer	Autumn	Winter
1	0.16	0.13	0.12	0.08	16	0.18	0.18	0.14	0.08
2	0.19	0.17	0.11	0.11	17	0.24	0.09	0.09	0.12
3	0.11	0.11	0.09	0.16	18	0.12	0.13	0.11	0.11
4	0.12	0.13	0.13	0.09	19	0.15	0.21	0.13	0.07
5	0.16	0.29	0.1	0.13	20	0.23	0.14	0.12	0.09
6	0.21	0.16	0.12	0.12	21	0.09	0.08	0.08	0.1
7	0.26	0.18	0.16	0.08	22	0.08	0.08	0.09	0.11
8	0.06	0.11	0.08	0.09	23	0.11	0.11	0.12	0.08
9	0.1	0.08	0.09	0.08	24	0.15	0.07	0.13	0.13
10	0.15	0.16	0.12	0.11	25	0.18	0.12	0.15	0.11
11	0.21	0.18	0.11	0.12	26	0.11	0.08	0.11	0.12
12	0.28	0.21	0.16	0.11	27	0.08	0.11	0.08	0.09
13	0.11	0.19	0.13	0.14	28	0.15	0.09	0.09	0.08
14	0.08	0.07	0.08	0.09	29	0.09	0.15	0.12	0.11
15	0.11	0.1	0.11	0.11	30	0.12	0.12	0.09	0.13
	Spring	Summer	Autumn	Winter					
<b>Mean</b>	0.15	0.13	0.11	0.15					
<b>S D</b>	0.06	0.05	0.02	0.06					
<b>Min</b>	0.06	0.07	0.08	0.06					
<b>Max</b>	0.28	0.29	0.16	0.28					

Also this table show :

- **Also water supply of Noshahr city is an spring that fluoride concentrations were 0.12 , 0.00 , 0.08 and 0.21 ppm in spring, summer, autumn and winter respectively.**

- **Since fluoride is determined according to ambient temperature , To determine the optimal amount of fluoride and local standards, average maximum daily temperature in seasons were received from Mazandaran Meteorology Organization.**

- **The suggested fluoride concentration for fluoridated water supply system can be estimated from follow relation :**

$$F \text{ (mg/l)} = \frac{0.34}{0.038 + (0.0062 T^{\circ f})}$$


Fluoride concentration according to the formula

## **Reference:**

Fawell JK, Bailey K. Fluoride in drinking-water: World Health Organization 2006

**Comparison of Fluoride concentrations (ppm) in urban water distribution network \***  
**due to the optimal fluoride the seasonal average maximum daily temperature\*\***

City	T °f in Sep	T °f in Oct	Fluoride(mg/l)		
			Mean*	in Sep* *	in Oct **
<b>Noshahr</b>	<b>78.44</b>	<b>74.12</b>	<b>0.154</b>	<b>0.65</b>	<b>0.68</b>
<b>Ramsar</b>	<b>78.44</b>	<b>74.48</b>	<b>0.108</b>	<b>0.65</b>	<b>0.68</b>
<b>Tonekabon</b>	<b>78.44</b>	<b>74.48</b>	<b>0.136</b>	<b>0.65</b>	<b>0.68</b>
<b>Sari</b>	<b>83.84.</b>	<b>78.26</b>	<b>0.255</b>	<b>0.61</b>	<b>0.65</b>

the average maximum daily temperature in Noshahr city was 78.44 Fahrenheit in september and 74.12 in october and Fluoride concentrations (ppm) in urban water distribution network was 0.154 mg per liter and the Fluoride concentrations (ppm) according to the seasonal average maximum daily temperature were Obtained 0.65 and 0.68 ppm in september and october respectively.

**The suggested fluoride .(ppm)**

# Discussion & Conclusion



- **It was emphasized that in setting national standards for fluoride, it is particularly important to consider climatic conditions, average annual temperature, Protectors of teeth , volume of water intake and intake of fluoride from other sources (food, air , ...)**

instance (And etcetera)



**( EPA 2012)**

in 2012 the Environmental Protection Agency explained that:

**The Maximum Contaminant Level Goal (MCLG) and The Maximum Contaminant Level (MCL) for fluoride are 4 mg/l (ppm) also Secondary Drinking Water Regulations (SDWR ) is 0.2 mg/l.**

<b>MCLG</b>	<b>MCL</b>	<b>SDWR</b>
<b>4 mg/l</b>	<b>4 mg/l</b>	<b>0.2 mg/l</b>



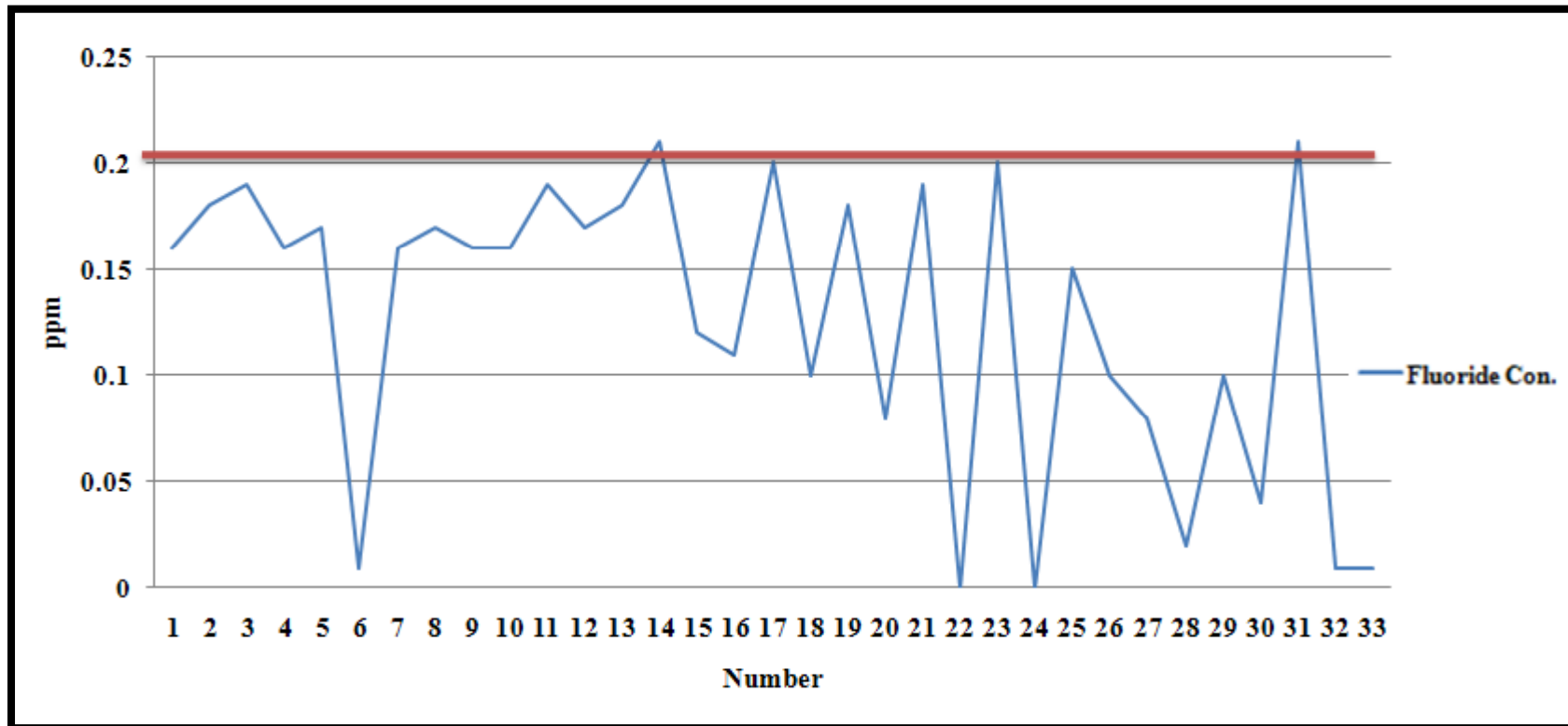
in 2008 [World Health Organization](#) and in 2009 [Institute of Standards & Industrial Research of Iran](#) explained that

**Guideline value (Min and Max) are 0.5 and 1.5 mg/l .The amounts added to drinking-water are such that final concentrations are between 0.5 and 1 mg/l.**

<b>WHO 2008 and ISIRI 2009</b>	
<b>Min</b>	<b>Max</b>
<b>0.5 mg/l</b>	<b>1.5 mg/l</b>

**The fluoride in final water is always present as fluoride ions, whether from natural sources or from artificial fluoridation**

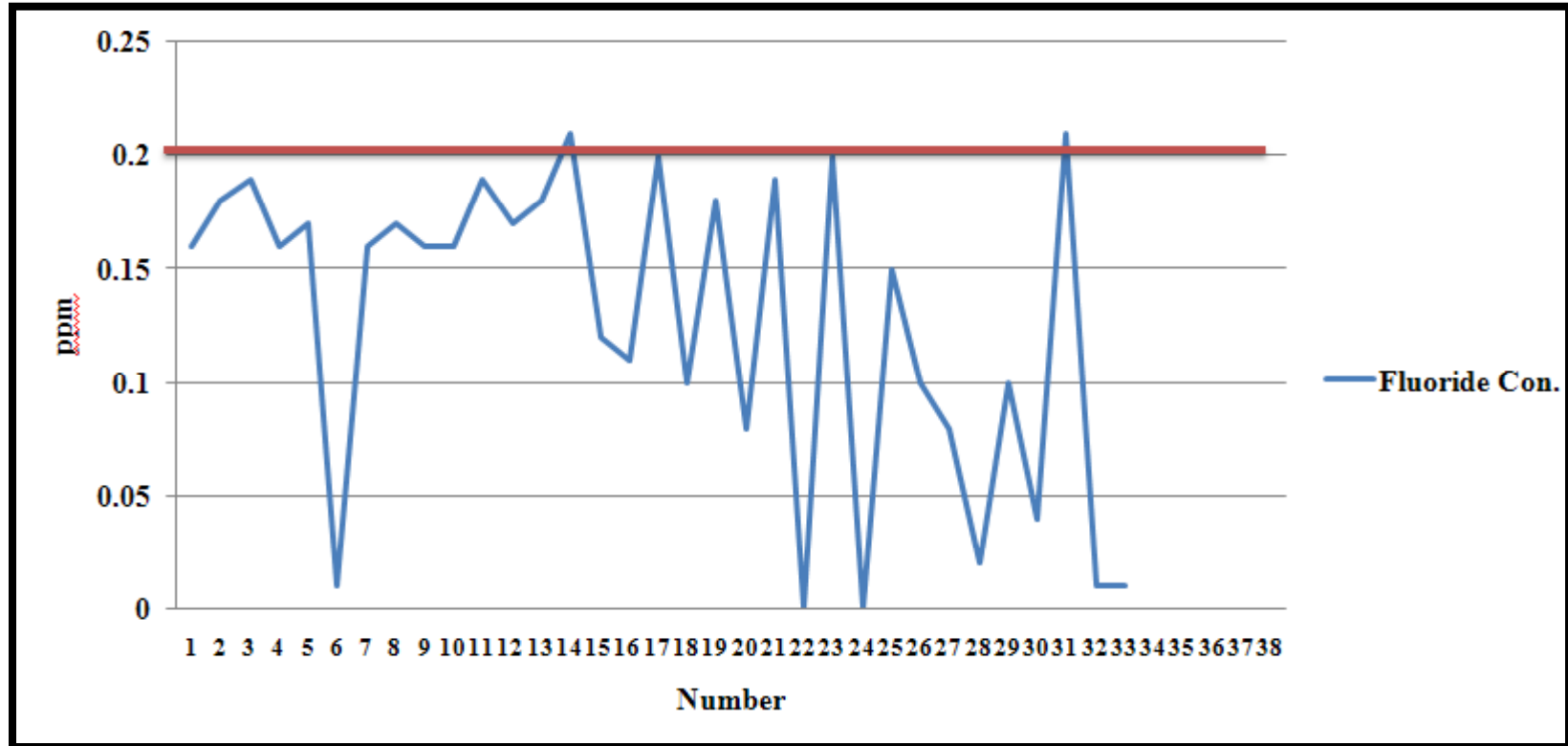
**That Fluoride concentration in 12% of the samples in this city were relevant to SDWR ( 0.2 ppm) also 100% (one Hundred percent) of the samples were lower than 0.5 ppm.**



This figure shows

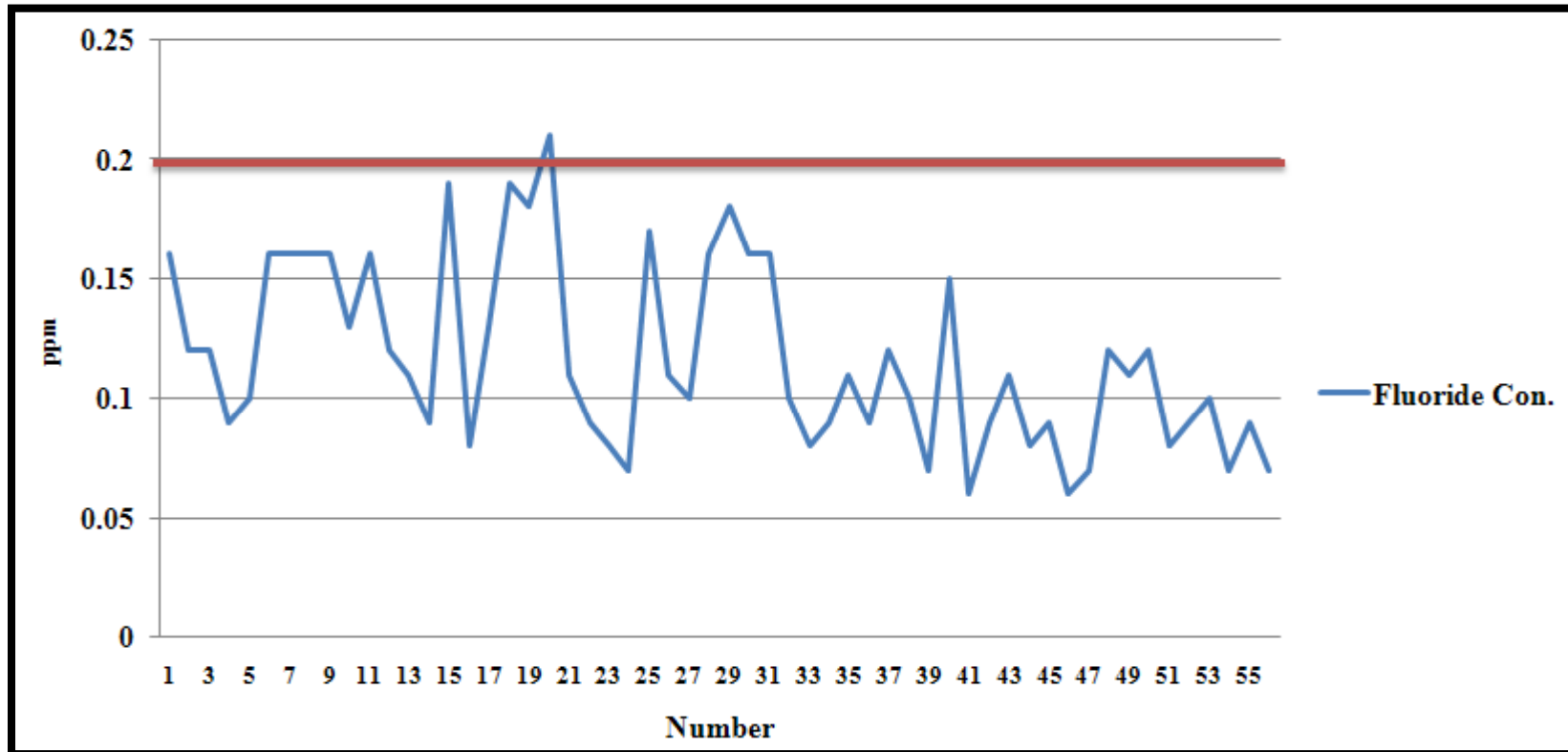
**Fluoride concentrations (ppm)  
in urban water distribution network in Noshahr city in 2011**

**Fluoride concentration in 11% of the samples in this city were relevant to SDWR ( 0.2 ppm) also 100% (Hundred percent) of the samples were lower than 0.5 ppm.**



**Fluoride concentrations (ppm)  
in urban water distribution network in Ramsar city in 2011**

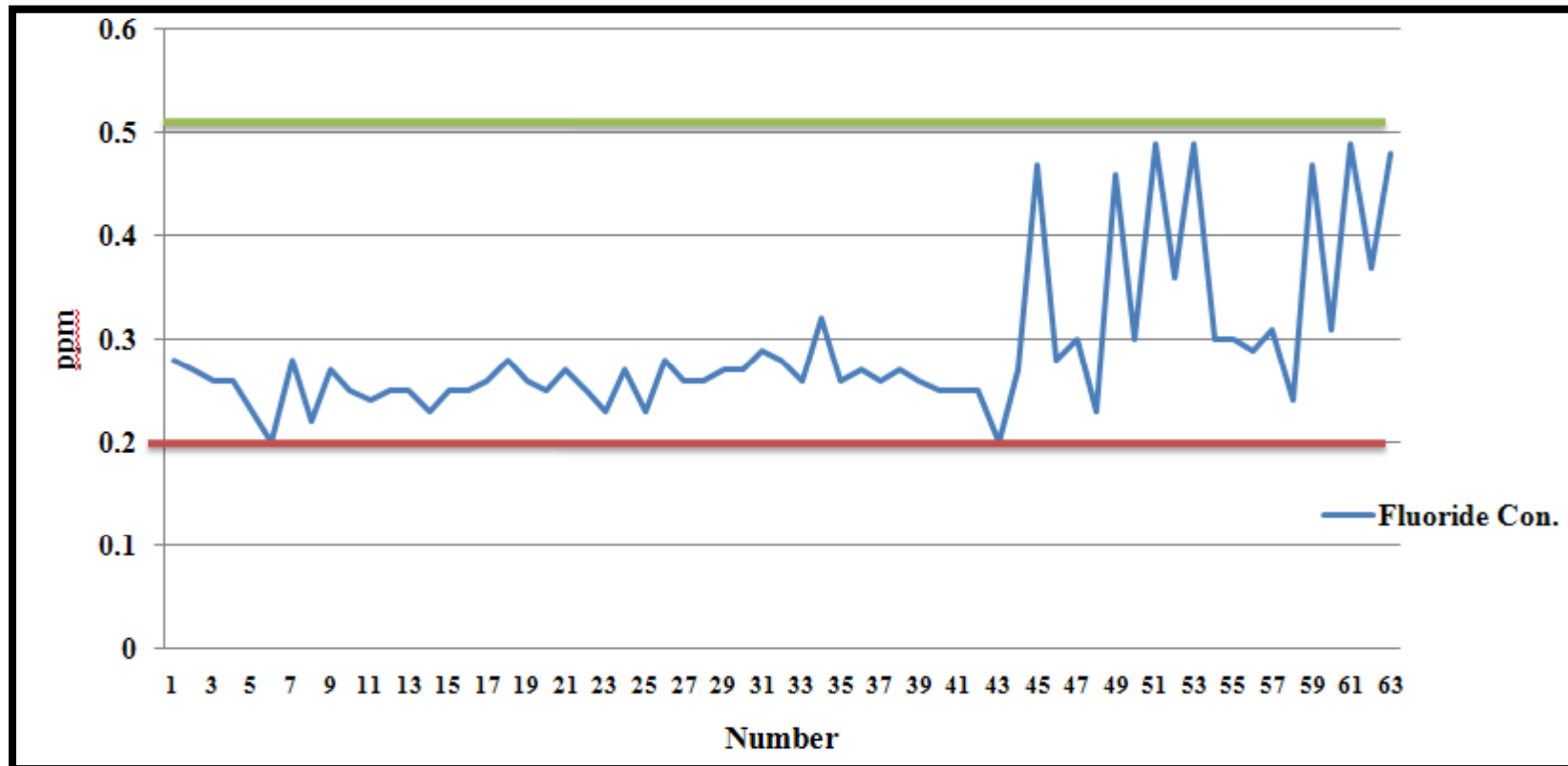
**Fluoride concentration in 0.02 % of the samples in this city were relevant to SDWR ( 0.2 ppm) also 100% (one Hundred percent) of the samples were lower than 0.5 ppm.**



This figure shows

**Fluoride concentrations (ppm)  
in urban water distribution network in Tonekabon city in 2011**

**Fluoride concentration in 100 % of the samples in this city were relevant to SDWR ( 0.2 ppm) also 100% (one Hundred percent) of the samples were lower than 0.5 ppm.**

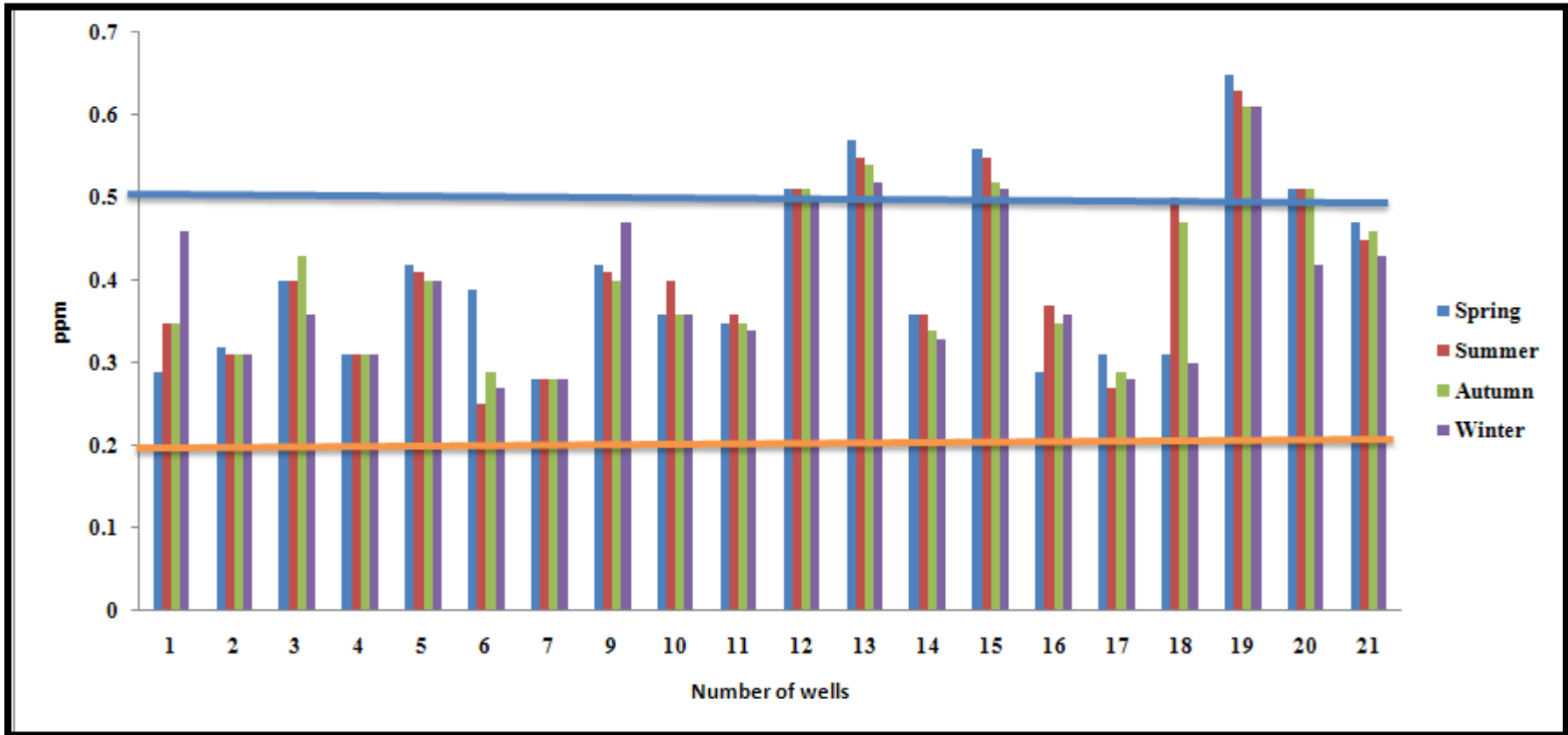


**Fluoride concentrations (ppm)  
in urban water distribution network in Sari city in 2011**

- **According to information from urban water and wastewater of Mazandaran and Water laboratory in the health center of Mazandaran province, the results showed that:**

This Table shows 100 % of the samples of sari city Fluoride concentration were relevant to Secondary Drinking Water Regulations (SDWR = 0.2 ppm) and 25% of the samples were (> 0.5 , 0.5 – 0.65 ppm )in Spring , Summer and Autumn also 20% in winter .

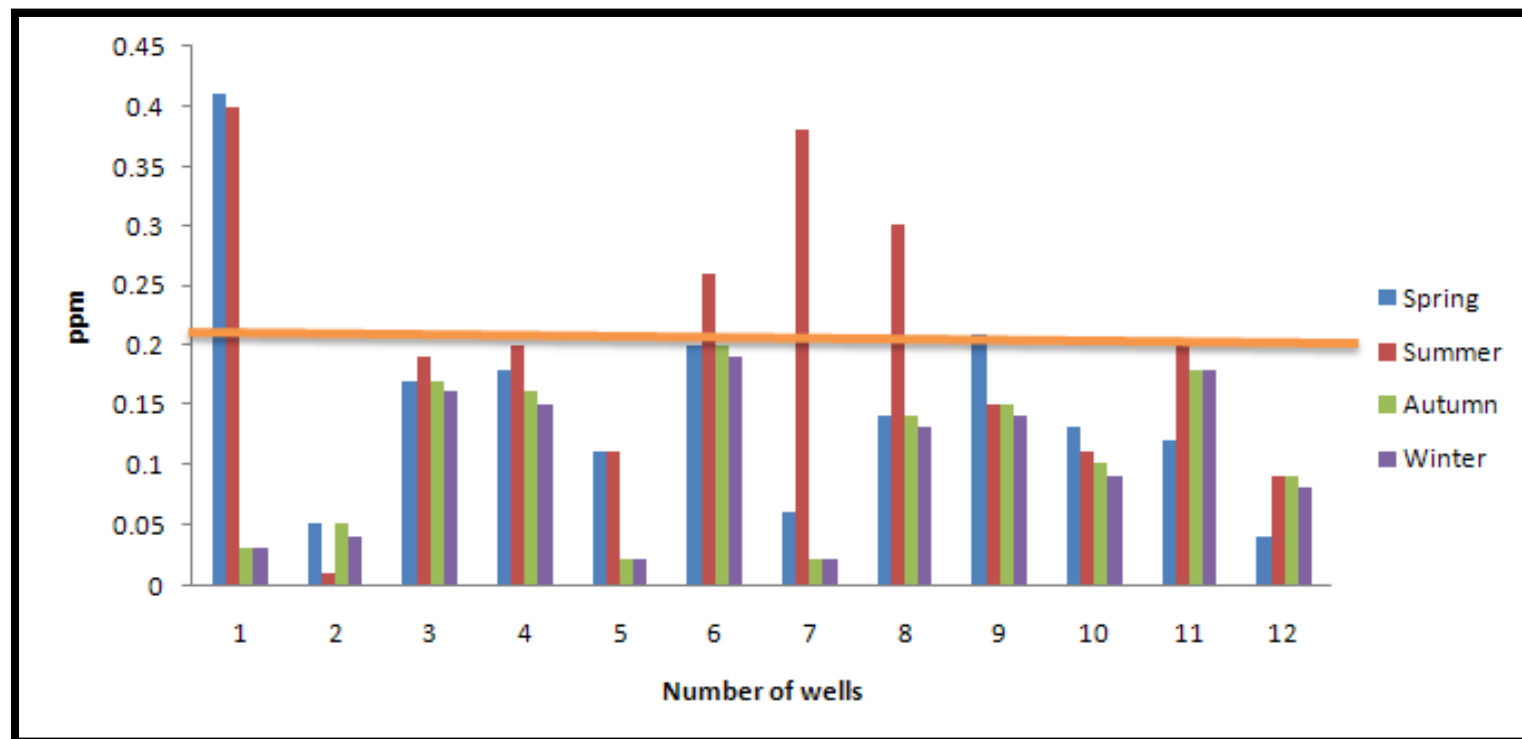
Bigger than five



## Fluoride Con. (ppm) in underground water sources in Sari city in different seasons (2011-12)



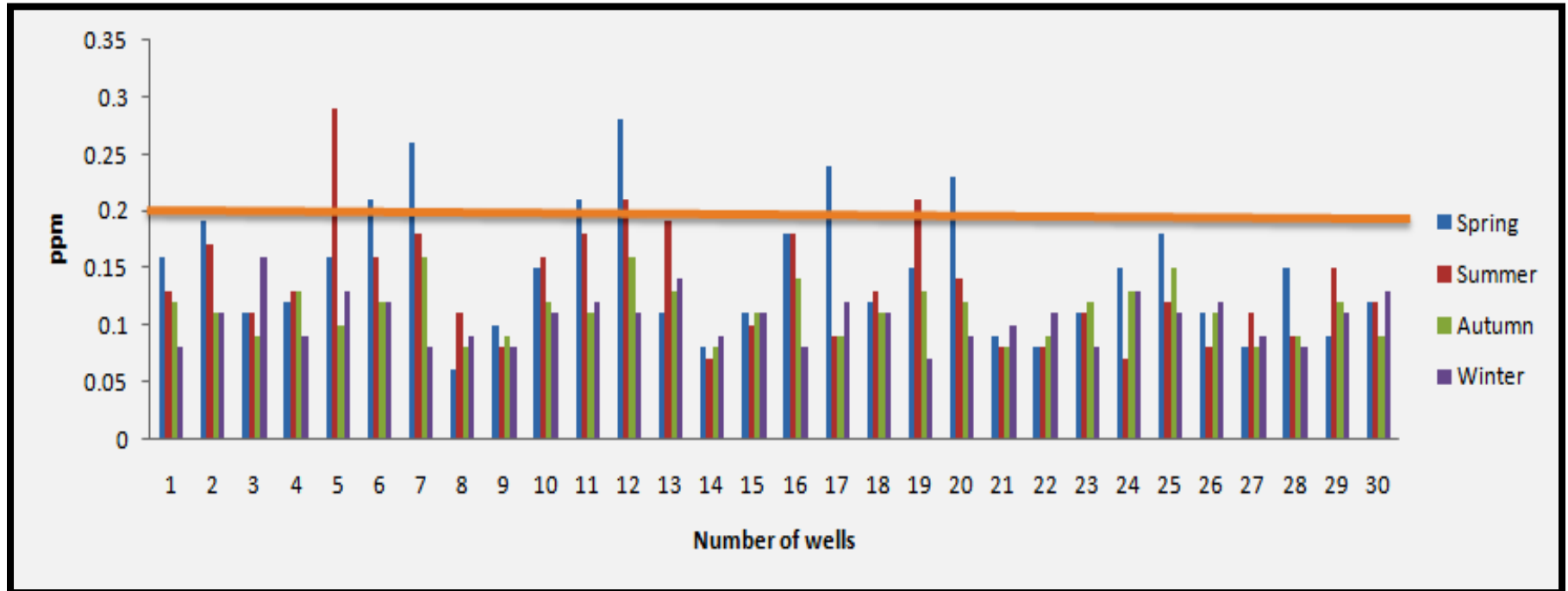
**Fluoride Con. (ppm) in underground water sources were relevant to SDWR ( 0.2 ppm) in spring , Summer , Autumn and Winter 25 % , 50 % , 0.00% and 0.08 % of the samples respectively.**



**Fluoride Con. (ppm) in underground water sources in Ramsar city in different seasons ( 2011- 2012)**

Graph shows that :

**Fluoride Con. (ppm) in underground water sources were relevant to SDWR ( 0.2 ppm) in spring , Summer , Autumn and Winter 20% , 10% , 0.00% and 0.00 % of the samples respectively.**



**Fluoride Con. (ppm) in underground water sources in Tonekabon city in different seasons ( 2011- 2012)**

Graph shows that :

**The protective effects of fluoride increase with fluoride concentration of more than 2 mg per liter in drinking-water ; the minimum required concentration of fluoride in drinking-water is approximately 0.5 mg/l**

- **According to the results of fluoride concentration in studied cities (in Urban water distribution network) , Fluoride levels were lower than universal standards (MCLG , MCL = 4 ppm) , national (0.5 – 1.5 ppm) and climatic conditions (0.61 – 0.68 ppm).**

**100 % of the samples of sari city ,0.11 % of Ramsar city , 0.02 % Tonekabon city and 12% Noshahr city Fluoride concentration were relevant to Secondary Drinking Water Regulations (SDWR = 0.2 ppm) in urban water distribution network.**

- **The Fluoride levels in studied cities in urban water distribution network were lower than universal standards, national and climatic conditions ,thus it is recommended that adding fluoride to food chain of the studied citizens should be noticed by the relevant authorities.**



**Thanks to the Laboratory applied Geological research Center (GRCIR) in Karaj ; urban water and wastewater department of Mazandaran and also special Thanks to all those who involved in this conference prepration .**



*Thanks for your attention*

