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Under the Guidance of Dr. Devaraj. P

B. Tech Project Report

On

Fluoride Contamination

Submitted in Partial Fulfillment for the B. Tech Second Year

Human Geography and Societal Needs (HS202)

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This is to certify that the B. Tech project title "Fluoride Contamination" prepared by (names of the students) is approved for submission for the course on Human Geography and Societal Needs in the Department of Humanities and Social Sciences, Indian Institute of Technology, Ropar.

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Declaration

I hereby declare that the report entitled "Fluoride Contamination" submitted by me, for the partial fulfilment of the course on Human Geography and Societal Needs (HS 202) in the second year of the B. Tech programmed in IIT, Ropar. The work carried out by us under the supervision of Dr. Devaraj. P, Assistant Professor, Department of Humanities and Social Sciences. We further declare that this written submission represents our ideas and other's ideas or words have been included. We also have adequately cited and referenced the original sources in the case of other's ideas or words. We have not misrepresented any idea/data/fact/source to the best of our knowledge. Therefore, we affirm that our group has adhered to all principles of academic honesty and integrity.

Place: Ropar

Date:17 May 2021

Signature of the Candidates

Acknowledgement

Project is like a combination of theoretical and practical work. First, we would like to thank Dr. Devaraj. P. This would not have been possible without him, as all through the course he has guided us and corrected us at every wrong turn. We are extremely thankful to the villagers of the village Umarda and Debari, Udaipur, Rajasthan for their cooperation and their hospitality throughout all field trips. We extend our gratitude to IIT Ropar for giving us this opportunity. We also acknowledge with a deep sense of reverence, our gratitude towards our parents and members of our families, who have always supported us morally as well as economically. At last, but not least gratitude goes to all our batchmates and other staff who directly or indirectly helped us to work on this project. Any omission in this brief acknowledgment does not mean lack of gratitude.

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INTRODUCTION AND OBJECTIVE

The Problem selected by us is Fluorosis. Fluorosis is caused by excess fluoride ion in water, food, medicines etc. The two major types of fluorosis are dental and skeletal fluorosis. When a human consumes Fluoride ion more than the safety limit it starts accumulating in the body and replaces calcium on the bones and teeth which are termed as skeletal and dental fluorosis respectively. The safety limit of fluoride ion as specified by WHO is 1.5ppm. A small amount of fluoride is helpful for the body as depicted by data but even a slightly larger amount is harmful. The state of Rajasthan has an extremely high concentration of fluoride in water which is mainly because of the rich mineral soil of Rajasthan and factories which are responsible for Fluoride release in water. The Fluoride concentration in water in some districts reaches even around 9ppm which is extremely high and alters the body structure and halts growth. There are large number of villages in Rajasthan and many people in villages are illiterate and hence have no knowledge about the safe limit of fluorosis and they consume the water available to them and fall prey to the disease of fluorosis. The disease is more prevalent in children because children are in growing stage and concentration of fluoride easily affects them and as a result some of them are not even able to walk as it alters the body structure of children as a result, they are not able to live their lives to the fullest and contribute to the society and contribute towards the economy of the country.

THEORETICAL AND CONCEPTUAL ASPECTS OF THE PROBLEM

The theory data tell us that it is a major problem and if not solved will perish the condition of the country. The theory tells us that the number of villages with fluoride concentration more than 3mg/1 has increased over the past 10 years. The problem is not only limited to Rajasthan but also to the other states of the country making it a major problem for the country. The villagers are highly dependent on ground water and it has a highest concentration of fluoride and hence it is prevalent in the state and also the same water is used to water the fields and as a result it can be taken into the body through the food. Also, Medicines and toothpaste have fluoride concentration and excess usage can be harmful to the body especially in younger children and hence should be avoided for the best and even if used they should be used in moderation. Drinking fluoride contaminated water does not have immediate consequences rather it affects slowly due to continuous long exposure so people underestimate the problem and overlook the steps needed to stop this menace. This should not be overlooked. Illiteracy is a major cause of unawareness. In the past government has made many steps trying to address the problem but it has not resulted in completely eradicating the problem since the population of the country is very high and even if some parts are given the required knowledge about the problem and the basic requirements such as water filtration units, not all parts of the country can be given such amenities in old times but now world has evolved. Nowadays Media is prevalent in all parts of the country , almost every household receives a newspaper and many have television as well so communication Is very easy also many innovations have come up in the sector .The objectives of the government should be to spread mass awareness of the problem establish filtration units in as many households as possible ,encourage people to practice rain water harvesting as t is the simplest and cheapest method of acquiring fresh water also rain water is the purest form of water. There are many innovations made in the field which are cost effective and helpful like the water pyramid which also uses evaporation as the main process for purification. The problem is affecting the youth of the country especially Rajasthan and should be addressed as soon as possible because youth are the future of the country and act as an asset for the country and if they are harmed t is ultimately affecting the overall development of the country and hence some major steps should be taken by the government towards the problem to try to finish it completely and help the country grow.

METHODOLOGY

STATE DESCRIPTION

Geographically Rajasthan is the largest state of India. The state is divided into 33 districts and 7 divisions. It has a land area of 342,239 sq km and population (2011) 68,621,012. It shares its boundaries with Punjab, Haryana, Uttar Pradesh, Madya Pradesh, Gujarat and Pakistan. It has a literacy rate of 66.1%. Its Major attractions include Indus valley civilization, Aravalli mountain, Dilwara temple, Mount Abu, Ranthambore national park etc. There are a total of 44672 villages in Rajasthan.

VILLAGE DESCRIPTION

Debari is a village in Girwa Tehsil in Udaipur District of Rajasthan state. It is situated 12km away from Udaipur. Total geographical area of the village is 1058.45 hectares. Total population of the village is 4052. There are about 825 houses in the village debari. Pin code of the village is 313024. Village Debari is also a Gram Panchayat.

Another Village we visited is Umarda. It is also in the Udaipur District. Population of Umarda village is 4506. Area of the village is 16.32 sq km. it is situated at a distance of 12.5 km from Udaipur. Pin Code of Umarda is 313003.

Methods of Data collection

There are two types of data collection.
1. Primary
2. Secondary

These are the six types of data collection methods

- Research papers
- Articles
- Government survey (RGNDWM)
- Worldwide survey (WHO, etc.)
- Video analysis
- Self-analysis data

Udaipur zinc smelter plant

The site for collecting data is selected near the zinc selter which is situated at Debari (Udaipur, Rajasthan). The samples of vegetables and soil are collected from different distances 0,1,2,5,10 km from the factory. Three samples of soil {from upper (0 -20cm) and deep layer (20 - 40cm)} and three samples of vegetables also were collected from above given distances and sent to the laboratory for determining the fluoride content and water samples from different sources also collected from these distances to analyses fluoride content variation from zinc smelters.

Reference

Distance (km)	F conc. in vegetables (ppm) (Mean ± SD)	F conc. in soil (ppm) (Mean ± SD)	
		Upper layer	Deeper layer
0	0.71 ± 0.90	189 ± 1	139 ± 1
1	0.66 ± 0.84	179 ± 1	128 ± 1
2	0.56 ± 0.71	168.3 ± 0.58	108 ± 0
5	0.39 ± 0.53	101.67 ± 0.58	97.33 ± 0.58
10	0.36 ± 0.69	101.67 ± 0.58	98 ± 0

SD – Standard deviation

F conc. in vegetables (ppm) Udaipur
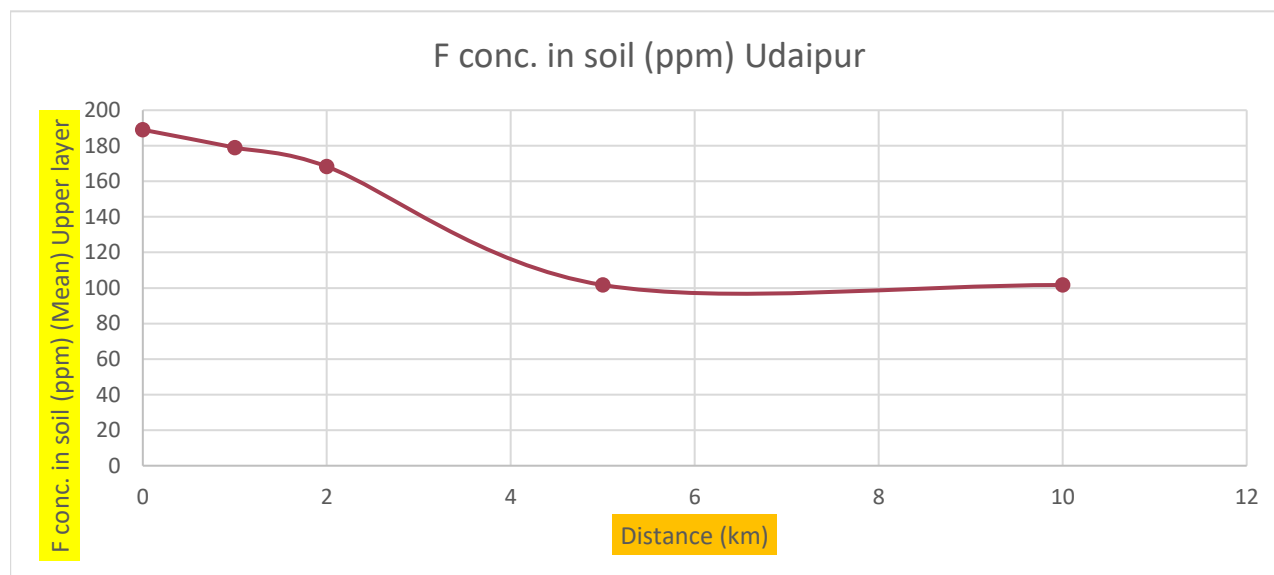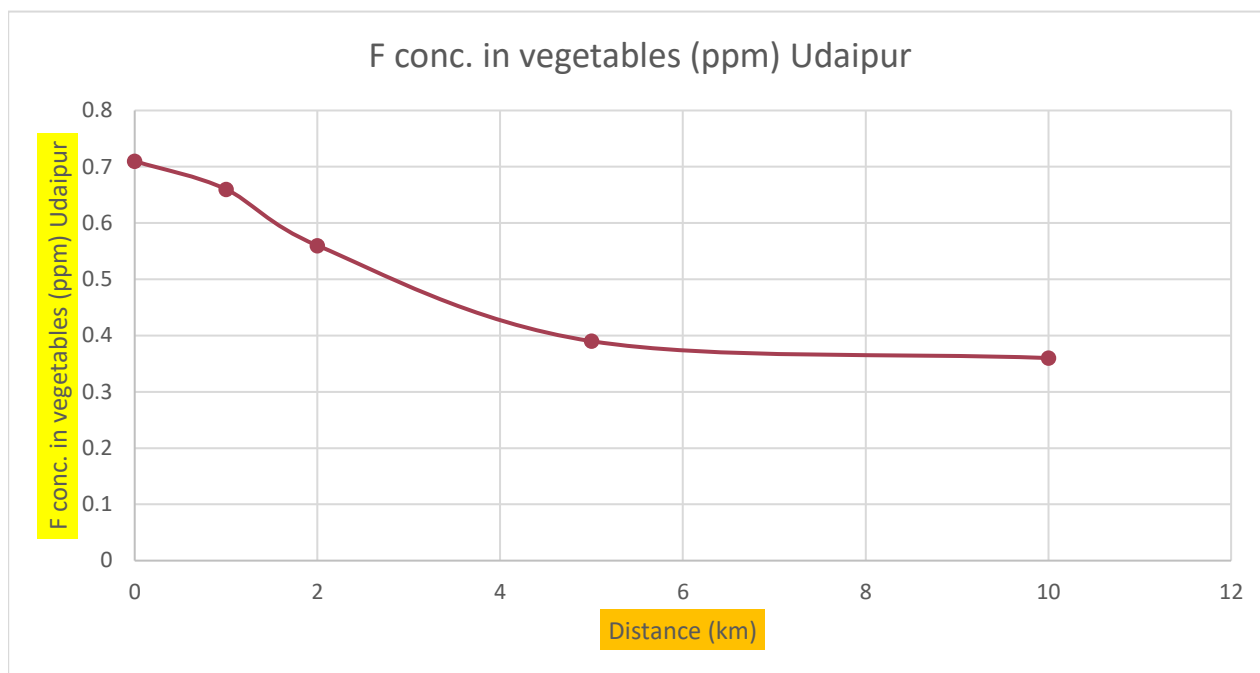
Umarda Village (FERTILIZER)

Another site for collecting data is near superphosphate fertilizer plants situated at Umarda village (12km from Udaipur) chosen for collecting samples. First samples were collected from Umarda village plants. As these plants are emitting Fluoride fumes or gases into the nearby environment. Some samples are collected from different water sources within 1km radius of the plant and determine the variation of fluoride content in these sources with distance and some samples are collected from fodder.

S.NO.	Samples Source	Fluoride Concentration
1.	Fodder	534.4±74.9 mg/kg
2.	Pond water	1.19±0.29 mg/L
3.	Tube-well water	0.479±0.351 mg/L

Reference

ANALYSIS OF DATA

Table 1. District-wise distribution of fluoride (F) in drinking groundwater sources of Rajasthan

| District	F content (ppm)			District	F content (ppm)		
	Range	Average	Reference		Range	Average	Reference
Ajmer	0.1–12.0	1.6	16	Jalor	0.0–14.2	2.4	29, 56
	0.0–16.2	2.94	17		0.0–14.0	–	29
	0.1–12.0	–	18		1.5– >10.0	–	23
	0.24–17.6	–	19	Jhalawar	0.0–1.2	0.19	17
	0.25–16.9	–	20		0.1–1.5	–	57
	0.3–14.2	–	21	Jhunjhunu	0.0–12.0	–	30
Alwar	0.0–4.0	–	22		0.6–8.8	–	27
	1.5–9.9	–	23		1.5– >3.0	–	58
	0.45–3.6	–	24		0.6–1.4	–	59
	1.1–1.8	–	25		0.1–1.5	–	60
Banswara	0.0–3.2	0.81	17	Jodhpur	0.1–12.8	–	61
	0.1–4.6	3.75	26		0.0–11.2	–	22
Baran	0.0–2.0	0.59	17, 27		0.0–22.0	2.4	29
Barmer	0.2–10.9	–	22, 28	Karauli	0.5–4.5	–	27
	0.0–19.6	2.3	29		1.5– >3.0	–	58
	0.0–18.0	–	30, 31	Kota	0.0–4.8	0.95	17, 39
Bharatpur	0.1–18.4	1.34	32	Nagaur	0.1–12.3	–	22
	0.1–18.4	–	22		1.0–2.0	–	62
	1.5–4.9	–	23		0.0–90.0*	3.2	29
Bhilwara	2.1–24.0	6.0	33		0.0–34.0	–	30
	0.1–24.0	–	22		1.5– >10.0	–	23
	0.0–7.4	1.77	17		0.3–5.9	–	63
	0.4–13.0	8.72	34–38		0.64–14.62	–	64, 65
Bikaner	0.0–20.0	–	22, 28		1.1–6.6	–	66
	0.0–12.0	2.1	30		0.5–8.5	–	67-70
	1.5–9.9	–	23	Pali	0.0–18.3	6.2	29
Bundi	0.1–6.8	0.80	39		0.0–14.0	–	30
	0.0–5.0	0.88	17		0.0–9.9	–	23
Chittorgarh	0.0–6.6	0.67	17	Pratapgarh	0.1–4.7	2.41	44, 71
Churu	0.0–30.0	1.9	22, 25	Rajsamand	0.0–4.5	0.99	17
	0.0–32.0	–	30	Sawai Madhopur	1.5– >10.0	–	23
	0.1–14.0	–	40		0.1–3.6	–	72
	1.2–7.8	–	41	Sikar	0.0–15.0	–	30
Dausa	1.5–9.9	–	23		1.5– >10.0	–	23
	0.2–14.9	–	42	Sirohi	0.0–8.0	–	22
Dholpur	1.5–4.9	–	23		1.5–9.9	–	23
Dungarpur	0.0–6.2	1.25	17		1.0–16.0	11.17	73
	0.1–10.8	6.0	43, 44		1.0–14.0	–	74
	1.5–9.9	–	23		0.18–13.0	–	75
Hanumangarh	0.5–8.5	5.75	45	Sri Ganganagar	0.1–28.2	–	76
	1.0–4.78	2.82	46		0.0–26.0	1.6	29
Jaipur	4.5–28.1	12.2	47		0.5–5.0	3.5	45
	1.2–15.0	6.3	48	Tonk	0.0–4.0	–	22
	0.1–28.1	–	22		1.50–11.82	–	77
	1.5– >10.0	–	23		0.08–11.30	–	78
	2.17–10.14	–	49		0.5–10.7	–	79
	0.4–5.4	–	50		0.26–9.60	–	80
	1.20–18.0	–	51		0.6–15.8	–	81
	0.1–12.5	–	52		1.10–14.62	–	82
	0.20–6.45	–	53	Udaipur	0.1–21.6	4.5	83
	0.19–3.70	–	54		0.0–11.65	1.11	84
Jaisalmer	0.0–8.0	–	22		0.1–21.6	–	22
	0.0–8.0	1.7	29		0.0–5.9	0.84	17
	0.0–12.0	–	30		0.1–7.0	5.87	61
	3.0– >10.0	–	23				
	0.6–4.74	–	55				

*Source is open well, now closed.

Table 2. Categorization of 33 districts of Rajasthan based on F range in drinking water

Group one F 1.0–5.0 ppm +	Group two F 5.1–10.0 ppm + +	Group three F 10.1–20.0 ppm + + +	Group four F > 20.0 ppm + + + +
Jhalawar	Chittorgarh	Dungarpur	Udaipur
Baran	Bundi	Jhunjhunu	Jodhpur
Rajsamand	Hanumangarh	Jaisalmer	Bhilwara
Karauli	Alwar	Jalore	Jaipur
Banswara	Sawai Madhopur	Dausa	Sri Ganganagar
Pratapgarh		Sika	Churu
Kota		Tonk	Nagaur
Dholpur		Sirohi	
		Ajmer	
		Pali	
		Bharatpur	
		Barmer	
		Bikaner	

+, + +, + + + and + + + +, Degree of F intolerance.

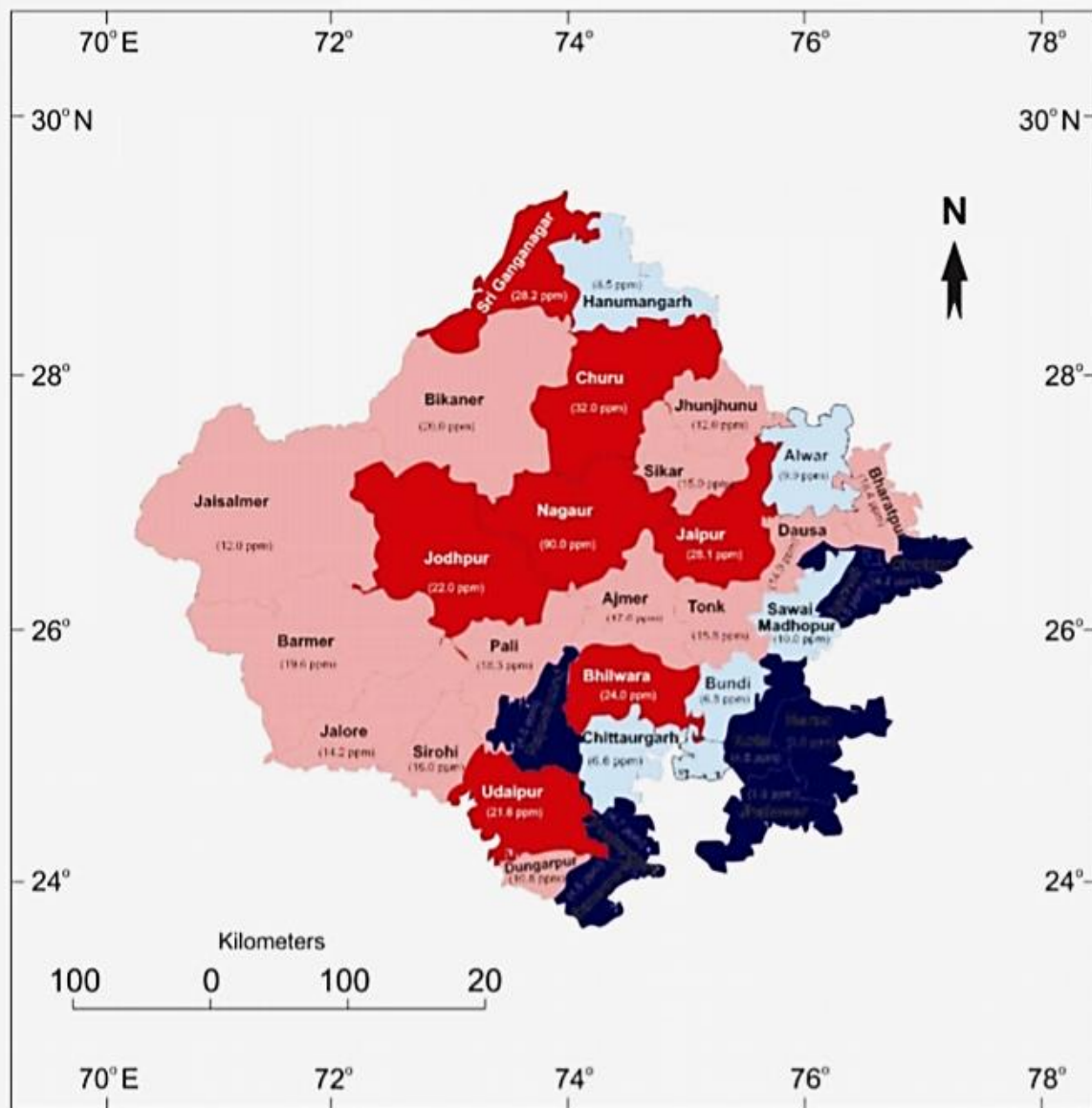| Rocks	Flouride range (in ppm)	Average (in ppm)
Basalts	20-1060	360
Granites and Gniesses	20-2700	870
Shales and Clasy	10-2700	800
Line stones	0-1200	220
Sandstones	10-880	180
Phosphorite	24000-41500	31000
Coal (ash)	40-480	80
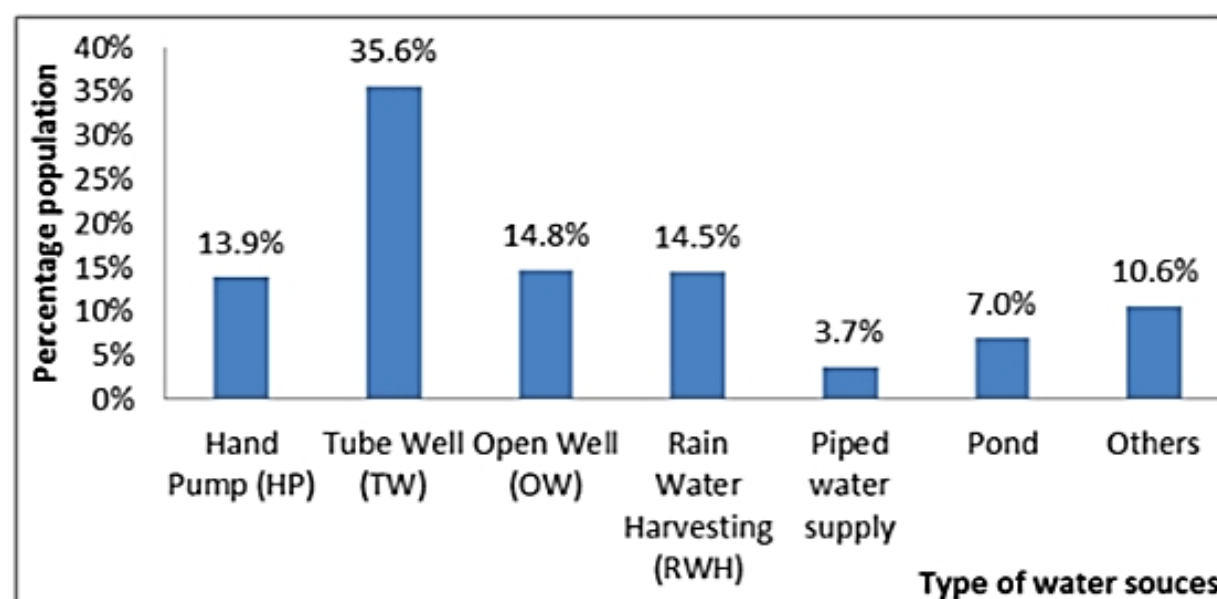
Figure 1. Map of Rajasthan showing district-wise fluoride distribution in groundwater sources. Districts having fluoride in the range 1.5–5.0, 5.1–10.0, 10.1–20.0 and >20.0 ppm are indicated by deep blue, light blue, light red and deep red colours respectively.

We collected quantitative data in our study.

Quantitative Data

1. Fluoride concentration in vegetables and soil at a distance of around 10 km from Zinc Smelter Plant Debari (Udaipur).

2. Fluoride concentration in different water sources near superphosphate fertilizer plants situated at Umarda village.

Through our collected data we observed that concentration of fluoride is higher in the region situated nearer to the industrial area. In soil fluoride concentration was found higher in the upper layer as compared to lower layer. By analyzing the above tables and graph we get that the major cause of fluorosis in Rajasthan is groundwater and the most affected areas of Rajasthan are Udaipur, Churu, Jaipur, Nagaur, Bhilwara, Sri Ganganagar and Jodhpur.

FINDINGS

We find main sources which cause fluorosis like: -1. Ground water 2. Food items 3. Industrial fluoride emission. The main reason for fluorosis is observed due to high concentration in drinking water.

A. Water

1. Water is rightly equated with life because life is not possible without water. It is the most essential ingredient in our life for survival. We can survive for several weeks without food, but without water we cannot survive for even a few days. Groundwater is generally less susceptible to contamination and pollution as compared to surface water. Most of the population in the village is solely dependent on groundwater, which is depleting at a fast rate. Shortage of drinking water occurs in the summer seasons in Rajasthan. In our field site there is a high concentration of fluoride found in groundwater.

2. In villages we found that people are now using public water tanks which are made for rainwater harvesting. People are using drinking water from these tanks. As GOVT. of Rajasthan provides subsidies for making water tanks to collect rainwater.

3. We find during field visit area Nagaur (**Village: -Thakariyawas**) that there are almost 75%-80% houses that have water tanks for collecting rainwater for drinking purposes (Made under **Mukhya Mantri Jal Swavlamban Abhiyan.)**

4.Mahatma Gandhi National Rural Employment Guarantee Act 2005, is an Indian labor law and social security measure that aims to guarantee the 'right to work. Under this act in villages of Rajasthan (near Nagaur) people are making new Ponds and Bawari to store rain water. In Nagaur (**Village: -Thakariyawas**) there are about 6 ponds created and maintained before summer season under MGNREGA. As rain water sources are increasing in villages as result more sources available for drinking water which have very less concentration of water and that results decrease in fluorosis.

5.For drinking water problems there are many policies and techniques by the government. and local administration is applied. We find 50% efficient techniques in decreasing fluorosis cases in Rajasthan and found many people in villages do not know about these.

A. Project Sarita (Based on Nalgonda technique launched in Dungarpur, Rajasthan)

B. National Rural Drinking Water Program (NRDWP)

C. RAJASTHAN INTEGRATED FLUOROSIS MITIGATION PROGRAMME (RIFMP)

 B. Food: -

1. As food is very important for survival and an essential part for us. Then we focus on food items which are causing fluorosis.

2. In our field site people are consuming Bajra, Wheat, Rice, Supari, Paan, Tea, Green and Red Gram Dal, many vegetables and fruits which contain high fluoride concentration and results in Fluorosis. We saw that local people are do not aware about food items which are having high concentration of fluoride.

3. During field visits to villages we know from people about what type of food they are using. And match data to know how food items affect local people.

 4. Fluoride concentration in different food items used by local people were obtained from different sources. And classify drinking and eating items based on fluoride concentration in different groups. From data we find how different food items increase fluorosis in people.
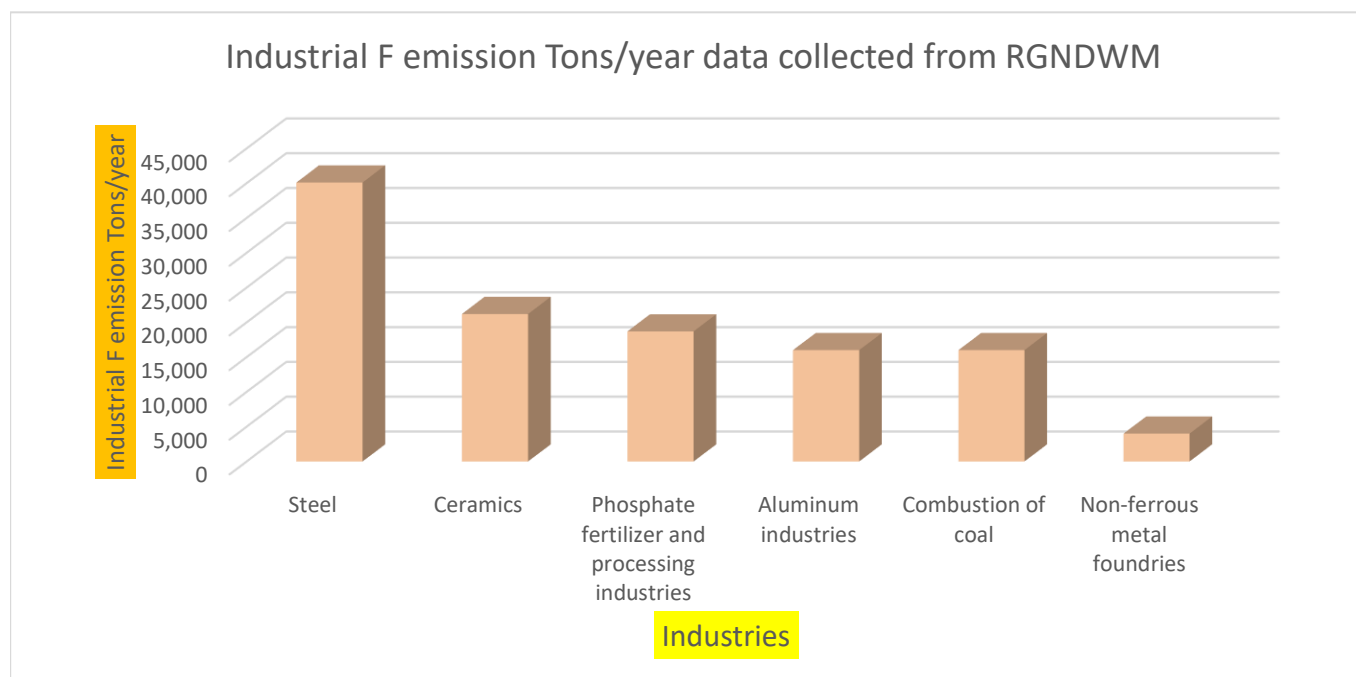
C. INDUSTRY: -

1. As we all know that industry results increase in pollution in air, water and soil. There is increased fluoride in air near some industries which emit fluoride substances in gaseous form. Main industries which emit fluoride in large amounts are marked and by observation industries are listed on the basis of their emission amount.

2. We found from data that fluoride varies with distance from industries in air. As a result, we saw that in air high fluoride was found near these industries and also found the same type of variance in water and soil.

3. From different data we find how industries increase fluoride in air, water and soil that causes fluorosis in nearby local people and workers at these industries.

4. We find how these industries work with the government. Manage emission of fluoride and other waste and increase efficiency of these techniques and manage emission based on different branches of civil engineering (Environment, Water management, Structural) aspects like Water management efficient plant.

5. From data from different sources we found how these affect local people and workers. We make different group based on working condition, age, and sex. Then we found that workers who are in direct contact are more affected with fluorosis than administration people. We also found high concentration of fluoride in people near industrial area. At last, we can say that industries increase fluorosis cases in humans and cattle.

Industrial F emission Tons/year data collected from RGNDWM

DISCUSSION

Fluorosis is caused by fluoride contaminated water. People in many states of India, especially in Rajasthan, can be seen suffering from Fluorosis disease. Lack of pure water in groundwater resources or due to industrialization, it's really impossible to avoid Fluorosis in both rural and urban areas without doing anything serious. So, by articulating the field data, we get that groundwater is the main reason behind the problem of fluorosis in the state of Rajasthan. So, in order to improve the quality of water and ensure that every household gets safe and clean drinking water we arrived at the solution of installing RO plants and Water Pyramids. By analyzing the condition of a region, we will use the best suited method in that area. It is rather an impossible task to have a RO Water Plants per family so on the basis of population density RO water plants will be installed in a particular region.

We will install RO plants at the major water supply tank of the village/town to supply clean drinking water directly to every household. We will try to provide 40litres per day of safe water to each household. Earlier Rajasthan govt has installed it in Nagaur district for trial basis but we will implement it on a large scale to supply clean water to every household.

Reverse Osmosis (RO) Plant: RO plant is based on the process of reverse osmosis, basically it's a water purification process in which water is forced through a membrane.

In the process of reverse osmosis, there is a requirement of various pretreatment techniques which includes softening, dichlorination and antiscalant treatments. After all the pre-treatments are done, a very high pressure is applied which is able to send water through a semipermeable membrane. The semi permeable layer allows pure water to pass through it and retains all other unwanted particles on itself. If the concentration of unwanted particles like salt, F etc. are higher, then there will be higher needs of Energy to treat the impure water. The reverse osmosis process is different from the process of filtration. Straining or size exclusion is the predominant removal mechanism whereas in the case of reverse osmosis, it's difference in the solubility. Reverse osmosis is more efficient as the pore size is 0.001 micrometers which is 10 times smaller than the filtration. The reverse osmosis process is dependent on pressure, solute concentrations and other conditions.

A reverse osmosis system that may remove Fluoride, salt, Chlorine, Arsenic etc. from the water so indirectly it will remove Fluorosis from our society or village. Approximately it removes 98 percent of dissolved solids. The problem of fluorosis is mainly due to uses of groundwater and seawater because of too much Fluoride concentration and RO plants are commonly used for these water sources. There will be no danger of health issues in drinking RO water, it's 100 percent safe to drink. So, it will be working nicely to remove fluorosis diseases.

Another idea is of the **Water Pyramid.** This is developed for rural tropical areas, employs solar energy to produce potable water from saline, brackish or polluted water and removes fluoride. Water Pyramid has a conical shape whose height is 8 meters and diameter of base is 30 meters. It's made of plastic sheeting which is inflated by using a fan. The Pyramid generates solar energy which is used in powering the fan. The water present inside the cone is evaporated by the thermal energy as the temperature is nearly 75 degrees centigrade. There are water tanks to collect the water. The Pyramid contains two types of water; distilled water and falling water. Distilled water is collected in tanks. If the weather changes and it becomes rainy, the falling water is also collected for use in dry weather. If there is high population density then water production can be increased by adding additional Pyramids in those particular areas. A water pyramid with a total area of 600m square, placed under favorable tropical conditions, can produce about 1250 liters of fresh water a day. The rate of production is however dependent on local atmospheric conditions such as climate, temperature, cloud-cover and wind activity. It can easily provide water to 200-300 people on a daily basis. We can get pure water from the Pyramid in all weather conditions, so it's an efficient way to overcome the challenges of Fluorosis in our society.
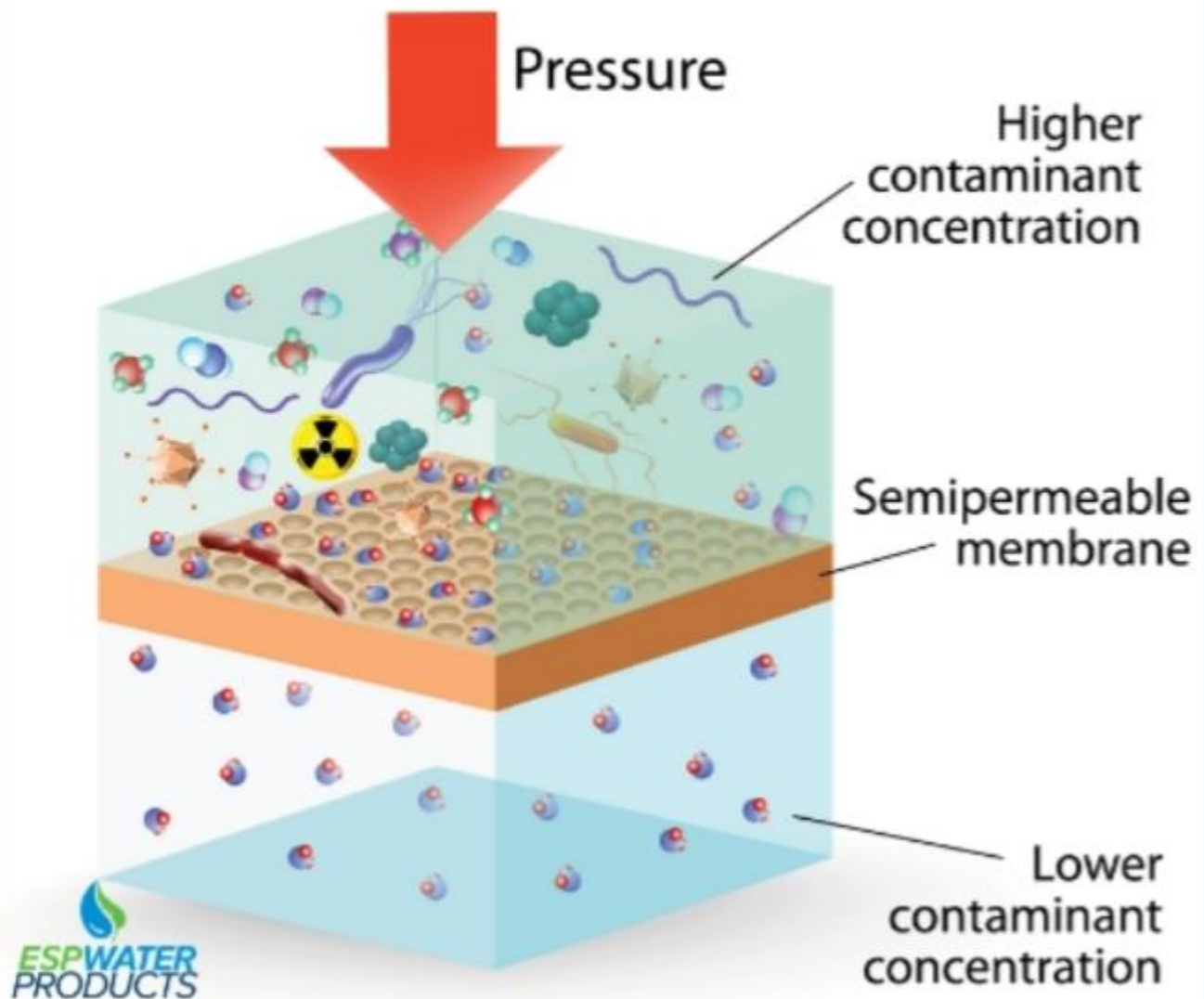
Some general effective methods are:

Calcium Consumption –Calcium reduces the absorption of fluoride.

Fresh Fruits and Vitamin c reduce the effect of fluoride.

Fluoridated toothpastes should be used in regulation.

REVERSE OSMOSIS

Pressure

Higher contaminant concentration

Semipermeable membrane

Lower contaminant concentration

ESP WATER PRODUCTS

CONCLUSION

In this project, we tried to solve the problem of "fluoride contamination of water". First, we identified the areas which are severely affected by fluoride contamination. The geogenic and anthropogenic reasons behind this contamination were identified. How the industrial pollution also adds to this problem of fluoride contamination is also looked at in this project. Role of food in amplifying as well as reducing fluoride contamination is studied by us.

Then a survey was conducted to gauge the awareness and extent of this problem. Scientific and technical data was collected using secondary sources. A proper understanding of the problem is necessary to formulate a good solution so we did a proper study of the cultural, social, economic and environmental aspects of the problem. After understanding the problem, we come up with different solutions for different situations. For economically backward regions, cost effectiveness is taken care of. For remote regions, a solar powered water purification system is suggested. For areas near urban centers, where it is possible to supply pipeline water by distribution systems that is being suggested.

Environmental sustainability of the water purification system is also taken care of it.

We tried to address the problem by giving the best possible solution according to the situation using our civil engineering knowledge.

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ANNEXURE: QUESTIONNAIRES

- What are the factors responsible for fluorosis?

- What are the types of fluorosis?

- How can we prevent fluorosis?

- Which state is the most affected by fluorosis?

- Which district of Rajasthan is the most affected by fluorosis?

- What is the main reason for fluorosis in Rajasthan?

- What is Reverse Osmosis?

- What is a water Pyramid?

- What type of food contains more amount of fluoride?