

Assessing The Deteriorating Water Quality In Jaipur City Through GIS Interpolation

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KEYWORDS	ABSTRACT
Quality of water, Dental fluorosis, fluoride, GIS, Infant Mortality, Nitrate, TDS	Poor management of water resources is a major challenge for developing countries in providing safe water to the growing population. The work of measuring the quality of water in Jaipur city is done continuously by the Central Ground Water Department. The quality of water is mainly determined on the basis of elements like hardness, alkalinity, fluoride, nitrate, chloride and presence of iron. The quality of water has been studied on the basis of standards set by the Bureau of Indian Standards in 2012. Water was not uniform everywhere in Jaipur and differences in water quality standards have been found in different areas, the reason for which is the difference in the geological rock structure and quantity of water here. In the presented research paper, out of the five blocks of Jaipur Municipal Corporation Greater, 15 wards out of the total 64 wards of two blocks of the assembly constituency Vidyadhar Nagar and Jhotwara have been selected and the average amount of presence of major ions in water in the year 2023 has been estimated on the basis of the quality of water obtained from the PHED Public Health Engineering Department, Borewell, Private Tank Aadhi there. The results show that some wards are in a serious situation in terms of degradation of water quality, which will have to be paid attention to by the planners and urban local bodies of Jaipur city.

INTRODUCTION

In the world, only water is such a gift of nature which is available in all three states like solid (ice), liquid (water) and gas (water vapor). According to scientists, if all possible types of compounds having general formula H₂O are counted, then there can be a total of 48 types of water. Out of these, nine types of water are permanent and durable. Almost all the physical and chemical properties of water are sedimentary in nature. Hence, it is considered to be the most unique liquid in the world. Chemical analysis is of special importance in the study of natural water and waste water because the more information we have about the properties of the components, pollutants and other chemical substances present, the better the aquatic environment can be understood.

The World Health Organization has set the standard of pure water in 1971, although it is for Europe. In India, the Medical Counseling of Medical Research has set the standard for the quality of drinking water and available water. If we talk about the quality of water, it is divided into two parts, one is chemical, the other is microbiological. By detecting heavy metals, organic compounds in chemical and physical parameters, solid water is classified into two parts. If the substance (TSS) and turbidity are to be removed, then in microbiology, coliform bacteria, E. coli and specific pathogenic species of bacteria, viruses and protozoan parasites are to be eliminated. In chemical parameters, if the amount of nitrate, nitrite and arsenic is high, then it affects health, whereas microorganisms are directly pathogenic. Apart from disease-causing organisms, many types of toxic elements also affect our health through water. Under general physical quality, water surface, water currents, color, odor, temperature, heat budget, penetration light, and bottom light etc. are

studied. In natural water, color is produced due to humic acid, fulvic acid, metals, iron, suspended matter, phytoplankton, weeds and industrial effluents. With the increase in water temperature, the speed of chemical reactions increases and the metabolic activity of bacteria increases. The uncleanliness of water can be said to be the measure of its optical properties. This optical property, called the Tyndall effect, is related to the scattering of light by suspended particles in water. When the turbidity of water is mostly due to phytoplankton, it is considered an indicator of the productivity of the water.

In the 20th century, the world population has increased 3.8 times while the use of renewable water resources has increased six times. The world population is estimated to increase by 40 to 50 percent in the next 50 years. This increased population will increase the demand for water by 5 to 6 times with the increase in industrialization and urbanization. Whereas at present only one out of every six people in the world has access to safe drinking water. This means that 1.3 billion people in the present world are deprived of safe drinking water. The issue of lack of availability of water is related to the quality of water. About 70 percent of our sources are contaminated and our major rivers are drying up due to pollution. In one-third of the 755 districts of the country, groundwater is contaminated with fluoride and arsenic. The Central Ground Water Report says that the fluoride level is high in 244 districts of the country, of which Rajasthan has the highest number of districts. Similarly, the arsenic level is above the standard in 80 districts of 10 states, of which the highest are 20 in Uttar Pradesh, 18 in Assam and 18 in Bihar. 15 districts of Rajasthan and 13 districts of Haryana are included. India's Water Quality Index 2019 ranks 120th among 122 countries with nearly 70 percent polluted water. The availability of water in the state is not in accordance with the demand of water. The availability of water in Rajasthan is 780 cubic meters per person per year, while the minimum requirement has been estimated to be 1000 cubic meters per year. It is feared that by the year 2050, this availability will be reduced to about 450 cubic meters. According to international standards, water availability of less than 500 cubic meters is a sign of extreme water crisis. The condition of groundwater in the state is also very worrying. This problem is increasing very rapidly in the last two decades. About 90 percent of drinking water and 60 percent of the water requirement in the agricultural sector is exploited from groundwater. Rajasthan is the most water quality affected state in the country because 51 percent of the state's water contains fluoride and 42 percent is saline water. Initially, water supply in Jaipur city was done through local wells and Expanded based on water sources. Later in 1844, water was allocated to the city through Amanishah Nala Dam. In 1931, water supply to the city was started from Ramgarh Dam, but after 1981, due to continuous decrease in water, Bisalpur water source was constructed in 2009 at a distance of 106 km from the city on the south bank. Water supply in Jaipur city is done through both ground water (tube well) and surface water (Bisalpur Dam). But the water department has cut Bisalpur supply by 50 percent, due to which water is supplied to these deprived areas through tankers and tube wells. Due to 70 percent bacteria, fluoride, calcium and magnesium content in water received through tankers, people are getting infected with diseases like cancer, jaundice, typhoid, neck, back, shoulder, knee joint bones, etc. Therefore, PHED (Public Health Engineering Department) has taken steps to reduce this type of problem. There is a need to arrange for cleanliness and cleaning of tankers and sediments.

Study Area -

Jaipur, the capital city of Rajasthan State in India, is the tenth most populous city of the country. It is located at 26° 54'N latitude and 75° 49'E longitude and experiences a continental type of climate. The city witness extreme temperatures both in summer as well as in winters and low to moderate relative humidity. The highest mean monthly maximum temperature of 40.6° C is recorded in May and the lowest mean monthly temperature of 8.3° C is recorded in January. The

city receives 90 per cent of its rainfall during the monsoon period (June-September) and the average annual rainfall in the city is 567.70 mm. Studies reveal that probability of exceedance of average annual rainfall in Jaipur city is about 25% and normal drought 19.4% whereas probability of severe and most severe drought is almost negligible (CDP,2005).

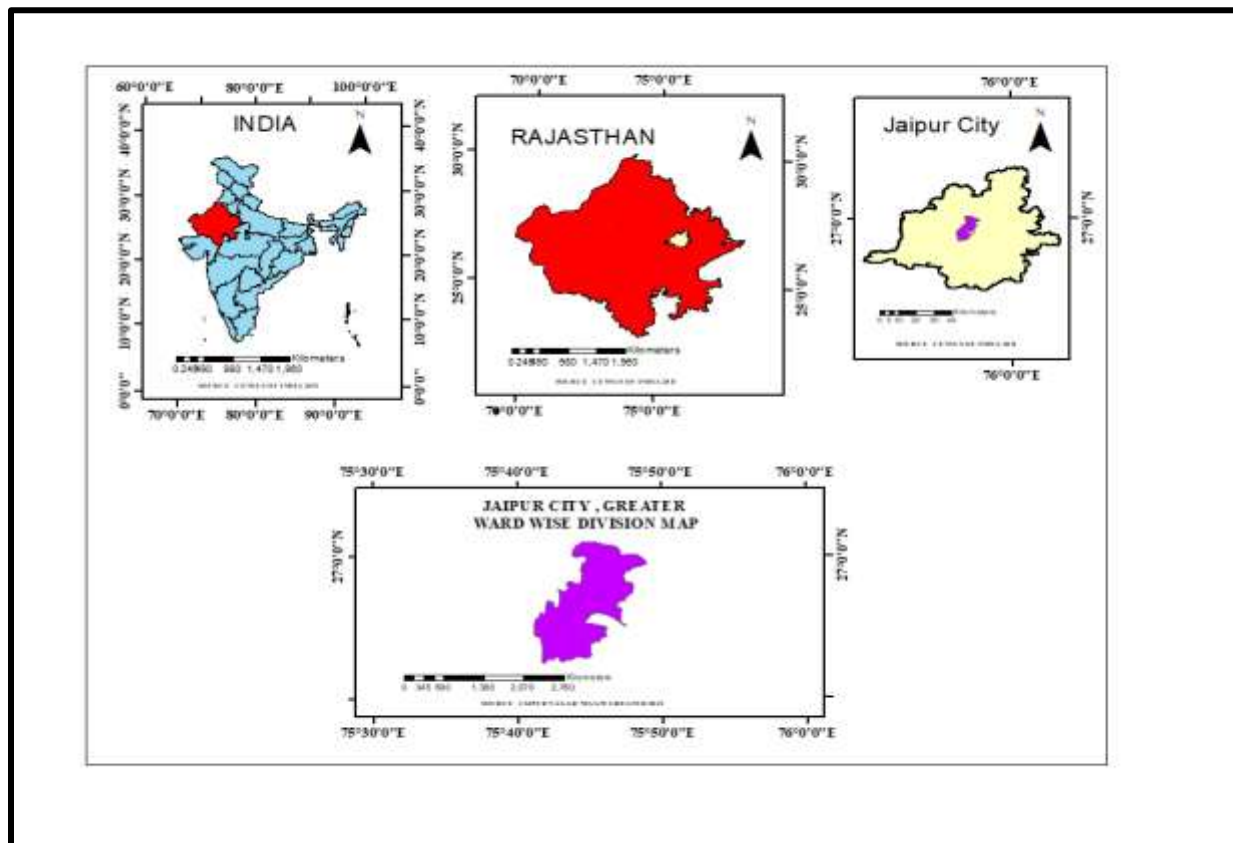


Fig. 1. The locational Aspect of Jaipur City

Research Methodology –

In this paper, 10 wards (about 25 percent) out of 42 wards of Vidyadhar Nagar assembly constituency of Municipal Corporation Greater Jaipur city and 5 wards (about 25 percent) of Jhontwara have been selected to find out the quality of water. Primary data has been used to complete this research work. In these wards, water obtained from sources like PHED (Public Health Engineering Department), borewell, private tanker etc. was collected in a one-liter plastic bottle and tested in the Environment Laboratory of the Department School of Earth Sciences of Banasthali Vidyapeeth. The quality of water in Jaipur city is definite and unreliable. Compounds like pH value, TDS, dissolved solids, electrical conductivity, chloride, fluoride, calcium, magnesium etc. were found in the water, which gave rise to the question of water quality in Jaipur city.

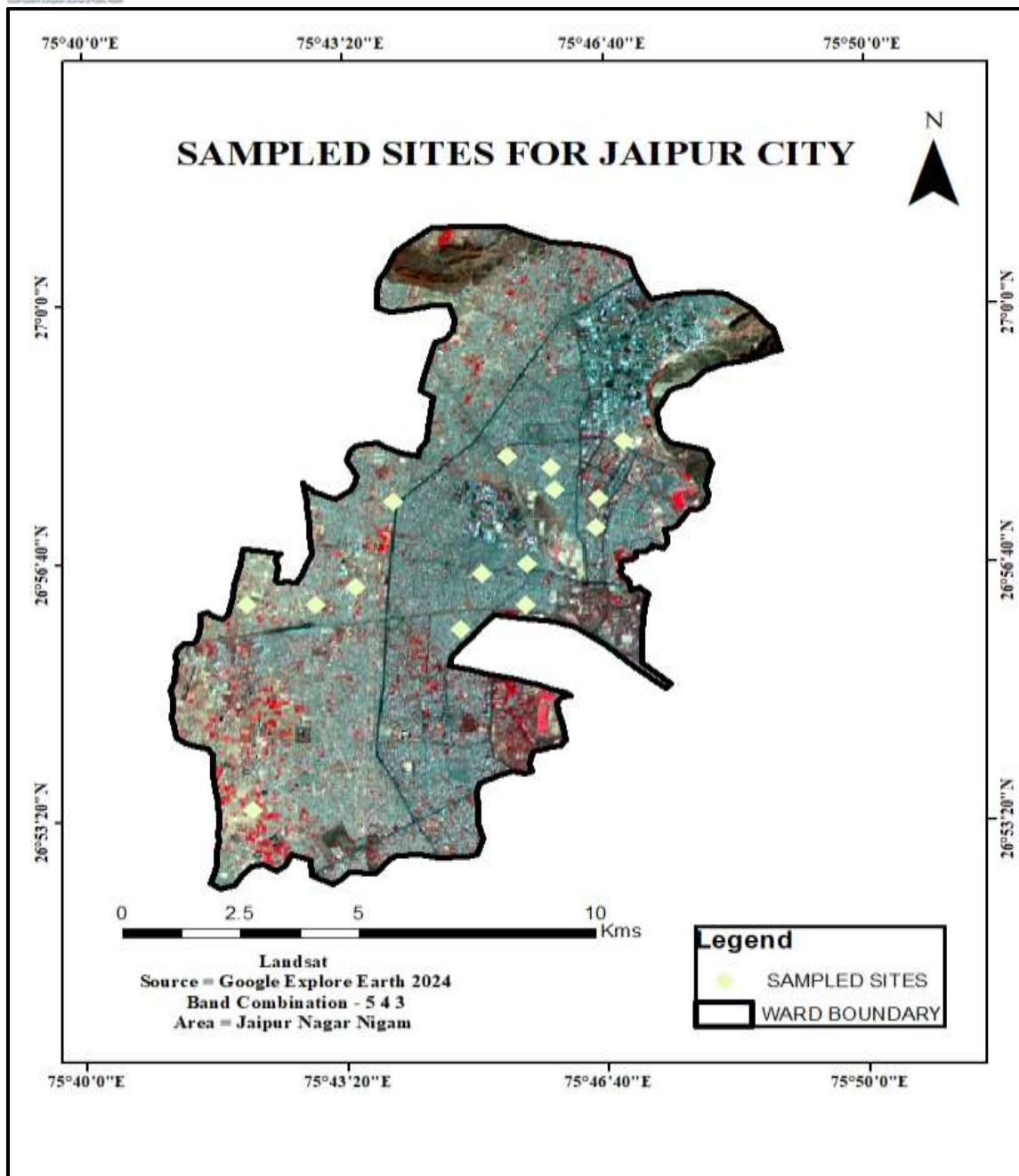


Fig. 2. Sampled Sites of Jaipur City

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

$$KR = \frac{Na^+}{Ca^{2+} + Mg^{2+}}$$

$$\text{MAR} = \frac{\text{Mg}^{2+}}{\text{Ca}^{2+} + \text{Mg}^{2+}}$$

$$\text{Chloride} = \frac{\text{Cl}^- + \text{NO}_3^-}{\text{CO}_3 + \text{HCO}_3 + \text{SO}_4 + \text{Cl}^- + \text{NO}_3^-}$$

and its surrounding areas has deteriorated. Statistical methods like average, percentage etc. will be used to analyze the data obtained from the quality of water. To test the quality of drinking water, various parameters will be calculated by the following equations. These data will be displayed with the help of suitable diagrams (bar diagram, line diagram, pie chart) and maps (chromatic map) etc. For mapping, RGI Earth Explore Satellite Image Landsat 8 and statistical methods SPSS (Post Graph 20) software will also be used for data analysis.

RESULTS AND DISCUSSION

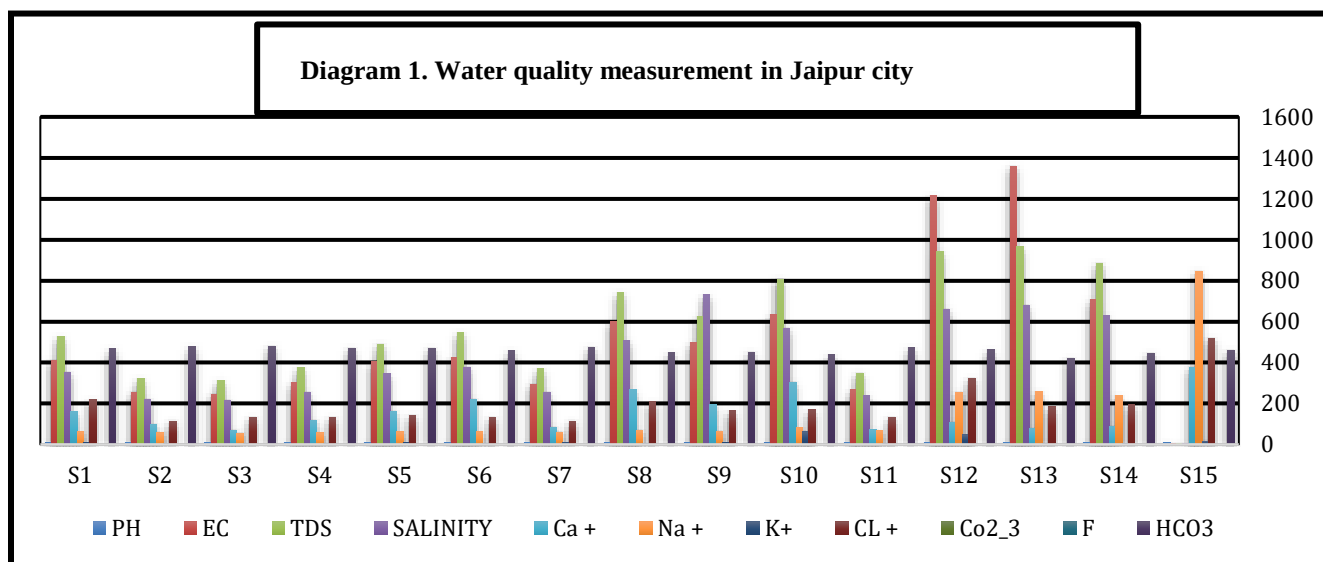
The work of measuring the quality of water in Jaipur city is done continuously by the Central Ground Water Department. The quality of water is mainly determined on the basis of hardness, alkalinity, fluoride, nitrate, chloride, and presence of iron element etc. The quality of water has been studied on the

Table 1. Water quality parameters

S.N	Ward Number	PH	EC	TDS	SALINITY	Ca +	Na +	K+	CL +	Co 2 _3	HC O3	F	M g +
S1	8	7.32	412	526	353	7.7	62.5	7.8	219	0.1	467	1.782	13
S2	18	8.22	255	321	222	4.6	56.2	6.5	114	0.2	477	1.622	28
S3	20	8.24	246	313	216	3.3	56	6.3	134	0.5	480	1.808	65
S4	21	8.24	301	374	256	5.6	56.9	7	134	0.5	470	1.314	8
S5	26	8.21	403	490	347	7.7	61.1	7.8	144	1.2	470	1.84	13
S6	31	8	424	547	378	10.5	61.4	7	134	0	457	1.656	145
S7	33	8.27	293	370	256	4	60.4	9.1	114	0.4	475	1.688	75
S8	38	7.91	601	740	507	12.7	70.6	6.1	209	0	449	1.638	213
S9	15	7.54	497	624	732	9.2	65.7	7.5	164	0.1	450	1.45	17

S10	41	7.38	633	807	568	14.5	82	62	169	0	438	1.902	6.3
S11	43	8.34	269	349	238	3.4	67.4	6.1	134	0.1	472	1.782	6
S12	46	8.07	1214	942	660	5.2	255	48	324	0.4	462	1.21	7.5
S13	47	8.33	1358	965	679	3.7	256.5	7.1	184	0.1	420	1.24	7.5
S14	45	8.2	708	885	629	4.2	239.5	4.6	194	0.3	445	1.208	8.5
S15	49	7.58	4.72	5.97	4.68	18	845	16.3	519	0	461	1.05	14.6

Source_ Data Based On Field Survey 2024



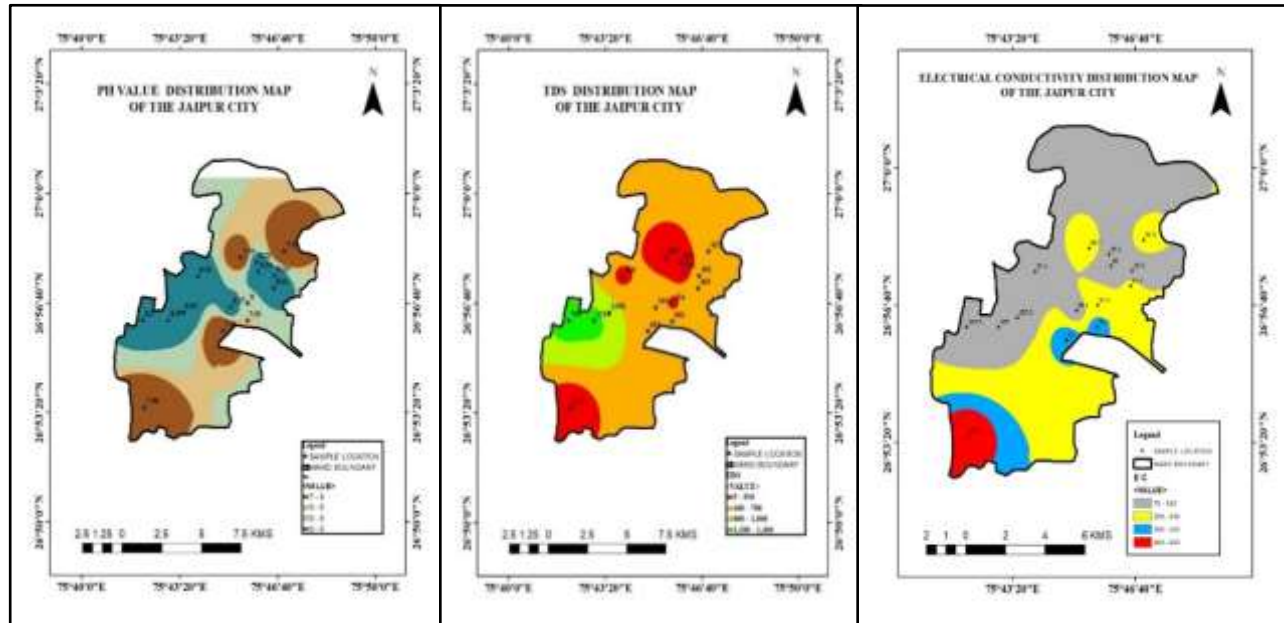
Source_ Data Based On Field Survey 2023

basis of standards set by the Bureau of Indian Standards in the year 2012. Water was not uniform everywhere in Jaipur and differences in water quality standards have been found in different areas. The reason for this is the difference in the geology, rock structure and quantity of water in these areas. In this chapter, out of the five blocks of Jaipur Municipal Corporation Greater, 15 wards out of the total 64 wards of two blocks of the assembly constituency Vidyadhar Nagar and Jhotwara were selected and the quality of water obtained from sources like Public Health Engineering Department, borewell, private tanker etc. was measured by PHED (Public Health Engineering Department) there. On this basis, the average amount of major ions present in water in the year 2023 has been estimated, which is shown in the following table

PH value -

Generally the pH value of water is 7. This is called the neutral point. The solution whose value is found to be more than 7 is alkaline and if it is less, it is acidic in nature. The pH scale has marks from 0 to 14. In this study area, the pH value of water in the selected wards has been found to be between 7.32 to 8.34.

This makes it clear that the nature of water is alkaline, which has an adverse effect in domestic areas. Also, due to the high amount of heaviness in drinking water, soap does not foam and a white layer is deposited on utensils and pipes, which hinders water supply.



TDS -

The value of water-soluble solids is obtained from the weight of the elements left after the water is evaporated. Different types of minerals are measured in ppm. Water with 1000 ppm value is classified as pure water. Water with 1000 to 10000 value is classified as back water. 100 ppm has clarified that most domestic and industrial water should have less than 1000 ppm soluble elements but according to World Health Organization and Indian Council of Medical Research, the amount of soluble solids in any type of useful water should not be more than 500 ppm. More than 500 ppm is harmful for agriculture. Out of 15 selected wards of the study area, the amount of soluble solids in 8 wards is between 526 - 965 ppm. In 7 wards, the amount of soluble solids is less than 500 ppm.

Electrical conductivity -

Shows the salinity of water according to the amount of soluble salts in it. Some amount of salinity is found everywhere in groundwater but Its quantity depends on the soluble substances in the underground rocks. The value of electrical conductivity is continuously increasing in the study area. However, the presence of electrical conductivity depends on the amount of rainfall. The conductivity of water in the selected wards in the study area has been found to be between 246 $\mu\text{S}/\text{CM}$ to 1358 $\mu\text{S}/\text{CM}$. Out of the total 15 selected wards, the concentration of electrically conducting ions in 5 wards is between 200 -400 $\mu\text{S}/\text{CM}$, in 7 wards the concentration of electrically conducting ions is between 400 to 700 $\mu\text{S}/\text{CM}$ and in 2 wards the amount of electrical conductivity

is between 700 to 1400 $\mu\text{S}/\text{CM}$ is between $\mu\text{S}/\text{CM}$, hence the conductivity of water in a ward is less than 4.72 $\mu\text{S}/\text{CM}$, thus the value of electrical conductivity has exceeded the desired and maximum permissible limit. This shows that there has been an increase in various ions in the water of the area. The increase in electrical conductivity shows that the harshness and alkalinity of water in the area is increasing, due to which barren and alkaline land is expanding.

Chloride –

Chloride is found in all types of natural water. It is a water soluble element and keeps flowing with water. The desired limit of chloride in water is considered up to 250 ppm. If it is more than this, the water is considered polluted. Out of the 15 wards selected in the study area, the amount of chloride in 13 wards was between 114 ppm to 219 ppm. The water of these wards is potable due to the presence of chloride which is less than the desired level. But the amount of chloride in water of two wards in the area is between 324 ppm to 519 ppm due to which the water is not potable due to excess of chloride and there is a possibility of stomach related diseases in humans and animals. The continuous increase in the amount of chloride in the water of the area has emerged as a major problem related to water.

Fluoride –

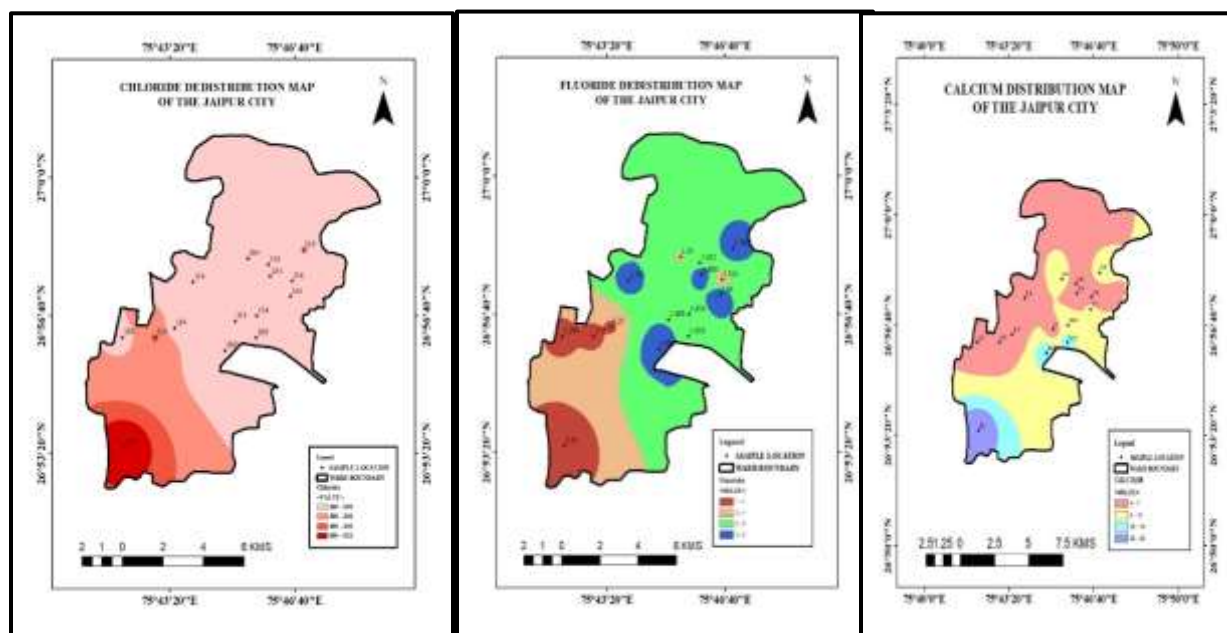
Fluoride is a mineral element found in various types of geological rocks. It is a reactive substance. Its excess amount in water is harmful for health. The presence of excess fluoride in water is responsible for a disease called fluorosis, which causes yellowing of teeth, pain in joints, hunchback and brittleness in bones. In the desert area of Rajasthan, its amount is relatively high in groundwater. The permissible limit of fluoride has been fixed by the Bureau of Indian Standards at 1.5 μm . In 15 selected wards of the study area, fluoride is present in the groundwater. Out of the wards, fluoride content was found to be between 1.0 μH to 1.4 μH in 6 wards, which is higher than the recommended limit. In the desert areas of Rajasthan, its quantity is found relatively high in ground water. The permissible limit of fluoride has been determined by the Bureau of Indian Standards to be 1.5 μH . Out of the 15 wards selected in the study area, the fluoride content in 6

Fig. 6. Chloride

Fig. 7. Fluoride

Fig. 8. Calcium

Source_ Data Based On Field Survey 2023



wards was found to be between 1.0 uH to 1.4 uH, which is within the permissible limit, but in 9 wards, the fluoride content was between 1.6 to 1.9 uH, which is the desired limit.

Calcium -

For drinking water use, the calcium content in water should be between 10 and 100 ppm. The amount of calcium up to this limit does not harm the health of humans and animals in any way. Out of the selected wards, the calcium content in 6 wards was found to be between 69 ppm, due to which the water of those areas is potable and in 9 wards, the calcium content is between 109 ppm to 378 ppm, which is more than the prescribed amount of calcium, which is harmful to humans. It is harmful for both humans and animals

Magnesium -

Hardness of water: The mixture of calcium and magnesium increases the hardness of water. Due to hardness of water, the concentration of all the elements is high. This type of water is not suitable for drinking and has an adverse effect on the health of humans and animals. Excess of calcium causes the problem of stones in the urinary bladder. The magnesium level in water is considered to be correct from 0-150 Out of the total 15 wards in the study area, the magnesium level in 13 wards is between 4 to 147 which is within the prescribed limit. In two wards, the magnesium level is more than 150 and hence the water there is considered to be more hard.

SALINITY -

Salinity is a map of the amount of salt in water. As dissolved ions move, it increases both salinity and conductivity. Both are measured by sensors. The salt in seawater is usually sodium chloride. Some lakes can also have high salinity due to a combination of dissolved ions such as sodium chloride, carbonate, and sulfate. Salt affects the quality of water used for drinking. Out of the 15 selected wards in the study area, water salinity in 8 wards was found to be between 216 to 378, water salinity in 6 wards was found to be between 507 to 679 and water salinity in one ward was found to be less than 4.68.

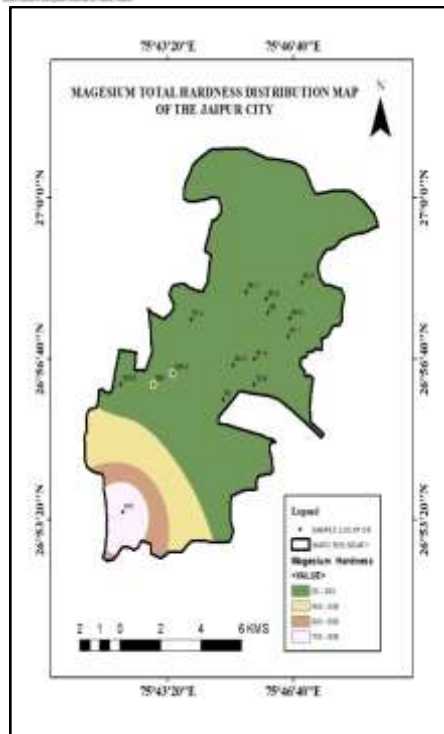


Fig. 9. Magnesium

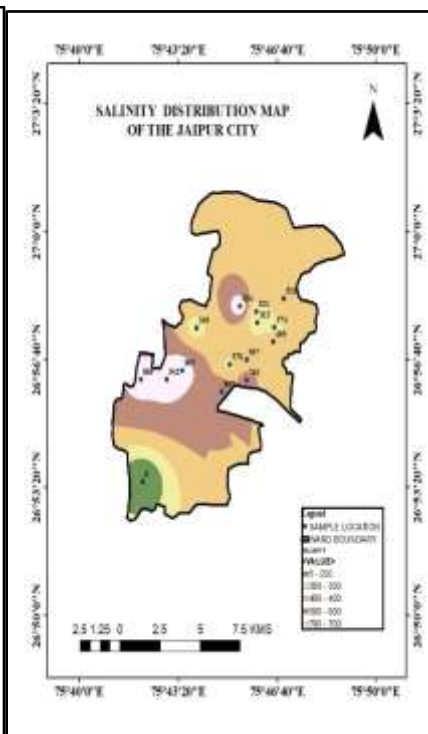


Fig. 10. Salinity

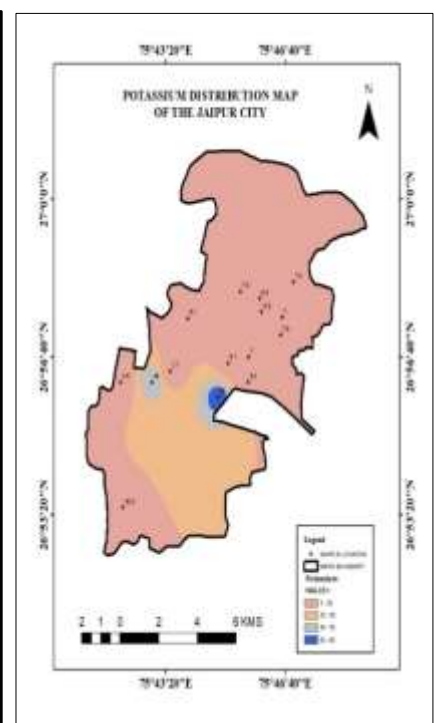


Fig.11 . Potassium

Source_ Data Based On Field Survey 2023

Potassium -

Potassium is an essential element for humans but its concentration is negligible in most drinking water. Potassium is found in drinking water at levels that can be a matter of concern for human health. Its concentration is less than 20 Mg L⁻¹ in fresh water and can be 400 Mg L⁻¹ or more in salty water. Out of the 15 wards selected in the study area, the potassium content in water of 13 wards ranged from 4.6 to 7.8. The potassium content in water of one ward was 16.3 and in another ward it was more than 48.

Sodium -

To evaluate the quality of sodium water, it is necessary to know the ratio of sodium present in it and the sum of sodium-magnesium. The concentration of sodium is considered important in determining the quality of water in comparison to calcium and magnesium. Quality of water with the help of US salinity Sodium is measured. Out of the total 15 wards selected in the study area, 11 wards have sodium content

between 56 to 82 ppm. In 3 wards, sodium content is between 239 to 256 ppm and in one ward, sodium content is more than 845 ppm.

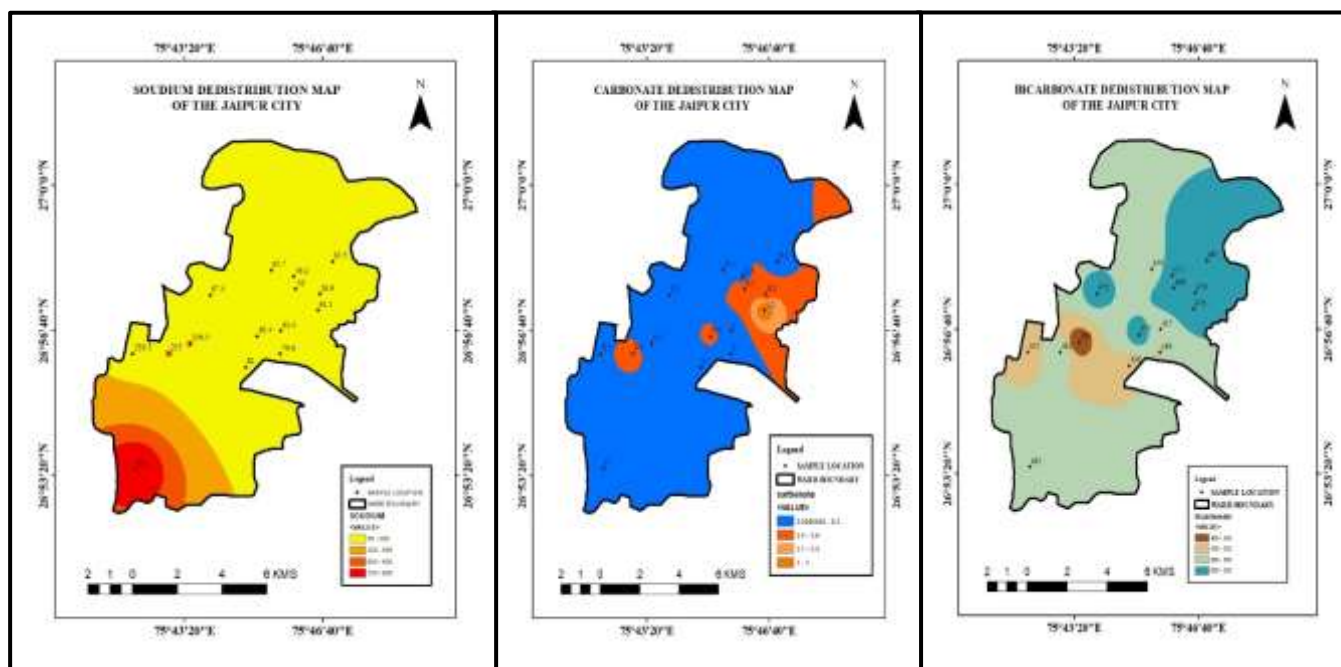


Fig. 13. Carbonate

Fig. 14. Bicarbonate

Fig.12. Sodium

Source_ Data Based On Field Survey 2023

Carbonate & Bicarbonate -

Phenolphthalein and methyl orange or methyl rand are used as indicators of carbonates and bicarbonates. When the colour of phenolphthalein in the sample turns colourless to pink, it shows half neutralisation of carbonates. Now if methyl rand orange is added to it, its colour changes from yellow to pink, which indicates bicarbonate

Out of the 15 wards selected in the study area, the amount of carbonate in water of 10 wards was found to be between 0.1 and 0.5, the amount of carbonate in water of 4 wards was 0 and the amount of carbonate in water of one ward was found to be 1.2. The amount of bicarbonate in water of all the selected wards of the study area was found to be between 400 and 480.

Correlation analysis -

To find out the relationship between various parameters correlation matrix was prepared which is presented in Table 6. Negative correlation was observed between total dissolved solids and electrical conductivity (-0.29 -0.09). Positive correlation was observed between salinity and magnesium (-0.12 -0.04). Sodium -0.69 Calcium (-0.50) Chloride (-0.03) Fluoride (0.89) Potassium (0.07) Carbonate (0.19) Bicarbonate (-0.28) Positive correlation was observed

Fig. 15. Correlation Matrix Parameters

NAM E	PH	EC	TDS	SALI NITY	Mg ⁺	Ca +	Na +	K ⁺	CL +	Co ²⁻ 3	HC O3	F
PH	1											
EC	0.107 904	1										
TDS	- 0.026 24	0.91 0803	1									
SALI NITY	- 0.186 6	0.82 3391	0.93 4438	1								
Mg ⁺	- 0.180 61	- 0.26 595	- 0.21 402	- 0.1201 8	1							
Ca +	- 0.852 04	- 0.25 181	- 0.16 981	- 0.1197 8	0.28 6406	1						
Na +	- 0.324 9	- 0.05 749	- 0.25 813	- 0.2703 1	- 0.01 292	0.50 2037	1					
K ⁺	- 0.542 66	0.34 7715	0.36 7712	0.2969 93	- 0.30 717	0.35 3622	0.11 8938	1				
CL +	- 0.421 43	- 0.36 244	- 0.52 553	- 0.4980 6	0.11 2531	0.63 8504	0.93 8211	0.05 1834	1			
Co ²⁻³	0.451 572	- 0.07 543	- 0.09 832	- 0.1361 6	- 0.18 007	- 0.38 818	- 0.25 287	- 0.14 77	- 0.24 189	1		
HCO ₃	- 0.347 03	0.69 7628	0.72 568	0.7166 27	- 0.12 424	0.26 8557	0.18 4816	0.24 845	- 0.01 909	- 0.45 088	1	1
F	0.003 99	- 0.29 435	- 0.09 799	- 0.1214 7	0.04 7634	- 0.03 7	- 0.69 863	0.07 0372	- 0.50 755	0.19 2618	- 0.2 894	0.8 91

Source_ Data Based On Field Survey 2023

CONCLUSION

In this Paper, 10 wards (approximately 25 percent) out of 42 wards of Vidyadhar Nagar of the assembly constituency of Municipal Corporation Greater Jaipur city and 5 wards (approximately 25 percent) from Jhontwara have been selected to find out the quality of water. Primary data has been used to complete this research work. In these wards, water obtained from sources like PHD (Public Health Engineering Department), borewell, private tanker etc. was collected in a one-litre

plastic bottle and tested in the laboratory of the Department of Geology of Banasthali Vidyapeeth. The water quality in Jaipur city is definite and unreliable. PH value, TDS, dissolved solids, electrical conductivity, chloride, fluoride, calcium, magnesium etc. compounds were found in water, due to which the quality of water in Jaipur city and its surrounding areas has deteriorated. The quality of water is mainly determined on the basis of elements like hardness, alkalinity, fluoride, nitrate, chloride and presence of iron. The quality of water has been studied on the basis of standards set by the Bureau of Indian Standards in 2012. Water was not uniform everywhere in Jaipur and differences in water quality standards have been found in different areas, the reason for which is the difference in the geological rock structure and quantity of water here. The results show that some wards are in a serious situation in terms of degradation of water quality, which will have to be paid attention to by the planners and urban local bodies of Jaipur city.

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