GROUNDWATER CHEMICAL QUALITY BULLETIN

Gujarat&UT of Daman ,Diu & DNH

ABSTRACT

Periodic ground water quality assessment (2020-24) highlighting the findings, significant Trends and groundwater contamination status

CGWB,WCR,Ahmedabad

1. INTRODUCTION :

Ground water is an important resource widely used for drinking, irrigation and industrial purpose. Ground Water plays an important role in the sustainable socio-economic development. In regions with scarcity of fresh surface water sources dependence on ground water increases exponentially. The ground water quality is dependent upon chemical characteristic of rocks and minerals composition of aquifer material. Due to redox reaction, ions can be dissolved from minerals by dissolution and crystallization within aquifer and concentrate beyond permissible limits. Poor ground water quality can also be due to excessive use of fertilizers, urbanization and industrial effluent discharge. According to UNESCO more than 80% of health issues are caused due to consumption of poor-quality water. Inorganic contaminants including Salinity, Fluoride, Nitrate, Arsenic, Iron and Uranium are important in determining the suitability of ground water for drinking purposes. Therefore, periodic ground water quality assessment is important to alert people who utilize it for domestic and irrigation purpose. Numerous studies have been carried out on the poor quality of groundwater. However, an extensive temporal and spatial study of Gujarat State is lacking. Our efforts in the present study are to full fill the following objectives:

1. To present current GW quality scenario, parameter wise for each district
2. To identify present day hot spots of poor-quality ground water through spatial variation analysis of latest 2024 quality data.
3. To assess temporal variation of ground water quality showing improvement / deterioration during the period from 2020 to 2024, providing insights for effective water quality management measures.

2.0 STUDY AREA

The Central Ground Water Board, West Central Region, Ahmedabad has jurisdiction over the State of Gujarat covering an area of 1,96, 024 sq km. The Gujarat State is situated between North latitudes 20° 06’ 00” to 24° 42’ 00” and East longitudes 68° 10’ 00” to 74° 28’ 00”. Gujarat has nearly 1600 km long coastline, which is the longest as compared to any other state in the country. It is extending from Lakhpat in north to Daman in south. The State has common boundaries with the states of Rajasthan, Madhya Pradesh and Maharashtra and shares international border with Pakistan in northwest.

Gujarat along with UT of Daman and Diu is a vast state with varied hydro geological situations resulting from diversified geological, climatological and topographic settings. Water bearing rock formations (aquifers), range in age from Archaean to Recent. Similarly, the landform varies from the hilly tract to the uplands of Kachchh and Saurashtra, the alluvial plains extending from Banaskantha in the north to Valsad in the south, the low lying coastal tract surrounding the Kachchh and Saurashtra uplands and the marshy to saline tracts of the Rann of Kachchh and little Rann of Kachchh.

Central Ground Water Board, as a part of its national programme, has established Groundwater monitoring wells in the state of Gujarat for periodic monitoring of groundwater levels and to study its quality variation in time and space.

Large rivers like Narmada, Mahi, Tapi, and Sabarmati flow through the state and form their own basins. Other minor rivers have been grouped together to form river basins. In all, eight river basins have been identified by the All India Soil Survey & Land Use Department as listed below:

1. Sabarmati river basin.
2. Mahi river basin.
3. Narmada river basin.
4. Tapti river basin.
5. Luni and other draining in to Great Rann of Kachchh
6. Draining in to Gulf of Kachchh
    a. Southern Kathiawar
    b. Sharavati to Tapti

3.0 GROUND WATER QUALITY MONITORING

Monitoring of ground water quality is an effort to obtain information on chemical quality through representative sampling in different hydrogeological units. Ground Water is commonly tapped from phreatic aquifers. The main objective of ground water quality monitoring programme is to get information on the distribution of water quality on a regional scale as well as create a background data bank of different chemical constituents in ground water. The probable causes of deterioration in ground water quality ae depicted in Figure 1.

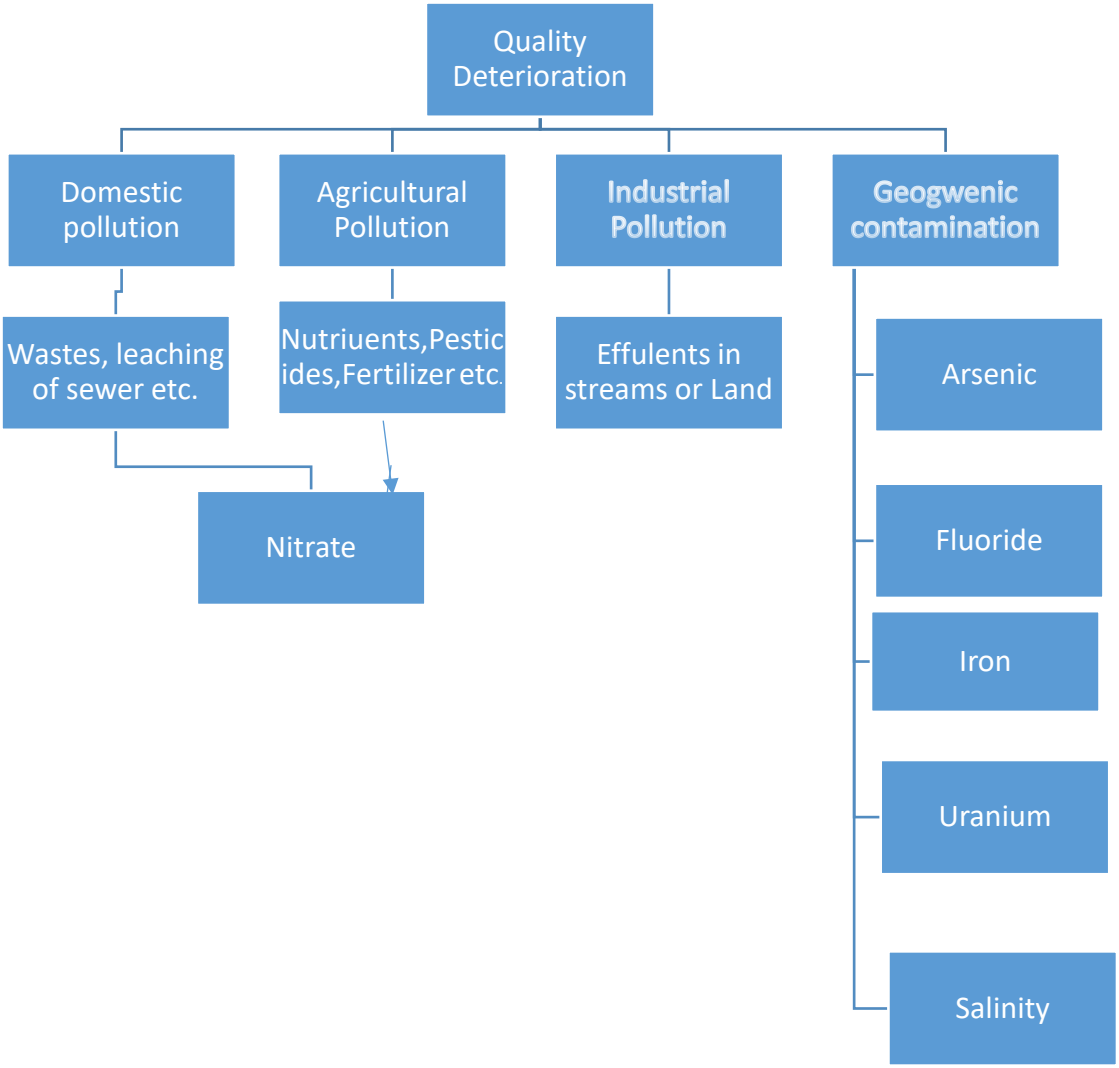


Figure 1: Schematic diagram illustrating the potential factors contributing to the degradation of groundwater quality.

The chemical quality of shallow ground water is being monitored by Central Ground Water Board twice in a year (Pre-monsoon and Post monsoon) since 2024 through 573 locations located all over the state and UT of Daman, Diu & DNH (Figure 2).

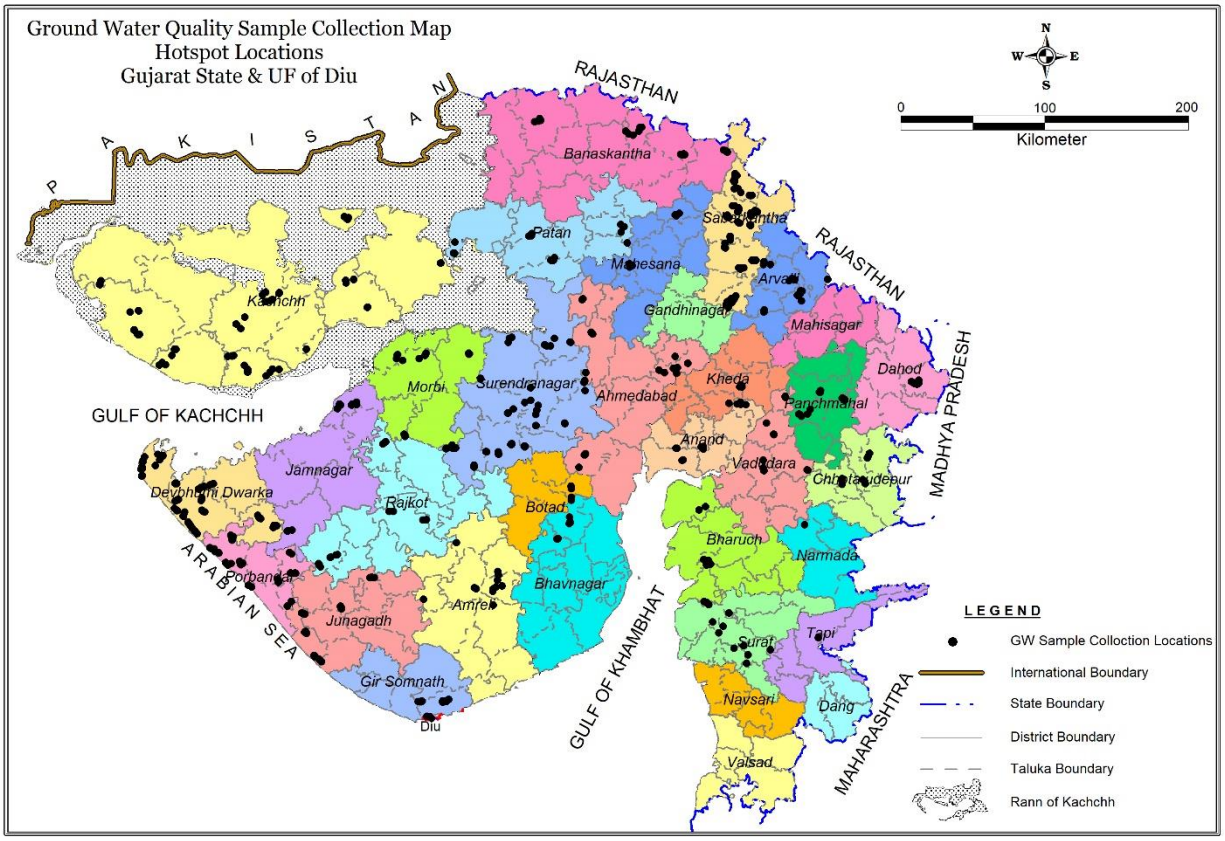


Figure 2: Map showing Spatial Distribution of 573 Groundwater Quality Monitoring Stations in State of Gujarat and UT of Diu based on 2024 NHS

The district-wise distribution of water Quality Monitoring Stations of CGWB is given in Table 1. The present bulletin is based on the changing scenario in water quality in network observation wells of CGWB in year 2020 and 2024

SN	District	Nos. of Water quality monitoring stations				
		May-20	May-21	May-22	May-23	May-24
1	Ahmedabad	12	16	5	6	20
2	Amreli	39	23	31	32	13
3	Anand	9	10	10	12	14
4	Arvalli	17	14	14	16	17
5	Banaskantha	12	9	19	16	20
6	Bharuch	24	26	23	26	9
7	Bhavnagar	32	21	31	28	11
8	Botad		5	7	8	3
9	Chhota udepur	14	10	9	10	11
10	Dadra And Nagar Haveli			14	10	
11	Gandhinagar	1	1	1		
12	Dahod	21	16	19	14	7
13	Daman	2	2	5	4	

14	Dang	24	20	20	18	
15	Devbhumi Dwarka		23	39	44	64
16	Diu	3		3	3	3
17	Gir Somnath	1	15	19	18	9
18	Jamnagar	55	19	27	25	12
19	Junagadh	57	25	42	39	24
20	Kachchh	31	33	37	37	54
21	Kheda	13	13	8	5	5
22	Mahesana	15	12	20	14	8
23	Mahisagar	10	14	11	10	
24	Morbi	8	15	15	14	19
25	Narmada	8	11	7	10	1
26	Navsari	12	19	15	11	
27	Panchmahal	19	18	19	16	16
28	Patan	6	7	9	10	15
29	Porbandar	29	20	30	30	37
30	Rajkot	26	31	29	24	20
31	Sabarkantha	25	24	24	26	72
32	Surat	30	28	31	23	11
33	Surendranagar	19	33	50	52	66
34	Tapi		8	8	9	
35	Vadodara	13	8	4	10	12
36	Valsad	14	16	27	19	
		601	565	682	649	573

Table 1: District wise distribution of water Quality Monitoring Stations

4.0 GROUND WATER QUALITY SCENARIO

The main objectives of ground water quality monitoring are to assess the suitability of ground water for drinking purposes as the quality of drinking water is a powerful environmental determinant of the health of a community. Bureau of Indian Standards (BIS) vide its document IS: 10500:2012, Edition 3.2 (2012-15) has recommended the quality standards for drinking water. The ground water samples collected from phreatic aquifers are analysed for all the major inorganic parameters. Based on the results, it is found that ground water of the Gujarat and UT Daman, Diu and DNH is mostly of calcium bicarbonate (Ca-HCO3) type when the total salinity of water is below corresponding to electrical conductance of 750 µs/cm at 25°C). They are of mixed cations and mixed anions type when the electrical conductance is between 750 and 3000 µs/cm and waters with electrical conductance above 3000 µs/cm are of sodium chloride (Na-CI) type. However, other types of water are also found among these general classifications, which may be due to the local variations in hydro-chemical environments due to anthropogenic activities. Nevertheless,

occurrence of high concentrations of some water quality parameters such as Salinity (EC), Fluoride, Nitrate and the changes in water quality based on these parameters have been observed in the various parts of Gujarat and UT Daman, Diu and DNH.

4.1 QUALITY ASSESSMENT OF GROUNDWATER IN UNCONFINED AQUIFERS

Unconfined aquifers are extensively tapped for water supply and irrigation across the state therefore; its quality is of paramount importance. The chemical parameters like TDS, Fluoride, Nitrate etc are main constituents defining the quality of ground water in unconfined aquifers. Therefore, presence of these parameters and the changes in chemical quality with respect to these in ground water in samples collected during NHS monitoring 2020 & 2024 are discussed below.

1. Electrical Conductivity (> 3000 µS/cm)
2. Fluoride (>1.5 mg/litre)
3. Nitrate (>45 mg/litre)

4.1.1 THE ELECTRICAL CONDUCTIVITY

Electrical conductivity or Total dissolved solids or Salinity is the dissolved salt content in a water body. Different substances dissolve in water giving it taste and odour. Electrical conductivity represents total number of cations and anions present in groundwater, indicating ionic mobility of different ions, total dissolved solids and saline nature of water.

In general water having EC < 1500µS/cm, is considered as fresh water, EC 1500 –15000µS/cm, is considered as brackish water and >15000µS/cm is considered as saline water. Salinity always exists in ground water but in variable amounts. It is mostly influenced by aquifer material, solubility of minerals, duration of contact and factors such as the permeability of soil, drainage facilities, quantity of rainfall and above all, the climate of the area. BIS has recommended a drinking water standard for total dissolved solids a limit of 500mg/I corresponding to EC of about 3000 US/cm at 25°C that can be extended to a TDS of 2000mg/I (corresponding to EC of about 3000 US/cm at 25°C) in case of no alternate source. Water having TDS more than 2000 mg/litre are not suitable for drinking purposes.

Distribution of Electrical Conductivity (EC)

The EC value of ground waters in the State varies from 399 at Kesharpura, Himmatnagar block of Sabarkantha district to 36012 µS/cm at Choraniya, Limdi block of Surendranagar district at 25°C. Grouping water samples based on EC values, it is found that 5.23 % of them have EC less than 750 µS/cm, 53.58 % have between 750 and 3000 µS/cm and the remaining 41.19 % of the samples have EC above 3000µS/cm occurring sporadically all over the state. The map showing aerial distribution of EC (Figure 3) with intervals corresponding to limits as above indicates that less than 750 class of water occur throughout the state in patches but in high proportion is in South Gujarat, Eastern and western parts of the State. The ground water occurring in the Northern , central and some part in west comprising of parts of Junagarh, Kachchh ,Jamnagar, Porbandar , Surendranagar, Amreli, Botad, Narmada, Diu , Devbhoomi Dwarka and Bhavnagar and districts is

67%, 63%,58%, 65%,53%, 69%, 100%,100%, 100% , 53%and 45% of collected Samples affected by EC respectively.

Figure 3: Map showing distribution of Electrical Conductivity in Gujarat &UT based on NHS 2024 Data, High EC of the state and UT i.e..EC > 15000 µS/cm, was found at 10 locations namely ; Varvada 15,030 µS/cm (**Devbhoomi dwarka), Dangarvadi DW 15060 (Diu),**Dagachi DW 15,260(Diu), Gochanand 15,390 (Patan), LimbdaTW 16,920(Bhavnagar), Bamanbor 17060 (Surendranagar), Bamanbor DW217,260 (Surendranagar)while EC >30000 µS/cm was found at Bamansar 31,400 µS/cm (Kachchh)**,** Motichander 32970µS/cm **(Patan),** Choraniya TW 36,012 (Surendranagar)showing brackish and saline water problem is not suitable for drinking purpose in terms of Electrical Conductance.

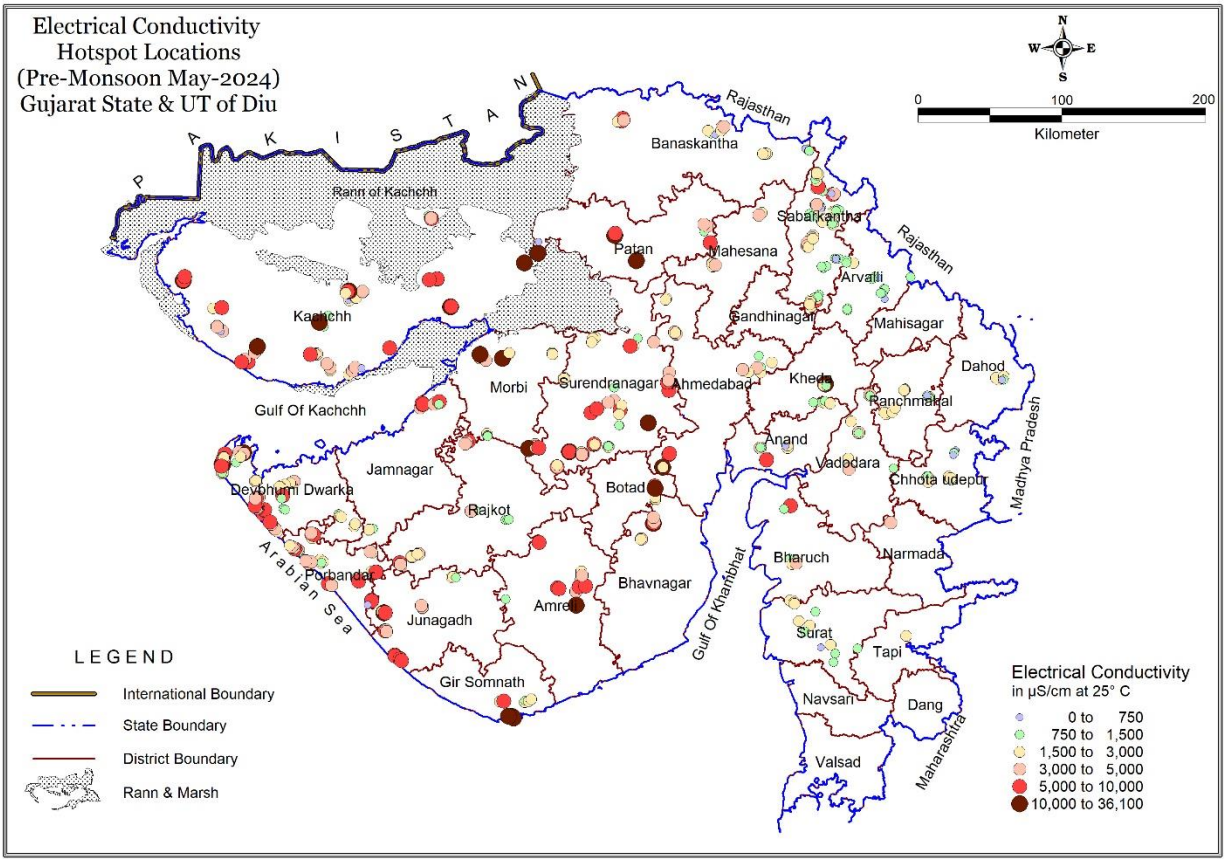


Figure 3: Map showing distribution of Electrical Conductivity in Gujarat and UT of Diu based on NHS 2024 Data

The Table 2 given below provides for the number of samples analyzed per district, along with their minimum, maximum, and mean EC values based on NHS 2024 Data.

EC										
S. No	District	No of Samples analysed	Permissible limit (µS/cm)	Desirable limit (µS/cm)	Min	Max	Mean	No of Samples (%)		
								<750	750-3000	>3000
1	Ahmedabad	20	3000		943	11058	3576	0	65	35
2	Amreli	13	3000		1135	10700	4838	0	30.77	69.23
3	Anand	14	3000		723	6004	2228	7.14	71.43	21.43
4	Arvalli	17	3000		703	1576	1105	11.76	88.24	0
5	Banaskantha	20	3000		689	6895	2386	10	60	30
6	Bharuch	9	3000		1026	5986	2442	0	66.67	33.33
7	Bhavnagar	11	3000		1633	16920	4425	0	54.55	45.45
8	Botad	3	3000		4125	14852	8121	0	0	100
9	Chhota udaipur	11	3000		560	4054	1615	18.18	72.73	9.09
10	Dahod	7	3000		498	2810	1427	28.57	71.43	0
11	Devbhumi Dwarka	64	3000		438	15030	3791	3.13	43.75	53.12
12	Diu	3	3000		14980	15260	15100	0	0	100
13	Gir Somnath	9	3000		1227	7342	2614	0	77.78	22.22
14	Jamnagar	12	3000		986	9620	4281	0	41.67	58.33
15	Junagadh	24	3000		991	14300	4442	0	33.33	66.67
16	Kachchh	54	3000		472	31400	4993	9.26	27.78	62.96
17	Kheda	5	3000		1074	13850	4337	0	60	40
18	Mahesana	8	3000		1499	4249	2665	0	62.5	37.5
19	Morbi	19	3000		851	14180	3911	0	63.16	36.84
20	Narmada	1	3000		3238	3238	3238	0	0	100
21	Panchmahal	16	3000		691	2821	1709	6.25	93.75	0
22	Patan	15	3000		418	32970	6265	13.33	26.67	60
23	Porbandar	37	3000		594	9966	3839	2.7	32.43	64.87
24	Rajkot	20	3000		751	7906	2887	0	55	45
25	Sabarkantha	72	3000		399	6596	1943	6.94	79.17	13.89
26	Surat	11	3000		632	2466	1450	9.1	90.9	0
27	Surendranagar	66	3000		605	36012	4769	4.55	42.42	53.03
28	Vadodara	12	3000		589	4230	1939	8.33	66.67	25

Table 2: District wise Range and distribution of EC in shallow GW of Gujarat and UT of Daman, Diu &DNH

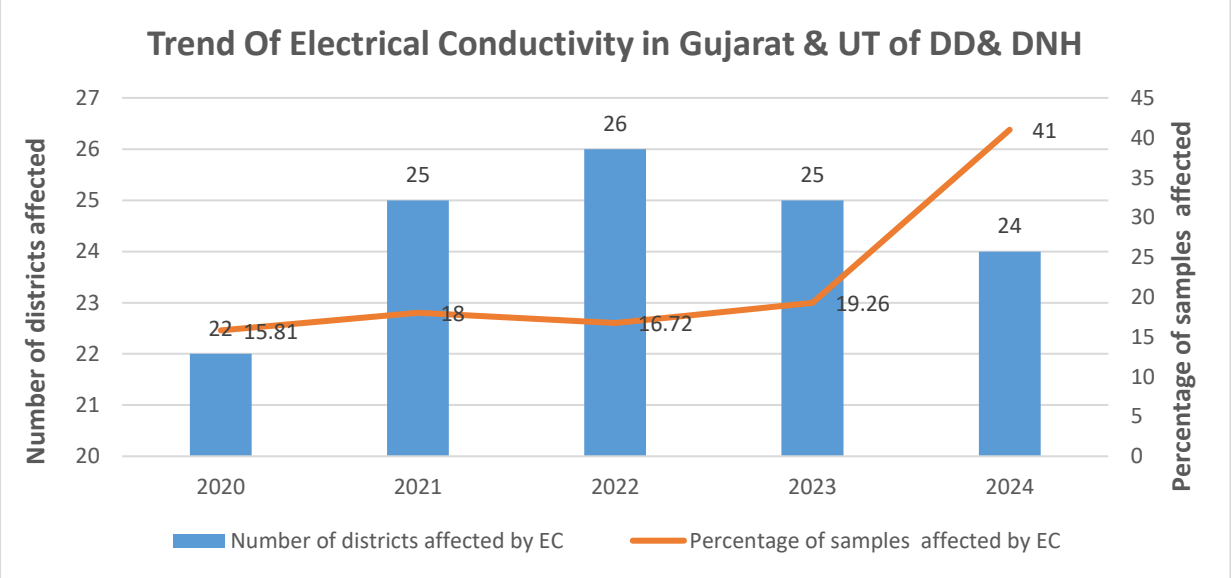
In comparison to 2020 (Table 3), it has been observed that there is increase in the no. of Districts having EC more than 3000 µS/cm in 2024.

S.NO	Districts	No of Samples having EC>3000 µS/cm				
		2020	2021	2022	2023	2024
1	Ahmedabad	5	6	3	3	7
2	Amreli	5	4	5	9	9
3	Anand	2	2	1	2	3
4	Aravalli	3	1	1	0	0
5	Banaskantha	2	1	2	3	6
6	Bharuch	4	6	6	7	3
7	Bhavnagar	5	2	4	7	5
8	Chhota Udaipur	1	1	1	1	1
9	Dohad	1	1	0	0	0
10	Daman	0	0	0	0	
11	The Dang	0				
12	Diu	3	0	1	1	3
13	Gandhinagar	0	0	0	0	
14	Gir Somnath	0	0	1	1	2
15	Jamnagar	8	2	4	3	7
16	Junagadh	9	7	6	7	16
17	Kachchh	12	14	17	18	34
18	Kheda	4	4	2	0	2
19	Mahesana	5	2	3	3	3
20	Mahisagar	0	0	0	0	
21	Morbi	1	6	4	5	7
22	Narmada	0	0	0	1	1
23	Navsari	0	2	2	1	
24	Panchmahals	0	0	0	0	0
25	Patan	2	2	2	4	9
26	Porbandar	7	9	10	8	24
27	Rajkot	3	5	4	5	9
28	Sabarkantha	3	2	2	2	10
29	Surat	0	1	0	0	0
30	Surendranagar	7	12	17	15	35
31	Vadodara	3	2	1	3	3
32	Valsad	0	0	1	1	
33	Botad	0	3	1	1	3

34	Devbhumi Dwarka	0	5	13	14	34
35	Tapi	0	0	0	0	
36	DNH	0	0	0	0	
	Total	95	102	114	125	236

Table 4: Periodic variation in suitability Classes of EC in groundwater of Gujarat and UT of Daman, Diu &DNH

Parameter	Class	Percentage of Sample					Periodic Variation 2020-2024
		2020	2021	2022	2023	2024	
		n=601	n=565	n=682	n=649	n=573	
Salinity as EC	<750 µS/cm	22.96	24.24	24.34	21.47	5.23	-17.73
	750-3000	**61.23**	57.16	58.94	59.32	53.58	-7.65
	>3000	15.8	18.58	16.71	19.26	41.19	25.39



4.1.2 NITRATE

Naturally occurring nitrate forms when nitrogen and oxygen combine in soil, primarily sourced from atmospheric nitrogen. Groundwater nitrate mainly comes from chemical fertilizers, animal manure leaching, and sewage discharge. Identifying natural vs. manmade sources is challenging. Chemical and microbiological processes like nitrification and denitrification also affect groundwater nitrate levels.

As per the BIS standard for drinking water the maximum desirable limit of nitrate concentration in groundwater is 45 mg/l. Though nitrate is considered relatively non-toxic, a high nitrate concentration in drinking water is an environmental health concern arising from increased risks of methaemoglobonaemia particularly to infants. Adults can tolerate little higher concentration.

PRESENT DAY SCENARIO IN GUJARAT AND UT OF DAMAN,DIU &DNH W.R.T NITRATE (NO3)

Distribution of Nitrate (NO3)

The probable sources of nitrate contamination of ground water are through excessive application of fertilizers, bacterial nitrification of organic nitrogen, and seepage from animal and human wastes and atmospheric inputs. In the State, nitrate in ground water samples varies from 0 to 1026 mg/L. BIS permits a maximum concentration of 45 mg/L nitrate in drinking water. Considering this limit, it is found that 49.21 % of the samples, spread over the entire State, have nitrate below 45 and 50.79 % have more than 45 mg/L. Spatial distribution of nitrate (Figure 4) indicates maximum concentration of nitrate exceeding 45 mg/L. in considerable area of the western, central and northeast part of state.

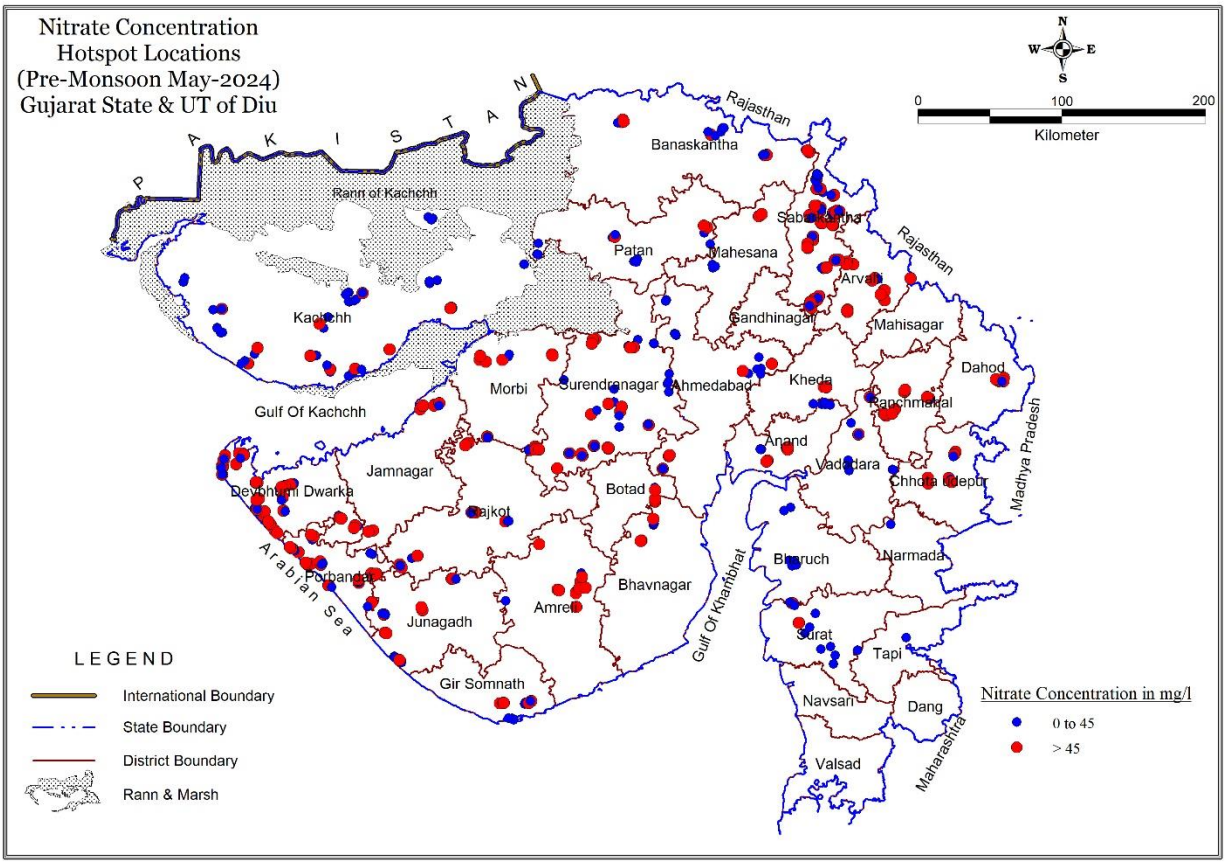


Figure 4: Map showing distribution of Nitrate in Gujarat state and UT of Diu based on NHS 2024 Data

The Table 5 given below provides for the number of samples analyzed per district, along with their minimum, maximum, and mean Nitrate values based on NHS 2024 Data.

Table 5: District wise Range and distribution of Nitrate in shallow GW of Gujarat and UT of Daman, Diu &DNH

Nitrate									
S. No	**District**	**No of Samples analysed**	**Permissible limit (µS/cm)**	**Desirable limit (µS/cm)**	**Min**	**Max**	**Mean**	**No of Samples (%)**	
								≤45	**>45**
1	Ahmedabad	20	45		8	759	120	75	25
2	Amreli	13	45		9.44	217	108	15.38	84.62
3	Anand	14	45		1	129	38	64.29	35.71
4	Arvalli	17	45		10	147	92	11.76	88.24
5	Banaskantha	20	45		1	125	45	50	50
6	Bharuch	9	45		1	187	32	88.89	11.11
7	Bhavnagar	11	45		13	153	82	36.36	63.64
8	Botad	3	45		13	57	34	66.67	33.33
9	Chhota udaipur	11	45		0.4	115	51	36.36	63.64
10	Dahod	7	45		20	145	86	42.86	57.14
11	Devbhumi Dwarka	64	45		2	515	89	31.25	68.75
12	Diu	3	45		1.91	2.08	2	100	0
13	Gir Somnath	9	45		4	155	56	44.44	55.56
14	Jamnagar	12	45		1	189	75	25	75
15	Junagadh	24	45		3	129	47	58.33	41.67
16	Kachchh	54	45		0	143	28	75.93	24.07
17	Kheda	5	45		2	199	98	40	60
18	Mahesana	8	45		3	64	23	75	25
19	Morbi	19	45		9	1026	171	47.37	52.63
20	Narmada	1	45		21	21	21	100	0
21	Panchmahal	16	45		12	975	228	12.5	87.5
22	Patan	15	45		1	217	33	80	20
23	Porbandar	37	45		2	484	71	40.54	59.46
24	Rajkot	20	45		7.2	410	83	45	55
25	Sabarkantha	72	45		0.1	331	93	38.89	61.11
26	Surat	11	45		0.2	59	16.1	90.91	9.09

27	Surendranagar	66	45		0	866	104	53.03	46.97
28	Vadodara	12	45		1	243	35	75	25

It has been observed (Table 6) that No. of locations in various Districts having high Nitrate (more than 45 mg/l) content in ground water has increased from 193 in year 2020 to 291 in the year 2024.

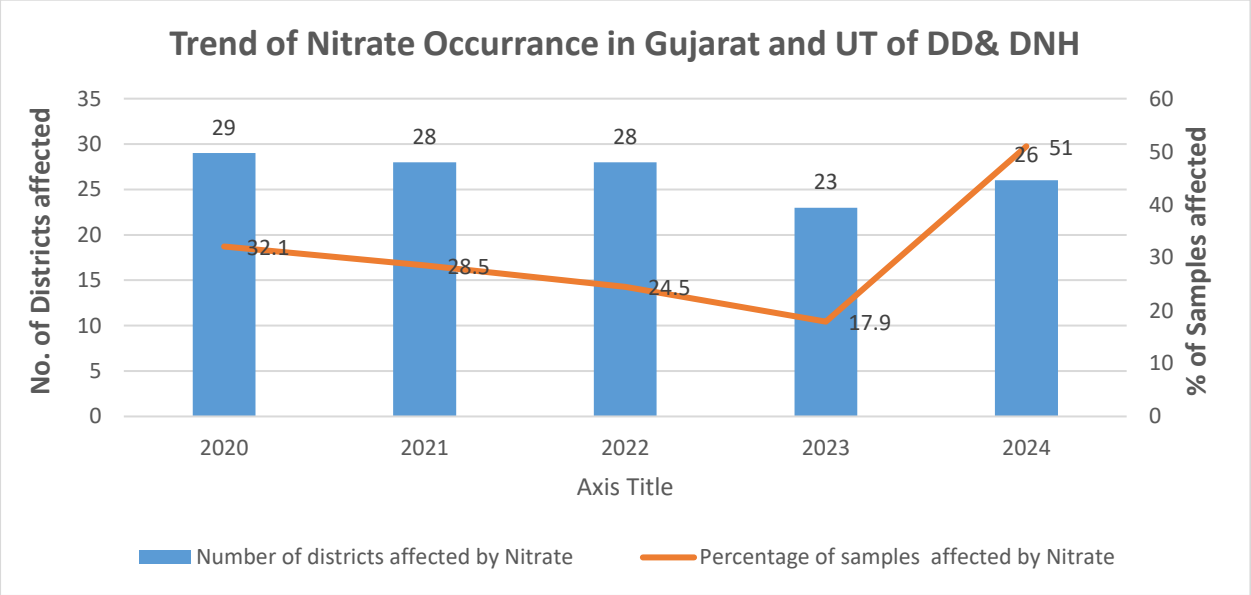
Table 6: Comparative Change in number of locations having Nitrate > 45 mg/l

S.NO	Districts	No of Samples having Nitrate > 45 µS/cm				
		2020	2021	2022	2023	2024
1	Ahmedabad	2	1	1	2	**5**
2	Amreli	17	9	12	5	11
3	Anand	3	4	2	3	5
4	Aravalli	10	8	6	8	15
5	Banaskantha	5	4	5	0	10
6	Bharuch	4	4	2	2	1
7	Bhavnagar	11	12	17	1	7
8	Chhota Udaipur	3	0	1	1	7
9	Dahod	8	5	2	4	4
10	Daman	0	0	0	0	
11	The Dang	2	0	0	0	
12	Diu	2	0	1	0	0
13	Gandhinagar	1	1	0	0	
14	Gir Somnath	0	4	4	0	5
15	Jamnagar	26	9	11	4	9
16	Junagadh	23	6	6	8	10
17	Kachchh	5	4	6	4	13
18	Kheda	1	1	1	1	3
19	Mahesana	3	2	1	0	2
20	Mahisagar	1	1	1	0	
21	Morbi	4	5	3	2	10
22	Narmada	1	2	0	0	0
23	Navsari	1	0	0	0	
24	Panchmahals	5	5	3	4	14
25	Patan	2	1	1	0	3
26	Porbandar	13	7	10	6	22
27	Rajkot	13	22	18	6	11
28	Sabarkantha	16	17	14	19	44
29	Surat	2	5	2	2	1

30	Surendranagar	6	10	15	13	31
31	Vadodara	3	0	0	2	3
32	Valsad	0	1	1	1	
33	Botad	0	2	4	0	1
34	Devbhumi Dwarka	0	9	17	17	44
35	Tapi	0	0	0	1	
36	DNH	0	0	0	0	
	Total	193	161	167	116	291

Table 7: Periodic variation in suitability Classes of Nitrate in groundwater of Gujarat and UT of Daman, Diu &DNH

Parameter	Class	Percentage of Sample					Periodic Variation 2020-2024
		2020	2021	2022	2023	2024	
		n=601	n=565	n=682	n=649	n=573	
Nitrate as NO_3	<45 mg/L	67.9	71.5	75.5	82.1	49.21	-18.69
	>45mg/L	32.1	28.5	24.5	17.9	50.79	18.69



4.1.3 FLUORIDE

Fluoride does not occur in the elemental state in nature because of its high reactivity. It exists in the form of fluorides in a number of minerals of which Fluorspar, Cryolite, Fluorite & Fluorapatite are the most common.

Most of the fluoride found in groundwater is naturally occurring from the breakdown of rocks and soils or weathering and deposition of atmospheric particles. Most of the fluorides are sparingly soluble and are

present in groundwater in small amount. The type of rocks, climatic conditions, nature of hydro geological strata and time of contact between rock and the circulating groundwater affect the occurrence of fluoride in natural water.

BIS has recommended a desirable limit of 1.0 mg/l of fluoride concentration in drinking water and maximum permissible limit of 1.5 mg/l in case no alternative source of drinking water is available. It is well known that small amount of fluoride (upto1.0 mg/l) have proven to be beneficial in reducing tooth decay. However, high concentrations (>1.5mg/l) have resulted in staining of tooth enamel while at still higher levels of fluoride (> 5.0 mg/l) further critical problems such as stiffness of bones occur. Water having fluoride concentration more than 1.5mg/l is not suitable for drinking purposes. High Fluoride >1.5mg/l is mainly attributed due to geogenic conditions. The fluoride content in ground water from observation wells in a major part of the State is found to be less than 1.0 mg/l.

PRESENT DAY SCENARIO IN GUJARAT W.R.T FLUORIDE (F)

Distribution of Fluoride (F)

Fluoride in small amounts in drinking water is beneficial for the dental health while in large amounts it is injurious. The fluoride content in ground water ranges from 0.04 to 33 mg/L.
BIS recommends that fluoride concentration up to 1.0 mg/L in drinking water is desirable, up to 1.50 mg/L it is permitted and above 1.50 mg/L is injurious and is not suitable for drinking purposes.
Classification of samples based on this recommendation, it is found that 58.64 % samples have fluoride in desirable range, 17.45% in the permissible and the remaining 23.91 % have fluoride above 1.50 mg/L. Map showing spatial distribution (Figure 5) of fluoride contents in ground water indicates that high concentration of fluoride above 1.50 mg/L are found in western, central and northern part of state mainly in Kachchh, Sabarkantha, Surendernagar, Devbhumi Dawrka, Gir Somnath, Bhavnagar,Patan,Porbandar and Ahmedabad districts of the State.

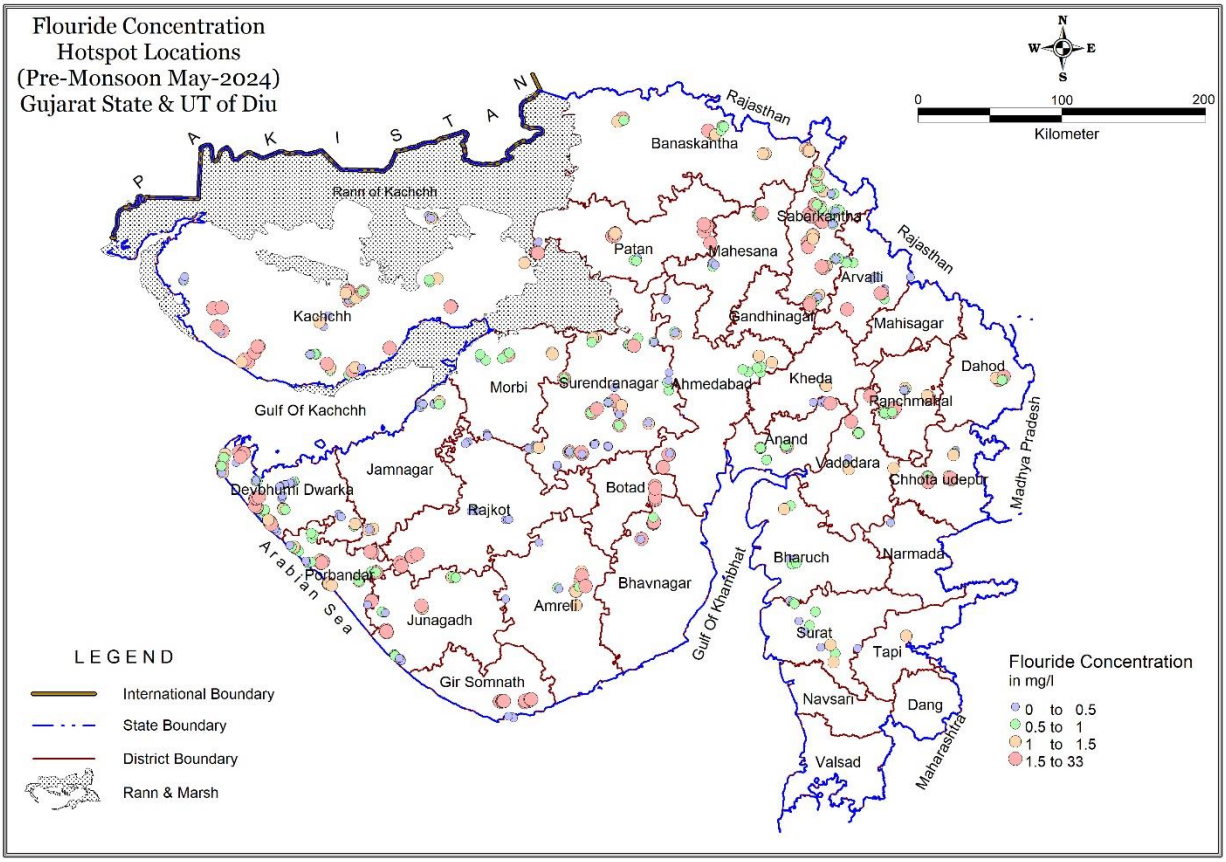


Figure 5: Map showing distribution of Fluoride in state of Gujarat and UT of Diu based on NHS 2024 Data

The Table 8 given below provides for the number of samples analyzed per district, along with their minimum, maximum, and mean Fluoride values based on NHS 2024 Data

Table 8: District wise Range and distribution of Fluoride in shallow GW of Gujarat and UT of Daman, Diu &DNH based on NHS 2024 Data

Fluoride									
S. No	District	No of Samples analysed	Permissible limit (µS/cm)	Desirable limit (µS/cm)	Min	Max	Mean	No of Samples (%)	
								<= 1.5	>1.5
1	Ahmedabad	20	1.5		0.06	6	1.71	70	30
2	Amreli	13	1.5		0.28	3.25	1.22	69.23	30.77
3	Anand	14	1.5		0.04	1.98	0.68	85.71	14.29
4	Arvalli	17	1.5		0.35	4.4	0.86	82.35	17.65
5	Banaskantha	20	1.5		0.53	4.39	1.52	80	20
6	Bharuch	9	1.5		0.28	1.47	0.6	100	0
7	Bhavnagar	11	1.5		0.07	8.2	3.24	27.27	72.73
8	Botad	3	1.5		3.55	5.65	4.9	0	100
9	Chhota udaipur	11	1.5		0.27	2.78	1.27	63.64	36.36
10	Dahod	7	1.5		0.61	2.95	1.25	71.43	28.57
11	Devbhumi Dwarka	64	1.5		0.04	2.8	0.88	81.25	18.75
12	Diu	3	1.5		0.1	0.18	0.13	100	0
13	Gir Somnath	9	1.5		2.06	5.25	3.75	0	100
14	Jamnagar	12	1.5		0.19	1.21	0.6	100	0
15	Junagadh	24	1.5		0.13	2.08	0.87	79.17	20.83
16	Kachchh	54	1.5		0.12	9.8	1.69	64.81	35.19
17	Kheda	5	1.5		0.06	1.03	0.46	100	0
18	Mahesana	8	1.5		0.32	4.29	1.23	75	25
19	Morbi	19	1.5		0.23	2.16	0.65	94.74	5.26
20	Narmada	1	1.5		0.47	0.47	0.47	100	0
21	Panchmahal	16	1.5		0.42	4.5	1.41	75	25
22	Patan	15	1.5		0.22	33	4.5	46.67	53.33
23	Porbandar	37	1.5		0.08	4.6	1.2	78.38	21.62
24	Rajkot	20	1.5		0.13	3.44	0.82	75	25
25	Sabarkantha	72	1.5		0.39	5.9	1.34	79.17	20.83
26	Surat	11	1.5		0.12	1.45	0.7	100	0
27	Surendranagar	66	1.5		0.1	5.42	0.92	83.33	16.67
28	Vadodara	12	1.5		0.34	2.24	1.16	83.33	16.67

It has been observed (Table 9) that No. of locations in various Districts affected by high fluoride has increased from 83 in 2020 to 137 in 2024.

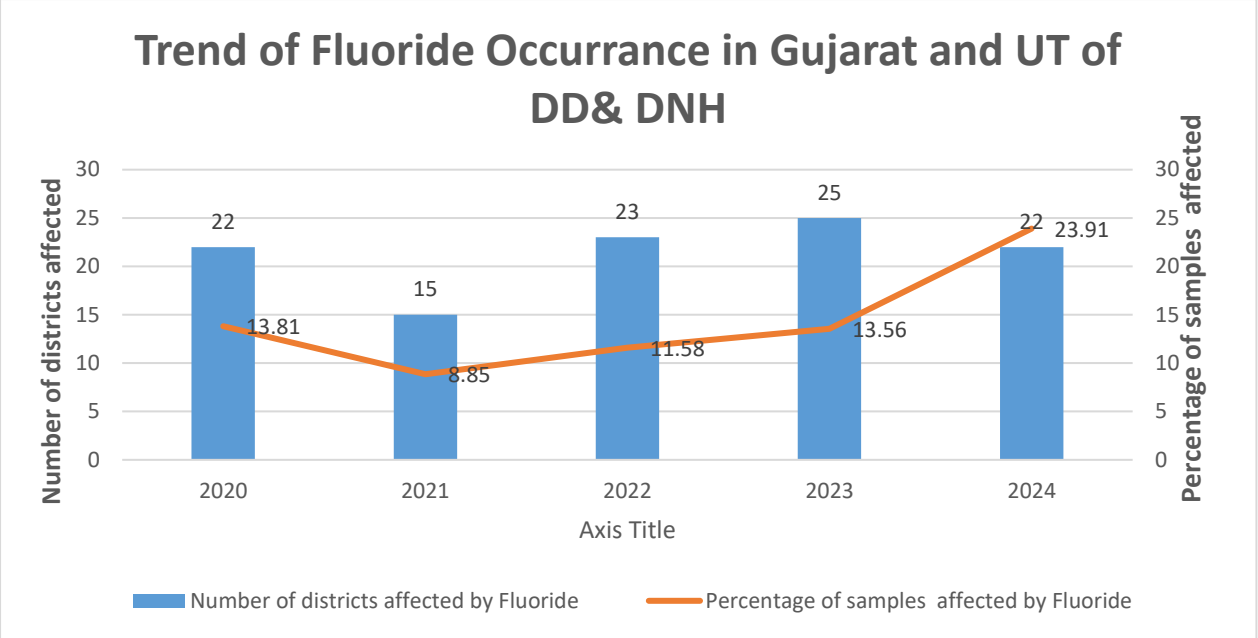
Table 9: Comparative Change in number of Locations having F > 1.5 mg/l

S.NO	Districts	No of Samples having Fluoride >1.5 µS/cm				
		2020	2021	2022	2023	2024
1	Ahmedabad	4	7	0	4	6
2	Amreli	3	0	3	1	4
3	Anand	5	0	2	2	2
4	Aravalli	1	0	0	1	3
5	Banaskantha	5	0	4	5	4
6	Bharuch	2	1	2	0	0
7	Bhavnagar	3	2	3	4	8
8	Chhota Udaipur	5	0	3	3	4
9	Dahod	5	5	6	2	2
10	Daman	0	0	0	0	
11	The Dang	0	0	0	0	
12	Diu	0	0	0	0	0
13	Gandhinagar	0	0	0	0	
14	Gir Somnath	0	2	2	2	9
15	Jamnagar	8	0	0	1	0
16	Junagadh	3	0	1	1	5
17	Kachchh	8	7	8	9	19
18	Kheda	1	0	0	0	0
19	Mahesana	2	0	0	1	2
20	Mahisagar	0	0	1	0	
21	Morbi	0	4	4	2	1
22	Narmada	0	0	0	1	0
23	Navsari	0	0	1	0	
24	Panchmahals	1	2	4	2	4
25	Patan	2	2	3	3	8
26	Porbandar	5	2	0	4	8
27	Rajkot	2	2	2	2	5
28	Sabarkantha	9	6	7	10	15
29	Surat	0	0	1	3	0
30	Surendranagar	4	6	16	10	11
31	Vadodara	4	0	1	4	2
32	Valsad	1	0	0	0	
33	Botad	0	1	1	1	3
34	Devbhumi Dwarka	0	1	3	10	12

35	Tapi	0	0	0	0	
36	DNH	0	0	1	0	
	Total	83	50	79	88	137

Table 10: Periodic variation in suitability Classes of Fluoride in groundwater of Gujarat and UT of Daman, Diu &DNH

Parameter	Class of F	Percentage of Sample					Periodic Variation 2020-2024
		2020	2021	2022	2023	2024	
		n=601	n=565	n=682	n=649	n=573	
Fluoride as F	<1.0	87.7	80.53	84.43	78.27	58.64	-29.06
	1.0-1.5	7.48	10.61	5.27	8.16	17.45	9.97
	>1.5	13.81	8.84	11.29	13.55	23.91	10.1


Trend of Fluoride Occurrance in Gujarat and UT of DD& DNH
Number of districts affected
Percentage of samples affected
30
25
20
15
10
5
0
22
15
23
25
22
13.81
8.85
11.58
13.56
23.91
2020
2021
2022
2023
2024
Axis Title
Number of districts affected by Fluoride
Percentage of samples affected by Fluoride

6. SUMMARY

The analytical results show a concerning trend: compared to 2020, more districts in Gujarat and UT of Daman,Diu &DNH had groundwater samples exceeding permissible limits for Salinity, Fluoride and Nitrate by 2024. This decline in water quality may stem from geogenic or anthropogenic sources. While most samples from Central Ground Water Board observation wells meet drinking water standards for basic parameters, some exceed permissible limits, posing health risks with prolonged use.

DISTRICT WISE CONTAMINANT WISE STATUS SUMMARY BASED ON NHS 2024 PRE- MONSOON DATA

The Table 11 provides a detailed summary of groundwater quality across various districts in Gujarat and UT of Daman,Diu &DNH, focusing on basic parameters (electrical conductivity, nitrate, fluoride).

District	Total No. of Basic samples	EC	NO3	F
		µS/cm at 25°C	mg/l	mg/l
Ahmedabad	20	7(35%)	5(25%)	6(30%)
Amreli	13	9(69%)	11(85%)	4(31%)
Anand	14	3(21%)	5(36%)	2(14%)
Arvalli	17	0(0%)	15(88%)	3(18%)
Banaskantha	20	6(30%)	10(50%)	4(20%)
Bharuch	9	3(33%)	1(11%)	0(0%)
Bhavnagar	11	5(45%)	7(64%)	8(73%)
Botad	3	3(100%)	1(33%)	3(100%)
Chhota udepur	11	1(9%)	7(64%)	4(36%)
Dadra And Nagar Haveli				
Dahod	7	0(0%)	4(57%)	2(29%)
Daman				
Dang				
Devbhoomi Dwarka	64	34(53%)	44(69%)	12(19%)
Diu	3	3(100%)	0(0%)	0(0%)
Gandhinagar				
Gir Somnath	9	2(22%)	5(56%)	9(100%)
Jamnagar	12	7(58%)	9(75%)	0(0%)
Junagadh	24	16(67%)	10(42%)	5(21%)
Kachchh	54	34(63%)	13(24%)	19(35%)
Kheda	5	2(40%)	3(60%)	0(0%)
Mahesana	8	3(38%)	2(25%)	2(25%)
Mahisagar				
Morbi	19	7(37%)	10(53%)	1(5%)
Narmada	1	1(100%)	0(0%)	0(0%)
Navsari				

Panchmahal	16	0(0%)	14(88%)	4(25%)
Patan	15	9(60%)	3(20%)	8(53%)
Porbandar	37	24(65%)	22(59%)	8(22%)
Rajkot	20	9(45%)	11(55%)	5(25%)
Sabarkantha	72	10(14%)	44(61%)	15(21%)
Surat	11	0(0%)	1(9%)	0(0%)
Surendranagar	66	35(53%)	31(47%)	11(17%)
Tapi				
Vadodara	12	3(25%)	3(25%)	2(17%)
Valsad				
Total	573	236	291	137

Basic Parameters:

- EC (Electrical Conductivity): 41 % of samples exceed permissible limits. The ground water occurring in the Northern , central and some part in west comprising of parts of Junagarh, Kachchh ,Jamnagar, Porbandar , Surendranagar, Amreli, Botad, Narmada, Diu , Devbhoomi Dwarka and Bhavnagar and districts is 67%, 63%,58%, 65%,53%, 69%, 100%,100%, 100% , 53%and 45% of collected Samples affected by EC respectively.
- NO3 (Nitrate): 51% of samples exceed limits across Gujarat and UT of Daman,Diu &DNH,
- F (Fluoride): Overall, 24% of samples surpass permissible levels, with varying percentages across districts.

STATE & UT SUMMARY

The Table 12 provides a summary of groundwater quality in the state of Gujarat and UT of Daman, Diu &DNH ,broken down by the number of samples collected and the percentage of those samples that are contaminated with various parameters

Table 12: Summary of Groundwater Quality in Gujarat and UT of Daman, Diu &DNH :Samples Collected and Contamination Percentage

	Number of Samples Contaminated (%age of Samples contaminated)			
Gujarat and UT of Daman,Diu &DNH Summary	Total no. of basic samples	EC	NO3	F
	573	236(41)	291(51)	137(24)

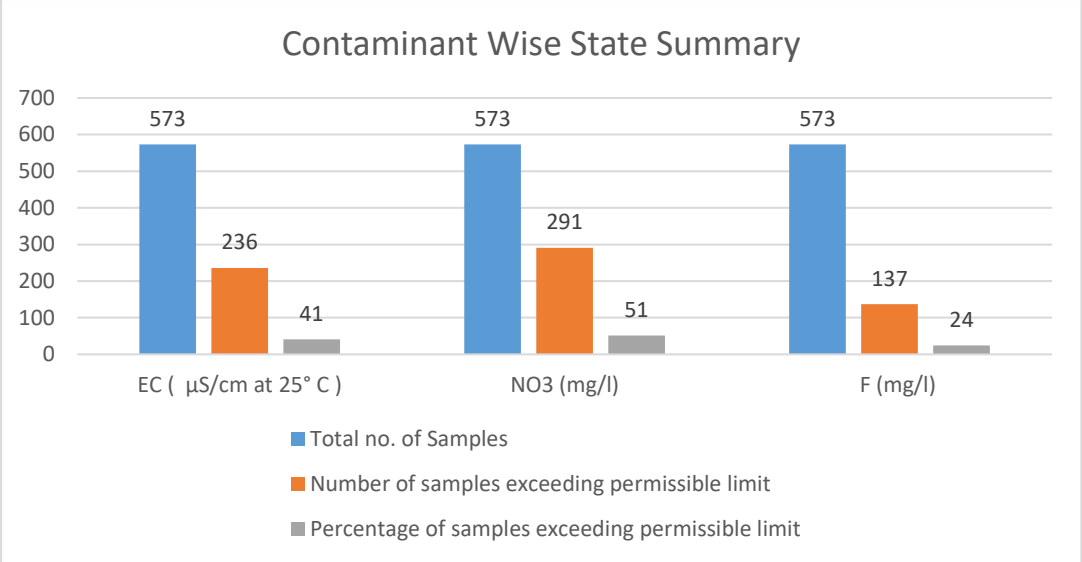


Figure 6 : Graph showing contaminant wise state summary

The groundwater quality assessment in Gujarat and UT of Daman, Diu &DNH revealed notable levels of contamination across various parameters. Nitrate (NO3) emerged as the predominant contaminant, with 51 % of samples surpassing permissible limits, followed by electrical conductivity (EC) at 41%, and Fluoride at 24%.