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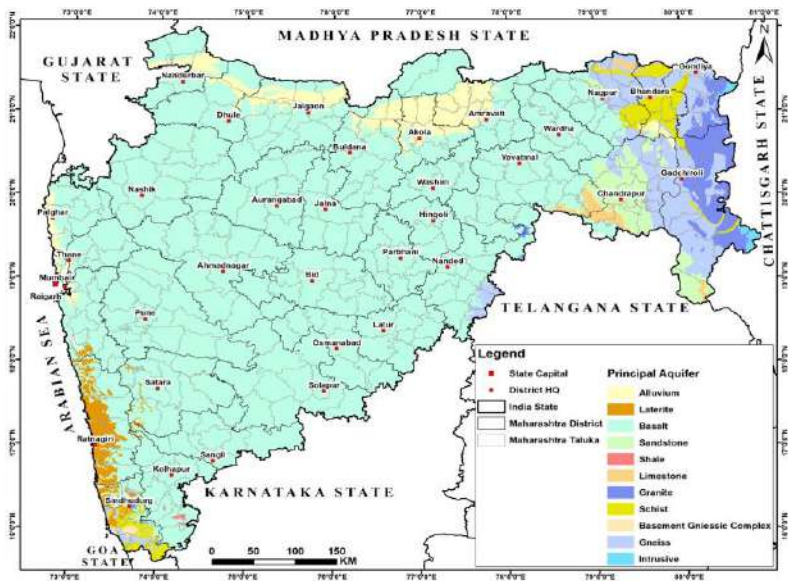
GOVERNMENT OF INDIA
MINISTRY OF JAL SHAKTI
DEPARTMENT OF WATER RESOURCES, RD & GR
CENTRAL GROUND WATER BOARD

वार्षिक भूजल गुणवत्ता पुस्तिका (महाराष्ट्र)
GROUND WATER QUALITY YEARBOOK (MAHARASHTRA)

(YEAR 2024-2025) **(AAP 2025-2026)**



By

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अगस्त **2025 /August 2025**

FOREWORD

The National Water Policy of India considers safe water for drinking and sanitation as pre-emptive needs, followed by for other basic domestic needs including needs of animals, achieving food security, supporting sustenance agriculture and minimum eco-system needs etc.

The National groundwater regime monitoring which was initiated in the year 1969 by establishing 1 station/degree sheet and has been continuously strengthened and now it monitors ~25000 monitoring stations and additional 9000 Pzs will be added under PIB and GWMR schemes in next two years.

Groundwater based irrigation in India exists from the ages of Indus civilization and now about 78% of irrigation needs of the country is met from groundwater, almost 85% of rural drinking water supply and about 50% of urban water supply is met from groundwater as a source. Groundwater being a universal solvent, is prone to contamination, and it is more where underlying rocks are having presence of cracks/fractures through which the toxic compounds can more easily flow. The contamination of groundwater can be serious, especially if the water is source of drinking water or crop irrigation. Therefore, groundwater quality has become more important than quantity.

In order to highlight the groundwater quality during the year 2024-25, based on quality monitoring from n = 335 trend stations during pre-monsoon and post-monsoon season of 2024 respectively, a report titled “Ground Water Quality Yearbook of Maharashtra (2024-25)” is prepared. In brief, the report reveals, overall groundwater is of alkaline nature, the groundwater from western coastal area and hilly area is less mineralized as compared to other areas and the Purna alluvium is highly mineralized due to inland salinity. Overall, the groundwater quality is suitable for drinking purposes except few samples where either nitrate an anthropogenic contaminant or fluoride a geogenic contaminant is beyond maximum permissible limits of BIS (i.e., 45 mg/L and 1.5 mg/L respectively). As far as suitability for irrigation is concerned, ~99% samples from shallow aquifer are suitable for irrigation needs.

The analysis and compilation of this report is a joint endeavour of all the officers and officials of this region, and their contribution is highly appreciated. The team of officers led by Shri Rakesh Dewangan, Sc-D, Dr. Rajni Kant Sharma, Sc-D, Dr. Sailee Bhange & Shri Vishal Meena, STA (Chem) is highly commendable, and the efforts made by Dr. Pandith Madhnure, Sc-D & then HOO, is highly appreciable and praiseworthy.

I am sure that this report will be of immense help to the planners, policy makers, administrators, researchers and all other stakeholders alike, and will be a valuable input towards sustainable development of groundwater resources in the state.

Dr. Umesh S. Balpande
Regional Director

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GROUND WATER QUALITY YEARBOOK OF MAHARASHTRA (2024-2025)

EXECUTIVE SUMMARY

The ground water quality assessment in Maharashtra is a part of Ground Water Regime Monitoring and Ground Water Exploration undertaken by the Central Region, Nagpur in every Annual Action Plan (AAP). The present findings are based on National Hydrograph Stations monitoring conducted during AAP 2024-25 undertaken by this region.

The present report is a compilation of the ground water quality monitoring of shallow aquifer through 335 monitoring wells carried out during pre and post monsoon. It suggests that the ground water from shallow aquifer in the state is predominantly alkaline in nature. The EC of groundwater ranges from 51 µS/cm to 11040 µS/cm (pre-monsoon) and 55 µS/cm to 9,174 µS/cm (post-monsoon) for samples collected under the NHS monitoring work.

Groundwater in the western coastal tract and hilly areas of the state is less mineralized than in plain areas, particularly in Western Maharashtra, Marathwada, and parts of Vidarbha. This is due to physiographical, climatic, and hydrogeological conditions. The Purna basin of Vidarbha has highly mineralized groundwater due to inland salinity issues. The total alkalinity is mainly due to bicarbonate ions. The total hardness of groundwater in the pockets of the plain areas of Western Maharashtra, Marathwada and parts of Vidarbha, is more than 600 mg/L.

The concentration values of chloride, sulphate and nitrate in groundwater are indicative of groundwater contamination from surface anthropogenic activities. During the pre-monsoon the average NO_3^- content in groundwater of a shallow aquifer is ~48 mg/L, which is more than the maximum permissible limit of BIS (45 mg/L). The average fluoride concentration was recorded at 0.45 mg/L while the maximum concentration was recorded at 4.65 mg/L in shallow aquifers of Maharashtra, but the average concentrations indicate that, with few exceptions, the concentrations of fluoride in shallow basaltic aquifers are low. The 3% of monitoring wells having F^- greater than 1.5 mg/L were recorded in Chandrapur and Gadchiroli districts. The source of fluoride in the groundwater of these wells is inherent fluoride-bearing minerals present in the geological formation existing in the area.

The potability of groundwater in the monitoring wells from shallow aquifer is mainly affected by nitrate followed by total hardness. However, if other parameters are considered, the ground water is potable in almost all parts of Maharashtra barring few places.

The ground water quality for irrigation based on EC, SAR and RSC values of shallow aquifer suggest that 5.4 % of samples fall under high and very high salinity water, 20.6 % of samples in medium salinity ground water in shallow aquifer while 74 % of ground water samples are considered good for irrigation. The ~ 90 % of the samples of pre-monsoon show RSC values less than 1.25 meq/L while 74 % of the samples of post-monsoon show RSC values less than 1.25 meq/L. This shows that the ground water in the pre-monsoon season from shallow aquifer in the State can be used for irrigation with proper soil and crop management practices.

During the post-monsoon season, 66% of samples are having high nitrate concentration more than the maximum permissible limit of BIS drinking water standards (45 mg/L) which is alarming for the nitrate parameter. The high concentrations of nitrate in post-monsoon indicate that the water recharge from surface is getting polluted from the surface anthropogenic activities as the ion is usually not contributed from natural geogenic sources existing in the State. The concentration of fluoride is low in post-monsoon as compared to pre-monsoon. The recharge processes controlling the dissolution of fluoride in groundwater seems to be more favourable during the pre-monsoon as compared to post-monsoon. The average Fluoride concentration in post-monsoon was observed as 0.47 mg/L, whereas the highest concentration of F was recorded 2.8 mg/L. The potability of ground water in post-monsoon is mainly affected by nitrate and fluoride.

The overall findings based on the various groundwater quality related studies undertaken by the CGWB suggest that Nitrate, Fluoride, Inland salinity and high inorganic matter in ground water around industrial areas are the major ground water quality issues in Maharashtra. The problem of high concentration of nitrate from anthropogenic sources is spread all over the State. The natural contamination of fluoride has been observed in the Chandrapur and Gadchiroli districts. The problem of inland salinity has affected the quality of groundwater in parts of Purna alluvial basin of Amravati, Akola and Buldhana districts.

The artificial recharge of ground water by rainwater harvesting, blending good quality water with contaminated water for water supply and adopting treatment technologies are few remedial measures for improving and protecting ground water quality. The proper treatment and disposal of the waste and wastewater from domestic and industrial sources can also prevent the ground water getting polluted. The above measures, creating awareness among the people, can help to solve the problems related to ground water quality.

The authors are grateful to Dr Umesh S. Balpande, Regional Director and Dr. Pandith Madhnure, Sc-D and TS to RD, for their constant guidance and support. The authors are thankful to Shri Modi Durgaprasad, OIC (RODC) and Shri Vishal Wagh, YP, Central Region, Nagpur for providing the report and data from GWRA 2024 of the State, Ground Water level Bulletin 2025 and the water quality maps which helped in compilation of this report. Authors also acknowledge the hard work of all the field officers of Central Region, Nagpur for timely collection of ground water samples from the State. The authors also acknowledge Shri Dinesh Lonare, Smt. Shubhangi Bharti and Shri Gaurav Parmar, Lab Attendants, for their assistance during the chemical analysis of ground water in the CGWB, CR, Nagpur Chemical Lab.

Ground Water Quality Yearbook of Maharashtra

1 INTRODUCTION

Since 1969, the Central Ground Water Board (CGWB) has been monitoring groundwater levels across India four times a year in January, May, August, and November. Based on this data, CGWB prepares a Groundwater Bulletin that highlights seasonal, annual and long-term changes in the groundwater regime throughout the country. This monitoring is conducted through representative observation wells, offering valuable insights into the dynamics of groundwater.

Natural factors such as rainfall, evapotranspiration, and other climatic variables influence groundwater levels, while human activities like groundwater extraction, artificial recharge through irrigation, and waste disposal also play a significant role. Continuous monitoring enables a scientific assessment of these factors and supports effective groundwater resource management across different regions.

2 STUDY AREA

The State of Maharashtra occupies the west-central part of India. It lies between latitudes 15°45' to 22°00' N and longitudes 73°00' to 80°59' E **(Figure 1).** Maharashtra, the third largest state in India has a total geographical area of 3,07,713 sq km with 9.4 % of the country area. It is bound on the north by Madhya Pradesh, north-west by Gujarat, east by Chhattisgarh, south-east by Telangana, south by Karnataka and Goa and in the west by the Arabian Sea. Administratively, the state is governed by 36 districts which are grouped into six divisions namely Konkan, Pune, Nashik, Chatrapati Sambhaji Nagar (Aurangabad), Amravati and Nagpur. The State is further divided into five regions namely Konkan, Western Maharashtra, Khandesh, Marathwada and Vidarbha. Total population of the State is 112.37 million (as per census 2011) out of which 50.81 million (45.21%) is urban and 61.56 million (54.78%) is rural. The average density of population is 365 persons/km^2. The overall growth in total population during the decade is ~15.99 % (2001 to 2011 census).

Central Ground Water Board, Central Region, Nagpur has set up a network of 2091 observation wells known as the Ground Water Monitoring Wells (GWMW's) located all over Maharashtra which comprises of 1777 dug wells and 314 piezometers. The average density of Monitoring stations is 147 km^2/well.

Physiographically, the state can be divided into 3 units namely Sahyadri Range (Western Ghats), the Western Coastal Tract (Konkan), and the Eastern Plateau (Deccan Plateau). Godavari, Krishna, Tapi, Mahanadi, Narmada and Coastal Basins are the Major River basins in the State. About 75% area of Maharashtra is drained by eastward flowing rivers, viz., the Godavari and Krishna draining into the Bay of Bengal, the remaining 25% of the area is drained by westward flowing rivers, viz., Tapi and Konkan coastal rivers, draining into the Arabian Sea. 45% of state's water resources are from West Flowing Rivers which are mainly monsoon specific rivers emanating from the Ghats and draining into the Arabian Sea. ~53 % of network stations fall in Godavari basin, 16 % fall in Tapi, 16% fall in Krishna, and 15 % network stations fall in the Coastal basins.

Approximately 82% area of the State (2,49,934 sq km) is covered by Deccan trap basalts, whereas rest of area is covered by Quaternary alluvium (14,526 sq km; 4.7 %), Gondwanas (4800 sq km; 1.6 %), Precambrian (Vindhyans, Cuddapahs, and Kaladgi group of rocks - 6,217 sq km; 2%) and Archaean's (32,235 sq km; 10.5%). The aquifers are grouped under three major hydrogeological groups namely unconsolidated, semi-consolidated and consolidated and nine different types of hydrogeological sub-groups based on geological age and hydrogeological characters. These hydrogeological units are further divided into 11 Principal aquifers system.

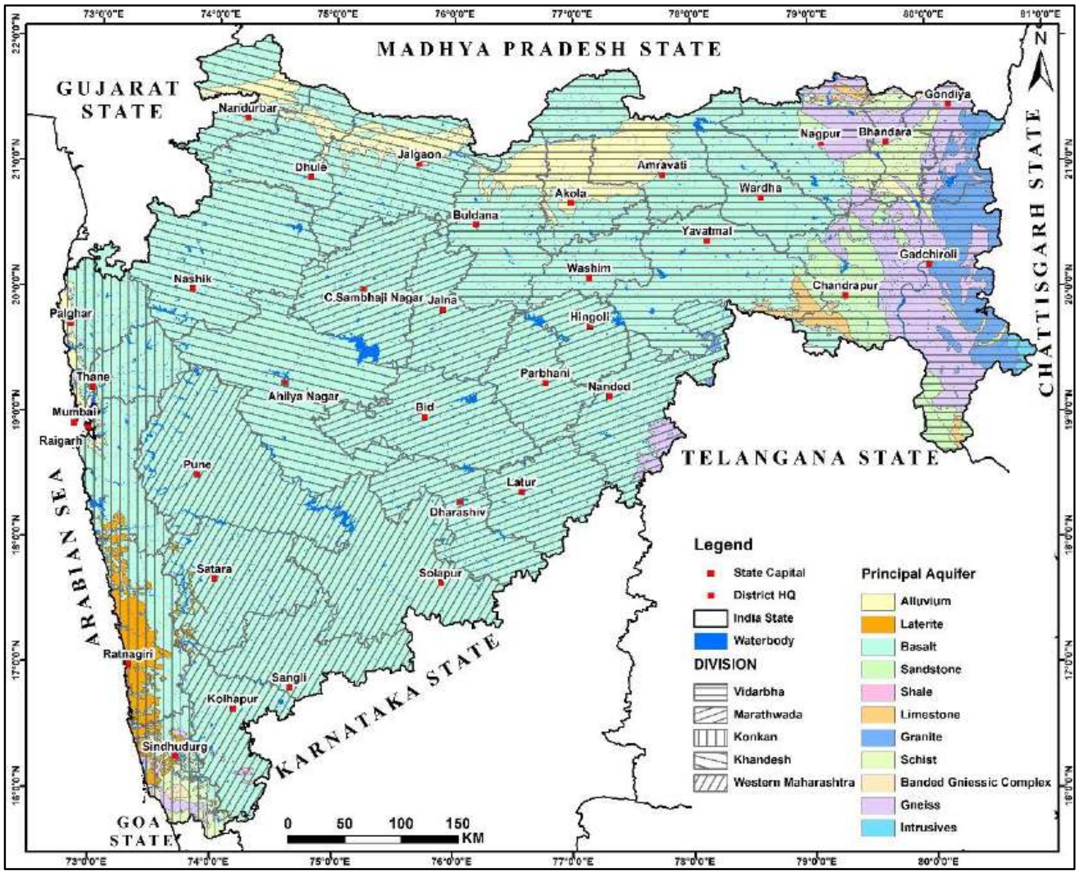


Figure 1: Major Aquifers & Administrative Divisions of Maharashtra.

3 GROUND WATER MONITORING

Central Ground Water Board (CGWB) monitors ground water levels all over the country, four times a year in order to bring out spatial and temporal changes in ground water regime. This continuous monitoring provides a valuable tool to decipher the seasonal and long-term changes in ground water levels and in turn helps in managing the ground water resources in a scientific and effective manner. Analysis of data is carried out through GEMS a dedicated software. Out of 2091 ground water monitoring wells, 80 dug wells and 4 Borewells were found dry and are represented by their corresponding well depth. The location of GWMWs is shown in **Figure 2** and district wise status of GWMWs for the month of May 2025 is presented in **Table 1**.

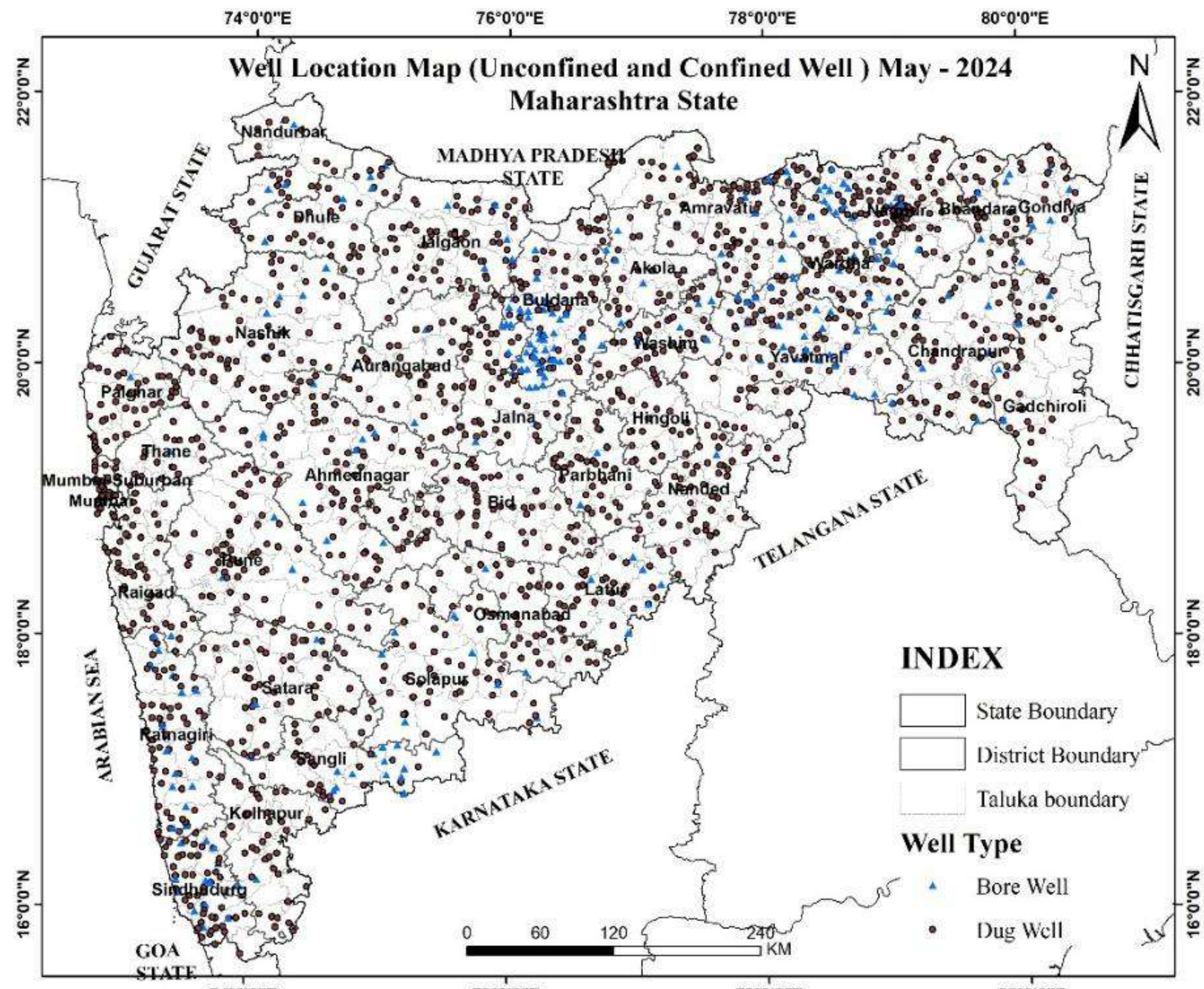


Figure 2: Ground Water Monitoring Wells (GWMWs), Maharashtra

Table 1: District wise status of Ground Water Monitoring Wells (May-2024).

District	Active		Dry		Wells Not Monitored #		No of wells		
	DW	BW	DW	BW	DW	BW	DW	BW	Total well
Ahilyanagar (Ahmednagar)	77	11	2	0	1	0	80	11	91
Akola	25	7	1	0	0	0	26	7	33
Amravati	88	15	1	0	2	1	91	16	107
Ch. Sambhaji Nagar	48	3	3	0	0	0	51	3	54
Beed	57	1	8	0	0	0	65	1	66
Bhandara	31	4	0	0	1	0	32	4	36
Buldhana	67	52	4	1	1	0	72	53	125
Chandrapur	55	11	7	0	5	1	67	12	79
Dhule	34	3	2	2	0	2	36	7	43
Gadchiroli	40	4	3	0	0	0	43	4	47
Gondia	17	8	1	0	1	0	19	8	27
Hingoli	19	0	9	0	1	0	29	0	29
Jalgaon	59	5	3	0	0	0	62	5	67
Jalna	47	6	2	0	0	0	49	6	55
Kolhapur	40	4	0	0	0	0	40	4	44
Latur	41	7	0	0	0	0	41	7	48
Mumbai City	6	0	0	0	0	0	6	0	6
Mumbai Suburban	19	0	0	0	0	0	19	0	19
Nagpur	81	28	2	1	3	2	86	31	117
Nanded	44	1	7	0	5	1	56	2	58
Nandurbar	21	4	1	0	0	0	22	4	26
Nashik	70	6	2	0	1	2	73	8	81
Osmanabad	37	3	1	0	1	0	39	3	42
Parbhani	31	3	13	0	3	0	47	3	50
Pune	49	4	1	0	3	0	53	4	57
Raigad	49	1	0	0	0	0	49	1	50
Ratnagiri	61	18	1	0	1	0	63	18	81
Sangli	40	19	0	0	1	0	41	19	60
Satara	54	2	0	0	1	1	55	3	58
Sindudurg	58	16	0	0	0	1	58	17	75
Solapur	55	7	0	1	0	0	55	8	63
Thane	61	2	5	0	0	0	66	2	68
Wardha	61	9	0	0	0	1	61	10	71
Washim	47	6	0	0	1	0	48	6	54
Yavatmal	77	27	0	0	0	0	77	27	104
Grand Total	1666	297	79	5	32	12	1777	314	2091

4 RAINFALL

As per the Indian Meteorological Department (IMD), the departure of monsoon rainfall from normal rainfall for the period from 1st June 2023 to 30th September 2023 for all districts of Maharashtra has been considered to correlate the prevailing ground water level scenario. The district-wise data analysis indicates that out of 35 districts, 25 districts received normal rainfall, 2 received excess and 9 district deficient rainfall (**Table 2 and Figure 3**).

Table 2: District wise departure of rainfall w.r.t. Normal Rainfall (01-06-2023 to 30-09-2023).

S. No.	District	% Departure of Rainfall wrt Normal Rainfall	Category
1	Ahilyanagar (Ahmednagar)	**-10**	**Normal**
2	Akola	**-23**	**Deficient**
3	Amravati	**-27**	**Deficient**
4	C. Sambhaji Nagar (Aurangabad)	**-11**	**Normal**
5	Beed	**-21**	**Deficient**
6	Bhandara	**7**	**Normal**
7	Buldhana	**-8**	**Normal**
8	Chandrapur	**3**	**Normal**
9	Dhule	**-9**	**Normal**
10	Gadchiroli	**6**	**Normal**
11	Gondia	**-8**	**Normal**
12	Hingoli	**-23**	**Deficient**
13	Jalgaon	**6**	**Normal**
14	Jalna	**-33**	**Deficient**
15	Kolhapur	**-16**	**Normal**
16	Latur	**-8**	**Normal**
17	Mumbai	**5**	**Normal**
18	Mumbai Suburban	**-5**	**Normal**
19	Nagpur	**5**	**Normal**
20	Nanded	**23**	**Excess**
21	Nandurbar	**-3**	**Normal**
22	Nashik	**3**	**Normal**
23	Dharashiv (Osmanabad)	**-24**	**Deficient**
24	Palghar	**21**	**Normal**
25	Parbhani	**-17**	**Normal**
26	Pune	**-6**	**Normal**
27	Raigad	**13**	**Normal**
28	Ratnagiri	**-2**	**Normal**
29	Sangli	**-44**	**Deficient**
30	Satara	**-37**	**Deficient**
31	Sindhudurg	**6**	**Normal**
32	Solapur	**-30**	**Deficient**
33	Thane	**27**	**Excess**
34	Wardha	**-3**	**Normal**

S. No.	District	% Departure of Rainfall wrt Normal Rainfall	Category
35	Washim	**-15**	**Normal**
36	Yavatmal	**14**	**Normal**

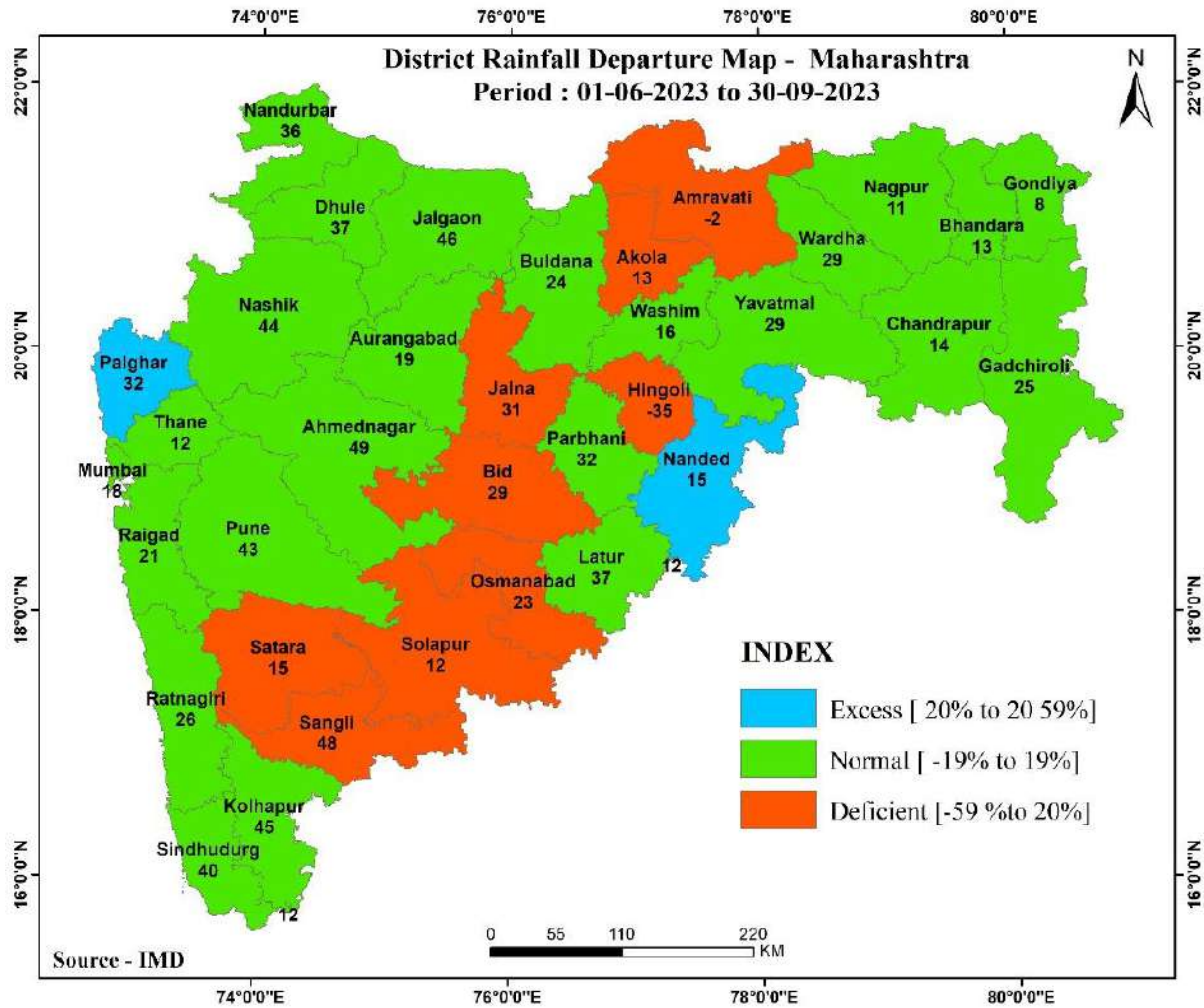


Figure 3: Rainfall deviation (June to September 2023) from normal rainfall.

5 GROUND WATER LEVEL SCENARIO (UNCONFINED AQUIFER)

5.1 Depth to water level in unconfined Aquifer (May 2024)

During pre-monsoon season of 2024, depth to water level in unconfined aquifer (Dug Well zone) ranges from 0.1 to 69.50 m bgl, shallowest in Raigad district and deepest in Jalgaon district (**Figure 4)**. Shallow water levels of < 2 m bgl are observed in 5 % of wells (5537 km^2). In 23 % wells covering ~47758 km^2 area have shown water levels in the range of 2-5 m bgl, falling in Raigad, Thane district and in parts of Pune, Kolhapur, Sangli, Satara, Jalgaon and Nashik districts. Water levels in the range of 5-10 m bgl are more predominant and covers ~175493 km^2 (47 % of wells). In ~25% wells, water levels are in the range of >10 m bgl. The frequency of distribution of wells in different water levels zones is presented as pie diagram in **Figure 5**.

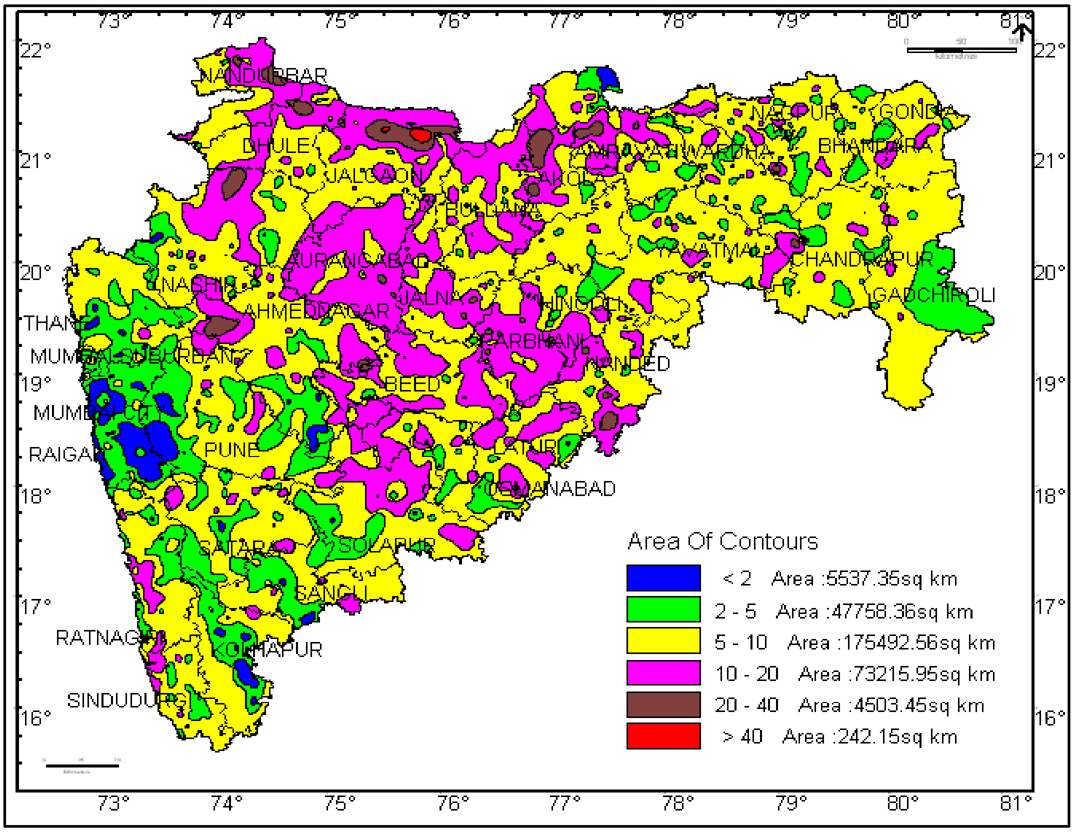


Figure 4: Depth to Water Level in an Unconfined Aquifer During May 2024.

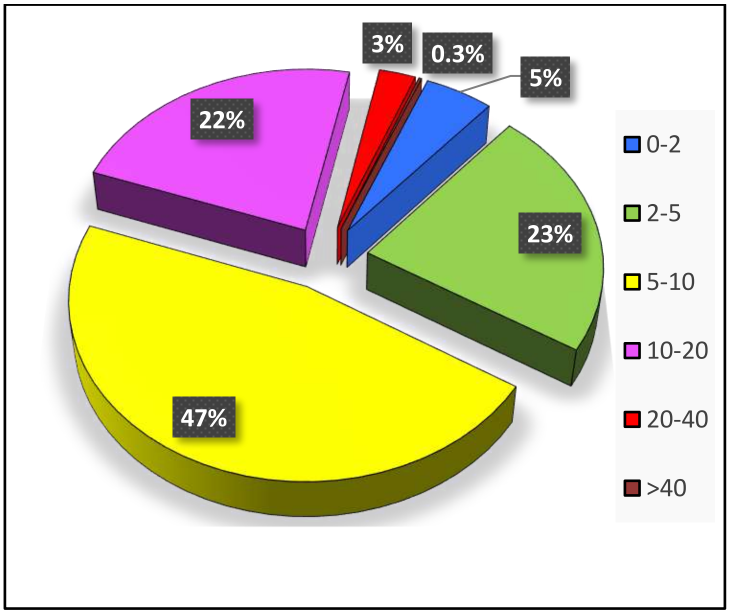


Figure 5: Percentage of wells in different water level ranges in an unconfined aquifer.

5.2 Annual Fluctuation in Water Level

Unconfined Aquifer (May 2024 wrt May 2023)

The water level data in respect of 1673 wells for the month of May 2024 is analyzed and compared with May-2023 data. It is observed that ~39 % of wells have recorded rise in water level during May 2024 as compared with the water level data of May 2023 and 47.3 % wells have recorded fall in water level in the range of 0-2 m, 2-4 m and >4 m (**Figure 6**).

Rise: The rise in water levels <2 m is observed in 28 % of wells covering about 85870 km^2 area. 2 to 4 m rise is observed in 16277 km^2 6.4% wells and > 4 is observed in 4 % of wells covering about 9609 km^2. The rise has mostly occurred in Vidarbha region, central-northern part of state, southern part and in coastal region of the state.

Fall: The decline in water levels is observed in about 47.3 % of states geographical area. Fall less than 2 m is observed in 124638 km^2 area, 2-4 m in 44179 km^2 area and > 4 m in 26195 km^2 area.

The frequency distribution of % of wells showing rise and fall is shown as bar diagram in **Figure 7.**

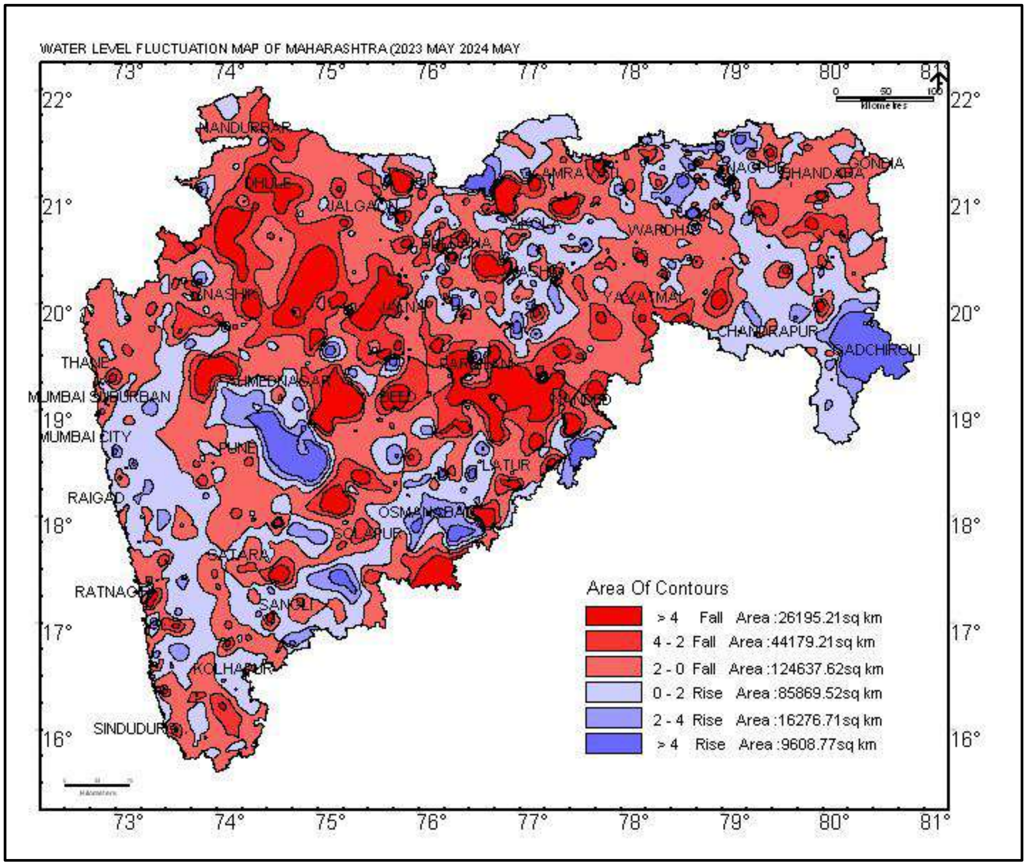


Figure 6: Annual water level fluctuations in an unconfined aquifer During May-24 WRT May-23.

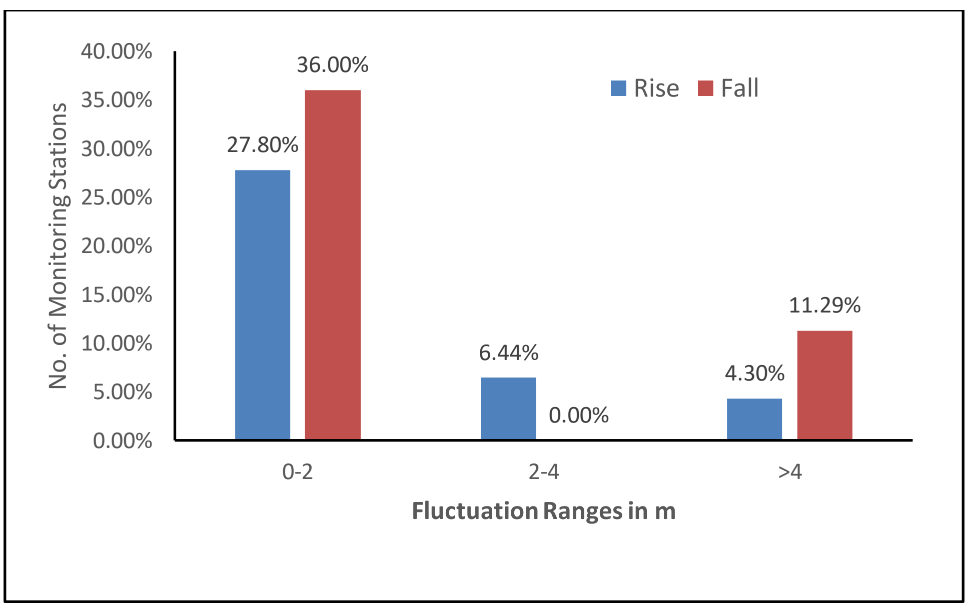


Figure 7: Percentage of wells showing Rise/Fall in WL, unconfined aquifer (May-24 WRT to May-23).

Unconfined Aquifer (May 2024 WRT May-2022)

Rise:

In the state, rise is observed in about 47.3% of wells covering 1,31,122 Km^2 (43%) (**Figure 8**). In 34% wells, water levels have shown a rise of < 2 m and in 8 % wells, it shown rise 2-4 m. more than 4 m rise is observed in 5 % wells. Rise is mostly observed in Vidarbha region and in central western part of the state.

Fall:

In the state, fall is observed in about 51 % of wells covering 1,75,646 Km^2 (57%) (**Figure 8**). In 31 % wells, water levels have shown fall < 2 m and in 10 % wells water levels have fallen by 2-4 m. more than 4 m fall is observed in 5 % wells. Fall is mostly observed in Nashik and Marathwada region.

The distribution of rise/fall in water levels is shown as bar diagram in **Figure 9**.

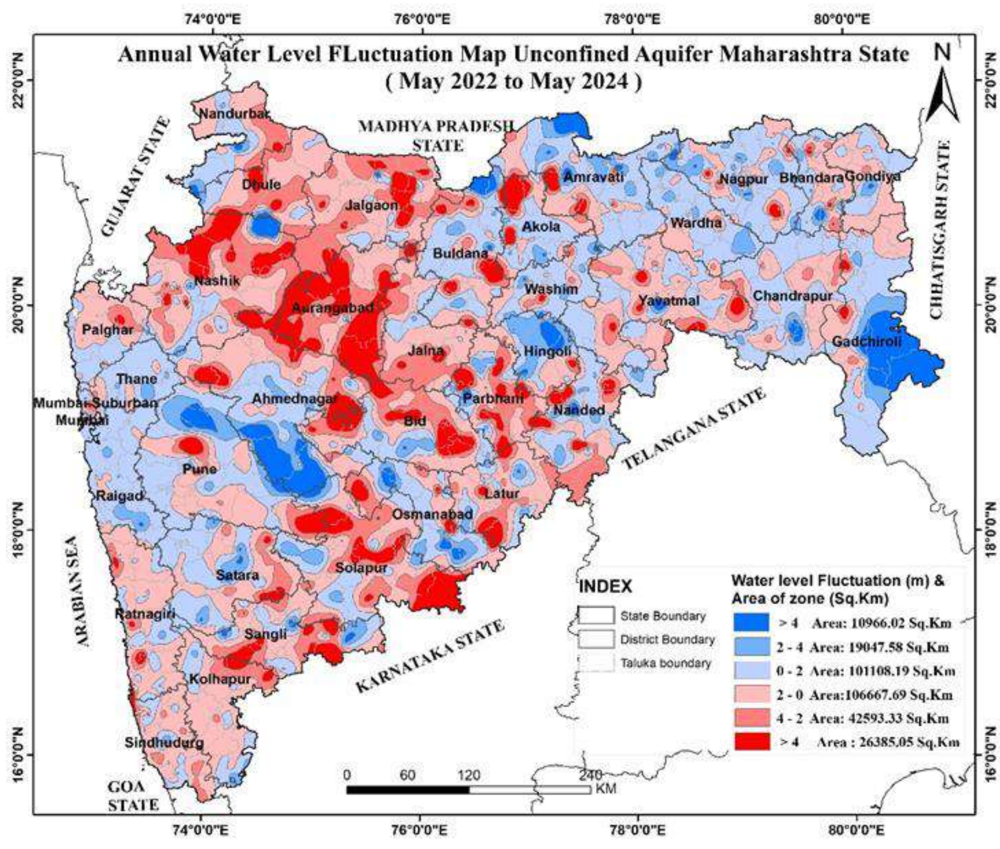


Figure 8: Annual water level fluctuations in an unconfined aquifer (May-24 WRT May-22).

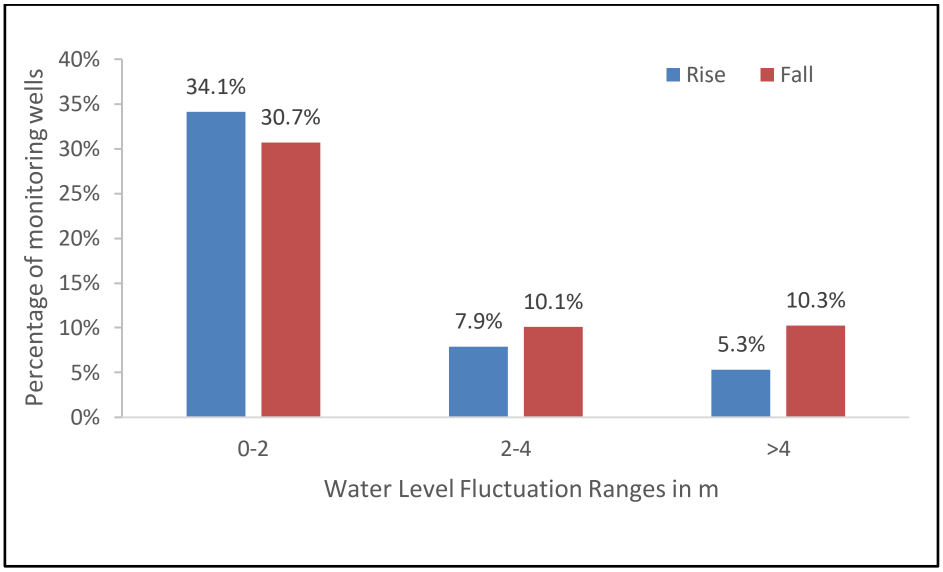


Figure 9: Percentage of wells Rise/Fall in WL in an unconfined aquifer (May-24 WRT May-22).

5.3 DECADAL FLUCTUATION IN WATER LEVEL

Unconfined Aquifer (May-2024 WRT May-2014-23)

Rise:

The perusal of map shows that in 60 % of wells covering about 190,756 km^2 area (62 % states geographical area) shows a rise in water level (**Figure 10**). In 40 % wells rise up to 2 m is observed covering ~1,38,137 km^2. in 13 % wells rise in the range of 2-4 m covering 36699 km^2 area and rise of >4 m is observed in 15919 km^2 area. Maximum rise is observed in eastern parts of Gadchiroli, and in southern parts of Ahilyanagar district and in patches in other parts of state.

Fall:

Fall in water levels is observed in 38% of states area covering 116011 km^2 (**Figure 10)**. In 26.5 % wells fall up to 2 m is observed covering ~87797 km^2. in 7.7 % wells fall in the range of 2-4 m covering 19346 km^2 area and fall of >4 m is observed in 8868 km^2 area. A significant Decline of > 4 m is observed in major parts of Thane, Dhule, Nashik, Pune, Osmanabad, Akola, Jalgaon, and Nandurbar Districts and isolated parts in almost all the districts. This decline is mainly due to negative departure in rainfall during 2023 WRT decadal rainfall and more ground water extraction for agriculture and domestic needs. The frequency distribution of % of wells showing rise and fall is shown as bar diagram in **Figure 11.**

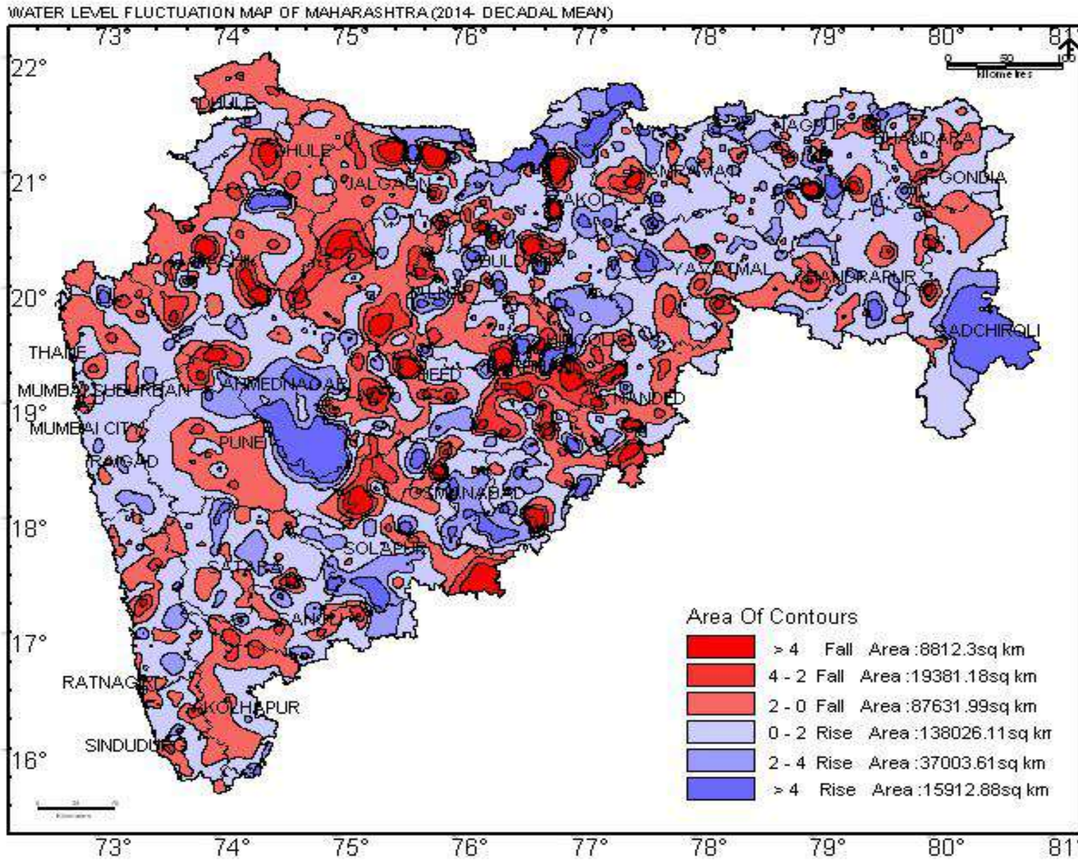


Figure 10: Decadal water level fluctuations in unconfined aquifer (May-24 WRT Decadal May-2014-23).

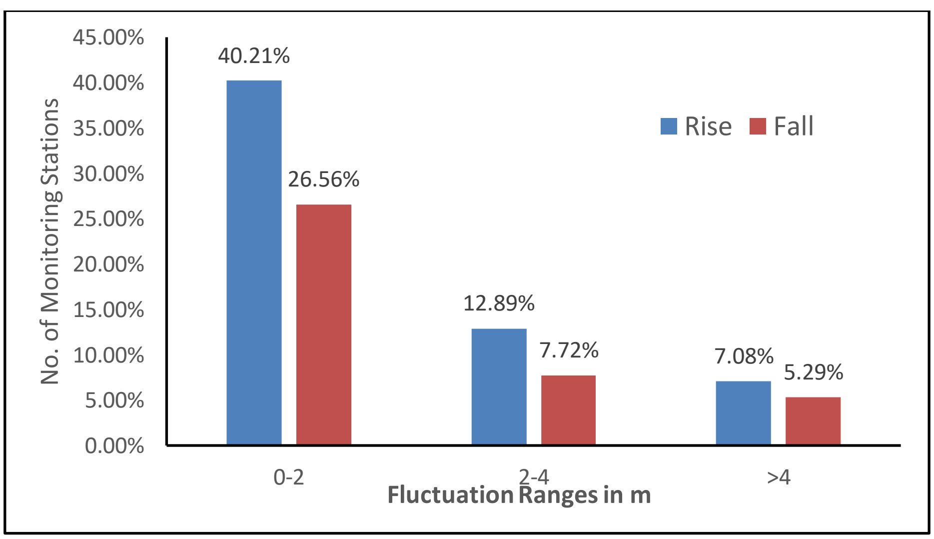


Figure 11: Percentage of wells Rise/Fall in WL in an unconfined aquifer (May-24 WRT Decadal 2014-23).

6 GROUND WATER QUALITY

6.1 Physicochemical characteristic of ground water

The quality of the groundwater depends upon the rainfall pattern, recharge processes, climatic conditions, hydrogeological processes, etc. The concentrations of various gases and ions dissolved in water—from the atmosphere, soil, minerals, and rocks with which it comes into contact during its journey—define its characteristics. Groundwater contains a wide variety of dissolved constituents, mainly inorganic, considered to be total dissolved solids (TDS). The most common substances present in groundwater are calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}), potassium (K^{+}), carbonate (CO_3^{2-}), bicarbonate (HCO_3^{-}), chloride (Cl^{-}), sulphate (SO_4^{2-}), and nitrate (NO_3^{-}). Some ions like fluoride (F^{-}), present in minor quantity, and trace elements such as iron (Fe), copper (Cu), arsenic (As), selenium (Se), manganese (Mn), chromium (Cr), aluminium (Al), lead (Pb), cadmium (Cd), and uranium (U) play a significant role in determining the suitability of groundwater for various uses. All these dissolved constituents contribute to the quality of groundwater.

The concentration of CO_3^{2-}, HCO_3^{-}, OH^{-}, and H^{+} ions, along with dissolved CO_2 gases in water, determines whether water is acidic, basic, or neutral. Salts of Ca^{2+} and Mg^{2+} make water soft or hard. Water with high Na^{+} and Cl^{-} concentration becomes saline. Nitrate ions, typically from anthropogenic sources, can become the predominant major anion in groundwater. Excess fluoride in groundwater, from fluoride-bearing minerals, may correlate with the concentrations of Ca^{2+}, Na^{+}, and HCO_3^{-} ions.

During AAP 2024–25, NHS ground water quality monitoring was conducted in Maharashtra State during the pre-monsoon (May 2024) and post-monsoon (November 2024) seasons using standard protocols. A total of n=335 groundwater samples were collected during both seasons. Additionally, 1,567 samples were collected during the pre-monsoon of 2023, comprising n=1,404 from NHS monitoring stations and n=163 from piezometers. Approximately 24% (n=335) of NHS stations were selected as water quality trend monitoring stations to observe seasonal variations in groundwater quality for AAP 2024–25. As per the previous ground water quality reports it has been observed that Sindhudurg & Ratnagiri districts have very good ground water quality due to the physiological condition. In those districts no significant seasonal and temporal variation was observed, hence it has not been considered for the trend analysis in this report. Also, Palghar district samples have been included in Thane district.

Groundwater quality analysis in Maharashtra was conducted using the 24th Edition APHA (2023) standard procedure. Parameters including minimum, maximum, and exceedance of BIS-prescribed limits for pH, electrical conductivity (EC), nitrate, fluoride, total hardness, total alkalinity, chloride, sodium, potassium, sulphate, uranium, arsenic, lead, iron, manganese, zinc, copper, sodium absorption ratio (SAR), and residual sodium carbonate (RSC) were computed and presented in maps, and graphs and **Table-3**.

Table 3: Minimum, maximum and average value of the Physico-chemical parameters.

Parameter	*BIS Acceptable - Permissible Limit*	*Pre-Monsoon*			*Post-Monsoon*		
		Min	*Max*	*Average*	*Min*	*Max*	*Average*
pH	6.5−8.5	6.93	8.96	7.82	6.38	8.67	7.70
EC (µS/cm at 25°C)	3000	51	11040	1361	55	9174	1327
TDS (mg/L)	500−2000	33	7066	870	35	5871	856
CO_3 (mg/L)	−	0	30	0	0	18	0
HCO_3 (mg/L)	−	18	1025	357	37	1001	362
Total Alkalinity (mg/L)	200−600	15	840	295	30	820	297
Cl (mg/L)	250−1000	5	2233	173	3	1843	160
NO_3 (mg/L)	45	0	466	48	0	368	75
SO_4 (mg/L)	200−400	0	725	89	3	850	87
F (mg/L)	1−1.5	0.06	4.65	0.45	0.02	2.80	0.47
Total Hardness (mg/L)	200−600	15	2260	412	55	2240	415
Ca (mg/L)	75−200	4	490	96	4	521	83
Mg (mg/L)	30−100	1	386	39	1	476	50
Na (mg/L)	−	4	1070	102	7	1081	115
K (mg/L)	−	0.5	187.0	13.6	0.3	510.0	21.0
Fe (mg/L)	1	BDL	0.15	0.0013	NA	NA	NA
As (µg/L)	10	BDL	5.403	0.622	NA	NA	NA
U (µg/L)	30	BDL	74.72	2.27	BDL	72.00	1.94
RSC	> 2.5	-29.23	11.20	-2.25	-34.83	7.29	-2.30
SAR	> 26	0.11	19.95	2.33	0.24	24.6	3.40
% Na	> 90	3.33	87.87	32.08	5.59	89.23	33.15

BDL- Below Detection Limit, NA- Not Analysed.

6.1.1 Electrical Conductivity (EC):

The measurement of EC indicates the ion concentration in water. As the concentration of dissolved ions increases, water becomes more conductive, resulting in higher TDS values. EC and TDS are interrelated, since most dissolved substances in groundwater are inorganic. EC represents the sum of ion concentrations in groundwater and is an important parameter for water quality assessment. The distribution of EC in Maharashtra's groundwater is shown in **Figures 12** and **13**.

In shallow aquifers, EC ranged from 51 µS/cm to 11,040 µS/cm during the pre-monsoon season and from 55 to 9,174 µS/cm during the post-monsoon season. The lowest EC values were recorded in Raigad district during both seasons. The exceptional high EC values of 11,040 µS/cm at Gadchiroli and Nagpur district may be due to local contamination as during post-monsoon sampling it was recorded to be 903 µS/cm and 734 µS/cm in respective districts. It was also confirmed from the previous years' observations that EC values at these locations were less than the permissible limit of 3000 µS/cm. High EC value was observed at Tunki village in Ch. Sambhaji Nagar district, in both pre-monsoon (9090µS/cm) and post-monsoon season (9174 µS/cm).

The average EC values of groundwater samples indicate that most monitored wells have fresh water. In the majority of areas, EC is within the permissible limit of 3,000 µS/cm. In Maharashtra's western coastal tract, EC values are often less than 500 µS/cm at 25°C due to unique physiographical, climatic, and hydrogeological conditions. This hilly region, which receives the state's highest rainfall and is covered by porous laterite over basalt, allows quick aquifer flushing and short residence time for groundwater.

Pre-monsoon groundwater samples grouped by EC values show that 24.18% had EC <750 µS/cm, 70.45% had EC between 750–3000 µS/cm, and 5.37% exceeded 3000 µS/cm. Similarly, in the post-monsoon season, 25.97% had EC <750 µS/cm, 68.06% were between 750–3000 µS/cm, and 5.97% exceeded 3000 µS/cm. The districts with high EC (>3000 µS/cm) include Ahilyanagar (Ahmednagar), Akola, Amravati, Beed, Buldhana, Chandrapur, Ch. Sambhaji Nagar, Gadchiroli, Jalna, Nagpur, Nashik, Raigad, Sangli, Satara, Solapur, Thane and Wardha. Inland salinity issues in the Purna alluvial basin of Amravati, Akola and Buldhana districts are likely due to sluggish groundwater movement and lack of recharge, resulting in elevated EC at deeper depths. In contrast, in Maharashtra's western coastal zone, EC remains below 750 µS/cm because of favourable physiographical, climatic, and hydrogeological features.

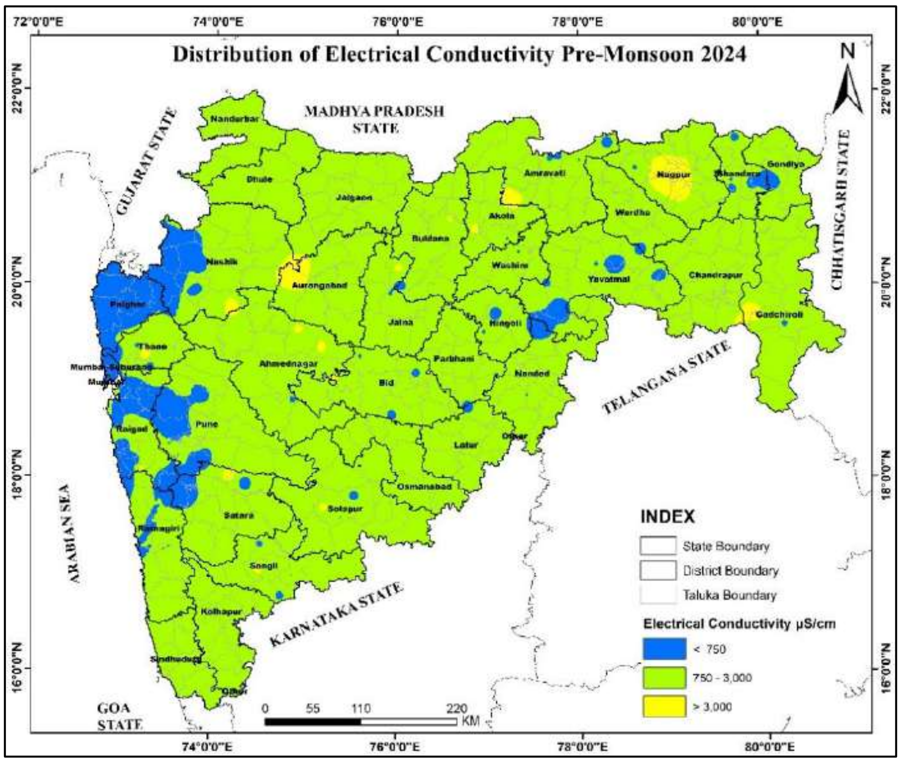


Figure 12: Distribution of Electrical Conductivity in Pre-Monsoon 2024.

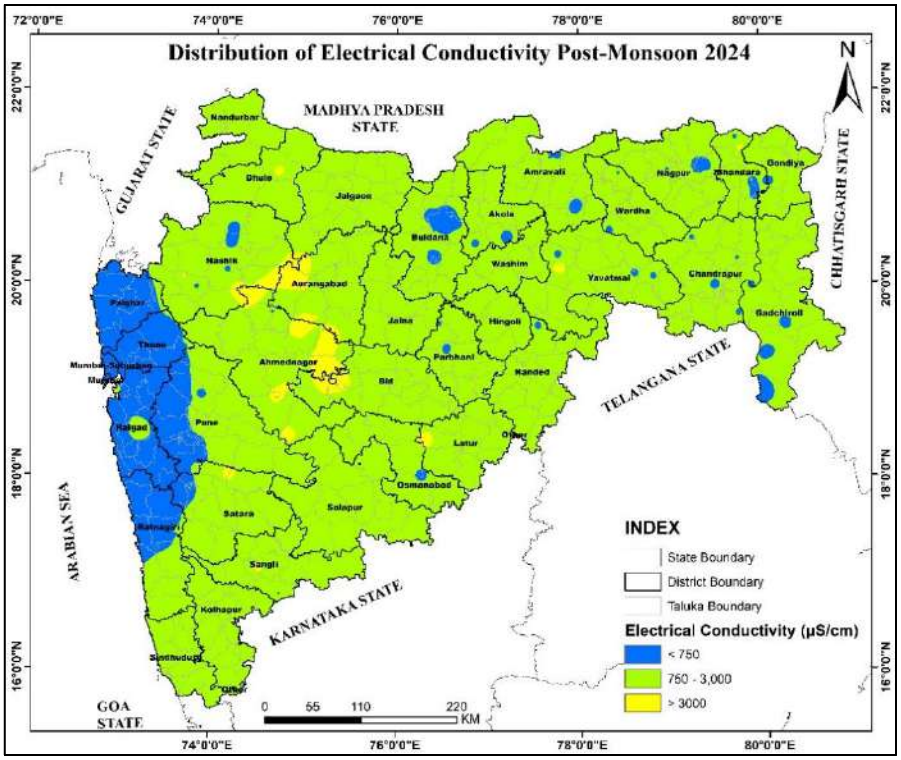


Figure 13: Distribution of Electrical Conductivity in Post-Monsoon 2024.

Groundwater conductivity reflects ionic concentration. District-wise values—minimum, maximum, high conductivity (>3000 µS/cm), percentage of samples exceeding the threshold during pre- and post-monsoon and groundwater extraction stage are summarised in **Table 4**.

The analysed number of samples in each district were plotted along with number of samples having EC value above the BIS permissible limit in both of pre & post monsoon season given in **Figure-14**.

The effect of rainfall on EC values, in terms of the number of samples where EC has either improved or deteriorated, is quantified in **Table 5**. A variation of more or less than 20% is considered a significant change in EC at the respective district locations listed in Table 6. Approximately 50% of the locations (i.e., 167) showed improvement, while the remaining 50% (i.e., 168) exhibited deterioration in EC values between the pre- and post-monsoon seasons.

Out of the 167 improved locations, 84 showed an improvement within 20%, while at 83 locations, deterioration in EC was observed during the pre-monsoon season. Conversely, during the post-monsoon season, 82 locations showed improvement within 20%, whereas 86 locations recorded deterioration in EC values. The highest improvement was observed in Chandrapur, Buldhana, and Nagpur districts, while the most significant deterioration occurred in Ahilyanagar district. The distribution of improvement and deterioration across districts is illustrated in **Figure 15**.

Table 4: District wise Distribution of EC (>3000 µS/cm) based on 2024 Pre & Post Monsoon Data

Sr. No.	District	No. of Samples	Minimum		Maximum		No. of Samples >3000µS/cm		Percentage of Samples >3000 µS/cm		Stage of Extraction (Critical/ Semi-Critical/ Overexploited / Safe/ Saline)
			Pre-M	Post-M	Pre-M	Post-M	Pre-M	Post-M	Pre-M	Post-M	
1	Ahilyanagar	26	496	609	3822	8808	2	9	7.69	34.62	Semi critical
2	Akola	6	600	483	5352	2963	1	0	16.7	0.00	Safe
3	Amravati	19	396	413	4292	3062	1	1	5.26	5.26	Semi critical
4	Beed	12	632	690	3287	7650	1	1	8.33	8.33	Safe
5	Bhandara	9	556	585	1710	3810	0	1	0.00	11.11	Safe
6	Buldhana	12	145	440	3822	1795	1	0	8.33	0.00	Semi critical
7	Chandrapur	20	728	359	3015	3267	1	1	5.00	5.00	Safe
8	C.Sambhaji Nagar	5	1232	1326	9090	9174	1	1	20.0	20.00	Safe
9	Dharashiv	2	1321	604	1612	1419	0	0	0.00	0.00	Safe
10	Dhule	12	734	810	2279	4547	0	1	0.00	8.33	Safe
11	Gadchiroli	13	645	516	11040	1917	1	0	7.69	0.00	Safe
12	Gondia	7	409	518	1538	1749	0	0	0.00	0.00	Safe
13	Hingoli	4	528	870	2435	2190	0	0	0.00	0.00	Safe
14	Jalgaon	9	1098	1226	2240	2547	0	0	0.00	0.00	Semi critical
15	Jalna	8	696	770	3555	2973	1	0	12.5	0.00	Safe
16	Kolhapur	1	2144	1470	2144	1470	0	0	0.00	0.00	Safe
17	Latur	6	677	1013	1806	3769	0	1	0.00	16.67	Safe
18	Mumbai City	6	565	557	980	866	0	0	0.00	0.00	Safe
19	Mumbai Suburban	1	521	495	521	495	0	0	0.00	0.00	Safe
20	Nagpur	9	648	284	11040	1215	1	0	11.1	0.00	Safe
21	Nanded	8	514	704	1914	1904	0	0	0.00	0.00	Safe
22	Nandurbar	1	1879	1624	1879	1624	0	0	0.00	0.00	Safe
23	Nashik	25	253	235	6327	3950	1	1	4.00	4.00	Safe
24	Parbhani	7	720	661	1492	1111	0	0	0.00	0.00	Safe
25	Pune	11	192	335	2050	2140	0	0	0.00	0.00	Safe
26	Raigad	13	51	55	3822	1785	1	0	7.69	0.00	Safe
27	Sangli	15	313	633	4416	4320	1	1	6.67	6.67	Safe
28	Satara	7	176	158	3899	3694	1	1	14.3	14.29	Safe
29	Solapur	11	533	774	3299	2950	1	0	9.09	0.00	Semi critical
30	Thane	15	266	199	5018	718	1	0	6.67	0.00	Safe
31	Wardha	15	498	621	3057	1847	1	0	6.67	0.00	Safe
32	Washim	6	711	820	1342	1690	0	0	0.00	0.00	Safe
33	Yavatmal	14	488	375	1711	4280	0	1	0.00	7.14	Safe

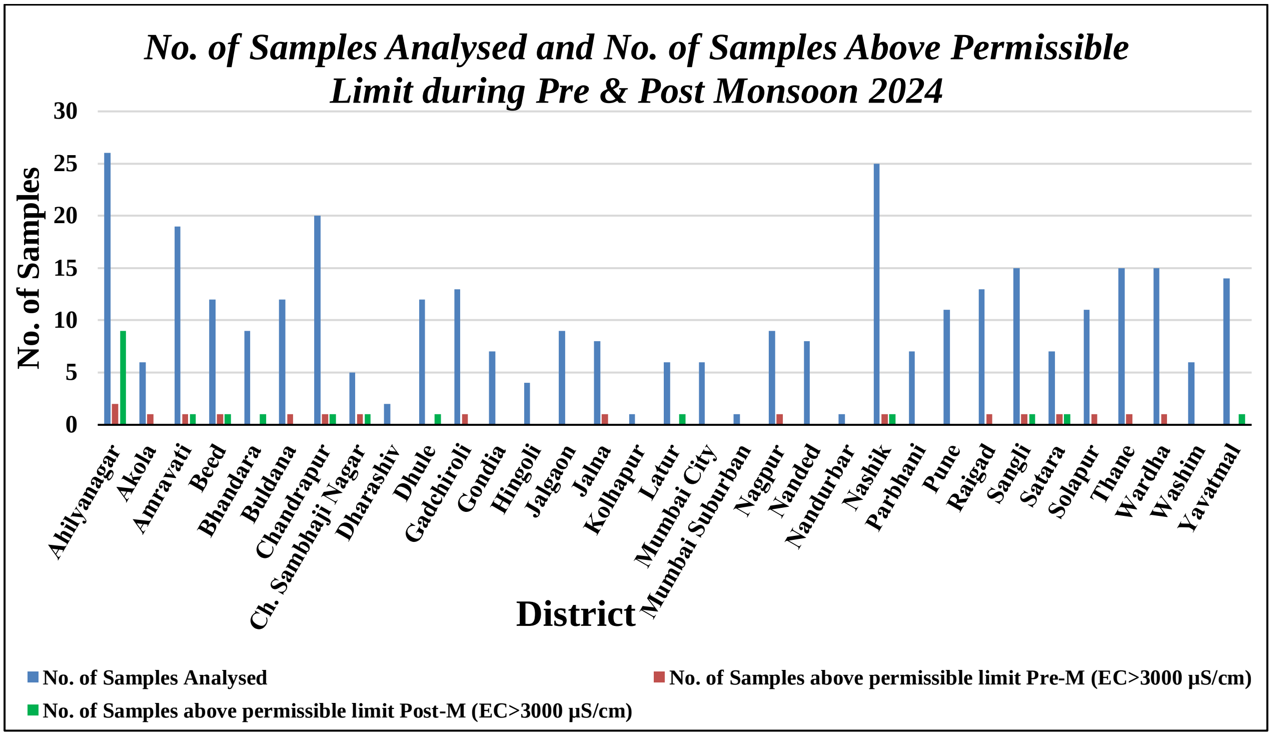


Figure 14: District wise No. of Samples analysed and No. of Samples above Permissible Limit for Electrical Conductivity (Pre-M & Post-M 2024).

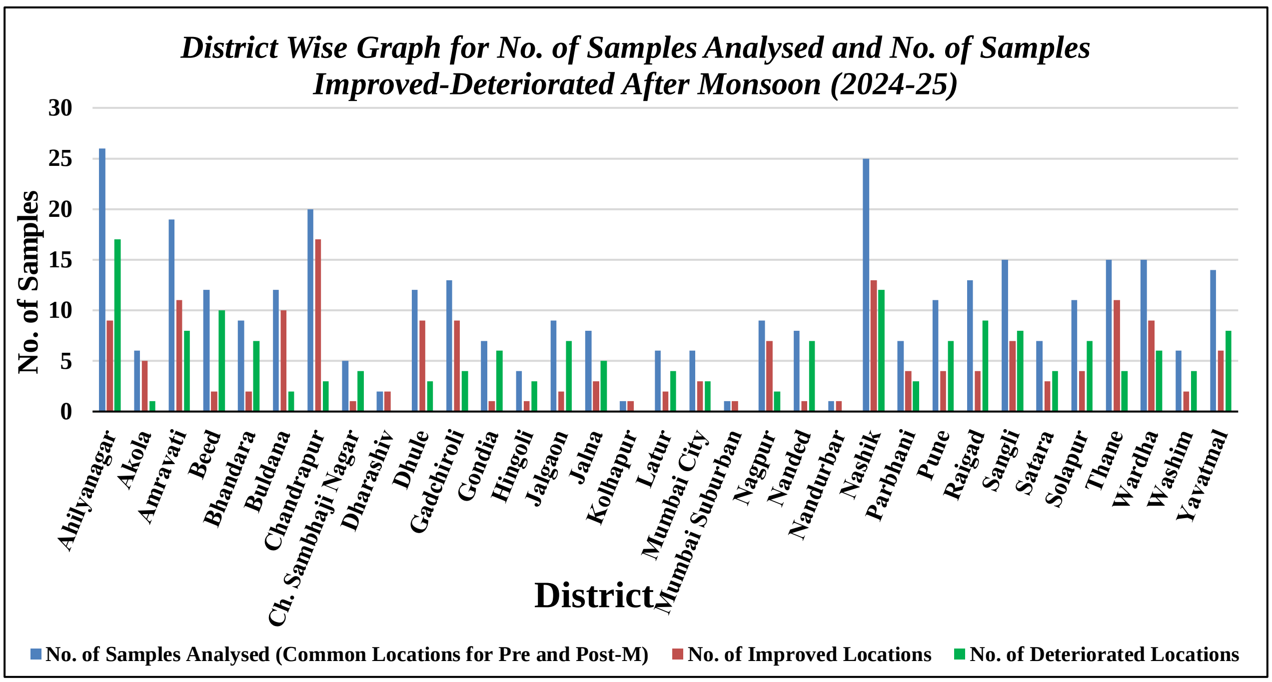


Figure 15: District wise representation of No. of Samples Analysed and No. of Location Improved & Deteriorated After Monsoon (2024-25)

Table 5: No. of Improved and Deteriorated Locations for Electrical Conductivity after Monsoon (w.r.t Pre-M EC).

Sr. No.	District	No. of Samples Analysed (Common Locations for Pre and Post-M)	No. of Improved Locations	No. of Deteriorated Locations	No. of Locations (Where Improvement is within 20% w.r.t Pre-M Value) No Significant Change	No. of Locations (Where Improvement is beyond 20% w.r.t Pre-M Value) Significant Improvement	No. of Locations (Where Deterioration is within20% w.r.t Pre-M Value) No Significant Change	No. of Locations (Where Deterioration is beyond 20% w.r.t Pre-M Value) Significant Deterioration
1	Ahilyanagar	26	9	17	4	5	4	13
2	Akola	6	5	1	1	4	0	1
3	Amravati	19	11	8	6	5	4	4
4	Beed	12	2	10	2	0	8	2
5	Bhandara	9	2	7	2	0	4	3
6	Buldhana	12	10	2	2	8	0	2
7	Chandrapur	20	17	3	5	12	2	1
8	Ch.Sambhaji Nagar	5	1	4	1	0	4	0
9	Dharashiv	2	2	0	1	1	0	0
10	Dhule	12	9	3	7	2	0	3
11	Gadchiroli	13	9	4	4	5	4	0
12	Gondia	7	1	6	0	1	3	3
13	Hingoli	4	1	3	0	1	0	3
14	Jalgaon	9	2	7	2	0	3	4
15	Jalna	8	3	5	3	0	3	2
16	Kolhapur	1	1	0	0	1	0	0
17	Latur	6	2	4	1	1	0	4
18	Mumbai City	6	3	3	2	1	2	1
19	Mumbai Suburban	1	1	0	1	0	0	0
20	Nagpur	9	7	2	1	6	1	1
21	Nanded	8	1	7	1	0	5	2
22	Nandurbar	1	1	0	1	0	0	0
23	Nashik	25	13	12	7	6	4	8
24	Parbhani	7	4	3	1	3	3	0
25	Pune	11	4	7	2	2	5	2
26	Raigad	13	4	9	1	3	8	1
27	Sangli	15	7	8	7	0	3	5
28	Satara	7	3	4	3	0	2	2
29	Solapur	11	4	7	1	3	2	5
30	Thane	15	11	4	4	7	3	1
31	Wardha	15	9	6	6	3	2	4
32	Washim	6	2	4	2	0	2	2
33	Yavatmal	14	6	8	3	3	1	7
	Total	335	167	168	84	83	82	86

The EC value is categorized into three classes: fresh (<750 µS/cm), moderate (750–3000 µS/cm), and highly mineralized (>3000 µS/cm). The number of locations and the percentage of samples falling within each of these categories are provided in **Table 6** and illustrated in **Figure 16**.

Table 6: Percent Distribution of EC during Pre-M & Post-M 2024.

State	Range		No. of Samples (N=335)		Percentage of Samples	
			Pre-M	Post-M	Pre-M	Post-M
Maharashtra	Fresh	<750 µ S/cm at 25 ° C	81	87	24.18	25.97
Maharashtra	Moderate	750-3000 µ S/cm at 25 ° C	236	228	70.45	68.06
Maharashtra	Highly Mineralised	>3000 µ S/cm at 25 ° C	18	20	5.37	5.97

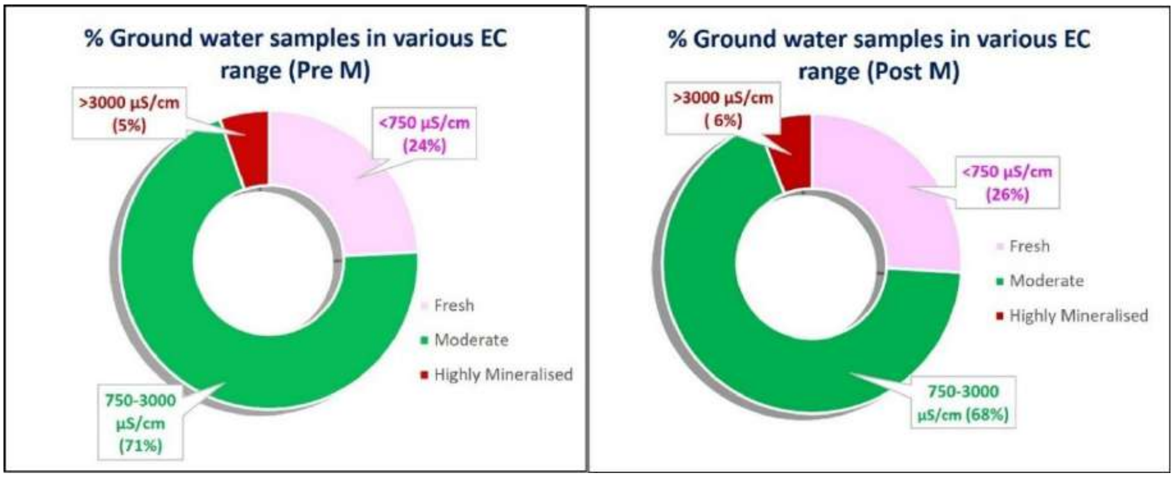


Figure 16: Percentage of Ground water samples in various EC ranges in Pre and Post Monsoon.

The temporal variation in EC values—affected districts, number of blocks, affected locations, and the percentage of affected locations from 2017 to 2024 is presented in **Table 7**. (Due to Covid pandemic restrictions, limited number of samples were collected in the year 2020 and 2021, hence are not being considered for comparison of entire State data). Over the past seven years, approximately 2.2% to 5.4% of locations recorded EC values exceeding 3000 µS/cm. The variation in the number of affected districts and locations over the years (2017 to 2024) is illustrated in **Figure 17**. Compared to 2017, a marginal decrease in the number of districts with EC values greater than 3000 µS/cm was observed in 2024, as presented in **Table 7**. The blocks within districts having high EC values (>3000 µS/cm) in 2024 are summarised in **Table 8**.

Ahilyanagar (Ahmednagar), Amravati and Ch. Sambhaji Nagar are the top three districts with EC values exceeding 3000 µS/cm at 25°C during the pre-monsoon season of 2024, as shown in **Table 9**. Nevasa, Daryapur, Vaijapur, Shirur-Kasar and Sinnar blocks are identified as the most affected blocks, as detailed in **Table 10**. The percentage of samples with EC >3000 µS/cm at 25°C during the pre- and post-monsoon seasons has been compared and is presented in **Figure 18.**

Table 7: Temporal Trend of High EC in Groundwater: % of Locations Having EC>3000 µ S/cm at 25 °C (2017-2024).

State	Year	Total Number of Samples Analysed	No. of District Affected by EC	No. of Blocks Affected by EC	Total No of Locations Affected by EC	Percentage of locations Affected by EC
Maharashtra	2017	1163	21	33	37	3.2
Maharashtra	2018	1265	20	36	42	3.3
Maharashtra	2019	1065	17	24	26	2.4
Maharashtra	2022	1353	15	25	30	2.2
Maharashtra	2023	1567	21	42	56	3.6
Maharashtra	2024	335	17	17	18	5.4

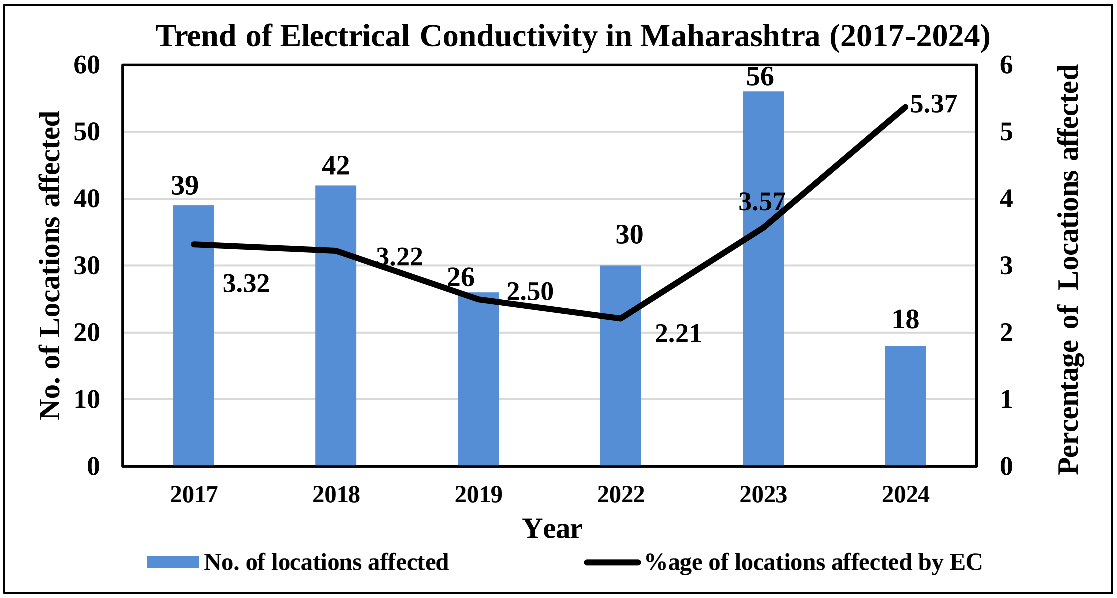


Figure 17: Graphical Representation of Trend for various EC ranges (2017-24).

Table 8: Districts & Blocks in which anomalous value of Electrical Conductivity (EC>3000 µ S/cm at 25 °C) was detected at one or more Locations (Based on Pre-M 2024).

Sl. No.	District	No. of Blocks Affected	Blocks (Affected)
1	Ahilyanagar (Ahmednagar)	1	Nevasa
2	Amravati	1	Daryapur
3	Akola	1	Balapur
4	Beed	1	Shirur-Kasar
5	Buldhana	1	Khamgaon
6	Chandrapur	1	Sindewahi
7	Chatrapati Sambhaji Nagar	1	Vaijapur
8	Gadchiroli	1	Chamorshi
9	Jalna	1	Jafrabad
10	Nagpur	1	Nagpur (Rural)
11	Nashik	1	Sinnar
12	Raigad	1	Mhasala
13	Satara	1	Khatav
14	Sangli	1	Palus
15	Solapur	1	Pandharpur
16	Thane	1	Kalyan
17	Wardha	1	Samudrapur

Table 9: Top 3 Affected Districts (in terms of no. of locations Where EC > 3000 µS/cm at 25 ° C in Pre-M).

State	District	Total No. of Sample Analysed	No. of Samples with EC>3000 µS/cm at 25°C	% Samples with EC>3000 µS/cm at 25 °C
Maharashtra	Ahilyanagar	26	2	7.7
Maharashtra	Amravati	19	1	5.3
Maharashtra	Ch.Sambhaji Nagar	5	1	20.0

Table 10: Top 5 Affected Blocks (in terms of no. of locations Where EC > 3000 µS/cm at 25 °C in Pre-M).

State	District	Blocks	Total No. of Sample Analysed	No. of Samples with EC>3000 µS/cm	Percentage of Samples with EC>3000 µS/cm	Stage of Extraction (Critical/ Semi-Critical/ Overexploited/ Safe /Saline)	RainFall 2024-25
Maharashtra	Ahilyanagar	Nevasa	5	1	20	Semi-Critical	Excess
Maharashtra	Amravati	Daryapur	1	1	100	Saline	Normal
Maharashtra	Ch.Sambhaji Nagar	Vaijapur	2	1	50	Safe	Normal
Maharashtra	Beed	Shirur-Kasar	2	1	50	Safe	Excess
Maharashtra	Nashik	Sinnar	4	1	25	Critical	Excess

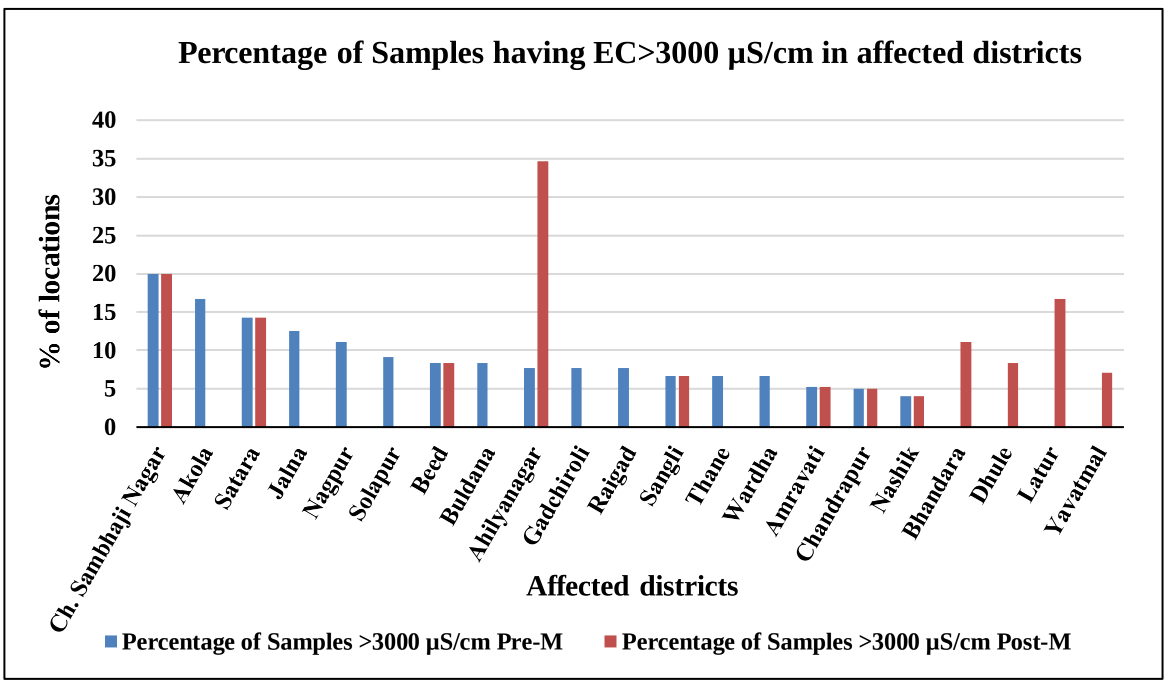


Figure 18: Percentage of Samples having EC value above Permissible Limit (EC > 3000 µS/cm at 25 °C) in Affected Districts. (Pre-M and Post-M Chart Comparison).

Recharge from rainwater affects the quality of native groundwater. These changes depend on rainfall patterns, hydrogeological conditions, and local pollution levels. The spatial variability in EC is presented in both tabular form (**Table 11**) and graphical form (**Figure 19**).

Table 11: Impact of Monsoon recharge on Electrical Conductivity Value.

State	District	No. of Locations >3000 µ S/cm (Pre-M)	No. of Location Improved (After Monsoon) But still have EC Value >3000 µS/cm (post-M)	No. of Location improved and EC Value becomes <3000 µS/cm (post-M)	No. of Location Deteriorated (after Monsoon)	*No. of Location Deteriorated after Monsoon and EC becomes > 3000 µS/cm
Maharashtra	Ahilyanagar	2	1	0	1	7
Maharashtra	Akola	1	1	0	0	0
Maharashtra	Amravati	1	0	0	1	0
Maharashtra	Beed	1	0	0	1	0
Maharashtra	Bhandara	0	0	0	0	1
Maharashtra	Buldhana	1	0	1	0	0
Maharashtra	Chandrapur	1	0	1	0	1
Maharashtra	Ch. Sambhaji Nagar	1	0	1	0	0
Maharashtra	Dhule	0	0	0	0	1
Maharashtra	Gadchiroli	1	0	1	0	0
Maharashtra	Jalna	1	0	1	0	0
Maharashtra	Latur	0	0	0	0	1
Maharashtra	Nagpur	1	0	1	0	0
Maharashtra	Nashik	1	0	1	0	1
Maharashtra	Raigad	1	0	1	0	0
Maharashtra	Sangli	1	0	1	0	0
Maharashtra	Satara	1	0	1	0	0
Maharashtra	Solapur	1	1	0	0	0
Maharashtra	Thane	1	1	0	0	0
Maharashtra	Wardha	1	0	1	0	0
Maharashtra	Yavatmal	0	0	0	0	1
	Total	18	4	11	3	13
*Locations where pre-monsoon EC is less than 3000 µS/cm and after monsoon is more than 3000 µS/cm.						

The graph indicates improvement—where EC values decreased to below 3000 µS/cm after the monsoon—in Akola, Jalna, Nagpur, Solapur, Buldhana, Gadchiroli, Raigad, Thane and Wardha districts. Conversely, deterioration in EC values was observed after the monsoon in Ahilyanagar, Bhandara, Dhule, Latur and Yavatmal districts. Significant deterioration, where EC values exceeded 3000 µS/cm, was recorded in Ahilyanagar.

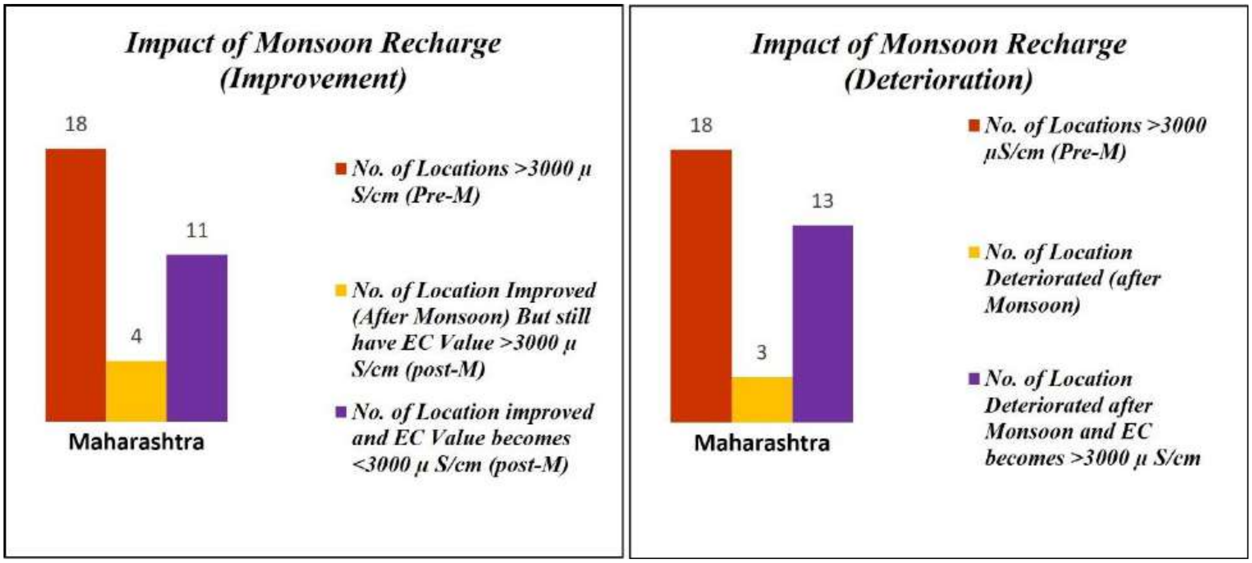


Figure 19: Impact of Monsoon recharge on Electrical Conductivity.

6.1.2 Fluoride (F):

Fluorine does not occur in its elemental state in nature due to its high reactivity. Instead, it exists as fluorides in a few minerals, the most common being fluorspar, cryolite, fluorite, and fluorapatite. Most of the fluoride found in groundwater originates naturally from the breakdown of rocks and soil or from the weathering and deposition of atmospheric particles. Fluorides are generally sparingly soluble and are present in groundwater in small amounts. The type of rock, climatic conditions, nature of the hydrogeological strata, and the duration of contact between rock and circulating groundwater all influence the presence of fluoride in natural water.

The occurrence of the Fluoride in groundwater is predominantly a geological phenomenon, influenced basically by the local and regional geological setting and hydro-geological conditions. Fluoride enrichment in groundwater takes place mainly through leaching and weathering of the Fluoride-bearing minerals present in the rocks and sediments (**Table-12**). These geological sources have sufficient amount of fluorine in their composition. Some minerals like micas have high fluoride content such as in Biotite-Fluoride ranges from 970 to 3500 mg/L, in Phlogophite-Fluoride ranges from 3300 to 37000 mg/Lin Lepidolite-Fluoride ranges from 19000 to 68000 mg/L, in Muscovite Fluoride ranges 170 to 14800 mg/L.

The fluoride gets into the ground water through weathering and leaching which depends on several factors such as the origin of water, composition of water bearing medium, the length of time the water has been in contact with the medium, the temperature and pressure conditions, ion-exchange, rate of recharge and discharge etc.The Bureau of Indian Standards (BIS) has recommended a desirable limit of 1.0 mg/L of fluoride in drinking water and a maximum permissible limit of 1.5 mg/L, in cases where no alternative drinking water source is available. It is well known that small amounts of fluoride (up to 1.0 mg/L) can help reduce tooth decay. However, higher concentrations (>1.5 mg/L) may lead to staining of tooth enamel, while levels above 5.0 mg/L can cause more serious issues such as bone stiffness. Water with fluoride concentrations exceeding 1.5 mg/L is considered unsuitable for drinking. High fluoride levels (>1.5 mg/L) are primarily attributed to geogenic conditions. In most parts of the state, fluoride levels in groundwater from observation wells are below 1.0 mg/L.

Table 12: Fluoride in Rocks (Keller, 1979)

ROCKS	FLUORIDE RANGE (mg/L)	AVERAGE
Basalt	20-1060	360
Granites and Gniess	20-2700	870
Shale and Clays	10-7600	800
Limestone	0-1200	220
Sandstone	10-880	180
Phosphate	24000-41500	31000
Coals (ash)	40-480	80

Fluoride concentrations in the state range from 0.06 to 4.65 mg/L. While high fluoride levels (above 1.5 mg/L) are observed in isolated pockets of the state, overall concentrations in the shallow basaltic aquifer remain low, with an average of approximately 0.46 mg/L. Locations with fluoride concentrations exceeding 1.5 mg/L during the pre- and post-monsoon seasons are illustrated in **Figures 20** and **21**.

The distribution of fluoride concentrations across districts during the pre- and post-monsoon periods of 2024, along with minimum and maximum values and groundwater development stage is detailed in **Table 13**. A district-wise comparison of the total number of groundwater samples analyzed and those exceeding the permissible fluoride limit during the 2024 pre- and post-monsoon periods is presented in **Figure 22**.

Chandrapur district had the highest number of samples with Fluoride concentrations more than 1.5mg/L during the pre-monsoon season. The number of locations that showed improvement or deterioration in fluoride levels after the monsoon—relative to pre-monsoon values—is summarized in **Table 14**. This comparison reflects the influence of seasonal recharge on groundwater quality, highlighting districts where post-monsoon conditions either diluted or concentrated fluoride levels. The same data is visualized in graphical format in **Figure 23**.

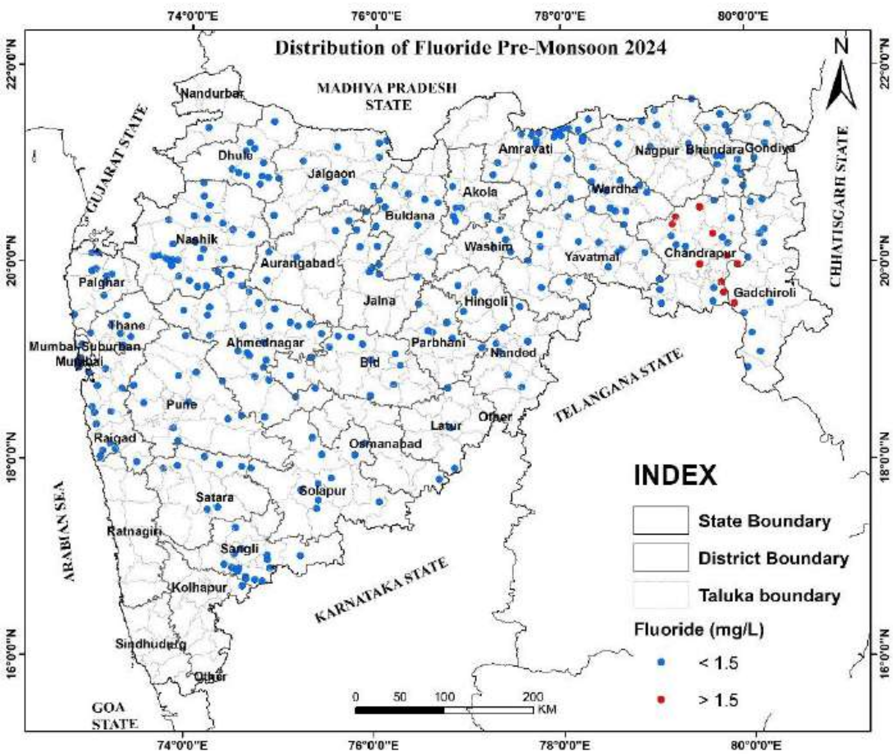


Figure 20: Distribution of Fluoride in Pre-Monsoon 2024.

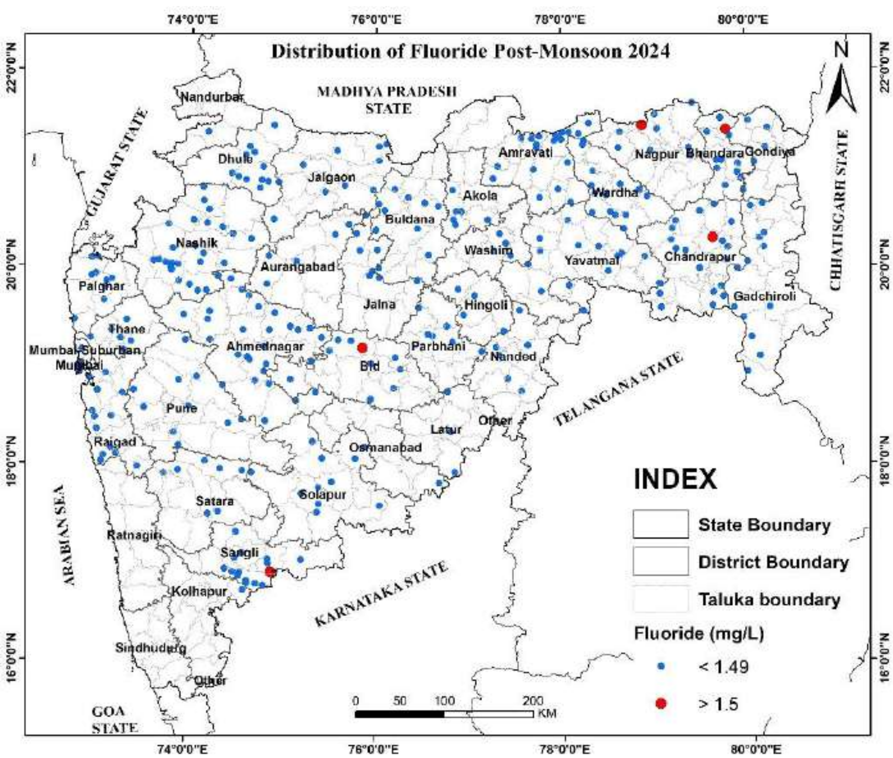


Figure 21: Distribution of Fluoride in Post-Monsoon 2024.

Table 13: Distribution of fluoride based on 2024 Pre & Post Monsoon Data.

Sr No.	District	No. of Samples	Minimum		Maximum		No. of Samples >1.5 mg/l		Percentage of Samples >1.5 mg/l		Stage of Extraction (Critical/ Semi-Critical/ Overexploited/ Safe/Saline)
			Pre-M	Post-M	Pre-M	Post-M	Pre-M	Post-M	Pre-M	Post-M	
1	Ahilyanagar	26	0.09	0.16	1.05	0.88	0	0	0	0	Semi critical
2	Akola	6	0.18	0.25	0.36	0.51	0	0	0	0	Safe
3	Amravati	19	0.2	0.22	1.36	0.7	0	0	0	0	Semi critical
4	Beed	12	0.25	0.61	0.89	1.76	0	1	0	8.33	Safe
5	Bhandara	9	0.1	0.25	1.2	2.8	0	1	0	11.11	Safe
6	Buldhana	12	0.14	0.21	1.4	0.61	0	0	0	0	Semi critical
7	Chandrapur	20	0.15	0.2	4.65	2.36	9	1	45	5	Safe
8	Ch.Sambhaji Nagar	5	0.23	0.42	0.45	0.95	0	0	0	0	Safe
9	Dharashiv	2	0.21	0.2	0.5	0.21	0	0	0	0	Safe
10	Dhule	12	0.4	0.145	0.79	1.12	0	0	0	0	Safe
11	Gadchiroli	13	0.22	0.27	1.59	0.69	1	0	7.69	0	Safe
12	Gondia	7	0.19	0.39	0.96	1.22	0	0	0	0	Safe
13	Hingoli	4	0.8	0.35	1.23	0.64	0	0	0	0	Safe
14	Jalgaon	9	0.09	0.15	0.32	0.59	0	0	0	0	Semi critical
15	Jalna	8	0.23	0.23	0.65	0.71	0	0	0	0	Safe
16	Kolhapur	1	0.21	0.33	0.21	0.33	0	0	0	0	Safe
17	Latur	6	0.09	0.19	0.72	0.51	0	0	0	0	Safe
18	Mumbai City	6	0.08	0.04	0.58	0.32	0	0	0	0	Safe
19	Mumbai Suburban	1	0.64	0.2	0.64	0.2	0	0	0	0	Safe
20	Nagpur	9	0.22	0.29	0.8	1.7	0	1	0	11.11	Safe
21	Nanded	8	0.42	0.14	0.97	1.28	0	0	0	0	Safe
22	Nandurbar	1	0.24	0.23	0.24	0.23	0	0	0	0	Safe
23	Nashik	25	0.14	0.13	0.82	0.73	0	0	0	0	Safe
24	Parbhani	7	0.25	0.38	1.5	1.33	0	0	0	0	Safe
25	Pune	11	0.11	0.16	0.42	1.33	0	0	0	0	Safe
26	Raigad	13	0.06	0.02	0.36	0.18	0	0	0	0	Safe
27	Sangli	15	0.17	0.26	0.86	1.55	0	1	0	6.67	Safe
28	Satara	7	0.1	0.11	0.42	1.05	0	0	0	0	Safe
29	Solapur	11	0.07	0.16	0.33	0.54	0	0	0	0	Semi critical
30	Thane	15	0.1	0.02	0.19	0.18	0	0	0	0	Safe
31	Wardha	15	0.21	0.07	0.8	0.88	0	0	0	0	Safe
32	Washim	6	0.21	0.18	0.53	0.78	0	0	0	0	Safe
33	Yavatmal	14	0.15	0.12	1.34	1.3	0	0	0	0	Safe

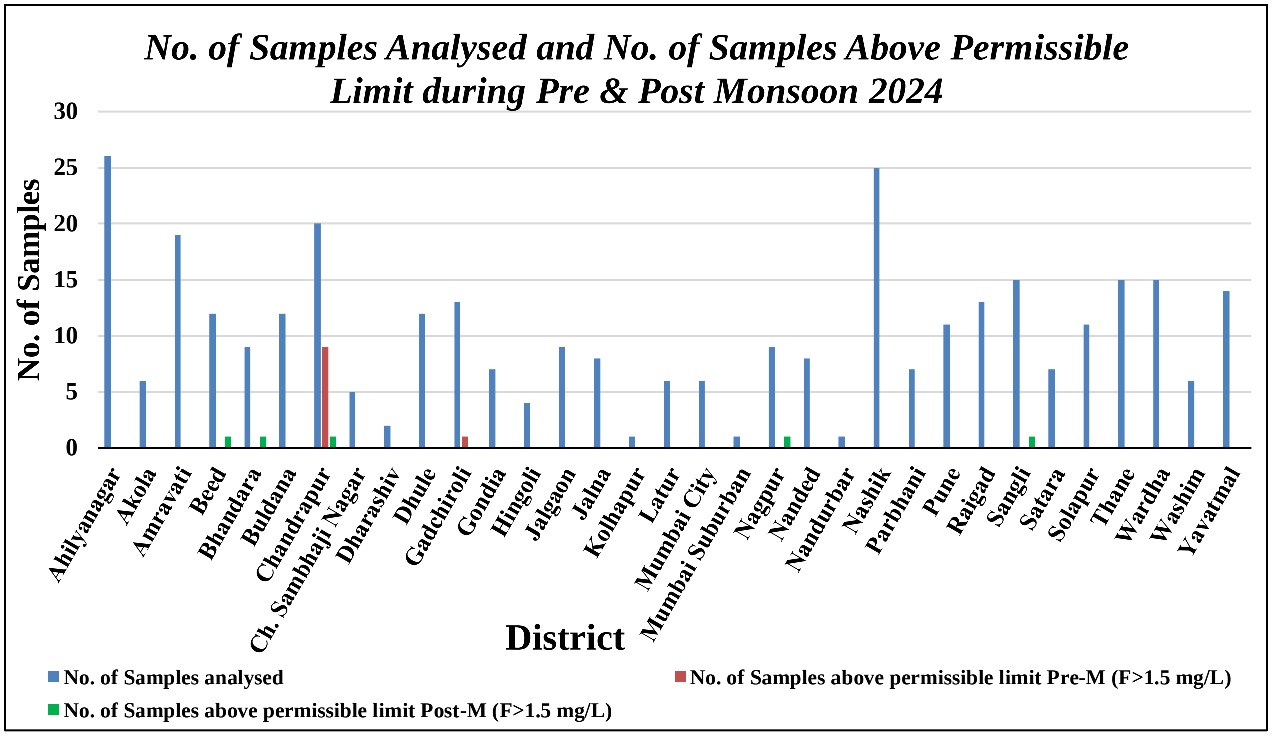


Figure 22: District wise No. of Samples analysed and above Permissible Limit for Fluoride (Pre-M & Post-M 2024).

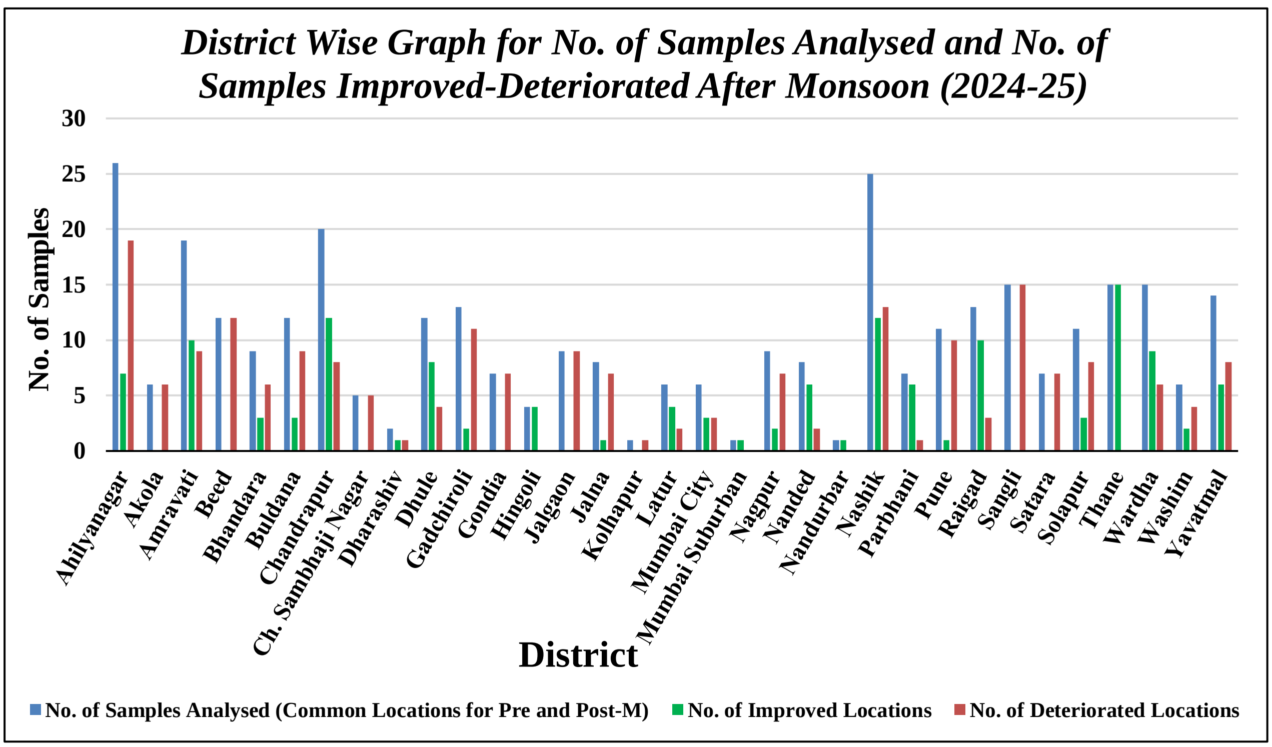


Figure 23: District wise representation of No. of Samples Analysed and No. of Location Improved and Deteriorated After Monsoon (2024-25).

Table 14: No. of Improved and Deteriorated Locations for Fluoride after Monsoon (w.r.t Pre-M Fluoride concentration).

Sr. No.	District	No. of Samples Analysed stric (Common Locations for Pre and Post-M)	No. of Improved Locations	No. of Deteriorated Locations	No. of Locations (Where Improvement is within 20% w.r.t Pre-M Value)	No. of Locations (Where Improvement is beyond 20% w.r.t Pre-M Value)	No. of Locations (Where Deterioration is within20% w.r.t Pre-M Value)	No. of Locations (Where Deterioration is beyond 20% w.r.t Pre-M Value)
					No Significant Change	Significant Improvement	No Significant Change	Significant Deterioration
1	Ahilyanagar	26	7	19	4	3	7	12
2	Akola	6	0	6	0	0	1	5
3	Amravati	19	10	9	7	3	4	5
4	Beed	12	0	12	0	0	1	11
5	Bhandara	9	3	6	1	2	0	6
6	Buldhana	12	3	9	1	2	1	8
7	Chandrapur	20	12	8	1	11	1	7
8	Ch.Sambhaji Nagar	5	0	5	0	0	0	5
9	Dharashiv	2	1	1	1	0	1	0
10	Dhule	12	8	4	2	6	1	3
11	Gadchiroli	13	2	11	2	0	6	5
12	Gondia	7	0	7	0	0	0	7
13	Hingoli	4	4	0	0	4	0	0
14	Jalgaon	9	0	9	0	0	0	9
15	Jalna	8	1	7	1	0	4	3
16	Kolhapur	1	0	1	0	0	0	1
17	Latur	6	4	2	2	2	0	2
18	Mumbai City	6	3	3	0	3	0	3
19	Mumbai Suburban	1	1	0	0	1	0	0
20	Nagpur	9	2	7	0	2	2	5
21	Nanded	8	6	2	2	4	1	1
22	Nandurbar	1	1	0	1	0	0	0
23	Nashik	25	12	13	4	8	6	7
24	Parbhani	7	6	1	1	5	0	1
25	Pune	11	1	10	0	1	0	10
26	Raigad	13	10	3	3	7	1	2
27	Sangli	15	0	15	0	0	1	14
28	Satara	7	0	7	0	0	1	6
29	Solapur	11	3	8	0	3	2	6
30	Thane	15	15	0	2	13	0	0
31	Wardha	15	9	6	2	7	2	4
32	Washim	6	2	4	1	1	1	3
33	Yavatmal	14	6	8	4	2	2	6
	Total	**335**	**132**	**203**	**42**	**90**	**46**	**157**

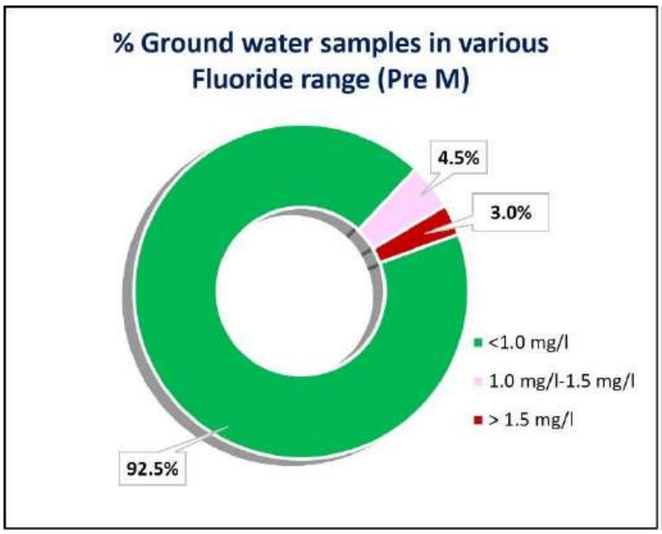
Fluoride concentrations less than 1 mg/L are considered safe, those between 1 and 1.5 mg/L are categorized as moderate, and concentrations greater than 1.5 mg/L are considered high and thus hazardous. The number of samples falling into each of these categories is presented in **Table 15** and illustrated in **Figure 24**.

In the pre-monsoon season, 92.5% of the samples fall within the safe category, 4.5% in the moderate category, and 3.0% in the high category. During the post-monsoon period, 93.4% of the samples fall within the safe category, 5.1% in the moderate category, and 1.5% in the high category.

It is observed that the recharge of groundwater in the monsoon has led to a reduction in high fluoride concentrations during the post-monsoon season.

Table 15: Percent Distribution of F during Pre-M & Post-M 2024.

State	Range		No. of Samples (N=335)		Percentage of Samples	
			Pre-M	Post-M	Pre-M	Post-M
Maharashtra	Safe	<1.0 mg/L	310	313	92.5	93.4
Maharashtra	Moderate	1.0 mg/L - 1.5 mg/L	15	17	4.5	5.1
Maharashtra	High	> 1.5 mg/L	10	5	3.0	1.5



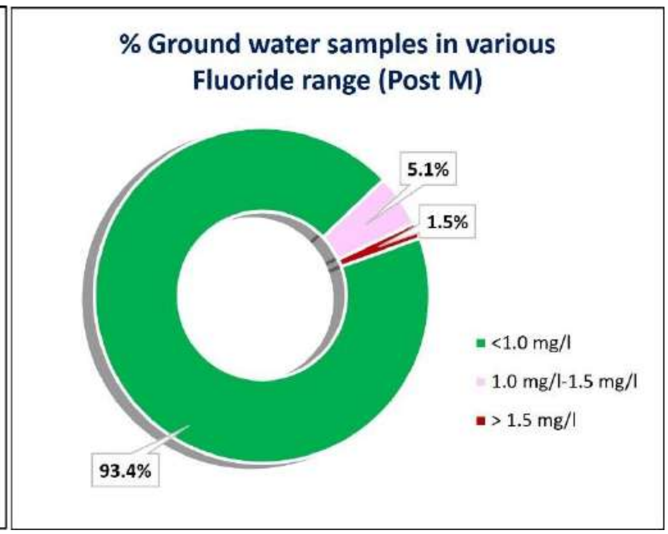


Figure 24: Representation for Percent Distribution of F (Pre-M and Post-M).

Since levels above 1.5 mg/l are especially hazardous they are monitored and presented as a percent of the total number of samples in a particular year in **Table 16**. This data is then further illustrated in **Figure 25** to observe the trend. The highest percent of affected locations was seen in 2018 with 4.8% with the lowest being in the preceding year of 2017 with 0.9%.

Table 16: Temporal Trend of High F in Groundwater: % of Locations Having F>1.5 mg/l (2017-2024).

State	Year	Total Number of Samples Analysed	No. of District Affected by F	No. of Blocks Affected by F	Total No of Locations Affected by F	Percentage of locations Affected by F
Maharashtra	2017	1163	6	10	11	0.9
Maharashtra	2018	1265	16	41	61	4.8
Maharashtra	2019	1065	9	14	17	1.6
Maharashtra	2022	1353	11	29	38	2.8
Maharashtra	2023	1567	10	19	30	1.9
Maharashtra	2024	335	3	8	10	3.0

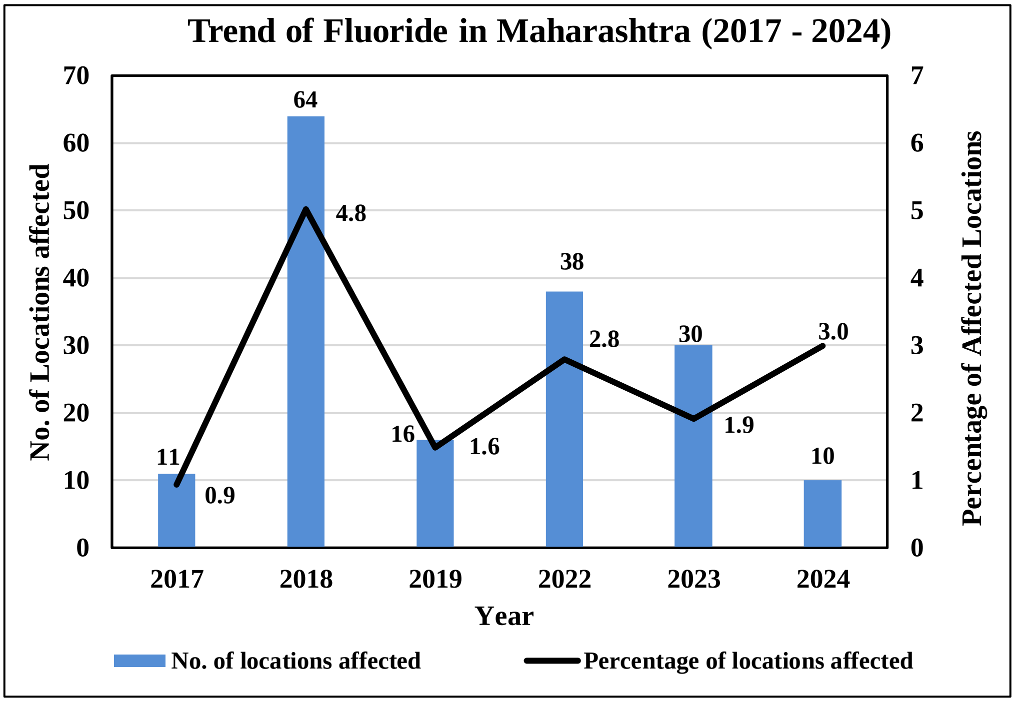


Figure 25: Graphical Representation of Trend for F (2017-24).

The districts (Chandrapur and Gadchiroli) and blocks (Chandrapur, Chimur, Gondpipri, Pomburna, Saoli, Sindewahi, Warora, Charmoshi) having the highest number of locations affected with high fluoride are listed in **Table 17**, while those that have high F (also Chandrapur, Gadchiroli) are depicted in **Table 18**. The affected blocks (in terms of number of locations where F > 1.5 mg/L in pre-monsoon) are in **Table 19**.

Table 17: Districts & Blocks in which anomalous concentration of Fluoride (F > 1.5 mg/l) was detected at one or more Locations (Based on Pre-M 2024).

State	District	No. of Blocks Affected	Blocks (Affected)
Maharashtra	Chandrapur	7	Chandrapur, Chimur, Gondpipri, Pomburna, Saoli, Sindewahi, Warora
Maharashtra	Gadchiroli	1	Chamorshi

Table 18: Affected Districts (in terms of no. of locations Where F > 1.5 mg/l in Pre-M).

State	District	Total No. of Sample Analysed	No. of Samples with F>1.5 mg/l	Percentage of Samples with F>1.5 mg/l
Maharashtra	Chandrapur	20	9	45.00
Maharashtra	Gadchiroli	13	1	7.69

Table 19: Affected Districts with Blocks (in terms of no. of locations Where F>1.5 mg/l in Pre-M).

State	District	Blocks	Total No. of Sample Analysed	No. of Samples with F>1.5 mg/l	Percentage of Samples with F>1.5 mg/l	Stage of Extraction (Critical/ Semi-Critical/ Overexploited/ Safe/Saline)	RainFall 2024-25
Maharashtra	Chandrapur	Chimur	2	2	100	Safe	Normal
Maharashtra	Chandrapur	Saoli	2	2	100	Safe	Normal
Maharashtra	Chandrapur	Warora	1	1	100	Safe	Normal
Maharashtra	Chandrapur	Chandrapur	1	1	100	Safe	Normal
Maharashtra	Chandrapur	Pomburna	1	1	100	Safe	Normal

Samples may have F values above the permissible limit in either the pre- or post-monsoon season, and as such, the percentage of samples in a region that might be above the permissible limit of fluoride in districts with this affliction is displayed in **Figure 26**, with both pre- and post-monsoon samples being taken into consideration. Monsoon rain has ability to impact fluoride concentration through recharge, leading to either improvement or deterioration, as displayed in **Table 20** and **Figure 27**.

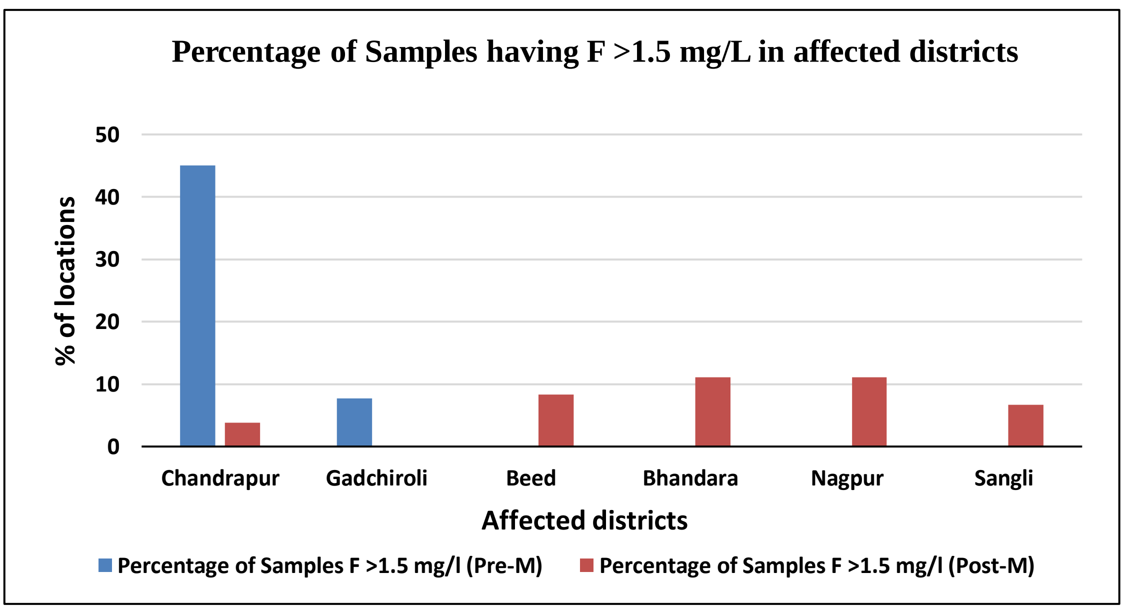


Figure 26: Percentage of Samples having F concentration above Permissible Limit (F>1.5 mg/l) in Affected Districts. (Pre-M and Post-M Chart Comparison).

Table 20: Impact of Monsoon recharge on Fluoride Concentration.

Sl. No	*Districts*	*No. of Locations >1.5 (Pre-M)*	*No. of Location Improved (After Monsoon) But still have Fluoride Value >1.5mg/l (post-M)*	*No. of Location improved and Fluoride Value becomes <1.5mg/l (post-M)*	*No. of Location Deteriorated (after Monsoon)*	**No. of Location Deteriorated after Monsoon and Fluoride becomes >1.5mg/l*
1	Chandrapur	9	1	8	0	0
2	Gadchiroli	1	0	1	0	0
3	Beed	0	0	0	0	1
4	Nagpur	0	0	0	0	1
5	Bhandara	0	0	0	0	1
6	Sangli	0	0	0	0	1
	Total	10	1	9	0	4

*Locations where pre-monsoon F is less than 1.5mg/L and after monsoon is more than 1.5 mg/L.

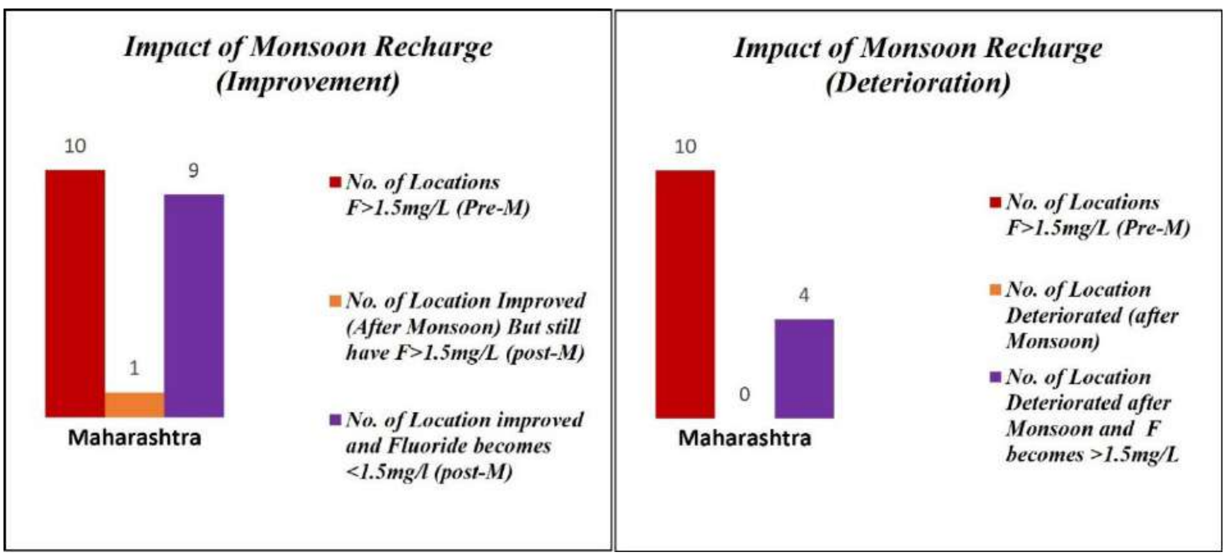


Figure 27: Impact of Monsoon recharge on Fluoride Concentration.

6.1.3 Nitrate (NO_3):

Nitrate (NO_3) is the most common contaminant in groundwater but is undetectable without testing because it is colorless, odorless, and tasteless. A water test for nitrate is highly recommended for households with infants, pregnant women, nursing mothers, or elderly people. Nitrate is a naturally occurring compound that is formed in the soil when nitrogen and oxygen combine. The primary source of all nitrates is atmospheric nitrogen gas. This is converted into organic nitrogen by some plants through a process called nitrogen fixation. Dissolved nitrogen in the form of NO_3 is the most common contaminant in groundwater. Nitrate in groundwater generally originates from point and non-point sources such as the leaching of chemical fertilizers and animal manure, groundwater pollution from septic and sewage discharges, etc. Some chemical and microbiological processes, such as nitrification and denitrification, also influence the nitrate concentration in groundwater. Nitrate is highly leachable and readily moves with water through the soil profile. If there is excessive rainfall or over-irrigation, nitrate will be leached below the plant's root zone and may eventually reach groundwater.

As per the BIS (2012) standard for drinking water, the maximum desirable limit of nitrate concentration in water is 45 mg/L, with no relaxation. Though nitrates are considered relatively non-toxic, a high nitrate concentration in drinking water is an environmental health concern, arising from increased risks of methemoglobinemia, particularly in infants under six months of age. The enzyme systems for reducing methemoglobin to oxyhemoglobin are incompletely developed and methemoglobinemia can occur. This also may happen in older individuals who have genetically impaired enzyme systems for metabolizing methemoglobin. Adults can tolerate slightly higher concentrations. The specified limits are not to be exceeded in the public water supply.

In Maharashtra, nitrate in groundwater samples varies from BDL to 466 mg/L. Approximately 46% of the samples, spread over the entire state, have nitrate below 45 mg/L, and 54% of samples have more than 45 mg/L in the pre-monsoon season, whereas in the post-monsoon season, 34% of these samples are in the safe category, and 66% have nitrate concentrations >45 mg/L. Spatial distribution of nitrate (**Figures 28 & 29**) in pre-monsoon and post-monsoon seasons indicates high nitrate >45 mg/L found throughout Maharashtra. The data is computed district-wise: minimum, maximum, stage of groundwater development, and average annual rainfall in each district are summarized in **Table 21**.

NO_3 is a major groundwater contaminant in the state. It is observed that high NO_3 concentrations increase during the post-monsoon period in comparison to the pre-monsoon period due to surface run-off local pollutants washed out and leached into the groundwater through fractures in the hard rock aquifer. District-wise number of samples analysed and number of samples above the permissible limit for NO_3 (Pre-M & Post-M 2024) are given in **Figure 30**. The graph depicts all the districts along with the number of samples in both the pre- and post-monsoon seasons that surpass the permissible NO_3 limit of 45 mg/L. The number of locations that showed improvement or deterioration in NO_3 concentration after the monsoon, relative to pre- and post-monsoon levels, is presented in **Table 22**. This comparison reflects the influence of seasonal recharge on groundwater quality, highlighting districts where monsoon conditions led to either dilution or concentration of nitrate levels. The same is visualised in graphical format in **Figure 31**. The percentage of samples, out of those analysed, that fall outside the threshold of 45 mg/L is depicted in **Table 23**. This data is also visualised in **Figure 32**. Temporal trend of high NO_3 level above 45 mg/L are presented as a percentage of the total number of samples from 2017 to 2024 in **Table 24**. This data is then further illustrated in **Figure 33** to observe the trend. The highest percentage of affected locations was seen in 2024 with 53.58%, with the lowest being in the year of 2018 with 3.24%.

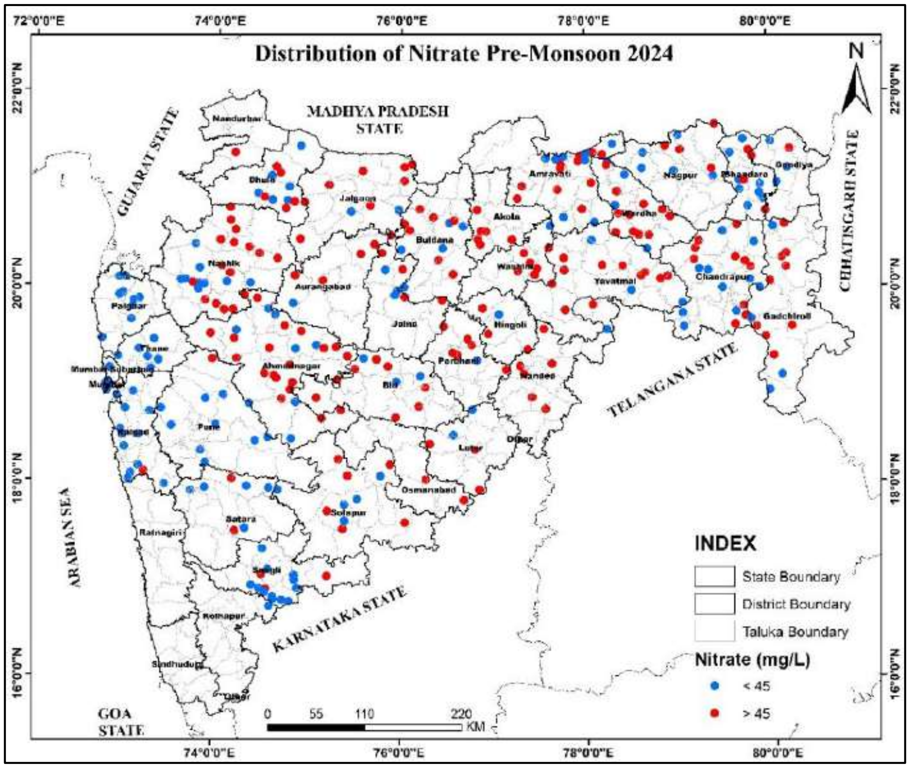


Figure 28: Distribution of Nitrate Pre-Monsoon 2024.

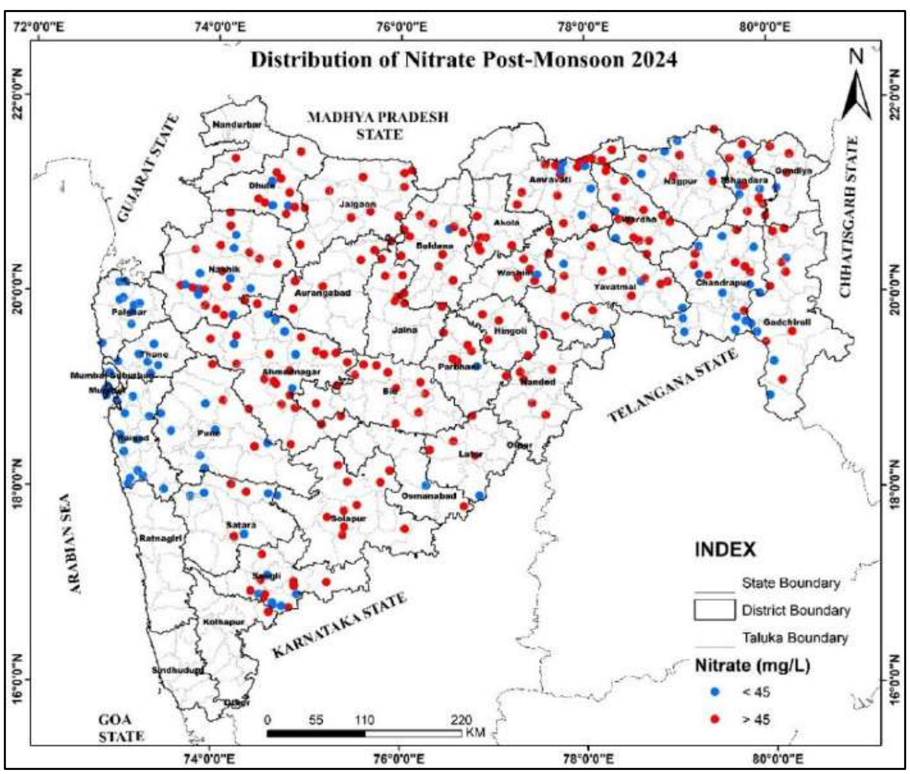


Figure 29: Distribution of Nitrate Post-Monsoon 2024.

Table 21: District wise Distribution of NO_3 based on 2024 Pre & Post Monsoon Data.

Sr. No.	District	No. of Samples	Minimum		Maximum		No. of Samples >45 mg/L		Percentage of Samples >45 mg/L		Stage of Extraction (Critical/Semi-Critical/ Overexploited/ Safe/Saline)
			Pre-M	Post-M	Pre-M	Post-M	Pre-M	Post-M	Pre-M	Post-M	
1	Ahilyanagar	26	14.5	4.0	164.9	315.0	19	20	73.1	76.9	Semi critical
2	Akola	6	48.0	52.0	53.0	64.0	6	6	100.0	100.0	Safe
3	Amravati	19	2.4	4.0	149.9	270.0	11	14	57.9	73.7	Semi critical
4	Beed	12	18.0	50.0	466.0	364.0	9	12	75.0	100.0	Safe
5	Bhandara	9	18.9	4.6	54.0	74.0	2	5	22.2	55.6	Safe
6	Buldhana	12	3.4	33.0	283.7	58.0	7	11	58.3	91.7	Semi critical
7	Chandrapur	20	2.2	1.0	79.0	67.0	10	8	50.0	40.0	Safe
8	Ch.Sambhaji Nagar	5	42.6	90.0	102.0	297.0	4	5	80.0	100.0	Safe
9	Dharashiv	2	52.7	44.0	56.5	57.0	2	1	100.0	50.0	Safe
10	Dhule	12	10.6	16.0	52.5	338.3	6	9	50.0	75.0	Safe
11	Gadchiroli	13	24.7	8.0	56.0	67.0	9	8	69.2	61.5	Safe
12	Gondia	7	2.0	15.0	52.0	74.0	3	6	42.9	85.7	Safe
13	Hingoli	4	13.8	52.0	75.4	62.0	3	4	75.0	100.0	Safe
14	Jalgaon	9	40.6	114.4	164.9	326.7	7	9	77.8	100.0	Semi critical
15	Jalna	8	21.2	82.0	58.0	368.0	5	8	62.5	100.0	Safe
16	Kolhapur	1	1.0	45.3	1.0	45.3	0	1	0.0	100.0	Safe
17	Latur	6	3.0	40.7	164.9	55.9	4	5	66.7	83.3	Safe
18	Mumbai City	6	1.0	4.8	10.0	23.5	0	0	0.0	0.0	Safe
19	Mumbai Suburban	1	33.0	9.2	33.0	9.2	0	0	0.0	0.0	Safe
20	Nagpur	9	8.7	11.0	74.0	122.0	4	5	44.4	55.6	Safe
21	Nanded	8	37.2	34.0	55.6	148.0	7	7	87.5	87.5	Safe
22	Nandurbar	1	51.2	148.0	51.2	148.0	1	1	100.0	100.0	Safe
23	Nashik	25	1.4	0.3	259.0	274.4	15	15	60.0	60.0	Safe
24	Parbhani	7	22.8	42.0	57.0	92.0	6	6	85.7	85.7	Safe
25	Pune	11	2.0	3.5	47.0	305.0	1	4	9.1	36.4	Safe
26	Raigad	13	0.0	2.8	61.9	25.5	1	0	7.7	0.0	Safe
27	Sangli	15	7.5	21.0	122.8	149.3	3	9	20.0	60.0	Safe
28	Satara	7	4.5	4.5	205.0	103.3	2	3	28.6	42.9	Safe
29	Solapur	11	0.3	29.0	49.9	60.2	6	10	54.5	90.9	Semi critical
30	Thane	15	4.0	0.7	36.0	13.3	0	0	0.0	0.0	Safe
31	Wardha	15	6.1	25.0	82.8	57.0	11	13	73.3	86.7	Safe
32	Washim	6	14.8	43.0	51.0	179.0	5	5	83.3	83.3	Safe
33	Yavatmal	14	5.2	8.0	57.8	71.0	11	11	78.6	78.6	Safe

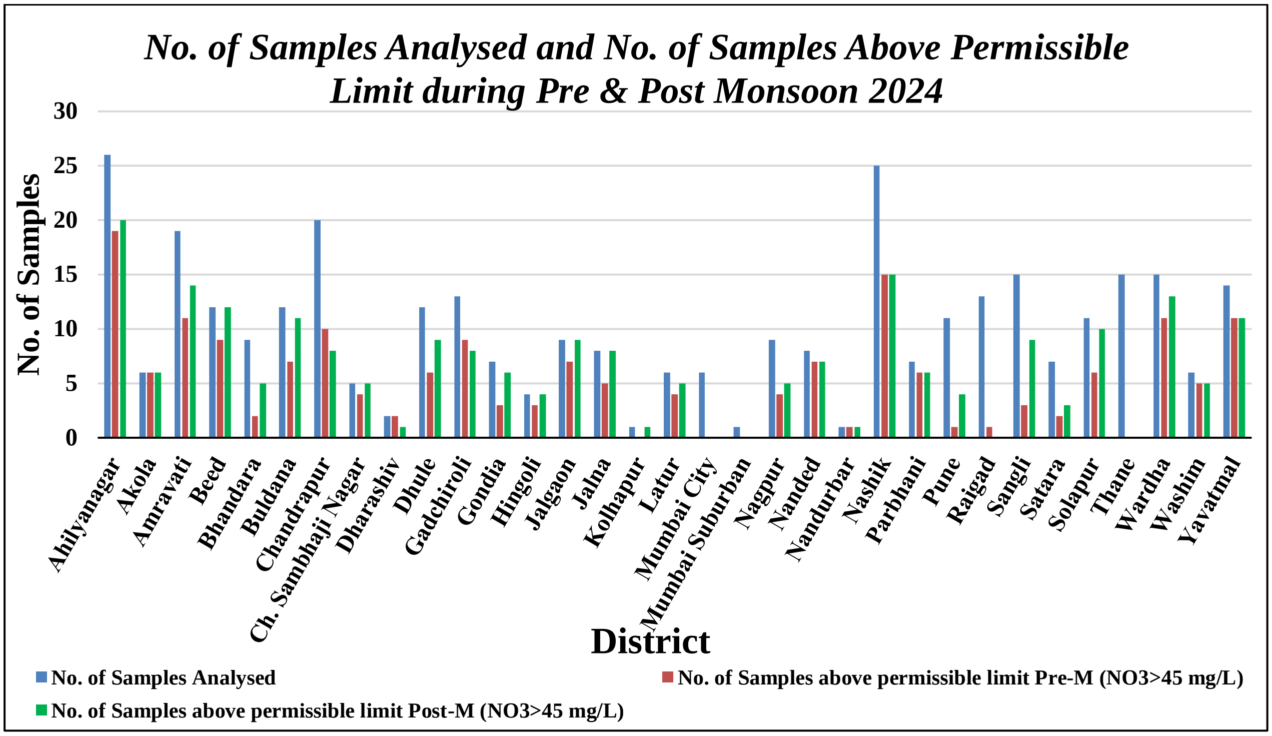


Figure 30: District wise No. of Samples analysed and No. of Samples above Permissible Limit for NO3 (Pre-M & Post-M 2024).

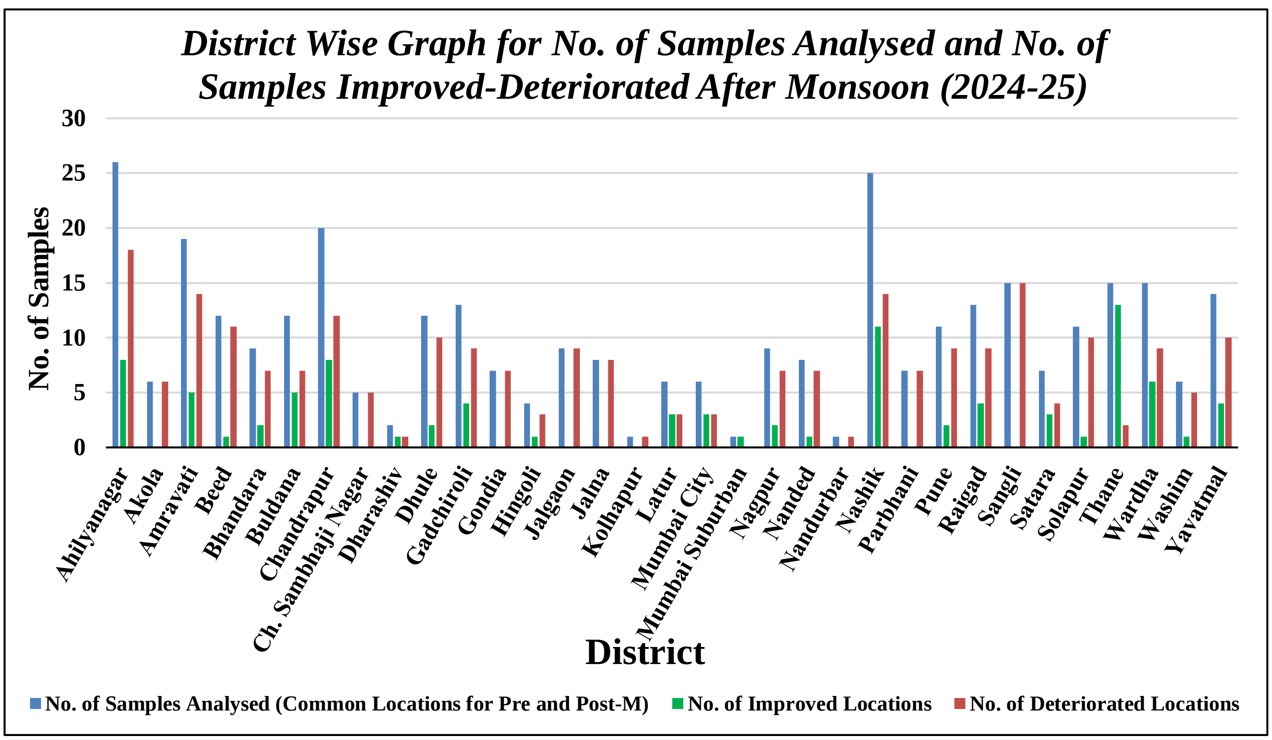


Figure 31: District wise representation of No. of Samples Analysed and No. of Location Improved and Deteriorated After Monsoon (2024-25).

Table 22: No. of Improved and Deteriorated Locations for Nitrate after Monsoon (w.r.t Pre-M NO_3 value).

Sl. No.	District	No. of Samples Analysed (Common Locations for Pre and Post-M)	No. of Improved Locations	No. of Deteriorated Locations	No. of Locations (Where Improvement is within 20% w.r.t Pre-M Value) No Significant Change	No. of Locations (Where Improvement is beyond 20% w.r.t Pre-M Value) Significant Improvement	No. of Locations (Where Deterioration is within20% w.r.t Pre-M Value) No Significant Change	No. of Locations (Where Deterioration is beyond 20% w.r.t Pre-M Value) Significant Deterioration
1	Ahilyanagar	26	8	18	1	7	3	15
2	Akola	6	0	6	0	0	4	2
3	Amravati	19	5	14	0	5	2	12
4	Beed	12	1	11	0	1	1	10
5	Bhandara	9	2	7	0	2	2	5
6	Buldhana	12	5	7	2	3	2	5
7	Chandrapur	20	8	12	4	4	3	9
8	Chatrapati Sambhaji Nagar	5	0	5	0	0	0	5
9	Dharashiv	2	1	1	0	1	1	0
10	Dhule	12	2	10	1	1	1	9
11	Gadchiroli	13	4	9	0	4	2	7
12	Gondia	7	0	7	0	0	0	7
13	Hingoli	4	1	3	1	0	2	1
14	Jalgaon	9	0	9	0	0	0	9
15	Jalna	8	0	8	0	0	0	8
16	Kolhapur	1	0	1	0	0	0	1
17	Latur	6	3	3	1	2	1	2
18	Mumbai City	6	3	3	3	0	0	3
19	Mumbai Suburban	1	1	0	0	1	0	0
20	Nagpur	9	2	7	0	2	1	6
21	Nanded	8	1	7	1	0	2	5
22	Nandurbar	1	0	1	0	0	0	1
23	Nashik	25	11	14	4	7	4	10
24	Parbhani	7	0	7	0	0	2	5
25	Pune	11	2	9	0	2	2	7
26	Raigad	13	4	9	0	4	4	5
27	Sangli	15	0	15	0	0	3	12
28	Satara	7	3	4	0	3	0	4
29	Solapur	11	1	10	0	1	6	4
30	Thane	15	13	2	1	12	0	2
31	Wardha	15	6	9	4	2	6	3
32	Washim	6	1	5	1	0	3	2
33	Yavatmal	14	4	10	2	2	3	7
	Total	**335**	**92**	**243**	**26**	**66**	**60**	**183**

Table 23: Percent Distribution of NO_3 during Pre-M & Post-M 2024.

State	Range		No. of Samples (N=335)		Percentage of Samples	
			Pre-M	Post-M	Pre-M	Post-M
Maharashtra	NO_3	>45 mg/l	180	221	53.73	65.97
Maharashtra	NO_3	<45 mg/l	155	114	46.27	34.03

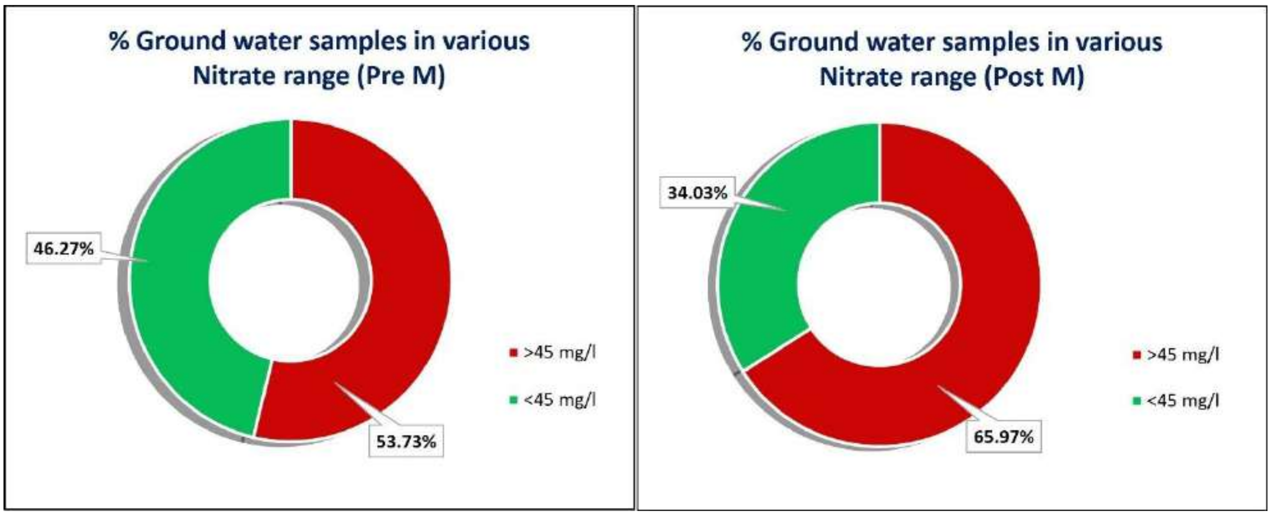


Figure 32: Representation for Percent Distribution of NO_3 (Pre-M and Post-M).

Table 24: Temporal Trend of High NO_3 in Groundwater: % of Locations Having NO_3> 45 mg/L (2017-2024).

State	Year	Total Number of Samples Analysed	No. of District Affected by NO_3	No. of Blocks Affected by NO_3	Total No of Locations Affected by NO_3	Percentage of locations Affected by NO_3
Maharashtra	2017	1163	33	199	484	41.19
Maharashtra	2018	1265	6	18	41	3.22
Maharashtra	2019	1065	15	31	43	3.98
Maharashtra	2022	1353	30	191	510	37.56
Maharashtra	2023	1567	32	199	560	35.74
Maharashtra	2024	335	29	127	180	53.73

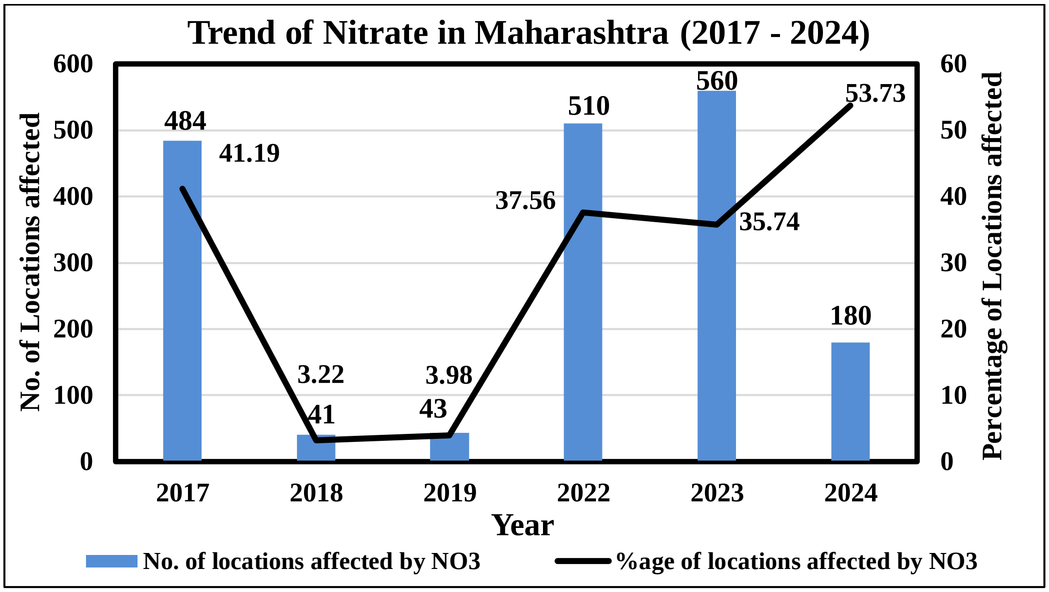


Figure 33: Graphical Representation of Trend for NO_3 (2017-24).

Samples may have NO_3 values above the permissible limit in either the pre- or post-monsoon season, and as such, the percentage of samples in a region that might be above the permissible limit of NO_3 in districts with this affliction is displayed in **Figure 34**, with both pre- and post-monsoon samples being taken into consideration.

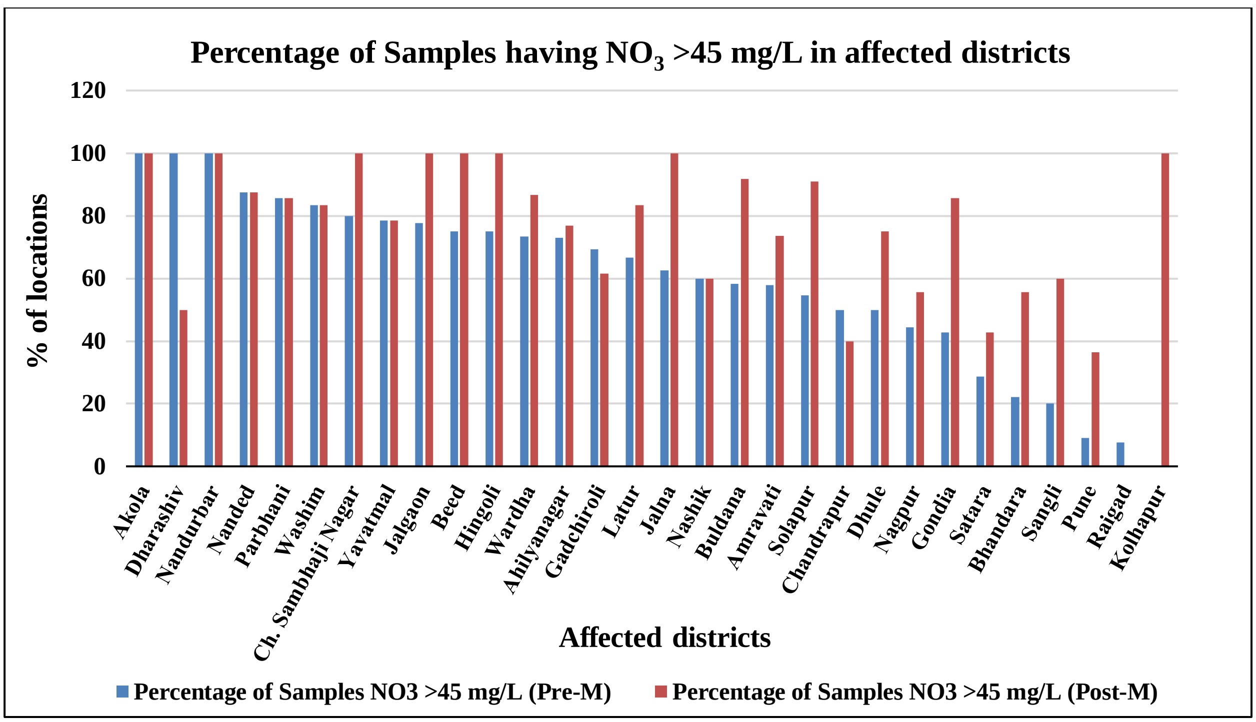


Figure 34: Percentage of Samples having NO_3 value above Permissible Limit (NO_3>45 mg/l) in Affected Districts. (Pre-M and Post-M Chart Comparison).

The concentration of NO_3 > 45 mg/L is considered particularly anomalous, and thus the number of blocks that are affected by such a condition are listed along with their respective districts in **Table 25**. The districts with the highest number of locations and the top seven affected blocks with high NO_3 levels are depicted in **Table 26** and **Table 27** respectively. Monsoon rain has the ability to impact nitrate concentration through recharge, leading to either improvement or deterioration, as displayed in **Table 28**. During the monsoon, contaminants from the surface, agricultural runoff, manure, overflow from drainage, and leakage from septic tanks contribute nitrate. The impact of monsoon recharge on NO_3 concentration in pre- and post-monsoon is presented in **Figure 35**.

Table 25: Districts & Blocks in which anomalous value of NO_3>45 mg/L was detected at one or more Locations (Based on Pre-M 2024).

Sl. No.	District	No. of Blocks Affected	Blocks (Affected)
1	Ahmednagar	11	Akola, Jamkhed, kopargaon, Nagar, Nevasa, Parner, Rahuri, Sangamner, Shevgaon, Shrigonda, Shrirampur
2	Akola	3	Balapur, Barshitakli, Patur
3	Amravati	8	Amravati, Anjangaon Surji, Chandur Bazar, Chandur Railway, Daryapur, Morshi, Teosa, Warud
4	Beed	5	Ashti, Georai, Kaij, Majalgaon, Shirur-Kasar
5	Bhandara	2	Bhandara, Tumsar
6	Buldana	5	Khamgaon, Malkapur, Mehkar, Motala, Nandura
7	Chandrapur	7	Bhadrawati, Chimur, Gondpipri, Nagbhir, Pomburna, Sindewahi, Warora
8	Ch. Sambhaji Nagar	3	Khuldabad, Sillod, Vaijapur
9	Dharashiv	2	Osmanabad, Umarga
10	Dhule	3	Dhule, Sakri, Sindkheda
11	Gadchiroli	7	Aheri, Chamorshi, Dhanora, Gadchiroli, Itapalli, Kurkheda, Mulchera
12	Gondia	3	Arjuni Morgaon, Gondia, Tirora
13	Hingoli	3	Kalmnuri, Purna, Sengaon
14	Jalgaon	6	AMALNER, Chalisgaon, Edlabad, Jamner, Raver, Yawal
15	Jalna	4	Bhokardan, Jafrabad, Jalna, Mantha
16	Latur	4	Ahmadpur, Ausa, Latur, Shirur Anantpal,
17	Nagpur	3	Mauda, Ramtek, Saoner,
18	Nanded	6	Bhokar, Biloli, Hadgaon, Mahur, Naigaon, Nanded
19	Nandurbar	1	Nandurbar
20	Nashik	8	Baglan, Chandvad, Deola, Kalwan, Nandgaon, Nasik, Niphad, Sinnar
21	Parbhani	5	Aundha, Jintur, Manwat, Parbhani, Selu,
22	Pune	1	Junnar
23	Raigad	1	Mhasala
24	Sangli	3	Jath, Miraj, Palus
25	Satara	1	Khatav
26	SOLAPUR	6	Barshi, Karmala, Madha, Mangalvedhe, Pandharpur, Solapur South
27	Wardha	7	Arvi, Ashti, Deoli, Hinganghat, Samudrapur, Seloo, Wardha
28	Washim	3	Mangrulpir, Manora, Washim

29	Yavatmal	8	Darwha, Digras, Ghatanji, Kelapur, Manora, Maregaon, Wani, Yavatmal

Table 26: Top 3 Affected Districts (in terms of no. of locations Where NO_3 > 45 mg/L).

SL. No.	Districts	Total No. of Sample Analysed	No. of Samples with Nitrate>45mg/L	Percentage of Samples with Nitrate>45mg/L
1	Ahilyanagar	26	19	73.1
2	Akola	6	6	100
3	Beed	12	9	75

Table 27: Top 7 Affected Blocks (in terms of no. of locations Where Nitrate > 45 mg/L in Pre-M)

Sl. No.	District	Blocks	Total No. of Sample Analysed	No. of Samples with Nitrate >45mg/l	Percentage of Samples with Nitrate>45mg/l	Stage of Extraction (Critical/ Semi-Critical/ Overexploited/ Safe/ Saline)	RainFall 2024-25
1	Ahilyanagar	Nagar	5	5	100	Safe	Excess
2	Nashik	Sinnar	4	4	100	Critical	Excess
3	Nashik	Baglan	3	3	100	Semi critical	Excess
4	Akola	Balapur	3	3	100	Safe	Normal
5	Chandrapur	Sindewahi	3	3	100	Safe	Normal
6	Wardha	Arvi	3	3	100	Safe	Excess
7	Wardha	Deoli	3	3	100	Safe	Excess

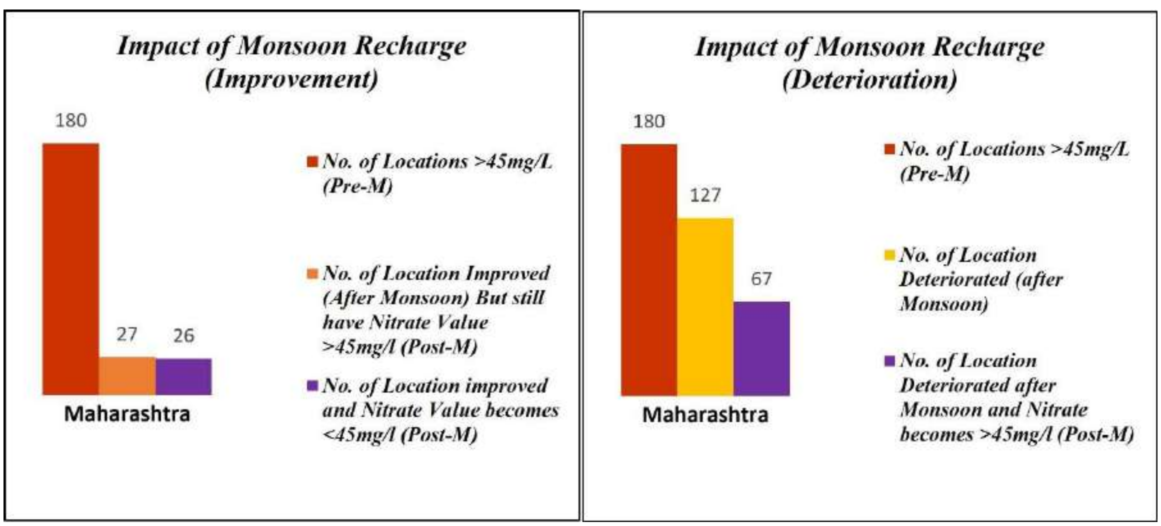


Figure 35: Impact of Monsoon recharge on NO_3 concentration.

Table 28: Impact of Monsoon recharge on Nitrate Concentration.

State	District	No. of Locations NO_3 > 45 mg/l (Pre-M)	No. of Location Improved (After Monsoon) But still have NO_3 (post-M)	No. of Location improved and NO_3 (post-M)	No. of Location Deteriorated (after Monsoon)	No. of Location Deteriorated after Monsoon and NO_3 becomes >45 mg/l
Maharashtra	Ahilyanagar	19	2	3	*14*	*4*
Maharashtra	Akola	6	0	0	*6*	*0*
Maharashtra	Amravati	11	1	3	7	6
Maharashtra	Beed	9	1	0	8	3
Maharashtra	Bhandara	2	0	1	1	4
Maharashtra	Buldhana	7	5	0	2	4
Maharashtra	Chandrapur	10	2	3	5	1
Maharashtra	Ch. Sambhaji Nagar	4	0	0	4	1
Maharashtra	Dharashiv	2	0	1	1	0
Maharashtra	Dhule	6	1	0	5	3
Maharashtra	Gadchiroli	9	0	3	6	2
Maharashtra	Gondia	3	0	0	3	3
Maharashtra	Hingoli	3	1	0	2	1
Maharashtra	Jalgaon	7	0	0	7	2
Maharashtra	Jalna	5	0	0	5	3
Maharashtra	Latur	4	2	1	1	2
Maharashtra	Nagpur	4	0	2	2	3
Maharashtra	Nanded	7	0	0	7	0
Maharashtra	Nandurbar	1	0	0	1	0
Maharashtra	Nashik	15	4	4	7	4
Maharashtra	Parbhani	6	0	0	6	0
Maharashtra	Pune	1	0	0	1	3
Maharashtra	Raigad	1	0	1	0	0
Maharashtra	Sangli	3	0	0	3	6
Maharashtra	Satara	2	1	0	1	1
Maharashtra	SOLAPUR	6	0	0	6	4
Maharashtra	Wardha	11	5	1	5	3
Maharashtra	Washim	5	0	1	4	1
Maharashtra	Thane	0	0	0	0	0
Maharashtra	Mumbai city	0	0	0	0	0
Maharashtra	Kolhapur	0	0	0	0	1
Maharashtra	Yavatmal	11	2	2	7	2
	Total	**180**	**27**	**26**	**127**	**67**

6.1.4 Chloride (Cl):

The distribution of Chloride in ground water of Maharashtra is shown in **Figure 36** (pre-monsoon) and **Figure 37** (post-monsoon). In the pre-monsoon season, it is observed from the map that in 83.6 % ground water samples of the State having chloride content less than the 250 mg/L as prescribed by Bureau of Indian Standards, and 14.3% samples are within the BIS guidelines (250 - 1000 mg/L). Only 2.1% i.e. seven samples in following districts of the state have been found with chloride concentration more than the maximum permissible limits of BIS i.e. 1000 mg/L, viz. Akola, Chatrapati Sambhaji Nagar, Gadchiroli, Nagpur, Nashik, Sangli and Thane in pre-monsoon season. Whereas in post-monsoon season 85 % of the samples having chloride concentration < 250 mg/L and 13.4% are having chloride concentration within 250 to 1000 mg/L. Rest 1.4% samples having chloride concentration >1000mg/L belong to Ahilyanagar, Beed, Dhule districts of the State.

6.1.5 Total Alkalinity (TA):

Alkalinity of water is acid neutralizing capacity of water. Alkalinity in water is a function of carbonate, bicarbonate and hydroxide content. It is an excess of alkaline earth metal concentrations significant in determining the suitability of water for irrigation. Alkalinity is defined as equivalent concentration of base. Alkalinity helps to regulate the pH of water and also regulate the metal content. As per BIS guidelines the acceptable and maximum permissible limit of total alkalinity in drinking water is 200 and 600 mg/L respectively. In the State, 21.5% samples it is below 200 mg/L and 75.7% of the ground water samples having total alkalinity between acceptable and permissible limit (200-600 mg/L) while 2.8% water samples having total alkalinity > 600 mg/L in the pre-monsoon season. Whereas in the post-monsoon season in 21.2% samples it is found below 200 mg/L and 75.3 % of the ground water having total alkalinity between acceptable and permissible limit (200-600 mg/L) while 3.4 % water samples having total alkalinity > 600 mg/L. It is found that around 97% of the ground water is suitable for drinking purpose in both the seasons. Total alkalinity in the ground water is not much varied during pre-& post-monsoon in Maharashtra.

6.1.6 Total hardness (TH):

The total hardness (TH) is the sum of calcium (Ca) and magnesium (Mg) concentration expressed in terms of $CaCO_3$ in mg/L. The carbonate and bicarbonate salts of Ca and Mg give temporary hardness to ground water while a chloride and sulphate salt gives permanent hardness. The distribution of TH in ground water of Maharashtra is given in **Figure 38** (pre-monsoon) and **Figure-39** (post-monsoon). The perusal of the figures indicates that in the pockets of the plain areas of Western Maharashtra, Marathwada and parts of Vidarbha, the TH of ground water is more than 600 mg/L. This shows that the concentration of Ca and Mg along with their salts is more in the area. The dissolution of Ca and Mg to high extent from geological sources is ruled out as this area is mainly covered by the basalts. The high concentration of these ions in groundwater may be from anthropogenic sources. However, the high TH in ground water of Purna basin area of Vidarbha is due to the inland salinity problem existing in the area. During pre-monsoon season, in 14.6% samples Total Hardness was recorded < 200 mg/L, in 71.9% samples it was recorded between 200 to 600 mg/L and in rest of the 13.4% samples high total hardness value > 600 mg/L was recorded. During post- monsoon season, in 16.1 % samples Total Hardness was recorded < 200 mg/L, in 68.4% samples it was recorded between 200 to 600 mg/L while rest of the 15.5 % (50 samples) have high total hardness value > 600 mg/L in the ground water samples of Ahilyanagar, Akola, Amravati, Beed, Buldhana, Chandrapur, Ch. Sambhaji Nagar, Dhule, Gadchiroli, Gondia, Jalgaon, Jalna, Kolhapur, Latur, Nagpur, Nanded, Nandurbar, Nashik, Pune, Raigad, Sangli, Satara, Solapur, Thane, Wardha and Yavatmal districts of the state.

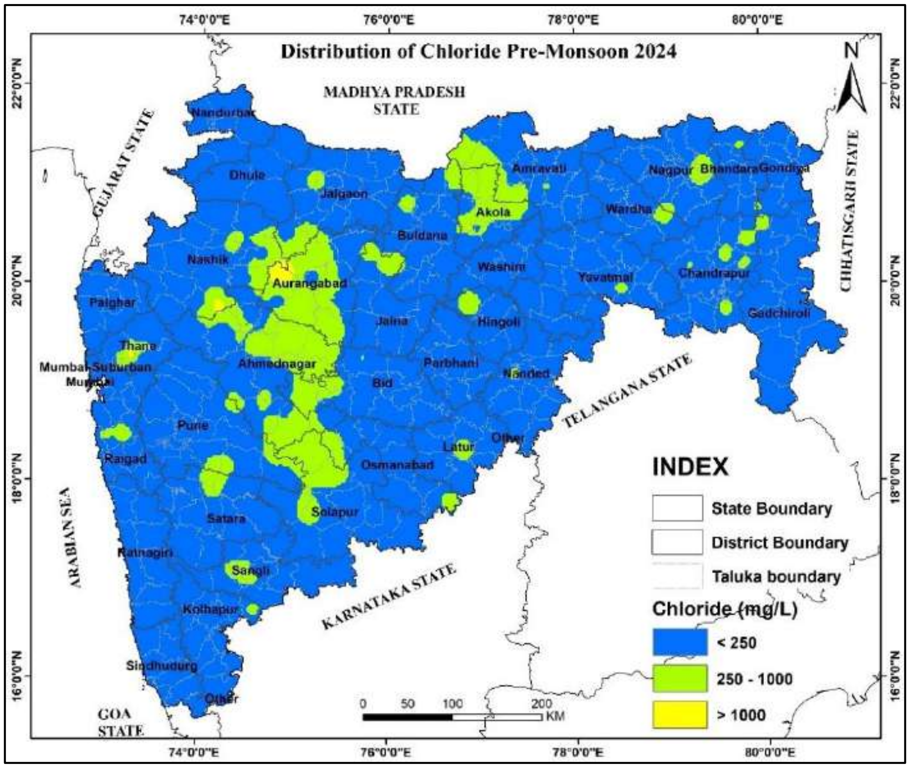


Figure 36: Distribution of Chloride Pre-Monsoon 2024.

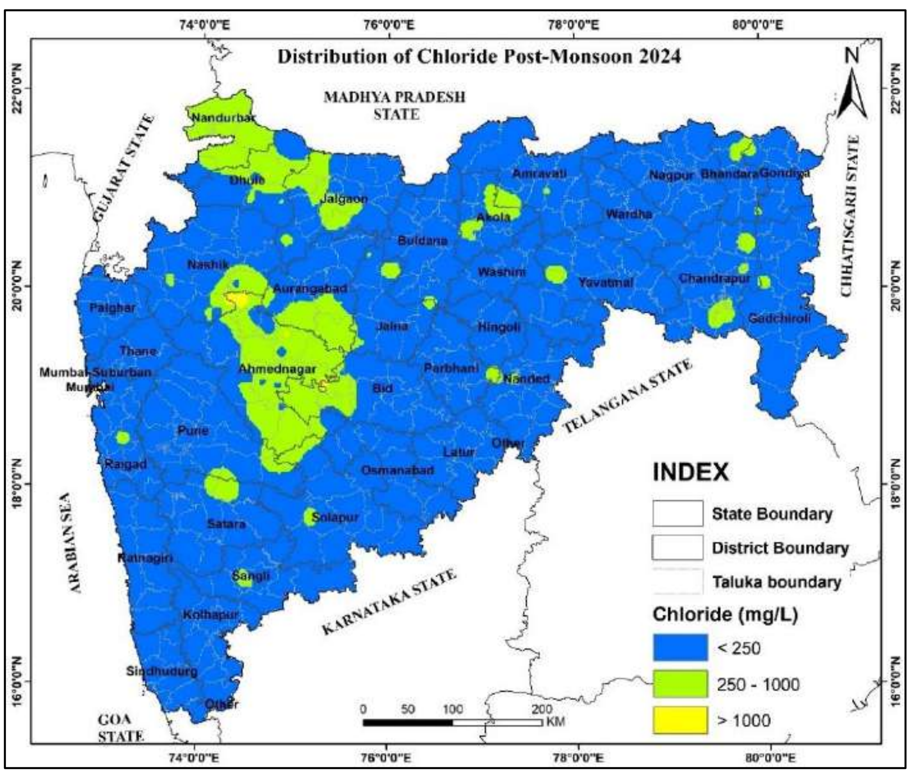


Figure 37: Distribution of Chloride Post-Monsoon 2024.

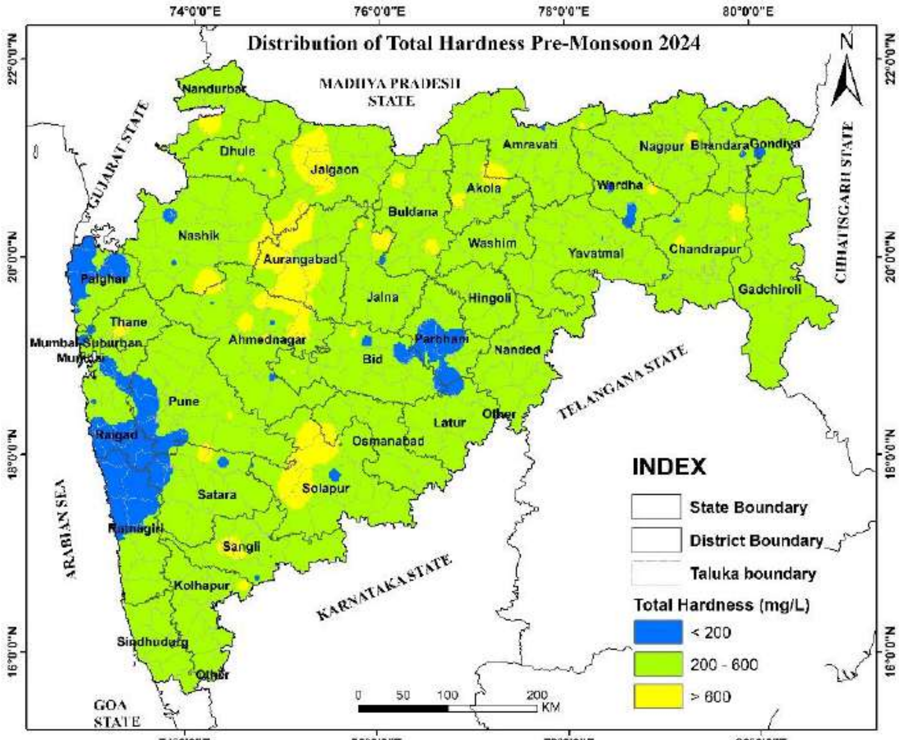


Figure 38: Distribution of Total hardness Pre-Monsoon 2024.

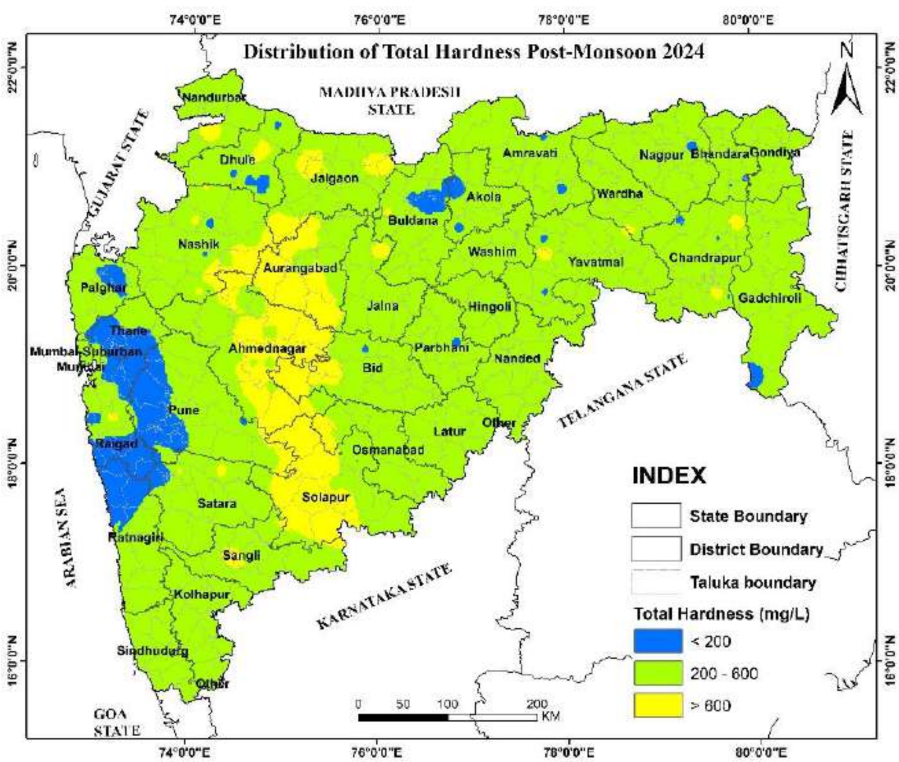


Figure 39: Distribution of Total hardness Post-Monsoon 2024.

6.1.7 Heavy Metals:

To identify the heavy metal contents in the groundwater of Maharashtra State, acidified samples were collected in the pre-monsoon season. These samples were analysed by ICP-MS for As, Fe, Cu, Mn, Pb, and U. The chemical analysis results reveal that, except for U, all analysed heavy metals are within the BIS permissible limits for drinking purposes. The distribution of the heavy metals is given in **Figure 40**.

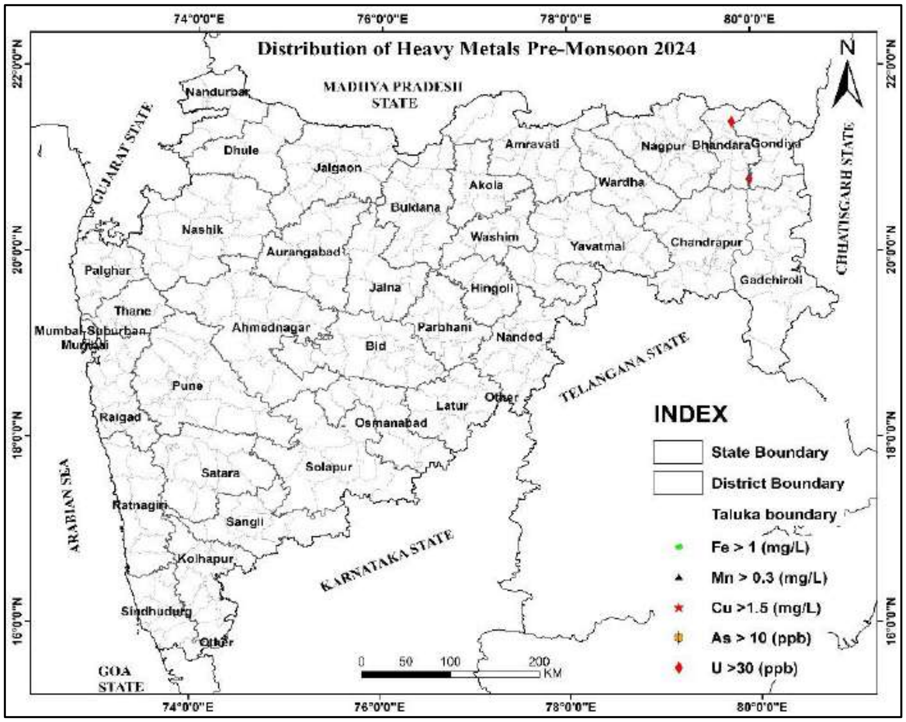


Figure 40: Distribution of Heavy Metals Pre-Monsoon 2024.

6.1.8 Uranium:

Uranium occurs naturally in groundwater and surface water. Uranium, being naturally occurring in groundwater and surface water, poses health risks due to its radioactive properties. Sources include natural deposits, nuclear industry emissions, coal combustion, and phosphate fertilizers. Human exposure occurs mainly through drinking water, food, air, and occupational hazards. Concentrations exceeding 30 ppb, according to BIS standards, can cause damage to internal organs with prolonged intake, necessitating caution in consumption.

Uranium (U) content in groundwater ranges from BDL to 74.73 ppb. BIS recommends that uranium concentration up to 30 ppb in drinking water is acceptable. Classification of samples based on this recommendation shows that 0.32% of samples have uranium above 30 ppb in pre-monsoon 2024. During pre-monsoon 2024, the higher uranium concentration (>30 ppb) in groundwater samples was found in two locations: 74.73 ppb at Khair Langi (Bhandara district) and 46.22 ppb at Dhabetekdi (Gondia district). The concentrations and distributions of uranium in groundwater from aquifers in Maharashtra indicate that the concentration of U in groundwater is negligible and found well within the permissible limit of <30 ppb (BIS), except for two dug wells during the pre-monsoon, and one dug well during the post-monsoon as presented in **Figure 41 and 42** respectively. The source of uranium in the groundwater samples may be geogenic contamination from the host aquifer. The number of samples analysed per district, along with their minimum, maximum, and mean uranium values, is based on NHS 2024 data and given in **Table 29**. Bhandara district has a higher average concentration of U (9.57 ppb).

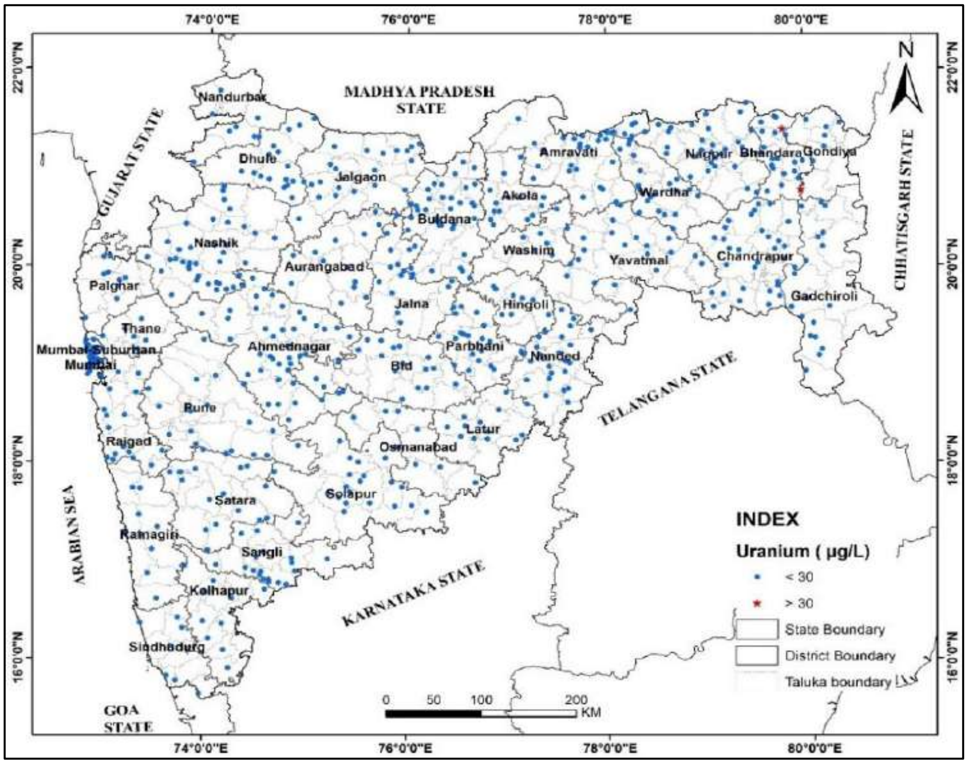


Figure 41: Distribution of Uranium (U) in groundwater of Maharashtra 2024 Pre-Monsoon.

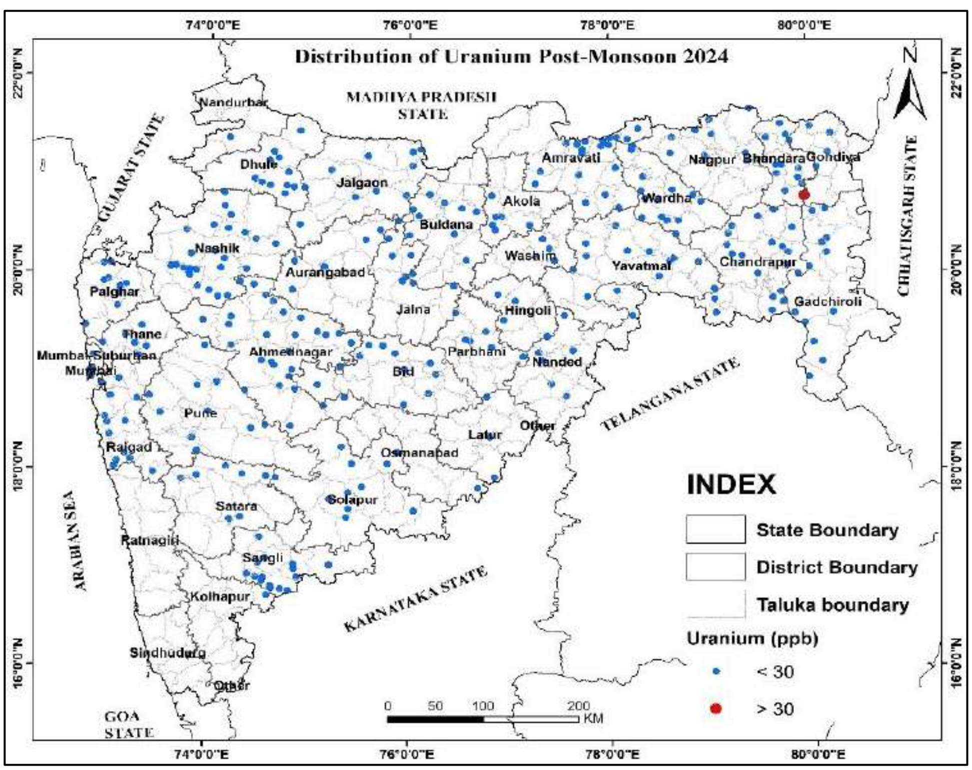


Figure 42: Distribution of Uranium (U) in groundwater of Maharashtra 2024 Post-Monsoon.

Table 29: District wise Distribution of Uranium based on 2024 Pre & Post Monsoon Data.

Sr. No.	District	No. of Samples	Min. Value of U		Max. Value of U		No. of Samples >30 ppb	
			Pre-M	Post-M	Pre-M	Post-M	Pre-M	Post-M
1	Ahilyanagar	26	0.06	0.00	12.09	13.00	0	0
2	Akola	6	0.12	0.00	3.50	4.50	0	0
3	Amravati	19	0.16	0.00	13.84	1.91	0	0
4	Beed	12	0.00	0.17	0.00	3.62	0	0
5	Bhandara	9	0.06	0.00	74.73	10.00	1	0
6	Buldhana	12	0.21	0.00	4.31	2.50	0	0
7	Chandrapur	20	0.26	0.00	18.19	20.80	0	0
8	Chatrapati Sambhaji Nagar	5	1.07	0.28	6.36	9.01	0	0
9	Dharashiv	2	1.38	0.40	1.69	0.50	0	0
10	Dhule	12	0.29	0.72	5.42	4.50	0	0
11	Gadchiroli	13	0.06	0.00	8.90	8.00	0	0
12	Gondia	7	0.04	0.00	46.22	72.00	1	1
13	Hingoli	4	0.15	0.63	0.43	1.72	0	0
14	Jalgaon	9	0.03	0.06	4.22	5.82	0	0
15	Jalna	8	0.29	0.50	3.55	8.49	0	0
16	Kolhapur	1	1.42	7.80	1.42	7.80	0	0
17	Latur	6	0.23	1.10	3.16	3.80	0	0
18	Mumbai City	6	0.05	0.00	0.55	2.32	0	0
19	Mumbai Suburban	1	0.58	0.16	0.58	0.16	0	0
20	Nagpur	9	0.32	0.21	25.82	5.63	0	0
21	Nanded	8	0.12	0.28	5.42	13.73	0	0
22	Nandurbar	1	0.44	0.37	0.44	0.37	0	0
23	Nashik	25	0.01	0.00	12.69	4.21	0	0
24	Parbhani	7	0.15	0.31	3.68	0.90	0	0
25	Pune	11	0.01	0.00	2.68	2.20	0	0
26	Raigad	13	0.00	0.00	1.66	2.71	0	0
27	Sangli	15	0.01	0.61	4.84	11.04	0	0
28	Satara	7	0.00	0.08	3.54	10.48	0	0
29	SOLAPUR	11	0.00	0.40	1.01	2.50	0	0
30	Thane	15	0.00	0.00	0.69	2.10	0	0
31	Wardha	15	0.00	0.00	0.00	4.70	0	0
32	Washim	6	0.40	0.37	1.33	0.77	0	0
33	Yavatmal	14	0.19	0.00	4.26	2.80	0	0

Temporal Variation of Uranium in Ground Water 2019 to 2024:

The periodic variation from 2019 to 2024 in suitability classes of uranium content in groundwater of the state is given in **Figure 43**.

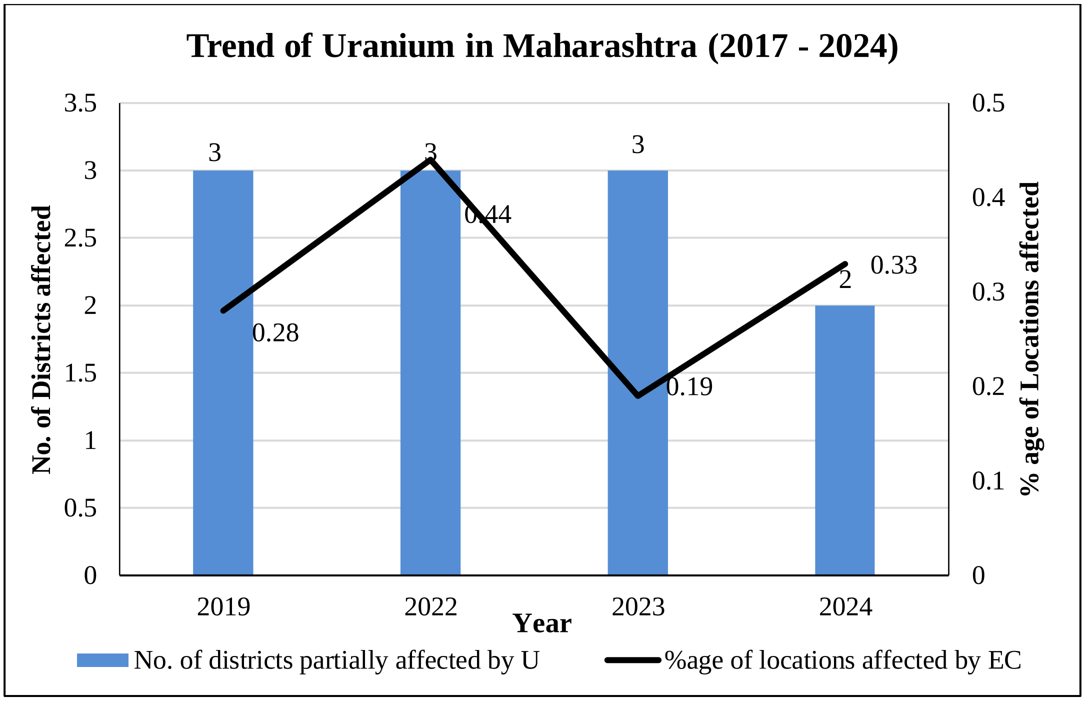


Figure 43: Trend of Uranium in Maharashtra.

6.2 Hydro-Chemical Facies

Determining the nature and distribution of hydro-chemical facies can provide insight into how groundwater quality changes within and between aquifers. The pre & post-monsoon groundwater is evaluated to determine its facies by plotting the percentages of select chemical constituents in a Piper diagram, which indicate that most of them are of Ca-Mg-HCO_3 type, some belong to the subgroup of Na-K-HCO_3 type, and Na-K-Cl-SO_4 type and a few fall in the Ca-Mg-Cl-SO_4 type water facies category in decreasing order (**Figure-44 & 45**) while the rest fall in mixed type. The Piper plots showed a scattered distribution on the cation side and a clustered distribution of majority HCO_3 on the anion side. The Piper plot shows that the mineralogy of the aquifer material was significant in that it impacts the water chemistry. The Na^+ and Ca^{2+} are in a transitional state, with Na^+ replacing Ca^{2+} and HCO_3-Cl due to physiochemical changes in the aquifer and water-rock interactions. The concentrations of major cations and anions and their interrelationships were investigated to better understand and explain the hydrogeochemical processes that occurred in the aquifer domain throughout the evolution of various groundwater facies. Percentage distribution of ground water samples based on Piper diagram is presented in **Table 30**.

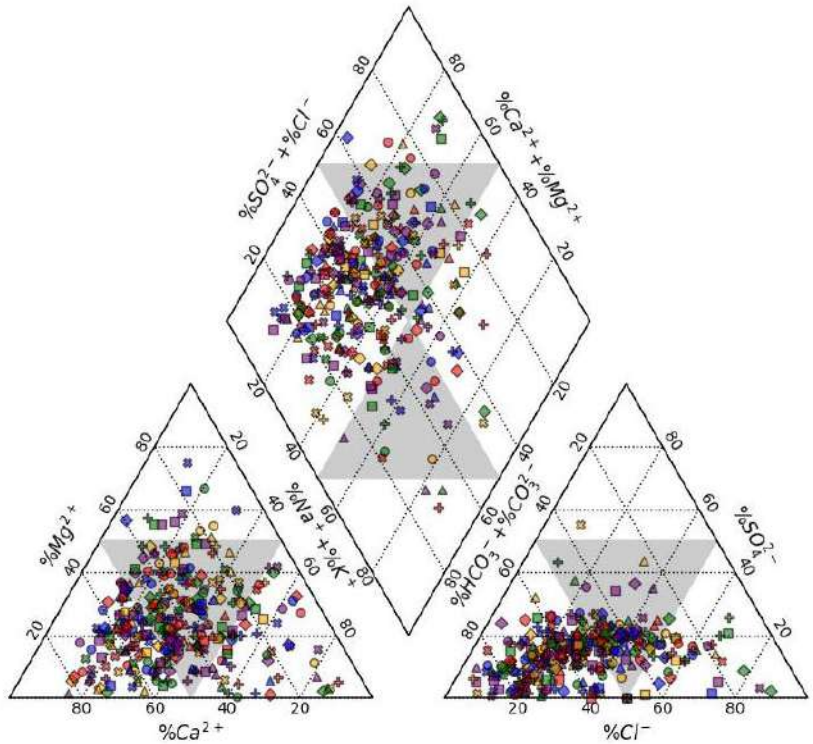


Figure 44: Piper diagram of pre-monsoon water samples (2024)

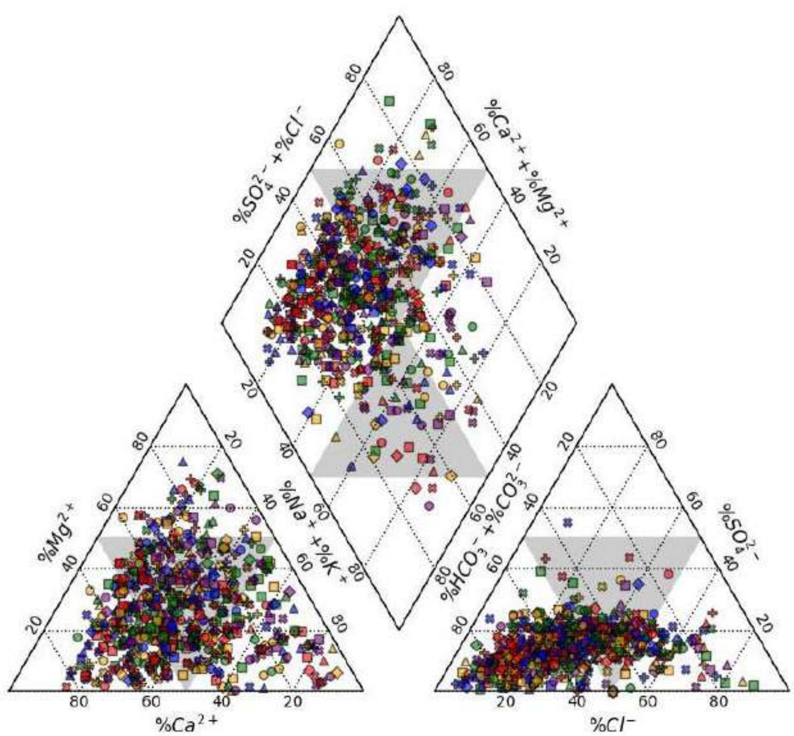


Figure 45: Piper diagram post-monsoon water samples.

Table 30: Percent Distribution of Ground Water Samples based on Piper Diagram.

Type of water	Pre-monsoon	Post-monsoon
	% of sample	% of sample
$CaHCO_3$	22.69	21.8
$MgHCO_3$	2.99	2.7
$NaHCO_3$	6.87	9.3
$CaCl_2$	1.79	2.09
$MgCl_2$	0.00	0.30
NaCl	2.99	1.19
Mixed type	62.69	62.62

6.3 Suitability of Ground Water for Irrigation Purpose

The quality of water used for irrigation is an important factor in crop productivity, its yield, and quality. The irrigation water quality depends primarily on the presence of dissolved salts and their concentrations. The Electrical Conductivity (EC), Sodium Absorption Ratio (SAR), and Residual Sodium Carbonate (RSC) are the most important quality criteria as per the Bureau of Indian Standards (BIS) for the quality of irrigation water (IS-11624-1986, Reaffirmed 2009), which influence the water quality and its suitability for irrigation.

6.3.1. Electrical Conductivity (EC)

The concentration of dissolved ions in the water is best represented by the parameter electrical conductivity. In relation to hazardous effects of the total salt concentration (EC), the irrigation water can be classified into four major groups.

Low Salinity Water (EC: Below 1500 µS/cm): Suitable for sensitive crops.

Medium Salinity Water (EC: 1500 – 3000 µS/cm): Suitable for semi-tolerant crops.

High Salinity Water (EC: 3000 – 6000 µS/cm): Suitable for tolerant crops.

Very High Salinity Water (EC: >6000 µS/cm): Not suitable for irrigation.

It is clear from **Table 31** that 74% of samples fall under low salinity, 20.6% samples fall under medium salinity, 4.2% samples come under high salinity and ~1% sample comes under very high salinity category This shows that the groundwater from pre and post monsoon in the state could be used for irrigation with proper soil and crop management practices.

Table 31: Classification of groundwater for irrigation based on EC values.

Sr. No.	Class	Range of EC in μS/cm	Pre-Monsoon		Post-Monsoon	
			No. of samples	% of samples	No. of samples	% of samples
1	Low Salinity Water	< 1500	248	74.03	251	74.93
2	Medium Salinity Water	1500 – 3000	69	20.60	65	19.40
3	High Salinity Water	3000 – 6000	14	4.18	16	4.78
4	Very High Salinity Water	> 6000	4	1.19	3	0.90
Total			**335**	**100**	**335**	**100**

6.3.2. Sodium Adsorption Ratio (SAR):

Since calcium and magnesium replace sodium more readily than vice versa, the ratio reflects the sodium hazard. The SAR indicates the relative activity of the sodium ions in exchange reactions with the soil. Irrigation water with a high SAR will cause the soil to tighten up. The SAR value is used to calculate the degree to which irrigation water tends to enter the cation exchange section in the soil. The main problem with high sodium concentration is its effect on soil permeability and water irrigation. The SAR can be calculated from the following formula—

$$\text{Sodium Absorption ratio} = \frac{Na^{+}}{\left[\frac{(Ca^{++} + Mg^{++})}{2}\right]^{1/2}}$$

(Here, the concentrations of cations are expressed in meq/L).

Sodium also contributes directly to the total salinity of the water and may be toxic to sensitive crops such as fruit trees. A higher value of SAR indicates soil structure damage. In relation to the hazardous effects of SAR, the irrigation water quality of groundwater samples in Maharashtra is shown in **Table 31**. 97.6% of groundwater samples have a low SAR value (0–10), 1.7% of samples have a medium SAR value (10–18), 0.6% have high SAR values (18–26), and none of the samples have an SAR value greater than 26 in the pre-monsoon season. Similarly, 93.1% of groundwater samples have SAR values in the 0–10 range, 5.6% have SAR values in the 10–18 range, 1.2% have SAR values in the 18–26 range, and none of the post-monsoon samples have a high SAR value >26. Classification of ground water for Irrigation based on SAR values are given **Table-32.** The groundwater of the state is considered good for irrigation. Classification of ground water based on SAR values of water samples from 2022 to 2024 is given in **Table 33** and **Figure 46.** Classification of ground water based on SAR values of water samples for 2024-25 is given in **Table 34.**

Table 32: Classification of Ground Water for Irrigation Based on SAR Values.

Sr. No.	Class	SAR Value	Pre-Monsoon		Post-Monsoon	
			No. of samples	% of samples	No. of samples	% of samples
1	Low	0-10	327	97.6	312	93.1
2	Medium	10-18	6	1.7	19	5.6
3	High	18-26	2	0.6	4	1.2
4	Very high	>26	0	0.0	0	0
Total			**335**	**100**	**335**	**100**

Table 33: Classification of Ground Water Based on SAR values.

Class	SAR Class	2022	2023	2024
SAR Value range	0-10	98.8	99.43	93.1
Pre-monsoon	10-18	1.2	0.57	5.6
% of samples	18-26	0.07	0	0.6
	>26	0	0	0

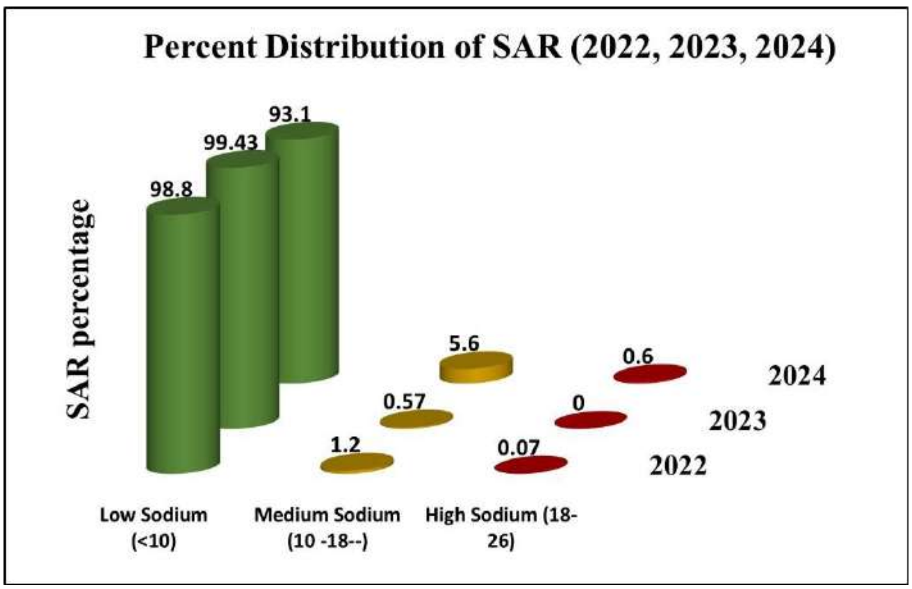


Figure 46: Graphical Representation of SAR Distribution (2022, 2023 & 2024 Pre-M).

Table 34: Classification of ground water for Irrigation based on SAR values (2024-25)

Sr. No.	District	No. of Samples	Min. Value of SAR		Max. Value of SAR		No. of Samples <10		Percentage of Samples 10-18		No. of Samples 18-26		No. of Samples >26	
			Pre-M	Post-M	Pre-M	Post-M	Pre-M	Post-M	Pre-M	Post-M	Pre-M	Post-M	Pre-M	Post-M
1	Ahilyanagar	26	0.64	0.80	14.33	9.26	25	26	1	0	0	0	0	0
2	Akola	6	0.41	0.62	5.55	10.51	6	5	0	1	0	0	0	0
3	Amravati	19	0.44	0.69	11.98	12.15	17	18	2	1	0	0	0	0
4	Beed	12	1.07	0.59	8.93	6.39	12	12	0	0	0	0	0	0
5	Bhandara	9	0.52	0.76	3.80	14.15	9	8	0	1	0	0	0	0
6	Buldhana	12	0.21	1.15	4.47	4.41	12	12	0	0	0	0	0	0
7	Chandrapur	20	0.72	0.24	15.61	8.02	19	20	1	0	0	0	0	0
8	Chatrapati Sambhaji Nagar	5	1.32	0.80	9.78	9.93	5	5	0	0	0	0	0	0
9	Dharashiv	2	2.07	1.01	2.28	6.07	2	2	0	0	0	0	0	0
10	Dhule	12	1.09	1.15	4.78	15.41	12	8	0	4	0	0	0	0
11	Gadchiroli	13	0.42	0.50	19.95	3.48	12	13	0	0	1	0	0	0
12	Gondia	7	0.69	0.91	2.56	3.11	7	7	0	0	0	0	0	0
13	Hingoli	4	0.95	0.84	7.10	5.28	4	4	0	0	0	0	0	0
14	Jalgaon	9	0.64	0.91	2.28	5.18	9	9	0	0	0	0	0	0
15	Jalna	8	0.63	0.69	5.18	4.22	8	8	0	0	0	0	0	0
16	Kolhapur	1	1.69	9.94	1.69	9.94	1	1	0	0	0	0	0	0
17	Latur	6	0.64	1.21	4.20	3.38	6	6	0	0	0	0	0	0
18	Mumbai City	6	0.50	3.56	1.49	7.38	6	6	0	0	0	0	0	0
19	Mumbai Suburban	1	1.03	5.21	1.03	5.21	1	1	0	0	0	0	0	0
20	Nagpur	9	0.54	0.44	19.95	2.15	8	9	0	0	1	0	0	0
21	Nanded	8	0.66	0.57	2.79	5.40	8	8	0	0	0	0	0	0
22	Nandurbar	1	1.22	1.08	1.22	1.08	1	1	0	0	0	0	0	0
23	Nashik	25	0.29	0.34	8.74	9.61	25	25	0	0	0	0	0	0
24	Parbhani	7	0.40	0.60	11.26	6.70	6	7	1	0	0	0	0	0
25	Pune	11	0.33	0.52	3.60	8.45	11	11	0	0	0	0	0	0
26	Raigad	13	0.44	1.23	3.96	10.81	13	12	0	1	0	0	0	0
27	Sangli	15	0.42	3.62	3.90	21.43	15	5	0	7	0	3	0	0
28	Satara	7	0.27	1.80	6.12	24.60	7	4	0	2	0	1	0	0
29	Solapur	11	0.11	1.25	4.92	17.22	11	9	0	2	0	0	0	0
30	Thane	15	0.39	0.42	4.63	1.14	15	15	0	0	0	0	0	0
31	Wardha	15	0.87	0.42	11.73	3.60	14	15	1	0	0	0	0	0
32	Washim	6	0.86	0.69	1.50	2.97	6	6	0	0	0	0	0	0
33	Yavatmal	14	0.49	0.48	5.18	3.29	14	14	0	0	0	0	0	0

6.3.3 Residual Sodium Carbonate (RSC):

The RSC index of irrigation water and soil water is used to indicate the alkalinity hazards for soil. RSC is considered to be superior to SAR as a measure of sodicity, particularly at low salinity levels. Calcium reacts with bicarbonate and precipitates as $CaCO_3$. Magnesium salt is more soluble, and so there is less tendency for it to precipitate. When calcium and magnesium are lost from the water, the proportion of sodium is increased, resulting in an increase in sodium hazard. This hazard is evaluated in terms of RSC.

$$\text{Residual Sodium Carbonate} = \left(CO_3^{2-} + HCO_3^{-}\right) - (Ca^{2+} + Mg^{2+})$$

(All the ionic concentrations in the above equation are expressed in meq/L).

In relation to the hazardous effects of RSC, the irrigation water quality is given in Table 31. From the tables, it is observed that 89.2%, 3.6%, and 7.2% of the pre-monsoon samples show RSC values less than 1.25 meq/L, 1.25–2.5 meq/L, and >2.5 meq/L, respectively. While 74.3%, 5.1%, and 20.6% of the post-monsoon samples show RSC values less than 1.25 meq/L, 1.25–2.5 meq/L, and >2.5 meq/L, respectively. The district wise percentage distribution of RSC values of ground water for both pre and post-monsoon are given in **Table 35** and graphical representation of high RSC value districts is given in **Figure 47**. Classification of ground water for Irrigation based on RSC values are given **Table-36.** The districts and blocks having high RSC value are given in **Table 37**. The yearly RSC Distribution (2022, 2023 & 2024 Pre-M) is given in **Table 38** and **Figure 48**. Overall, the groundwater quality of Maharashtra is suitable for irrigation purposes based on the above study.

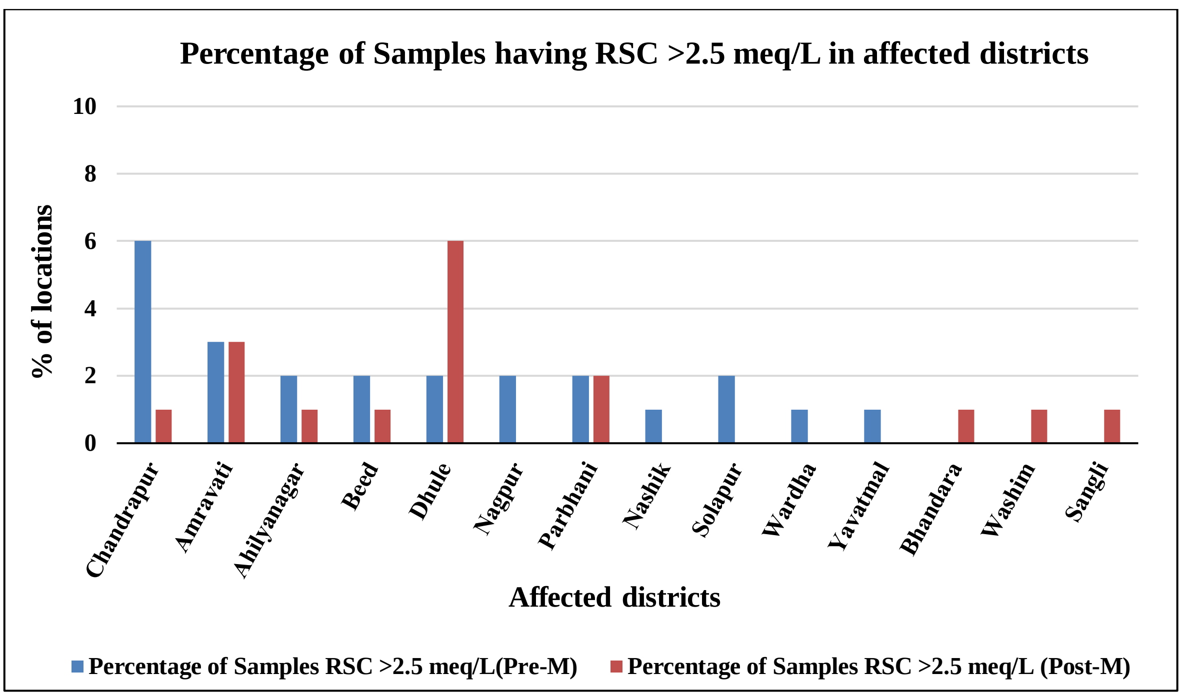


Figure 47: District wise graphical representation of high RSC (Pre-M and Post-M)

Table 35: Percentage distribution of high RSC values (Pre-M and Post-M)

Sr. No.	District	No. of Samples <1.25		No. of Samples 1.25 – 2.5		No. of Samples >2.5	
		Pre-M	Post-M	Pre-M	Post-M	Pre-M	Post-M
1	Ahilyanagar	24	25	0	0	2	1
2	Akola	6	5	0	1	0	0
3	Amravati	15	15	1	1	3	3
4	Beed	10	11	0	0	2	1
5	Bhandara	9	8	0	0	0	1
6	Buldana	12	12	0	0	0	0
7	Chandrapur	14	16	0	3	6	1
8	Chatrapati Sambhaji Nagar	5	4	0	1	0	0
9	Dharashiv	2	2	0	0	0	0
10	Dhule	9	4	1	2	2	6
11	Gadchiroli	13	12	0	1	0	0
12	Gondia	7	6	0	1	0	0
13	Hingoli	2	4	2	0	0	0
14	Jalgaon	9	9	0	0	0	0
15	Jalna	8	8	0	0	0	0
16	Kolhapur	1	1	0	0	0	0
17	Latur	6	6	0	0	0	0
18	Mumbai City	6	6	0	0	0	0
19	Mumbai Suburban	1	1	0	0	0	0
20	Nagpur	7	9	0	0	2	0
21	Nanded	8	7	0	1	0	0
22	Nandurbar	1	1	0	0	0	0
23	Nashik	24	24	0	1	1	0
24	Parbhani	4	5	1	0	2	2
25	Pune	11	11	0	0	0	0
26	Raigad	13	13	0	0	0	0
27	Sangli	12	12	3	2	0	1
28	Satara	5	6	2	1	0	0
29	Solapur	9	11	0	0	2	0
30	Thane	15	15	0	0	0	0
31	Wardha	13	14	1	1	1	0
32	Washim	6	5	0	0	0	1
33	Yavatmal	12	14	1	0	1	0
	Total	**299**	**302**	**12**	**16**	**24**	**17**

Table 36: Classification of ground water for Irrigation based on RSC values.

Sr. No.	Class	RSC Value	Pre-monsoon		Post-monsoon	
			No. of samples	% of samples	No. of samples	% of samples
1	Low	< 1.25	299	89.3	249	74.3
2	Medium	1.25 – 2.5	11	3.3	17	5.1
3	High	> 2.5	24	7.2	69	20.6
Total			335	100	335	100

Table 37: Classification of ground water for Irrigation based on RSC values.

Sr. No.	Districts	No. of Blocks	Name of Blocks
1	Ahilyanagar	2	Nevasa,Sangamner
2	Amravati	3	Amravati,Anjangaon Surji,Chandur Bazar
3	Beed	2	Georai,Majalgaon
4	Chandrapur	6	Chandrapur,Chimur,Saoli,Sindewahi,Warora
5	Dhule	2	Dhule
6	Nagpur	2	Mauda,Saoner
7	Nashik	1	Baglan
8	Parbhani	2	Manwat, Parbhani
9	Solapur	2	Dharmpuri, Hivre
10	Wardha	1	Hinganghat
11	Yavatmal	1	Wani

Table 38: Yearly Classification of Ground Water Based on RSC values (2022, 2023 & 2024)

Class	RSC Value	2022	2023	2024
Low	<1.25	90.91	89.6	89.25
Medium	1.25 – 2.5	4.98	5.42	3.59
High	> 2.5	4.11	4.98	7.16

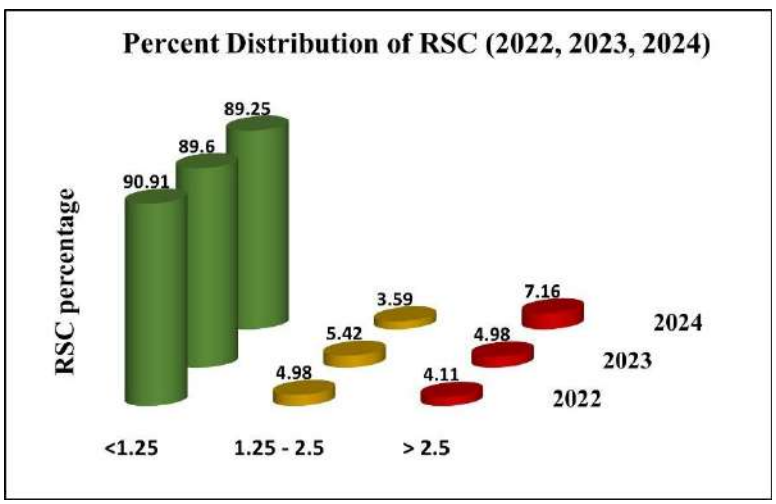


Figure 48: Graphical Representation of RSC Distribution (2022, 2023 & 2024 Pre-M).

US Salinity diagram

In order to assess the sodic and salinity potential of irrigation waters, the U.S. Salinity Laboratory (1954) has adopted an irrigation water classification based upon SAR and electrical conductance. The C and S classification adhere to the description of the diagram drawn on semi log paper with SAR on ordinary scale. This classification is extensively used worldwide and consists of 16 groups of irrigation waters – C1S1, C2S2, S2C1, S2C2 etc. These groups are summarized here in 4 groups on each of four original groups for brief discussion. The US Salinity diagrams for pre and post monsoon 2024 are given in **Figures 49 and 50**. 98.1% of the groundwater samples have a low Sodium hazard value (0–10) and fall mostly in C2-S1 and C3-S1 group with few samples in C1-S1 and C4-S1 group, 1.9% of samples have a medium SAR value (10–18) and fall mostly in C3-S2 and C4-S2 group, with few samples in C3-S3, C4-S3 and C3-S4 group in the pre-monsoon season. Similarly, 97.8% of the groundwater samples have a low Sodium hazard value (0–10) and fall mostly in C2-S1 and C3-S1 group with few samples in C1-S1 and C4-S1 group, 2.2% of samples have a medium SAR value (10–18) and fall mostly in C3-S2 and C4-S2 group, with few samples in C3-S3, C4-S3 and C3-S4 group in the post-monsoon season.

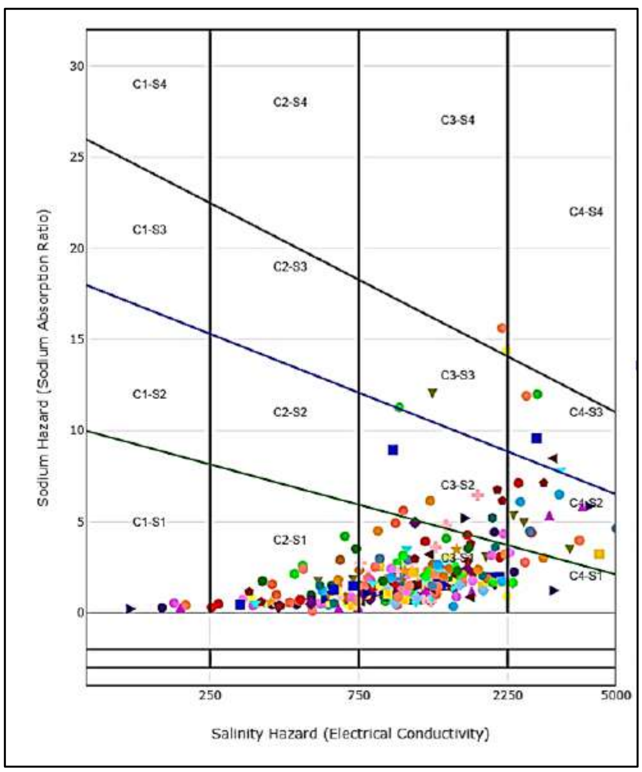


Figure 49: US Salinity diagram for pre-monsoon 2024.

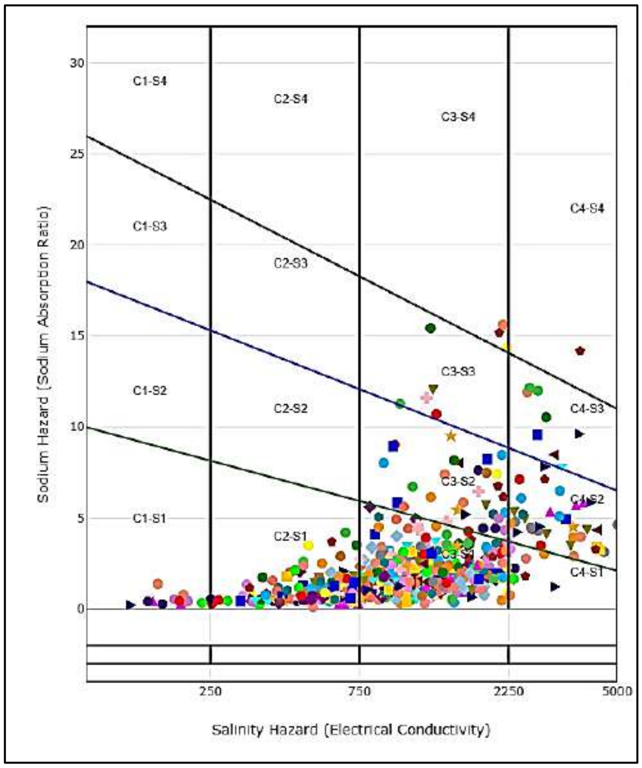


Figure 50: US Salinity diagram for post-monsoon 2024.

Wilcox diagram

EC and sodium concentration are very important in classifying irrigation water. The Wilcox diagram (Wilcox 1948) relating EC and %Na (**Figure 51** and **52**) shows that all the samples are plotted in excellent to good and good to permissible categories in most of the water samples indicating their suitability for irrigation. Only 5 to 7 % of the samples fall in the unsuitable zone for irrigation which have EC> 3000 µS/cm and high RSC values > 2.5. Nevasa, Sangamner block of Ahilyanagar district; Amravati, Anjangaon Surji, Chandur blocks of Amravati district; Georai, Majalgaon blocks of Beed district; Chandrapur, Chimur, Saoli, Sindewahi, Warora blocks of Chandrapur district; Dhule block of Dhule district; Mauda, Saoner block of Nagpur district; Baglan block of Nasik district; Manwat, Parbhani blocks of Parbhani district; Malshiras, Mohol block of Solapur district having high RSC values in pre-monsoon season and ground water is less suitable for irrigation in long run under the low drainage conditions.

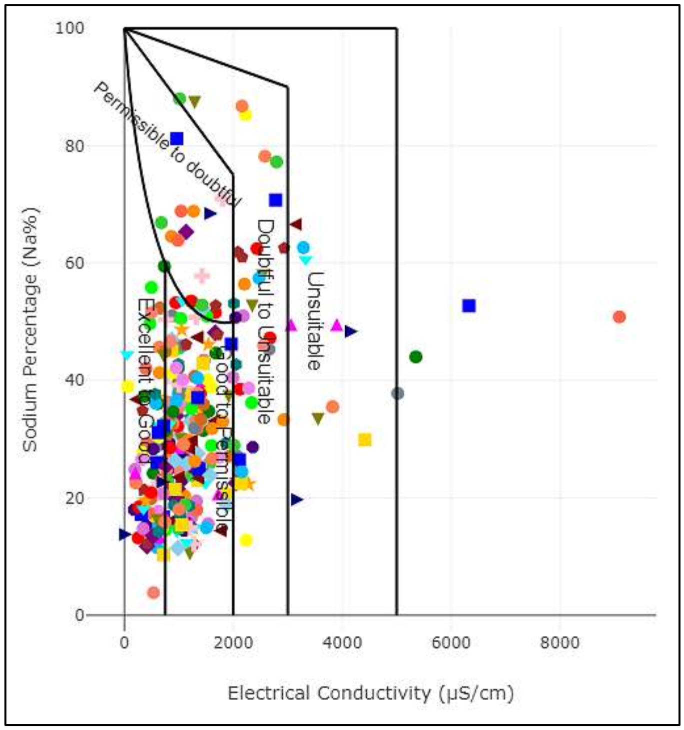


Figure 51: Wilcox diagram for Pre-monsoon 2024.

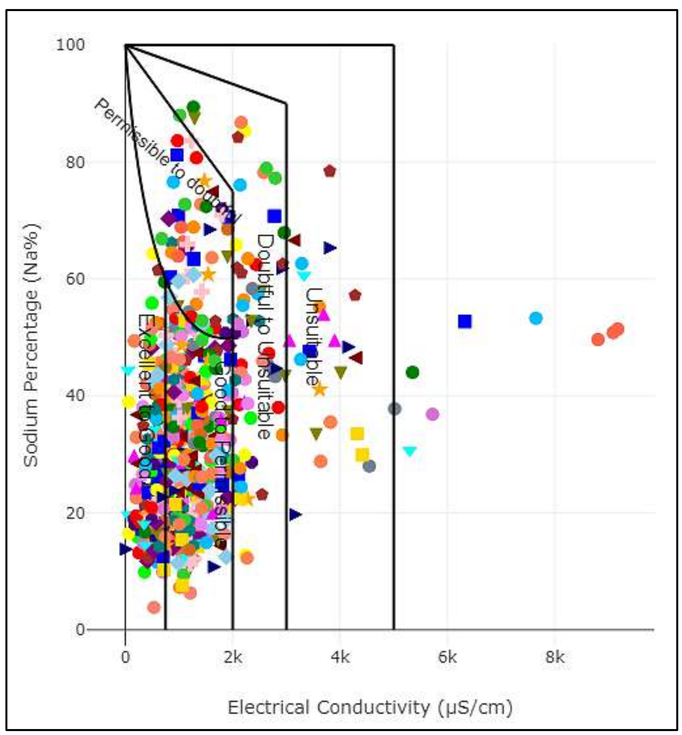


Figure 52: Wilcox diagram for Post-monsoon 2024

7 CONCLUSION AND RECOMMENDATIONS

- The outcome of the groundwater quality monitoring studies of CGWB has revealed that the natural as well as anthropogenic contamination of groundwater in some parts of the State has affected the groundwater quality. High electrical conductivity was recorded in 5.4% and 6.0% of the water samples collected in pre & post-monsoon respectively. The problem of inland salinity has affected the quality of groundwater in parts of the Purna alluvial basin of Amravati, Akola and Buldhana districts.

- Groundwater quality in Maharashtra is affected by high fluoride in few isolated locations but is potable in most parts of the State. Fluoride contamination is mainly due to geogenic sources. The fluoride content was recorded > 1.5 mg/L in 3.0 % and 1.5% of samples in the pre-monsoon and post-monsoon season respectively. In the post-monsoon season the fluoride content was reduced due to the recharge of the ground water.

- Nitrate is the main contaminant in the State with 53.7% and 66% of samples having high nitrate > 45 mg/L in the pre-monsoon and post-monsoon season respectively. The nitrate content was enhanced in post-monsoon mainly due to surface run-off and anthropogenic contamination like excess utilization of fertilizers/nitrogen fixation by leguminous plants, poor drainage system and leakage from the septic tanks.

- High total hardness (>600 mg/L) was recorded at 13.4% and 15.5% in the samples during the pre-monsoon and post-monsoon season respectively. High chloride contamination, more than the permissible limit of 1000 mg/L, was observed at five locations during both seasons.

- High uranium more than 30 µg/L was recorded only at two locations of Bhandara and Gondia districts in the pre-monsoon season due to the local geological source, whereas in post-monsoon season it was recorded only at one location in Gondia district.

- In 98% of shallow aquifer groundwater samples in Maharashtra have SAR values 0–10, and 2% samples SAR value 10 - 26 making them suitable for irrigation. Additionally, 90 % of shallow samples have RSC values below 1.25 meq/L, indicating that the groundwater quality in Maharashtra is suitable for irrigation.

- The trend analysis of groundwater samples for the conductivity chloride, fluoride, and nitrate content are slightly increasing with years, and no significant change in uranium concentration in groundwater is recorded in the State. Based on short-term stability, there is no significant change in groundwater quality parameters from 2017–2024, and further, long-term monitoring is required to observe the changes in groundwater quality. Groundwater chemistry across Maharashtra, despite the drastic changes in precipitation between seasons. The relatively stable ion concentrations might indicate that the aquifers have good buffering capacity or that anthropogenic impacts are consistent year-round.

- The groundwater quality must be monitored regularly to watch changes in chemical quality with time and season. Demarcation of the area having groundwater quality problems and specific strategies may be adopted to mitigate the contamination. Suitable water treatment systems may be installed to supply safe drinking water to the public.

- The artificial recharge of groundwater by rainwater harvesting, blending good quality water with contaminated water for water supply, and adopting treatment technologies are a few remedial measures for improving and protecting the groundwater quality. The proper treatment and disposal of the waste and wastewater from domestic and industrial sources can also prevent the groundwater from getting polluted. The above measures, along with creating awareness among the people, can help to solve the problems related to groundwater quality.
- The study emphasizes the need for a multi-sector approach to conserving groundwater resources, including conjunctive use, groundwater legislation, agency involvement, community participation, awareness campaigns, pump selection, high-tech irrigation systems, low water requirement crops, and tissue culture technology.

8 REMOVAL TECHNIQUES / METHODS

The remediation of groundwater contamination is majorly classified into two techniques: in situ and ex situ. The in-situ techniques are based on the alteration of the releasing mechanism of the contaminants. Most of the ex-situ methods applied to the groundwater extracted from the aquifers are based on the following processes:

• Precipitation processes: Coagulation/filtration, direct filtration, coagulation, assisted microfiltration, enhanced coagulation, lime/softening, and enhanced lime softening.

• Adsorptive processes: Adsorption onto activated alumina, activated carbon, and iron/manganese oxide-based or coated filter media.

• Ion exchange processes: Specifically, anion exchange.

• Membrane processes: Nano-filtration, reverse osmosis, and electro-dialysis.

Proposed remedial measures water supplied for drinking purposes goes through pre-treatment processes like reverse osmosis, ion exchange, electro-dialysis, adsorption, coagulation, and precipitation. Most of the contaminants are sporadic in nature. Blending of contaminated groundwater with good quality surface water or groundwater. Conjunctive use of water is to be adopted for the sustainable and continuous supply of the water. Alternative sources (shallow, as deep wells, or less contaminated aquifers) of groundwater and surface water sources may be identified. The column methods need periodical assessment and corrective action, like cleaning of the column and other parts of the filter plant, and chemical methods generate huge amounts of sludge; the disposal of it is a big environmental problem. A proper sludge disposal plan may be a workout to ensure further damage to the environment.

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The quality of irrigation water (IS-11624-1986, BIS).

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Annexure 1: Locations with EC>3000 µS/cm at 25°C

Sl. No.	State	District	Block/Taluka	Location	Well Depth	Latitude	Longitude	Stage of GW Extraction (Critical/Semi-Critical/Overexploited/ Safe/Saline)	EC (µS/cm at 25 °C)	
									Pre-M	Post-M
1	Maharashtra	Ahilyanagar	Nevasa	Nevasa Bk	30	19.5583	74.9211	Semi Critical	3329	5298
2	Maharashtra	Ahilyanagar	Nevasa	Khamgaon	20	19.3864	75.1703	Semi Critical	3822	3639
3	Maharashtra	Amravati	Daryapur	Samda Kasmpur	7.35	20.9269	77.2631	Salinity	4292	3062
4	Maharashtra	Beed	Shirur-Kasar	Manur	24.33	19.0667	75.3167	Safe	3287	7650
5	Maharashtra	Ch. Sambhaji Nagar	Vaijapur	Tunki	15.75	20.1333	74.8500	Safe	9090	9174
6	Maharashtra	Jalna	Jafrabad	Jafrabad	16.5	20.2000	76.0167	Safe	3555	2973
7	Maharashtra	Nagpur	Nagpur (Rural)	Ashti	30	21.2019	78.9683	Safe	11040	734
8	Maharashtra	Akola	Balapur	Wadegaon	18	20.5917	76.8667	Safe	5352	2963
9	Maharashtra	Buldana	Khamgaon	Khamgaon	20	20.7000	76.5750	Safe	3822	585
10	Maharashtra	Chandrapur	SINDEWAHI	Ladbori	11	20.3125	79.6308	Safe	3015	1495
11	Maharashtra	Gadchiroli	Chamorshi	Ashti	30	19.6833	79.7917	Safe	11040	903
12	Maharashtra	Wardha	Samudrapur	Kandhli (Juna)	10.2	20.7375	78.9256	Safe	3057	1785
13	Maharashtra	Nashik	Sinnar	Marhal Kh	11.5	19.7800	74.1822	Critical	6327	842
14	Maharashtra	Thane	Kalyan	Kolimb (KOLAM)	14	19.2833	73.2667	Safe	5018	561
15	Maharashtra	Raigad	Mhasala	Khamgaon	20	18.1117	73.2406	Safe	3822	170
16	Maharashtra	Satara	Khatav	Mayani	12.6	18.0458	74.1883	Semi Critical	3899	3694
17	Maharashtra	Sangli	Palus	Yelavi	14.5	17.0667	74.5167	Safe	4416	4320
18	Maharashtra	Solapur	Pandharpur	Bhandi-Shegaon	13.05	17.7167	75.2167	Semi Critical	3299	2950

Annexure 2: Locations with Nitrate > 45 mg/L

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	Nitrate >45 mg/L	
									Pre-M	Post-M
1	Maharashtra	Ahilyanagar	Nagar	Jeur1	18	19.2128	74.8031	Safe	131	178
2	Maharashtra	Ahilyanagar	Nagar	Jakhangaon	19	19.1056	74.6306	Safe	91	120
3	Maharashtra	Ahilyanagar	Akola	Runbodi	24.5	19.5303	73.9433	Semi Critical	53	56
4	Maharashtra	Ahilyanagar	Parner	Malkup	20	19.1256	74.5308	Safe	53	57
5	Maharashtra	Ahilyanagar	Nagar	Hivre Bazar	14	19.0772	74.6561	Safe	165	50
6	Maharashtra	Ahilyanagar	Nagar	Takle-Kazi	13.11	19.0333	74.8333	Safe	69	37
7	Maharashtra	Ahilyanagar	Nevasa	Nevasa Bk	30	19.5583	74.9211	Semi Critical	55	87
8	Maharashtra	Ahilyanagar	Shevgaon	Bodhgaon	13	19.3069	75.4233	Semi Critical	55	52
9	Maharashtra	Ahilyanagar	Shrigonda	Chikhale	11.35	18.8667	74.7167	Semi Critical	97	307
10	Maharashtra	Ahilyanagar	Sangamner	Chandanapuri	23	19.4833	74.2000	Critical	69	44
11	Maharashtra	Ahilyanagar	Nevasa	Khamgaon	20	19.3864	75.1703	Semi Critical	62	81
12	Maharashtra	Ahilyanagar	Nagar	Dahigaon	11	18.9625	74.8069	Safe	83	211
13	Maharashtra	Ahilyanagar	Sangamner	Bote	9	19.2778	74.2278	Critical	73	120
14	Maharashtra	Ahilyanagar	Jamkhed	Jogeshwarwadi	15	18.7522	75.3589	Safe	53	72
15	Maharashtra	Ahilyanagar	Shrirampur	Khokar	20	19.6158	74.7433	Critical	53	24
16	Maharashtra	Ahilyanagar	kopargaon	manjur	13.7	19.9250	74.3075	Critical	69	73
17	Maharashtra	Ahilyanagar	Shevgaon	Ghotan	10.8	19.4000	75.3000	Semi Critical	54	264
18	Maharashtra	Ahilyanagar	Rahuri	Malharwadi	14	19.3833	74.5819	Critical	56	162
19	Maharashtra	Ahilyanagar	Kopargaon	Murshedpur	9.5	19.8969	74.4442	Critical	73	160
20	Maharashtra	Amravati	Morshi	Ashtagaon	8	21.3083	77.9250	Semi Critical	75	113
21	Maharashtra	Amravati	Chandur Bazar	Chandur Bazar	28	21.2333	77.7333	Over Exploited	48	49
22	Maharashtra	Amravati	Chandur Railway	Chandur Railway	10.1	20.8167	77.9667	Safe	52	32
23	Maharashtra	Amravati	Morshi	Chicholi	10.92	21.3600	77.9444	Semi Critical	147	270

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	Nitrate >45 mg/L	
									Pre-M	Post-M
24	Maharashtra	Amravati	Chandur Bazar	Dilalpur	30.2	21.2722	77.7364	Over Exploited	132	39
25	Maharashtra	Amravati	Morshi	Hiwarkheda	15.35	21.3931	78.0839	Semi Critical	54	142
26	Maharashtra	Amravati	Warud	Loni	22.8	21.3764	78.1903	Over Exploited	150	188
27	Maharashtra	Amravati	Anjangaon Surji	Nimbhari	12.03	21.0500	77.3125	Safe	150	103
28	Maharashtra	Amravati	Daryapur	Samda Kasmpur	7.35	20.9269	77.2631	Salinity	138	178
29	Maharashtra	Amravati	Teosa	Teosa	11.5	21.0861	78.0681	Safe	107	40
30	Maharashtra	Amravati	Amravati	Walgaon	9.5	21.0167	77.7000	Safe	86	87
31	Maharashtra	Beed	Majalgaon	Dindrur-1	20	18.9892	76.2664	Safe	53	159
32	Maharashtra	Beed	Georai	Georai-1	15	19.2747	75.7386	Safe	466	80
33	Maharashtra	Beed	Ashti	Khadkhat	16	18.6667	75.1500	Safe	53	152
34	Maharashtra	Beed	Shirur-Kasar	Manur	24.33	19.0667	75.3167	Safe	55	364
35	Maharashtra	Beed	Ashti	Sheri Bk	15	18.8794	75.0906	Safe	54	328
36	Maharashtra	Beed	Georai	Shirsadevi	19.6	19.2028	75.8628	Safe	49	62
37	Maharashtra	Beed	Shirur-Kasar	Tintarvani-1	8	19.1750	75.5078	Safe	53	265
38	Maharashtra	Beed	Kaij	Uttareshwar Pimpri	30	18.6811	75.9486	Safe	47	109
39	Maharashtra	Beed	Kaij	Waguli	23	18.7947	76.1953	Safe	53	175
40	Maharashtra	Ch. Sambhaji Nagar	Sillod	Bharadi	20	20.3558	75.5619	Safe	56	162
41	Maharashtra	Ch. Sambhaji Nagar	Sillod	Golegaon Budruk	10.15	20.4564	75.7100	Safe	56	148
42	Maharashtra	Ch. Sambhaji Nagar	Vaijapur	Tunki	15.75	20.1333	74.8500	Safe	102	297
43	Maharashtra	Ch. Sambhaji Nagar	Khuldabad	Walur Tanda	15.9	20.0833	75.1500	Safe	54	90
44	Maharashtra	Hingoli	Purna	Chudawa-1	16	19.1697	77.1392	Safe	47	52

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	Nitrate >45 mg/L	
									Pre-M	Post-M
45	Maharashtra	Hingoli	Kalmnuri	Dongarkada	12	19.3775	77.3747	Safe	51	55
46	Maharashtra	Hingoli	Sengaon	Sengaon	15	19.8006	76.8847	Safe	75	62
47	Maharashtra	Jalgaon	Chalisgaon	Adgaon	10.5	20.5069	74.9028	Semi Critical	54	176
48	Maharashtra	Jalgaon	Raver	Khanapur-1	25	21.2750	76.1161	Over Exploited	57	114
49	Maharashtra	Jalgaon	Yawal	Kingaon	50	21.2058	75.5819	Over Exploited	165	220
50	Maharashtra	Jalgaon	Edlabad	Mendhoda	17	21.1056	76.0333	Semi Critical	54	327
51	Maharashtra	Jalgaon	Jamner	Neri	10.5	20.8539	75.6639	Semi Critical	53	132
52	Maharashtra	Jalgaon	Amalner	Nimjhari	18	21.0611	75.2136	Semi Critical	56	287
53	Maharashtra	Jalgaon	Raver	Raver1	34.25	21.2472	76.0344	Over Exploited	83	130
54	Maharashtra	Jalna	Jafrabad	Jafrabad	16.5	20.2000	76.0167	Safe	58	368
55	Maharashtra	Jalna	Jalna	Navha	17	19.9167	76.0389	Safe	54	192
56	Maharashtra	Jalna	Bhokardan	Pimpalgaon Renukai	18	20.5511	75.8911	Safe	56	202
57	Maharashtra	Jalna	Mantha	Talni	9	19.8833	76.4444	Safe	47	235
58	Maharashtra	Jalna	Bhokardan	Wakdi	12	20.3667	75.7917	Safe	57	320
59	Maharashtra	Nagpur	Saoner	Kelwad	17	21.4597	78.8764	Safe	50	11
60	Maharashtra	Nagpur	Saoner	Kothulna	13.3	21.4194	79.0383	Safe	55	122
61	Maharashtra	Nagpur	Ramtek	Manegaon Tek	11.08	21.6806	79.4222	Safe	53	54
62	Maharashtra	Nagpur	Mauda	Tarsha	13.45	21.2258	79.3811	Safe	74	12
63	Maharashtra	Nanded	Mahur	Anjankhed	7.2	19.8389	78.0778	Safe	56	148
64	Maharashtra	Nanded	Nanded	Dhanegaon	14.5	19.1300	77.3297	Safe	53	80
65	Maharashtra	Nanded	Naigaon	Kolambi	10.6	18.8900	77.4178	Safe	52	54
66	Maharashtra	Nanded	Biloli	Kuncheli	12	18.7694	77.5631	Safe	54	60
67	Maharashtra	Nanded	Hadgaon	Mathala	12	19.5881	77.5469	Safe	54	81
68	Maharashtra	Nanded	Bhokar	Narwat	15.31	19.2333	77.6333	Safe	55	114
69	Maharashtra	Nandurbar	Nandurbar	Sundarde-1	16	21.3886	74.1881	Safe	51	148

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	Nitrate >45 mg/L	
									Pre-M	Post-M
70	Maharashtra	Nanded	Nanded	Taroda (Bk)	24.6	19.2094	77.2906	Safe	47	71
71	Maharashtra	Parbhani	Selu	Devgaon	16	19.6142	76.4625	Safe	52	86
72	Maharashtra	Parbhani	Aundha	Gojegaon	9.6	19.5394	76.9444	Safe	57	64
73	Maharashtra	Parbhani	Parbhani	Jhari-1	24	19.4264	76.7658	Safe	52	78
74	Maharashtra	Parbhani	Manwat	Kola	29.6	19.3439	76.5617	Safe	49	50
75	Maharashtra	Parbhani	Manwat	Tarborgaon	17.5	19.3239	76.6083	Safe	52	66
76	Maharashtra	Parbhani	Jintur	Bori	10.94	19.4856	76.7225	Safe	54	92
77	Maharashtra	Washim	Washim	Bitoda (Bhoyar)	12.5	20.1833	77.2667	Safe	50	148
78	Maharashtra	Washim	Mangrulpir	Sakhar Doha	14	20.2667	77.4000	Safe	51	179
79	Maharashtra	Washim	Manora	Sendurjan Adhao	11.8	20.1458	77.4500	Safe	50	172
80	Maharashtra	Washim	Mangrulpir	Wada	16	20.3667	77.3333	Safe	48	96
81	Maharashtra	Washim	Manora	Giroli	10.2	20.2086	77.4756	Safe	51	43
82	Maharashtra	Akola	Patur	Sasti	14.65	20.5081	76.8331	Safe	48	58
83	Maharashtra	Akola	Balapur	Mazod	14	20.5900	76.9219	Safe	50	57
84	Maharashtra	Akola	Balapur	Wadegaon	18	20.5917	76.8667	Safe	53	64
85	Maharashtra	Akola	Balapur	Ural	14	20.8069	76.8250	Safe	48	56
86	Maharashtra	Akola	Barshitakli	Hatola	8	20.5064	77.2044	Semi Critical	49	52
87	Maharashtra	Akola	Patur	Ambashi	13	20.4567	76.8592	Safe	50	53
88	Maharashtra	Buldana	Mehkar	Mehkar	16	20.1500	76.5667	Safe	57	58
89	Maharashtra	Buldana	Mehkar	Loni	22.8	20.2936	76.4053	Safe	150	57
90	Maharashtra	Buldana	Khamgaon	Khamgaon	20	20.7000	76.5750	Safe	62	51
91	Maharashtra	Buldana	Motala	Dhamangaon	10	20.6667	76.0333	Safe	56	57
92	Maharashtra	Buldana	Nandura	Tarvadi	11.4	20.7333	76.3500	Semi Critical	56	54
93	Maharashtra	Buldana	Malkapur	Datala-1	17	20.8164	76.2028	Safe	284	54
94	Maharashtra	Buldana	Motala	Ubalkhed	15.4	20.5994	76.0967	Safe	153	57

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	Nitrate >45 mg/L	
									Pre-M	Post-M
95	Maharashtra	Bhandara	Tumsar	Khair Langi	9.4	21.4092	79.7844	Safe	54	5
96	Maharashtra	Bhandara	Bhandara	Dhargaon-1	12.8	21.0997	79.7350	Safe	47	50
97	Maharashtra	Gondia	Tirora	Navegaon II (KHURD)	9	21.3464	79.8217	Safe	51	74
98	Maharashtra	Gondia	Gondia	Khamari	20	21.4189	80.2369	Safe	48	74
99	Maharashtra	Gondia	Arjuni Morgaon	Dhabetekdi	24	20.7900	79.9647	Safe	52	74
100	Maharashtra	Chandrapur	Gondpipri	Dabha	9	19.6250	79.6208	Safe	55	1
101	Maharashtra	Chandrapur	Pomburna	Bhimni	8.6	19.8167	79.7167	Safe	45	56
102	Maharashtra	Chandrapur	Bhadrawati	Shegaon Khurd	10.4	20.2936	79.1803	Safe	51	53
103	Maharashtra	Chandrapur	Chimur	Wahangaon	9.5	20.4836	79.2336	Safe	54	8
104	Maharashtra	Chandrapur	Nagbhir	Mohadi Mokasa	12	20.6458	79.6500	Safe	53	67
105	Maharashtra	Chandrapur	Gondpipri	Navegaon-1	10	19.7119	79.7353	Safe	46	5
106	Maharashtra	Chandrapur	Sindewahi	Tambegadi Mendha	10.9	20.2111	79.7908	Safe	56	67
107	Maharashtra	Chandrapur	Warora	Ralegaon-1	14.6	20.4094	79.1964	Safe	55	67
108	Maharashtra	Chandrapur	Sindewahi	Ladbori	11	20.3125	79.6308	Safe	79	67
109	Maharashtra	Chandrapur	Sindewahi	Maregaon	14	20.2703	79.7347	Safe	52	47
110	Maharashtra	Gadchiroli	Chamorshi	Chaudampalli	10.15	19.6000	79.8500	Safe	56	8
111	Maharashtra	Gadchiroli	Mulchera	Bori	10.94	19.5000	79.9500	Safe	54	67
112	Maharashtra	Gadchiroli	Dhanora	Chatgaon	13.25	20.2083	80.1750	Safe	54	67
113	Maharashtra	Gadchiroli	Itapalli	Itapalli	14.35	19.6000	80.2333	Safe	46	53
114	Maharashtra	Gadchiroli	Aheri	Nandigaon	9.2	19.3000	80.0333	Safe	52	10
115	Maharashtra	Gadchiroli	Gadchiroli	Govindpur	15.09	20.0653	80.0014	Safe	55	67
116	Maharashtra	Gadchiroli	Dhanora	Rangi	11.17	20.3472	80.1819	Safe	51	23

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	Nitrate >45 mg/L	
									Pre-M	Post-M
117	Maharashtra	Gadchiroli	Kurkheda	Vihirgaon Kukdi	16.8	20.6522	80.1681	Safe	53	67
118	Maharashtra	Gadchiroli	Gadchiroli	Maregaon-1	13.9	20.3058	80.1317	Safe	52	59
119	Maharashtra	Wardha	Samudrapur	Kandhli (Juna)	10.2	20.7375	78.9256	Safe	57	57
120	Maharashtra	Wardha	Wardha	Dahigaon	11	20.7544	78.4853	Safe	83	54
121	Maharashtra	Wardha	Hinganghat	Alipur	12.4	20.5489	78.6942	Safe	55	52
122	Maharashtra	Wardha	Deoli	Giroli	10.2	20.5489	78.5850	Safe	51	54
123	Maharashtra	Wardha	Ashti	Dhadi	14	21.2667	78.2333	Safe	52	57
124	Maharashtra	Wardha	Arvi	Wadhona-1	15	20.9964	78.3453	Safe	56	55
125	Maharashtra	Wardha	Arvi	Rasulabad	22.05	20.7710	78.3636	Safe	54	56
126	Maharashtra	Wardha	Deoli	Adgaon	10.5	20.5832	78.5280	Safe	54	57
127	Maharashtra	Wardha	Deoli	Vijaygopal	12.1	20.5742	78.3331	Safe	53	27
128	Maharashtra	Wardha	Seloo	Jhadshi	9.7	20.8623	78.6391	Safe	58	56
129	Maharashtra	Wardha	Seloo	Helodi	7.8	20.8053	78.8450	Safe	55	55
130	Maharashtra	Yavatmal	Darwha	Selodi	9.8	20.3167	77.7667	Safe	56	8
131	Maharashtra	Yavatmal	Maregaon	Maregaon	14	20.1000	78.8167	Safe	52	53
132	Maharashtra	Yavatmal	Yavatmal	Kolambi	10.6	20.2417	78.1833	Safe	52	64
133	Maharashtra	Yavatmal	Digras	Vai (Lingi)	9	20.1917	77.7717	Safe	58	71
134	Maharashtra	Yavatmal	Kelapur	Karanji1	11.5	20.1333	78.6025	Safe	54	37
135	Maharashtra	Yavatmal	Manora	Singad	13.7	20.2322	78.4028	Safe	45	61
136	Maharashtra	Yavatmal	Ghatanji	Mowada	12.7	20.0525	77.6356	Safe	52	50
137	Maharashtra	Yavatmal	Kelapur	Khatara	8.4	19.7819	77.7800	Safe	54	52
138	Maharashtra	Yavatmal	Wani	Wani-1	13.1	20.1636	78.6464	Safe	52	53
139	Maharashtra	Yavatmal	Darwha	Sangwi Rly	15.6	20.1261	78.8936	Safe	51	55
140	Maharashtra	Yavatmal	Yavatmal	Talni	9	20.4192	77.6053	Safe	47	57
141	Maharashtra	Pune	Junnar	Otur	26.5	19.2708	73.9667	Semi Critical	47	49

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	Nitrate >45 mg/L	
									Pre-M	Post-M
142	Maharashtra	Nashik	Sinnar	Sinnar	13.8	19.8333	74.0000	Critical	91	77
143	Maharashtra	Nashik	Chandvad	Savargaon	11	20.3575	74.4611	Semi Critical	67	274
144	Maharashtra	Nashik	Sinnar	Malwadi-1	15	19.7733	74.0847	Critical	129	167
145	Maharashtra	Nashik	Sinnar	Marhal Kh	11.5	19.7800	74.1822	Critical	259	5
146	Maharashtra	Nashik	Sinnar	Wadgaon Pingla	15.5	19.8728	73.8811	Critical	95	81
147	Maharashtra	Nashik	Nasik	Matori	18.6	20.0539	73.7425	Safe	73	69
148	Maharashtra	Nashik	Chandvad	Dhotarkheda	14.5	20.2258	74.0581	Semi Critical	62	85
149	Maharashtra	Nashik	Baglan	Satana	22.5	20.6000	74.2042	Semi Critical	106	21
150	Maharashtra	Nashik	Nandgaon	Nandgaon	10	20.3083	74.6583	Safe	48	56
151	Maharashtra	Nashik	Deola	Deola-1	17.2	20.4639	74.1839	Semi Critical	135	2
152	Maharashtra	Nashik	Baglan	Virgaon	35	20.6936	74.1453	Semi Critical	189	66
153	Maharashtra	Nashik	Deola	Umrane-1	17.45	20.4219	74.3500	Semi Critical	132	140
154	Maharashtra	Nashik	Kalwan	Kalwan	24.6	20.4925	74.0383	Safe	162	171
155	Maharashtra	Nashik	Baglan	Pimpalkothe	20.7	20.8269	74.1411	Semi Critical	89	168
156	Maharashtra	Nashik	NIPHAD	Vanasgaon	15	20.1536	74.1461	Critical	53	0
157	Maharashtra	Dhule	Dhule	Mukti	11.4	20.8833	74.9500	Safe	52	159
158	Maharashtra	Dhule	Sindkheda	Chimthane	11	21.1833	74.6833	Safe	48	338
159	Maharashtra	Dhule	Sindkheda	Methi	14.5	21.2458	74.6375	Safe	52	309
160	Maharashtra	Dhule	Sakri	Sakri2	12.5	20.8208	74.7458	Safe	52	51
161	Maharashtra	Dhule	Dhule	Ner-1	12	20.9361	74.5147	Safe	52	99
162	Maharashtra	Dhule	Dhule	Phagne	8	20.8900	74.8381	Safe	51	101
163	Maharashtra	Raigad	Mhasala	Khamgaon	20	18.1117	73.2406	Safe	62	9
164	Maharashtra	Satara	Khatav	Vikhle	12.05	17.5089	74.2278	Semi Critical	56	87
165	Maharashtra	Satara	Khatav	Mayani	12.6	18.0458	74.1883	Semi Critical	205	97
166	Maharashtra	Sangli	Jath	Jath	12.2	17.0500	75.2167	Safe	65	101

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	Nitrate >45 mg/L	
									Pre-M	Post-M
167	Maharashtra	Sangli	Palus	Yelavi	14.5	17.0667	74.5167	Safe	123	134
168	Maharashtra	Sangli	Miraj	Karnal-1	13.5	16.9169	74.5669	Safe	68	117
169	Maharashtra	Latur	Latur	Murud-Akola	19	18.7611	76.7722	Safe	56	48
170	Maharashtra	Latur	Ahmadpur	Kingaon	50	18.4083	76.3139	Safe	165	55
171	Maharashtra	Latur	Shirur Anantpal	Rapka	12.85	17.9417	76.8497	Safe	97	41
172	Maharashtra	Latur	Ausa	Ujed-1	19.4	18.3536	76.8050	Safe	48	49
173	Maharashtra	Solapur	Mangalvedhe	Eklaspur	14	17.5333	75.3833	Semi Critical	50	56
174	Maharashtra	Solapur	Solapur South	Chincholi	14	17.6000	76.0500	Safe	47	52
175	Maharashtra	Solapur	Pandharpur	Bhandi-Shegaon	13.05	17.7167	75.2167	Semi Critical	49	56
176	Maharashtra	Solapur	Barshi	Nari	13	18.1958	75.8875	Semi Critical	50	55
177	Maharashtra	Solapur	Karmala	Varkute	11.5	18.2500	75.3333	Semi Critical	50	59
178	Maharashtra	Solapur	Madha	Bhosre	15.3	18.0806	75.4336	Semi Critical	50	60
179	Maharashtra	Dharashiv	Umarga	Turori	13.4	17.8333	76.6833	Safe	53	57
180	Maharashtra	Dharashiv	Osmanabad	Khanapur-1	25	18.0453	76.2747	Safe	57	44

Annexure 3: Locations with Fluoride >1.5 mg/L.

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	Fluoride >1.5 mg/L	
									Pre-M	Post-M
1	Maharashtra	Chandrapur	Chimur	Kawadsi	16.32	20.5833	79.4917	Safe	1.63	0.8
2	Maharashtra	Chandrapur	Chandrapur	Chichpalli	12.75	20.0028	79.4861	Safe	1.68	0.45
3	Maharashtra	Chandrapur	Pomburna	Bhimni	8.6	19.8167	79.7167	Safe	1.6	0.78
4	Maharashtra	Chandrapur	Saoli	Sawali	12.08	20.0833	79.7833	Safe	2.58	1.45
5	Maharashtra	Chandrapur	Chimur	Wahangaon	9.5	20.4836	79.2336	Safe	1.63	0.63
6	Maharashtra	Chandrapur	Saoli	Sakhri	8.43	19.9986	79.8892	Safe	2.44	0.86
7	Maharashtra	Chandrapur	Gondpipri	Navegaon-1	10	19.7119	79.7353	Safe	1.6	0.25
8	Maharashtra	Chandrapur	Warora	Ralegaon-1	14.6	20.4094	79.1964	Safe	2	1.05
9	Maharashtra	Chandrapur	Sindewahi	Ladbori	11	20.3125	79.6308	Safe	4.65	2.36
10	Maharashtra	Gadchiroli	Chamorshi	Chaudampalli	10.15	19.6000	79.8500	Safe	1.59	0.35

Annexure 4: Locations With TH>600 mg/L as $CaCO_3$.

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	TH >600 mg/L	
									Pre-M	Post-M
1	Maharashtra	Ahilyanagar	Nagar	Jeur1	18	19.2128	74.8031	Safe	670	625
2	Maharashtra	Ahilyanagar	Nevasa	Nevasa Bk	30	19.5583	74.9211	Semi Critical	655	1845
3	Maharashtra	Ahilyanagar	Nevasa	Khamgaon	20	19.3864	75.1703	Semi Critical	1315	1290
4	Maharashtra	Ahilyanagar	Shrirampur	Khokar	20	19.6158	74.7433	Critical	780	380
5	Maharashtra	Ahilyanagar	Rahuri	Malharwadi	14	19.3833	74.5819	Critical	715	800
6	Maharashtra	Amravati	Warud	Loni	22.8	21.3764	78.1903	Over Exploited	715	400
7	Maharashtra	Amravati	Daryapur	Samda Kasmpur	7.35	20.9269	77.2631	Salinity	980	610
8	Maharashtra	Beed	Georai	Georai-1	15	19.2747	75.7386	Safe	705	540
9	Maharashtra	Beed	Ashti	Sheri Bk	15	18.8794	75.0906	Safe	615	870
10	Maharashtra	Ch.Sambhaji Nagar	Vaijapur	Tunki	15.75	20.1333	74.8500	Safe	2260	2240
11	Maharashtra	Jalgaon	Pachora	Lasgaon	18	20.7897	75.4556	Semi Critical	650	600
12	Maharashtra	Jalgaon	Amalner	Nimjhari	18	21.0611	75.2136	Semi Critical	950	780
13	Maharashtra	Jalna	Jafrabad	Jafrabad	16.5	20.2000	76.0167	Safe	1160	900
14	Maharashtra	Jalna	Bhokardan	Wakdi	12	20.3667	75.7917	Safe	660	590
15	Maharashtra	Nagpur	Nagpur (Rural)	Ashti	30	21.2019	78.9683	Safe	1510	300
16	Maharashtra	Nagpur	Mauda	Tarsha	13.45	21.2258	79.3811	Safe	735	120
17	Maharashtra	Nanded	Nanded	Dhanegaon	14.5	19.1300	77.3297	Safe	625	360
18	Maharashtra	Nandurbar	Nandurbar	Sundarde-1	16	21.3886	74.1881	Safe	705	680
19	Maharashtra	Akola	Balapur	Wadegaon	18	20.5917	76.8667	Safe	1285	640
20	Maharashtra	Buldana	Mehkar	Mehkar	16	20.1500	76.5667	Safe	680	250
21	Maharashtra	Buldana	Mehkar	Loni	22.8	20.2936	76.4053	Safe	715	125
22	Maharashtra	Buldana	Khamgaon	Khamgaon	20	20.7000	76.5750	Safe	1315	145
23	Maharashtra	Buldana	Malkapur	Datala-1	17	20.8164	76.2028	Safe	740	325

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	TH >600 mg/L	
									Pre-M	Post-M
24	Maharashtra	Gondia	Arjuni Morgaon	Dhabetekdi	24	20.7900	79.9647	Safe	625	445
25	Maharashtra	Chandrapur	Bramhapuri	Mendki	15.3	20.4667	79.8333	Safe	795	830
26	Maharashtra	Chandrapur	Bhadrawati	Chora	16.05	20.1992	79.2344	Safe	845	240
27	Maharashtra	Chandrapur	Sindewahi	Tambegadi Mendha	10.9	20.2111	79.7908	Safe	700	620
28	Maharashtra	Gadchiroli	Chamorshi	Ashti	30	19.6833	79.7917	Safe	1510	390
29	Maharashtra	Gadchiroli	Gadchiroli	Govindpur	15.09	20.0653	80.0014	Safe	615	480
30	Maharashtra	Wardha	Samudrapur	Kandhli (Juna)	10.2	20.7375	78.9256	Safe	760	540
31	Maharashtra	Wardha	Seloo	Jhadshi	9.7	20.8623	78.6391	Safe	605	580
32	Maharashtra	Pune	Daund	Patas	5.36	18.4333	74.4333	Semi Critical	625	240
33	Maharashtra	Nashik	Sinnar	Malwadi-1	15	19.7733	74.0847	Critical	745	678
34	Maharashtra	Nashik	Sinnar	Marhal Kh	11.5	19.7800	74.1822	Critical	1550	190
35	Maharashtra	Dhule	Sindkheda	Methi	14.5	21.2458	74.6375	Safe	655	312
36	Maharashtra	Dhule	Dhule	Ner-1	12	20.9361	74.5147	Safe	755	298
37	Maharashtra	Dhule	Dhule	Phagne	8	20.8900	74.8381	Safe	770	212
38	Maharashtra	Thane	Kalyan	Kolimb (KOLAM)	14	19.2833	73.2667	Safe	1500	188
39	Maharashtra	Raigad	Mhasala	Khamgaon	20	18.1117	73.2406	Safe	1315	55
40	Maharashtra	Satara	Khatav	Mayani	12.6	18.0458	74.1883	Semi Critical	900	595
41	Maharashtra	Sangli	Palus	Yelavi	14.5	17.0667	74.5167	Safe	1580	1370
42	Maharashtra	Kolhapur	Shirol	Shirol	11.3	16.7381	74.6042	Safe	865	455
43	Maharashtra	Solapur	Pandharpur	Bhandi-Shegaon	13.05	17.7167	75.2167	Semi Critical	1546	810
44	Maharashtra	Solapur	Karmala	Varkute	11.5	18.2500	75.3333	Semi Critical	690	605
45	Maharashtra	Solapur	Madha	Bhosre	15.3	18.0806	75.4336	Semi Critical	945	860

Annexure 5: Locations With Chloride > 1000 mg/L.

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	Cl > 1000 mg/L	
									Pre-M	Post-M
1	Maharashtra	Ch. Sambhaji Nagar	Vaijapur	Tunki	15.75	20.1333	74.8500	Safe	2233	703
2	Maharashtra	Nagpur	Nagpur (Rural)	Ashti	30	21.2019	78.9683	Safe	1959	57
3	Maharashtra	Akola	Balapur	Wadegaon	18	20.5917	76.8667	Safe	1136	770
4	Maharashtra	Gadchiroli	Chamorshi	Ashti	30	19.6833	79.7917	Safe	1959	99
5	Maharashtra	Nashik	Sinnar	Marhal Kh	11.5	19.7800	74.1822	Critical	1739	97
6	Maharashtra	Thane	Kalyan	Kolimb (KOLAM)	14	19.2833	73.2667	Safe	1331	98
7	Maharashtra	Sangli	Palus	Yelavi	14.5	17.0667	74.5167	Safe	1055	730

Annexure 6: Locations with Uranium >30 µg/L or ppb.

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	TH >600 mg/L	
									Pre-M	Post-M
1	Maharashtra	Bhandara	Tumsar	Khair Langi	9.4	21.40917	79.78444	Safe	74.7	6.0
2	Maharashtra	Gondia	Arjuni Morgaon	Dhabetekdi	24	20.79	79.96472	Safe	46.2	72.0

Annexure 7: Locations with Arsenic >10 µg/L or ppb.

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	Arsenic >10 µg/L	
									Pre-M	Post-M
1	0	0	0	0	0	0	0	0	0	0

Annexure 8: Locations with Lead >10 µg/L or ppb.

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	Lead >10 µg/L	
									Pre-M	Post-M
1	0	0	0	0	0	0	0	0	0	0

Annexure 9: Locations with Iron >1.000 mg/L or ppm.

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	Iron >1.0 mg/L	
									Pre-M	Post-M
1	0	0	0	0	0	0	0	0	0	0

Annexure 10: Locations with Manganese >0.3 mg/L or ppm.

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	Mn >0.3 mg/L	
									Pre-M	Post-M
1	0	0	0	0	0	0	0	0	0	0

Annexure 11: Locations With Zinc >15 mg/L or ppm.

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	Zn > 15 mg/L	
									Pre-M	Post-M
1	0	0	0	0	0	0	0	0	0	0

Annexure 12: Locations with Copper >1.5 mg/L or ppm.

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	Cu >1.5 mg/L	
									Pre-M	Post-M
1	0	0	0	0	0	0	0	0	0	0

Annexure 13: Locations with SAR >26.

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	SAR>26	
									Pre-M	Post-M
1	0	0	0	0	0	0	0	0	0	0

Annexure 14: Locations with RSC >2.5 meq/L.

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	TH >600 mg/L	
									Pre-M	Post-M
1	Maharashtra	Ahilyanagar	Sangamner	Sangamner	15	19.5667	74.2208	Critical	2.5	0.0
2	Maharashtra	Ahilyanagar	Nevasa	Shani Shingnapur	15	19.3819	74.8642	Semi Critical	5.9	4.7
3	Maharashtra	Amravati	Chandur Bazar	Chandur Bazar	28	21.2333	77.7333	Over Exploited	2.9	2.6
4	Maharashtra	Amravati	Anjangaon Surji	Nimbhari	12.03	21.0500	77.3125	Safe	11.2	4.4
5	Maharashtra	Amravati	Amravati	Walgaon	9.5	21.0167	77.7000	Safe	9.0	6.8
6	Maharashtra	Beed	Majalgaon	Dindrur-1	20	18.9892	76.2664	Safe	2.8	0.4
7	Maharashtra	Beed	Georai	Shirsadevi	19.6	19.2028	75.8628	Safe	5.5	4.1
8	Maharashtra	Nagpur	Saoner	Kothulna	13.3	21.4194	79.0383	Safe	2.8	-3.4

Sl. No.	State	District	Block/ Taluka	Location	Well Depth	Latitude	Longitude	Stage of Extraction (Critical/Semi-Critical/Overexploited/Safe/Saline)	TH >600 mg/L	
									Pre-M	Post-M
9	Maharashtra	Nagpur	Mauda	Mouda-1	12.85	21.1472	79.4003	Safe	3.0	-1.8
10	Maharashtra	Parbhani	Parbhani	Karegaon	18.35	19.2661	76.8225	Safe	5.8	2.6
11	Maharashtra	Parbhani	Manwat	Tarborgaon	17.5	19.3239	76.6083	Safe	3.5	-0.4
12	Maharashtra	Chandrapur	Chimur	Kawadsi	16.32	20.5833	79.4917	Safe	2.6	-0.1
13	Maharashtra	Chandrapur	Chandrapur	Chichpalli	12.75	20.0028	79.4861	Safe	2.9	0.4
14	Maharashtra	Chandrapur	Saoli	Sawali	12.08	20.0833	79.7833	Safe	3.2	1.2
15	Maharashtra	Chandrapur	Saoli	Sakhri	8.43	19.9986	79.8892	Safe	3.0	-0.7
16	Maharashtra	Chandrapur	Warora	Ralegaon-1	14.6	20.4094	79.1964	Safe	6.5	1.3
17	Maharashtra	Chandrapur	Sindewahi	Ladbori	11	20.3125	79.6308	Safe	4.6	3.0
18	Maharashtra	Wardha	Hinganghat	Alipur	12.4	20.5489	78.6942	Safe	7.1	-1.2
19	Maharashtra	Yavatmal	Wani	Bhandewada	8	19.8528	79.0511	Safe	3.2	-4.4
20	Maharashtra	Nashik	Baglan	Satana	22.5	20.6000	74.2042	Semi Critical	5.4	-0.5
21	Maharashtra	Dhule	Dhule	Dhule	9.67	20.9042	74.7667	Safe	2.7	7.3
22	Maharashtra	Dhule	Dhule	Kusumba	12	20.9075	74.5983	Safe	3.9	6.3
23	Maharashtra	Solapur	Mohol	Hivre	17	17.8417	75.5375	Semi Critical	5.0	-4.0
24	Maharashtra	Solapur	Malshiras	Dharmpuri	9	17.9333	74.6833	Overexploited	3.7	-4.8

Annexure 15: Locations Where all analysed parameters found within permissible limit (Pre-M 2024)

S. No.	District	Block/ Taluka	Village	Well Depth	Longitude (DD)	Latitude (DD)	pH	EC (µS/cm)	TDS (mg/L)	Cl (mg/L)	NO_3 (mg/L)	F (mg/L)	TH (mg/L)
1	Ahmednagar	Newasa	Rastapur	10.5	74.5644	19.7881	8.11	996	637	121	36	0.44	300
2	Ahmednagar	Karjat	Baradgaon Sudrik	12.5	74.8233	18.4583	7.81	2778	1778	639	44	0.67	450
3	Ahmednagar	Shrigonda	Banpimpri	11.15	74.8667	18.8333	8.17	496	317	43	23	0.56	110
4	Ahmednagar	Nevasa	Gondegaon	16.5	74.6425	19.7289	8.21	870	557	92	20	0.69	220
5	Ahmednagar	Nevasa	Kokona-1	16	75.0875	19.4181	7.68	1566	1002	252	38	0.48	525
6	Amravati	Warud	Dhanodi	14.25	78.2997	21.4825	7.89	474	303	10	6	0.27	195
7	Amravati	Chandur Bazar	Kharapi	33	77.5706	21.3378	7.40	752	481	20	37	0.26	330
8	Amravati	Nandgaon Khandeshwar	Mahuli	9	77.7667	20.7333	7.52	980	627	42	41	0.44	335
9	Amravati	Morshi	Moorshi new	10	78.0022	21.3189	7.53	622	398	35	8	0.61	275
10	Amravati	Morshi	Pala	12.5	78.0111	21.3861	7.35	1448	927	120	18	0.72	495
11	Amravati	Dhamangaon Railway	Shendurjana Khurd	10.6	78.1000	20.6833	7.86	923	590	60	29	0.58	300
12	Amravati	Chandur Bazar	Sirasgaon (Kasba)	27	77.6825	21.3278	7.78	593	380	17	30	0.20	270
13	Amravati	Chandur Bazar	Wishroli1	17.85	77.7653	21.3528	7.66	396	253	7	2	0.70	120
14	Beed	Majalgaon	Patrud-1	15	76.2125	19.1044	8.19	653	418	75	21	0.66	180
15	Beed	Beed	Pimpalner	21.5	75.9525	19.0439	7.72	987	632	53	18	0.49	255
16	Beed	Georai	Umapur	17	75.6000	19.2833	8.09	632	404	7	44	0.51	200
17	Ch. Sambhaji Nagar	Vaijapur	Waghalgaon	12.2	74.8311	19.8475	7.86	1343	860	149	43	0.30	490
18	Hingoli	Hingoli	Sawad	6.8	77.0608	19.7372	8.19	528	338	43	14	0.91	245
19	Jalgaon	Bodwad	Jamthi	10	75.9703	20.8067	7.54	1192	763	135	43	0.16	490
20	Jalna	Bhokardan	Baranjala Lokhande	15.3	75.8286	20.1944	7.83	1516	970	227	35	0.65	350
21	Jalna	Jalna	Gondegaon-1	19	75.9311	19.9364	7.74	696	445	39	21	0.36	270
22	Jalna	Jalna	Pokhari Shindhkhed	11.8	75.9583	19.9811	8.02	727	465	32	39	0.41	300
23	Nagpur	Parseoni	Nagalwadi	13.5	79.0167	21.5667	7.61	826	529	30	15	0.53	305
24	Nagpur	Katol	Ridhora	13.5	78.6206	21.2322	7.97	648	415	22	9	0.43	260
25	Nagpur	Narkhed	Sawargaon	12.9	78.6350	21.3917	8.26	1142	731	87	38	0.22	420
26	Nanded	Kinwat	Gokunda (Kinwat)-1	9.55	78.2333	19.5833	7.49	1073	687	146	37	0.42	345
27	Washim	Karanja	Nagalwadi	13.5	77.6192	20.6469	7.61	826	529	30	15	0.53	305

S. No.	District	Block/ Taluka	Village	Well Depth	Longitude (DD)	Latitude (DD)	pH	EC (µS/cm)	TDS (mg/L)	Cl (mg/L)	NO_3 (mg/L)	F (mg/L)	TH (mg/L)
28	Buldana	Deulgaon-Raja	Deolgaon Raja	11.3	76.0333	20.0167	8.21	145	93	14	3	0.30	60
29	Buldana	Buldana	Dhad	12.2	76.0000	20.4000	7.34	1460	934	181	44	0.35	385
30	Buldana	Khamgaon	Godhnapur	12.7	76.5244	20.6758	7.96	1445	925	249	22	1.40	385
31	Buldana	Khamgaon	Rohna	21	76.6725	20.6428	7.73	929	595	117	22	0.32	360
32	Buldana	Chikli	Amdapur	13.9	76.4500	20.4167	7.31	912	584	85	42	0.16	345
33	Bhandara	Mohadi	Jamb	13.75	79.5833	21.3833	7.34	1460	934	181	44	0.35	385
34	Bhandara	Bhandara	Daodipar Khapa	14.42	79.6833	21.1000	8.28	685	438	53	19	1.10	255
35	Bhandara	Bhandara	Pagora	15	79.6858	21.0083	8.01	617	395	36	38	1.20	200
36	Bhandara	Lakhandur	Masal	15	79.7733	20.8356	7.93	747	478	85	24	0.51	255
37	Bhandara	Lakhni	Murmadi	14.25	79.9003	20.9706	7.93	745	477	92	32	0.39	210
38	Bhandara	Tumsar	Gobarwahi	9.4	79.7264	21.5239	8.00	556	356	43	32	0.27	180
39	Bhandara	SAKOLI	Mundipar Sadak	10.2	79.9092	21.0614	8.02	640	410	85	22	0.10	175
40	Gondia	Goregaon	Murdoli	10.1	80.2083	21.2250	8.01	870	557	103	3	0.96	250
41	Gondia	Sakoli	Salebardi	19.25	79.9403	20.9097	7.93	854	547	121	42	0.37	305
42	Gondia	Tirora	Sejgaon	9.95	80.0267	21.4958	7.88	801	513	167	16	0.19	300
43	Gondia	Sadak-Arjuni	Sondad	15.55	80.0917	21.0750	8.02	409	262	46	2	0.47	145
44	Chandrapur	Gondpipri	Aksapur	15.15	79.6333	19.7583	7.62	2472	1582	469	5	0.45	530
45	Chandrapur	Bhadrawati	Mahurli	8.45	79.3333	20.1833	7.49	941	602	99	44	0.23	220
46	Chandrapur	Korpana	Wansadi-1	10	79.0522	19.7475	8.07	781	500	36	12	1.00	275
47	Chandrapur	Jiwati	Jivati	7.9	79.0661	19.6089	7.49	1042	667	146	44	0.28	370
48	Gadchiroli	Sironcha	Bamni	9.2	79.9833	18.9500	8.20	1228	786	114	38	0.47	390
49	Gadchiroli	Aheri	Govindgaon	8.39	80.1203	19.1058	8.01	1055	675	85	41	0.66	395
50	Wardha	Ashti	Sahur	10.25	78.2417	21.3083	7.61	1230	787	89	31	0.41	435
51	Wardha	Karanja	Nagalwadi	13.5	78.4333	21.1667	7.61	826	529	30	15	0.53	305
52	Wardha	Arvi	Rohna	21	78.3258	20.8531	7.73	929	595	117	22	0.32	360
53	Wardha		Ajansara	13	78.6713	20.4093	7.96	498	319	20	6	0.40	135
54	Yavatmal	Kelapur	Pahapal	10.45	78.5000	19.9833	8.34	1401	897	320	19	0.39	491
55	Yavatmal	Babulgaon	Savar	10.7	78.0667	20.4978	8.12	895	573	75	5	0.22	290

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56	Pune	Ambegaon	Loni (Ambegaon)	9.65	74.0875	18.9028	7.92	1000	640	75	44	0.42	340
57	Pune	Bhor	Kasurdi-1	15	73.9022	18.2042	8.10	192	123	14	4	0.11	60
58	Pune	Haveli	Shivpur Khed	11	73.8500	18.3333	7.83	844	540	71	19	0.18	255
59	Pune	Haveli	Wagholi-1	10	74.0086	18.5992	7.73	1552	993	238	41	0.30	485
60	Pune	Khed	Rajgurnagar (Khed)	13.6	73.8972	18.8639	8.12	600	384	25	5	0.23	205
61	Pune	Mawal	Lonawala	10.72	73.4181	18.7583	8.06	415	266	18	2	0.18	160
62	Pune	Mulshi	Kolwan	8	73.5319	18.5819	8.04	366	234	39	3	0.14	145
63	Pune	Pune	Daund	10	74.5739	18.4675	7.91	1001	641	43	22	0.29	320
64	Pune	Shirur	Shirur	16.18	74.3667	18.8167	7.71	2050	1312	321	42	0.39	435
65	Nashik	Dindori	Dindori	15	73.8167	20.2000	7.12	451	288	27	8	0.18	205
66	Nashik	Nasik	Mhasrul	11	73.8078	20.0467	7.44	793	507	52	30	0.19	290
67	Nashik	Nasik	Dhondegaon	14	73.6125	20.0750	7.29	566	362	20	35	0.20	250
68	Nashik	Yevla	Purangaon-Jalgaon	14.4	74.3681	20.0536	7.55	774	496	102	20	0.29	270
69	Nashik	Nasik	Nashik_city-I	20.7	73.7958	20.0114	7.62	762	487	35	9	0.79	260
70	Nashik	Nasik	Nashik_city-II	10.7	73.8042	19.9828	7.37	253	162	10	1	0.14	120
71	Nashik	Nasik	Adgaon-1	14.8	73.8697	20.0392	7.45	1046	669	77	32	0.32	420
72	Nashik	Niphad	Jalgaon	11.25	74.1111	20.0639	7.53	798	511	107	21	0.33	290
73	Nashik	Nasik	Gangawadi	11.42	73.6667	20.0833	7.52	611	391	25	15	0.25	220
74	Nashik	Surgana	Ghagbari	14.5	73.7675	20.4467	7.47	338	216	12	9	0.18	125
75	Dhule	Sakri	Ichhapur	9.35	74.4444	20.9722	7.88	960	614	112	43	0.58	295
76	Dhule	Sindkheda	Shewade	14.7	74.5925	21.1564	8.09	952	609	123	38	0.43	325
77	Dhule	Shirpur	Samaryapada	16.9	74.8997	21.4606	7.92	1024	655	82	36	0.58	375
78	Dhule	Dhule	Sarvad	12.1	74.7814	21.0400	8.04	1134	726	55	28	0.51	305
79	Thane	Ambarnath	Katolwadi (Mulgaon)	7	73.3028	19.1639	6.96	343	220	21	36	0.16	150
80	Thane	Bhiwandi	Padgha	5.25	73.1722	19.3625	7.79	573	367	46	13	0.11	205
81	Thane	Dahanau	Kasa	8.5	72.9500	19.9167	7.89	484	310	35	6	0.15	195
82	Thane	Dahanu	Dharmapur Khinipada	10	72.9919	19.9378	8.00	368	236	25	4	0.17	220
83	Thane	Jawhar	Balkhapara	10	73.1667	19.8833	7.77	266	170	11	6	0.16	120

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84	Thane	Murbad	Murbad	4.7	73.3833	19.2500	8.02	720	461	103	9	0.14	265
85	Thane	Shahapur	Cherfully	7	73.3333	19.4667	8.15	772	494	110	11	0.11	265
86	Thane	Talasani	Kurje	7.5	72.9447	20.0983	8.05	392	251	21	6	0.19	150
87	Thane	Talasari	Udhwa	7	73.0083	20.1042	8.11	632	404	82	7	0.14	260
88	Thane	Thane	Bhaindarpada	6.8	72.9500	19.2833	6.93	562	360	71	34	0.11	165
89	Thane	Vada	Gothanpada	8	73.0833	19.6667	7.83	421	269	46	7	0.14	225
90	Thane	Vasai	Agashi	7.3	72.7728	19.4667	7.79	529	339	24	14	0.13	190
91	Thane	Vikramgad	Vikramgadh	7	73.0950	19.7967	7.81	639	409	67	17	0.16	240
92	Thane	Vikramgarh	Wehelpada	9.7	73.1064	19.8619	8.00	349	223	35	10	0.14	145
93	Mumbai City	Mumbai	Bombay (Church Gate)	4.4	72.8311	18.9319	8.06	634	406	51	6	0.58	250
94	Mumbai City	Mumbai	Colaba-Fort	3.8	72.8367	18.9381	8.06	980	627	89	10	0.08	350
95	Mumbai City	Mumbai	Mahim	5.8	72.8444	19.0250	7.67	565	362	36	3	0.09	300
96	Mumbai City	Mumbai	Varli_Naka	6.9	72.8186	18.9983	7.98	679	435	46	9	0.11	275
97	Mumbai City	Mumbai	Mazgaon	13.6	72.8439	18.9692	7.92	615	394	43	1	0.13	200
98	Mumbai City	Mumbai	Colaba-Fort	3.8	72.8311	18.9319	8.06	980	627	89	10	0.08	350
99	Mumbai Suburban	Borivali	Goregaon	11.55	72.8575	19.1656	8.21	521	333	50	33	0.64	160
100	Raigad	Alibag	Bilji (Umta)	6.1	72.9833	18.5347	7.78	365	234	25	0	0.11	140
101	Raigad	Khalapur	Kargaon	10	73.2986	18.7264	7.96	396	253	18	13	0.10	160
102	Raigad	Mangaon	Chandore	9	73.1833	18.1667	7.87	62	40	11	2	0.08	20
103	Raigad	Mhasala	Kelte	4.8	73.1056	18.0889	7.65	51	33	7	0	0.06	15
104	Raigad	Murud	Khutal	6.85	73.0306	18.3583	8.00	467	299	43	1	0.08	120
105	Raigad	Panvel	Chinchwan	10.3	73.1167	18.9250	7.81	201	129	36	1	0.07	75
106	Raigad	Pen	Veshwi	9.82	73.0333	18.7500	8.02	604	387	39	0	0.10	250
107	Raigad	Poladpur	Poladpur	9.07	73.4667	17.9833	7.77	318	204	39	24	0.09	115
108	Raigad	Roha	Dapoli	8	73.0083	18.4778	7.17	1610	1030	462	10	0.09	550
109	Raigad	Shrivardhan	Saigaon Govalwadi	5	73.0806	18.0319	7.87	80	51	14	4	0.09	25
110	Raigad	Sudhagad	Sukeli	8.52	73.1842	18.4875	7.14	1478	946	430	21	0.06	495
111	Raigad	Uran	Uran	6.5	72.9419	18.8794	8.02	845	541	89	11	0.06	245

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112	Satara	Wai	Wai	6.7	73.9000	17.9500	7.58	905	579	62	4	0.23	370
113	Satara	Paltan	Mirgaon	13	74.3500	17.9667	7.76	334	214	56	11	0.39	120
114	Satara	Mahabaleshwar	Panchgani	20.6	73.7500	17.9167	7.08	176	112	5	22	0.10	75
115	Satara	Khatav	Aundh	13.15	74.3333	17.5333	8.24	881	564	61	20	0.15	250
116	Satara	Man	Wavarhire-1	10	74.5861	17.9508	7.95	1038	664	72	33	0.42	240
117	Sangli	Walwa	Ashta	11.5	74.4094	16.9536	7.77	1110	710	92	8	0.26	470
118	Sangli	Miraj	Arag	5.25	74.8167	16.7875	7.58	780	499	67	33	0.25	260
119	Sangli	Kavathe Mahankal	Kawathe Mahankal	8.28	74.8694	17.0083	7.97	643	412	55	10	0.25	175
120	Sangli	Miraj	Nimaj-1	16.2	74.6403	16.8333	8.02	876	561	57	11	0.56	205
121	Sangli	Kavathe Mahankal	Kuchi	15	74.8644	17.0572	7.72	1343	860	147	41	0.41	390
122	Sangli	Miraj	Miraj-1	15	74.6447	16.8108	7.74	1451	929	182	35	0.33	465
123	Sangli	Miraj	Sangli_Sangalwadi	14.5	74.5536	16.8831	7.82	1680	1075	145	43	0.24	480
124	Sangli	Miraj	Tung	13	74.4931	16.9219	7.84	1224	783	77	32	0.73	290
125	Sangli	Miraj	Bedag	11	74.7381	16.8011	7.45	313	200	10	9	0.23	135
126	Sangli	Tasgaon	Visapur	15	74.5875	17.1156	7.85	976	624	82	23	0.32	385
127	Sangli	Kavathe Mahankal	Sarati	13	74.8986	16.9231	7.87	1542	987	140	23	0.86	415
128	Sangli	Khanpur	Ghanwad_Anandpur	14	74.5264	17.3278	7.81	643	412	15	15	0.38	260
129	Latur	Chakur	Ashta	11.5	76.5694	18.5014	7.77	1110	710	92	8	0.26	470
130	Latur	Deoni	Rajwadi	17	76.7722	18.7611	8.01	677	433	85	3	0.72	110
131	SOLAPUR	Pandharpur	Ranzani	7.83	75.4000	17.6167	8.00	720	461	95	23	0.14	220
132	SOLAPUR	Pandharpur	Rople	22	75.4000	17.7833	8.21	951	609	90	21	0.28	275