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Comparative Study of Groundwater Quality of Pune City: Post-Monsoon and Post-Monsoon

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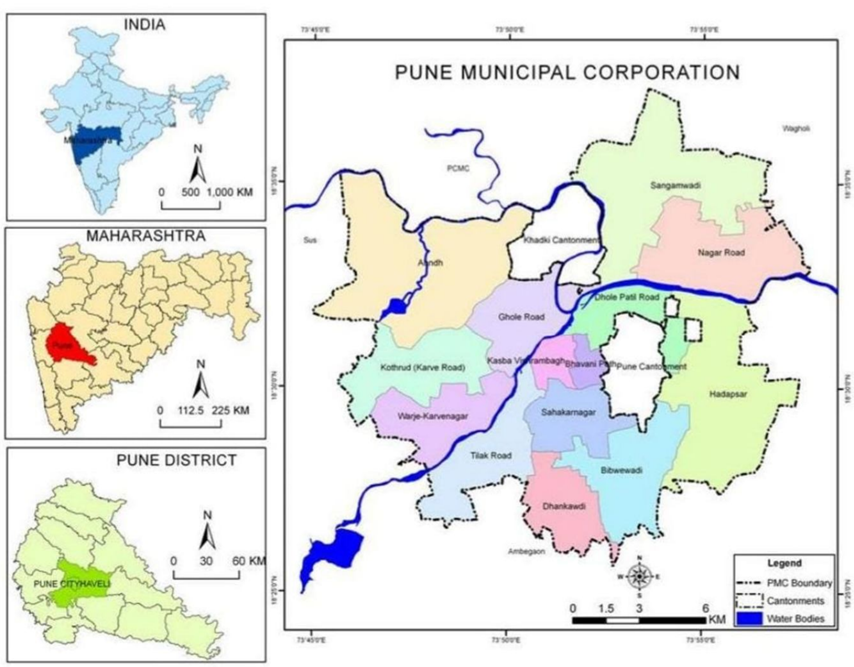
Abstract: This study investigates the variations in groundwater quality in Pune city between the pre-monsoon and post-monsoon seasons. Groundwater is a vital resource for drinking, irrigation, and industrial purposes, especially in the city's periphery where treated water supply is limited. This research examines the impact of seasonal rainfall, runoff, and anthropogenic influences on groundwater quality by analysing key physicochemical parameters, major ions, heavy metals, and microbiological indicators. The findings highlight the importance of continuous monitoring and management strategies to ensure the sustainability of groundwater resources in the face of increasing contamination and environmental changes.
Keywords: Groundwater quality, Pre-monsoon, Post-monsoon, Pune city, Physicochemical parameters, Seasonal variation

I. INTRODUCTION

Groundwater is a vital resource, essential for drinking, household use, irrigation, and industrial applications, especially in areas where treated surface water is scarce or unavailable. In Pune's periphery, groundwater serves as a primary water source due to the limited reach of the city's piped water supply. Understanding the seasonal variations in groundwater quality is critical for ensuring sustainable management and protecting public health. Rainfall, runoff, and anthropogenic activities significantly influence groundwater quality, leading to fluctuations between pre- and post-monsoon periods. This study aims to assess and compare groundwater quality in Pune city during the pre-monsoon and post-monsoon seasons. By analyzing key physicochemical parameters, this research seeks to provide insights for effective water resource management and to address the challenges posed by increasing urbanization and environmental changes.

Pune District at a Glance



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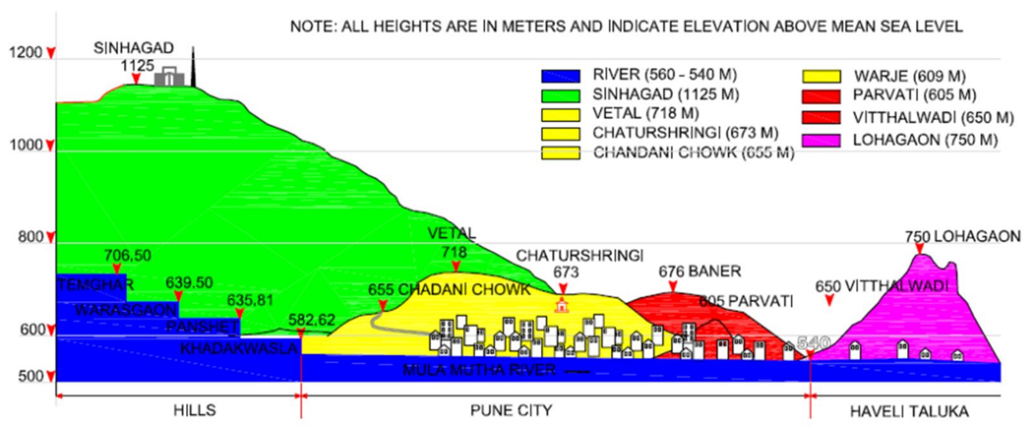
II. LITERATURE REVIEW

Groundwater quality in and around Pune, Maharashtra, India, has been the subject of several investigations, highlighting various influencing factors and assessment methodologies. Studies consistently emphasize the need for comprehensive evaluation due to increasing anthropogenic pressures. Gautam et al. (2024) employed an integrated approach, combining a water quality index (WQI) with multivariate statistical techniques, to characterize groundwater quality. This methodology provides a holistic understanding of the spatial variations and the key parameters influencing groundwater quality in the studied area. The impact of waste disposal on groundwater is a significant concern, as highlighted by Nihalani et al. (2022). Their study focused on the groundwater quality in proximity to the solid waste dumpsite at Uruli Devachi, Pune, revealing potential contamination and the need for proper waste management practices to safeguard water resources. Kadam et al. (2021) took an integrated approach, combining hydrogeochemistry and human health risk assessment in the Shivganga river basin, Pune. Their work provides insights into the geochemical processes affecting groundwater quality and evaluates the potential health risks associated with its use. Several reports from the Central Ground Water Board (CGWB) provide fundamental information on the groundwater resources of the Pune district (Mishra, 2013; CGWB, n.d.). These reports offer baseline data on groundwater availability, quality, and potential issues, serving as crucial resources for further research and management strategies. Sayyed et al. (2013) specifically investigated the impact of urbanization on groundwater quality in the southeastern part of Pune city using hydrogeochemical facies analysis. Their findings likely demonstrate how urban development activities can alter groundwater composition and quality, emphasizing the need for sustainable urban planning. While the primary focus is on the Pune region, Mishra et al. (2011)'s study in Madhya Pradesh, though geographically different, underscores the broader issue of groundwater quality assessment and the importance of considering specific contaminants like fluoride. This highlights that similar challenges and assessment approaches might be relevant in the Pune context as well. Collectively, these studies and reports paint a picture of ongoing research and monitoring efforts aimed at understanding and managing groundwater quality in the face of urbanization, industrialization, and waste disposal in the Pune region. The methodologies employed range from statistical analyses and water quality indices to hydrogeochemical assessments and health risk evaluations, reflecting the multifaceted nature of groundwater quality management.

III. STUDY AREA

Introduction to Pune District



Source: *Mashal* Figure 2.2: Topographical

Pune district, located in the western part of Maharashtra, India, lies between 17°54' and 19°24' north latitude and 73°29' and 75°10' east longitude. It covers an area of 15,642 sq. km, accounting for 5.08% of Maharashtra's total area. Administratively, the district is divided into 14 talukas and includes 1866 villages.

Geomorphologically, Pune district comprises four major physiographic units: the Western Ghats, foothills, the central plateau, and eastern plains. The major drainage systems include the Bhima-Ghod, Mula-Mutha, and Nira rivers. The district experiences a tropical monsoon climate with significant variations in rainfall, ranging from 468 mm to 4659 mm annually.

Hydrogeologically, the water-bearing formations consist of weathered, fractured, jointed, and vesicular basalts. Pre-monsoon depth to the water level in May 2011 ranged from 0.40 to 20.10 meters below ground level (mbgl), while post-monsoon levels in November 2011 ranged from 0.09 to 14.65 mbgl. Groundwater quality is generally good, suitable for drinking and irrigation, though localized nitrate contamination has been observed. About 50% of Pune district falls under the rain shadow zone, leading to drought-prone conditions in several talukas. Baramati and Purandhar talukas are categorized as "Semi-Critical" due to groundwater development reaching up to 96.13%.

IV. METHODOLOGY

1) Data Collection:

- Sampling Locations: Groundwater samples will be collected from a diverse range of sources, including dug wells, borewells, and community water sources, to ensure a representative assessment of groundwater quality across the study area. The selection of sampling locations will be based on factors such as accessibility, well distribution, and potential sources of contamination. GPS coordinates will be recorded for each sampling site to facilitate spatial analysis.
- Sampling Frequency: To capture seasonal variations in groundwater quality, samples will be collected during two critical periods:
- Post-Monsoon: Conducted after the monsoon season, this sampling will assess the impact of rainfall and runoff on groundwater quality.

2) Parameters to be Tested:

The following key groundwater quality parameters will be analyzed:

- Physicochemical Parameters:
- pH,
- Electrical Conductivity (EC),
- Turbidity

3) Sample Analysis:

- Detailed descriptions of the laboratory methods used for analyzing each parameter will be included.
- Quality control measures: Calibration of instruments, the use of standard solutions, and replicate analysis will be conducted.

4) Data Analysis:

- Statistical Analysis: Descriptive statistics (mean, median, standard deviation) will be calculated for each parameter. Correlation analysis will be performed to identify relationships between different parameters. T-tests will be used to compare pre- and post-monsoon data for significant differences.
- Spatial Analysis: Groundwater quality parameters will be mapped using GIS software to identify pollution hotspots and assess spatial variations.
- Water Quality Index (WQI) Calculation: The WQI will be calculated using standard methods to provide an overall assessment of water quality based on multiple parameters. The WQI values will be compared with drinking water standards to determine the suitability of groundwater for consumption.

Water Quality Criteria for Drinking Purpose With the objective of safeguarding water from degradation and to establish a basis for improvement in water quality, standards / guidelines / regulations have been laid down by various national and international organizations such as Bureau of Indian Standards (BIS, 2012), World Health Organization (WHO, 2011), European Economic Community (EEC), Environmental Protection Agency (EPA), United States, and Inland Waters Directorate, Canada. The Bureau of Indian Standards (BIS) earlier known as Indian Standards Institutions (ISI) has laid down the standard specification for drinking water during 1983, which have been revised and updated from time to time. In order to enable the users to exercise their discretion towards water quality criteria, the maximum permissible limit has been prescribed especially where no alternative sources are available. The national water quality standards describe essential and desirable characteristics required to be evaluated to assess suitability of water for drinking purposes. The important water quality characteristics as laid down in BIS standard (IS 10500: 2012) are summarized in Table:

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Table 4.1: Drinking Water Characteristics (IS 10500: 2012)

S. No.	Parameters	Desirable Limits (mg/l)	Permissible limits (mg/l)
Essential Characteristics			
1	Colour Hazen Unit	5	15
2	Odour	Unobjectionable	-
3	Taste	Agreeable	-
4	Turbidity (NTU)	1	5
5	pH	6.5-8.5	No relaxation
6	Total Hardness, $CaCO_3$	200	600
7	Iron (Fe)	1.0	No relaxation
8	Chloride (Cl)	250	1000
9	Residual Free Chlorine	0.2	1
10	Fluoride (F)	1.0	1.5
Desirable Characteristics			
11	Dissolved Solids	500	2000
12	Calcium (Ca)	75	200
13	Magnesium (Mg)	30	100
14	Copper (Cu)	0.05	1.5
15	Manganese (Mn)	0.1	0.3
16	Sulphate (SO_4)	200	400
17	Nitrate (NO_3)	45	No relaxation
18	Phenolic Compounds	0.001	0.002
19	Mercury (Hg)	0.001	No relaxation
20	Cadmium (Cd)	0.003	No relaxation
21	Selenium (Se)	0.01	No relaxation
22	Arsenic (As)	0.01	No relaxation
23	Cyanide (CN)	0.05	No relaxation
24	Lead (Pb)	0.01	No relaxation
25	Zinc (Zn)	5.0	15
26	Hexavalent Chromium	0.05	No relaxation
27	Alkalinity	200	600
28	Aluminum (Al)	0.03	0.2
29	Boron (B)	0.5	2.4
30	Pesticides	Absent	0.001
31	Uranium	0.03	No relaxation

11| Ground Water Quality of Maharashtra

NTU- Nephelometric Turbidity Unit.

Source: Drinking Water Characteristics (IS 10500: 2012)

Summarized results of groundwater quality ranges of unconfined aquifer, (May 2022)

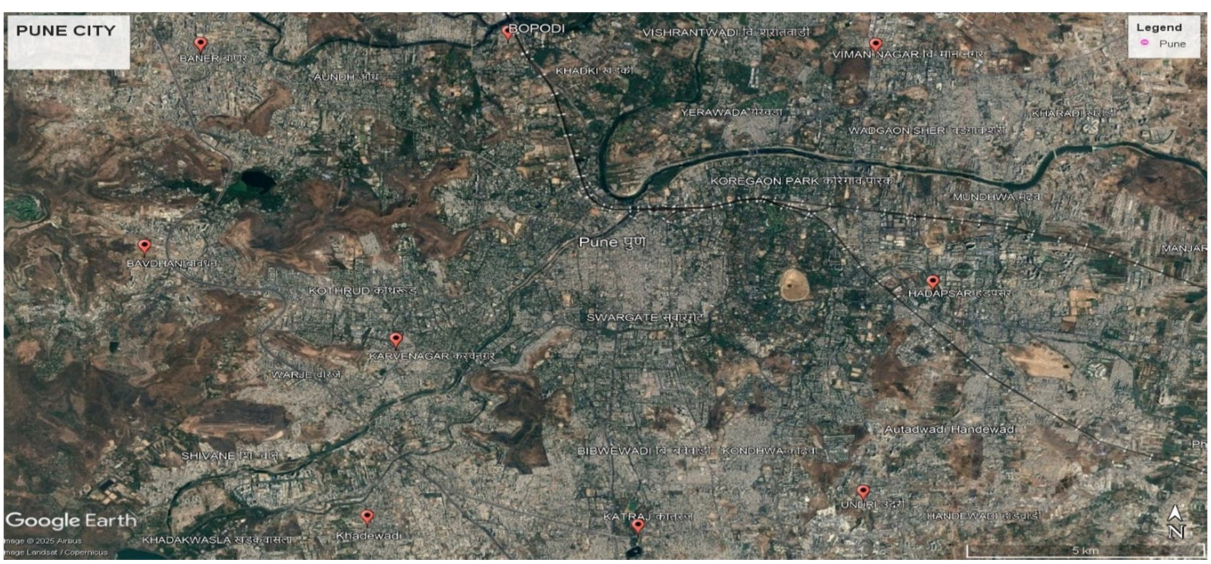
S.No	Parameters		Range
1	Electrical Conductivity µs/cm at 25˚C	Fresh	< 750
		Moderate	750- 2250
		Slightly mineralized	2251- 3000
		Highly mineralized	> 3000
2	Chloride mg/l	Desirable limit	< 250
		Permissible limit	251-1000
		Beyond permissible limit	> 1000
3	Fluoride mg/l	Desirable limit	< 1.0
		Permissible limit	1.0 - 1.5
		Beyond permissible limit	>1.5
4	Nitrate mg/l	Permissible limit	< 45
		Beyond permissible limit	> 45

Source: Drinking Water Characteristics (IS 10500: 2012)

Locations:

Groundwater samples will be collected from various points, including dug wells, borewells, and community water sources across the selected study area. Various locations are as follows:

North-Western: Baner,
Western: Bavdhan
South-Western: Dhayri
South-Central: Karve Nagar
Northern: Bopodi
Noth-Eastern: Viman Nagar
Eastern : Hadapsar
Southern : Katraj
South-Eastern: Undri



V. OBSERVATION OF PARAMETER TESTING

A. *Groundwater Quality Parameters in Pune City - Post – Monsoon*

(October-November)

1) *pH*

Definition: pH is a measure of how acidic or basic water is, on a scale from 0 to 14, with 7 being neutral. Values below 7 indicate acidity, while values above 7 indicate alkalinity. Expected Range in Pune:

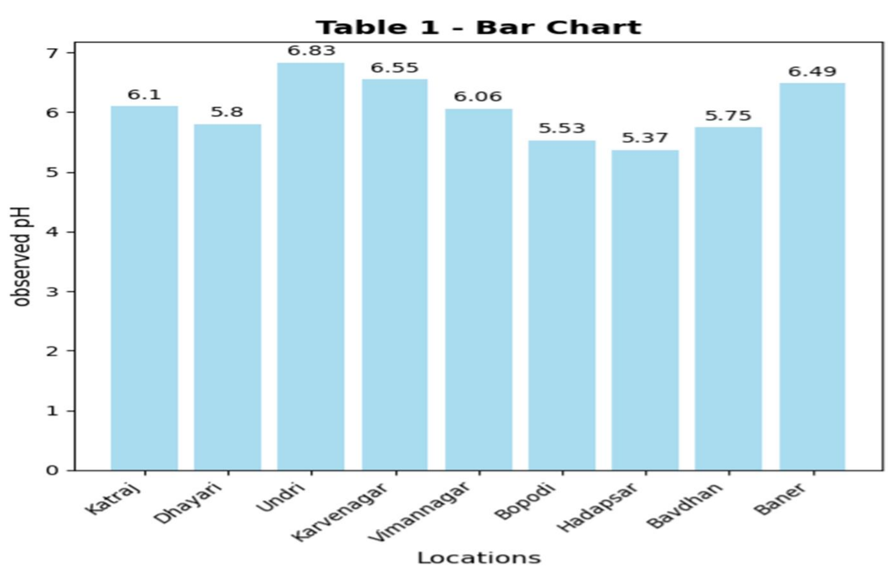
- Typical Range: Groundwater pH levels in urban areas like Pune can vary widely but generally fall between 6.0 and 8.5.
- Ideal Range for Drinking Water: The World Health Organization (WHO) recommends a pH range of 6.5 to 8.5 for potable water.

Implications:

- Acidic Water (pH < 6): Can lead to leaching of heavy metals from pipes and soil, potentially contaminating the water supply.
- Alkaline Water (pH > 8.5): May indicate high concentrations of bicarbonates or carbonates and can affect the solubility of nutrients and metals in water.
- Effect on human health: Indicative of acidic or alkaline waters, affects taste, corrosivity and the water supply system
- pH: To assess acidity or alkalinity.

Sr. no.	Location	Desirable limits (mg/I)	Observed pH
1	Katraj	6.5 – 8.5	6.10
2	Dhayari	6.5 – 8.5	5.80
3	Undri	6.5 – 8.5	6.83
4	Karvenagar	6.5 – 8.5	6.55
5	Vimannagar	6.5 – 8.5	6.06
6	Bopodi	6.5 – 8.5	5.53
7	Hadapsar	6.5 – 8.5	5.37
8	Bavdhan	6.5 – 8.5	5.75
9	Baner	6.5 – 8.5	6.49

- Result: Hadapsar have the lowest pH of 5.37 followed by Bopodi, Karvenagar, Bavdhan, Dhayari, Vimannagar, Katraj, Baner and Undri with the highest pH 6.83.



pH meter

2) Turbidity

Definition:

Turbidity measures the cloudiness or haziness of water due to suspended particles such as sediments, microorganisms, and organic matter. Expected Ranges in Pune:

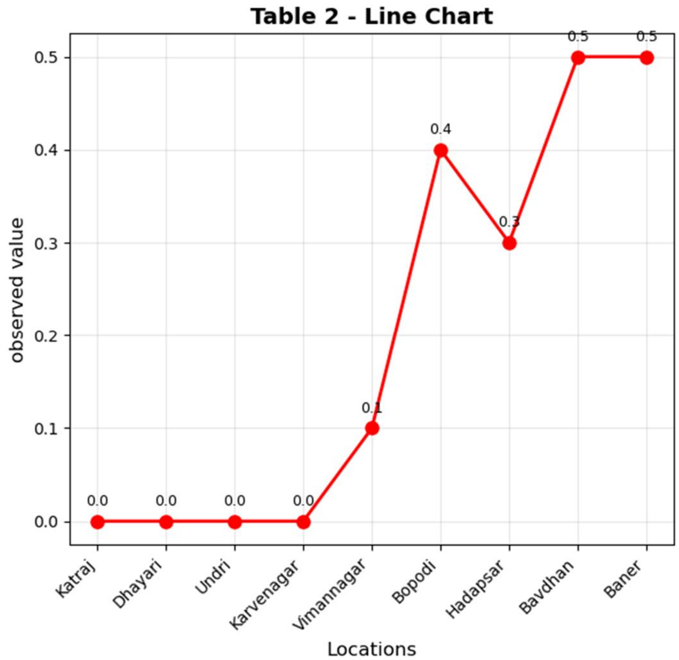
- Typical Range: Turbidity levels can vary significantly based on location and season. In urban settings, turbidity might range from less than 1 NTU (nearly clear) to over 100 NTU (very turbid) during heavy rainfall or runoff events.
- WHO Guidelines: The acceptable limit for drinking water is generally less than 5 NTU.

Implications:

- High Turbidity (>5 NTU): Indicates potential contamination and can interfere with disinfection processes, making water unsafe for consumption.
- Sources of Turbidity: Urban runoff, construction activities, industrial discharges, and natural sedimentation can all contribute to increased turbidity levels.
- Effects on human health: High turbidity indicates contamination / Pollution.
- Turbidity: To measure the clarity of the water.

Sr.no.	Location	Desirable & permissible limit	Observed value
1	Katraj	1-5	00
2	Dhayari	1-5	00
3	Undri	1-5	00
4	Karvenagar	1-5	00
5	Vimannagar	1-5	0.1
6	Bopodi	1-5	0.4
7	Hadapsar	1-5	0.3
8	Bavdhan	1-5	0.5
9	Baner	1-5	0.5

- Result: Katraj, Dhayari, Karve Nagar and Undri have lowest turbidity (0.0) while Bavdhan and Baner have highest turbidity (0.5) in the given samples.



Turbidimeter

3) Electrical Conductivity (EC)

Definition:

Electrical conductivity measures the ability of water to conduct electricity, which is directly related to the concentration of dissolved ions (salts) in the water. Expected Range in Pune:

- Typical Range: EC values in groundwater can vary widely; typical values might range from 250 µS/cm to over 2,500 µS/cm depending on pollution sources and geological conditions.
- WHO Guidelines: For drinking water, EC should ideally be below 1,500 µS/cm.

Implications:

- High EC Levels (>1,500 µS/cm): May indicate salinity issues or pollution from agricultural runoff or industrial waste. High salinity can adversely affect drinking water quality and agricultural productivity.
- Sources of High EC: Industrial effluents, agricultural fertilizers, sewage discharge, and natural mineral dissolution contribute to elevated conductivity levels.

- Health Risks Associated with High EC

  Increased Salinity:

  High levels of dissolved salts can lead to increased salinity in drinking water, which may cause dehydration and other health issues, particularly in vulnerable populations such as children and the elderly.

The EC of groundwater is contributed by all the dissolved ionic constituents. Therefore, it is a measure of the total ionic content of the water.

Electrical Conductivity µs/cm at 25°C

Range

Fresh < 750

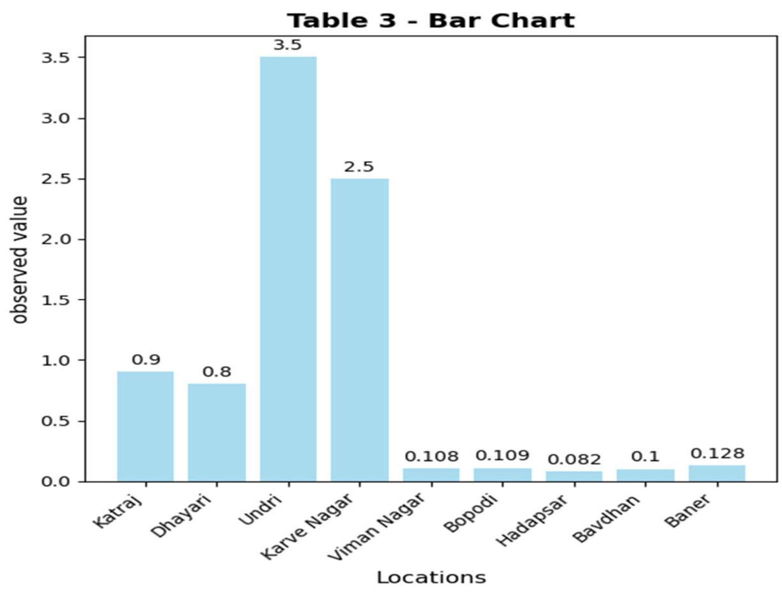
Moderate 750- 2250

Slightly mineralized 2251- 3000

Highly mineralized > 3000

Sr. no.	Location	Observed value
1	Katraj	0.9
2	Dhayari	0.8
3	Undri	3.5
4	Karve Nagar	2.5
5	Viman Nagar	0.108
6	Bopodi	0.109
7	Hadapsar	0.082
8	Bavdhan	0.100
9	Baner	0.128

- Results: Hadapsar have low conductivity (0.082) while Undri have highest conductivity (3.5). it is followed by Baner (0.128).




Conductometer

B. Groundwater Quality Parameters in Pune City -Post - Monsoon
(March- April)

1) pH

Definition:

pH is a measure of how acidic or basic water is, on a scale from 0 to 14, with 7 being neutral. Values below 7 indicate acidity, while values above 7 indicate alkalinity. Expected Range in Pune:

- Typical Range: Groundwater pH levels in urban areas like Pune can vary widely but generally fall between 6.0 and 8.5.
- Ideal Range for Drinking Water: The World Health Organization (WHO) recommends a pH range of 6.5 to 8.5 for potable water.

Implications:

- Acidic Water (pH < 6): Can lead to leaching of heavy metals from pipes and soil, potentially contaminating the water supply.
- Alkaline Water (pH > 8.5): May indicate high concentrations of bicarbonates or carbonates and can affect the solubility of nutrients and metals in water.
- Effect on human health: Indicative of acidic or alkaline waters, affects taste, corrosivity and the water supply system
- pH: To assess acidity or alkalinity.

Sr. no.	Location	Desirable limits (mg/I)	Observed pH
1	Katraj	6.5 – 8.5	7.09
2	Dhayari	6.5 – 8.5	6.86
3	Undri	6.5 – 8.5	6.21
4	Karvenagar	6.5 – 8.5	6.70
5	Vimannagar	6.5 – 8.5	6.82
6	Bopodi	6.5 – 8.5	6.81
7	Hadapsar	6.5 – 8.5	6.92
8	Bavdhan	6.5 – 8.5	6.63
9	Baner	6.5 – 8.5	6.64

- Result: Undri have least pH of 6.21 followed by Bavdhan, Baner, Karve Nagar, Bopodi, Viman Nagar, Dahyari, Hadapsar and Katraj with highest pH of 7.09.

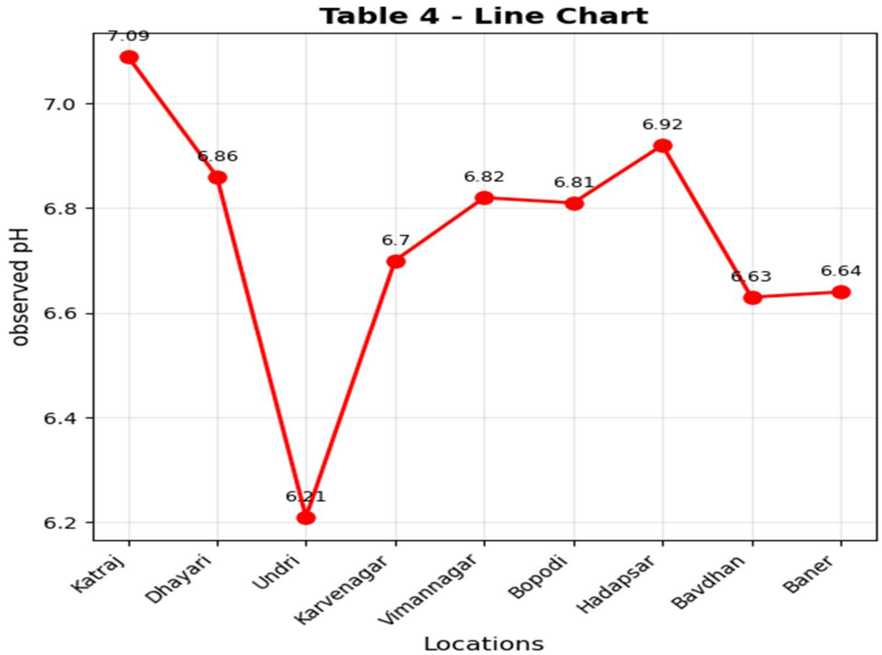
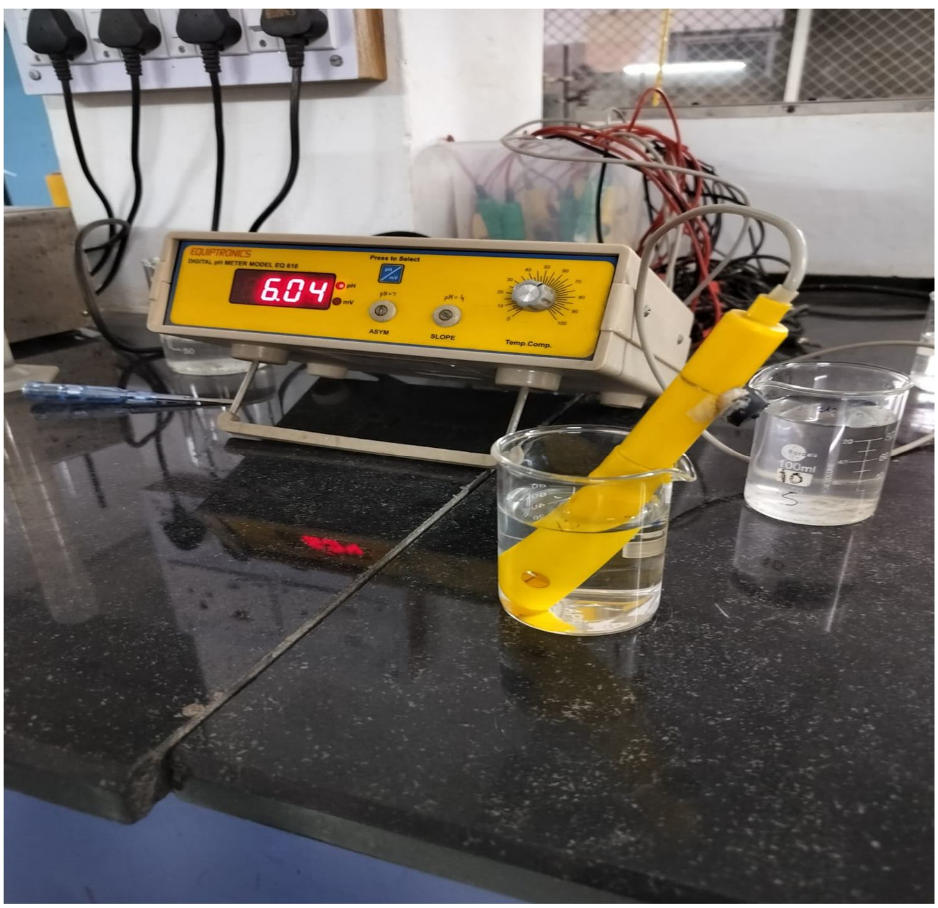


Table 4 - Line Chart
observed pH
Locations
7.09
6.86
6.21
6.7
6.82
6.81
6.92
6.63
6.64
7.0
6.8
6.6
6.4
6.2
Katraj
Dhayari
Undri
Karvenagar
Vimannagar
Bopodi
Hadapsar
Bavdhan
Baner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pH meter

2) Turbidity

Definition:

Turbidity measures the cloudiness or haziness of water due to suspended particles such as sediments, microorganisms, and organic matter. Expected Ranges in Pune:

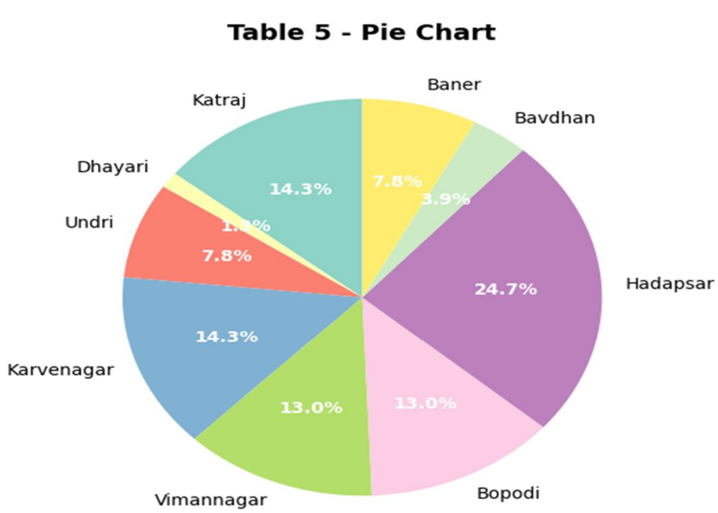
- Typical Range: Turbidity levels can vary significantly based on location and season. In urban settings, turbidity might range from less than 1 NTU (nearly clear) to over 100 NTU (very turbid) during heavy rainfall or runoff events.
- WHO Guidelines: The acceptable limit for drinking water is generally less than 5 NTU.

Implications:

- High Turbidity (>5 NTU): Indicates potential contamination and can interfere with disinfection processes, making water unsafe for consumption.
- Sources of Turbidity: Urban runoff, construction activities, industrial discharges, and natural sedimentation can all contribute to increased turbidity levels.
- Effects on human health: High turbidity indicates contamination / Pollution.
- Turbidity: To measure the clarity of the water.

Sr.no.	Location	Desirable & permissible limit	observed value
1	Katraj	1-5	1.1
2	Dhayari	1-5	0.1
3	Undri	1-5	0.6
4	Karvenagar	1-5	1.1
5	Vimannagar	1-5	1.0
6	Bopodi	1-5	1.0
7	Hadapsar	1-5	1.9
8	Bavdhan	1-5	0.3
9	Baner	1-5	0.6

- Result : Dhayari have least turbidity of 0.1 followed by Bavdhan, Baner, Undri, Viman Nagar, Bopodi, Katraj, Karve Nagar and Hadapsar with highest turbidity of 1.9.




Turbidimeter

3) Electrical Conductivity (EC)

Definition:

Electrical conductivity measures the ability of water to conduct electricity, which is directly related to the concentration of dissolved ions (salts) in the water. Expected Range in Pune:

- Typical Range: EC values in groundwater can vary widely; typical values might range from 250 µS/cm to over 2,500 µS/cm depending on pollution sources and geological conditions.
- WHO Guidelines: For drinking water, EC should ideally be below 1,500 µS/cm.

Implications:

- High EC Levels (>1,500 µS/cm): May indicate salinity issues or pollution from agricultural runoff or industrial waste. High salinity can adversely affect drinking water quality and agricultural productivity.
- Sources of High EC: Industrial effluents, agricultural fertilizers, sewage discharge, and natural mineral dissolution contribute to elevated conductivity levels.
- Health Risks Associated with High EC
  Increased Salinity:
  High levels of dissolved salts can lead to increased salinity in drinking water, which may cause dehydration and other health issues, particularly in vulnerable populations such as children and the elderly.

The EC of groundwater is contributed by all the dissolved ionic constituents. Therefore, it is a measure of the total ionic content of the water.

Electrical Conductivity µs/cm at 25°C

Range

Fresh < 750

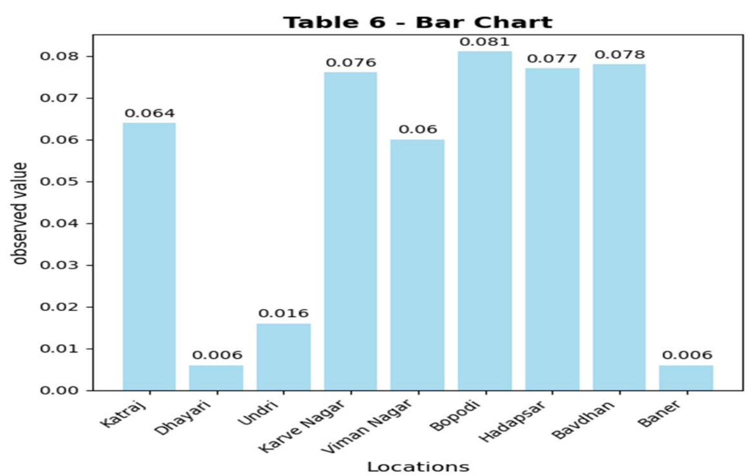
Moderate 750- 2250

Slightly mineralized 2251- 3000

Highly mineralized > 3000

Sr. no.	Location	Observed value
1	Katraj	0.064
2	Dhayari	0.006
3	Undri	0.016
4	Karve Nagar	0.076
5	Viman Nagar	0.060
6	Bopodi	0.081
7	Hadapsar	0.077
8	Bavdhan	0.078
9	Baner	0.006

- Results: Dhayrai and Baner have least conductivity (0.006) followed by Undri, Viman Nagar, Kartraj, Karve Nagar, Hadapsar, Bavdhan and Bopodi having highest conductivity of 0.081.



Conductometer

VI. OBSERVATION

Here are detailed observations from the survey and study:

1) pH Levels:
   - Post-Monsoon: The pH ranged from 5.37 (Hadapsar) to 6.83 (Undri), showing acidic trends in several regions. This lower pH can lead to leaching of harmful metals from pipes and soil into water supplies.
   - Pre-Monsoon: The pH was more stable, ranging from 6.21 (Undri) to 6.92 (Hadapsar), closer to the recommended range for potable water.
2) Turbidity:
   - Post-Monsoon: Certain areas, such as Bavdhan and Baner, exhibited increased turbidity levels (0.5 NTU), indicating potential contamination from urban runoff.
   - Pre-Monsoon: Overall turbidity was lower compared to post-monsoon conditions, with Hadapsar showing the highest turbidity at 1.9 NTU. This reflects greater clarity but increased susceptibility to concentrated contaminants.
3) Electrical Conductivity (EC):
   - Post-Monsoon: Undri recorded the highest EC values (3.5 µS/cm), signaling salinity concerns likely due to dissolved salts introduced during the rainy season. Locations such as Hadapsar had the lowest EC (0.082 µS/cm), indicating comparatively fresh water.
   - Pre-Monsoon: Conductivity levels were significantly reduced across most locations, showing minimal salinity and dissolved ion content.

Additional survey findings revealed:

- A majority of households struggled with inconsistent water availability.
- Common health issues included skin conditions and digestion-related diseases due to water quality.
- Average water supply duration varied widely, with several households receiving less than six hours of water per day.

VII. KEY INSIGHTS

1) Seasonal Dynamics: Seasonal rainfall plays a dual role—while it naturally dilutes existing pollutants, it introduces new contaminants such as fertilizers and pesticides through agricultural runoff, particularly in urban settings.
2) Regional Disparities: Locations such as Hadapsar faced the lowest water quality parameters in terms of pH and turbidity, reflecting increased risk factors for public health and usability.
3) Health Implications: Communities heavily dependent on groundwater face risks from contaminants, including nitrates, heavy metals, and pathogens. The lack of stable, clean drinking water contributes to gastrointestinal disorders, kidney-related issues, and skin diseases.
4) Environmental Impact: Contaminant influx during the monsoon disrupts local ecosystems, reduces agricultural yields, and exacerbates water stress in affected regions.
5) Economic Considerations: The financial strain from healthcare, water treatment, and reduced agricultural productivity highlights the need for investment in advanced water management technologies and policies.

These observations and insights call for enhanced strategies like regular monitoring, improved runoff management, and innovative water purification techniques.

VIII. CONCLUSION

Monitoring pH, turbidity, and electrical conductivity is crucial for assessing groundwater quality in Pune City. These parameters provide insights into potential health risks associated with contaminated water supplies and inform necessary interventions for improving water quality. Regular testing against established standards ensures that groundwater remains safe for consumption and use within the community.

Here are detailed observations from the survey and study:

1) *pH Levels:*

Post-Monsoon: The pH ranged from 5.37 (Hadapsar) to 6.83 (Undri), showing acidic trends in several regions. This lower pH can lead to leaching of harmful metals from pipes and soil into water supplies.

Pre-Monsoon: The pH was more stable, ranging from 6.21 (Undri) to 6.92 (Hadapsar), closer to the recommended range for potable water.

2) Turbidity

Post-Monsoon: Certain areas, such as Bavdhan and Baner, exhibited increased turbidity levels (0.5 NTU), indicating potential contamination from urban runoff.

Pre-Monsoon: Overall turbidity was lower compared to post-monsoon conditions, with Hadapsar showing the highest turbidity at 1.9 NTU. This reflects greater clarity but increased susceptibility to concentrated contaminants.

3) Electrical Conductivity (EC):

Post-Monsoon: Undri recorded the highest EC values (3.5 µS/cm), signaling salinity concerns likely due to dissolved salts introduced during the rainy season. Locations such as Hadapsar had the lowest EC (0.082 µS/cm), indicating comparatively fresh water.

Pre-Monsoon: Conductivity levels were significantly reduced across most locations, showing minimal salinity and dissolved ion content.

Additional survey findings revealed:

- A majority of households struggled with inconsistent water availability.
- Common health issues included skin conditions and digestion-related diseases due to water quality.
- Average water supply duration varied widely, with several households receiving less than six hours of water per day.

IX. RECOMMENDATIONS

1) Almost entire Pune district is underlain by Deccan Trap Basalt, where dug wells are most feasible ground water abstraction structures for ground water development.

2) Borewells are another alternative structure but their construction requires special technical and scientific attention. Borewells generally tap deeper fracture in hard area for which selection of sites is suggested at favourable hydrogeological locations.

3) The Overall Stage of Ground Water Development in the district has reached about 71.51%. Therefore, future development of ground water resources should be taken up with proper care and planning.

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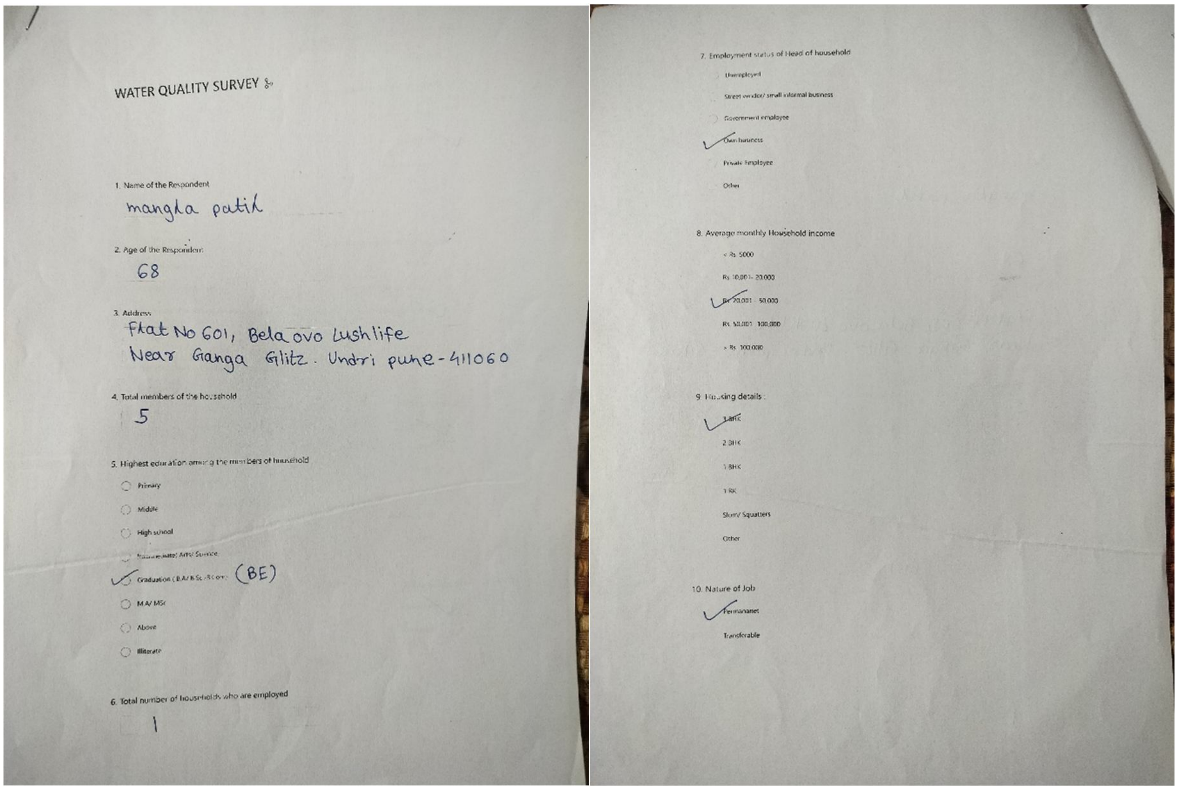
PHOTOGRAPHS

Samples

Questionare



WATER QUALITY SURVEY

1. Name of the Respondent
mangla patil

2. Age of the Respondent
68

3. Address
Flat No 601, Bela ovo Lushlife
Near Ganga Glitz. Undri pune-411060

4. Total members of the household
5

5. Highest education among the members of household
- Primary
- Middle
- High school
- Intermediate/ Arts/ Science
- ✓ Graduation (B.A/ B.Sc./ B.Com) (BE)
- M.A/ MSc
- Above
- Illiterate

6. Total number of households who are employed
1

7. Employment status of Head of household
- Unemployed
- Street vendor/ small informal business
- Government employee
- ✓ Own business
- Private Employee
- Other

8. Average monthly Household income
- < Rs. 5000
- Rs 10,001- 20,000
- ✓ Rs 20,001 - 50,000
- Rs 50,001 100,000
- > Rs 100,000

9. Housing details :
- ✓ 3 BHK
- 2 BHK
- 1 BHK
- 1 RK
- Slum/ Squatters
- Other

10. Nature of Job
- ✓ Permananet
- Transferable

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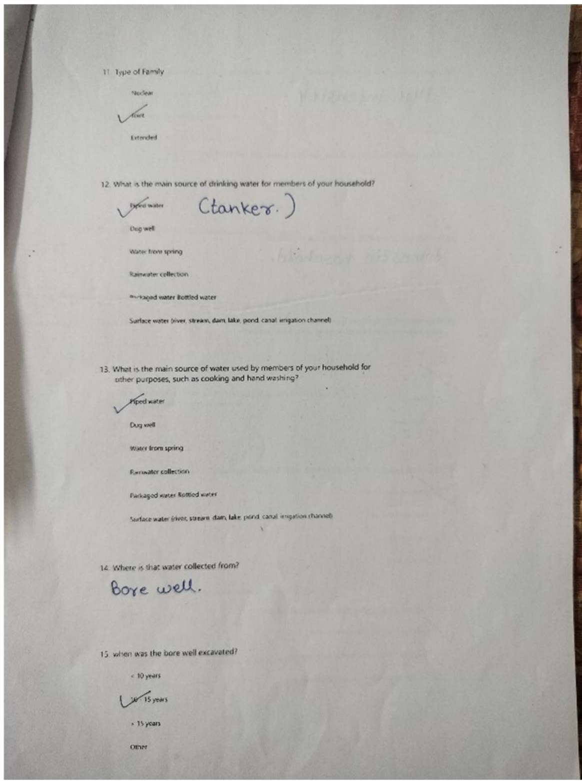
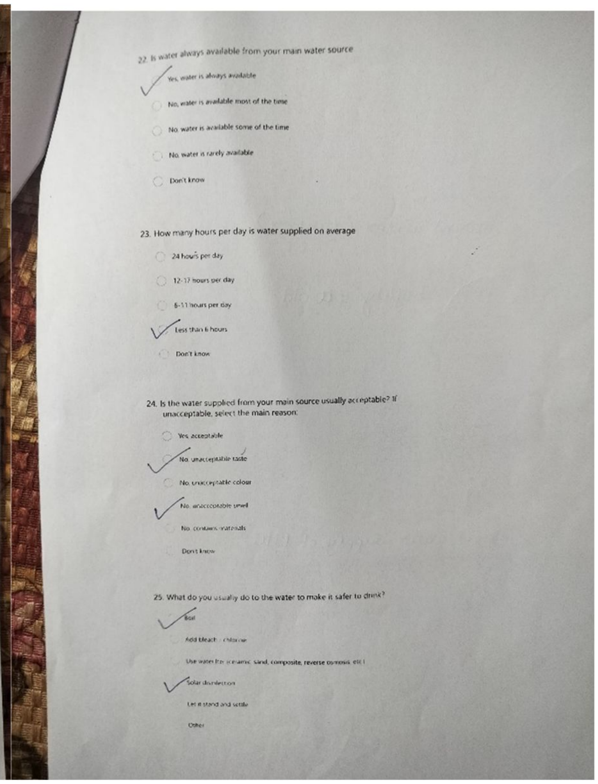

11. Type of Family
Nuclear
Joint ✓
Extended

12. What is the main source of drinking water for members of your household?
Piped water ✓ (tanker.)
Dug well
Water from spring
Rainwater collection
Packaged water Bottled water
Surface water (river, stream, dam, lake, pond, canal, irrigation channel)

13. What is the main source of water used by members of your household for other purposes, such as cooking and hand washing?
Piped water ✓
Dug well
Water from spring
Rainwater collection
Packaged water Bottled water
Surface water (river, stream, dam, lake, pond, canal, irrigation channel)

14. Where is that water collected from?
Bore well.

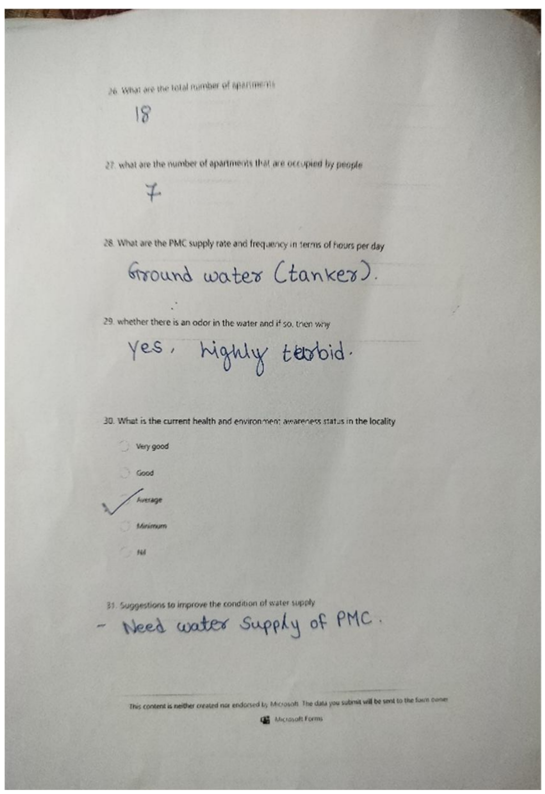
15. when was the bore well excavated?
< 10 years
10 - 15 years ✓
> 15 years
Other


22. Is water always available from your main water source
Yes, water is always available ✓
No, water is available most of the time
No, water is available some of the time
No, water is rarely available
Don't know

23. How many hours per day is water supplied on average
24 hours per day
12-17 hours per day
6-11 hours per day
Less than 6 hours ✓
Don't know

24. Is the water supplied from your main source usually acceptable? If unacceptable, select the main reason:
Yes, acceptable
No, unacceptable taste ✓
No, unacceptable colour
No, unacceptable smell ✓
No, contains materials
Don't know

25. What do you usually do to the water to make it safer to drink?
Boil ✓
Add bleach / chlorine
Use water filter (ceramic, sand, composite, reverse osmosis, etc.)
Solar disinfection ✓
Let it stand and settle
Other


26. What are the total number of apartments
18

27. what are the number of apartments that are occupied by people
7

28. What are the PMC supply rate and frequency in terms of hours per day
Ground water (tanker).

29. whether there is an odor in the water and if so, then why
yes, highly turbid.

30. What is the current health and environment awareness status in the locality
Very good
Good
Average ✓
Minimum
Nil

31. Suggestions to improve the condition of water supply
- Need water supply of PMC.

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