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Water Audit Assessment and Evaluation of Physicochemical Parameters of Water in Haibat Mau Mawaiya, Raibareli Road, Lucknow, India

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

The present study deals with quantitative and qualitative analysis of water. Water is essential for life on Earth, and it has finite resources in the world. Water resources are very beneficial to humans, and beyond human uses, they have a crucial role in every living creature. Nevertheless, as the population increases and moves, the accessibility of quality and quantity of water systems declines. For quantitative analysis, a water audit was conducted in the Indrapuri colony of Haibat Mau Mawaiya locality, Lucknow, India. The water audit gives a balanced, scientific framework that classifies a system's exclusive use of water and controls problems associated with drought, losses,

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leakage, and shortage. The quality of water indicates the condition of water concerning its suitability for a designated use like drinking, bathing, and so on. The qualitative analysis was done by taking several physicochemical parameters of water. If these parameters do not meet the standards, further preventive measures are required for social well-being and good economic health. Standards of water quality make sure the appropriate use of water for different purposes like drinking, industrial, irrigation, etc. For social well-being and good economic health, water quality is vital.

Keywords: Water audit; water quality analysis; physicochemical parameter; Bureau of Indian Standards (BIS).

ABBREVIATIONS

WHO : World Health Organization
BIS : Bureau of Indian Standards
LHD : Liters Per Head Per Day
LPCD : Liters Per Capita Per Day
WQI : Water Quality Index
WQS : Water Quality Status
TDS : Total Dissolved Solids
PPM : Parts Per Million
mg/L : Milligram per liter
EC : Electrical Conductivity
μS/cm : Microsiemens per centimeter

1. INTRODUCTION

The fundamental constituent of life on earth is water. It composes over 80% of the human body mass. It is imperative for the well-being of around 30 million species inhabiting the Earth with their concurrent ecosystems. Industry, agriculture, power generation, navigation, etc., sectors need water. Water appears abundant, with the oceans in a considerable quantity. 97.6% of the total water in the hydrosphere is in the ocean and cannot be readily used because it is saline. Water can fascinate some human needs when saline to a substantial degree [1]. Only about 2.4% of the world's surface water is fresh. Out of this, 2.4%, 75.2% lies in frozen and polar regions, another 22.6% is present as groundwater, and the rest 2.2% is available in lakes, rivers, atmosphere, moisture, soil, and vegetation, as shown in Fig. 1 [2]. Water as a resource is available as surface water and groundwater. The groundwater is the largest regulator of freshwater resources. It varies from place to place and may be present today even in dry climates because of local geology and local climate history [3,4]. It is the critical source of drinking water in rural and urban areas and an essential source of water in agriculture and industry. It is increasingly being used to cover all these demands. In India, agriculture, industry, and domestic needs are the primary water consumers with 70%, 20%, and 10%, respectively [5]. The water demand has increased over the years as population, economic activity, and agricultural irrigation grow, this has led to water scarcity in numerous parts of the world. The balance between consumption (demand) and resource (supply) has become unstable. More than thirty countries worldwide are suffering from a chronic severe water shortage. The water table is moving down 1 to 3 m per year in most parts of India. People in several areas of the world lack fresh drinkable water. With increasing water demand, there is a growing need for finding, developing, and maintaining a suitable water supply. Precious groundwater resources increase the need to be protected and well managed to allow sustainable long-term use.

The term 'audit' has originated in the financial sector. An audit is executed to learn the authority and dependability of data and to assess the internal control of a system. An audit's ambition is to deliberate a concept on the system/person/organization, particularly estimation predicted on the work carried out. The flow chart representation of the audit process is shown in Fig. 2.

The study of the water use of an entity is called a water audit. It starts when water enters the premises and goes up to where the wastewater is discharged, critically examining all use aspects [6]. The audit establishes the quantity of water used, wastage, leakages existing, excess use, etc., and identifies areas where consumption can be reduced. It critically examines existing treatment systems and practices and recommends changes to improve efficiency and

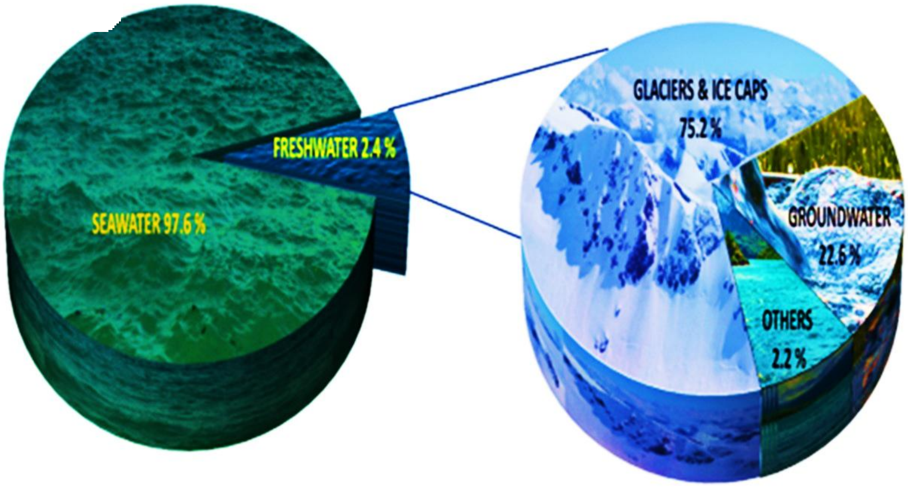

Fig. 1. Distribution of water on the surface of the earth

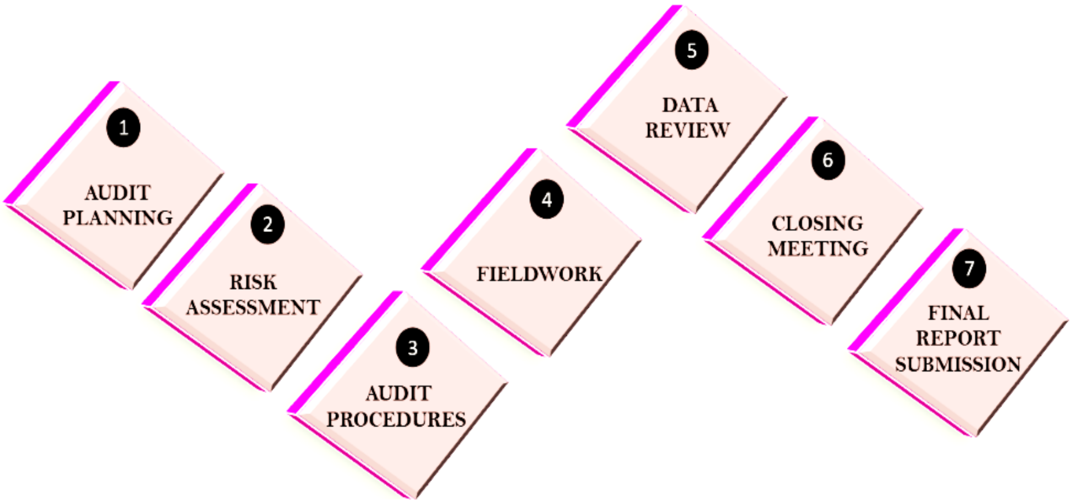

Fig. 2. Flowchart representation of the audit process

reduce usage. An audit recommends reducing wastage and water consumption, enhancing treatment methods and practices, and conducting cost-effective analyses. It also helps set up a system to account for the quantity of water entering and determine how it is distributed and used [7]. It is a systematic procedure of purposely bringing a water balance by measuring water flow from the site of water withdrawal or treatment through the distribution system and into areas where it is used and finally discharged. Conducting a water audit involves calculating water balance, and water use, and identifying ways to save water [8]. Water audits are performed on large and small scales for a state or a city. It is done to determine how much water is being used and how it can be saved by taking precautionary measures. Based on applications, six types of water audits are classified (as shown in Fig. 3).

A household or domestic water audit assesses how much water is used and how much water can be saved in the home. It is an excellent opportunity to get a detailed assessment of water use in the houses and awareness of saving water. It involves calculating the water use and determining easy ways to conserve water in houses. Fig. 4 represents the steps involved in a domestic water audit process.

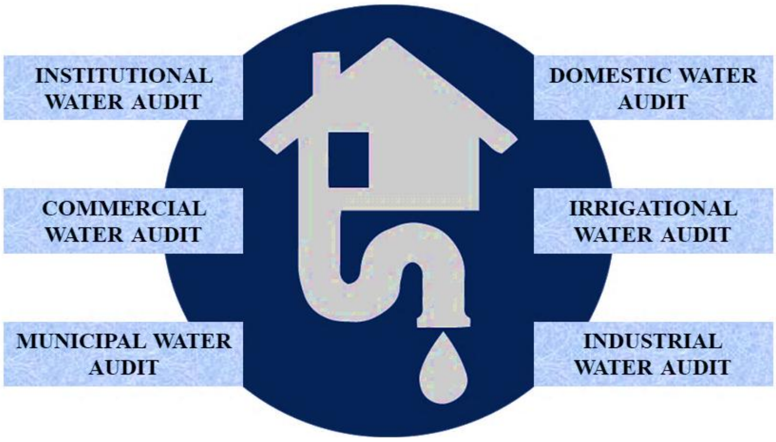

Fig. 3. Classification of water audit

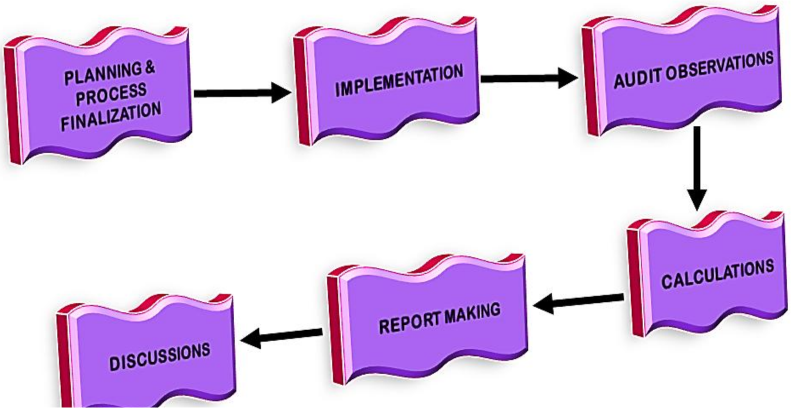

Fig. 4. Flowchart representation of a domestic water audit

A water audit has done the intelligence and validation of the distribution system. It provides a way to inventory all water uses in our facility and identify ways to increase water use efficiency. It can identify the risk and problem areas and significantly understand what is happening to the water after leaving the source point. The results can help us sequential steps to execute cost-effective water-saving measures. Conduction of a water audit can help us save money by decreasing our home water bill (and sewer bill is connected to a public sewer system). It is possible to cut our water usage by thirty percent (%) by implementing simple conservation measures without drastically modifying our lifestyle. Thus, such a tool like a water audit identifies money wastage of the public due to water loss and unauthorized connection as a benefit over the increased utilization of water resources with environmental protection [9,10]. The water audits have observed a variety of benefits. These benefits of water audit are listed in Fig. 5.

Each person's water supply and sanitation facility must be continuous and sufficient for personal and domestic uses. These ordinarily include drinking, personal sanitation, clothes washing, food preparation, and personal and household hygiene. At the international level, guidelines for per capita water consumption have been set by World Health Organization (WHO). At the national level, the guidelines regarding this are given by the Bureau of Indian Standards (BIS). WHO is a specialized organization of the United Nations and was established in 1948. It is an international body responsible for the health of the public. It produces guidelines for regulation and standard-setting in developed and developing countries globally. Drinking water quality is a powerful environmental determinant of health. The guidelines are developed through a worldwide consultative process that involves member states of WHO (India is the member state), national authorities, and international agencies in consultation with the WHO Expert Advisory Panel.According to the WHO,

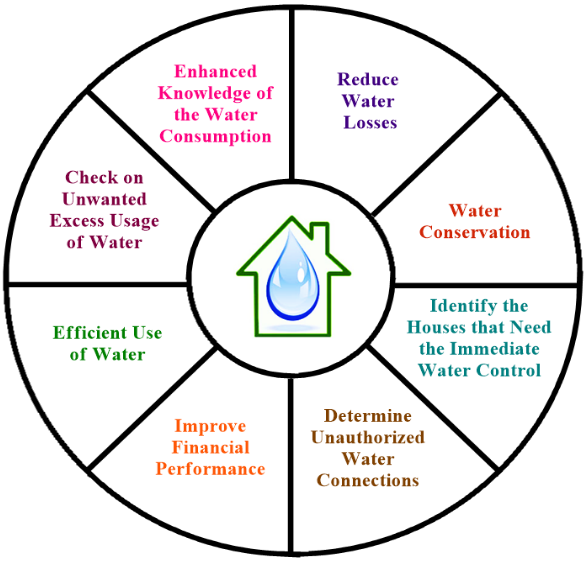

Fig. 5. Benefits of water audit

between 50 and 100 liters of water per person per day are required to secure that most basic needs are met, and few health concerns arise. In India, BIS is the recognized body of standards established under the BIS Act 2016 for the balanced development of standardization, marking, and quality certification of goods and matters connected to that or incidental to them. It provides safe, reliable quality goods, minimizes health hazards to consumers, promotes imports and exports substitutes; controls the proliferation of varieties, etc., through standardization, certification, and testing. According to the BIS, the requirement includes drinking, cooking, sanitation, house cleaning, clothes washing, etc. Sprinkling requirements include water for garden watering, lawn sprinkling, car washing, etc., [11]. Household consumption under usual conditions in an Indian city as per National Building Code has been taken as 135 liters per head per day (in short, designated as lhd) or liters per capita per day (lpcd). Similarly, the water requirement will be more than a small town for a big city per capita. Per capita demand for a place may be as low as 75 lpcd to as high as 500 to 600 lpcd.

Water quality tells the condition of the water, including physical, chemical, and biological properties, respective to the demands of one or more living species and any human demands and desires [12]. The water quality of lakes and rivers varies with the geographic areas and seasons, although no pollution exists. Good water quality suggests that pollutants, i.e., harmful matters are not present in the water, and there is a presence of required substances (oxygen, nutrients). Strangely, there is no particular measure that composes good water quality. Poor water quality indicates that water does not support beneficial use. The water quality index (WQI) is a vital parameter for determining drinking water quality in urban, rural, and industrial areas [13]. WQI gives a quantitative result that expresses the overall water quality depending upon some water quality parameters at a specific time and location. The primary purpose of WQI is to convert complicated water quality data into useful information for the public [14,15]. Water Quality Index (WQI) range, status, and possible water usage are shown in Table 1 [16].

Water quality analysis is required to measure water's physical, chemical, and biological characteristics by following some standard methods. Therefore, it is a measure of conditions relative to the need of humans or even the requirements of various land or aquatic animal species. For this, various parameters are considered to check whether they are following the standards or not. Water quality standards are placed to assure the usefulness of water for a selected purpose. If these parameters do not meet the standards, further preventive measures are required for social well-being and good economic health [10, 17]. Water quality analysis is vital because it assures that end-users will remain well-functioning and healthy if proper standards are continued. The end users are

Table 1. Summarize data of WQI

WQI Value	Water Quality Status (WQS)	Grading	Uses/ Purpose
0-25	Excellent	A	Drinking, Irrigation & Industrial
26- 50	Good	B	Drinking, Irrigation & Industrial
51- 75	Poor	C	Irrigation & Industrial purposes
76- 100	Very poor	D	Irrigation
>100	Not suitable for drinking	E	Proper treatment required

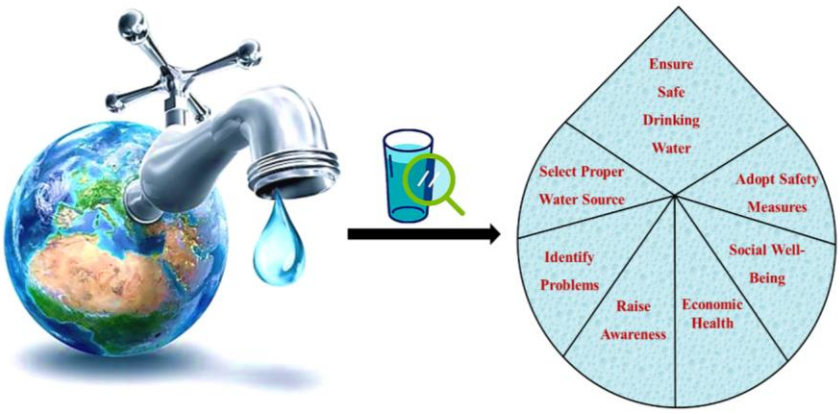

Fig. 6 Benefits of water quality analysis

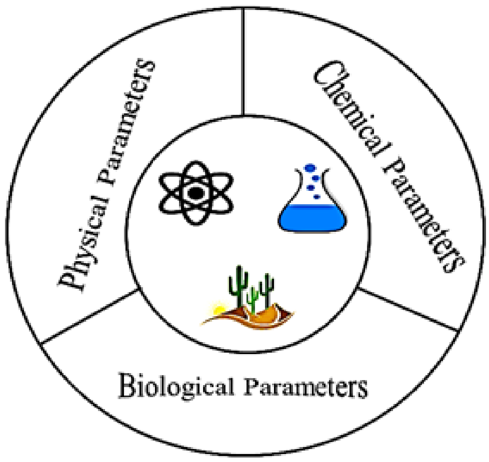

Fig. 7. Water quality parameters

people drinking healthily, industries operating without implements caused by off-spec water, or natural environments thriving thanks to the lack of pollution. Each user has a concentration threshold for the different contaminants, beyond which poorer water quality will have an adverse effect [18]. The importance of water quality analysis is shown in Fig. 6.

Three water quality parameters help measure water quality, including physical, chemical, and biological parameters (Fig. 7.) [19].

Physical parameters are determined by the senses of sight, smell, touch, and taste. These parameters are as follows:

1. **Colour:** The color of water has been impacted by the materials decomposed from organic substances such as inorganic matter (like stones, soil, and rocks) and vegetation.For aesthetic reasons, water quality is primarily concerned with color in water. Colored water indicates that it is incapable of drinking, however, the water may be excellently healthy for public use.

2. **Taste and Odor:** Organic materials released directly into the water, such as runoff, falling leaves, etc., are sources of taste and odor-producing compounds released during biodegradation. Taste and odor are human perceptions of water quality [20].
3. **Turbidity:** It measures the cloudiness of water and the light-transmitting characteristics of water. It is constituted of colloidal and suspended material.
4. **Temperature:** It disturbs a few of the essential physical properties of water: viscosity, density, surface tension, etc. With the rising temperature, there is an increase in chemical and biological reaction rates.

Chemical parameters reflect the soils and rocks the water has been in contact with. Moreover, agricultural-urban runoff and municipal-industrial treated wastewater impact the water quality. Microbial and chemical transformations also affect the chemical characteristics of water. These parameters are the following:

1. **Total Dissolved Solids (TDS):** This evaluates the inorganic salts and small quantity of organic matter present in solution in water. The principal constituents are calcium, magnesium, sodium, and potassium cations and carbonate, hydrogen carbonate, chloride, sulfate, and nitrate anions.
2. **Electrical Conductivity (EC):** The conductivity measures the ability of water to conduct electrical current. The electrical conductivity enhances as the concentration of TDS is raised.
3. **pH:** It measures the acidity or basicity of water. Generally, a pH scale ranges from 0 to 14, with 7 being neutral. A pH of less than 7 designates acidity, whereas a greater than 7 indicates a base.
4. **Hardness:** Water hardness measures the amount of magnesium and calcium salts in the water. Weathering of rocks is responsible for absorbing calcium and magnesium in water. The hardness of water enhances as the calcium and magnesium salts increase in water.
5. **Acidity and Alkalinity:** Acidity measures a solution’s ability to react with a strong base (usually NaOH, i.e., sodium hydroxide) to an agreed pH value. Alkalinity measures a solution’s ability to react to a predetermined pH with a strong acid (usually sulfuric acid H_2SO_4).

Biological parameters are used to describe the presence of microbiological organisms and are more important than physical and chemical parameters in terms of the direct effect on human health. These include the following:

1. **Bacteria:** A bacteria is a single-celled plant that can ingest food and reproduce rapidly if the pH of water, food supply, and temperature is ideal. In most cases, bacteria will reproduce slowly in colder water. Many harmful waterborne diseases can be caused by high amounts of bacteria in water, including cholera, typhoid, and tularemia.
2. **Algae:** Algae is a tiny, microscopic plant consisting of photosynthetic pigments. The chief issues caused by algae include poor taste and strange odor problems.
3. **Viruses:** These are tiny biological structures that can harm a person’s health. Only strong electronic microscopes can view viruses. All viruses require parasites to live. They can pass through most filters because of how small viruses are.

The process of advancement of water quality standards was first directed by the Water Quality Act (1965) and continued by requirements in the Federal Water Pollution Control Act (1972), with amendments in 1977, 1982, and 1987 (collectively referred to as the Clean Water Act). A water quality standard defines a water body's water quality goals, or a portion thereof, by designating the water uses and setting criteria that protect the designated uses. Water quality standards aim to protect public health and the environment and keep the water quality standards consistent with their designated uses. The World Health Organization produces international norms on water quality and human health (shown in Table 2). The quality standards for drinking water are prescribed by the Bureau of Indian Standards (shown in Table 3) in India.

The main aims of the present research are to determine physical losses due to overflow and pipe leakage, find out the debt due to metering errors, water conservation, unauthorized connections, accessible water supply to be provided by the municipal authority for park and public stand posts in the distribution system, to obtain quantitative information on physicochemical parameters of drinking water via sampling, to find whether the water quality complies with the standards or not and so is advisable for drinking or not, to investigate the capability of an organization

Table 2. World Health Organization (WHO) drinking water specifications

S.No.	Parameters	Units	Desirable Limits	References
01	Colour	Hazen Units	5-50	[21]
02	Taste & Odor	-	Unobjectionable	[21]
03	TDS	Parts Per Million (PPM) or Milligram per liter (mg/L)	500-1500	[21]
04	pH	-	6.5- 9.2	[21]
05	EC	Microsiemens per centimeter (µS/cm)	300	[22]

Table 3. Bureau of Indian standards (bis) drinking water specifications (IS 10500: 2012)

S.No.	Parameters	Units	Desirable Limits	References
01	Colour	Hazen Units	5- 15	
02	Taste & Odor	-	Agreeable	
03	TDS	Parts Per Million (PPM) or Milligram per liter (mg/L)	500-2000	[23, 24]
04	pH	-	6.5- 8.5	
05	EC	Microsiemens per centimeter (µS/cm)	300-2250	[24]

working for quality maintenance, to check if there is a need to change the existing water supply system, and to find whether the water quality complies with rules and regulations.

2. MATERIALS AND METHODS

2.1 Materials

A digital pH Meter was used to measure the pH, acidic and alkaline buffer solutions of 6.86 pH and 4.00 pH, respectively, prepared in 250 ml of distilled water, were used to calibrate the digital pH meter before use to ensure accurate readings. A three-in-one digital TDS, EC, and temperature meter was used to record the readings. It produces values corresponding to the TDS, EC, and temperature in ppm, micro-Siemens/cm, and ℃ or °F, respectively. A compass was used to measure each house's coordinates, i.e., latitude and longitude.

2.2 Methods

For the domestic water audit purpose, information on house number, total number of people, water tank capacity (in Liters), and water tank filling time from every house was taken. Each house's coordinates (latitude/ longitude) were recorded using a digital compass. Water samples were collected from each house to analyze different physicochemical parameters. Firstly, a 250 mL buffer solution was prepared to calibrate the digital pH meter for water analysis. After the proper calibration of the pH meter, the pH of each sample was measured and noted. After this, each sample's TDS, EC, and temperature were also measured. At last, an inventory was prepared to compile all the information gathered regarding the water auditing and analysis. Calculations were made of each house's total water consumption and per capita water consumption.

The formulae used for calculating per capita water consumption are as followed:

If, Total Number of People = P
Water Tank Capacity = C
Filling time = T
∴ Total Water Consumption, W = C × T
Now,
Per Capita Water Consumption, N = $C/_P$

2.3 Study Area: Haibat Mau Mawaiya, Raibareli Road, Lucknow, India

The locality Haibat Mau Mawaiya falls in Ibrahimpur Ward No. II, Lucknow. The area has a latitude of 27.1093 and a longitude of 80.6868. It covers an area of about 4.96 km^2. As of 2020, there is a total population of 25226, out of which 13134 are male and 12092 are female. There is a population density of about 5085.88 people/km^2. The map of the study area has been shown in Fig. 8.

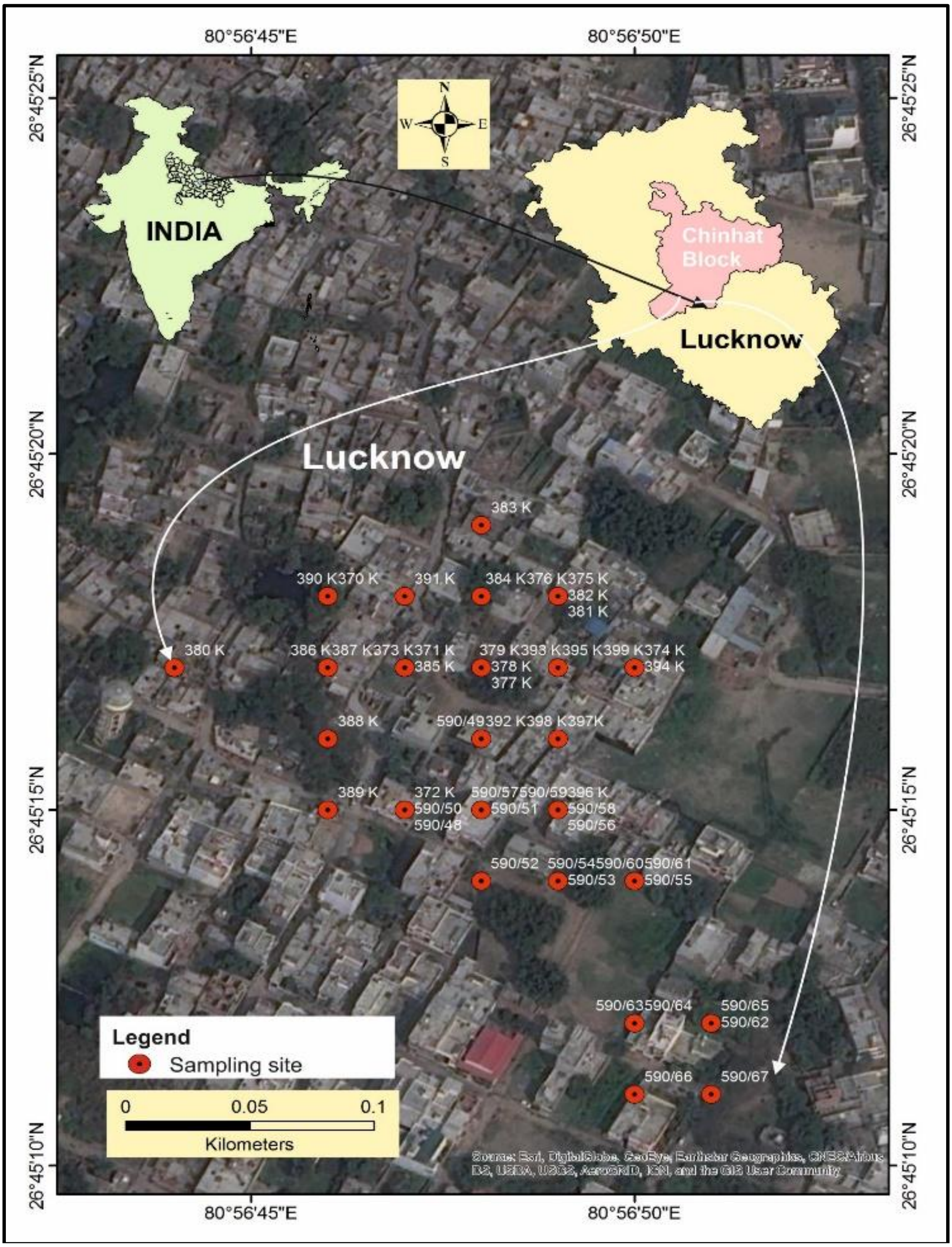

Fig. 8. Map of the study area

3. RESULTS AND DISCUSSION

Water auditing is a repetitive, systematic, and documented process of objectively obtaining a balance between water input and water output from an operation. The lower and upper limits of per capita water consumption by BIS in India are 135 lpcd and 250 lpcd, respectively. The data collected during the water audit is shown in Table 4. Results showed the following:

- The maximum per capita water consumption is 500 lpcd.
- The minimum per capita water consumption is 125 lpcd.
- Only house number 380 K has per capita water consumption below the BIS's lower limit.
- House numbers 590/67, 378 K, 379 K, 398 K, 399 K, 377 K, 590/52, 393 K, 385 K, 397 K, 375 K, 590/53, 590/57, 590/64, 388 K and 374 K have consumption above the lower limit and below the upper limit set by BIS.
- House numbers 381 K, 382 K, 384 K, 391 K, 395 K, 373 K, 590/54, 590/55, and 590/58 are at the upper limit of per capita water consumption by BIS.
- House numbers 590/51, 590/52, 590/53, 590/54, 590/55, 590/56, 590/57, 590/58, 590/59, 590/60, 590/61, 590/62, 590/63, 590/64, 590/65, 590/66, 590/67, 590/68, 590/69, 590/70, 590/71, 590/72, 590/73, and 590/74 have the per capita water consumption above the upper limit of BIS. Therefore, these houses need immediate water control for water conservation.

Pie chart representation of per capita water consumption and graphical representation of per capita consumption of each house are shown in Fig. 9 and 10, respectively.

Water quality assessment is essential to check the suitability of a water source for a particular use. The water samples of every house in the study area were analyzed for physicochemical parameters, including temperature, total dissolved solids (TDS), electrical conductivity (EC), and pH. The collected data is shown in Table 5. Results showed the following:

- **Temperature:** The temperature variation is mainly due to weather conditions and atmospheric temperature. The minimum temperature was 18.1℃ at house number 389 K, and the maximum temperature was 22.0℃ at house numbers 378 K, 395 K, 372 K, and 590/54.
- **TDS:** During the study, TDS was found within the permissible range at all houses. The minimum TDS was 450 ppm at house number 378 K, and the maximum TDS was 675 ppm at house numbers 388 K, 397 K, and 590/67.
- **EC:** It was also within the permissible limit at all the houses in the study area. The minimum EC was 900 μS/cm at house number 378 K, and the maximum TDS was 1350 μS/cm at house numbers 388 K, 397 K, and 590/67.
- **pH:** Minimum pH was seven at house number 374 K and maximum pH was 8 at house numbers 590/49, 590/50, 590/57, and 590/67. pH was found within the permissible range at all houses.

The plots for graphical representation of the temperature, TDS, EC, and pH of each house are shown in Fig. 11(a-d).

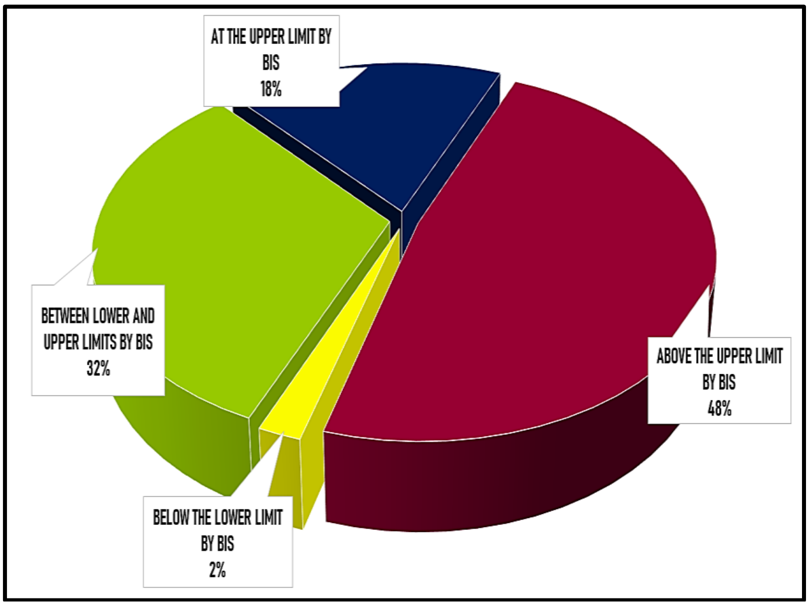

Fig. 9. Pie chart representation of per capita water consumption

Table 4. Water audit inventory

S. No.	House No.	Coordinates		No. of People	Water Tank Capacity (Liters)	Filling Time	Total Water Consumption	Per Capita Water Consumption
		Latitude	Longitude					
1	377 K	26°45´17´	80°56´48´´	12	500	4	2000	166.67
2	378 K	26°45´17´	80°56´48´´	20	1000	3	3000	150.00
3	379 K	26°45´17´	80°56´48´´	20	1000	3	3000	150.00
4	380 K	26°45´17´	80°56´44´´	8	1000	1	1000	125.00
5	381 K	26°45´18´	80°56´49´´	4	500	2	1000	250.00
6	382 K	26°45´18´	80°56´49´´	8	1000	2	2000	250.00
7	383 K	26°45´19´	80°56´48´´	5	500	3	1500	**300.00**
8	384 K	26°45´18´	80°56´48´´	4	500	2	1000	250.00
9	385 K	26°45´17´	80°56´47´´	11	500	4	2000	181.81
10	386 K	26°45´17´	80°56´46´´	12	1000	5	5000	**416.67**
11	387 K	26°45´17´	80°56´46´´	10	600	6	3600	**360.00**
12	388 K	26°45´16´	80°56´46´´	10	300	7	2100	210.00
13	389 K	26°45´15´	80°56´46´´	5	500	3	1500	**300.00**
14	390 K	26°45´18´	80°56´46´´	6	1000	3	3000	**500.00**
15	391 K	26°45´18´	80°56´47´´	4	500	2	1000	250.00
16	392 K	26°45´16´	80°56´48´´	6	1000	3	3000	**500.00**
17	393 K	26°45´17´	80°56´49´´	25	1500	3	4500	180.00
18	394 K	26°45´17´	80°56´50´´	7	1000	2	2000	**285.71**
19	395 K	26°45´17´	80°56´49´´	8	500	4	2000	250.00
20	396 K	26°45´15´	80°56´49´´	5	1000	2	2000	**400.00**
21	397 K	26°45´16´´	80°56´49´´	5	500	2	1000	200.00
22	398 K	26°45´16´´	80°56´49´´	10	500	3	1500	150.00
23	399 K	26°45´17´´	80°56´50´´	25	2000	2	4000	160.00
24	376 K	26°45´18´´	80°56´49´´	5	500	3	1500	**300.00**
25	375 K	26°45´18´´	80°56´49´´	5	500	2	1000	200.00
26	374 K	26°45´17´´	80°56´50´´	7	500	3	1500	214.28
27	373 K	26°45´17´´	80°56´47´´	8	1000	2	2000	250.00
28	372 K	26°45´15´´	80°56´47´´	8	500	5	2500	**312.50**
29	371 K	26°45´17´´	80°56´47´´	4	500	4	2000	**500.00**
30	370 K	26°45´18´´	80°56´46´´	5	500	3	1500	**300.00**
31	590/48	26°45´15´´	80°56´47´´	9	500	5	2500	**277.78**
32	590/49	26°45´16´´	80°56´48´´	12	1500	4	6000	**500.00**
33	590/50	26°45´15´´	80°56´47´´	3	500	2	1000	**333.34**
34	590/51	26°45´15´´	80°56´48´´	11	1000	3	3000	**272.73**
35	590/52	26°45´14´´	80°56´48´´	6	500	2	1000	166.67
36	590/53	26°45´14´´	80°56´49´´	5	500	2	1000	200.00
37	590/54	26°45´14´´	80°56´49´´	6	500	3	1500	250.00
38	590/55	26°45´14´´	80°56´50´´	4	500	2	1000	250.00
39	590/56	26°45´15´´	80°56´49´´	4	500	3	1500	**375.00**
40	590/57	26°45´15´´	80°56´48´´	5	500	2	1000	200.00
41	590/58	26°45´15´´	80°56´49´´	8	500	4	2000	250.00
44	590/59	26°45´15´´	80°56´49´´	11	1000	4	4000	**363.64**
43	590/60	26°45´14´´	80°56´50´´	10	1000	3	3000	**300.00**
44	590/61	26°45´14´´	80°56´50´´	15	1500	3	4500	**300.00**
45	590/62	26°45´12´´	80°56´51´´	12	500	8	4000	**333.34**
46	590/63	26°45´12´´	80°56´50´´	6	500	6	3000	**500.00**
47	590/64	26°45´12´´	80°56´50´´	5	500	2	1000	200.00
48	590/65	26°45´12´´	80°56´51´´	9	750	5	3750	**416.67**
49	590/66	26°45´11´´	80°56´50´´	2	300	3	900	**450.00**
50	590/67	26°45´11´´	80°56´51´´	7	500	2	1000	142.86

** The bold red color data in the table shows that these houses are consuming much more water than the standards set by the BIS*

Table 5. Water analysis inventory

S. No.	House No.	Coordinates		Temperature (℃)	Total Dissolved Solids (PPM)	Electrical Conductivity (µS/cm)	pH
		Latitude	Longitude				
1	377 K	26°45´17´´	80°56´48´´	20.8	527.5	1055	7.8
2	378 K	26°45´17´´	80°56´48´´	22.0	450.0	900	7.7
3	379 K	26°45´17´´	80°56´48´´	21.1	475.0	950	7.8
4	380 K	26°45´17´´	80°56´44´´	18.2	487.5	975	7.9
5	381 K	26°45´18´´	80°56´49´´	20.0	558.0	1116	7.5
6	382 K	26°45´18´´	80°56´49´´	19.8	590.0	1180	7.9
7	383 K	26°45´19´´	80°56´48´´	21.0	559.5	1119	7.4
8	384 K	26°45´18´´	80°56´48´´	20.2	544.0	1088	7.5
9	385 K	26°45´17´´	80°56´47´´	19.1	502.0	1004	7.1
10	386 K	26°45´17´´	80°56´46´´	19.1	544.0	1088	7.4
11	387 K	26°45´17´´	80°56´46´´	20.1	605.0	1210	7.7
12	388 K	26°45´16´´	80°56´46´´	20.9	675.0	1350	7.5
13	389 K	26°45´15´´	80°56´46´´	18.1	550.0	1100	7.3
14	390 K	26°45´18´´	80°56´46´´	20.0	549.0	1098	7.6
15	391 K	26°45´18´´	80°56´47´´	21.0	500.0	1000	7.7
16	392 K	26°45´16´´	80°56´48´´	20.2	531.5	1063	7.4
17	393 K	26°45´17´´	80°56´49´´	21.0	600.0	1200	7.6
18	394 K	26°45´17´´	80°56´50´´	20.0	505.0	1010	7.2
19	395 K	26°45´17´´	80°56´49´´	22.0	562.5	1125	7.4
20	396 K	26°45´15´´	80°56´49´´	21.0	555.0	1110	7.1
21	397 K	26°45´16´´	80°56´49´´	19.2	675.0	1350	7.5
22	398 K	26°45´16´´	80°56´49´´	20.1	555.0	1110	7.3
23	399 K	26°45´17´´	80°56´50´´	21.1	527.0	1054	7.6
24	376 K	26°45´18´´	80°56´49´´	19.8	487.0	974.0	7.1
25	375 K	26°45´18´´	80°56´49´´	20.7	545.0	1090	7.9
26	374 K	26°45´17´´	80°56´50´´	20.8	500.0	1000	7.0
27	373 K	26°45´17´´	80°56´47´´	18.3	531.0	1062	7.3
28	372 K	26°45´15´´	80°56´47´´	22.0	562.0	1124	7.6
29	371 K	26°45´17´´	80°56´47´´	21.9	610.0	1220	7.9
30	370 K	26°45´18´´	80°56´46´´	18.7	605.0	1210	7.8
31	590/48	26°45´15´´	80°56´47´´	19.8	585.0	1170	7.7
32	590/49	26°45´16´´	80°56´48´´	18.5	470.0	940	8.0
33	590/50	26°45´15´´	80°56´47´´	19.9	495.0	990	8.0
34	590/51	26°45´15´´	80°56´48´´	19.0	510.0	1020	7.1
35	590/52	26°45´14´´	80°56´48´´	21.5	560.0	1120	7.2
36	590/53	26°45´14´´	80°56´49´´	21.8	549.0	1098	7.5
37	590/54	26°45´14´´	80°56´49´´	22.0	600.0	1200	7.6
38	590/55	26°45´14´´	80°56´50´´	20.3	562.5	1125	7.2
39	590/56	26°45´15´´	80°56´49´´	19.7	487.0	974	7.9
40	590/57	26°45´15´´	80°56´48´´	18.2	499.0	998	8.0
41	590/58	26°45´15´´	80°56´49´´	21.6	519.0	1038	7.3
42	590/59	26°45´15´´	80°56´49´´	20.8	505.0	1010	7.1
43	590/60	26°45´14´´	80°56´50´´	19.1	580.0	1160	7.5
44	590/61	26°45´14´´	80°56´50´´	18.2	601.0	1202	7.6
45	590/62	26°45´12´´	80°56´51´´	20.1	615.0	1230	7.9
46	590/63	26°45´12´´	80°56´50´´	20.5	499.0	998	7.1
47	590/64	26°45´12´´	80°56´50´´	21.1	507.0	1014	7.2
48	590/65	26°45´12´´	80°56´51´´	21.2	544.0	1088	7.4
49	590/66	26°45´11´´	80°56´50´´	19.3	605.0	1210	7.9
50	590/67	26°45´11´´	80°56´51´´	18.4	675.0	1350	8.0

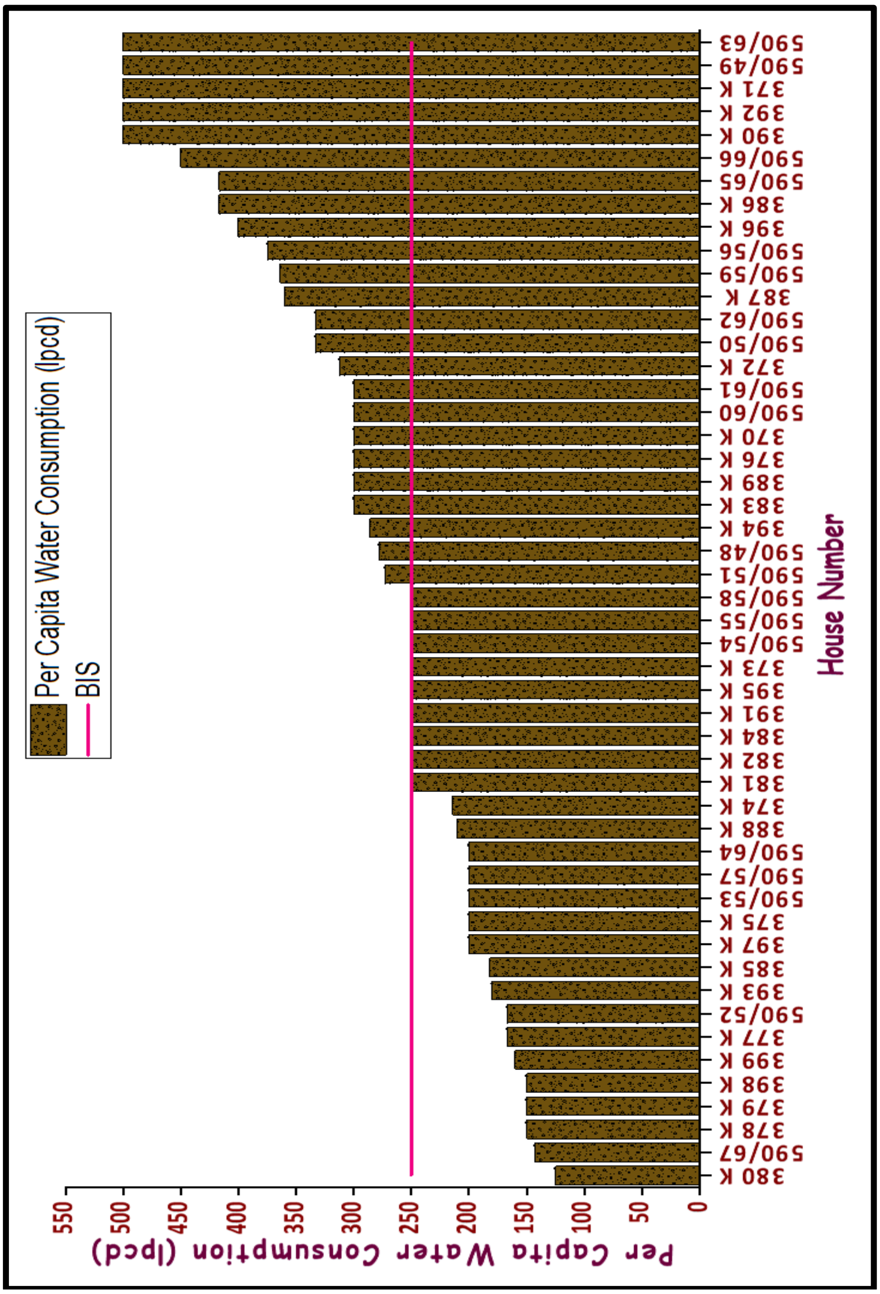

Fig. 10. Graphical representation of per capita consumption of each house

Concerning today's scenario, water audit has become an unavoidable activity in India and the world. Therefore, a water audit is a tool to identify the quantity of water used, the status of the water supply system, the cost of energy to utilize the water supply scheme, physical losses due to pipe leakage and overflow, unauthorized access connections, etc. It identifies areas where consumption can be reduced, and water can be conserved. Twenty-four houses in the study area have per capita water consumption above the limit set by BIS in India. So, these houses are advised to conserve water and hence save money. Many precautionary measures can be taken. Every method should be considered toreduce water loss, leak detection, timely response to maintenance problems, and development of water supply systems. Plans for improving metering, loss control, pressure management, outflow prevention, and consumer education should be implemented. Water can also be conserved by water harvesting, recycling water, and using rainwater.

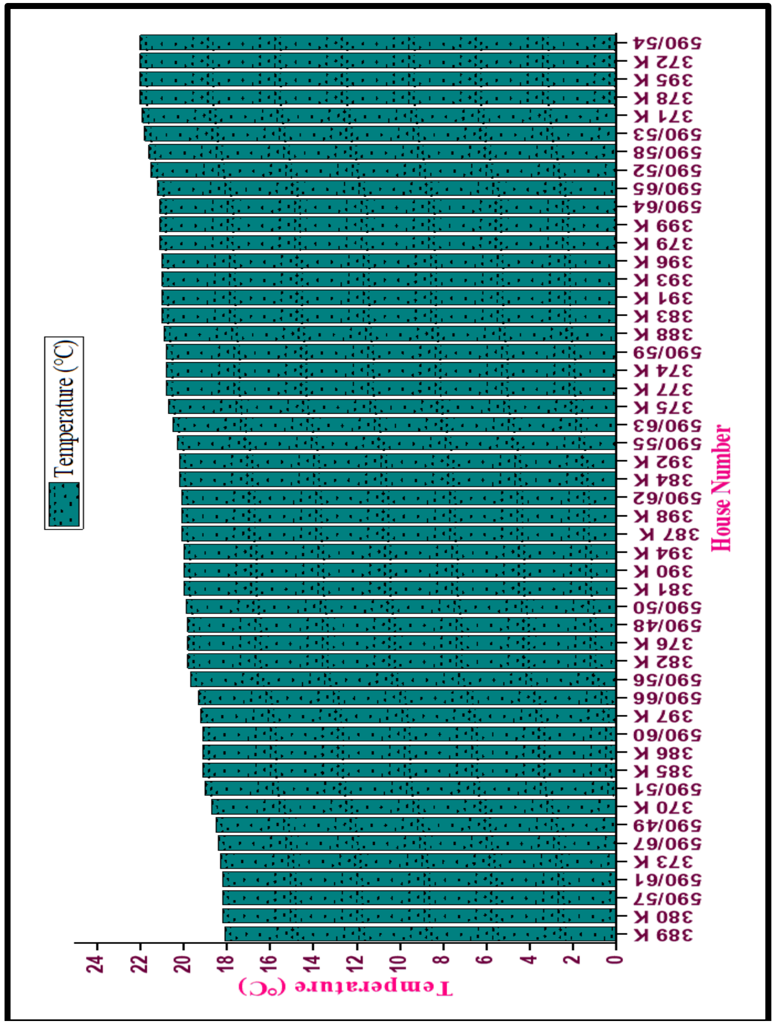

Fig. 11(a). Graphical representation of the temperature of each house

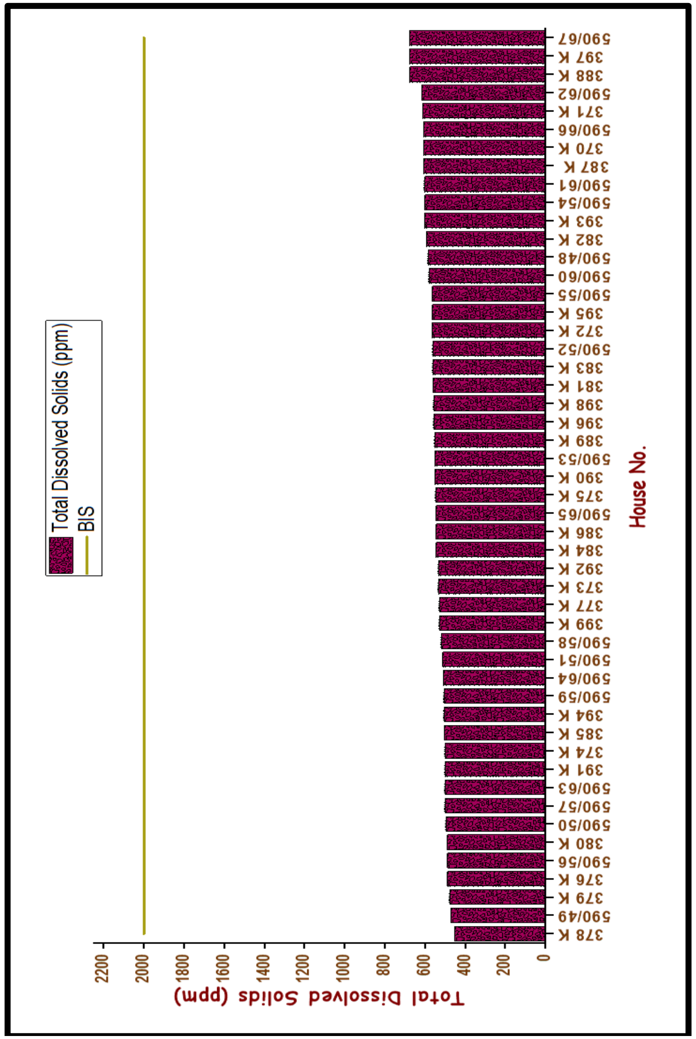

Fig. 11(b). Graphical representation of TDS of each house

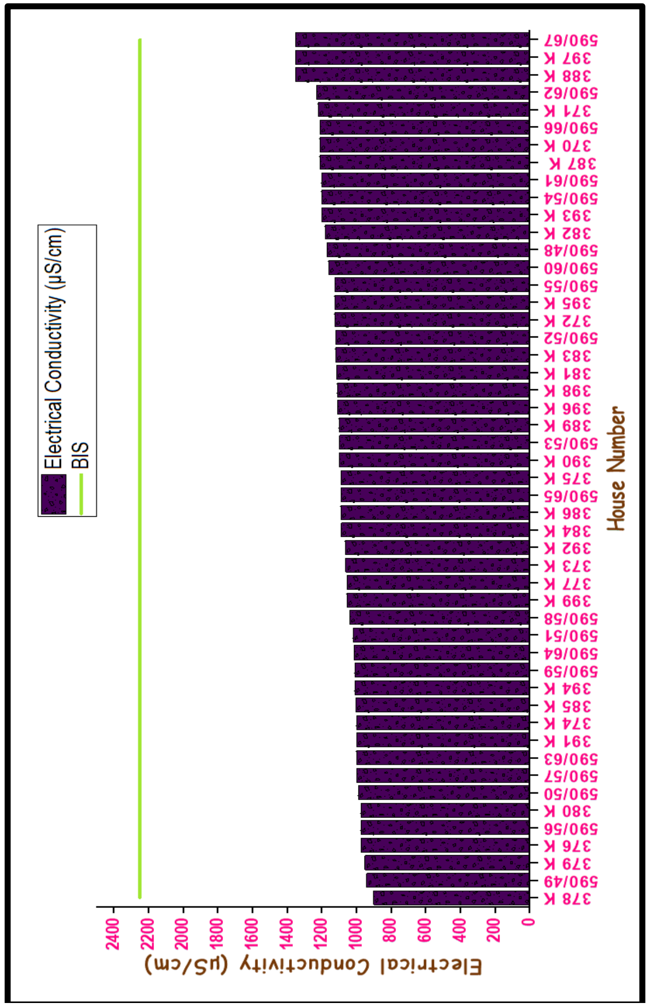

Fig. 11(c). Graphical representation of EC of each house

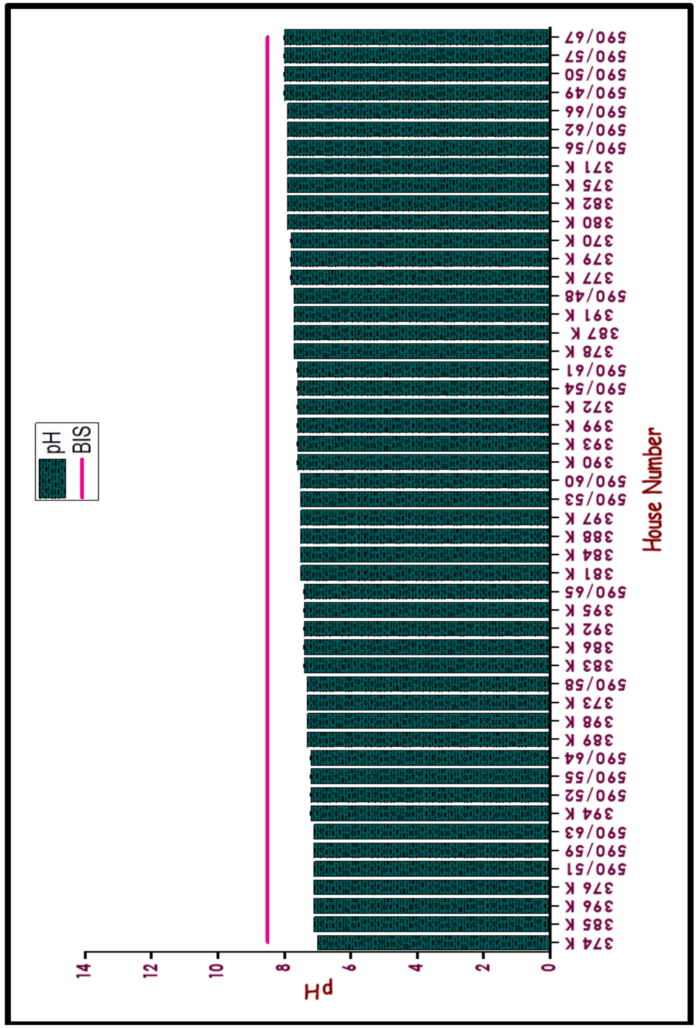

Fig. 11(d). Graphical representation of pH of each house

Good water quality is crucial for ecosystems and the economy [25]. Water quality tells the condition of the water, including physical, chemical, and biological properties, respective to the demands of living species and any human demands and desires. Water quality assessment is essential to determine the suitability of a water source for a particular use like drinking, bathing, etc. If the physicochemical parameters do not meet the standards, further preventive measures are required for social well-being and good economic health. The water quality of every house in the area is good, and the physicochemical parameters taken for analysis are according to the standards set by BIS. Hence, the water is suitable for any desired purpose, including drinking, and as of now, there is no requirement to take any preventive measures to make the water quality good.

4. CONCLUSION

The present study deals with water audit and water quality analysis which was conducted in the Indrapuri Colony, Haibat Mau Mawaiya, Lucknow, India. It reveals that the water audit can be a good tool for the status of the water supply system, the cost of energy to utilize on the water supply scheme, to find out the overflow and physical losses due to pipe leakage, and unauthorized access connections. It has enormous potential cost savings achievable by water harvesting, recycling water, and using rainwater. Thus, water auditing might be viewed as quantitative water conservation in the broadest sense. The results show that a few houses' per capita water consumption is more than the standards set by the BIS for per capita water consumption. Those houses that do not meet BIS's per capita water consumption limit are advised to optimize the water for better growth for future generations and bring water losses to less than 15%. Water quality tells the condition of the water, including physical, chemical, and biological properties respective to a living species daily demands and desires. Water quality assessment is essential to check the suitability of a water source for a particular use. Several physicochemical parameters (temperature, TDS, EC, and pH) of water were assisted and compared with their standard values to determine whether the water quality was good. The result of the water analysis showed that the quality of water is good and meets the standards set by the BIS and WHO. The efficiency of water use complements water conservation. The aim is to maximize the social, economic, environmental, and ecological benefits from the water's given quantity and quality.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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