Corrosion Management ISSN: 1355-5243
(https://corrosion-management.com/)
Volume 35, Issue 02 – 2025
SCOPUS

Assessment of Drinking Water Quality level in Narnaul, City of Haryana

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Abstract

Human existence depends on water accessibility, as well as quantity and quality. Over 50% of water is wasted in the home, agricultural, and industrial sectors as a result of extensive water extraction for these uses. A large portion of the accessible water is becoming unfit to drink due to water contamination. Surface water is the primary source of drinking water for most of Indians. The WQI, or Water Quality Index, calculates an individual value that measures the overall state of the water at a given location and time. The Indian Council of Medical Research (ICMR) and the Bureau of Indian Standards (BIS) provide a standardized method for computing the Water Quality Index, which is used in this work. The aim of this work, is to assess the Water Quality Index (WQI) of drinking water in the Narnaul city, which is based upon both primary and secondary data, The analyzed data is contrasted with the standard values that the ICMR and BIS recommend. Number of water quality parameters, including pH, total alkalinity, calcium, magnesium, chloride, sulfate, and nitrate, are taken into account in this work in order to compute the WQI. Additionally, the periodical, fluctuations of the Physicochemical characteristics of the quality of water Narnaul city are calculated. The results shows According to the WQI values, the east of the city had a higher percentage of drinking water in the excellent water quality category, while the south had neutral water quality.The water quality index (WQI) is different everywhere in the city . The lowest variation was in Sample4 (Rewari Rode bore-well) 15.144339, and the highest variation was in Sample10 (Nalapur bore-well) 222.7897. A more methodical approach, the WQI method makes it easier to compare the drinking water quality of multiple sampling locations.It is clearly visible from the view that only about 50% samples in the city have suitable quality for drinking water. It is very important to treat the remaining 50% sampling stations before use. The quality of water is poor in most parts of the study area.

Introduction

Man and water have always had a close association; in fact, it is commonly known that the initial implements used by humans may be found in river gravels dating back to the Palaeolithic era. Water is indeed the fundamental component of all life and is essential for various activities, including residential, agricultural, and industrial purposes, for which there is no viable substitute.This circumstance makes it clear that water is necessary even for the most primitive man. Even in the age of contemporary science, It is uncommon to fully grasp the implications of this truth and the numerous direct and indirect ways in which humans depend on water (Bilas, 1981). In addition to all of the rigorous efforts to advance hydrology and water resources, the scientific and technological understanding of these resources has grown significantly. water, and an authorized synthesis of this knowledge is desperately needed. This knowledge is quite extensive and multidisciplinary because water is connected to so many different elements of both human culture and nature (Chow, 1964).

The current study examines the basis for using water resources for drinking purposes as well

ISSN: 1355-5243

as their quality. Water is one of the many diverse and abundant resources of nature that India possesses. Humans may live for several days without food, but water is so necessary that life is impossible without it. Water holds a special place in industry in addition to being necessary for the survival of plants and animals. Of all the water sources, groundwater is the most significant and dependable source of water worldwide. Because groundwater is depleted more quickly than it is naturally restored, people in some parts of the world are experiencing severe water shortages. Population increase and human progress have a wide range of Numerous and varied stresses are placed on the amount and quality of water resources as well as on the availability of them by human development and population increase. Since water quality evaluation and surveillance form the cornerstone of water quality management, there has been a growing need to regularly measure a variety of water quality variables in order to monitor the condition of many rivers and groundwater. It is generally accepted that groundwater is far cleaner and less polluted than surface water.

Life cannot exist without water and all individuals must have access to an adequate (suitable, secure, and attainable) supply (WHO, 2008). Enhancing access to pure drinking water can have real benefits to health. According to the Guidelines, there is no substantial danger to health from consuming safe consuming water throughout one's lifetime, even with potential sensitivity variations between life phases. The elderly, disabled, and newborns and young children are the groups most at risk for contracting a waterborne illness, particularly if they live in unhygienic surroundings. As much as possible should be done to ensure that drinking water is as safe as possible. People who are typically at risk of contracting a waterborne infection might need to take extra precautions. Every country needs a sufficient supply of clean water to support both economic growth and the improvement of human wellbeing. Water is the most precious gift of nature and the fundamental resource needed for human existence on Earth (Abebe, 2013).

All living things, including humans, plants, and animals, require water, which can be either surface or ground water. However, as a result of both population expansion and industrial development, water quality is now impacted. The underwater world and human health are being impacted by the contaminated water. The quality of surface and ground water supplies is impacted by human actions and natural processes. Living creatures, dissolved chemicals, and non-dissolved particulate matter are all naturally present in water; in fact, these components and organisms are necessary for a high-quality water supply because they sustain vital biogeochemical cycles. Rarely can naturally occurring substances cause problems with water quality that are harmful to human health (Van et al., 2009). Aquatic creatures require an ideal environment and sufficient nutrients to flourish; the water body's physical and chemical elements determine how productive they are. Human population growth, industrial development, Increased pollution of water is a result of many man-made activities, including the usage of fertilizers in agriculture. Other crucial elements that affect the development of living things in water bodies include temperature, turbidity, nutrition, hardness, alkalinity, and others (Smitha, 2013). Therefore, physico-chemical, biological, and microbiological parameters that represent the biotic and abiotic conditions of the environment are analyzed as part of the water evaluation process.

Table 1: **Water quality guidelines and regulatory organizations**

Sr.No.	Parameters	Standards	Recommended Agency
1.	pH	6.5 – 8.5	BIS/ WHO
2.	Magnesium (mg/I)	30	BIS
3.	Calcium (mg/I)	75	BIS
4.	Sulphate (mg/I)	150	BIS
5.	Chloride (mg/I)	250	BIS/ WHO
6.	Nitrate (mg/I)	45	BIS/ WHO
7.	Fluoride (mg/I)	1.5	BIS/ WHO
9.	Arsenic (mg/I)	0.01	BIS/ WHO
10.	Colour	No visible colour	BIS/ WHO

Source : Bureau of Indian Standards 2015, WHO 2019

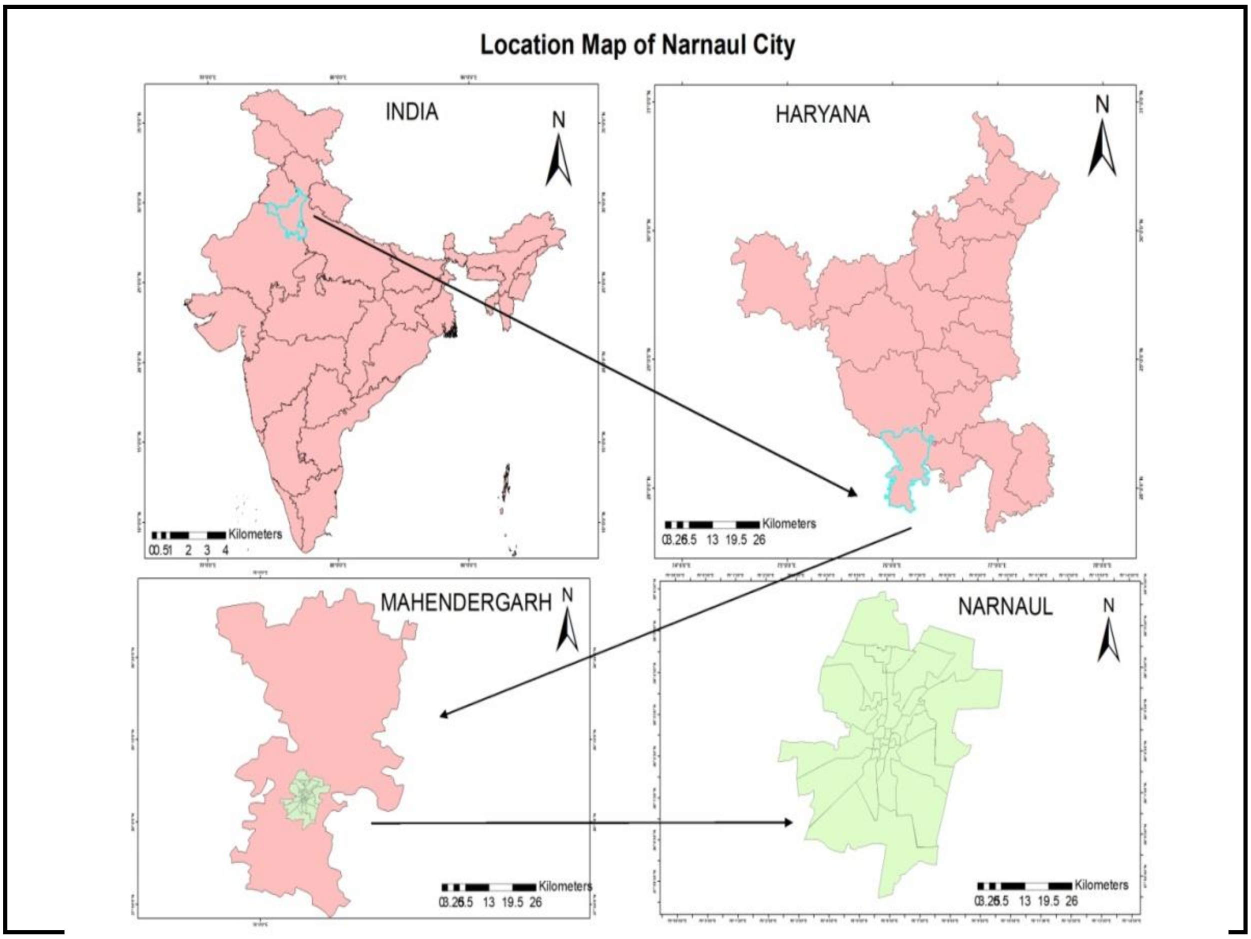
Water quantity that is accessible for drinking is directly impacted by poor water quality in a number of ways. A given area's usable water supply is significantly decreased by polluted water that is unfit for drinking, bathing, industry, or agriculture. Nevertheless, utilizing poor-quality water (such as brackish or salty water) may directly and significantly affect productive water uses like irrigated agriculture, which in turn may have significant implications on crop productivity and land degradation, and ultimately Regarding rural income and food security. Approximately 700 million people in 43 nations currently face water shortage, a condition in which there are insufficient water resources to meet humanity's long-term average needs (Falkenmark et al., 2001). Unsafe household use, agricultural production, mining operations, industrial production, power generation, and other factors can alter the physical, chemical, and biological characteristics of water, putting human health and ecological integrity at risk. Human settlement, industry, and agriculture are the main causes of water contamination. Unsanitary improper handling and disposal of both human and animal waste, poor industrial residue management and inadequacy, improper agricultural methods, and hazardous solid waste discharge are all detrimental factors associated with these activities. In developing nations, more than 80% of sewage is dumped straight into waterways without any treatment (WHO, 2008).

Material and methods

Study Area

Narnaul city is located in the south western part of Haryana state. The city is the headquarter of Mahendragarh district of Haryana state. It has been a historical region of not only the state but the entire country since the past. Before the formation of Haryana state, this city was a part of the United Punjab province. The city is of medium size and is located between 27º degrees 47′ minutes north latitude and 75 degrees 21 minutes east longitude. The area of Narnaul city is spread over 13 square kilometers. The southern part of the city forms the border with

Rajasthan. Generally, it is a plain region. Krishnavati river flows in its east and Dohan river flows in its northern part. The annual rainfall is between 50 to 100 cm and the annual temperature is 35 degree Celsius. The total population of Narnaul city is 74581 as per the year 2011. In this, the male population is 39569 and the female population is 35012. The average literacy rate is 68% and the sex ratio is 991 per thousand.



Source : Cencus 2011 & Municipal council narnaul 2022

Objectives

1. To evaluate the water quality and quality index at different stations.
2. To identify the origin and causes of the water degradation in the Narnaul city.
3. Presenting the problems arising out of excessive exploitation of ground water.
4. To study the chemical changes on the surface due to accessible using of ground water.

Methodology

The basis for this research is the primary and secondary information derived from the field servey and public health Engineering Department of Ground Water sell Narnaul, Mahendergarh district. 10 Chemical and physical parameters, such as electrical conductivity, pH, calcium, magnesium, chloride, sulfate, and nitrate, have been measured in laboratory using the Bureau of Indian Standards' (BIS) standard operating procedures. The samples are taken at a variety of boosting stations and water treatment plants in 2-liter pre-cleaned plastic bottles. To maintain the electrical conductivity and equalize the minimum volume, the water was

ISSN: 1355-5243

allowed to stream from the source for approximately four minutes. In order to prevent contamination, the bottles were held at the bottom when the samples were obtained, and they were examined right away. Within six hours, the samples were delivered to the lab, and within forty-eight hours, they were examined. The WQI was computed utilizing the quality of drinking water guidelines that the Indian Council for Medical Research , the BIS 2015, and the WHO 2019 suggest. MS Office 2007 and Arc GIS 10.4 software was used to located the sampled sites in the study area. In order to assess the drinking water's WQI, the weighted arithmetic index approach was employed. Using the following formula, the quality rating or subindex (Qn) has been further determined:

Quality Rating (Qn) = 100* [Vn – Vo] / [Sn – Vo] ………………. (i)

Qn = Quality rating for the nth water quality parameter.

Vn = Estimated value of the nth parameter at a given sampling stations.

Sn = Standard permissible value of the nth parameter.

Vo = Ideal value of nth parameter in a pure water.

In most situations, Vo = 0 is the optimal value, unless from certain criteria like pH. The pH of natural water is calculated to be 7.0, which is the quality rating.

pH assessment of quality calculation

For natural water, the pH should be 7.0, however 8.5 is OK. Thus, After that formula is used to determine the pH quality grade:

Qn = 100 [Vn (pH) – 7.0] / [8.5 – 7.0] …………….. (ii)

where (Vn pH) = the pH value that was observed

Determining the Unit weight (Wn) or Relative weight

Unit weight has been established using a value that is inversely proportional to the recommended standard values Sn of the corresponding parameters.

Unit weight (Wn) k/Sn ………..…………… (iii)

Wn = The nth parameter's unit weight.

Sn = nth parameter's standard value.

K = Percentage constant (K = 2.5)

The quality rating and the unit weight have been aggregated the overall quality index (WQI) in a linear fashion.

Water Quality Index (WQI) = ∑Wn Qn / ∑Wn ……………….(iv)

WQI = Water quality index

Wn = Weight of the nth parameter in units.

Qn, the nth parameter's quality rating.

Discussion and Results

WQI is determined by measuring a number of significant drinking water physical and chemical characteristics (Table 2). Table 3 provides a summary of the physico-chemical characteristics of ten various stations (Sample1…. Sample10). Some notable differences in the physico-chemical data can be observed at all the

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ISSN: 1355-5243
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thirteen sampling locations throughout the Narnaul city, the study region. Seasonal variations in temperature is one example of a hidden factor that can occasionally have greater control over certain characteristics, such as pH and electrical conductivity. Table 4 provides an example of how to calculate WQI.

Table 2 : WQI and the associated status of water quality

Sr.No.	WQI	Status	Possible usages
1.	0-25	Excellent	Drinking, Irrigation & Industrial
2.	26-50	Good	Domestic, Irrigation & Industrial
3.	51-75	Neutral	Irrigation & Industrial
4.	76-100	Poor	Irrigation
5.	101-150	Very Poor	Restricted use for Irrigation
6.	Above 150	Unhealthy for Drinking	Before using, it must be properly treated.

Source : WHO, 2004.

Table 3 : Physical-chemical characteristics of samples in drinking water (mg/l)

Sr. No.	Parameter	Sample 1	Sample 2	Sample3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample9	Sample10
1.	TDS (Total dissolved solid)	220	105	350	610	191	197	211	205	2060	1200
2.	Iron (fe)	0.19	0.17	0.15	0.18	0.17	0.15	0.16	0.14	0.14	0.17
3.	Sulphate (So4)	29	34	42	54	34	40	29	24	70	80
4.	Nitrate	1.9	2.4	3.2	4.2	2.4	2.1	2.3	1.9	4.4	6.7
5.	Turbidity	0.74	0.61	0.89	0.94	0.74	0.44	0.54	0.44	1.21	3.49
6.	pH	7.24	8.02	7.94	7.44	7.23	7.26	7.41	7.39	7.55	7.68
7.	Total Hardness	190	120	160	330	120	140	150	160	390	310
8.	Calcium (Ca)	24.04	16.03	20.04	40.8	16.03	20.04	20.04	24.04	44.08	40.08
9.	Magnesium (Mg)	31.59	19.44	26.73	55.89	19.44	21.87	24.3	24.3	68.04	51.03
10.	Chloride (Cl)	214.93	114.93	169.97	244.95	149.95	159.95	169.97	184.97	334.95	284.95
11.	Total Alkalinity	175	105	120	295	95	110	105	120	315	285
12.	Fluoride	0.44	0.36	0.63	0.94	0.59	0.48	0.29	0.25	1.71	2.34

Source : Public health Engineering Department Water testing Laboratory Narnaul 2024

TDS (Total dissolved solid) : An indicator of the quantity of organic materials and inorganic salts in water is total dissolved solids, or TDS. TDS concentrations are used to categorize water into several categories and can impact how it tastes.

The TDS values for drinking water are as follows :

Indian Standards Bureau (BIS): 500 mg/L is the maximum amount of TDS that can be present in drinking water.

Corrosion Management ISSN: 1355-5243
(https://corrosion-management.com/)
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WHO (World Health Organization) : Suggests that drinking water have a TDS level of less than 300 mg/L.

TDS shows the salinity behaviour water. The TDS value of drinking water varies at different places in South Haryana. The maximum and minimum concentration of TDS in Narnaul city is between 105 to 2060 mg/liter. The majority of Narnaul City's water samples are classified as saline.

Iron (fe) : According to reports, an average iron concentration in rivers is 0.7 mg/liter. Iron concentrations in acidic water are typically between 0.5 and 10 mg/liter, although occasionally they can reach 50 mg/liter. Iron concentrations in drinking water are typically less than 0.3 mg/liter, but they may be greater in nations where water treatment facilities utilize different iron salts as mixing agents and where water is distributed via cast iron, steel, and galvanized iron pipes. The **World Health Organization (WHO) states that the amount of iron in drinking water has no health-based recommended value.** Iron concentrations in well water below 0.3 milligrams per liter (mg/L) are undetectable, according to the WHO, but values between 0.3 and 3 mg/L are tolerable.

Sulphate (So4) : The taste of water is not significantly impacted by low sulfate concentrations. 200 mg/liter of sulfate is the recognized maximum. The average concentration of sulphate in the research area is 43.6 which is acceptable.

Nitrate : For all life, nitrogen is essential. The primary mechanism that distributes nitrogen in nature is the nitrogen cycle. Numerous intricate chemical and biological processes can occur in nitrogen in the atmosphere or soil. In a continuous cycle known as the nitrogen cycle, it can be mixed with both living and non-living components before returning to the soil or air. The concentrations of nitrate ranged from 1.9 – 6.7 mg/l at the sampling sites. This is well below the WHO/BIS acceptance limit of 45mg/l.

Total Hardness : For household use, hardness is a crucial characteristic of water that significantly affects human health. The research area's hardness concentration ranged from 120 to 400 mg/L, which is a dangerous level. In 1964, Beker and Durfor 54–70% of the samples at each site were classified as having extremely hard water, which could represent a serious health risk. Aside from this, a high range of TH in water can lead to pipe corrosion and the presence of specific heavy metals. When no other water supply is available, Total hardness (as CaCO3) can be increased to 600 mg l-1, while the current maximum is 200 mg l-1.

pH : The most significant factor in determining how corrosive water is is its pH. The corrosive quality of water increases with a lower pH value. Guptaa (2009) discovered a favorable relationship between pH and total alkalinity as well as electrical conductivity. The decrease in photosynthetic activity, the uptake of bicarbonates and carbon dioxide, which ultimately causes the pH to rise, and the low oxygen levels that accompanied the summer's high temperatures. Numerous factors can cause variations in the pH of water. The higher pH values show that carbon dioxide and carbonate-bicarbonate equilibrium are more affected by physicochemical condition changes (Karanth 1987). The highest pH value measured in Naraul City is 8.02 at station S2, The lowest, however, is 7.23 at station S5. Although pH has no direct harmful effects on health, it has been demonstrated that higher pH values reduce the germicidal power of chloride and the amount of scale that forms in water heating equipment.

Turbidity : According to WHO guidelines, Drinking water should have a turbidity is 1 Nephelometric Turbidity Units (NTU), but due to lack of resources no more than 5 NTU. Turbidity in drinking water can taint water storage tanks and harm faucets and valves. The maximum turbidity in the study area is 3.49 NTU and the minimum is 0.44 NTU.

Corrosion Management ISSN: 1355-5243
(https://corrosion-management.com/)
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Calcium (Ca) : This drinking water parameter varies according to the kinds of rocks. A small amount of calcium is preventing water pipes from corroding.A crucial component of shell formation, bone formation, and plant precipitation, One of the most prevalent ions in fresh water is calcium. Calcium levels in water in Narnaul City range from the greatest at 44 mg/l to the lowest at 16.03 mg/l.

Magnesium (Mg) : People who are not used to magnesium hardness, especially that which is connected to the sulfate ion, experience a calming effect (Khursid, 1998).The majority of the elderly adult population can safely consume less than 150 mg/l of magnesium each day. Magnesium may be harmful to the body at very high concentrations. The concentration of magnesium in Narnaul town was found to be between 68.04 to 19.44 mg/l.

Chloride (Cl) : The cleanliness or impurity of the water might be linked to the chloride concentration. The existence of living things, most likely of animal origin, is indicated by the high quantities of chloride (Tresh et al., 1944). It was discovered that Narnaul city's average chloride level was 202.95 mg/liter. The city's chloride concentrations ranged from 114.93 to 334.95 mg/l at the highest and lowest points.

Alkalinity : Alkalinity, which is mostly made up of bicarbonate (HCO3-) and carbonate (CO3 2-), stabilizes pH. The toxicity of numerous chemicals in water is influenced by alkalinity, pH, and hardness. In order to prevent corrosion, boiler water must have hydroxyl alkalinity, or causticity. Foaming is one of the other operating issues brought on by excessive causticity. The boiler may experience a form of caustic attack known as "embrittlement" if the causticity levels are too high. The research area's average alkalinity was 172.5 mg/l, the city's highest was 315 mg/l, and the lowest was 95 mg/l.

Fluoride : Fluoride ions dissolved from geological conditions have been found to be more abundant in groundwater than in surface water, with the exception of situations where surface water is tainted by industrial wastewater. As a result, fluoride buildup in groundwater varies depending on the water's source, the region's geology, rainfall, and the quality of water lost through evaporation. The highest fluoride limit in the research area is 2.34 mg/l, but the WHO recommendations state that 1.0 mg/l is the acceptable limit.

Table 4 : Water Quality Index assessments for station one (S1) (mg/l)

Sr. No.	Parameters	Standard Value (Sn)	Observed Value	Quality Rating (Qn)	Unit Weight (Wn)	Qn*Wn
1.	pH	6.5-8.5	7.24	16	0.2941	4.7056
2.	Sulphate	200	29	85.5	0.0125	1.06875
3.	Nitrate	45	1.9	4.22	0.055	0.2321
4.	Fluoride	1.0	0.44	112	1.666	186.592
5.	TDS	500	220	18.66	0.00125	0.023325
6.	Total Hardness	200	190	2.5	0.00416	0.0104
7.	Calcium	75	24.04	40.768	0.0125	0.5096
8.	Magnesium	30	31.59	2.271	0.025	0.056775
9.	Chloride	250	214.93	4.676	0.0025	0.01169
10.	Alkalinity	200	175	6.25	0.0041	0.025625
				∑Qn = 292.845	**∑Wn = 2.07711**	**∑Qn*Wn = 193.235865**

Water Quality Index (WQI) = ∑Qn Wn / ∑Wn
Water Quality Index (WQI) = 193.235865 / 2.07711
WQI = 93.0311

Source : Author-calculated

Table 5: Findings from all the samples station and their water quality index.

Sr.No.	Stations	Sample	Water Quality Index	Water Quality Stetus
1.	Old Court Boosting Station	S1	93.0311	Poor
2.	Rewari Rode Water Treatment Plant Inlet	S2	113.470	Very Poor
3.	Rewari Rode Water Treatment Plant Outlet	S3	69.236532	Neutral
4.	Rewari Rode Bore-Well	S4	15.144339	Excellent
5.	HUDA Sector Water Treatment Plant Inlet	S5	67.75132	Neutral
6.	HUDA Sector Water Treatment Plant Outlet	S6	86.97993	Poor
7.	Nasibpur Water Treatment Plant Inlet	S7	118.0340	Very Poor
8.	Nasibpur Water Treatment Plant Outlet	S8	125.0591	Very Poor
9.	Dhani Afgaan Bore-Well	S9	120.7804	Very Poor
10.	Nalapur Bore-Well	S10	222.7897	Unhealthy for Drinking

Source : Author-calculated.

Conclusions

WQI : Based on a variety of water quality measures, it is a single numerical value that can characterize the general state of the water at a specific place and time. The most straightforward type of index that the general public can understand and utilize is WQI. Table 5 lists the WQI values for several significant physico-chemical characteristics of drinking water. Based on the WQI values, the east of the city had a higher percentage of drinking water in the excellent water quality category, while the south had neutral water quality.The water quality index (WQI) is different everywhere in the city . The lowest variation is in S4 (Rewari Rode bore-well) 15.144339 and the highest is in S10 (Nalapur bore-well) 222.7897. A more methodical approach, the WQI method facilitates the comparison of the quality of drinking water from multiple sampling locations. It is clearly visible from the view that only about 50% samples in the city have suitable quality for drinking water. It is very important to treat the remaining 50% sampling stations before use. The quality of water is poor in most parts of the study area. The quality was found to be good only at S3 and S4 sites . A major reason for this is the lack of conservation and cleanliness of water resources. Awareness and cleanliness related programs are necessary for this at the state and local level.

 ISSN: 1355-5243

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