SHORT RESEARCH COMMUNICATION

Water quality analysis of Urun-Islampur City, Maharashtra, India

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Abstract

Safe drinking water is a human need and right of the people. This study focuses on water quality analysis of the Urun-Islampur city which is in the Maharashtra state of India. Water quality testing is very important to check the quality of drinking water to avoid waterborne diseases and improve health. Water Quality Index (WQI) is important to determine the depletion of the water quality of the study area. The Urun-Islampur city is divided into fourteen wards. The values of WQI of those fourteen wards were compared, where from each ward three water samples were taken for the test. In order to assess the water quality, we calculate the WQI with physical, chemical and biological parameters. In water quality tests, various parameters are measured, including pH, total hardness, chloride content (Cl^-), electric conductivity, residual chlorine and total dissolved solids (TDS), all those parameters compared with World Health Organization (WHO) standards of water quality; also in the present research paper classification of water samples of the 14 wards was an investigation into the basis of TDS, anions, cations, and total hardness. This article highlights the importance of using the WQI, and it is very useful to analyze the water quality. After water sample testing, it was observed that the pH of all water samples was found almost neutral. The TDS, conductance and hardness increased toward the old water supply line as compared to a new water supply line. The results of the Water Quality Assessment done in Urun-Islampur city show that all parameters were within the permissible limits as per WHO standards. The Water Quality Index (WQI) in the range of 86 to 90 was also good. But it may be affected by water distribution lines which were older than 30 years, so there is a need for proper maintenance of the distribution system and chlorination to avoid waterborne diseases.

Keywords Water samples · Physicochemical analysis · pH · Hardness · Chloride content · Electric conductivity · Residual chlorine · Total dissolved solids · Water quality index

Introduction

Water plays an important role in human life. About 37% of urban and 64% of rural Indians are without access to safe drinking water as per the World Health Organization (WHO) report (Akoto and Adiyiah 2007). Freshwater is important for the survival of all living beings. It is more important for the people as they depend upon it for industrial, food production, waste disposal and cultural requirement (APHA et al. 2012).

Groundwater is an important freshwater resource; during the last decade, it was observed that groundwater gets polluted because of increased human activities, and therefore, a number of cases of waterborne diseases have been seen. So there is a need for understanding the water chemistry, which includes the basis of the knowledge of the multidimensional aspect of aquatic environmental chemistry which involves the composition, source and reactions transportation of water. The quality of water is important for mankind because it is directly linked to human welfare.

India is one of the most populated countries in the world, with 127.423 crore population as per 28th January 2017. Cities accommodate nearly 31% of India's current population. Maharashtra is one of the state in the western region of India and with 11.237 cores of the population. Maharashtra is one of the wealthiest and the most developed state in India, contributing 25% of the country's industrial output and 23.2% of GDP as per the Census 2011.

Urun-Islampur is a Municipal Council city in the Sangli district of Maharashtra state of India and which is shown in Fig. 1. Urun-Islampur is located on 17° 2′ 42.46″ N and 74°

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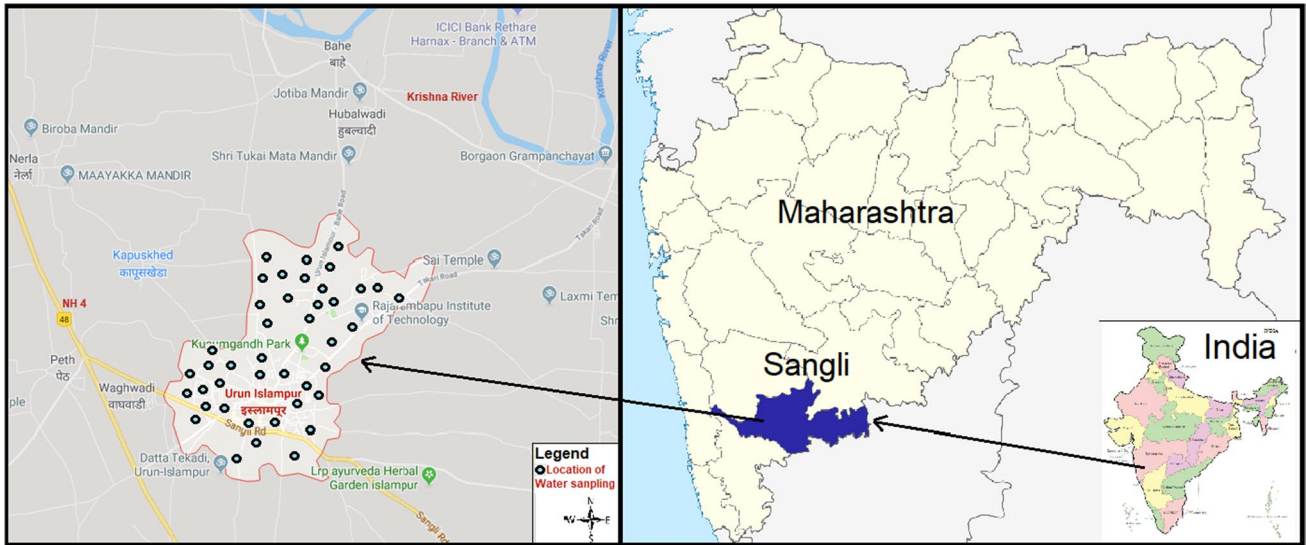of Engineering, Pune 411048, Maharashtra, India
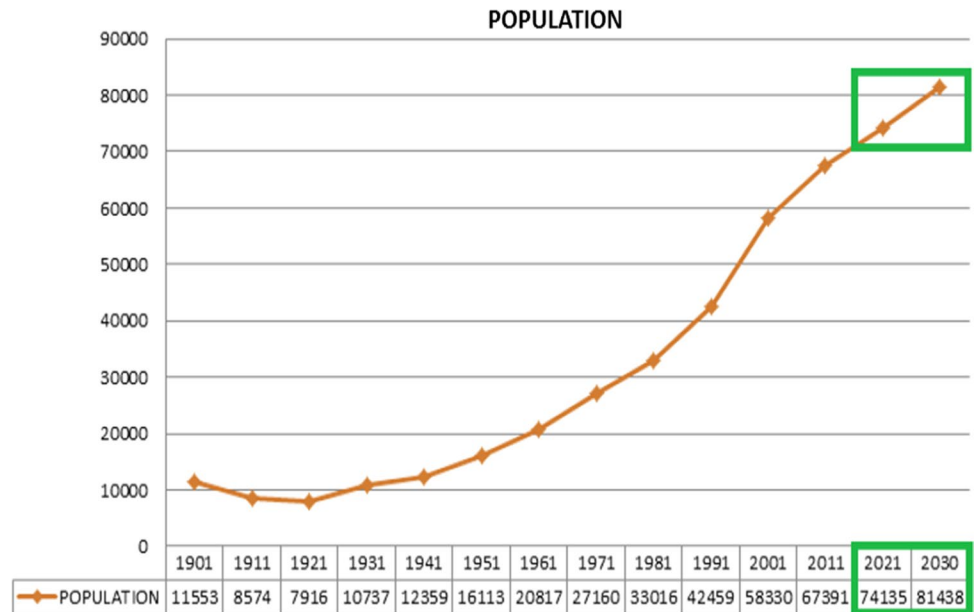
Fig. 1 Study area. *Sources*: Google Maps

15′ 42.97″ E. Urun-Islampur have geographical boundaries of Bhivari dam, Morna dam, Yelavi dam and Krishna River. As of the 2011 India census, Islampur had a population of 67,391 (Census India 2011). As the population is forecasted by Incremental Increase Method, for the year 2017, it will be 73,965, for 2021, it will 74,135 and for the year 2030, it will 81,438.

From Fig. 2, it is observed that the population is slightly decreasing from the year 1901 to 1921, and it may be because of the health and water for crops and some other parameters. Afterward from the year 1931, it is observed

that population growth slightly increased up to the year 1991 to every decade; after that from 1991 the population growth percent increased as compared to previous decade; this is because due to the development of the city, industry area, infrastructure, facilities, improved lifestyle , people are attracted toward city; it is also because the education facilities are good, etc.

Urun-Islampur has favorable conditions for stabilized market, work opportunity, modern trade setup; is able to fulfill the necessity for citizens and to develop the whole urban ecosystem; and is helpful in the advancement of organization

Fig. 2 Population of Urun-Islampur. *Source*: Census India

	1901	1911	1921	1931	1941	1951	1961	1971	1981	1991	2001	2011	2021	2030
POPULATION	11553	8574	7916	10737	12359	16113	20817	27160	33016	42459	58330	67391	74135	81438

Forecasted Population

and physical, social and economic framework, but due to these reasons, the city encompasses a prime significance and scope of advancement in different regions.

The main source for piped water supply for the city of Urun-Islampur is the Krishna River. In 1985, a 65-km pipeline was laid and has been increased to 125 km as of the year 2005 due to the requirement of 4 to 5 km pipeline expansion each year.

In the city, there are eight elevated storage reservoir (ESR) and water distribution lines which are older than 30 years; so, to check the quality of water to prevent health issues, we have decided to study and assess the quality of water of the Urun-Islampur city (Kate and Kumbhar 2017).

Materials and methods

The methodology includes, data collection, household survey for understanding the quality of water by people, collection of three water samples from each ward, testing the water samples, collection of secondary data, validation of secondary data. (Kate and Jamale 2018)

In the city, there are eight ESRs; capacity of ESR is given in Table 1, also six ESRs are proposed, capacity of WTP, daily hours of operation is 2 h, 1 h at morning and 1 h of evening in all wards, minimum water tax collected per household is Rs 750, and number of private connections are 12,000 (Kate et al. 2018).

As per the norms of APHA, the water samples were collected in a wide mounted plastic bottle of 1-liter size and preserved till the parameters were analyzed in the laboratory. The sample collection procedure and the preservation were as per

the guidelines given in Chapter 5—Fieldwork and sampling Edited by Jamie Bartram and Richard Balance, published on behalf of the United Nations Environment Programme and the World Health Organization (UNEP/WHO) (Boominathan and Khan 1994; Jafari et al. 2008; Kaushik et al. 2002; Jayabhaye et al. 2008; Ravindra and Garg 2006; Khan and Chaudhary 1994; Kadam et al. 2007; Kodarkar 1992; Pandey et al. 1993; Ramakrishnaiah et al. 2009; Salve and Hiware 2008; Trivedy and Goel 1986; Ballance and Bartram 1998; Bartram et al. 1996; World Health Organization (WHO) 2006).

Water samples were tested for the estimation of various physicochemical parameters like water temperature and pH were recorded using thermometer and digital pH Meter. Specific conductivities were measured by using a digital conductivity meter. The TDS values were measured by using the TDS meter. Other parameters such as hardness were estimated in the laboratory by using standard laboratory methods. The present study involves the analysis of water quality in terms of physicochemical methods.

Water Quality Index (WQI) was calculated for collecting water samples. Water Quality Index was calculated based on physicochemical parameters, and the standards of drinking water quality by the World Health Organization (WHO) is given in Table 2.

Water Quality Index (WQI) was calculated in three steps. In the first step, each parameter was assigned a weight (wi) according to its relative importance in the overall quality of water for drinking purposes. In the second step, the relative weight (WI) is computed from the following Eq. 1.

$$Wi = \frac{wi}{\sum_{i=1}^{n} wi} \qquad (1)$$

where Wi is the relative weight, wi is the weight of each parameter, and n is the number of parameters. Relative weight (Wi) values were calculated of each parameter.

In the third step, a quality rating scale (qi) for each parameter is assigned by dividing its concentration in each water sample by its respective standard according to the guidelines laid down in the Bureau of Indian Standards (BIS) and the result multiplied by 100 (Bureau of Indian Standards (BIS) (2012)).

Table 1 ESR locations and their capacity

S N	Name of Area	Location		Capacity in m³
		Latitude	Longitude	
1	Jantavidhalaya	17° 2′ 54.43″ N	74° 15′32.28″ E	700
2	Nagarpalika	17° 3′ 5.04″ N	74° 16′ 10.96″ E	750
3	Nagarpalika old	17° 3′ 4.38″ N	74° 16′ 7.62″ E	400
4	Nagarpalika new	17° 3′ 3.62″ N	74° 16′ 8.45″ E	650
5	Ambedkar-nagar	17° 2′ 42.38″ N	74° 16′ 30.04″ E	350
6	Khadi ESR	17° 3′ 2.18″ N	74° 15′ 40.36″ E	700
7	PWD office	17° 2′ 50.03″ N	74° 15′ 11.51″ E	750
8	Shivnagar	17° 3′ 6.06″ N	74° 15′ 37.88″ E	750

Table 2 Classification water quality index based on WQI value

S N	Water quality	WQI Value
1	Water unsuitable for drinking	> 300
2	Very poor water	200–300
3	Poor water	100–200
4	Good water	50–100
5	Excellent	< 50

$$qi = (ci/si) \times 100 \tag{2}$$

where qi is the quality rating, ci is the concentration of each chemical parameter in each water sample in mg/L, and si is the Indian drinking water standard for each chemical parameter in mg/L according to the guidelines of the Bureau of Indian Standards (BIS) (Census India. http://www. 2011).

For computing the WQI, the SI is first determined for each chemical parameter, which is then used to determine the WQI as per the following Eq. 3 and 4.

$$SIi = Wi \cdot qi \tag{3}$$

$$WQI = \sum SIi \tag{4}$$

SIi is the subindex of ith parameter; qi is the rating based on the concentration of ith parameter; and n is the number of parameters. The computed WQI values are classified into five types, which are given in the following Table 2.

Results and discussion

Three water samples taken from each of the fourteen wards within the city of Urun-Islampur were tested for pH, electrical conductivity, TDS, residual chlorine, chloride and hardness. The result shows that the water quality is good in the city, but the water distribution system is too old so the quality may be affected.

Figures 3, 4, 5, 6, 7, 8 show the results of water samples, and Table 3 shows the inclusive results of water samples. From the result, it was observed that pH, total hardness (TH), chloride content (Cl-), electric conductivity (EC), residual chlorine (RC) and total dissolved solids (TDS) were
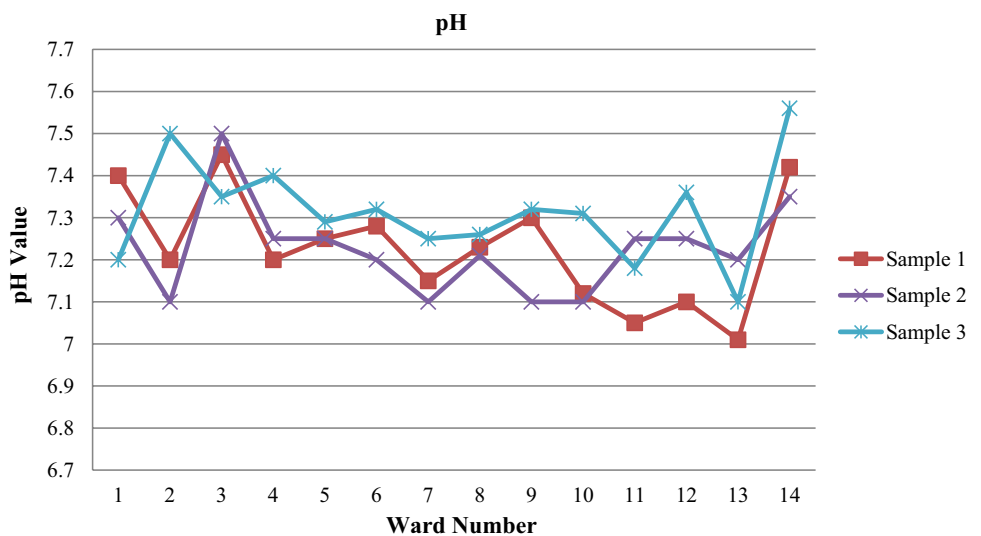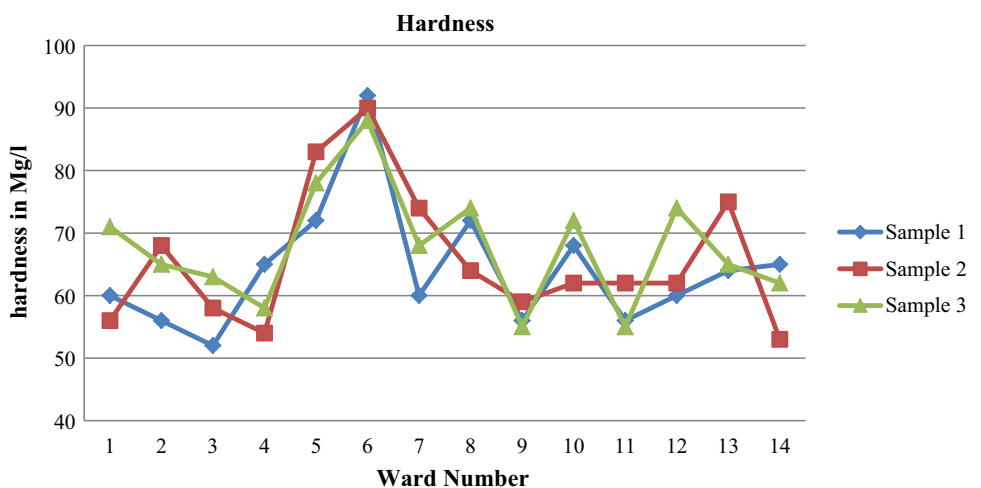
Fig. 3 pH

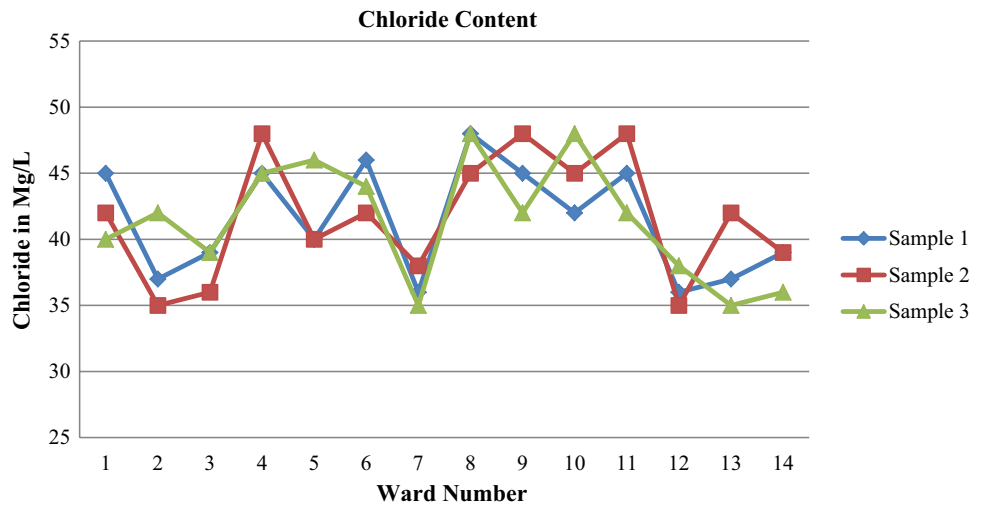**Fig. 4** Hardness

Fig. 5 Chloride contents

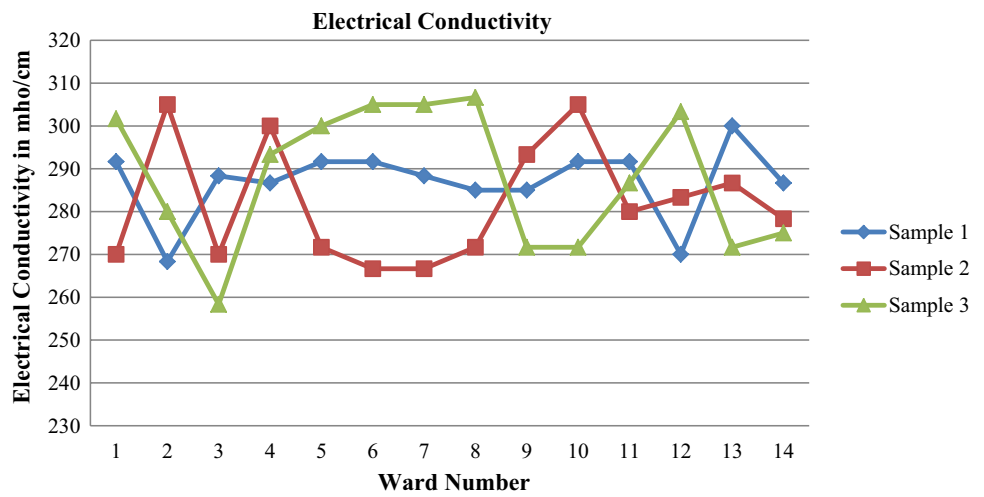**Fig. 6** Electric conductivity

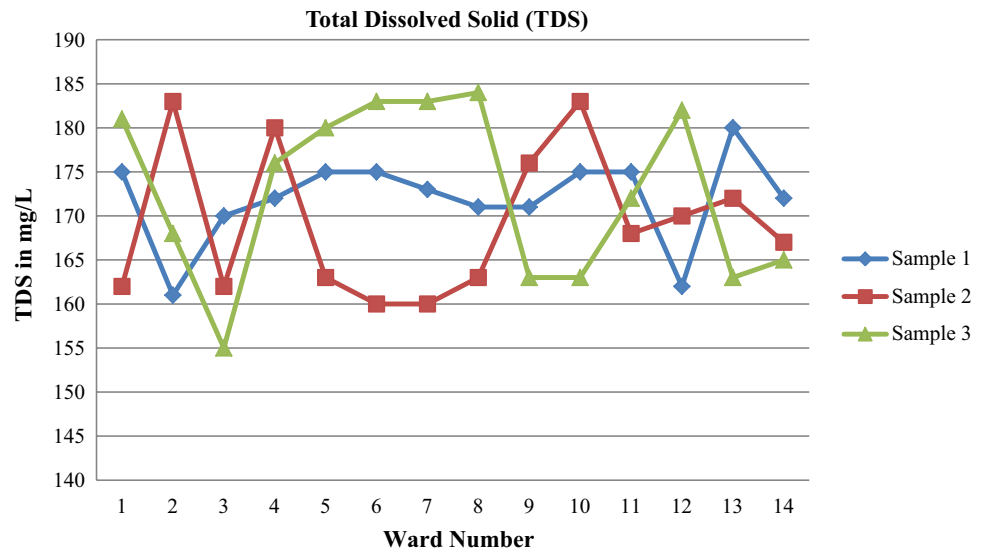**Fig. 7** Residual chlorine
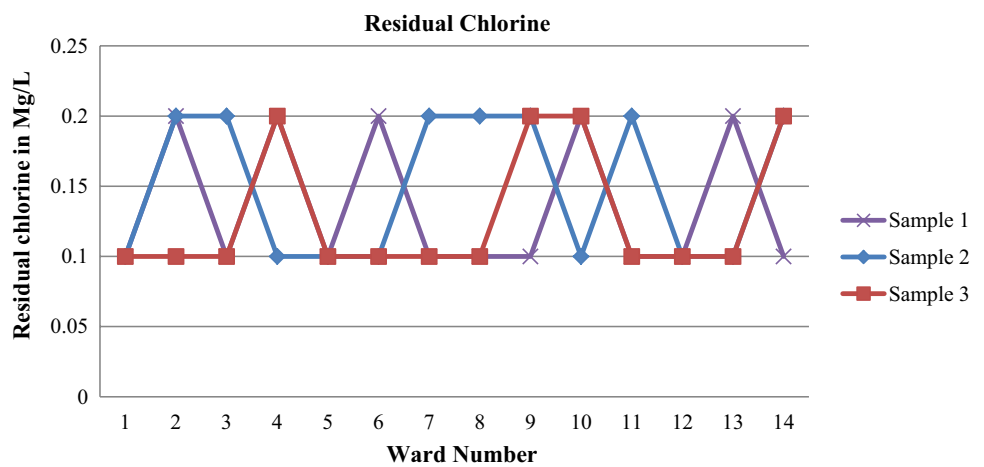
Fig. 8 TDS

Table 3 Inclusive results of water samples

Ward No.	pH			Conductivity (μMho/cm)			TDS (ppm)			Residual Chlorine (mg/L)			Chloride (mg/L)			Hardness (mg/L)		
Permissible limit	6.5–8.5			750			500			0.2			250			300		
Sample number	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	7.4	7.3	7.2	291.67	270.00	301.67	175	162	181	0.1	0.1	0.1	45	42	40	60	56	71
2	7.2	7.1	7.5	268.33	305.00	280.00	161	183	168	0.2	0.2	0.1	37	35	42	56	68	65
3	7.45	7.5	7.35	288.33	270.00	258.33	170	162	155	0.1	0.2	0.1	39	36	39	52	58	63
4	7.2	7.25	7.4	286.67	300.00	293.33	172	180	176	0.2	0.1	0.2	45	48	45	65	54	58
5	7.25	7.25	7.29	291.67	271.67	300.00	175	163	180	0.1	0.1	0.1	40	40	46	72	83	78
6	7.28	7.2	7.32	291.67	266.67	305.00	175	160	183	0.2	0.1	0.1	46	42	44	92	90	88
7	7.15	7.1	7.25	288.33	266.67	305.00	173	160	183	0.1	0.2	0.1	36	38	35	60	74	68
8	7.23	7.21	7.26	285.00	271.67	306.67	171	163	184	0.1	0.2	0.1	48	45	48	72	64	74
9	7.3	7.1	7.32	285.00	293.33	271.67	171	176	163	0.1	0.2	0.2	45	48	42	56	59	55
10	7.12	7.1	7.31	291.67	305.00	271.67	175	183	163	0.2	0.1	0.2	42	45	48	68	62	72
11	7.05	7.25	7.18	291.67	280.00	286.67	175	168	172	0.1	0.2	0.1	45	48	42	56	62	55
12	7.1	7.25	7.36	270.00	283.33	303.33	162	170	182	0.1	0.1	0.1	36	35	38	60	62	74
13	7.01	7.2	7.1	300.00	286.67	271.67	180	172	163	0.2	0.1	0.1	37	42	35	64	75	65
14	7.42	7.35	7.56	286.67	278.33	275.00	172	167	165	0.1	0.2	0.2	39	39	36	65	53	62

in the permissible limits as per World Health Organization (WHO) standards of water quality. Figure 9 shows the Water Quality Index (WQI) is in the range of 80 to 90 also good as per standards are given Table 2.

Conclusion

The results of water samples collected from all fourteen wards and tested in the laboratory as per the World Health Organization (WHO) standard indicate that the quality of water is within the permissible limit.

Fig. 9 Water quality index
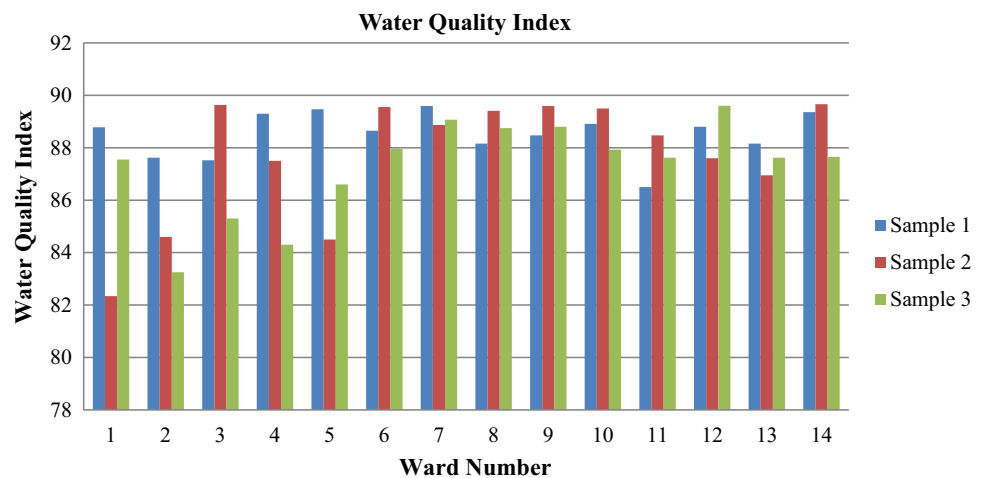
The water quality is satisfactory in all the wards for the domestic purposes; also the Water Quality Index (WQI) value is in the range of 80 to 90 also good; still there is a need regarding the water distribution system, as the main source of piped water supply for the city of Urun-Islampur is the Krishna River.

In 1985, a 65-km pipeline was laid and has been increased to 125 km as of the year 2005 due to the requirement of 4 to 5 km pipeline expansion each year, as the distribution system is 34 years old and prone to corrosion and may get affected by sewage and other waste in the nearby region, so there is need of proper maintenance of the distribution system and chlorination to avoid waterborne diseases to improve the health and quality of people.

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