Research Article

Distribution and Prevalence of Drinkable Water Contamination and Significance of Water Quality in Lahore

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Abstract

Water is vital for life and the availability of quality drinking water is the basic necessity and right of every human being. Over exploitation and misuse of fresh water has made it a scarce resource expecting current practices in future many countries are going to face severe water crisis. Pakistan is also at risk because of its depleting fresh water resources. Main causes of water pollution in Pakistan are the human activities including the discharge of untreated industrial waste in the fresh water bodies. In this study ground water quality is determined using Canadian water quality index (CWQI) in the area of Kot Lakhpat. This area is chosen because it is at the junction of two populated towns in the Lahore district and it includes both residential and industrial area. The results shows water is of good quality and safe for household use but as far as drinking water is concerned this water is not safe because of the higher arsenic and bacterial contaminations.

Keywords: Water, Drinking Water, Water Contamination, Water Quality Index, Pakistan.

Introduction

Water is vital for life but lately a lot of concerns relating to water are arising. Fresh water is a scarce resource, moreover, the quality of water is also deteriorating. According to a press release by UNO Secretary General on World Water Day 2002, "Around 1.1 billion people do not have access to safe drinking water; 2.5 billion people lack access to proper sanitation, and more than 5 million people die annually because of water borne diseases. Although water supplies are abundant but they are at risk due to increasing pollution and ever increasing demand. By 2050, around two third of world's population is likely to inhibit in the countries with the moderate or severe water shortage."

Even though three third of earth surface is covered with water, only 3% of that water is fresh and yet the water available for human use is 0.01%. Human race should learn to live sustainably with this small fraction of fresh water supply. But if the current water usage practices continue, in coming decades we would bear the consequences of our actions in form of severe water crises. According to a UNO report, world population and water supply are having an inverse relation, population is increasing exponentially while resources are depleting. In future many countries are going to face water shortage problems and this situation is going to become even worse for the developing countries because of the overpopulation, mismanagement of resources, lack of polices and professional and financial constraints.

Pakistan is a developing country and is also facing water crisis. In the last few years the per capita water availability has dropped, moreover, the quality of the ground and surface water is declining due to unchecked disposal of untreated industrial wastes. In Pakistan more than 44% of the population is living without having access to safe drinking water. This situation is even worse in the rural areas where upto 90% of the population is living without safe drinking water. Only 3% of the sweet water resources are used for drinking in the households. If water is defined as safe drinking water according to the international standards only 25.61% (rural 23.5% and urban 30%) of Pakistani population is availing this facility.

Drinking water quality is checked and monitored by the public and private institutions to make sure that people have access to safe drinking water. Water is considered polluted when various substances are present in excess than the permissible limits. Common pollutants are pathogenic organisms (bacteria, viruses and protozoa), organic and inorganic pollutants can pose serious health impacts if their concentration exceeds the allowable limits. In Pakistan drinking water is frequently contaminated with the bacteria and toxic metals like arsenic, cadmium and iron, such contamination can have deleterious effects on health [1]. There are various ways to identify the water quality but one of the convenient way is water quality index (WQI).Water Quality index can be used to summarize the complex water quality data, and make the factor understandable for a layman or general audience.

Material and Methods

Kot Lakhpat is chosen as the study area, it is situated in Lahore and contains various types of land use. Lahore is the second biggest city of Pakistan and Kot Lakhpat is a residential and industrial area located at the junction of two populated towns i.e. Gulberg and Allama Iqbal. Kot Lakhpat is bound by Ferozpur Road in the north and east. On the western side of the site Model Town is situated. Township is located in the south west of Kot Lakhpat. Residential area is present in the north and comprised of Bahar Colony, Model Colony and Pindi Rajputana while industrial area is located in the south. Major population of Kot Lakhpat belongs to middle class income group.

Description of Sampling Site

Drinking water samples were taken from the residential as well as industrial areas. Ten drinking samples were collected from study area. Samples were collected by PCRWR surveyor and tested at the PCRWR Laboratory. Some 21 different parameters were taken into consideration. These parameters were divided into two groups:-

1. Physio-chemical parameters
2. Bacterial Parameters

Physio-Chemical Parameters

Physio chemical parameters include Alkalinity, Bicarbonate, Calcium, Carbonate, Chloride, Color, Conductivity, Hardness, Magnesium, Odour, pH, Potassium, Sulfate, Sodium, taste, TDS, Turbidity, Nitrate and Arsenic. Temperature, TDS and pH values were evaluated at the site using TDS and pH meters. Sodium concentration was determined by using flame photometer. Titration is used to determine alkalinity and hardness. Turbidity meter was used to determine turbidity. Bicarbonate and carbonate was evaluated using standard table [4].

Bacterial Parameters

Bacterial parameter Total Coliform, Total E.Coli was evaluated using MPN technique. The MPN index/100 mL was determined from standard tables.

Sr. No.	Water Quality Parameters	Permissible Limits	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
1	Alkalinity (m.mol/l)	NGVS	4.6	4.6	5.3	6.6	4.6	6.6	7.4	6.99	7.6	5.8
2	Bircarbonate (mg/l)	NGVS	240	230	270	210	230	340	320	366	382	290
3	Carbonate (mg/l)	75 (KSA)	20	52	30	18	94	20	32	36	74	26
4	Calcium (mg/1)	NGVS	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
5	Chloride (mg/l)	250 (WHO)	17	29	24	22	53	51	41	27	112	24
6	Colour (TCU)	15 (WHO)	Unobjectable	Unobjectable	Unobjectable	Unobjectable	Unobjectable	Unobjectable	Unobjectable	Unobjectable	Unobjectable	Unobjectable
7	Conductivity (micro-S/cm)	NGVS	630	542	702	746	858	952	988	812	11.06	696
8	Hardness (mg/l)	500 (WHO)	90	205	100	120	310	95	155	390	415	125
9	Magnesium (mg/l)	150 (WHO)	9.72	19.44	12	15	18	11	18.22	38	51	15
10	Odour	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless
11	pH	6.5-8.5 (WHO)	7.58	7.42	7.52	7.33	7.17	7.6	7.78	7.07	7.73	8.12
12	Potassium (mg/l)	12 (EC)	1.9	3.7	0.9	1.5	3	3	2	1.6	8	0.2
13	Sulfate (mg/l)	250 (WHO)	78	78	86	90	170	166	124	56	125	69
14	Sodium (mg/1)	200 (WHO)	102	63	126	148	70	540	172	170	112	136
15	Taste	Unobjectionable	Unobjectable	Unobjectable	Unobjectable	Unobjectable	Unobjectable	Unobjectable	Unobjectable	Unobjectable	Unobjectable	Unobjectable
16	TDS (mg/l)	1000 (WHO)	365	381	450	478	546	365	611	520	738	443
17	Turbidity (NTU)	5 (WHO)	2.4	1.2	1.09	3.88	1.8	0.6	0.043	4.2	1.1	0.5
18	Nitrate as n (mg/l)	10 (WHO)	0.24	BDL	0.035	0.042	0.24	0.24	0.057	2.3	4.5	BDL
19	Arsenic (ug/l)	10 (PSQCA)	27.49	16.15	29.2	32.9	30.4	27.49	18.36	25.23	17.73	18.34
20	Total Coli form MPN/100 m	10 (WHO ground water)	5	Nil	0	240	240	5	Nil	2.2	Nil	38
21	Total Coli form MPN/100 m	10 (WHO ground water)	4.4	Nil	0	240	24	4.4	Nil	2	Nil	38

NGVS No guideline values
KSA Kingdom of Saudi Arabia
WHO World Health Organization

PSQCA Pakistan Standards and Quality Control Authority
BDL Below Detection Limit

Water Quality Index

Canadian water quality index was used to evaluate the quality of drinking water, while WHO values were used as the standard values. Canadian water quality index was developed by Canadian Council of Ministers for Environment. This index is able to measure both the frequency and the extent to which each parameter is exceeding to given limit.

Canadian WQI is calculated by using the given equation:-

$$WQI=100-\left[\frac{\sqrt{F1^2+F2^2+F3^2}}{1.732}\right]$$

Whereas

F1 = Scope: the percentage of variables whose objectives are not met at least once, it is calculated using following formula.

$$F1=\left[\frac{\text{Number of failed variables}}{\text{Total number of variables}}\right]x\ 100$$

F2 = Frequency: represents the percentage of individual tests that do not meet objectives [3].

$$F2=\left[\frac{\text{Number of failed tests}}{\text{Total number of tests}}\right]x\ 100$$

F3 = Amplitude: represents the amount by which failed test values do not meet their objectives. F3 is calculated in three steps.

I. Excursion: The number of times by which an individual concentration is greater than (or less than, when the objective is a minimum) the objective is termed an "excursion" and is expressed as follows [3].

$$nse=\left[\frac{\sum_{i}^{n}=1\ \text{excursion}}{\text{Total number of tests}}\right]-1$$

II. Normalized sum of excursions:

The collective amount by which individual tests are out of compliance is calculated by summing the excursions of individual tests from their objectives and dividing by the total number of tests [3].

$$\text{Excursion}=\left[\frac{\text{Failed test value}}{\text{Objective}}\right]-1$$

III. F3 is then calculated by an asymptotic function that scales the normalized sum of the excursions from objectives (nse) to yield a range between 0 and 100 [3].

$$F3=\left[\frac{nse}{0.01nse+0.01}\right]$$

Results and Discussion

The numerical summary of the data collected from the ten sampling sites is given in the table 1, which depicts the standard values and observed values for 21 selected parameters. Considering those standards the category of water quality index is determined using following table.

Table 2: WQI Values

Categories	CCME WQI Value	Remarks
Excellent	95-100	Water quality is protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels [3].
Good	80-94	Water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels
Fair	65-79	Water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels [3].
Marginal	45-64	Water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels [3].
Poor	0-44	Water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels [3].

According to the statistical data shown in the Table most of the parameters were within the permissible apart from Carbonates, Sodium, Arsenic, total Coliform and total E. coli.

The standard value for carbonate is 75 KSA. Although the concentration of carbonate is found in access i.e. 94mg/L only at one sample site (S5). PH and carbonate values show that groundwater of the study area is slightly basic but this accessibility do not cause any health implications. But if this water is used for washing purposes it may need more soap.

Another parameter which shows abnormality is sodium at sample site S6. Slightly high concentrations of sodium do not cause serious health implications but it may be problematic for the patients of hypertension, heart and kidney diseases because they need to maintain a low sodium intake.

Arsenic was found in higher concentration at all the samples sites. Water with high arsenic concentration is bad for human health because arsenic is carcinogenic.

Fecal contamination was also found in the ground water of Kot Lakhpat, in this study the standard value is taken as 10 MPN/100 ml and this value is taken from global drinking water quality index development and sensitivity analysis report.

The values of F1, F2 and F3 are Given below
F1 = 23.80
F2 = 8.57
F3 =7.65

$$WQI=100-\left[\frac{\sqrt{23.80^2+8.57^2+7.65^2}}{1.732}\right]$$

$$WQI=100-15.25$$

$$WQI=84.75$$

For safe drinking water the important factor is the presence of fecal coliform and its concentration must be zero according to WHO drinking water standards. According to the Azizullah et al., 2011 the major sources of ground water contamination in Pakistan are human activities, for example inappropriate and untreated disposal of the municipal and industrial wastes. Both chemical and bacterial pollutants

Conclusion

Water quality index is used to calculate the quality of ground water in Kot Lakhpat. Various physio-chemical and bacterial parameters were collected and tested at the Laboratory of PCRWR. Their results show that there were five Parameters that were exceeding the permissible limits, water was found contaminated with parameters like

Arsenic, Total coliform and total E.Coli as mentioned in the Table 1. Above mentioned parameters can cause serious health implications if used for drinking purposes but water was found safe for other household purposes.

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