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Physico-chemical characteristics of potable water of different sources in District Nowshera: A case study after flood – 2010

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Abstract

Chemical characteristics of different sources of drinking water were studied in district Nowshera, Khyber Pakhtunkhwa to know the effects of 2010 flood on drinking water. Samples of water were collected from different sources like tube wells, dug wells, and hands pump. The physical parameters including color, odour, taste, turbidity, conductivity and pH were studied whereas the chemical parameters such as total solids, total dissolved solids, total suspended, total hardness, calcium hardness, magnesium hardness, alkalinity, chlorides, sulphates, nitrites, sodium and potassium were also carried out. Most of the parameters like sulphate, nitrite, sodium contents, total solids, total dissolved solids, total suspended solids, total hardness, calcium hardness and magnesium hardness were found much higher than the permissible limits set by WHO and more than 60% of samples were found unfit for drinking purpose. It was indicated that the water quality of district Nowshera has been badly deteriorated and contaminated as a result of the flood of 2010.

Keywords: Drinking water; Nowshera; Flood hazards; Physico-chemical parameters

1. Introduction

Water pollution is the phenomenon that is characterized by the deterioration of the quality of land water (rivers, lakes, marshes and ground water) or seawater as a result of various human activities (Agarwal, 2002). Water is the basic need of life. Fresh water immediately available to man for drinking and other purposes is only 0.002% of the total water. Since the demand for water is mostly for fresh water, and everyone have to depend mainly on this tiny fraction of the total water present on this planet. Further the uneven distribution of water on the surface of the earth makes it a scarce resource at several places. A number of diseases are caused by the consumption of poor water quality. It has been reported in the "community health study" that 50% of all reported cases of illness, and 40% of deaths in Pakistan are due to drinking of poor water quality (Chhatwal, 1990).

More than 80% population of Khyber Pakhtunkhwa (KP) is using clean drinking water mainly from both surface and ground water sources. However, the surface water resources are limited while the ground water is generally brackish in the southern parts of the KP. In these areas, the clean water is only available at greater depth. In the central part of the KP, there is greater potential of ground water and the water is available through tube wells for daily use. The systems in the northern parts of the KP are generally based on springs or surface water. The quantity of drinking water in the KP, however, is often low due to the aging distribution system, lack of local treatment facilities, and contaminated water sources in some parts of urban centers (Bangash and Khan, 2001). Potable water quality of well water in the urban areas of Peshawar have been studied (Khan et al., 2005) which reveals that magnesium content in well water is higher than the WHO (1999) permissible limit. Chemical characteristics of subsurface water of Haripur area of Hazara were also studied (Khan et al., 1999a) which indicate that the potable water of Haripur area is contaminated due to the presence of

Nitrites. Quality characteristics of potable water from district Bannu were also studied (Khan et al., 1999b), which indicate that the dug-well, bore-well and shallow-well water are unfit for drinking purpose. Studies on the monitoring of the potable water of KP have also been carried out (Khan et al., 1993). Water quality characteristics of Kabul river (Pakistan) under low and high flow conditions were also studied (Shah and Khan, 1997).

Floods are playing greater role in causing environmental problems in an area. These cause damage to the drainage systems which results in raw sewage to spill out into bodies of water. The buildings can be significantly damaged and destroyed due to severe flooding. Their effects can be induced in to the environment to greater extent as many toxic materials such as paint, pesticide and gasoline can be released into the rivers, lakes and hence killing maritime life. Floods may also be responsible for the huge financial losses to the government for rehabilitation and reconstructions in the flood effected area. Flood water picks up numerous contaminants from roads, farms, factories and storage building, including sewage and chemicals. 80% of Nowshera district has been badly affected by the current devastative flood and torrential rains. 40% houses, animals, household items and other belongings were swept away by heavy flood in Nowshera. Around 10000 houses were totally destroyed while about 40,000 were damaged. The badly affected areas are Akora Khattak, Misribanda, Pirsabak, Adamzai, Hakimabad, Badrashi, Pirpiai, Azakhel, Pabbi, Dagbesud, Tarujabba, and Tarnab farm.

The present study is aimed to evaluate the drinking water sources of district Nowshera after flood and their possible remedial measure and recommendation to make the water fit for human consumption.

2. Materials and methods

One liter polythene bottles were washed with tape water followed by cleaning mixture and finally with double deionized water (DDW). At the time of taking sample, the bottle was rinsed with the source water before filling it. Thirteen samples were collected from various sources (Table 1) in the study area. The pH and conductivity were determined on the spot. The samples were transported to the PCSIR Laboratory, Peshawar for further analysis. The samples were kept in the refrigerator at 4ºC until analyzed.

The pH was determined with a potable pH meter (Natner, UK). The conductivity was measured with a potable conductivity meter (Jenway, England). The total solids (TS), total dissolved solids (TDS), total suspended (TS), hardness, calcium, magnesium, alkalinity, chlorides, and sulphates were determined by conventional method as referred by APHA / AWWA (APHA/AWWA 1998). Nitrates were determined by sulphonilic method using a UV Spectrophotometer (Hitachi-U-2000). Sodium and Potassium were determined by Flame Photometer (Jenway-FPF-7). The color was measured with naked eye, odour by smell and taste organolaptically.

3. Results and discussion

The data of physical parameters of the collected samples are presented in Table 1. The color, odour and taste of the samples collected from dug well, hand pump and bore well are somewhat objectionable whereas the tube well water are colorless, tasteless, and odourless. Samples collected from hand pumps, bore well and dug well are turbid whereas the tube well water is clear. The conductivity of the samples collected from hand pumps, dug well, and bore well, is higher than the permissible limits of WHO (1999). The pH of almost all the samples falls within the permissible limits of WHO (1999).

Table 2 showed that TS, TDS and TSS content of water samples collected from hand pumps, dug wells and bore well are higher than the permissible limit of WHO (1999) whereas these parameters for tube well water lie within the permissible limit of WHO (1999). The total hardness, calcium and magnesium contents of the hand pumps, bore

water, and dug well water are also higher than WHO (1999) limits.

It is clear from the Table 3 that the sulphate contents of the bore, hand pump and dug well water is higher than the WHO (1999) limits whereas the same lie within the permissible limit for tube well water. The nitrite contents in almost all the samples are higher than the WHO (1999) permissible level. The sodium content in sample collected from hand pumps bore well and dug well are higher than the WHO (1999) limit whereas the potassium concentration in all the samples lies within the permissible level.

The results of the present study showed that the shallow aquifer of the Nowshera area has been badly affected by the floods of 2010 as the drinking water of most (>60%) of the dug-wells, hand pumps and bore wells has alarming concentration of the studied physico-chemical parameters. The deep aquifer of the Nowshera area has not been affected by these floods as the studied physico-chemical parameters in the drinking water of the tube wells were found within the permissible limit of the WHO (1999). Keeping in view the deteriorating situation of the drinking water of the study area after the floods of 2010, the following recommendations are suggested to make the water safe for human consumptions, 1) chlorination followed by regular cleaning should be done in the overhead tanks to prevent algal growth, 2) filters should be installed, 3) proper training should be given to caretakers of storage facilities of water cleaning and supply of water to residents, 4) old and leaked pipes should be replaced and 5) effective awareness through seminars and media campaigns should be carried out.

Table 1. Physical characteristics of the drinking water of various sources of the study area.

S.#	Source	Location	Color	Odor	Taste	Turbidity	Conductivity	pH
1	Dug well	Akora Khattak	Colorless	Smelly	Pungent	Turbid	1625	7.8
2	Bore Well	Misribanda	Colorless	Smelly	Tasteless	Turbid	2030	7.2
3	Tube well	Pirsabak	Colorless	Odourless	Tasteless	Clear	825	7.5
4	Hand pump	Adamzai	Colorless	Odourless	Tasteless	Turbid	1830	7.15
5	Tube well	Hakimabad	Milky	Smelly	Pungent	Turbid	3250	8.5
6	Dug well	Badrashi	Colorless	Odourless	Tasteless	Clear	715	7.35
7	Tube well	Pirpiai	Brownish	Smelly	Pungent	Turbid	2780	8.6
8	Bore well	Azakhel	Colorless	Odourless	Tasteless	Clear	730	7.2
9	Tube well	Pabbi	Colorless	Odourless	Tasteless	Clear	680	7.6
10	Tube well	Dagbesud	Brownish	Smelly	Pungent	Turbid	3250	8.7
11	Dug Well	Tarujabba	Colorless	Odourless	Tasteless	Clear	530	7.3
12	Tube well	Tarnab farm	Colorless	Odourless	Tasteless	Turbid	1820	6.5
13	Hand pump	Pirpiai	Colorless	Odourless	Tasteless	Turbid	1810	7.13

Table 2. Chemical characteristics of drinking water of various sources of the study area.

Parameter		Tube well	Hand pump	Bore well	Dug well	WHO
TS (mg/L)	Range Mean± Std	790-915 805±62.123	880-940 910±42.426	880-2250 1565±968.73	1225-2050 1708±430.35	1000
TDS (mg/L)	Range Mean± Std	737-910 800±62.37	912-920 916± 5.656	875-2215 1545± 947.523	1210-2030 1687± 425.99	1000
TSS (mg/L)	Range Mean± Std	10-15 5± 2.483	19-20 19.5± 0.707	May-35 20± 21.21	15-30 22± 7.637	5
Total Hardness as $CaCO_3$ (mg/L)	Range Mean± Std	280-425 362± 54.93	550-590 570± 28.28	320-650 485± 233.34	560-690 643±72.34	500
Calcium as $CaCO_3$ (mg/L)	Range Mean± Std	150-305 222± 52.21	340-320 330± 14.14	215-330 272± 81.31	250-420 350±88.88	250
Magnesium as $CaCO_3$ (mg/L)	Range Mean± Std	120-205 141±32.31	219-220 219.5±0.707	105-320 212±152.02	260-310 293± 28.86	150
Total Alkalinity as $CaCO_3$ (mg/L)	Range Mean± Std	240-380 294±52	180-290 235±77.78	280-320 300±28.28	220-295 265±39.68	500

Table 3. Concentration of Cl, SO_4, NO_2, Na and K in water of various sources of the study area.

Parameter	Source	Tube well	Hand pump	Bore well	Dug well	WHO
Chlorides as Cl (mg/L)	Range Mean± Std	50-132 95±33.89	68-70 69±1.4142	75-80 77.5± 3.5355	115-130 121±7.93	250
Sulphates as SO_4 (mg/L)	Range Mean± Std	80-280 205±85.31	310-312 311±1.4142	220-225 222.5±3.5355	185-260 233±41.93	250
Nitrites as NO_2 (mg/L)	Range Mean± Std	0.5-1.5 1.06±0.43	1.2-1.3 1.25±0.0707	1.6-1.8 1.7±0.1414	0.8-2.0 1.36±0.602	0.5
Sodium as Na (mg/L)	Range Mean± Std	112-216 175±45.16	220-222 221±1.4142	180-222 201±29.69	125-210 154±48.23	200
Potassium as K (mg/L)	Range Mean± Std	1.3-3.1 2.38±0.68	3.0-3.5 3.25±0.3535	2.2-3.1 2.65±0.6363	2.3-3.6 2.9±0.655	75

4. Conclusions

It can be concluded from this study that most of the water resources in district Nowshera have been badly contaminated as a result of the flood of 2010. The tube well water on account of its deep depth has been saved from the flood whereas the rest of the resources i.e. hand pumps, dug well, and bore well have been badly polluted due to flood water.

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