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Case Study

Assessment of Ground Water Qualitiy for Drinking (Case Study: District Nowshera)

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Abstract

Water covers 75 % of the whole earth, out of which only 4.9 % is fresh and suitable for direct human uses. Water pollution causes serious effects on human life as well as on environment. Keeping in view the adverse effects of polluted water on human health, this study was carried out to assess ground water quality for drinking in District Nowshera. For this purpose, seven union councils of District Nowshera were selected and four water samples were collect from each union council. Number of tests were performed on the collected samples and the results were then compared with the WHO guidelines. The parameters assessed in this study include color, turbidity, electric conductivity (EC), Total dissolved solids (TDS), Nitrate, PH value and iron concentration. At some locations turbidity, total alkalinity values were found higher than those suggested by the WHO and the water is a bit harder in nature. these Twenty-four samples were collected from different sources including Tube wells, Dug wells, hand pumps and Pressure Pumps. The study resulted that pressure pumps and Hand Pumps provide good quality of water. In most of study area, the Tube well were lagging in some chemical disparity (like Nitrate and Iron). At the end it was concluded that the Dug wells should either be discouraged or maintained with proper care in far flung areas where other sources of water are unmanageable at limited scale. Similarly, the pressure pumps and Hand pumps should be encouraged locally.

Keywords: Water quality, Turbidity, pH, TDS, Nitrate, Electrical conductivity.

1. Introduction

The Nowshera whether is dry sub-tropical with high temperature in summer and low temperature in winter season. According to the statistics published by Pakistan Bureau of statistics in 2016-17, 66 % of total population of district Nowshera is supplied with water from different water supply schemes. This is really a Good coverage as compared to other areas of Khyber Pakhtunkhwa Province. One of the major source of water contamination is drinking of water by cattle from same streams that is being used by humans.

According to Survey conducted by the Paiman, 4% of the Population are using water of nearby streams for drinking while 2 % are using ponds water which are more vulnerable conditions. Because of urbanization and industrialization, wastewater that is being discharged into the natural water results in serious ground water contamination. The most dangerous pollutants in term of human health are

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pathogenic organisms. Improperly treated human waste is the main source of these pathogens. Drinking water supplies have a long history of being infected by wide spectrum of microbes. Therefore, the primary goal of water quality management from health point of view is to ensure the consumers are not exposed to pathogens that cause disease.

Treatment of water supplies have greatly reduced the impacts of these diseases in developed countries.According to WHO (1999), 2.2 million diarrhea-related deaths occurs each year. In the year 2000, 1.1 billion people remained without access to improved drinking water. Centers of Disease Control (CDC) safe water system approach combines locally produced sodium hypochlorite solution (chlorine bleach), storage in a narrow mouth container, and a program to change behavior.

The system has shown improvement in water quality and reduce the incidence of diarrhea by 44% in Bolivia, 48% in Zambia and 62% in Uzbekistan.Use of chlorine bleach to disinfect water has several limitations including: (1) chlorine resistant pathogens such as Cryptosporidium are unaffected. Ayers and Westcott in 1985 reported that the wastewater that is released from the municipal and industrial discharges is predominantly contaminated with the tracer elements like C_d, C_r, M_n, B, CO , As, Mo, Zn, and Pb [1]. If these elements are greater than threshold levels then they can be dangerous to Human, plants and animals. As human life is greatly influenced by the change of environment, thus ultimately effects the lives of human, plants and animals. Khan and Zahidullah in 1991 scrutinized the effluents of ghee and paper mills at AmanGarh (Nowshera), and found that PH, TSS and TDS at 25°C were 8.5, 12305mgL-1 and 2893.5mgL-1 respectively [2]. TSS & TDS were above NEQS. Hayatabad industrial Estate was analyzed by the banaras and found that Parameters were below the permissible limits [3]. Singh et al (1996) assessed the groundwater quality in Uttar Pardesh India and concluded that Total hardness, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, chloride, nitrate, fluoride, sulphate, E coliform and farcal coli form, that both handpumps and boreholes had poor quality [4]. According to study made by the Aitken at al the concentration of CU and Zn in plants were increased, but those of Cd, Cr, Ni, and Pb were unaffected by the sludge application [5]. Soltan's (1998) research about different water quality Parameters resulted that ground water samples were of suitable quality [7].
In this article Concentrations of the metals like lead, copper and nickel in drinking water samples taken from consumers' taps are determined mainly by influencing factors like
The materials of the water supply installations, The design of the water supply installations, particularly of the domestic distribution system, Operating conditions (flow and stagnation times, consumer behavior) , Age of the drinking water installation and Chemical and physical characteristics of drinking water. Lenz et al. (1998) studied the effects of wastewater irrigation on soil and groundwater at three locations in Germany [6]. Data on the concentration of chemicals in groundwater were available for two locations where municipal effluents were reused. A field test was carried out at a location where industrial water was used for irrigation. These results showed in all three cases a high content of nitrate in ground water. The measured chemical oxygen demand concentration of non-degradable organic compounds in groundwater was higher than the drinking water quality standard. While heavy metal and phosphorus of soil and ground water were below the limits of the sludge and drinking water ordinance. Nawaz (1999) worked on the inventory of Hayat Abad industrial Estate Peshawar II and reported that the effluents contain High level of COD which were higher than the permissible level and have a negative effect on the environment [9].Soltan (1999) examined the interrelationship between the major and minor ions behavior and the prevailing geological and environmental conditions through analysis of groundwater sample from artesian wells and soil samples in Egypt [8]. The result showed that groundwater quality varied widely even shortly distances, depending on hydro-geological conditions, pumping period, depth of aquifer, soil

type, and human activities. Moreover, significant differences of the flux coefficient values for metals and non-metals were observed as a result of the redox status of their environment and adsorption phenomena. Water quality index (WQI), and saturation index(SI) indicated the suitability of these samples for different uses. Moati and Al (2000) reported that huge amount of ammonia and urea were being discharged annually as liquid wastes to the marine environment during (1997-98) this amount raised the levels of ammonia and urea to 150 micro M and 55 micro M respectively near the outfall, compared to background concentration of 0.2 micro M and 0.05 micro M, respectively.

Reynard, et al. (2000) reported the results of several lakes which are exposed to industrial and domestic wastes [10]. One of them (Lake MazaisBaltezers) is used for artificial recharge of the groundwater (Quaternary aquifer) through infiltration basins. This study showed that the lake MazaisBaltezers was vulnerable due to human activities and its water Quality could very quickly deteriorate due to cyan bacteria. The soil of this area was not efficient enough to protect the ground water and the drinking water from toxins during the blooming period (August-September). Water clinic (2003) reported that the color in drinking water may due to the presence of colored organic substances, usually metal such as iron and manganese, colored industrial wastes [11]. Denmark (2003) reported that organic color and staining usually occur in areas with poor drainage, and sometime it combines with iron to form "hemi-iron" which is difficult to remove [12].

Damotharan et al. (2010) conducted experiment on the seasonal variation of the physicochemical characteristics in point Cali mere Coastal water's (south East coast of India) to assess variation in water quality [13]. Distribution of nutrients has exhibited considerable seasonal and spatial variation. The specific objectives of this study were to Analysis of selected physical and chemical parameter in 6 union councils of District Nowshera.

To Compare the results of selected drinking water samples with W.H.O. and National Environmental Quality Standards (NEQS), respectively, and to create awareness among the people of District Nowshera about the importance of portable water for good health. Figure 1 below shows the map of the study area.

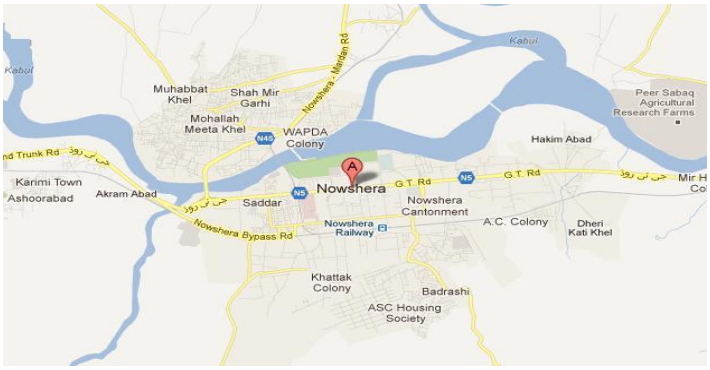

Figure 1. Complete Map of Union Councils of District Nowshera

2. Material and Methods

As discussed above the main objective of the study is to assess the ground water quality of district Nowshera. To perform the study experiments were conducted on the collected samples. The methodology adopted is discussed below starting from sample collection, then performing experiments and discussing results.

2.1 Sample collection

To assess the quality of deep and shallow ground water different water samples were collected from six union councils in district Nowshera. The samples were properly labeled and brought to the Laboratory in Agricultural Engineering Department, University of engineering & Technology Peshawar for analysis. The results were obtained from experimental analysis and were then compared to the National Environmental Quality standards (NEQS). The water quality parameters analyzed in this study and experimental procedure used are shown in table-1 below.

Table 1. Water quality parameter and method used for analysis

S.No	Parameters	Analysis method
01	Color (TUC)	Sensory test
02	pH	pH meter, Hana instrument, model 8610 Italy
03	Electrical conductivity	2520-B, E.0 meter, Hana, standard method
04	Turbidity (NTU)	2130-B, Nephelometric Standard Method
05	Iron	3500-Fe-D Phenanthroline, Standard Method (2004)
06	TDS	4500-DPD Method, Standard Method (2004)
07	Nitrate	Cadmium Reduction Method, Standard Method (2004)

Twenty-four water samples were collected from drinking water supply schemes including Pressure pumps, Hand pumps, Dug wells and Tube wells. The parameters analyzed for these samples are mentioned in table-1 above and the procedure for determining its values is discussed in the section to follow.

Color:

The color of water is usually expressed in Hazen Units, which are the same as TCU (true color units) and the platinum cobalt (Pt - Co scale color produced by one milligram of platinum cobalt in a liter of distilled water). Water often appears colored because of material in suspension, so true color is determined after filtration of the sample

pH:

pH refers to the negative log base 10 of hydrogen ion concentration. The pH of water samples was determined using pH meter. First it was standardized by using buffer solution of known pH (4 and 9). Then the probe was dipped into the water sample to record the pH value Richard (1954).

Electrical Conductivity:

It is measured in micro Siemens per centimeter units (μS/cm). The natural conductivity of fresh water varies from (30μS/cm) to vary high values (2000μS/cm) which is unsuitable for irrigation. The ECW (electrical conductivity) of water sample was determined using ECW meter. First the ECW meter was rinsed with distilled water and then dipped in the sample to record the ECw values, (Richard, 1954).

Turbidity:

It is a unit of measurement that quantifies the degree to which light is travelling through water column and is scattered by the suspended organic and inorganic particles. Turbidity is commonly measured in Nephelometric Turbidity Units (NTU). Turbidity of the given sample of water was measured by using turbidity meter. First the instrument was calibrated by using the solution of known turbidities of 9 and 10 NTU, respectively. Then vial containing sample was placed in the slot and turbidity value was recorded by turbidity scale.

Iron:

Iron is an essential trace element for living organisms. The guide line value for Iron (3mg/1) proposed by

(WHO) a provisional value is based on acceptability aspect of drinking water rather on any health effect. The above-mentioned trace element of Fe like (Cd, Zn, Pb, Cu, Fe and Mn) was determined by Atomic Absorption Spectroscopy (AAS). The trace element of Fe radiates through the atomizer system (flame or graphite tube cavetti) and is absorbed there by atoms in the ground state. The quantity of the absorbed light is proportional to concentration of non-excited atoms. It is measured as selective resonance in a detector.

Total dissolved solids:

TDS is the term used to describe inorganic salts and small amount of organic matter present in water solution. It is determined by the use of DPD-TDS conductivity meter giving the direct reading of total dissolved solids of the testing water sample.

Nitrate:

Nitrate, highly oxidized form of nitrogen is commonly present in natural water due to end product of the aerobic decomposition of organic nitrogenous mater. Samples were collected in plastic bottle with an addition of boric acid (2ml /I sample) and stored at 4°C. Before analysis, the sample were warmed to room temperature and neutralized with 5.0 (N) sodium hydroxide standard solutions. The method used for this analysis was cadmium Reduction Method. The range of measurement of nitrate (N) in drinking waters falls between 0 to 4.5 mg/l. After conducting all the experiment for all the collected samples, results were obtained.

3. Results and Discussions

3.1. Water quality results of water samples

Total numbers of 24 water samples were collected from drinking water supply schemes including Pressure Pumps, Hans Pumps, Dug wells and Tube wells from different sites of six Union Councils in District Nowshera. All the samples were analyzed for various water quality parameters in the laboratory like color, turbidity, pH, TDS, Nitrate, iron and ECW. The water quality results of all the water samples in 6 Union Councils are shown in the following Tables 2.

Table 2. Water quality results of water samples collected from Different Union Councils of District Nowshera

UC Name	Sample No	Mohallah	Source	Color	Turbidity (NTU)	pH	ECw	Nitrate	Iron	TDS
Badrashi Union Council	1	ASC colony	Pressure Pump	Colorless	2	6.7	611	8.91	0.2	305
	2	Eid Gah	Tube well	Colorless	1.5	7.3	580	8	0.2	315
	3	Suleman Khel	Pressure pump	Colorless	1.8	7.4	550	8.5	0.2	310
	4	Esa Khel	Tube well	Colorless	1.9	7	600	8.2	0.2	320

Khat Killi Union Council	1	Sonehri Masjid	Pressure Pump	Colorless	3	6.8	1378	22.44	0.1	688
	2	Rehmat Abad	Tube well	Colorless	2.5	6.5	1200	18	0.2	490
	3	Gul Abad	Tube well	Colorless	2.4	7.2	1150	15.5	0.2	450
	4	Talab Abad	Hand Pump	Colorless	1.95	7	950	14.75	0.2	423
Aman Garh Union Council	1	Khushal	Pressure pump	Colorless	1	6.6	933	21.45	0	467
	2	Gulzar	Tube well	Colorless	1.5	7.1	885	18.75	0.1	468
	3	Gujran	Hand Pump	Colorless	0.97	7	680	15.26	0.1	385
	4	Bijligar	Tube well	Colorless	2	7.3	500	12.58	0.1	400
Kabal River Union Council	1	WAPDA colony	Tube well	Colorless	4	7	455	9.24	0.1	228
	2	National colony	Tube well	Colorless	3.36	6.6	425	6.4	0.1	312
	3	Qazi Abad	Pressure Pump	Colorless	2.98	6.9	750	13.4	0.1	346
	4	Zaidi colony	Pressure Pump	Colorless	2.25	7	650	12	0.2	357
Nowshera city Union Council	1	Zwani Khel Masjid	Pressure pump	Colorless	2	7.1	645	19.47	0	322
	2	Dheri Khel	Tube well	Colorless	2.6	7	750	15.25	0	364
	3	Dagi Khel	Dug Well	Colorless	5.41	7	710	6.8	0.1	525

Chowki Town Union Council	4	Parachgan	Hand Pump	Colorless	2	6.7	890	8.1	0.1	335
	1	Hoti Khel	Pressure pump	Colorless	1	6.8	907	5.3	0.2	451
	2	Zaman Khel	Hand Pump	Colorless	2.1	7.1	450	9	0.3	329
	3	Shala Khel	Dug Well	Colorless	6.82	7.3	410	9.4	0.2	519
	4	Mana Khel	Tube well	Colorless	2.5	7.2	450	9.1	0.2	345

3.2. Comparison of Water Quality parameters with WHO guidelines for all samples:

Table 3 below the water quality status of District Nowshera is compared with the WHO guidelines on the basis of collected samples. The comparison is based on the percentage of samples lies within the permissible WHO limits and those exceeding the WHO limits for all parameters. The table shows that 91.66% of the samples for turbidity are within permissible limits while 8.34% were exceeding the permissible limits. All the samples were within the permissible limits for pH and Iron. In the rest of parameters, it was observed that in 12.5% of the samples TDS concentration, 50% of samples Nitrate concentration and 12.5% of samples ECw concentration is exceeding the permissible limit.

Table 3. Comparison with WHO Guidelines

S. No	Total Number of WSS	Parameters	WHO Guidelines	District Nowshera			
			Permissible range of WHO	No of samples within Permissible limits		Samples exceeding Permissible limits	
				Number	%age	Number	%age
1	24	Turbidity	5 NTU	22	91.66	2	8.34
2	24	pH	6.5-8.5	24	100	0	0
3	24	TDS	500 mg/1	21	87.5	3	12.5
4	24	Nitrate	10 mg/1	12	50	12	50
5	24	Iron	0.3 mg/1	24	100	0	0
6	24	ECw	1000 μS/cm	21	100	3	12.5

3.3. Union Council Wise Comparison with Who Guidelines:

After discussing the overall comparison in table 3, the samples collected from individual union council were compared with WHO guidelines to assess the water quality in each Union councils. The samples results shown in table 2 when compared with WHO guidelines shows that in Badrashi Union Council all the samples were within the permissible limits thus proving the water to be of good quality. While in Kabul River and Aman Garh Union council all the other parameters were within the permissible limits except nitrate which were exceeding the limits in 50 % samples of Kabul River and 100 % samples of Aman Garh Union Council. Similarly, in Nowshera city Union Council, nitrate was exceeding limits in 50 % samples and TDS in 25% samples. In Chowki UC, there was only problem in TDS while Khat Killi Union Council was the worst in water quality because TDS, Nitrates and ECw were exceeding the limits in 25%, 100 % and 25% samples respectively.

3.4. Source wise comparison of Samples parameters with WHO guidelines:

The water samples were collected from different sources including ten (10) samples from tube wells, two (02) from Dug wells, eight (08) for Pressure pumps and four (04) from hand pumps. The results comparison of source sample with WHO guidelines is given in Table-4 below. The table shows that for samples collected from tube wells, 50 % of samples exceeding limits in Nitrate and 20 % in Electrical conductivity, dug wells only 20% in Turbidity, Hand pumps 50% in nitrates showing slight inferior water quality. But the samples collected from pressure pumps shows very inferior quality because 12.5% samples are exceeding limits each for ECw and TDS while 37.5% of the samples are exceeding limits for nitrate.

Table 4. Source Wise comparison of Water Quality Parameters with WHO guidelines

S.No	Source	Parameter	WHO Permissible Limits	Total Number of samples	Sample within permissible limits		Sample Exceeding Permissible limits	
					Number	%	Number	%
1	Tube Well	Turbidity	5 NTU	10	10	100	0	0
2		pH	6.5-8.5	10	10	100	0	0
3		TDS	500 mg/1	10	10	100	0	0
4		Nitrate	10 mg/1	10	5	50	5	50
5		Iron	03 mg/l	10	10	100	0	0
6		ECw	1000 µS/cm	10	8	80	2	20
1	Dug Wells	Turbidity	5 NTU	2	0	0	2	100
2		pH	6.5-8.5	2	2	100	0	0
3		TDS	500 mg/1	2	2	100	0	0
4		Nitrate	10 mg/1	2	2	100	0	0
5		Iron	03 mg/l	2	2	100	0	0
6		ECw	1000 µS/cm	2	2	,100	0	0

1	Pressure Pumps	Turbidity	5 NTU	8	8	100	0	0
2		pH	6.5-8.5	8	8	100	0	0
3		TDS	500 mg/1	8	7	87.5	1	12.5
4		Nitrate	10 mg/1	8	5	62.5	3	37.5
5		Iron	03 mg/l	8	8	100	0	0
6		ECw	1000 µS/cm	8	7	87.5	1	12.5
1	Hand Pumps	Turbidity	5 NTU	4	4	100	0	0
2		pH	6.5-8.5	4	4	100	0	0
3		TDS	500 mg/1	4	4	100	0	0
4		Nitrate	10 mg/1	4	2	50	2	50
5		Iron	03 mg/l	4	4	100	0	0
6		ECw	1000 µS/cm	4	4	,100	0	0

4. Conclusion

The water qualities obtained from the Hand Pumps are normally fit for drinking and irrigation purposes although having some more nitrate content. With respect to turbidity, the dug well water of most of the region is unfit of drinking purposes. In some of the region the Iron are also polluting the drinking water. The Tube well water can also be regarded as of good except a few cases in some of the region that showing high nitrate content. The overall conclusion is that in some parts of the study area, turbidity, Nitrate and Iron is an issue and causing bad water quality.

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