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Assessment of Dug Wells' Water for Drinking and Irrigation Purposes at District Dir Lower, Khyber Pakhtunkhwa Pakistan

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Abstract: The present preliminary study was aimed to assess the dug wells' water quality in District Dir Lower, Khyber Pakhtunkhwa Pakistan, for drinking and irrigation purposes. During study 11 water samples were collected from dug wells at different places and were analyzed for various physico-chemical parameters. The results of evaluated parameters were compared against the standard guideline values suggested for drinking and irrigation purposes. The parameters studied were pH, electrical conductivity, total solids, total hardness, calcium hardness, magnesium hardness, alkalinity, total dissolved solids, total suspended solids, sodium, chlorides, nitrites, sulphate, potassium, carbonate and bicarbonate. The results showed that some of the water parameters for some sampled sites do not fall within the World Health Organization suggested permissible limits and should be treated before drinking. The chemical indices like Sodium Absorption Ratio, Sodium Percentage and Residual Sodium Carbonate qualify the water quality as excellent for agricultural practices. In order to recover and protect water quality, it is suggested that water quality should be assessed regularly. Agricultural run offs and domestic wastes should be treated properly before disposing off and the waste materials should be dumped to suitable sites.

Key words: Parameters, Permissible Limits, River Panjkora, Water Quality.

INTRODUCTION

No one can under estimate the need and necessity of water for human life. Water is the basic constituent of all living organisms. One cannot consider life without water. Being universal solvent, water is capable of dissolving many substances, so it's highly prone to contamination[1]. Contaminated water can hinder normal physiology of human beings. In the current era of green revolution and industrialization, water resources are being polluted to a great extent by domestic, agricultural and industrial waste disposals [2]. The water at the source is quite good, potable and having good quality for human health but it gets polluted and contaminated by mixing with sewage water. These wastes usually flow through crakes and holes in old and rusted pipes. Sometimes it gets polluted due to the fact that water pipes are laid beneath or parallel to the sewerage pipes, thus causing mixing of the water with these wastes [3].The total water quantity on earth surface is estimated to be 1.4 trillion cubic meters [4]. Of the total less than one percent is embodied to river and ground water resources and is consumptionable [5]. In Pakistan glaciers, rivers and lakes are the main sources of fresh water but on account of shortage of rain and snow falls, Pakistan is scanty of clean and fresh utilizable water. To cope with this situation the people depend on ground water resources. These are important natural water resource and are employed in almost all spheres of the human life and activities [6]. The ground water pollution is the burning issue of today and is like a broad day light on the horizon of environmental research.

Owing to the current scenario of ground water shortage, research has been conducted almost in all parts of Pakistan and in different districts of Khyber Pakhtunkhwa. Some of these districts are District Nowshehra [7], District Kohat [8], District Charsada [9], District Mardan[10], District Buner [11] and District Peshawar [12]. Similarly research has also been carried out on various rivers of the province but no updated data appears concerning water quality of District Dir Lower. Therefore the current work was carried out in order to assess dug wells' water quality at District Dir Lower.

The water quality is assessed by comparing it physico-chemical parameters against the suggested permissible limits [13]. So during the study different physico-chemical parameters were evaluated. These parameters were pH, electrical conductivity, total solids, total hardness, calcium hardness, magnesium hardness, alkalinity, total dissolved solids, total suspended solids, sodium, chlorides, nitrites, sulphate, potassium, carbonate and bicarbonate. The results of these parameters were compared with the values suggested by World Health Organization.

STUDY AREA

District Dir Lower is located with Latitudes and Longitudes of 71º, 31' to 72º, 14' East and 34º, 37' to 35º, 07' North respectively. It is approximately 2700 feet above mean sea level [14]. An annual rain fall of 1468.8 mm and 253.7 mm during December and March respectively is common. District Dir is bounded by District Chitral (North), by Bajaur and Afghanistan (West), by District Malakand (South) and by District Swat (East) [15]. River Panjkora is the key river in District Dir that originates from Kohistan, District Dir (Upper) and flow southward dividing District Dir Upper and Lower into two halves. River Panjkora joins River Swat at Sharbatti Pull (behind Totakan, District Malakand).

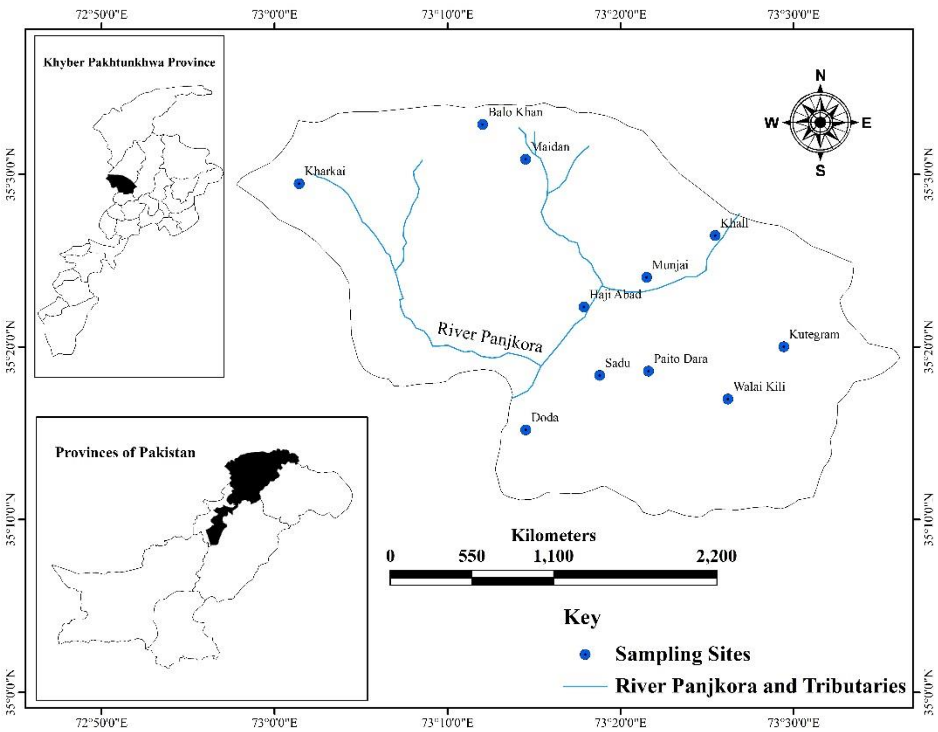

Fig 1. Shows sampling sites in the study area

MATERIAL AND METHOD

Water Sampling

The collection of Water samples was carried out by using polythene bottles. These bottles were first washed with tape water and were then rinsed using double deionized water. A total of eleven samples were collected from various places within the study area. The samples were tested for pH and conductivity on the spot and were transported to the laboratory for further analysis.

The pH was found out with portable pH meter (Natner, UK made). The conventional methods referred by APH/AWWA [16] were followed for determining total alkalinity (T.A), total suspended solids (TSS), total dissolved solids (TDS), total hardness (T.H), magnesium hardness (Mg^{+2}), calcium hardness (Ca^{+2}), chlorides (Cl_2), and sulphate (SO_4) contents. For finding out Nitrate (NO_2), Sodium (Na^+), Potassium (K^+), Carbonate ($CO3^{-2}$) and bicarbonate ($HCO3^-$) methods of Yousaf et al., [8] was followed. The other parameters i.e., color; odor, taste and turbidity were observed organolaptically.

Statistical Calculation

Mean, Standard deviation, Pearson Correlation Coefficient and Percentages were found out using Microsoft Excel 2010. Map for the study area was prepared using Arc GIS 9.3 platform. Sodium Absorption Ratio, Sodium Percentage and Residual Sodium Carbonate were calculated following Kaur and Singh [17].

RESULTS AND DISCUSSION

The results of the observed physico-chemical parameters showed variations. The results showed that 27.272% water samples were bluish, smelly, pungent and turbid. The observed mean electric conductivity was 1401.636µs/cm for all sampling sites, which falls within the suggested permissible limit but yet it deviates in three of the locations and exceeds suggested permissible limit. The observed mean pH was 7.42 for all locations, showing that pH of the study was falling within the suggested permissible limits and has no alarming situation [18].

The water quality parameters were observed and the results for some areas showed its fitness for human consumption while most of the areas' water was unfit. Most of water quality parameters were not within the permissible limits, suggested by World Health Organization for human consumptions, clearly rendering it unfit for drinking purpose. The descriptions of Physical parameters for the samples are given in Table 1.

Table 1: Description of Physical parameters of Dug wells' water samples

S. No	Location	Color	Odour	Taste	Turbidity	EC*	pH
1	Khall	Brownish	Smelly	Pungent	Turbid	3250	8.5
2	Munjai	Colorless	Odorless	Tasteless	Clear	2110	7.3
3	Sadu	Colorless	Odorless	Tasteless	Clear	825	7.2
4	Maidan	Colorless	Odorless	Tasteless	Clear	717	7.1
5	Haji Abad	Brownish	Smelly	Pungent	Turbid	3250	7.8
6	Paito Dara	Colorless	Odorless	Tasteless	Clear	871	7.2
7	Doda	Colorless	Odorless	Tasteless	Clear	1000	7.4
8	Kharkai	Colorless	Odorless	Tasteless	Clear	900	7.5
9	Kutegram	Brownish	Smelly	Pungent	Turbid	860	7.4
10	Walikali	Colorless	Odorless	Tasteless	Clear	835	7.1
11	Balo Khan	Colorless	Odorless	Tasteless	Clear	800	7.2

*Electrical Conductivity

Across all collected samples electrical conductivity ranged between 717 µs/cm and 3250 µs/cm. The strongest correlations ($r > 0.5$, $p = 0.001$) with electrical conductivity included total solids ($r = 0.946$), followed by total dissolved solids ($r = 0.858$), nitrate ($r = 0.854$) pH ($r = 0.829$), total suspended solids ($r = 0.728$) and sulphate ($r = 0.71$).

PH ranged from 7.1 to 8.5 across all sampling sites. The observed mean pH, 7.42, was showing that pH of the study area has no alarming situation and fall within the suggested permissible limits. The strongest correlations ($r > 0.5$, $p = 0.001$) with pH included total solids ($r = 0.766$), total dissolved solids ($r = 0.659$) and total suspended solids ($r = 0.525$).

The observed mean total solids was 1024.09 mg/L, total dissolved solids was 1198.63 mg/L, mean total suspended solids was 14.82 mg/L, total hardness was 510 mg/L, Calcium hardness was 271.36 mg/L, Magnesium hardness was 212.272 mg/L, alkalinity was 243.18 mg/L, Chloride was 182.27 mg/L, Nitrate was 0.936 mg/L, Sodium was 166.545 mg/L and Potassium was 7.07 mg/L. The results of Physico-chemical parameters are given in Table 2.

Table 2. Physico-chemical parameters of Dug Wells' water samples

Location	TS	TDS	TSS	T.H	Ca	Mg	T.A	Cl_2	SO_4	NO_2	Na	K

Khall	1250	1900	35	600	305	260	250	185	290	1.5	190	4.7
Munjai	1110	2010	35	615	310	260	270	190	290	1.8	220	4.4
Sadu	1020	1000	15	475	270	190	215	180	250	1.1	190	4.1
Maidan	925	800	5	420	210	105	220	170	210	0.5	142	3.8
Haji Abad	1205	1575	20	525	310	260	230	180	280	1.7	210	4.9
Paito Dara	950	850	5	470	230	155	215	170	230	0.5	170	3.6
Doda	1010	900	1	470	270	205	270	170	200	0.9	140	12.1
Kharkai	900	1100	3	450	240	170	210	220	190	0.5	190	7.2
Kutegram	925	1000	12	500	230	200	245	190	170	0.7	100	9.3
Walikali	980	990	17	510	270	250	345	160	200	0.6	110	10
Balo Khan	990	1060	15	575	340	280	205	190	270	0.5	170	13.7
S.D	116.2	425.8	11.8	63.1	41.2	54.9	40.9	16.1	43.5	0.5	39.2	3.6
WHO*	1000	1000	5	500	250	150	500	250	250	0.5	250	75

*= WHO upper permissible limits for drinking water, S.D = Standard Deviation, TS= Total solids, TDS= Total dissolved solids, TSS=Total suspended solids, T.H= Total hardness, Ca=Calcium hardness, Mg=Magnesium hardness, T.A=Total alkalinity, Cl_2=Chloride, SO_4=Sulphate, NO_2=Nitrate, Na=Sodium and K=Potassium.

The suitability of the groundwater for irrigation purpose was determined on the basis of Sodium Absorption Ratio (SAR), Sodium Percentage (Na %) and Residual Sodium Carbonate (RSC) by following the methodology of Kaur and Singh [17]. The results for SAR, Na% and RSC along with Sodium Hazard Classes (SHC) are given in Table 3.

Table 3. Tube wells' water parameters for irrigation purpose

S. No	Location	SAR	SHC	Na %	RSC
1	Khall	11.30431823	S2	25.62853758	-285
2	Munjai	13.03167531	S2	28.24773414	-280
3	Sadu	12.52822899	S2	29.67436172	-210
4	Maidan	11.31483084	S2	31.640625	-75
5	Haji Abad	12.43932643	S2	27.37928399	-390
6	Paito Dara	12.25274949	S2	31.07769424	-175
7	Doda	9.084399583	S1	24.25450486	-215
8	Kharkai	13.27017562	S2	32.47694335	-160
9	Kutegram	6.819943395	S1	20.26701279	-100
10	Walikali	6.821910402	S1	18.75	-300
11	Balo Khan	9.655351182	S1	22.85678736	-400

SAR= Sodium Absorption Ration, SHC= Sodium Hazard Class, Na %= Sodium Percentage, RSC= Residual Sodium Carbonate

SAR values were varying in the range of 6.819-13.27 for all sampling sites. Among the sites four were falling in S1 class (Excellent for Agriculture) and seven in S2 class (Good for Agriculture) [19]. Na % is expressed in epm. Sodium percentage values were falling in the range of 18.75-32.477 reflected that the water was good for agricultural purpose (0.624-4.675) [19].

RSC gives an account of calcium and magnesium in the water sample as compared to carbonate and bicarbonate ions. RSC value less than 1.25 indicates low hazard, whereas a value of 1.25- 2.5 indicates medium hazard and more than 2.5 indicates high hazard to crop growth. The results for RSC showed that all the sampling locations were less than 1.25. It means the water can be employed for agricultural practices and has no hazards to crop growth [17].

For the entire collected samples total dissolved solids ranged from 800 mg/L to 2010 mg/L. The observed mean total dissolved solid was 1198.64 mg/L. The strongest correlations ($r > 0.5$, $p = 0.001$) with TDS included total suspended solids ($r = 0.903$), nitrate ($r = 0.878$), total hardness ($r = 0.824$), sulphate ($r = 0.752$), sodium ($r = 0.66$), magnesium ($r = 0.637$), and calcium ($r = 0.632$).

Total suspended solids, across all sampling sites, ranged from 1 mg/L to 35 mg/L. The observed mean total suspended solid was 14.818 mg/L. The strongest correlations ($r > 0.5$, $p = 0.001$) with TSS was shown by total hardness ($r = 0.89$), followed by nitrate ($r = 0.782$), sulphate ($r = 0.76$) and calcium ($r = 0.657$).

Total hardness ranged from 420 mg/L to 615 mg/L. The observed mean Total Hardness was 510 mg/L. The strongest correlation ($r > 0.5$, $p = 0.001$) with Total hardness across all sampling sites was shown by magnesium ($r = 0.87$), calcium ($r = 0.834$), sulphate ($r = 0.742$) and nitrate (0.638).

Across all sampling sites calcium ranged from 210 mg/L to 340 mg/L. The observed mean Calcium Hardness was 271.36 mg/L. The strongest correlation ($r > 0.5$, $p = 0.001$) with calcium hardness across all sampling sites was shown by magnesium ($r = 0.915$), sulphate ($r = 0.783$), nitrate ($r = 0.572$) and sodium ($r = 0.509$).

For all sampling sites magnesium ranged from 105 mg/L to 280 mg/L. The observed mean Magnesium Hardness was 212.272 mg/L. The strongest correlations ($r > 0.5$, $p = 0.001$) with Total hardness across all sampling sites included sulphate ($r = 0.588$), followed by bicarbonate ($r = 0.575$) and nitrate ($r = 0.542$).

Total alkalinity ranged from 205 mg/L to 345 mg/L across all sampling sites. The observed mean Alkalinity was 243.181 mg/L. The highest correlation ($r > 0.5$, $p = 0.001$) with Total alkalinity was shown by bicarbonate ($r = 0.507$).

Chloride ranged from 160 mg/L to 220 mg/L across all sampling sites. The observed mean Chloride was 182.272 mg/L. Chloride was not having any significant correlation with any of the studied parameters.

Nitrite, across all sampling sites ranged from 0.5 mg/L to 1.8 mg/L. The observed mean Nitrite was 0.936 mg/L. The strongest correlations ($r > 0.5$, $p = 0.001$) with Nitrite across all sampling sites included sodium ($r = 0.648$).

Sodium ranged from 100 mg/L to 220 mg/L across all sampling sites. The observed mean Sodium was 166.545 mg/L. The strongest correlation ($r > 0.5$, $p = 0.001$) with Sodium across all sampling sites was shown by total dissolved solids ($r = 0.66$), electrical conductivity ($r = 587$), total solids ($r =0.577$) and potassium ($r = 0.503$).

Potassium ranged from 3.6 mg/L to 13.7 mg/L across all sampling sites. The observed mean Potassium was 7.072 mg/L. The highest correlations ($r > 0.5$, $p =$

0.001) with Potassium across all sampling sites were comprised of bicarbonate (r = 0.613).

Carbonate ranged from 140 mg/L to 300 mg/L across all sampling sites. The observed mean Carbonate was 220.9 mg/L. Carbonate was not having any significant correlation with any of the parameters.

Bicarbonate ranged from 0 mg/L to 70 mg/L across all sampling sites. The observed mean Bicarbonate was 27.273 mg/L. The highest correlations ($r > 0.5$, $p = 0.001$) with Bicarbonate across all sampling sites were comprised of magnesium ($r = 0.575$) and total alkalinity ($r = 0.507$).

CONCLUSION

It was concluded from the study that the water in some sampled locations were unfit and cannot be utilized for drinking purpose, anyhow water parameters of some of the areas were falling in the permissible limits and could be used for human consumption. The area with unfit water quality should be treated before drinking. Although the water quality was not that fit for drinking purpose yet the SAR, Na % and RSC analysis showed that the water is excellent for agriculture purpose. To protect the water quality from further deterioration and make the unfit sites usable certain steps should be adopted such as wastes from houses and agricultural run offs should be properly treated. Waste materials should be disposed of at proper place and with a planned manner. Proper attention should be paid to Sanitation pipes and should be carefully installed. Soil tests should be carried out before digging dug wells. Awareness campaign and seminars should be carried out in order to educate the local masses about safety measures and importance of water quality.

Disclosure

None of the authors have any conflict of interest.

REFERENCES

1. Ilyas, M., Gilani, A.H. & Bhatty, N. (2008). Study of chemical quality of drinking water available to the children of different schools of Ghulam Mohammad Abad, Faisalabad-Pakistan. Pak. J. Sc., 60(1-2):26-31.
2. Sattar, S.A. & Ramia, S. (1981). Water borne transmission of viral infections; implication for the developing world. J. Pak. Med. Assoc., 381:181.
3. Hussain, T. (2002). Environmental hazards and their management. The Daily "Dawn."
4. Farid, S., Baloch, M.K. & Ahmad, S.A. (2012). Water Pollution: Major issue in urban areas. Inter. J. Wat. Res. Environ. Eng., 4(3):55-65.
5. Qadeer, R. (2004). Pollution in drinking water: Their sources, harmful effects and removal procedures. J. Chem. Soc. Pak., 26:293-301.
6. Prasad, B.G. & TS Narayana, T.S. (2004). Subsurface water quality of different sampling stations with some selected parameters at Machilipatnam town. Nat. Env. Pollut. Tech., 3(1):47-50.

7. Yousaf, S., Zada, A. & Owais,M. (2013). Physico-chemical characteristics of potable water of different sources in District Nowshera: A case study after flood – 2010. J. Himal. Earth Sc., 46(1):83-87.
8. Khan, N., Hussain, S.T., Khan, A. & Kim, K.S. (2013). Physiochemical investigation of drinking water sources from Tehsil Lachi, Kohat. Amer. J. Res. Commun., 2013.
9. Khan, S., Shahnaz,M., Jehan, N., Rehman, S., Shah, M.T. & Din, I. (2012). Drinking water quality and human risk in Charsadda district, Pakistan. J. Clean. Prod., 012:1-9.
10. Saeed, T.U., Aziz, A., Khan, T.A. & Ullah, H.A. (2012). Application of geographical information system (GIS) to groundwater quality investigation: A case study of Mardan district, Pakistan. Int. J. Phy. Sc., 7(37):542-5448.
11. Khan, S., Haq, F. & Saeed, K. (2012). Pollution Load in Industrial Effluent and Ground Water due to Marble Industries in District Buner, Khyber Pakhtunkhwa, Pakistan. Int. J. Rec. Sc. Res., 3(5): 366-368.
12. Khan, A.R. (2005). Potable water quality characteristics of the urban areas of Peshawar (Pakistan) Part-2 Well-Water. J. Chem. Soc. Pak., 27 (3): 239-245.
13. Burston, M.W. (1993). Pollution of ground water in the Coventry region (UK) by chlorinated hydrocarbon solvents. J. Hydrol., 149:137–161.
14. Ali, H.J., Shah, J. & Jan, A.K. (2008). Medicinal value of family Ranunculaceae of District Dir Pakistan. Pak. J. Bot., 39(4): 1037-1044.
15. Khan, N., Ahmad M., Wahab, M., Ajaib, M. & Hussain, S.S. (2010). Studies along an altitudinal gradient in monotheca buxifolia (falc.) a.d, forest, district Lower Dir, Pakistan. Pak. J. Bot., 42(5):3029-3038.
16. APHA/AWWA. (1998). Standard Methods for the examination of water, and waste water, 20th edition. American Public Health Association, Washington DC, USA.
17. Kaur, R. & Singh, R.V. (2011). Assessment for different groundwater quality parameters for irrigation purposes in Bikarner city, Rajastan. J. App. Sc. Environ. Sanit., 6(3):385-392.
18. WHO. (2011). Guidelines for drinking water quality. World Health Organization. 4th Ed. Geneva, Switzerland.
19. Wilcox, L.V. (1995). Classification and Use of Irrigation Water, US Department of Agricultural Circular, Washington DC. US Department of Agriculture. p. 969.