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Water Quality Assessment from Spring Source in Chitral Watershed of Northern Pakistan

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Abstract

Availability of clean drinking water to the masses is one of the major challenges faced by developing countries, like Pakistan. Spring water is one of the major sources of water supply for the people dwelling in the northern Pakistan, including district Chitral. In many parts of Chitral, water from small natural springs remains the only source for water supply, however very little research data is available about the physical and biological characteristics of and its suitability as drinking water. In this research the water quality of thirty springs has been assessed through sample collection and analysis. The results have been statistically analyzed and compared with the World Health Organization (WHO) Standards for various physicochemical characteristics. The analysis has revealed that the springs provide good quality of water for the people but there is an urgent need for protection of such springs from surface runoff.

Keywords: Spring, Water supply, Chitral, Pakistan

INTRODUCTION

Water is an essential component of ecosystem making it an integral part of all biological processes. As other part of biosphere human being needs water continuously for sustaining life (Tebbut, 1998). Out of 2.5% global total fresh water volume less than 1% is readily available for human use, making it a challenge to supply population with clean and clear drinking water at ease and accessible distance (Wagner, 1974). The scarcity of drinkable water coupled with potential risk of water pollution endangering life on the planet.

Water pollution has been defined as the condition of water whereby it deviates from purity to the level affecting normal functions and properties (Kumar, 2003). Water for human consumption and ingestion must be of appropriate quality without any risk to health. According to recent reports about 663 million people lacks access to safe water, whereas about 4 times greater (i.e.2.4 billion) are devoid of proper sanitation systems causing fatality of over 3.4 million people mostly children, due to water born diseases (WHO, 2015).

Chitral valley having unique ecosystem situated on the western bank of the Kunar River, and at the foot hill of Tirich Mir (Figure 1), serves as water shed for most of low-lying area had been selected for this study. Currently the population growth rate of Chitral is 2.5% (GoP, 1999). Over growing population and massive human activities in the area increase burden on natural resources including water.

Pollutants in the drinking water are posing severe threats to the public health in Pakistan (Azizullah et al., 2010). Studies had been carried out on drinking water of different areas in Khyber Pakhtunkhwa,

identified ineffective disinfecting (Khan et al., 2007), metal toxicity and presence of both coliform and fecal coliform bacteria (Khan & Bangash 2001), and toxic metal accumulations (Khan et al., 2013) to be the major issues. However, most of such studies confined to low lying districts and there seems to be no study particularly focusing on Chitral valley. Fresh water acquired by man for body needs and recreational activities comes either from surface water, supplying to rivers, ponds and lakes or ground water, supplying to wells and springs.

Springs, which are characterized by emerging groundwater that creates aquatic–terrestrial and groundwater–surface water eco tones, are sources for headwater streams (Ward & Tockner, 2001). Though, springs are relatively isolated but less seasonal variation in water temperature and discharge is faced as compared to headwater streams which help the environmental stability (Lake, 2000). Spring water has increasingly become a major source of drinking water supply for rural communities in most of the mountainous areas (Greogy, 1996). There are three general conditions of the earth strata that produce springs, including, a stratum of water-bearing soil is exposed, a porous water-bearing rock is exposed and a stratum of rock that overlies a stratum of water, contains fissure or faults, which appears near the surface of the ground (Kundell & Matlock, 2010). Springs originating in hilly rocky areas usually have sandy stone bottom, very clear water, no vegetation and uniform low temperature throughout the year.

Chitral or Chetrar, translated as field in the native language Khowar, is the capital of Chitral District (Fig.1), the highest peak of the Hindu Kush, 25,289 ft (7,708 m) high. It has a population of 20,000, the district Chitral (14,833 km² or 5,727 sq mi), has a population of 300,000. The altitude of the valley is 3,700 ft (1,100 m) (Kendall, 1992).

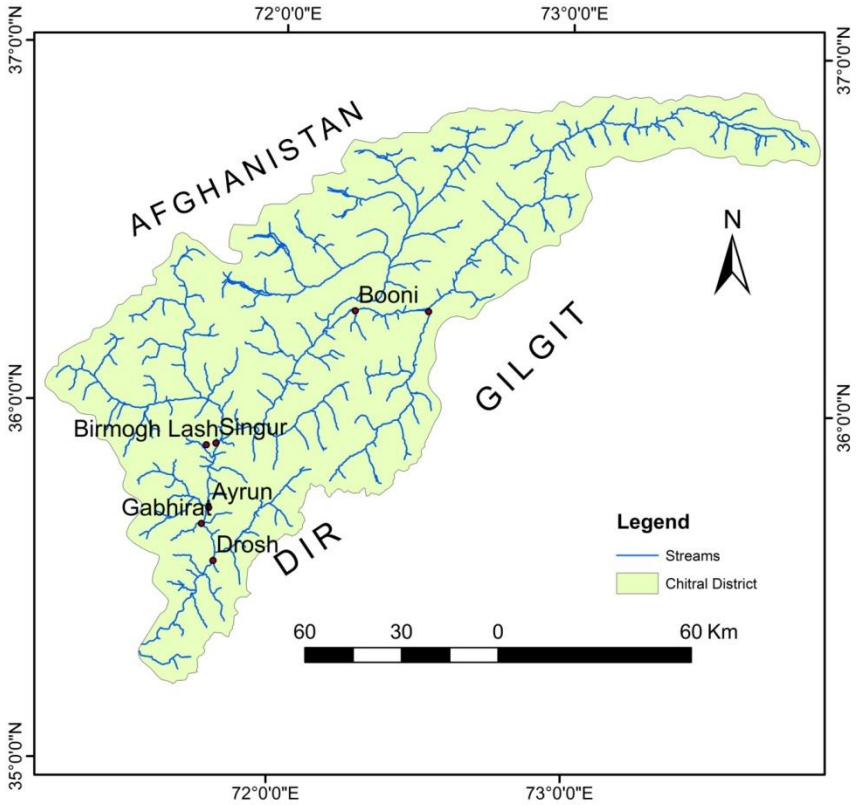

Figure 1. District Chital Pakistan (Reproduced from the Geological Survey of Pakistan)

Several large tributaries and streams flowing into the Chitral River, like Boonigol, Rashangol, Laspurgol, and Naghargol with many small springs and glaciers feeding the streams.

The climate of Chitral is distinctly continental i.e. during summer it is very hot in low land, warm in the upper land and cool in the higher elevation.

Surface water of rivers and the subsoil water of springs are used for drinking and recreational purposes in Chitral. The river water is used only in those areas which surround the river belt and thus most of the residents have to rely for their water on various springs abundantly found in the upper part of District Chitral. Regardless of the source, it is important that the fresh water should be free from pollutants and contain minerals and ions in appropriate quantity needed for normal body growth (i.e. WHO Standards).

With the growing concerns of water-borne diseases, the study of the physical and biological characters of drinking water has becomes an important issue to assess the quality water from various sources over the last several decades The increasing scarcity of potable water in the view of the exponential increase of human population and squeezing water resources make the water quality assessment even more important in all parts of the world. This kind of research becomes more important for rural areas, where the water resources are already very scarce.

Several studies have been conducted on drinking water quality assessment of District Chitral, however the current investigation provides a unique statistical portrait of the total area based on samples' investigations with particular reference to spring water.

The current investigation involves-

The drinking quality assessment of spring water of Chitral on the basis of sample survey, the comparative analysis of quality of water of various springs of Chitral, the comparison of the concentration of various nutrients and pollutants in this water to the WHO standards and judging its suitability as drinking water and the Development of an overall picture of the water quality of the springs of Chitral using statistical analysis.

MATERIALS AND METHODS

Site and Sample collection

Thirty springs were selected from different locations across Chitral valley and three samples were collected from each spring according to WHO recommended procedure (WHO, 2006) and their mean values were incorporated in the Physicochemical Analysis.

The sample collected were properly labeled and run for chemical analysis as described below; Temperature was recorded at the spot using portable thermometer. pH of all samples were recorded at the spot with a portable pH meter. Color was determined by modified platinum-cobalt standard method (ASTM, 2011), using DR/2000 spectrophotometer (Hach-USA).

Dissolved oxygen was determined with a DO meter (model OXI-57WTW) Germany. Total hardness; carbonates (CO_3), bi-icarbonates (HCO_3), and chlorides(Cl^-) were determined using standard methods (APHA, 2005).

Statistical Analysis

The data collected in triplicates was used to determine the confidence interval of various parameters for the entire population (i.e. Chitral). The population is assumed to be normally distributed and since the number of samples is less than 30, therefore *t*-statistics has been used to determine the confidence interval for population mean using 95% confidence level.

$C.I = X \pm t\ \alpha/2\ (d.f)\ S / \sqrt{n}$

RESULTS AND DISCUSSION

The results have been tabulated in Table 1, which shows the temperature, pH value, color, dissolved Oxygen (DO) , total Hardness (TH), carbonates, bi-carbonates and chlorides.

Table 1. Mean values of physical characteristics of Water Samples of different springs of Chitral Pakistan.

Spring	T (°C)	pH	Color (TON)	DO (ppm)	T.H (ppm)	CO_3^{--} (ppm)	HCO_3^- (ppm)	Cl^- (ppm)
Ishthoongole	11.0	6.7	4	10.50	275	33.0	19.5	04.7
Khonza Uch	16.5	6.4	5	12.28	73	23.7	13.4	10.0
Hara	11.9	6.7	6	05.10	110	96.0	27.6	11.6
Garam Chashma	60.0	6.4	8	11.07	335	22.5	11.3	06.8
Parabak Lothoh	10.6	7.2	3	08.71	330	65.2	42.0	03.9
Jughoor Chitral	14.5	6.7	3	07.37	100	06.0	36.6	07.5
Dolup L.	07.0	6.4	4	12.02	105	50.5	37.2	02.9
Dolup U.	06.0	6.4	3	12.44	70	25.5	05.0	04.2
Kukuliochogh	05.0	6.4	6	12.67	558	99.0	51.0	10.0
Poshkitogh	05.0	6.4	4	12.67	50	20.5	12.0	11.5
Souzalochogh	05.0	6.4	1	12.54	80	26.2	04.9	11.15
Lasht Uch	12.0	6.7	5	10.65	415	58.5	22.5	12.9
Seermari	11.0	7.0	4	09.49	250	63.0	70.0	6.26
Shakarandoor	11.2	6.7	3	10.89	85	55.5	27.0	09.0
Lologh	19.0	7.2	5	9.30	179	79.0	79.0	5.62
Khoshiantooq	18.0	6.7	5	7.04	306	100	33.5	07.5
Karkastogh	05.0	6.4	1	12.78	56	18.7	06.1	08.0
Angerghoon	16.0	6.7	4	9.79	150	69.0	39.6	08.0
Kuloom	11.0	7.2	2	10.90	102	37.0	25.0	08.2
Gaht Lower	13.0	7.2	3	10.73	182.5	30.0	67.0	07.9
Paloghkhamogh	08.0	6.7	4	11.76	236	75.0	34.0	08.9
Dragar	12.0	7.2	5	10.73	245	82.5	42.0	10.7
Dodoormari	10.0	6.7	3	11.06	122	35.0	28.0	02.3
Bloagh	33.0	7.2	5	07.20	250	135	18.0	6.35
Chilasi	13.0	6.4	4	10.41	125	62.2	30.5	05.2
Biyarok	25.8	7.5	7	08.13	88.5	180	91.0	01.8
Drasun	31.0	6.7	7	09.45	120	25.5	05.8	10.5
Awarogh	17.0	7.4	8	09.57	266	90.0	34.0	11.0
Istari	08.0	7.0	6	11.58	385	62.5	36.6	09.0
Palagu	08.0	6.4	4	11.81	251	46.5	36.6	09.0

Temperature shows wide variation range 5 - 25±1 °C except for one in Garam Chashma , which was 60 °C. This very high temperature may be due to the presence of sulfur in the water, such type of spring are common in Malakand, Gilgit and Chilas districts (Javed et al., 2012). The high temperature and high sulphur contents ascribed to the particular use of such water for treating skin related diseases. The presence of sulfur in the water acts as disinfectant and heals the skin diseases like dermatitis (Gupta & Nicol, 2004). The water temperature of springs is generally not affected by the weather.

The pH of spring water collected ranges from 6.4 to 7.5. This is in the close proximity of 7.0, showing the neutral character of the spring waters.

Dissolved Oxygen (DO) for the samples collected was 5.10 to 12.78 ppm. Minimum DO (5.10 mg/l) was observed in Hara spring, , whereas, high Do (12.78 ppm) showed by Karkastogh

The Total hardness (TH) ranges 50 – 558 mg/l. Having lowest (50 ppm) for Souzalochogh spring, whereas the maximum 558ppm for Kukuliochogh spring.

The carbonate ion sample is well in the range of 50-180 ppm. The Hara, Drasun and Awarogh springs show high level of carbonate contents.
The bi-carbonate level of the samples ranges from 5-90 ppm. Gaht Lower and Byarok springs show the maximum level of Carbonate contents i.e. 67 and 91 ppm respectively.
Chloride ion contents of all spring are reasonably low in the range of 2-12 ppm and results are quite satisfactory.
The mean values of all the thirty springs for the physical characteristics, their standards deviations, confidence interval and comparison of the means to the recommended values of WHO Standards for drinking water has been given in Table 2.

Table 2. Details of mean values, standard deviations, Confidence interval and comparison with WHO Standards for all springs of Chitral district.

Statistical Parameter	T (°C)	pH	Color (TON)	DO (ppm)	T.H (ppm)	$CO3^{--}$ (ppm)	$HCO3^{-}$ (ppm)	Cl^{-} (ppm)
Mean value (All springs)	14.4	6.77	4.4	10.3	196	59.1	32.8	7.75
Standard deviation	10.9	0.118	1.8	3.6	122	37	5.47	5.7
Confidence interval.	10-18	6.7-6.8	3 – 5	9.1-11.5	151-242	45-73	31-35	5.6-9.8
WHO limits	Nil	6.5-8.5	10	≥3	500	Nil	Nil	250

The mean pH values of springs lie within the tolerable level given by WHO i.e. 6.5-8.5. This range is also complied by the individual springs as no value of pH is more than the given values. Few values are just at the border of lower limit. Hence the pH value of all the springs is in the acceptable range. Similarly, mean value of color is also within the given range. Individually all the values of colors also fall in these limits.
Dissolved Oxygen (DO) for the collected samples was 5.10 to 12.78 ppm. Minimum level dissolved Oxygen was observed in the sample collected from Hara spring, i.e. 5.10 ppm, where the sample collected from Karkastogh shows the maximum level of dissolved oxygen i.e. 12.78 ppm. WHO has recommended the minimum level of dissolved oxygen for drinking water 3 ppm or more. All the springs water provides a high level of dissolved oxygen, showing better taste peculiar for spring water.

CONCULSION

The water samples collected from the thirty springs of Chitral, Pakistan has shown that the physicochemical characteristics of waters fall well within the prescribed limits of WHO, which is an encouraging fact. The confidence interval worked out on the basis of samples can also be used for judging the quality of other springs of the district. Some of the springs show high values of hardness and carbonates, bi-carbonates concentration than specified, which is a matter of concern for the local authorities and there is a need to further investigate the matters. There is also need for protecting the springs from surface runoff to maintain the quality of the water.

REFERENCE

American Public Health Association, 2005. Standard methods: For the examination of water and wastewater, 18th edn, Washington DC.
ASTM D1209-05. 2011. Standard Test Method for Color of Clear Liquids (Platinum-Cobalt Scale), ASTM International, West Conshohocken, PA, www.astm.org

Azizullah, A., Khattak, M.N., Richter, P., Hader, D.P., 2010. Water pollution in Pakistan and its impact on public health--a review. Environ Int. 37, 479-97.

Government of Pakistan (GoP) 1999. 1998 district census report of Chitral, census publication 20. Population Census Organization, Islamabad.

Gregory, D.J. 1996. Protecting Water Supply Springs. Extension Agricultural Engineering. North Carolina Cooperative Extension Service. Publication Number: AG 473-5, Washington DC, USA.

Gupta, A.K., Nicol, K., 2004. The use of sulfur in dermatology. J. Drugs Dermatol. 3, 427-31.

Javed, S., Zahoor, H., Sabar, I. Haq, U., Babar, M.E., 2012. Thermophilic bacteria from the hot springs of gilgit (pakistan). The Journal of Animal and Plant Sciences, 22, 83-87.

Kendall D. 1992. Languages of Chitral. In: Sociolinguistic Survey of Northern Pakistan. Islamabad: National Institute of Pakistan Studies, Quaid-i-Azam University and Summer Institute of Linguistics. Xxii. http://www.sil.org/sociolx/pubs/abstract.asp?id=32850

Khan. K., Lu. Y., Khan. H., Zakir. S., Ihsanullah., Khan, S., Khan. A.A., Wei.L., Wang, T., 2013. Health risks associated with heavy metals in the drinking water of Swat, northern Pakistan. J. Env. Sci. 25, 2003-13.

Khan, S., Bangash, F.K., 2001. Drinking water quality forecast of Peshawar valley on the basis of sample data. J. Chem. Soc. Pak. 23, 243-252.

Khan, S., Khan, F., Nisar, M., Ahmad, B., Khan, R., 2007. The effect of suspended solids on disinfecting process for drinking water in Peshawar valley. J. Chem. Soc. Pak. 29, 82-85.

Kumar A. De., 2003. Environmental chemistry. 5th edition. New Delhi. New Age International Ltd.

Kundell, J., Matlock, M., 2010. Spring. In: Encyclopedia of Earth. Eds. Cutler J. Cleveland Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment. http://www.eoearth.org/article/Spring.

Lake, P.S., 2000. Disturbance, patchiness, and diversity in streams. Journal of the North American Benthological Society, 19, 573–592.

Tebbutt, T.H.Y., 1998. Principles of water quality control. 5th edition. Eastbourne GB. Antony Rowe Ltd.

Wagner, R.H., 1974. Environment and man. New York. W.W.Norton and Co. Inc.

Ward, J.V., Tockner, K., 2001. Biodiversity: towards a unifying theme for river ecology. Freshwater Biology. 46, 807–819.

WHO ., 2006. Guidelines for drinking water quality. Geneva.

WHO., 2015. Drinking Water, Fact sheet. http://www.who.int/mediacentre/factsheets/fs391/en/