Evaluation of Drinking Water from Different Sources in Skardu- Northern area with Special Reference to Heavy Metals

Z.H. LODHI*, M. AKIF AND U. KALSOOM
PCSIR Laboratories
Jamrud Road Peshawar 25120, Pakistan

(Received 13th March, 2001, revised 10th December, 2002)

Summary: In Skardu and other northern area, demand for drinking water is met through both surface and subsurface water. No survey regarding the potability of water has been conducted in the past. Considering the importance of this survey, ten samples of drinking water from different sources were collected and analyzed for various parameters like pH, dissolved oxygen, electrical conductivity, suspended solids, alkalinity, hardness, nitrites, sulphates, chlorides, sodium, and potassium. They are also analyzed for heavy metals like iron, chromium, zinc, manganese, copper, nickel, cobalt and lead using atomic absorption spectrophotometer. The magnitude of different trace metals followed the order Zn > Fe > Ni > Pb> Co > Cu > Cr. Analysis indicate that there was no collinearity among the metals.

Introduction

Skardu valley is the most important region in the northern area of Pakistan. Northern area is proud of having K-2, the world's second highest peak and Baltoro the world longest glacier. Skardu valley is 550 KM from Islamabad by road. Skardu valley is some 7770 feet high from sea level. The climate of the valley is that of mountain desert, with bitterly cold winter and hot dry summer. The temperature remains below freezing point from November to February. Heavy snowfall occurs during the winter months, which serves the irrigation necessity of the people [1]. The quality of water is a determining factor for its suitability of users. Studies have made in the past to ascertain the suitability of water for human consumption in different area [2-3]. Akhtar et al [4] investigated high level of sodium, potassium and total dissolved solid content in water of river and dams whereas those from hilly area found to be deficient in iodine, the main cause of goiter.

A lot of work has been carried out upon the quality of spring water and river water in Pakistan [5], India [6], Bangladesh [7], Poland [8], and Egypt [9] using various methods. But no data on the quality of surface and subsurface water is available. During the past years the importance of determining the adverse effect of water contamination on public health has gained momentum. Keeping in view this hazardous effect on human health, strict water quality standards have been enforced in developed countries [10].

The present studies would give a guideline for determining the suitability of water quality of skardu valley. It also characterizes the surface water and subsurface water located at different area of skardu valley for and industrial uses.

Results and Discussion

All the samples were colorless and had no significant turbity, suspended solid (data in table 2). The tastes were tasteless and all the samples were odorless. Temperature recorded at the spot (table 1) indicated all the surface and subsurface were cold.

The pH of all the samples ranged between 7.2 to 8.2 with average of 7.74 shows neutral characteristic and within the permissible limits of WHO [10] which is 7.0 – 8.5. specific conductivity was also measure on the spot, its range from 280 – 305 μmohs/cm. But there is no limit for conductivity in WHO standard table. The dissolved oxygen was also measured on the spot [11]. The data are given in the table 2. The dissolved oxygen (DO) varied from 2.6 – 7.5 mg O_2/l, where its permissible limit is 3 mg O_2/l. Total solid being the sum of total suspended solids (TSS) and total dissolved solid (TDS) were calculated and reported in table 2. The TSS rang from 20 – 42 mg/l and TDS 85 – 168 mg/l, while the permissible limit for these were 5mg/l and 500mg/l respectively. TSS was above the permissible level in all samples. Total Hardness estimated as calcium

*To whom all correspondence should be addressed.

Table 1: Surface and Sub-surface Water of Skardu (Pakistan)

S.No.	Date of Sample Collection	Name of Location	Usage
1	07-02-2000 at 5:30 p.m.	Teriko	Drinking/House hold
2.	07-02-2000 at 8:00 a.m.	Gulabpur Shigar	-do-
3.	07-02-2000 at 3:00 p.m.	Pipe water	-do-
4.	07-02-2000 at 3:30 p.m.	Kuchura	-do-
5.	07-02-2000 at 11:00 a.m.	Chashma at Gol Skardu	-do-
6.	08-02-2000 at 3:15 p.m.	Hoto	-do-
7.	08-02-2000 at 10:00 a.m.	Chashma Bazar Skardu	-do-
8.	08-02-2000	Main Bazar Skardu	-do-
9.	08-02-2000	Lake water Skardu	-do-
10	08-02-2000	PCSIR Skardu	-do-

Table 2: Chemical Analyses of Surface and Sub-surface Water of Skardu

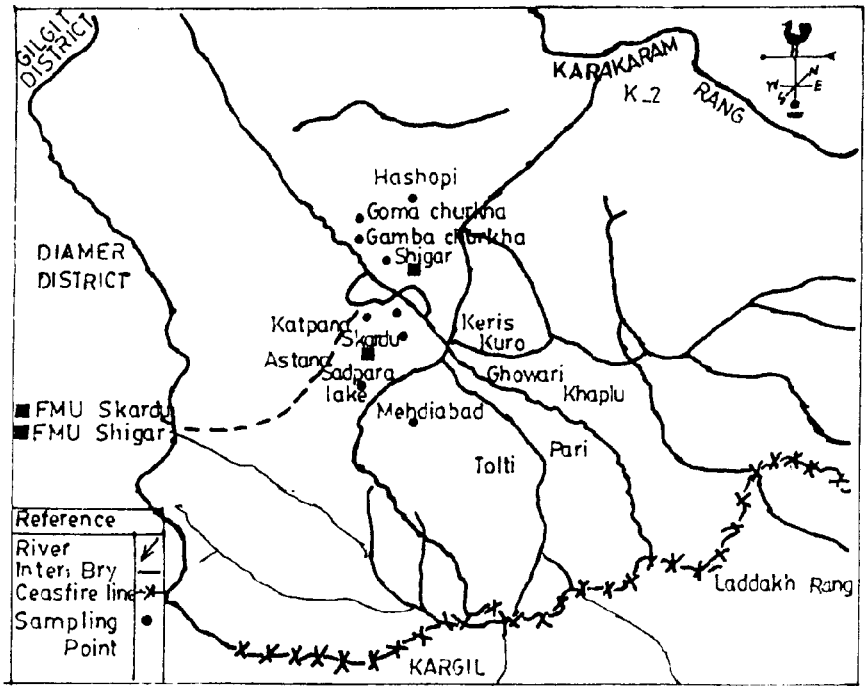
Parameters	Sample # Units	1	2	3	4	5	6	7	8	9	10	Average	W.H.O. Guideline
Taste		Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	-	Tasteless
Temperature	°C	16.8	16.4	18.2	17.1	17.2	16.9	17.8	18.1	16.4	17.2	17.2	12
pH		8.25	7.76	7.83	7.70	7.34	7.92	7.68	7.76	7.60	7.60	7.74	6.5 – 9.2
Specific Conductance	µmohs /cm	200	210	218	255	260	205	300	305	280	275	250.8	400
Dissolved Oxygen (D.O.)	mgO_2/l	2.3	2.2	208	5.0	3.5	2.4	4.0	3.1	3.3	2.8	3.14	3
Total Suspended Solids	mg/l	34.0	22.0	28.0	36.0	31.0	42.0	35.0	27.0	32.0	20.0	30.7	5
Total Dissolved Solids	mg/l	150.0	129.0	176.0	113.0	168.0	132.0	136.0	143.0	105.0	85.0	132.7	500
Total Hardness	mg/l	89.88	81.3	85.6	72.7	92.0	89.8	81.3	77.0	100.0	90.0	85.96	500
Calcium as $CaCO_3$	mg/l	59.92	55.6	55.6	54.5	66.3	55.6	55.6	57.7	70.0	60.0	59.08	250
Magnesium as $MgCO_3$	mg/l	29.96	25.6	29.9	18.19	25.6	34.2	25.6	19.2	30.0	30.0	26.83	150
Total Alkalinity	mg/l	80.0	80.0	84.0	72.0	74.0	80.0	76.0	76.0	64.0	64.0	75.0	-
Phenolphthalein Alkalinity	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	-
Carbonate Alkalinity	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	-
Hydroxide Alkalinity	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	-
Bicarbonate Alkalinity	mg/l	80.0	80.0	84.0	72.0	74.0	80.0	76.0	76.0	64.0	64.0	75.0	-
Nitrite	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.1
Sulphate	mg/l	24.6	28.7	32.8	32.8	39.0	32.8	28.7	26.7	40.0	20.0	30.6	250
Chloride	mg/l	6.3	5.4	6.3	5.4	6.3	6.3	8.1	6.3	16.0	16.0	8.24	250
Sodium	mg/l	11.3	4.5	5.4	5.0	10.7	9.4	10.8	5.2	6.0	4.0	7.19	250
Potassium	mg/l	7.1	4.5	1.8	3.5	4.7	7.1	4.5	1.7	2.5	1.5	3.89	12

carbonate, lay in the range of 72 – 100 mg/l which is below permissible limit as indicated by the average value which is 85.96 mg/l. Calcium as calcium carbonate is 75 mg/l in drinking water and observed concentration of calcium ion in all the samples below this limit. Water carry quantities of calcium bicarbonate when derived from upland sources up to 200 to 300 mg/l as calcium carbonate than those supplies derived from underground water, because the ground water in contact with sedimentary rocks of marine origin derives most of its calcium from calcite, aragonite, dolomite gypsum mixture [12]. The concentration of magnesium is also below the WHO permissible limits i.e. 26.83 mg/l while the permissible value is 50 mg/l for drinking water that generally Mg contributes to surface water by dolomite [12]. Total alkalinity estimated as calcium carbonate in range of 64 – 84 with the average value 75mg/l. This alkalinity is mainly due to the presence of bicarbonate of calcium and magnesium [13]. P-Alkalinity, carbonate alkalinity and hydroxide alkalinity as calcium carbonate were absent in all the samples. The chloride content of the samples ranged from 5 to 16 with the average value is 8.24. The entire sample had chloride content far below the WHO permissible limits, which is 250 mg/l. because of low chloride content the hilly water were tasteless or sweet. The sulphate source in surface water and subsurface water was mainly calcium sulphate and sodium sulphate. The table shows that sulfate concentration in the water is in the range of 20 – 40 mg/l while the permissible limit is 250 mg/l.

The sodium and potassium concentration in water samples are shown in table 2. the concentration of sodium varies from 4 – 11.3 mg/l with average value of all ten samples are 7.19 mg/l. the concentration of potassium were from 1.5 – 7.1 mg/l. the maximum allowable limit of sodium in drinking water was as suggested by WHO is 200 mg/l where as the value for potassium is 12 mg/l. high concentration lead to cardiovascular diseases and high blood pressure [14]. The potassium content in hilly water was less than that of sodium. All samples lay well within the range of WHO limits.

Heavy metals

Heavy metals in all ten samples were analyzed and the results were reported in table 3. The WHO limits for Zn is 5 mg/l in drinking water. Zn is absent in sample 3, 4 and 6. the highest quantity of Zn is 0.53 mg/l which is present in sample 2. the WHO limits for Fe in drinking water is 1 mg/l. the average value in all ten samples are 0.07 mg/l lay well below the range of WHO standard except sample no 6



Map of Baltistan

Table 3: Concentration of Heavy Metals of All Ten Samples

Sample #	Concentration in mg/l							
	Zn	Fe	Ni	Pb	Co	Mn	Cu	0
1.	0.03	0.06	0.09	0.06	0.05	N.D.	0.01	N.D.
2.	0.53	0.09	0.02	N.D.	N.D.	N.D.	N.D.	N.D.
3.	0.24	0.06	0.02	0.01	N.D.	0.01	0.01	N.D.
4.	N.D.	0.01	0.06	0.04	0.01	N.D.	0.02	N.D.
5.	N.D.	0.07	0.04	0.03	N.D.	N.D.	0.01	N.D.
6.	0.03	0.30	0.08	0.02	N.D.	N.D.	0.01	N.D.
7.	N.D.	0.01	0.03	N.D.	N.D.	N.D.	N.D.	N.D.
8.	0.10	0.04	0.04	0.06	0.01	N.D.	0.01	N.D.
9.	0.18	0.08	0.08	0.01	N.D.	0.02	0.01	N.D.
10	0.21	0.05	0,05	N.D.	0.02	N.D.	0.03	N.D.
Average	0.188	0.07	0.051	0.033	0.023	0.015	0.014	N.D.
WHO	5.0	1.0		0.05	1.0	-	1.0	0.05

N.D. = Not Detected, Below Detection Limits Detection limits for Zn, Pb, Co, Mn, Cu = 0.01 mg/1 Detection limit for Cr = 0.02 mg/1

which is highest content of Fe that is 0.3 mg/l. This may be due to the location of the sample points at the plan area of skardu. Pb is present in average amount of 0.033 mg/l. The WHO limit for Pb is 0.05 mg/l. High concentration of Pb (0.06 mg/l) was preset in sample 1 and sample 8. Cu, Mn and Ni were present in traces. In most of the samples Co and Mn were absent. Cr was almost not detected in the entire sample. Besides these eight metals trace of some other metals can be found in surface water which are toxic if their concentration were exceed [15]. Analysis of the table 3 indicate that the magnitude of different trace metal followed the order Zn > Fe > Ni > Pb > Co > Mn > Cu > Cr.

Experimental

Ten samples of surface and subsurface sources of water like springs, canals, stream, lakes, pipe and rain water were collected from different site of Skardu valley. Table 1. Approximately two liters sample was collected in cleaned plastic bottles, washed with tap water followed by distilled water. The temperature, pH and conductivity were measured

on the spot. A potable pH meter (METTLER DELTA 320) DO meter (OXI-57 WTW Weilheim, Germany) and a potable conductivity meter (HI 8033, HANNA instrument) were used through out this work. Chemical analyses were made employing standard method [11]. Sodium and potassium were measured using flame photometer (coring). For heavy metal the atomic absorption spectrophotometer (Z-8000 polarized Zeeman) with air acetylene based calibration method was used. The samples were not treated prior to absorption. Triply distilled water was used through the work. All chemical used were of spectroscopic ultrahigh purity by Merck.

Conclusions

The results of the chemical analysis and subsurface water from the different sites of Skardu valley are within the WHO limits of drinking water and are fit for drinking and house hold use. All the samples were better due to low hardness and alkalinity. All the samples are carbonate rocks water as they conform the sequences Carbonate > sulphate > chloride on the basis of their ionic composition. These waters are sweet tasteless and are potable and fit for human consumption.

References

1. Agha Khan Rural Support Programme, Activity Report, January to December (1998)
2. S. Hussain, M.Sc Thesis, Botany Department, Post Graduate College, Abbottabad, pp. 55 (1989)
3. M. Ibrar and M. Waqar, M.Sc Thesis, EPM, University of Peshawar (1996)
4. J. Akhter, I. Khan and S.A. Khan, *Sarhad J. Agri.* **11**(3), 373 (1995)
5. A. Tehseen, A. K. Israr, *Pak. J. Sci. Ind. Res.*, **43**(1), 13 (2000)
6. S. B. Saha and A. Mitra, *Indian J. Environ. Prot.*, **19**(11), 801 (1999)
7. M. A. Miah, *Indian J. Environ. Prot.*, **19**(9), 652 (1999)
8. K. Labus, *Bull. Pol. Acad. Earth Sci*, **47**(1), 47 (1999)
9. M. A. Hameed and A. A. Mohammad, *J. Environ. Sci.*, **17**, 89 (1999)
10. WHO, "Guide for Drinking Water Quality", Geneva Switzerland (1984)
11. A.P.H.A., A.W.W.A. and W.P.C.F., "Standards Methods for the Examination of Water and Wastewater" 17 Ed., American Public Health Inc. New York (1989)
12. S. N. Davis and R. J. M. Dewiest, 1996 Hydro-geology, John Wiley and Sons, New York, USA
13. F. D. Snell and F. M. Biffen, Commercial Methods of Analysis, Chemical Publishing Co. New York, 226 (1964)
14. J. H. Peverly and R. J. Kopka, "*Water, Air and Soil Pollution*", **57**, 399 (1991)
15. EPA (USA), *Fed. Regist. Superintendent of Documents*, **65**(8), 1950 (2000)