European Journal of Sustainable Development (2017), **6**, 4, 32-40 ISSN: 2239-5938
Doi: 10.14207/ejsd.2017.v6n4p32

Analysis of Drinking Water Quality for Presence of Heavy Metals and Its Impacts on Health of Local Population in Sibi District

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Abstract
This study aimed at finding out the presence of heavy metals in the drinking water sources of Sibi District, Pakistan. These metals are causing various diseases in the local population such as browning of the teeth, bone deformations, and malfunctioning of different organs of the human body. The researchers collected water samples from 8 sampling sites of Sibi district and the same were analyzed for fluoride, lead, arsenic and manganese. Modern instruments available in the advanced GSP laboratory were used for examining these samples. The results showed that the values of pH and TDS in water samples ranged from 7.2 to 8.31 and 650 to 9,800, fluoride was present from 2.0 to 12.5 mg/l, arsenic values were observed in the range of 0.0008 to 4.56 mg/l and lead was present from 0.0001 to 0.02 mg/l and manganese was present from 0.002 to 0.353 mg/l. These results show that the values of heavy metals are mostly higher than the values set by World Health Organization (WHO) except values of Manganese and Lead which were mostly within permissible limits. The reason for the presence of these heavy metals was observed to be the combination of rock alterations and exploitation of surface and underground minerals in the selected areas of Sibi district.

1. Introduction

Sibi division is situated at a distance of around 700 km south-west of Islamabad, the capital of Pakistan and around 120 km south of Quetta city. The coordinates of sibi division are 28°46'40"-30°07'34" N latitude and 67°21'3"-68°34'38" E longitude. Sibi division is located in arid zone where climatic zone is tropical agro-ecological. The people of Sibi do adopt agricultural profession with around 8.5% of the land is dedicated to agriculture, and, forests are spread over an area of around 9,000 hectares. The people of city receive water from different sources and the main source is water supply system accounting for around 77% of total water received by population. The water supply system is composed of pipelines (60%), tubewells (10%) and manually bored wells (6%). However, the water supply system is not free of defects as poor maintenance and inadequate treatment has made it vulnerable to different sources of pollution due to which end users are not receiving clean water

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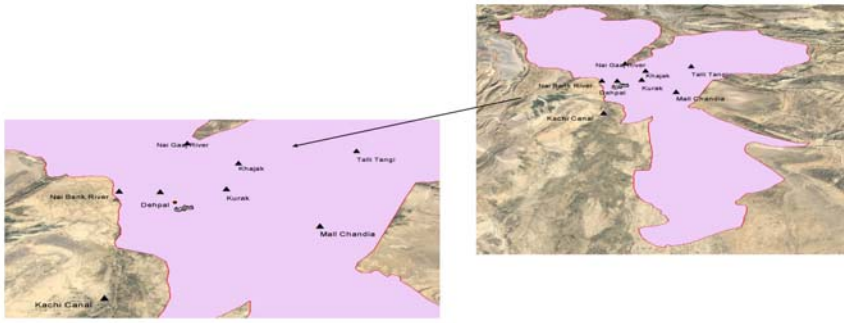

Figure 1: Sampling locations in Sibi District

Keeping in view the need for supply of clean water, this research plans to study the quality of potable water being supplied to the population of Sibi division. Thus, this study would examine the extent of different pollutants present in the drinking water and their adverse impacts on the health of the residents of Sibi Division. The parameters selected for this study were fluoride, lead, arsenic and manganese. Different areas were selected for sampling i.e. Mall Chaandia, Kacchi canal, Kurak, Dehpal, Kajak, Talli Tangi, Nai Gaaj River and Nai Bank River. The water samples were analyzed in modern GSP labs. Results indicated that the values of pH and TDS in water samples ranged from 7.2 to 8.31 and 650 to 9,800, fluoride vary from 2.0 to 12.5 mg/l, arsenic was observed to be between 0.0008 to 4.56 mg/l and lead was present from 0.0001 to 0.02 mg/l and manganese was present from 0.002 to 0.353 mg/l. These results show that the values of heavy metals was mostly higher than the values set by World Health Organization (WHO) except values of manganese and lead which were mostly within limits. The causes for the presence of these heavy metals in the drinking water were due to mixing of different minerals from various sources such as combination of rock alterations and the exploitation of surface and underground minerals.

2. Literature Review

Clean drinking water is vital for survival of human beings as well as livestock. Sound human health is dependent on availability of clean water due to which it has been declared as a primary right of the citizens of any country. Despite this, it has been noticed that millions of people mostly infants die around the world due to drinking of impure water. The main pollutants present in the drinking water are micro organisms and heavy metals. Mohod C.V & Dhote J (2013) researched that people living in the area faced many diseases due to presence of heavy metals in potable water in large quantities and pointed out the many fatal diseases affecting kidneys, brain, heart and lungs are due to use of unsafe drinking water. They gave example of Alzhemier disease as the most serious disease affecting local population due to use of unsafe water. Similarly, Chanpiwat et al. (2010) found that the while there may be different sources of population including human activities such as irrigation and mineral extraction, and, natural sources such as weathering of rocks etc.

In addition to this, the influence of geological environment is also significant on the local population. As, Salem H.M et al. (2000) found that the influence of geochemical environment on human health was the reason behind many health problems affecting humans as almost all minerals extracted by humans ultimately fall in water resources being used by local population. They pointed out that industrial, domestic and agricultural wastes were polluting ground water resources being used by local population for drinking purposes. The use of this unsafe water was thus affecting the human health and was cause of many fatal diseases. Other researchers such as Krishna et al. (2004) examined the surface and underground water resources and observed that such waters affected by heavy metals are unsafe for drinking purposes. Pekey et al. (2004) also provided similar findings which stated that heavy metals were toxic and their significant presence in the drinking water was resulting in many fatal diseases affecting humans. They further pointed out that such water were becoming more polluted due to arrival of dissolved inorganic pollutants from rocks thereby further affecting the human health.
Thus, the cause of presence of heavy metals in human body is use of unsafe drinking water which is polluted due to mixing with earth, minerals and other pollutants. And, if the level of these harmful minerals such as Manganese surpass the safe limits set by the WHO, then they cause toxic effects on human health. But, the even slight presence of some minerals in the drinking water is detrimental to human health such as lead and arsenic
One of the most toxic mineral is Arsenic and its existence in potable water is causing concern in the communities. Most of the researchers agree that the accumulation of Arsenic in the potable water do cause many serious effects on human health such as hypertension, black feet illness, hypo and hyper pigmentation, keratosisi, heart problems and diabetes. Arsenic also causes many diseases including cancers of skin, lungs and bladder. The countries most affected by the existence of Arsenic are Pakistan, India, Bangladesh, Mexico, Germany, China, Thiland, Hungary USA and Romania (Nickson et al. 2005, Faruqi et al. 2007; Kamal and Parkpian et al. 2002). There are varieties of Arsenic and the most harmful of it is Arsenite which is 70 times more harmful / toxic than Arsanate. Adewumi D. F et al. (2012) researched that there is constant requirement to check the water resources and water supply networks to protect the water from pollution and to ensure good human health. This will also ensure availability of safe water for agricultural and industrial purposes.
The examination of potable water for detecting the availability of lead, fluoride, arsenic, and manganese in selected parts of Sibi Division i.e. Dehpal, Kacchi canal, Kurrak, Kajak, Mall Chandia, Talli Tangi, Nai Gaaj River and Nai Bank River have not been carried out till date. The researcher therefore has endeavored to fill up the gap by examining the quality of water of the Sibi Division that is used for drinking purpose.

3. Methodology

Samples from ground and surface were collected every month (February – August, 2016) from eight selected sampling locations in Sibi District from varying depths as shown in table 1. The selected locations were Dehpal, Kacchi canal, Kurrak, Kajak, Mall Chandia, Talli Tangi, Nai Gaaj River and Nai Bank River. The sampling locations

were marked by using GPS.
The pH and total dissolved solids (TDS) in water samples were measured in the field by using the pH meter and Conductivity meter respectively.
For the determination of heavy metals; 1 Liter High Density Polyethylene (HDFE) bottles which were earlier soaked in nitric acid (10%)for one day and washed with ultra pure water were used to collect water samples. The collected water samples were stored in ice box and dispatched to the laboratory on the same day; then filtered through whatman filter paper(0.45µm)with the aid of vacuum pump, preserved by adding 10ml HNO_3 and refrigerated at 4ºC till analysis. The samples were then analyzed by using Atomic Adsorption Spectrophotometer.
The results of the laboratory tests were compiled in graphical form by plotting observed values against selected locations. Their ranges were compared with WHO limits to arrive at sound conclusion which is presented at the end of this report.

Table 1: Sampling locations selected for this study

S. #	Location	N	E	Source of water	Depth feet
1	Nai Gaaj River	29°40.385	67°52.722	River / Stream	5-6 ft
2	Nai Bank River	29°33.627	67°47979	River / Stream	5-6 ft
3	TalliTangi	29°39.208	68°07.356	Open Dug Well	20-25 ft
4	Mall Chandia	29°29.391	68°03.820	Open Dug Well	15-20 ft
5	Khajak	29°37.457	67°57.317	Tube Well	200-250 ft
6	Dehpal	29°33'32.67"	67°51'16.30	Tube Well	200-250 ft
7	Kurak	29°33'55.73	67°56'31.34	Tube Well	200-250 ft
8	Kachi Canal	29°21'57.87	67°49'04.11	Canal	8-12 ft

4. Objectives

- To detect the presence of toxic metals such as fluoride, lead, arsenic and manganese in the water (ground and surface) of Sibi district.
- To find out the adverse effects of toxic metals on human health.

5. Analysis & Discussion

5.1 Arsenic

The study found higher values of arsenic as compared to WHO limit of 0.01 mg/l. The values observed at Kachi canal, Nai Bank River and Nai Gaaj River were very high exceeding more than 2.5 mg/l, while the average of seven month values recorded at Kurak, Dehpal and Talli Tangi were comparatively lower as shown in Figure 2. The lowest and highest values observed were 0.0008 and 4.56 mg/l at Dehpal and Kachi Canal respectively. It can be deduced that the primary rivers i.e. Kachi Canal, Nai Gaaj River and Nai Bank River have elevated amount of arsenic which is due to their straight contribution from the main geological sources of arsenic in their catchments.

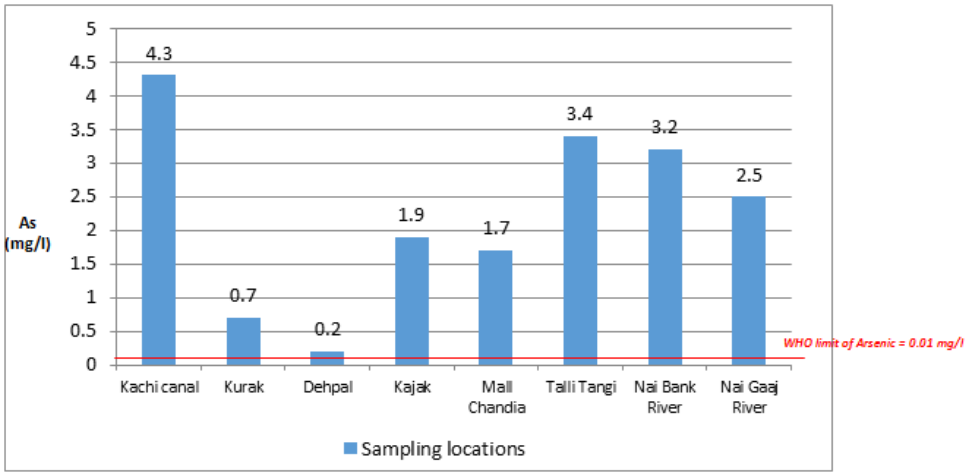

Figure 2: Average values of arsenic at selected locations showing higher values than WHO limits

5.2 Fluoride

The values of fluoride in drinking water also surpassed the limits fixed by WHO of 1.5 mg/l in the selected locations as shown in figure 3. The average seven month values of fluoride at locations of Kurak, Talli Tangi, Nai Bank River and Nai Gaaj River were much higher i.e. exceeding 2.5 mg/l as compared to other locations. The lowest and highest values observed were 2.0 to 12.5 mg/l at Dehpal and Nai Bank River respectively. The higher values indicate that these locations were near to the primary geological source of fluoride in the soil.

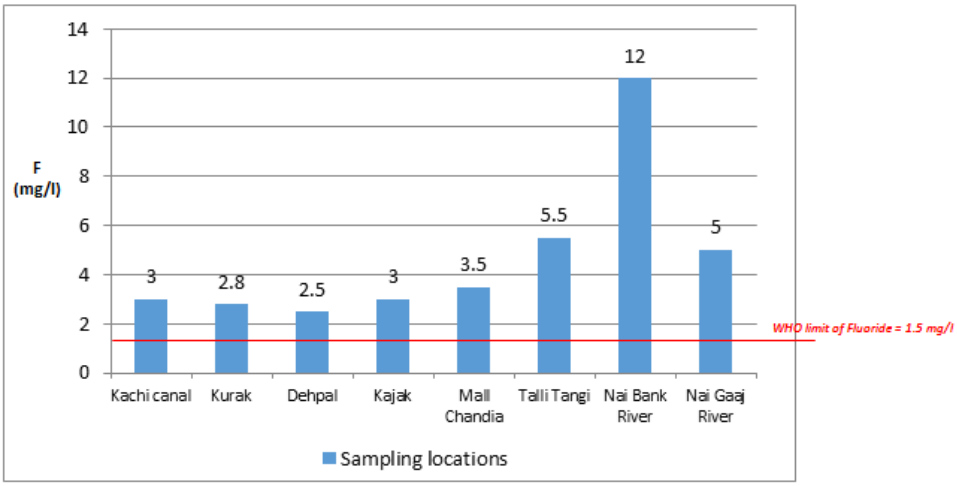

Figure 3: Average values of fluoride at selected locations showing higher values than WHO limits

5.3 Manganese

The observed values of Manganese in drinking water were lower than the limits specified by WHO i.e. 0.5 mg/l as shown in figure 4. However, the values observed at

Nai Gaaj River were comparatively higher than WHO limits. This showed that the drinking water was contaminated with Manganese too although the values were within limits. The lowest and highest values observed were 0.002 to 0.353 mg/l at Kurak and Nai Gaaj River respectively. This also shows that the values were higher near the source of Manganese and decreased with the distance.

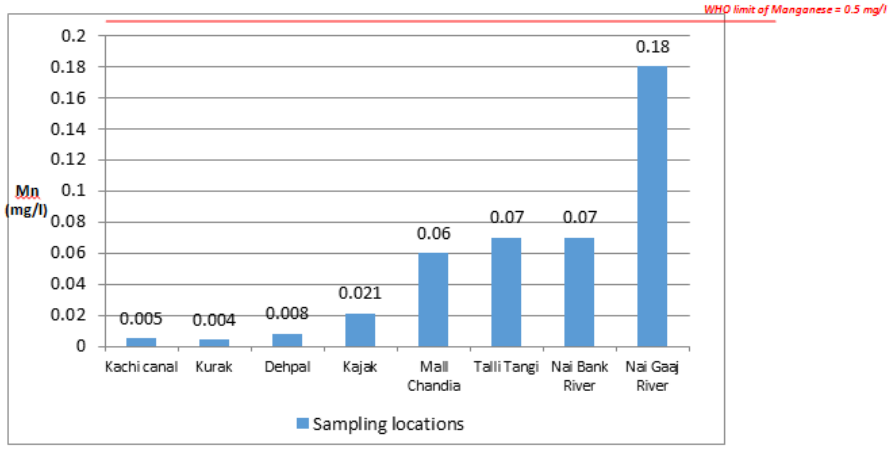

Figure 4: Average values of Manganese at selected locations showing observed values within limits specified by WHO

5.4 Lead

The values of lead in drinking water were mostly found lower than the WHO limit i.e. 0.01 mg/l except at Nai Gaaj River where readings exceeded 0.02 in May, 2016. The lowest and highest values found were 0.0001 to 0.02 mg/l at Dehpal and Nai Gaaj River respectively. This may be due to anthropogenic sources in the vicinity of the locations which increased the lead content in the drinking water.

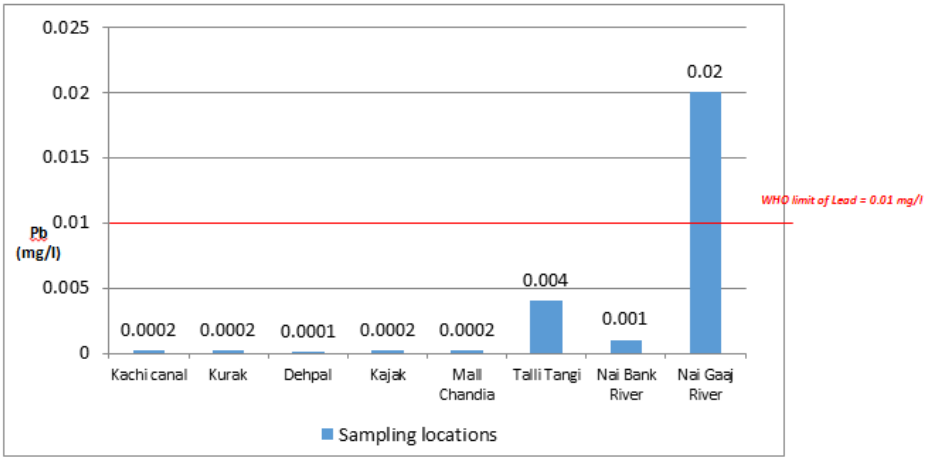

Figure 5: Average values of lead at selected locations showing lower values than WHO limits except at Nai Gaaj River

5.5 Diseases

The presence of arsenic in drinking water is globally well recognized public health problem. It may lead to various diseases such as skin diseases (pigmentation and rough dry skin lesions). Nobel A et al. (2014) pointed out that arsenic in drinking water also causes reproductive, neurological, heart, respiratory, liver, blood and diabetic problems in the population. He also mentioned that arsenic causes skin, bladder and lung cancers. The data mentioned below is showing that some of these diseases are already present in the local populace of Sibi District.

Lead grounds for kidney issues and heart diseases such as high blood pressure. WHO (2011) found that lead can lead to neurological impairments and observed that impact of lead has serious effects on fetus, children of less than six (6) years and pregnant women. WHO (2011) stated that presence of manganese in drinking water may cause Parkinson's disease, magnesium and neurological disorders. Sutton et al. (2011) found that excess presence of fluoride in drinking water may lead to ease of bone fracture and in worst cases may cause bone cancer.

The higher values of arsenic, manganese, fluoride and lead were analyzed further with the prevalence of diseases in the selected locations. The data for diseases was obtained from the Balochistan Health Department. The results showed the prevalence of water borne diseases i.e. Diarrhea, Hypertension, Depression, skin diseases, viral hepatitis and other common diseases as shown in table 2.

Table 2: Common diseases data for Chandia from April to December 2015

Month	Common Diseases				
	Diarrhea(<5yr)	Diarrhea(>5yr)	Hypertension	Depression	Dental Caries
December-15	12	22	5	0	9
November-15	15	2	0	0	5
October-15	10	40	8	9	2
September-15	18	25	7	11	3
August-15	25	15	19	20	20
July-15	21	29	5	0	7
June-15	19	24	9	11	3
May-15	6	5	4	5	2
April-15	20	15	4	5	2

Source: Balochistan Health Department

Table 3: Skin diseases data for Chandia from April to December 2015

Month	Skin Diseases		
	Scabies	Dermatitis	Cutaneous Leshminaneous
December-15	12	8	1
November-15	15	10	0
October-15	13	2	2
September-15	13	5	1
August-15	25	10	4
July-15	16	2	5
June-15	12	8	2

May-15	4	10	17
April-15	15	10	19

Table 4: Common diseases data for Sibi DHQ from April to December 2015

Month	Common Diseases				
	Diarrhea(<5yr)	Diarrhea(>5yr)	Hypertension	Depression	Dental Caries
December-15	23	23	10	7	6
November-15	17	12	5	5	5
October-15	22	34	6	7	8
September-15	32	67	9	11	13
August-15	43	69	40	6	14
July-15	66	56	28	17	24
June-15	28	45	33	4	17
May-15	21	27	60	9	17
April-15	43	32	56	8	19

Source: Balochistan Health Department

Table 5: Health Scenario of Sibi Division in 2015

Locations	Skin Diseases	Viral Hepatitis	Common Diseases
Sibi	525	1063	1104
Khajak	545	2293	1580
Dhepal	301	863	636
Kolachi	552	1131	1404
Kurak	421	421	683
Chandia	241	403	498
Talli	353	745	1040
Luni	473	1002	5298
Lundi	1644	978	7262

Conclusion

The findings from the selected locations of Kacchi canal, Kurrak, Dehpal, Kajak, Mall chandia, Talli Tangi, Nai Gaaj River and Nai Bank River showed higher values of arsenic and fluoride. However; values of lead and manganese were within WHO limits except values of lead at Nai Gaaj River was higher. Due to this the drinking water is required to be treated before supplying to the public residing in above mentioned villages. The study also concluded that the water was having worst impact on the health of the consumers and various water borne diseases were identified in the population of these selected villages as shown by the prevalence of various diseases i.e. diarrhea, hypertension, depression, skin diseases, viral hepatitis and other common diseases. The contaminated water also showed that the anthropogenic activities should be controlled to safeguard locals from water contamination which needed sound planning. Thus, safety precautions should be taken while performing mining activities. The water storage facilities also needed to be constructed to store water and ensure proper treatment before supply. Such precautions would ensure prevention of diseases in the population and reduce the health related expenditure of affected people.

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