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Devastating Flood of 2010, Effect on Potabile Water Supply in Rural Swat

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Abstract This study was conducted in areas of KuzKunda, Ghat and KwaroTangi, Madyan Union Council of the rural Swat with the aims to assess the potable drinking water quality after the devastating flood of 2010, in the valley. For doing this forty samples of the spring water were collected from different ground water sources, i.e. tube wells, springs, dug wells and hand pumps in the area. These samples were analyzed for physical and chemical parameters including heavy metals Plumbum (Pb), Zinc (Zn), Nickel (Ni) and Chromium (Cr) and the results were compared with international standards of the World Health Organization (WHO). According to standards of WHO the pH, EC, total dissolves solids and Turbidity of spring water in all villages were in fewer amounts. But the concentration is higher than the standard of WHO in KuzKunda and KwaroTangi. Findings also show that most of the physio-chemical parameters, i.e. total suspended solids, pH, salinity, total dissolved solids, chloride, sodium, potassium and zinc were, according to the international standard limits of WHO, while electrical conductivity, alkalinity, hardness, lead, chromium, nickel, calcium and magnesium were above the international standard of WHO. This is due to heavy metal contamination in the study area with mix zone rocks. These above limits of the mentioned ions lead to the unsafe drinking water quality of the Madyan area. The study recommends that the drinking spring water was generally of good quality, but it's better to be chlorinated and boiled before use.

Keywords: *physico-chemical parameters, heavy metals, drinking water, melange zone, health risk*

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1. Introduction

Potable, safe and clean drinking water is vital to public health and the wellbeing of our society. This is ever more important in the face of significant challenges to drinking water supplies from the impacts of climate change on the quality and availability of water resources [2]. This is because that 884 million people in the world do not have access to safe water. This is roughly one in eight of the world's population, 2.6 billion people (two fifths of the world's population) in the world do not have access to adequate sanitation, 1.4 million children die every year as a result of diarrhea caused by unclean water and poor sanitation. This amounts to around 4,000 deaths a day or one every 20 seconds. On average, a person will walk five miles (one way) in order to obtain drinking water from the nearest source. One gram (.035oz) of human feces can contain 10,000,000 viruses, 1,000,000 bacteria, 1000 parasite cysts, 100 parasite eggs. Every year, the average person produces 77 pounds of feces and 132 gallons of urine [10,11].

Environmental pollution is a worldwide problem of development and it is also the fourth pillar of sustainable development and the world in now a day's mainly focused on the problems which results in undesirable changes in the physical, chemical and biological characteristics of air, potable water and soil, ultimately affecting human life in one way or the others. But particularly the importance of the potable water cannot be ignored as it constitution a major portion of the human and animal bodies [4]. Water is clearly the most important nutrient and the most abundant substance in the human body. All the activities which a person does in everyday life routine are either one way or the other way related to water. Water is critical for every single bodily function. Water is necessary for the blood to flow, oxygen delivery, waste elimination, nutrient transportation and for the functioning of almost every organ and biochemical process [3].

Human population needs drinking water for sustaining life. As noted by the researcher that safe drinking water supply is important in terms of both quality and quantity

as it is essential to human existences [5]. The provision of a safe water supply is a high priority issue of safeguarding the health and well-being of humans. The production of adequate and safe drinking water is the most important factor contributing a decrease in mortality and morbidity in developing countries. Half of the population in these countries suffers from health problems associated with the lack of safe drinking water. In the developing countries more than 60% population has no access to pure drinking water [12]. These water contaminations are due to domestic waste, industrial effluents, municipal waste water as well as unplanned urbanization and over exploitation of the natural resource, which distressed the drinking water quality [10].

Potable water supply is not only a basic necessity of life, but also crucial for achieving sustainable development [8]. Providing clean and healthy water to reduce population incidence of diseases, increasing overall productivity and contributing to political stabilization [6]. In the world 1.1 billion people lack access to safe drinking water, 1.8 million People die every year from diarrheal diseases, including 90 % of children under 5 years of age [11,12].

Water pollution is one of the major threats to public health in Pakistan. Drinking water quality is poorly managed and monitored. Pakistan ranks at number 80 among 122 nations regarding drinking water quality. Drinking water sources, both surface and groundwater are contaminated with coliforms, toxic metals and pesticides throughout the country and are not according to the international standard parameters set by WHO. This is due to the human activities like improper disposal of municipal and industrial effluents and indiscriminate applications of agrochemicals in agriculture are the main factors contributing to the deterioration of water quality. Microbial and chemical pollutants are the main factors responsible exclusively or in combination of various public health problems [1]. People living in the rural area of developing countries do not have reasonable access to even unpolluted water [8].

The water precipitation rate is lower than the evaporation rate in our country, which results continuous decrease in water quantity in its rivers, lakes and diminishing the ground water as well. Potable clean drinking water is the basic necessity available to only a smaller proportion rapidly growing population in Pakistan. This is due to mismanagement, bad civic condition and natural disasters in Pakistan, there are a very high ratio of underground water contamination due to so many reasons includes waste water that is being discharged into natural water bodies' results in serious ground water contamination.

The poor health status of Pakistan's population is reflected in the high infant mortality rate of 12.6% and as low as 7% fertility rates. Many of the diseases traded are caused by waterborne microbes indicating that a substantial proportion of morbidity in Pakistan is due to use of polluted water. Gastrointestinal infection resulting in diarrhea show high frequency among children as well as adults, accounting for 25% of patients treated at hospitals and clinics.

Water is a scarce resource, with unlimited benefits. Fresh water is necessary to maintain human beings, animals and vegetative life. One cannot survive without water, but unsafe water is harmful to health. Water constitutes two third of the human body. The population of Khyber Pakhtunkhwa (KP) is about 18 millions which are 13.4 % of the country's total population. Out of this almost 83.1 % population lives in the rural areas (National census, 1998). The government figures for safe water coverage in the rural areas of KP are 71.96 %. But according to multiple sources the actual coverage is 52 %. Rural areas of the KP without potable water supply have been suffering from a number of water related problems like time and energy consumption in bringing water from far away source and water borne diseases like diarrhea, malaria, typhoid, tuberculosis, polio, hepatitis, skin and eye infection, vomiting and worms.

Swat is one of the beautiful hilly areas full of natural resources and attractive site in the KP, province and Pakistan. It is bounded by Malakand district in the south, Chitral in the north, Shangla in the east and district Dir in the west. The study area is part of Swat district and is located between latitude 34°37′-34°43′N and longitude 72°19′ -72°26′ E. The drinking water in Swat is generally obtained from various sources, such as springs, tube wells, hand pumps and streams. The quality of drinking water sources in the area is uncertain and can be dominantly contaminated by geogenic and anthropogenic sources [9]. Madyan is one of the beautiful place in the Swat valley. Public water supply is not available for the whole community, especially for Madyan area.

All the water sources were badly effect by flood, 2010. The contaminated water is of the biggest problem for the people of Madyan. A lot of organizations were working to provide safe drinking water to the affected community on their door step. One of the humanitarian organizations is a Sarhad Rural Support Program (SRSP) working in this area from the last 5 years. KuzaKunda village is situated in Union councial Madyan, district Swat at a distance of about 5 km from Madyan main bazaar. The total population of the village is 665 households [7]. The main source of water is spring. Women and children cover long distance to collect water. It takes about 50 minutes to reach to the spring. The existing community is mostly poor and vulnerable. The social team of SRSP visited this village and found that the community faces a lot of difficulties for not having the nearby facility of safe drinking water, more over the spring water is contaminated, because different animal excreta and other filth is mixed in this spring and become contaminated. Therefore, a need was felt to carry out a study to evaluate and compare water quality parameter KuzaKunda spring water waste and its effect on shallow and deep wells water in the vicinity of this drain. Drain and wells were analyzed for pH, EC, heavy metals/trace element (Cd, Pb, Ni, Fe, Zn, Mn) to evaluate the drinking water quality. Monitoring and close observation of water quality, testing the source of water is necessary, especially when there is no water treatment. This is useful as a result of the failure of the treatment process or as a part of an investigation of serious waterborne disease outbreaks. After 2010 flood, at least 75% of the population of Madyan were badly affected by water born diseases. Because the main source of water in this area was springs, hand dug wells and also open source like river, canals and ponds.

Objectives of the research

1. To determine the physical, chemical properties of water sample of the springs water in the area after the flood.

2. To investigate the water situation after the flood in the area.
3. To compare the study findings with the international stand set by WHO.

2. Materials and Methods

The objective of this study report was to evaluate the spring water quality of KuzKunda, Ghat and Kwaro Tangi of rural areas of Union Councial Madyan and to determine its suitability for human consumption. For this purpose, water sample from the selected locations in the study were analyzed for pH, EC, TDS and Turbidity. It was witnessed that the existing drinking water supply scheme is in very bad condition and the water supplying pipes were destroyed by the flood and people don't have any access to collect water from spring to meet their daily need.

2.1. Physico-chemical Analysis

Water samples were collected randomly from the springs at the head and tail sections procedure and the selected water samples were analyzed for water physical and chemical properties i.e. pH, Electrical Conductivity (EC), Turbidity and Total Dissolve Solids (TDS).

2.2. pH

pH refers to the negative log of hydrogen ion concentration. The pH scale measures the acidity of solution of graduated scale of 0-14. The pH of neutral solution such as distilled water is equal to 7. The solution which has pH range from 8-14 is called alkaline solution, while the solution having pH range from 1-6 is called concentrated acidic. The pH of water samples was determined by using pH meter, first it was standardized by using buffer solution of known pH (4-9). Then, the pH meter was dipped in to the water sample to record the pH value.

2.3. Electrical Conductivity

Electrical conductivity measure the amount of total salts in solution. EC can be determined readily and precisely with a conductivity meter. The EC of irrigation water is usually expressed in unit of decisiveness per meter ds/m at $25c^{o}$. The EC of water sample was determined by using EC meter. First the EC meter rinsed with distilled water and then inserted in the sample to record the EC value.

2.4. Turbidity

Turbidity is the quantification of the degree to which light travelling through water column is scattered by the suspended and inorganic particles. Turbidity is commonly measured a Nephlometric Turbidity Unit (NTU). Turbidity was measured by using turbidity meter. First the instrument was calibrated by using the solution of known turbidity, 9 and 10 NTU, respectively. Then vial containing sample was placed in the slot and turbidity value was recorded.

2.5. Total Dissolved Solids

The method of determining TDS in water supplies most commonly used is the measurement of specific conductivity with a conductivity probe that detects the presence of ions in water. Conductivity measurements are converted in to TDS values by means of a factor that varies with the type of water. The practical quantization limit for TDS in water by this method is 10 mg/liter. High TDS concentrations can also be measured gravimetrically, although volatile organic compounds are lost by this method. The constituents of TDS can also be measured individually.

3. Results and Discussions

The objective of this research was to evaluate the spring water quality of the vicinity of KuzKunda, Ghat and Kwaro Tangi to determine its suitability for human consumption. For this purpose, water sample from the selected location and the study area were analyzed for pH, EC, TDS and Turbidity. The results were compared with World Health Organization (WHO) standards for drinking water.

3.1. World Health Organization Standard of the Drinking Water

The data in Table 1. shows the standard set by the WHO for drinking water all over the word. It is clear from the data in the table that water having a pH between 7.5 and 8.5 is within the range of recommendation and is suitable for drinking purposes. Turbidity of level 5 and chloride of 250mg/lit., is recommended, while total hardness and nitrate level is 300 and 35 250mg/lit., and iron 03 250mg/lit respectively.

Table 1. Comperision of Sample water with WHO standards

Parameter	WHO	BIS	Range Min.	Range Max.	Mean	SD
pH	6.5- 8.5	6.5-8.5	7.0	7.5	7.10	0.15
Turbidity (NTU)	5	5	5	6	5.2	0.42
Chloride (mg/lit.)	250	205	10	220	50	63.42
Total Hardness (mg/lit.)	300	300	200	750	375	162.02
Nitrate (mg/lit.)	50	45	10	95	38.5	32.06
Fluoride (mg/lit.)	1.5	1.5	0.3	10	0.64	0.25
Iron (mg/lit.)	0.3	0.3	0.3	1.0	0.71	0.23
Free chlorine	-	-	Nil	Nil	-	-

Source: WHO, 2014.

3.2. Physico-chemical Properties of Drinking Water

Keeping in view the objective of study and limitation imposed by the paucity of resource and analysis facility, the data in Table 2 presents the physio-chemical parameter of the drinking water in the area. The physio-chemical properties include pH, EC, turbidity, TDS analysis of the drinking. It is evident from the data that the pH in all villages was in the range of WHO, followed by the level of Electrical conductivity and Turbidity. Also the TDS limits were, according to the international standard of WHO. Thus, it is clear that still the quality of the water in the area is suitable for drinking as no elements is not exceeding the standard limits.

Table 2. Physio-chemical characteristics of drinking water in the area

Parameter	Units	Concentration at		
		KuzKunda	Ghat	KwaroTangi
pH	-	7.50	7.50	7.40
Electrical Conductivity(EC)	dS/m	2.50	3.50	2.20
Turbidity	NTU	2.15	6.64	2.59
TDS	mgL	136	157	123

Source: Field data and own analysis.

3.3. pH of the Drinking Water

The data plotted at Figure 1 shows the graphical presentation of the pH value of drinking water at three locations in research area and its comparison with the WHO standard. In all the villages pH of spring drinking water was slightly acidic. This may be to make it aligned the dilution provide by surface drain water at the spring drain. The pH of drinking water at KuzKunda, Ghat and KwaroTangi is in the range of WHO standard i-e (6.5 - 8.5) as indicated by the graph.

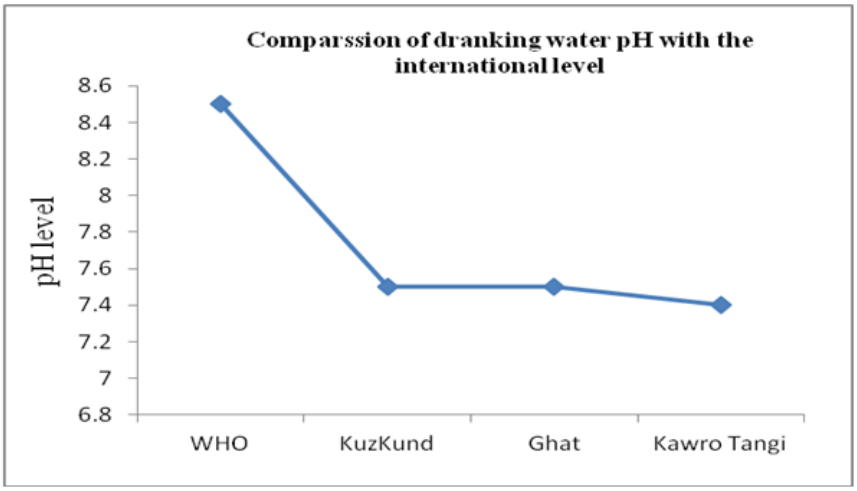

Figure 1. Compared pH of spring water with the standard

3.4. Electrical Conductivity of the Drinking Water

The data plotted at Figure 2 shows the EC of drinking water samples collected from the research area. The EC value of spring water at KuzKunda, Ghat and KwaroTangi was less than WHO limit 10 (dcm^{-1}), i.e. 2.50, 3.20 and 2.20 dsm^{-1}, respectively. This means it has less concentration of salts. The water categorized as non-saline, and is good for drinking.

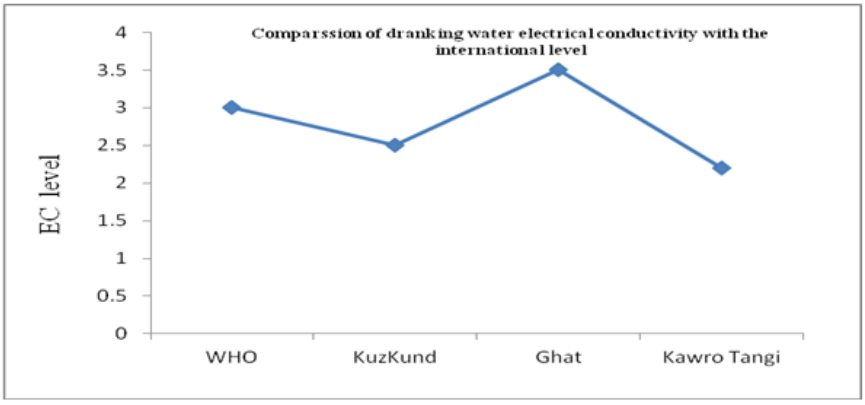

Figure 2. EC of spring water in comparison with WHO

3.5. Turbidity of the Drinking Water

Graphical presentation of data at Figure 3, depicts the turbidity of drinking water samples collected for the areas research. It is evident from the graph that the turbidity of drinking water of KuzKunda and Kwaro Tangi samples was in accordance with the WHO standard of <5 NTU, implies that the water is free from particular matter and organic matter that create turbid condition. The turbidity of Ghat spring water is 6.64 NTU. This indicates that there is a heavy amount of substances in this area that create turbid condition.

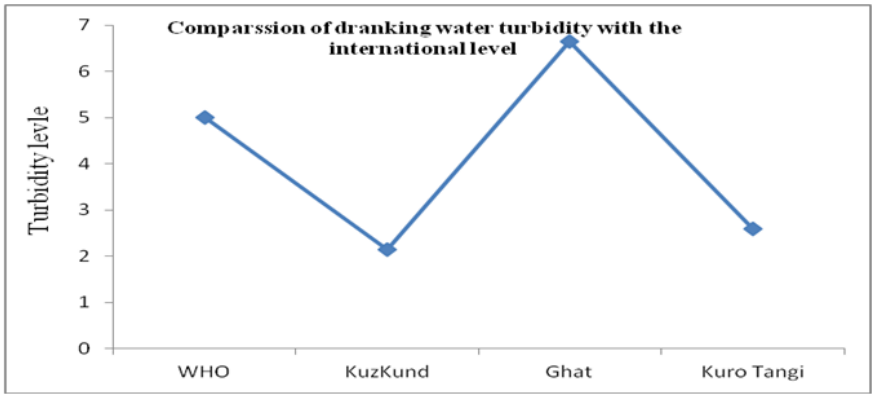

Figure 3. Turbidity of drinking water and comparison with WHO

3.6. Total Dissolved Solids of the Drinking Water

The TDS of all samples was determined in the research area. The total dissolved content in spring water of all three villages was less than WHO standard limit. This may be due to the fact that the water is still clean in the area and no more contamination resulted from the flood situation. Figure 4 shows the WHO standard is 1000 mgL^{-1} while the results are 136, 157 and 123 mgL^{-1} for KuzKunda, Ghat and KwaroTangi, respectively. These are very minute in the amount, and water is of good quality.

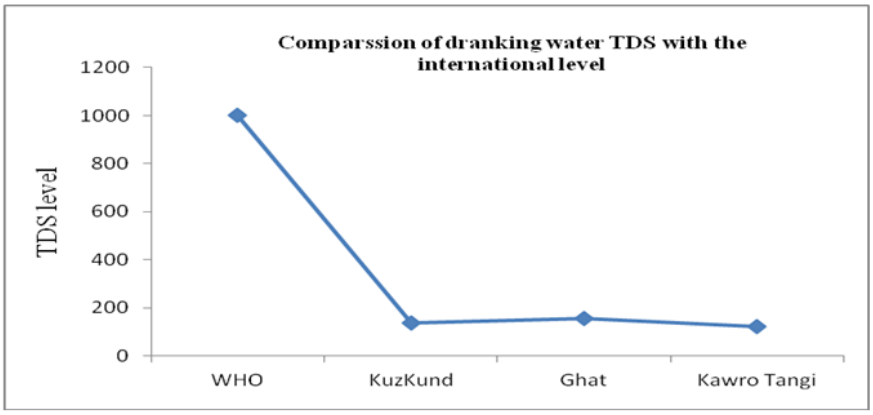

Figure 4. Total dissolve solid of spring water sample and who standards

4. Conclusion and Recommendations

It is clear from the findings that overall situation of drinking water in Madyan, Swat is satisfactory. Though the current study is based on limited number of samples but the results indicates that heavy and trace metal pollution could be a source responsible for health related problems in Madyan area of Swat. Drinking spring water was slightly alkaline, EC was 2.50, 3.50 and 2.20 dsm^{-1} for KuzKunda, Ghat and KwaroTangi, respectively, TDS (157,123,136 NTU) were within the WHO drinking water standards. On the basis of findings it is recommended that effort should be made for the chlorination of water sources and water before use, for this the local people must be educated and aware, followed by the proper maintenance of the water source by the community as well as the government and the water tanks must be must build for the storage of spring water by the government/Non Governmental Organizations as well as the people and effort should be made for its protection.

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