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Physio-chemical and biological drinking water quality analysis of barmas water supply complex, Gilgit, Pakistan

Ali Raza[1], Shoukat Ali[1],Yawar Abbas[2*], Salar Ali[1], Rizwan Karim[3], Nawazish Ali[4], Ajaz Ali[5]

[1]*Department of Earth and Environmental Sciences, Karakoram International University Gilgit, GB*

[2]*Department of Earth and Environmental Sciences, Bahria University, Islamabad, Pakistan*

[3]*Department of Forestry & Range Management, PMAS-Arid Agriculture University, Rawalpindi, Pakistan*

[4]*Department of Agriculture and Food Technology, Karakoram International University, Gilgit, Pakistan*

[5]*Environmental Protection Agency Gilgit, Pakistan*

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Abstract

Water is one of the most important of all natural resources known on the earth. The Safety of drinking water is important to health. The nature of water is affected by several factors such as Chemical, physical and biological contaminations. The Physio-chemical and biological analysis drinking water quality at Gilgit city was studied. samples were collected using random sampling technique, from inlet, outlet, school tape, house tape, and communal tap and storage tanks. WagTech Potatest kit was used for microbiological testing which employs Membrane Filtration Technique and membrane lauryl Sulphate Broth as medium. Aqua Culture Photometer (Hanna) was used for testing chemical parameters (Nitrate & nitrite). Conductivity meter was used to test conductivity/TDS. For bacteriological chemical analysis samples were brought to GB-Environmental Protection Agency Laboratory .Other parameters pH, taste, ordour, colour, Temperature and Turbidity was tested on site. Among the tested characteristics, temperature values fluctuated between 11.06–21.2°C, electric conductivity values ranged from 55-99.2µs/cm, turbidity values differed from 2–5 NTU, pH values varied between 7.00-7.93, total dissolved solids ranged from 400–600 mg/l, nitrate and nitrite contents fluctuated between 16.1–45.7 and 1-2 mg/l, while the investigated samples were free from faecal contamination as the sampling activity was done in the first week of October 2014 and during this season due to lower temperature of water samples the microbial growth reduces, as a result no colonies were found. All the inspected characteristics were within the approved standards set by WHO and NEQS.

***Corresponding Author:** Yawar Abbas ✉ yawar_zaid@yahoo.com

Introduction

Water is one of the most vital and plentiful compounds of the ecosystem. All living organisms on the earth in dire requirement of water for their survival and development. As of now only earth is the planet having about 70 % of water. But due to amplified human population, industrialization, use of fertilizers in the agriculture and man-made activity, it is extremely polluted with diverse damaging contaminants. Therefore it is essential that the quality of drinking water should be confirmed at regular time interval, because due to use of filthy drinking water, human population agonizes from varied of water borne diseases. It is hard to understand the biological phenomenon fully because the chemistry of water revels much about the metabolism of the ecosystem and explain the general hydro - biological connection (Simpi *et al.,* 2011). The approachability of good quality water is a key feature for stopping diseases and refining quality of life. Currently 1 billion of the world populations are deprived to safe drinking water (World Bank, 2009). Water resources are of critical importance to both natural ecosystem and human development. It is essential for agriculture, industry and human existence. The healthy aquatic ecosystem is depended on the physio-chemical and biological characteristics (Venkatesharaju *et al.,* 2010).

Domestic pollution of drinking water sources may involve seepage from broken septic tanks and pit latrines. Agricultural pollution emanates mainly from irrigation water and runoff water after rains, carrying fertilizers, pesticides, herbicide and faecal matter (Kumasi *et al.,* 2011). The main bacterial microorganisms of concern in contaminated water include Salmonella sp., Shigella sp., Escherichia coli and Vibrio cholera (Rajendran *et al.,* 2006). Approximately 2 million people annually, largely of them are children, die from water-connected diseases including diarrhea, dengue fever and typhoid, among others. Diarrhea remains in the third foremost cause of death among children under five globally, killing 1.5 million children each year (WHO, 2005). Water is compulsory for the growth and maintenance of human body and also for many biological activities (Garg *et al.,* 1999). (Pillai *et al.*,2000) reported that 50% of the Kerala population is using poorly protected wells water for drinking so the prevalence of water related diseases are common in this area. It plays a vital role for the survival of all forms of life on earth and works as a universal solvent (Patil *et al.,* 2009). Good quality of drinking water is compulsory for all the people throughout the world (Farah et al., 2002). Research Conducted on ogun river in Nigeria on July 2012. Ten samples were collected and after analysed those samples his finding was that the amount of TDSs were permissible and suggested that need to avoid from polluting the ground water (Singh *et al.,* 2012).

According to report different parameter of the water in that river and stated that some were in normal position like Mg,Ca,Ph and acidity.There were few parameters which were out of desireable level such as Nitrate,Total solid,Total suspended solid,Total dissolved solid,Sodium,Potassium and copper (Andrew, 2012).

Quality determination of five ponds of district Bhimber of Azad Jammu and Kashmir revealed that the analyzed physical parameters in WHO standards like conductivity 310-503 µs/cm (Mirza *et al.,* 2006). In Lahore, Pakistan drinking water supplied by water and sanitation Agency Lahore; they concluded that the contamination level of drinking water was increased after monsoon from 62.5% to 75%, it was due to cross connection of main pipe and sewages (Hayder *et al.,* 2009).

Gilgit River, Kargah and Jutial Nallah are the main sources of drinking water for Gilgit town. There are two water supply complexes and about nine pumping stations to fulfill the need of drinking water in Gilgit town. Unfortunately, none of the water supply system has water treatment facilities. Water collected from main sources through pumps or water channels is directly distributed to water users without any treatment. ("Water & Waste Water Survey in Seven

Urban Centers of Gilgit-Baltistan" EPA. 2013). In Oshikhandas Gilgit Pakistan assessment of drinking water from tap and channel ten samples revealed results as faecal coli form 10 cfu/100ml–500 cfu (Sumera and Shedayi, 2010).

The main cause of water related diseases is the presence of pathogenic organism in drinking water. Water born infections such as diarrhea, Cholera, Typhoid, and Hepatitis are endemic in Gilgit-Baltistan. Various epidemiological studies and hospital records indicates high prevalence of water born infections in the populations, among which children are the most affected group (EPA, 2012).

Material and methods

Study area

The current research was designed and carried out for the assessment of Physio-chemical and biological drinking water quality analysis of Barmas water supply complex, Gilgit, Pakistan. Gilgit is the administrative hub of district Gilgit and provincial capital of Gilgit- Baltistan. Research focused on the quality of water. The study was conducted in Barmas water supply complex. It is the main water supply source for almost 75 percent of the Gilgit town. Initially the main source of water supply complex is Kargha nallahh have supplied through 9 km long pips to reservoir. The reservoir it is supplied through supply networks to the sub subsequent localities of the city.

Water of Kargah Nallahh seems unsafe mainly because of human settlements along nallahh banks coupled with agricultural activities. The water becomes unhygienic for human consumption during summer due to glaciers melting and makes the water more turbid as all kind of suspended particles travels from pastures and snow bodies to downstream, which makes the water more infected. Surface water is likely to be physical, biological and chemical contaminated.

Materials and methods

Sample Collection

Total ten sampling sites were selected from Barmas water supply complex source to reservoir and taps, followed by random sampling technique. Locations of sampling are initial point of main source, Inlet, of water supply complex, water tank, outlet, community tape, school tape and bazaar tape selected to represent the water quality.

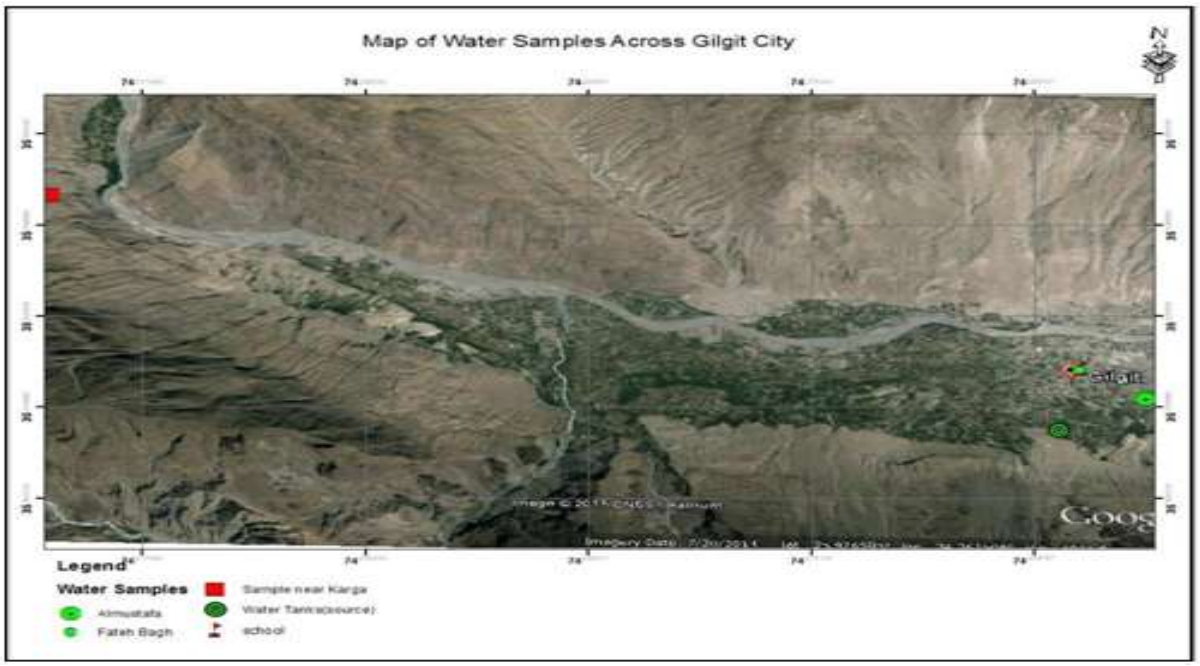

Fig. 1. Map of Study Area with sample collection points.

Generally ten sampling sites were selected for monitoring initially during the first week of October; water samples were tested with random sampling from inlet, outlet and households. Samples were tested and analyzed using on site testing kits, WagTech Potatest kit were used for microbiological testing which employs Membrane Filtration Technique and membrane Lauryl Sulphate Broth as medium. Aqua Culture Photometer (Hanna) used for testing of health based parameters (Nitrate & nitrite). Conductivity meter was used to test conductivity/TDS. Other parameters pH, taste, Ordour, Colour, Temperature and Turbidity was tested on site.

Apparatus and instruments

Polyethylene bottles, aqua culture photometer, WagTech Potatest kit, Conductivity Meter, pH Meter, Thermometer, Aluminium petri dishes, 12v battery cable with corcodile clips base, Filter funnel and locking collar, Hand pump, Membrane filters, Membrane forceps, Membrane pad dispenser, Sample cup and cable, Autoclave, Membrane pads, Petri dishes pack and Filter assembly used. Chemicals and Reagents. Methanol and Lauryl Sulphate Broth.

Experimental Analysis

(Temperature, Turbidity, Electric Conductivity EC, pH and Total Dissolved Solid)

Temperature of all the samples was measured by using Thermometer provided by WagTech Water testing kit. First thermometer is dipped in water sample and left for two to three minutes. After that reading was noted. Turbidity of the samples was measured by using turbidity transparency tubes (AOAC, 2000). Filled the turbidity tubes up to 50 ml line, one with h tap water and with the sample water. Looked both the tubes by vertically, placing side by side to compare their cloudiness by examining the fuzziness of black particles at the bottom of the tube. Shaken the Standard Turbidity Reagent vigorously and added 0.5 ml to the tap water tube, this reagent made the tap water cloudy, stirred the water in both tubes with the stirring rods, then again compared turbidity by vertically looking the tubes. Continued adding reagent until the tube appeared equally turbid. Stopped adding reagent when the turbidity of both the tubes vanished, finally calculated the reading according to the turbidity reagent has been utilized. EC of drinking water samples was calculated by using conductivity meter (AOAC, 2000). Electrode of the conductivity meter was dipped in each sample and conductivity of the sample was calculated when a flash has been appeared on the screen. Before taking each reading electrode was washed with distilled water and then dried with soft tissue papers. pH of different samples of drinking water from three sources was analyzed by using digital pH meter (AOAC, 2000). pH meter was standardized with standard buffers of pH 4.0 and 9 and before taking each reading electrodes were washed with distilled water and then dried with soft tissue papers**.** Total dissolved solids of all the samples were analyzed by using conductivity meter (AOAC, 2000). Electrode of the conductivity meter was dipped in each sample and TDS of the samples was considered when a flash has been appeared on the screen. Before taking every reading electrode was washed with distilled water and dried with tissue paper.

Measurement of Nitrate and Nitrite

Using the dropper, fills the cuvette with 6ml of sample, up to half of its height, and replaces the cap. Place the cuvette into the holder and close the lid. Press the zero key. The display will show "-0.0-"when the meter is zeroed and ready for measurement. Remove the cuvette and add the content of one packet of HI 93728-0 reagent. Replace the cap and immediately shake vigorously up and down for exactly 10 seconds. Continue to mix by inverting the cuvette gently for 50 seconds. Reinsert the cuvette into the instrument. Press timer and the display will show the countdown to the measurement or, alternatively, wait for 4 minutes and 30 seconds and press Read. When the timer ends the meter will perform the reading. The instrument displays the results in mg/L of nitrate-nitrogen. Press up and down buttons to access the second level functions.

Press Chem Frm key to convert the result in mg/L of Nitrate (NO3-).

Select the Nitrite HR method. Fill the cuvette up to the mark with 10 ml of un reacted sample and replace the cap. Place the cuvette into the holder and close the lid. Press the Zero key. The display will show "-0.0" when the meter is zeroed and ready for measurement. Remove the cuvette. Add the content of one packet of HI 93708-0 reagent. Replace the cap and shake gently until completely dissolved. Reinsert the cuvette into the instrument. Press Timer and the display will show the countdown prior to the measurement or, alternatively, wait for 10 minutes and press Read. When timer ends the meter will perform the reading. The instrument displays concentration in mg/L of nitrite. Press up and down keys to access second level functions. Press Chem Frm key to convert the result in mg/L of Nitrogen-nitrogen (NO2- -N) and Sodium Nitrite (NaNO2).

Membrane Filtration

A colony is formed with the accumulation of the same type of bacteria that have grown dense enough to be seen with the eye. The bacterium started to grow and divide, making a clone of itself. The incubation period (e.g. 22 to 24 hours for TC) is required to allow for enough bacteria to grow and become dense enough to see. Also, since every bacterium in the colony is a clone of the original bacterium, it can be assumed that all bacteria in that colony are identical, assuming no other colony is touching it.

The MF membrane has uniformly sized holes or pores of diameter 0.45 µm. This pore size is slightly smaller than the diameter of a typical TC or other bacteria of interest. As the water sample is drawn through the filter by a vacuum pump, the water passes through the pores, but the TC and anything larger in size than 0.45 µm are caught on the surface or trapped in the pores of the membrane. The membrane filter is then removed, saturated with a specific culture medium and these bacteria are supplied with the necessary nutrients and moisture for growth.

Results and discussions

Temperature

As shown in Figure 2, Examination of water samples taken from source, inlet, storage tank, outlet, halqa 2 school tape, FatahBaq School tape, Momin bazzar tape and Al- Mustafa School tape ranged from 13, 11.6, 12, 11.7, 14.5, 13.7, 15.6, 13.4, 18.2, and 21.2°C respectively. Maximum value recorded was 21.2°C and minimum was 11.2°C. A mean temperature ranging from 15 to 24 was recorded in a similar study on water quality of Barmas Water Supply Complex conducted.

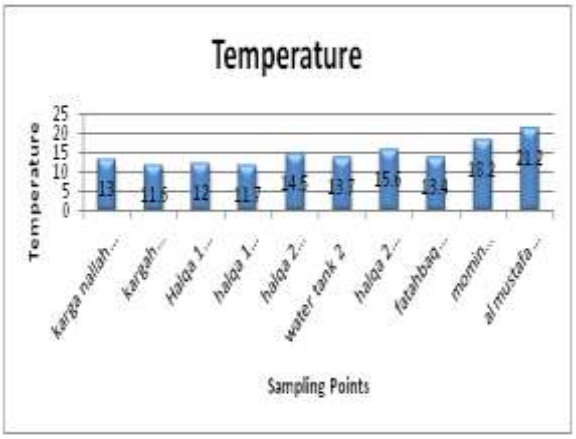

Fig. 2. Temperature of water samples of Barmas Water Supply Complex.

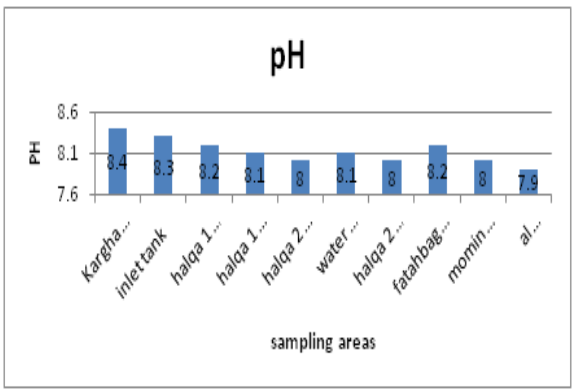

Fig. 3. PH of water samples of Barmas Water Supply Complex.

pH

As shown in Figure 3, pH values recorded from source, inlet, storage tank, outlet, halqa 2 school tape, FatahBaq School tape, Momin bazzar tape and Al-Mustafa School tape were, 8.4, 8.3, 8.2, 8.1, 8, 8.2, 8, 7.9. Minimum pH value was 7.9 and maximum 8.4

was recorded in the water samples. Prescribed limits set by WHO and NEQS ranges from 6.5–8.5 and pH values of all the analyzed samples were within the fixed standards.

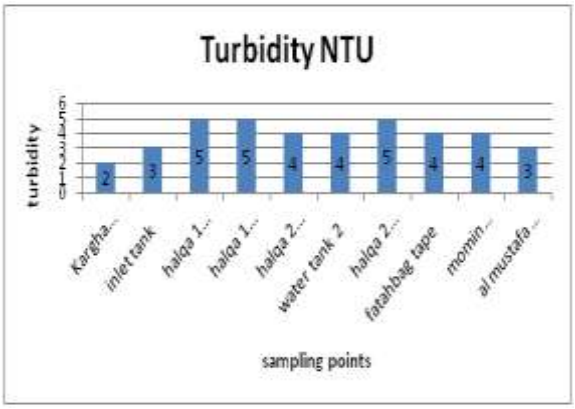

Fig. 4. Turbidity of water samples of Barmas Water Supply Complex.

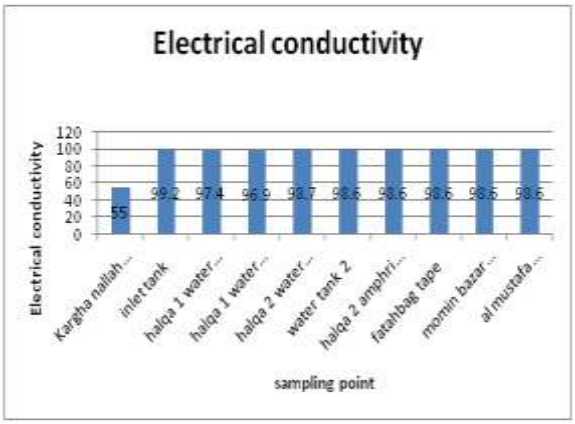

Fig. 5. Electrical conductivity of water samples of Barmas Water Supply Complex.

Turbidity

Turbidity values observed from the water samples of source, inlet, storage tank, outlet, halqa 2 school tape, Fateh Baq School tape, Momin bazzar tape and Al-Mustafa School tape were 2, 3, 5, 5, 4, 4, 5, 4, 4, and 3 respectivelyas shown in Figure 4. A little fluctuation in the findings of tested samples was observed, varied between 2–5 NTUs. Maximum turbidity value (5) was found from halqa 1 water tank water, halqa 1 outlet, and halqa 2 Amphary school while lowest values (2) were found from Kargha nallahh initial source.

Electrical conductivity

EC values determined from source, inlet, storage tank, outlet, halqa 2 school tape, FatahBaq School tape, Momin bazzar tape and Al- Mustafa School tape were. 55, 99.2, 97.4, 96.9, 98.7, 98.6, 98.6, 98.6, 98.6, 98.6 respectively Which are illustrated by Figure 5. Maximum value recorded was 99.1 and minimum was 55. So for no EC values has been recorded in any study of water quality Analysis in Barmas water supply complex. According to WHO and NEQ standard electrical conductivity of drinking water must not exceed 1400 µs/cm.

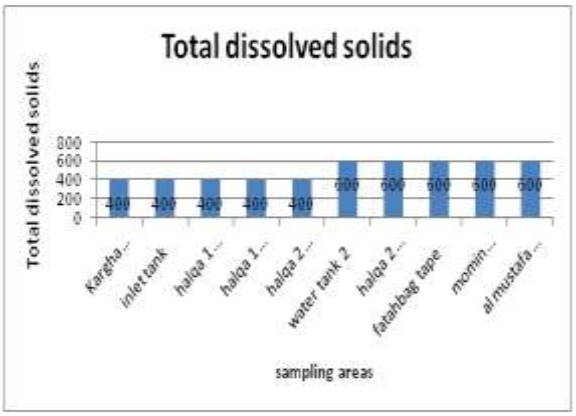

Fig. 6. Total dissolved solids of water samples of Barmas Water Supply Complex.

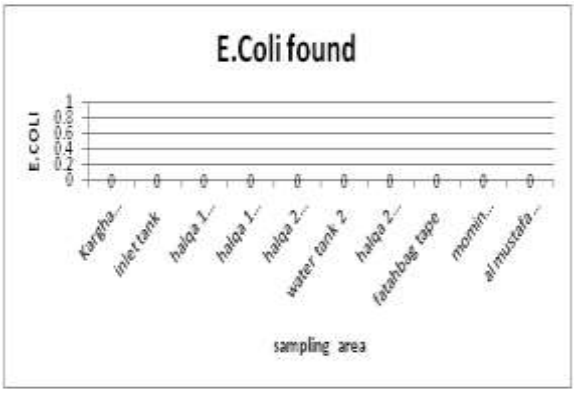

Fig. 7. E.COLI of water samples of different locations.

Total dissolved solids (TDS)

Outcomes of source, inlet and shown by Figure 6, storage tank, outlet, halqa 2 school tape, FatahBaq School tape, Momin bazzar tape and Al- Mustafa School tape were, 400, 400, 400, 400, 400, 600, 600, 600, 600, and 600 respectively. A recent study conducted by EPA 2013 on Water and Water Quality of Gilgit-Baltistan found the TDS value of 600 mg/l in water sample taken from Barmas Water Supply

Complex. Maximum value for TDS was 600 and minimum value recorded was 400. Water which has TDS levels less than 600 mg/l is regarded as good while water having TDS more than 1000 mg/l is unacceptable for human consumption (WHO, 2008).

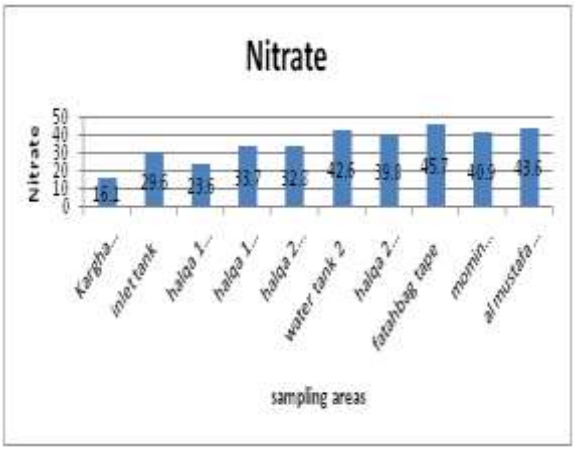

Fig. 8. Nitrate level in different sampling Areas.

Bacteriological Analysis

E Coli

No fecal contamination was found in all water samples of Barmas Water Supply Complex as shown in Figure 7.

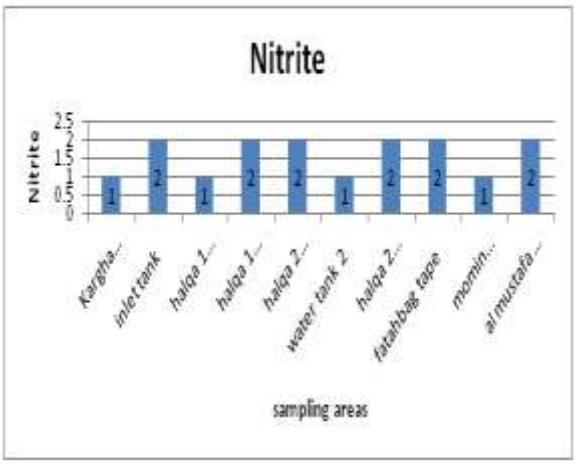

Fig. 9. Nitrite levels in different Sampling Areas.

Nitrate

In Barmas water supply complex no water treatment option is in practice therefore high Nitrate values of water samples from, FatahBaq School tape, water tank 2 tape, Al- Mustafa School tape. Maximum value recorded was 45.7 and minimum recorded value was 16.1. The Results of nitrates are illustrated by Figure 8.

Nitrite

As shown in Figure 9, The nitrite values recorded ranged from 1-2 in all the water samples. According to WHO and NEQS WHO & NEQ, nitrite value should be 3, and in the current study the values recorded were within the prescribed limits of W. Maximum value recorded was 2 and minimum value recoded was 1.

Conclusion

Water is the basic necessity of life. The water samples were collected from different places in Barmas water supply complex that are assessing some physico chemical and biological parameters such as Turbidity, TDS, pH, Nitrate (NO3) Nitrite (NO2), (E. coli). The study showed values of each tested sample safe for drinking purpose. Barmas Water Supply Complex is the main source of drinking water for about seventy percent people of Gilgit city. The main source of this water complex is glaciers. Reservoirs are not properly protected so the glaciers melting season increase contamination and enhance the biological activities. Lack of proper treatment and sedimentation by relevant staff and proper monitoring & management by the concerned authorities' water quality of study area is deteriorating. In the current study some selected physio-chemical and biological parameters of water quality were analyzed and all the obtained results were within the prescribed limits of WHO & NEQS. No faecal contaminations (E. coli colonies) were found as during the sampling season anthropogenic and animals activities are condensing.

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data collection and enumeration, and compilation of results in text form.

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