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Review Article

Water Quality Assessment of Fresh Water Resources in Gilgit Baltistan

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Abstract

Water is essential for survival of all living organism present on earth. There is no life without water. Water may be polluted due to anthropological activities, industrial discharge and sewages which affect the physical and chemical properties of water. The safe water is essential for healthy living. The present study area was Gilgit Baltistan. Water samples were collected from the springs, lakes, rivers, tap water and underground water and analyzed for physio chemical parameters. Six different physio chemical parameters were analyzed by using different laboratory methods and procedure. In the present study the value of pH ranged from 5.93-8.09, electrical conductivity 186µS-1444.3µS, total alkalinity 0-1638ppm, Calcium 20-174.6ppm, total dissolved oxygen 7-13.2, total dissolved solid 51.1-461.6, turbidity 0.18-19.86, Magnesium 6.4-64.4ppm, and Chloride 68.25-191.27. The results obtained were compared with WHO standards for drinking. Some parameters fall within WHO standard while some parameters were exceeding or below permissible limits.

Introduction

General Introduction

Water is the most important gift from nature to living organism. It is necessary for the growth and maintenance of human body and many biological activities. It plays an important role for the survival of all living organism. Because of solid suspended particles and dissolve impurities nature water is not pure for human. Due to presence of heavy metals in natural water, it is not safety for human life. Metal contamination is due to atmospheric deposition, weathering or release of agricultural residential or manufacturing runoff. 66% of drinking water in Pakistan is obtained through pipe and hand pumps. 30% of waterborne diseases and 40% of people dies due to unavailability of clean and safe water [1,2].

The main constituent of human body is water. The water produce by metabolism or ingestion of food is not enough to fulfill our body needs. So we have to pay attention of our drinking water. Water is important for life and is important constituent of cell, tissue and organs [3]. The human body weightconstitutes75%water and most vegetables contain 80% water [4]. Water has various roles in the human body. It acts as a building material; as a solvent, reaction medium, as a carrier for nutrients and waste products; in thermoregulation; and as a lubricant and shock absorber [5].

Because of harmful physical, chemical and biological agents many water resources are unhealthy. At least 2.5 billion peoples in developing countries have poor hygienic water system and over 780 million people have no right to use safe drinking water. As a result across the world about 2.3 billion people suffering from water related disease. [6]. Due to presence of high concentration of chemicals or its poor supply in water may cause different diseases like goiter and cancer [7]. Due to lack of cleanliness, better sewage treatment and use of extremely dirty water many gastrointestinal illnesses are in common [8]. Dental flurosis is cause by low or high level of fluoride ions concentration in water. Goiter is mainly due to low concentration of iodine in human. A potential high risk group has been considered in infant to the toxic effects of sodium from drinking water [9]. There would be 200milion fewer cases of diarrhea and 2.1 million fewer deaths caused by diarrheal illness each year if everyone had pure drinking water and satisfactory sanitation service [10]. Different acute and chronic health issues may cause because of toxic inorganic chemicals in water. Vomiting, nausea, dizziness, lungs irritation, skin rash and sometime death may occur due to acute effect. Cancer, birth defect, organ damage and some disorders of nervous system and immune system are included in chronic effect.

In northern area of Pakistan glacier and snow deposits are the main source of water for domestic purpose. The main contaminated source of water is spring water and showed the positivity of different bacteria like E.coli, total coliform bacteria and salmonella, human and animal fecal waste easily contaminate the exposed water [11]. Natural water is a universal and impressive symbol of life. Every person requires around 2 liters of clean drinking water and this amount reaches approximately 12 million m3 /day for the world population. According to WHO in total, there is 1400 million billion liters of water, but most of this water is not used for potable purpose, because 97% is sea water and only 3% is fresh water, out of which 2% is routed in the polar icecaps and glaciers, only 1% water is accessible for drinking purpose, whereas major water goes for irrigation than to drinking and all other use. The feasible water is of very poor quality. At the present situation, only 80% of the population in case of urban areas and only 11% in case of rural areas have access to the piped water [12].

All living organisms, most ecological systems, human health, food production and economic development depend on water [13]. Rivers, lakes, glaciers, rain water, ground water are main source of water. Besides the need of water is not only use for drinking purpose but also play an important role in different area of economy such

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as agriculture, livestock production, forestry, industrial activities, hydropower generation, fisheries and other creative activities. Due to some important factors like increasing population, industrialization, urbanization etc, the feasibility and quality of water either surface or ground, have been disintegrate. By using physical, chemical and biological parameters water quality of any specific area or specific source can be assessed. If the values of these parameters become more than defined limits, is harmful for human health [14].

Good quality and adequate water supply services are basic requirement for community health and well-being. Due to harmful physical, chemical and biological agents many water resources in developing countries are unhealthy. Due to presence of microorganisms in drinking water, usually has a physically great influence on the public health. So drinking water play important role in the spread of disease. Unfortunately, many people in the world are despoiling of this basic need [15]. Many of the freshwater sources are contaminated by use of pesticides in agricultural fields and other anthropogenic activities that completely change the physical, chemical, and biological processes related to water resources [16].

Introduction to Study Area

Northern area of Pakistan now called Gilgit Baltistan falls at junction of three mountain ranges namely Karakoram, Himalaya and Hindukush [17]. Geographically Gilgit Baltistan is mountainous, with zero temperature in winter, while in summer it may go beyond from 35 C^0 [18].

Gilgit Baltistan is located at the extreme north of Pakistan. It consist of 10 districts namely Gilgit, Skardu, Diamer, GhizirShiger, Hunza, Nager, Kharmang, Ghanche, And Astore. It lies between 35^0-70 North, and 72^0-75^0 East. it is surrounded by chitral in West, Kalan, Kohistan and Kaghan valley in the South, and Ladakh and Kashmir in the South. Its area is 7294km^2 along with a population of about 1.5 million bordering Afghanistan, China, India and Iran [19].

The study area includes different regions of Gilgit Baltistan including: Skardu, Shiger, Gilgit, Nager, Kharmang, and Khaplu.

Physio-Chemical Parameters of Water

pH: The hydrogen ion activity is known as pH and is a measure of acidity and alkalinity of sample [20]. pH is most important in determining the acidic nature of water [21]. According to designated limits set by WHO pH values ranged between 6.5-8.5 [11]. Due to high decomposition activities in summer pH value become high [22]. Due to aggregated organic matters and decomposition of vegetation which release CO2 which basically reduces the pH [23]. A pH meter is an instrument used to measure acidity or alkalinity of a solution. pH meters consist of a glass electrode made of a specialty glass membrane that is sealed at the end forming a bulb. Inside the glass is an internal standard acidity solution, usually 0.1 M HCl, along with an internal reference electrode, (typically an Ag/AgCl wire electrode). This solution is called the reference solution of known pH, 7.A second electrode RE_{ext} is placed in an external tube immersed in KCl. This external tube forms a concentric enclosure around the first enclosed glass tube containing the 0.1 M HCl (the internal tube).The external tube is made of pH sensitive glass and is in contact with the test solution through an opening called a porous diaphragm. The inclusion of a reference electrode encased by the internal tube is necessary as its pH is known and can be compared to a test solution so that its pH value can be determined. This set-up is called a combination pH electrode.

Electrical conductivity: Determination of concentration of electrolytes in water is known as electrical conductivity [24]. Or Electrical Conductivity (EC) is the calculation of capacity of water to conduct electric current through it [25]. During the summer season the value of conductivity was recorded as high while it were low in monsoon [26]. Conductivity of water depends upon the concentration of ions and dissolves solid particles. Because of evaporation in summer season the concentration of salt increase which results in variation in conductivity [27]. The addition of rain water in monsoon season dilutes the water as a result electrical conductance decrease [28]. The estimated values of EC prescribed by WHO ranged between 1400 µS [2].

An Electrical Conductivity meter (EC meter) measures the electrical conductivity in a solution. An alternating voltage is applied across two electrodes which are immersed in the same solution. This applied voltage is use to flow a current. The magnitude of current depends upon the electrolytic conductivity of the sample solution.

Total hardness: Calcium and magnesium are the main source of water hardness, which are present in many mineral like limestone consisting chalk (CaCO3), some industrial products and common ingredients of food. A secondary donation to the total hardness of water is made by polyvalent ions like zinc, manganese, aluminum, strontium, barium, and iron [29] TH determine capability of water for domestic, industrial and drinking purposes [30]. Magnesium is one of the major ingredients of the hardness of water [31]. The reasonable amount of magnesium changes the quality of water [32]. The value of hardness of water becomes high due to evaporation during summer and addition of calcium and magnesium salts by mean of plants and living organism [33]. High values of hardness are probably due to regular addition of large quantities of garbage and detergent into lakes from the close residential sectors [34]. According to WHO standards water is soft if its hardness value ranges between 0-50, it is moderately hard when the value is between 50- 150 and water is said to be hard if hardness value rises from 150-300 [35].

Total alkalinity: The ionic concentration, which can neutralize the hydrogen ion, is known as total alkalinity of water or the capacity of water to neutralize a strong acid is called alkalinity. Alkalinity of water is due to presence of bicarbonates, carbonate and hydroxide compounds of calcium, sodium and potassium. [36]. Or the concentration of titratable bases in water is known as total alkalinity. A hydrogen ion (H+) will neutralize when base will react, for example, in the reaction:

$H^+ + OH^- = H_2O$,

Hydroxyl ion is the base.

Carbonate ($CO_3^{2-} + H^+ = HCO_3^-$)

Bicarbonate ($HCO_3^- + H^+ = H_2O + CO_2$)

Ammonia ($NH_3 + H^+ = NH_4$)

The word "total" is added to alkalinity because of presence of different ions. Total alkalinity may sometimes be reported separately, for example, hydroxide alkalinity. In most natural water alkalinity is mainly due to HCO_3, CO_3 2, and OH [37]. The recommended value of total alkalinity is 500 mg/L [38]. Water having alkalinity less than 100mg/L is best for domestic use [39].

Dissolved oxygen: The majority of animals living in water required dissolve oxygen (DO) for the process of respiration.[18]. During the period of active photosynthesis DO is more in water [40]. Low value of DO in water is due to high temperature,increased microbial activities, addition of garbage and other waste product [41,42].

Chloride: One of the major inorganic anion in water is chlorine. The salty taste in drinking water is produced by the Chloride concentrations [43]. The high concentration of chlorides in water is due to throwing of garbage and industrial waste [44]. Human urine and feces are also source of chlorine in water. High rate of evaporation in summer and organic waste product of animal may increases the concentration of chloride in water [45].

Total dissolved solid: Water has the ability to dissolve a wide variety of organic and inorganic minerals and salts. WHO guidelines limit for TDS is 1000ppm [15]. The main components are usually chlorine, calcium, magnesium, sodium, potassium cation, potassium carbonates, hydrogen carbonate, chloride, sulphate and nitrate anion. Water containing TDS level less than 600ppm is safe while TDS level greater than 1000 ppm is not acceptable for drinking purpose. High level of TDS cause bitter taste to drinking water. It also affects a person who are suffering from kidney and heart problem [2]. Eutrophication of aquatic ecosystem may cause by high concentration of TDS [46].

TDS meter indicates the presence of total dissolved solid. All elements dissolved in water have some electrical charge. Therefore, it is possible to estimate the quantity of TDS by measuring the electrical conductivity of water by passing current through it

Turbidity: Turbidity of water shows the optical property in which the light is scattered by the particles present in water [47]. Turbidity in water is cause by clay, slit, phytoplankton's, organic matter and other microscopic organism [15]. Turbidity also shows the presence of disease-causing organisms. These organisms include bacteria's, viruses and parasites that can cause cramp, nausea and diarrhea. According to WHO guideline limit the turbidity of drinking water should be less than 5NTU [18].

Turbidimeter is an instrument use to measure the relative clarity of a fluid by measuring the amount of light scattering by particles suspended in a fluid sample

Materials and Methods

Sampling

Different sources of water like glacier, lake, spring, river, tap and underground water were collected from different region of Gilgit Baltistan. Total 19 samples were collected randomly from different regions of Gilgit Baltistan in prewashed polyethene bottles.

Laboratory Analysis, Instrumentation and Chemicals

All the collected samples were transported to the chemistry lab Karakoram international university Gilgit for physio chemical analysis. The parameters were pH, total hardness, total alkalinity, electrical conductivity, turbidity, total dissolve oxygen, chloride and total dissolve solid.

The water pH and electrical conductivity were measured by using pH meter and conductometer. Total dissolves solid were determined by TDS meter. Turbidity was measured by turbidimeter. Chloride, total alkalinity and total hardness were determined by titration method. Dissolve oxygen were determined by Winkler's method.

The chemical, which was used during the analysis were sulphuric acid, silver nitrate, potassium dichromate, ethylenediamine tetra acetic acid, manganese sulphate, sodium thiosulphate, alkali iodide azide solution, Erichrome black T indicator, muroxide, methyl orange, starch indicator.

General Procedure

Determination of pH:

PH of water samples were determined by using pH meter.

- Before using the pH meter firstly calibrated the instrument with potassium hydroxide
- After calibrating, the pH meter, the electrode is washed by dipping into distilled water to get rid of any adhered buffer.
- The electrode is gently wiped with a tissue paper.
- The electrode is then dipped in the sample solution and its reading is noted.
- The electrode is washed again by dipping in distilled water and the pH of the sample is measured two more times.

Determination of electrical conductivity:

Electric conductivity was measure by conductometer.

- Calibrated the conductometer with standard KCl solution at 25°.
- Took water sample in a beaker.
- Rinsed the electrode with distilled water and dried the electrode with the tissue paper.
- Inserted the electrode in water sample and noted the reading.
- The electrode is washed again by dipping in distilled water and the electrical conductivity of the sample is measured two more times.

Determination of total hardness:

Total estimation of calcium and magnesium was determined by following procedure:

- Took 30ml of water sample in a conical flask with the help of graduated cylinder.
- Added 5ml buffer of pH 10.(ammonium buffer)
- Added 3-4 drops of Erichrome black T as an indicator.
- Filled the burette with 0.005M EDTA.
- Titrated the solution with EDTA until blue color appeared.

- Noted the reading and calculated the total hardness.

Determination of calcium:

Took 30ml water sample in a conical flask with the help of graduated cylinder.

Added 5ml Sodium hydroxide NaOH.

Then added 2-3 drops of muroxide indicator.

Filled the burette with 0.005M EDTA solution.

Titrated the solution against EDTA until purple color appeared.

Determination of magnesium

Magnesium was determined by using the difference.

Determination of total alkalinity:

- To calculate the total alkalinity of water samples the following procedure is subsequently adopted:
- Took 20ml water sample in a conical flask with the help of graduated cylinder.
- Added 2-3 drops of phenolphthalein indicator.
- Filled the burette with 0.02M H_2SO_4.
- Added 2-3 drops of methyl orange as an indicator and titrated it against H_2SO_4in a burette until pink color appeared.
- Noted the reading and calculated the total alkalinity.

Determination of dissolved oxygen:

- 150ml of sample was collected in a glass bottle having an accurate fitting stopper.
- Add 1ml manganous sulphate solution followed by 1ml alkaline iodide azide solution. Brownish color was obtained.
- Concentrated sulphuric acid was added and was shaken to distribute iodide evenly.
- Titrated with Sodium thiosulfate to get a pale-yellowcolor.
- Added 1 ml of 1% starch to get blue-black color. At a point, the blue-black color disappeared which is noted to as the end point
- The volumes of the titrant used were noted down and calculated the amount of DO.

Determination of chloride:

Chloride present in water samples can be calculated by using the following procedure:

- Took 20ml water sample in a conical flask with the help of graduate cylinder.
- Added 2-3 drops of potassium dichromate as an indicator.
- Titrated against 0.01M silver nitrate present in the burette.
- Brick red color was the end point.

Determination of TDS:

- Remove the protective cap and switch on the TDS meter.
- Dip the TDS meter in water sample
- Wait for 10 to 15 seconds for the reading to stabilize.
- Noted the reading.
- The electrode is washed again by dipping in distilled water and the TDS of the sample is measured two more time

Determination of turbidity:

- Filled turbidity vial to the line with water sample. Cap the cell.
- Wiped the cell with soft cloth to remove the water spot and figure prints.
- Pressed on/off. The instrument will turn on.
- Placed he sample vial in the instrument cell compartment so its diamond mark aligns with the raised orientation marked in front of the cell compartment. Close the cover.
- Pressed READ the display will show in NTU.
- Washed the vail with distilled water .Repeated the process thrice.

Result and Discussion

Analysis of Physiochemical Parameters

The water quality analysis of different water samples has been carried out for the determination of pH, electrical conductivity, total hardness, total alkalinity and chloride. Standard values or different physiochemical parameters were given in table 1 and results of physiochemical analysis are indicated in table 3 and 4.

pH Analysis: The ph observed were ranging from 5.93-8.04. According to WHO the pH value for drinking water ranged from 6.5-8.5.InTap Water Skardu it was 6.96 ±0.13, in Gilgit River it was 7.64 ±0.23, in Benazir Spring Skardu it was7.17 ±0.05, in Bural Shiger it was 6.76 ±0.02, in tap water shiger it was 6.38 ±0.04, in Katpana Lake it was 8.09 ±0.16, in Under Ground Water Skardu it was 7.53 ±0.09, in Burga Nala Skardu it was 7.33 ±0.02, in Hopper Nager it was 7.21 ±0.01, in Thalay Glacier it was 7.47 ±0.01, in Masharrabrum Glacier it was 6.51 ±0.1, in Murgha Glacier it was 7.03 ±0.06, in Kharmang River it was 6.48 ±0.04, in Main Hot Spring Shiger it was 7.44 ±0.02, in Khosho Chumik Skardu it was 7.36 ±0.08, in Manthokha Abshare it was 6.62 ±0.09, in Blind Lake Shiger it was 5.93 ±0.04, in Kharmang chumik it was 6.12 ±0.07 and in chumikshigerbisil it was 6.3±0.005.

All the water samples have pH value range in WHO standard

Table 1: Standard values for physiochemical parameters of drinking water.

Parameters	Units	WHO standards
pH	---	6.5-8.5
Electrical conductivity	µS	500-1200
Total dissolved solids	mg/L	1400
turbidity	mg/L	< 5
chloride	mg/L	250
Total hardness	mg/L	500
Total alkalinity	mg/L	500
Total dissolved oxygen	mg/L	4-18

Table 2: Sampling area.

A= TAPWATER SKARDU
B= GILGIT RIVER
C= BENAZIR SPRING SKARDU
D= BURAL SHIGER
E= TAPWATER SHIGER
F= KATPANA LAKE
G= UNDERGROUND WATER SKARDU
H= BURGA NALA SKD
I= HOPPER NAGER
J= THALAY GLACIER
K= MASHRABBRUM GLACIER
L= MURGHA GLACIER
M= KHARMAMANG RIVER
N= MAIN HOT SPRING SHIGER
O= KHOSHO CHUMIK SKARDU
P= MANTHOKHA ABSHAR
Q=BLIND LAKE SHIGER
R= KHARMAMANG CHUMIK
S= CHUMIK SHIGER BISIL

limit except Blind Lake Shiger 5.93.

Electrical conductivity measurement: According to WHO standard EC ranged between 500-1200 µS. EC ranged between 186-1444 µS. In Tap Water Skardu it was, in Gilgit River it was 7.64 ±0.23, in Benazir Spring Skardu it was 7.17 ±0.05, in Bural Shiger it was 6.76 ±0.02 in tap water shiger it was 6.38 ±0.04 in Katpana Lake it was 8.09 ±0.16 in Under Ground Water Skardu it was 7.53 ±0.09, in Burga Nala Skardu it was 7.33 ±0.02 in Hopper Nager it was 7.21 ±0.01 in Thalay Glacier it was 7.47 ±0.01 in Masharrabrum Glacier it was 6.51 ±0.1 in Murgha Glacier it was 7.03 ±0.06 in Kharmang River it was 6.48 ±0.04 in Main Hot Spring Shiger it was 7.44 ±0.02 in Khosho Chumik Skardu it was 7.36 ±0.08 in Manthokha Abshare it was 6.62 ±0.09 in Blind Lake Shiger it was 5.93 ±0.04, in Kharmang chumik it was 6.12 ±0.07 and in chumikshigerbisil it was 6.3±0.005.

Graphes

Graphical representations of different parameters are as follow:

Discussion

Tap Water Skardu has pH value 6.96±0.13, electrical conductivity 244.66µS±1.15, total alkalinity 408ppm, calcium 24.33ppm, TDO 10.3ppm, TDS 66.16ppm, turbidity 1.35NTU, magnesium 18.32ppm and chloride 86.27.

Gilgit River has pH value 7.64±0.23, electrical conductivity 315µS±1.73, total alkalinity 507ppm, calcium 22.2ppm, TDO 11.5ppm, TDS 76.033ppm, turbidity 3.31NTU, magnesium 16ppm and chloride 101.5ppm.

Benazir Spring Skardu has pH value 7.17±0.05, electrical conductivity 403.66µS±2.80, total alkalinity 660ppm, calcium 35.46ppm, TDO10.53ppm, TDS 107.66ppm, turbidity 1.62NTU magnesium 13.2ppm and chloride 112ppm.

Bural Shiger has pH value 6.76±0.02, electrical conductivity 328µS±2.46, total alkalinity 859ppm, calcium 174.6ppm, TDO 10.6ppm, TDS 197.66ppm, turbidity 0.93NTU magnesium 6.4ppm and chloride 105ppm.

Table 3: Physiochemical parameters of water.

S.No	Sampling Area	pH of water	E.C Of Water in µS	Turbidity in NTU	TDS In ppm
1	TAP WATER SKARDU	6.96 ±0.13	244.6 ±1.15	1.356667±0.1	66.16667±1.04
2	GILGIT RIVER	7.64 ±0.23	315 ±1.73	3.316667±0.4	76.03333±1.76
3	BENAZIR SPRING SKARDU	7.17 ±0.05	403.66 ±2.80	1.62±0.4	107.6667±2.51
4	BURAL SHIGER	6.76 ±0.02	328 ±2.64	0.9367±0.07	197.6667±1.52
5	TAP WATER SHIGER	6.38 ±0.04	438 ±6.55	0.3±0.01	130.6667±4.04
6	KATPANA LAKE SKD	8.09 ±0.16	483.33 ±9.0	3.72667±0.08	80.86667±2.11
7	UNDERGROUND WATER SKARDU	7.53 ±0.09	545.33 ±1.52	0.8733±0.05	161±5.56
8	BURGA NALA SKRDU	7.33 ±0.02	325.33 ±3.51	6.74±0.07	91.1±0.1
9	HOPPER NAGER	7.21 ±0.01	570.33 ±1,52	0.28±0.02	184.5±0.5
10	THALAY GLACIER	7.47 ±0.01	412.66 ±2.88	3.97±4.02	128.3333±2.08
11	MASHRABRUM GLACIER	6.51 ±0.1	312.33 ±0.57	5.676667±0.1	84.36667±3.06
12	MURGHA GLACIER	7.03 ±0.06	428.3±5.52	0.1833±0.005	96.9±2.
13	KHARMANG RIVER	6.48 ±0.04	443.66 ±1.52	19.867±3.2	113.6s67±4.04
14	MAIN HOT SPRING SHIGER	7.44 ±0.02	1431.6 ±2.08	0.89±0.03	384.6667±3.5
15	KHOSHO CHUMIK SKARDU	7.36 ±0.08	346 ±3.46	0.5133±0.004	96.2±0.6
16	MANTHOKHA ABSHARE	6.62 ±0.09	186 ±1.4	10.86±0.59	51.1667±0.15
17	BLIND LAKE SHIGER	5.93 ±0.04	847 ±2.64	0.4233±0.025	301.333±4.7
18	KHARMANG CHUMIK	6.12 ±0.07	175.4 ±1.34	1.8033±0.005	59.5667±0.1
19	CHUMIK SHIGER BISIL	6.3±0.005	1444.3±3.05	1.7567±0.53	461.667±4.7

Table 4: Physiochemical parameters of water.

S.No	Sampling Area	Amount of Ca in ppm	Amount of Mg in ppm	Alkalinity in ppm	Chloride in ppm	Dissolved oxygen in ppm
1	TAP WATER SKARDU	24.33	18.32	408	86.275	10.3
2	GILGIT RIVER	22.2	16	507.6	101.5	11.5
3	BENAZIR SPRING SKARDU	35.46	13.2	660	112	10.53
4	BURAL SHIGER	174.6	6.4	859	105	10.6
5	TAP WATER SHIGER	38.2	22.72	1098	108.5	9.2
6	KATPANA LAKE SKD	46.6	33.3	507.6	96.827	11.6
7	UNDERGROUND WATER SKARDU	20	17.3	1638	132.3	7
8	BURGA NALA SKRDU	22.2	16.8	432	190.75	10.5
9	HOPPER NAGER	76.4	21.6	452	100.27	10.4
10	THALAY GLACIER	40	14.4	1206	413	10.3
11	MASHRABRUM GLACIER	34.6	13.2	834	80.5	9.8
12	MURGHA GLACIER	22.8	21.12	960	125	11.3
13	KHARMANG RIVER	43.4	11.92	1392	185.5	8.66
14	MAIN HOT SPRING SHIGER	126.6	50	0	157.5	12.4
15	KHOSHO CHUMIK SKARDU	38	11.68	655.8	68.25	13
16	MANTHOKHA ABSHARE	30.6	5.04	312	191.27	9.7
17	BLIND LAKE SHIGER	34.66	64.4	996	126	13.2
18	KHARMANG CHUMIK	20	8.52	439	99.09	10.7
19	CHUMIK SHIGER BISIL	86	6.4	0	189	9.2

Figure 1: Map of Gilgit Baltistan.

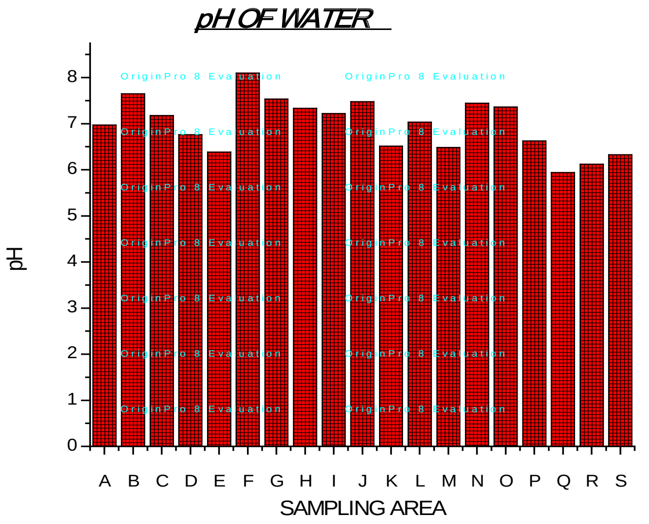
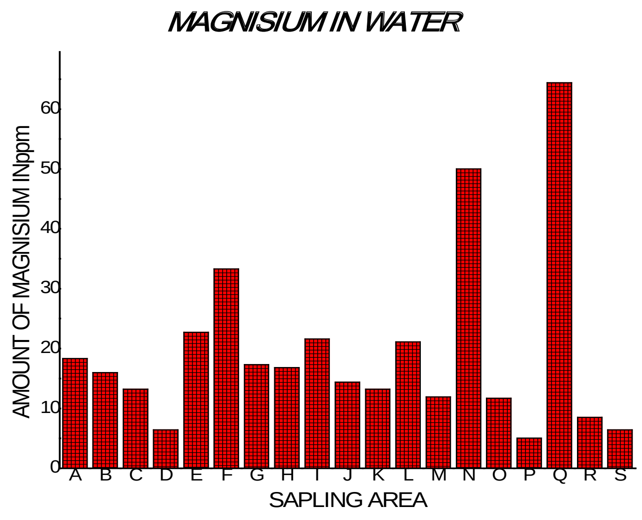


Figure 2: pH of water samples.



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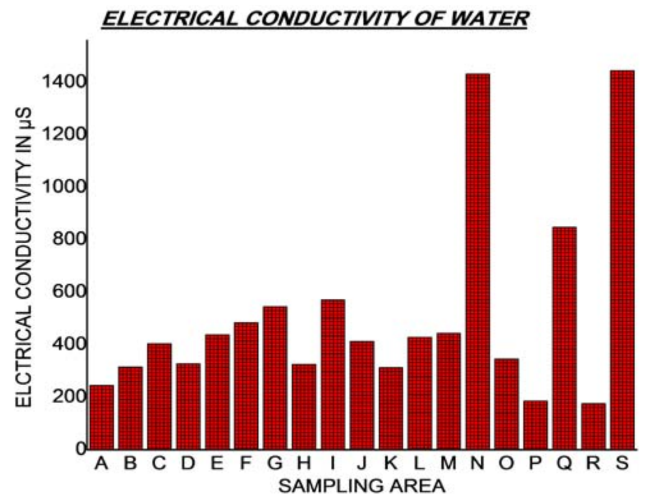

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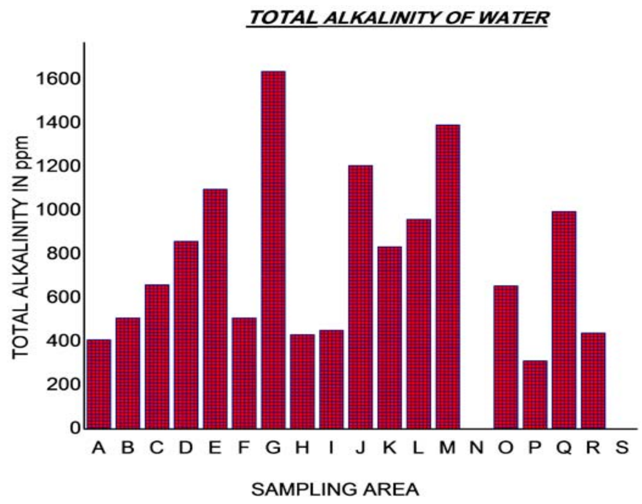

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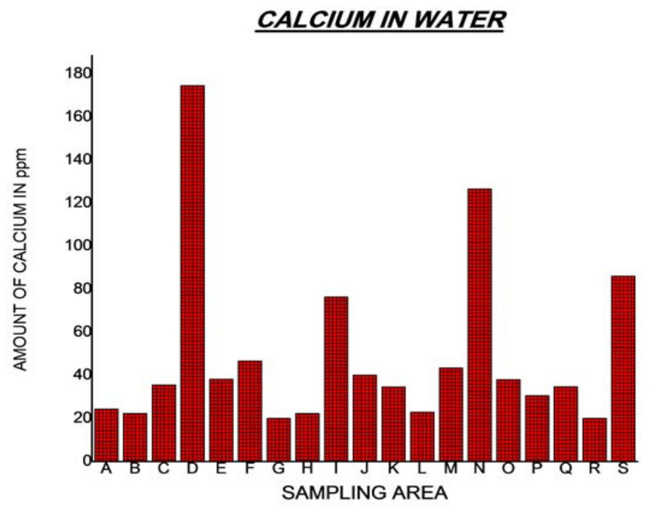

Figure 4:

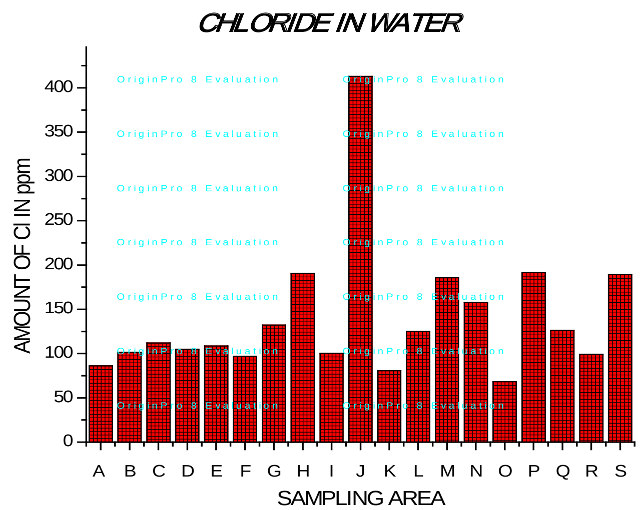

Figure 7:

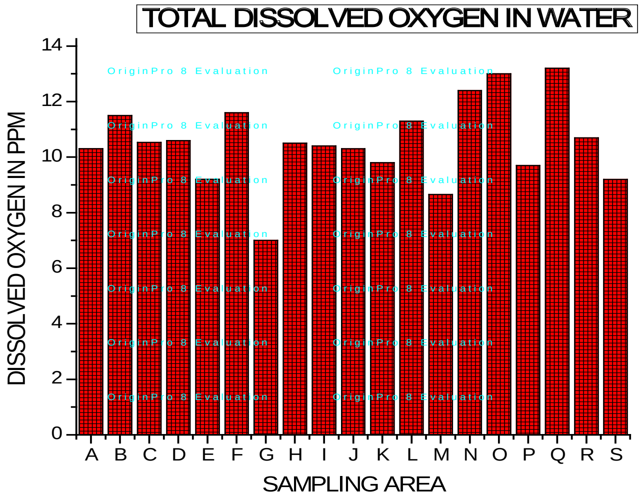

Figure 8:

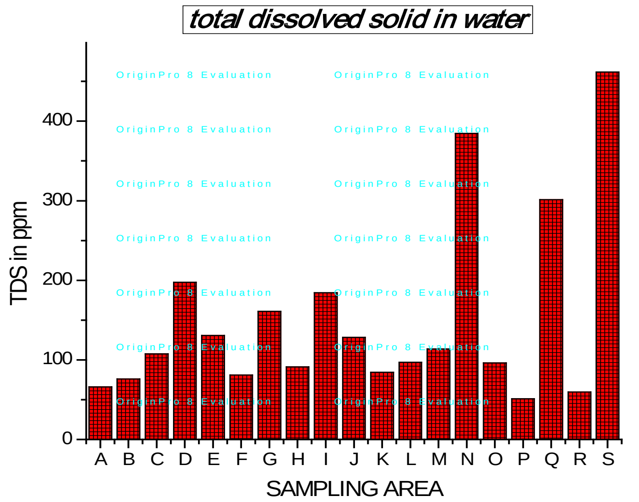

Figure 9:

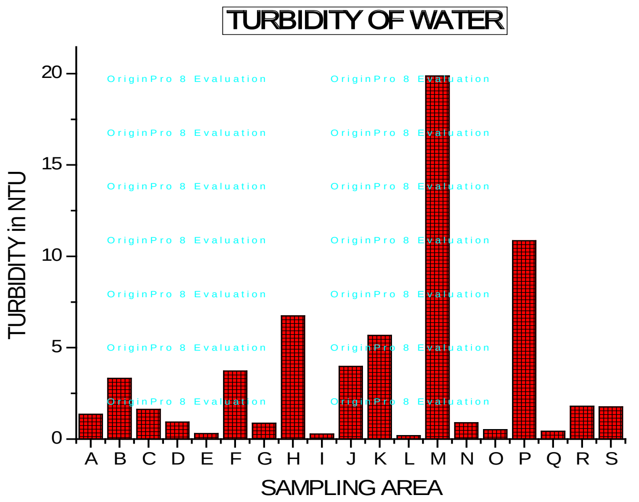

Figure 10:

Tap Water Shiger has pH value 6.38 ±0.04, electrical conductivity 438µS±6.55, total alkalinity 1098ppm, calcium 38.2ppm, TDO 9.2ppm, TDS 130ppm, turbidity 0.3NTU magnesium 22.72ppm and chloride 108.5ppm.

Katpana Lake has pH value 8.09 ±0.16, electrical conductivity 483.33µS±9.0, total alkalinity 507.6ppm, calcium 46.6ppm, TDO 11.6ppm, TDS 80.8ppm, turbidity 3.7NTU magnesium 33.3ppm and chloride 96.827ppm.

Under Ground Water Skardu has pH value 7.53 ±0.09, electrical conductivity 545.33 µS ±1.52, total alkalinity 1638ppm, calcium 20ppm, TDO 7ppm, TDS161ppm, turbidity 0.8NTU magnesium 17.3ppm and chloride132ppm.

Burga Nala Skardu has pH value 7.33 ±0.02, electrical conductivity 325.33µS±3.51, total alkalinity 432ppm, calcium 22.2ppm, TDO 10.5ppm, TDS 91.1ppm, turbidity 6.74NTU magnesium 16.8ppm and chloride 190.75ppm.

Hopper Nager has pH value 7.21 ±0.01 , electrical conductivity 570.33µS±1.15, total alkalinity 452ppm, calcium 76.4ppm, TDO 10.3ppm, TDS 184.5ppm, turbidity 0.28NTU magnesium 21.6ppm and chloride 100.27ppm.

Thalay Glacier has pH value 7.47±0.01, electrical conductivity 412.66µS±2.88, total alkalinity 1206ppm, calcium 40ppm, TDO 10.3ppm, TDS 128.33ppm, turbidity 3.97NTU magnesium 14.4ppm and chloride 41ppm.

Masharrabrum Glacier has pH value 6.51±0.1, electrical conductivity 312.33µS±0.57, total alkalinity 834ppm, calcium 34.6ppm, TDO 9.8ppm, TDS 84.366ppm, turbidity 5.67NTU magnesium 13.2ppm and chloride 80.5ppm.

Murgha Glacier has pH value 7.03±0.06, electrical conductivity 428µS±5.53, total alkalinity 960ppm, calcium 22.8ppm, TDO 11.3ppm, TDS 96.9ppm, turbidity 0.18NTU magnesium 21.12ppm and chloride 125ppm.

Kharmang River has pH value 6.48±0.04, electrical conductivity 443.66µS±1.52, total alkalinity 1392ppm, calcium 43.4ppm, TDO 8.66ppm, TDS 384.66ppm, turbidity 0.98NTU magnesium 11.9ppm and chloride 185.5ppm.

Main Hot Spring Shiger has pH value 7.44±0.02, electrical conductivity 1431.6µS±2.08, total alkalinity 0ppm, calcium 126.6ppm, TDO 12.4ppm, TDS 384.66ppm, turbidity 0.89NTU magnesium 50ppm and chloride 157.5ppm.

Khosho Chumik Skardu has pH value 7.36±0.08, electrical conductivity 346µS±3.46, total alkalinity 655.8ppm, calcium 38ppm, TDO 13ppm, TDS 96.2ppm, turbidity0.51 NTU magnesium 11.68ppm and chloride 68.25ppm.

Manthokha Abshare has pH value 6.62±0.09, electrical conductivity 186µS±1.4, total alkalinity 312ppm, calcium 30.6ppm, TDO 9.7ppm, TDS 51.16ppm, turbidity 10.8NTU magnesim 5.04ppm and chloride 191.27ppm.

Blind Lake Shiger has pH value 5.93±0.04, electrical conductivity 847µS±2.64, total alkalinity 996ppm, calcium 34.66ppm, TDO 13.2ppm, TDS 301.33ppm, turbidity 0.4NTU magnesium 64.4ppm and chloride 126ppm.

Kharmang Chumik has pH value 6.12±0.07, electrical conductivity 175.4µS±1.34, total alkalinity 439ppm, calcium 20ppm, TDO 10.7ppm, TDS 59.5ppm, turbidity 1.8NTU magnesium 8.52ppm and chloride 99.09ppm

Chumik Shiger Bisil has pH value 6.3±0.0.005, electrical conductivity 1444.3µS±3.05, total alkalinity 0ppm, calcium 86ppm, TDO 9.2ppm, TDS 461.66ppm, turbidity 1.756NTU magnesium 6.4ppm and chloride 189ppm.

Conclusion

Physiochemical analysis of water is important to indicate their quality profile for various water uses for example associated with domestic and agricultural uses. The present investigation of water quality assessment of fresh water in Gilgit Baltistan has led us to conclude that some parameters fall within WHO standard while some parameter were exceeding or below permissible limits. According to WHO the pH value for drinking water ranged from 6.5-8.5. All the water samples have pH value range in WHO standard limit. EC of all water samples ranges prescribed by WHO standard except main hot spring Shiger and chumik Shiger Bisil they exceeding the limit. Total alkalinity of all water samples exceeding the standard limit except few that is tap water Skardu, Burganala Skardu, Hopper Nager, Manthokha Abshare and Kharmang. Amount of calcium and magnesium of all samples ranges within limit. tubidity of all samples range within standard limit except Kharmang river and Mashrabrum glacier which exceeding the limit. Amount of dissolved oxygen total dissolved solid and chlorine also ranges in WHO standard limit.

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