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Assessment of water quality of River Bashgal

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Abstract

The Bashgal Valley is a geographical feature ofNuristan, province of Afghanistan, formed by the Bashgal River, which empties into the Kunar river at Arundu and Bagalgrom. River Bashgal is also called ''LANDAI SIN'' Which is bordered with Pakistan from district Chitral side. During the present study From February to July 2012the following water quality parameters of River Bashgal were studied. Water quality of River Bashgal was studied from February to March 2012. The River Bashgal was divided into 3 stations. These were Luluk, Baghicha and Arandu.The water quality parameters recorded between the following minimum and maximum values PH(PH6.1 to PH8.5), Hardness (233mg/l to 304mg/l), Conductivity (90 µS/cm to 160 µS/cm), Alkalinity (40mg/l to 76mg/l), Sodium (2.3mg/l to 8.5mg/l), Potassium (1.8 mg/l to 2.9 mg/l), Chloride (12mg/l to 70 mg/l), Sulfate (7 mg/l to 39 mg/l), TSS (3 mg/l to 19 mg/l), TDS (70 mg/l to 172 mg/l). Ammonia could not be detected. All the studied parameters like pH, Conductance, TDS, TSS, Alkalinity, Potassium, Sodium, Sulfate, Ammonia, hardness and Chloride were within the tolerable range and the water was found safe for drinking during the study period.

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Introduction

Water is a primary driving force for major physical, chemical and biological changes all over the world (Brady and Weil, 1996; Boyd, 2000). Oceans and seas contain approximately 97%, whereas, freshwater resources consist of 3% of the entire water reserve of the earth (Wilson and Carpenter, 1999). About 68.7% of freshwater is locked up in glaciers and icecaps on poles, 30.1% in ground water, 0.3% in surface water bodies and 0.9% in other forms (Gleick, 1996). It is not only main component of biosphere but also a major part of the living organisms (Jackson *et al.,* 2001; Pandey*,* 2006). Life cannot be sustained more than few days without water, even inadequate supply of water change the pattern of distribution of organisms as well as human being (WHO, 2005).

Freshwater is a limited resource, which is essential not only for survival of living organisms but also for human activities such as agriculture, industry and domestic needs (Bartram & Balance, 1996). The history of freshwater resource utilization is as old as human civilizations (Gleick *et al.,* 2002). Water has also played a vital role in the evolution of human civilizations. Human social cultural evolution started in those areas, where adequate quantity and quality of freshwater was available. Most of the ancient human civilizations established around the freshwater resources such as rivers (Gupta *et al.,* 2006). Early civilizations like Mesopotamian, Egyptian, Chinese and Indo-Gangatic civilizations developed around rivers to fulfill the needs of water for domestic, agriculture and irrigation. Several rivers such as Euphrates, Tigris, Nile, Yangtze, Indus and Ganges have been the lifelines for ancient civilizations (Wichelns and Oster, 2006).

Freshwater resources can be classified into three major categories such as lotic (rivers and streams), lentic (lakes and ponds) and ground water (aquifer). Rivers and streams are characterized by uni-directional flow with relatively high velocity > 0.1 m/sec (Meybeck*et al.,* 1989). Pristine rivers and streams exhibit stable aquatic ecosystem, which are rapidly degrading due to over exploitation to fulfil human demands (Hinrichsen *et al.,* 1998).

Natural as well as anthropogenic factors determine the water quality of an aquatic ecosystem, which is essential for biological communities and maintain the human demands (Scott *et al.,* 2002; Schoonover *et al.,* 2005; Pandey*,* 2006; Singh *et al.,* 2007). Information of surface water quality is an inevitable component for the assessment of pollution and long-term environmental impacts assessment of human activities in a particular area. Generally, pristine aquatic systems exhibit less variation in water quality parameters in comparison to those of polluted aquatic ecosystems. Any significant human activity in the catchment area can produce huge volume of pollutants such as heavy metals, organic pollutants, nutrients, salts and other synthetic compounds (Miller, 2002), which alter the water quality and consequently disintegrate the ecological integrity of lotic ecosystems (Lytle and Peckarsky, 2001; Brown *et al.,* 2005).

Metals are one of the important contaminant group responsible for deterioration of surface water quality, which either originate naturally from parent rock material as a result of weathering or contributed from anthropogenic process (Selin and Selin, 2006). Alkali metals (Na, K) and alkaline earth metals (Ca, Mg) are found abundantly in earth's crust, whereas, heavy metals are present in trace amount. Heavy metals such as Fe, Cr, Ni, Cu and Zn are essential in living organisms because of their structural and functional roles in various physiological processes (Wepener *et al.,* 2001), whereas, non-essential metals have no known role in metabolic functions of the organisms and are toxic even in trace amount. Essential heavy metals are required in trace quantities by organisms and if their concentration exceeds the threshold level become toxic (Wright and Welbourn, 2002). Toxic effects of heavy metal vary according to their position in food chain. At higher trophic levels, their effect of heavy metals become more conspicuous among aquatic organisms (Devlin, 2006; Rasmussen *et al.,* 2008).

In an aquatic ecosystem, metals are present either in dissolved form or bind with suspended particulate matter. Dissolved heavy metals are bio-available and highly toxic to aquatic organisms, whereas, metals in particulate matter are comparatively stable and less toxic (Morrison *et al.,* 1990). It is difficult to estimate the biological availability of metals; however, the dissolved content of metals gives a general estimate of available metals (Charlesworth and Lees, 1999).

Particulate metals settle down in the form of sediments in stream bed may build up to high concentrations with the passage of time (Colman and Sanzolone, 1992). Availability of heavy metals depends upon several factors such as pH, organic matter, electrical conductivity, salinity and total hardness (Wright and Welbourn, 2002). Other factors such as turbidity, flow rates and size can also influence the availability of metals and metal load in surface water (Caruso *et al.,* 2003).

Heavy metal pollution is a long term and irreversible process that affects the productivity of aquatic ecosystem, may lead to complete loss of species and biological communities and disrupt the structural and functional integrity (Majagi *et al.,* 2007). Heavy metals in aquatic medium are harmful for aquatic biota even at very low concentration (Schüürmann and Markert, 1998).

Any characteristic of water that effects the survival, growth, reproduction, production or management of fish in any way is called water variables (Ali, 1992). Water quality parameters provide important information about the health of a water body. These parameters are used to find out if the quality of water is good enough for drinking water, recreation, irrigation, and aquatic life (Boustani *et al.,* 2001).

Among aquatic organisms, fishes are good indicators of pollution stress and have wide range of tolerance. Fishes respond to change in physical, chemical and biological conditions of aquatic ecosystem caused by human activities (Plafkin *et al.,* 1989).

Many of the major problems that humanity is facing in the twenty-first century are related to water quantity and water quality issues (Ali, 1992).These problems are going to be more aggravated in the future by climate change, resulting in higher water temperatures, melting of glaciers, and an intensification of the water cycle, with potentially more floods and droughts (Crawshaw, 1979).

The current study was conducted on River Bashgal for the identification of water quality parameters and contamination sources,which bring variations in water quality.

Materials and methods

River Bashgal is also called ''LANDAI SIN'' Which is bordered with Pakistan from district Chitral side. River Bashgal empty into River chitral at the area of Arandu, which is the last village in the bottom of Chitral. The complete length of River Bashgal is 120 km, which is from the upper most area called Luluk, to the lower end point called Arandu where it empty into River Chitral. Above this Region River Chitral, River Bashgal and River Kunar combine empties into the River Kabul at just to the East of the city of Jalalabad in Afghanistan.

The current study was conducted in the period from February to July 2012. The River Bashgal was divided into three stations; these were A=Luluk, B=Baghicha and C=Arandu.

During the current study period the water quality parameters of River Bashgal were studied.

Water Analysis

The water of the river Bashgal was analyzed for the parameters.Velocity of Water, Water depth, Temperature, PH, Hardness, Electrical Conductivity, Alkalinity, Sodium, Potassium, Ammonia, Chloride, Sulfate, Total suspended solid and Total Dissolve solid.

Results

Water Chemistry

The result of different water quality parameters of River Bashgal from February 2012 to July 2012, carried out. All the parameters, like pH, Conductivity, Hardness, Alkalinity, Chloride, Sodium, Potassium, Ammonia, TDS, TSS, and Sulfate were checked in PCSIR Laboratories' Peshawar by using the standard methods. The details are given in table 1.

Table 1. The overall results of water quality parameters of River Bashgal.

MONTHS	MARCH			APRIL			MAY			JUNE			MEAN
PH	7.5	6.8	6.4	6.2	6.1	6.4	6.4	5.8	6.7	8.5	7.1	7.6	6.79
Conductivity	160	160	120	90	120	120	110	100	120	150	155	160	130.42
Hardness	244	304	272	280	292	300	233	245	250	242	262	300	268.67
Alkalinity	64	76	68	42	48	40	52	48	40	70	68	64	56.67
TDS	117	117	88	140	160	172	70	80	76	75	81	90	105.5
TSS	10	4	9	7	3	19	7	3	9	8	8	14	8.42
Sodium	6	6	4	3.7	2.3	3.1	3.5	2.5	3.3	3.5	4	5	3.91
Sulfate	38	19	22	15	27	29	21	7	8	9	8	7	17.5
Potassium	2.3	2.3	1.9	2.2	1.8	1.8	1.9	2.9	2.3	2.7	2.9	2.3	2.28
Chloride	12.9	12.9	15	25	23	19	19.93	35	25	33	27	29	23.07
Ammonia	0	0	0	0	0	0	0	0	0	0	0	0	0

Discussion

Water quality of River Bashgal was analyzed for the selected physical and chemical parameters from February to July 2012 at three different stations along the river. The studied parameters are pH, Conductivity, Hardness, Alkalinity, Total Dissolved solids, Total Suspended solids, Sodium, Sulfate, Potassium, Chloride and Ammonia.

Water samples from the selected stations of River Bashgal were studied for four months. The values for pH vary from minimum pH 6.1 to maximum of pH 8.5 during April at Baghicha and June at Luluk stations respectively. The mean pH of four months at Luluk station is pH 7.15 which is highest mean value of the three stations and it is lowest at Baghicha station pH 6.45. Highest mean of the stations can be seen for the month of June which is pH 7.73 while lowest value is pH 6.23 during the month of April. All the shown variations are irregular in occurrences.

Ideal pH value for fish fauna ranges from pH 6.6 to pH 8.5. Thus the pH values of water samples from the selected stations of River Bashgal remains within the suitable range.

Variations in Hardness during the four month study of water samples from the selected stations of River Bashgal shows variations from station to station each month except station (B) Baghicha, all the shown variations for Hardness are in descending order from station (A) Luluk to station (C) Arandu. But the variations are irregular in occurrence. The highest value was recorded from station B during March which is 304 mg/l. The lowest value is 233 mg/l at Luluk during May. The mean value of hardness for station A during the study is 249.75 mg/l, 275.75 mg/l for station B and 280.5 mg/l for station C. Month wise means of Hardness are 273.33 mg/l in March, 290.66 mg/l in April, 242.66 mg/l in May and 268 mg/l in June.

WHO standard value for Hardness in drinking water is 250 mg/l. The values of Hardness in the water samples of River Bashgal mostly remain higher from the drinking water quality value during the study period. But the increase is not too large.

The variations shown in the water samples from the selected stations of River Bashgal vary within a close range during each month. The variations are however irregular from station to station and month to month. It varies from 90 µS/cm at station A during April to maximum of 160 µS/cm during March at all stations and in June at station C. The mean value of Conductivity for the four months at station A is 127.5 µS/cm at station B 133.75 µS/cm and 140 µS/cm at station C which shows highest value of Conductivity at station (C) Arandu. Mean of the three stations is highest during March which is 160 µS/cm and lowest 110 µS/cm in April and May. Mean value of Conductivity of the three stations in June is 155 µS/cm.

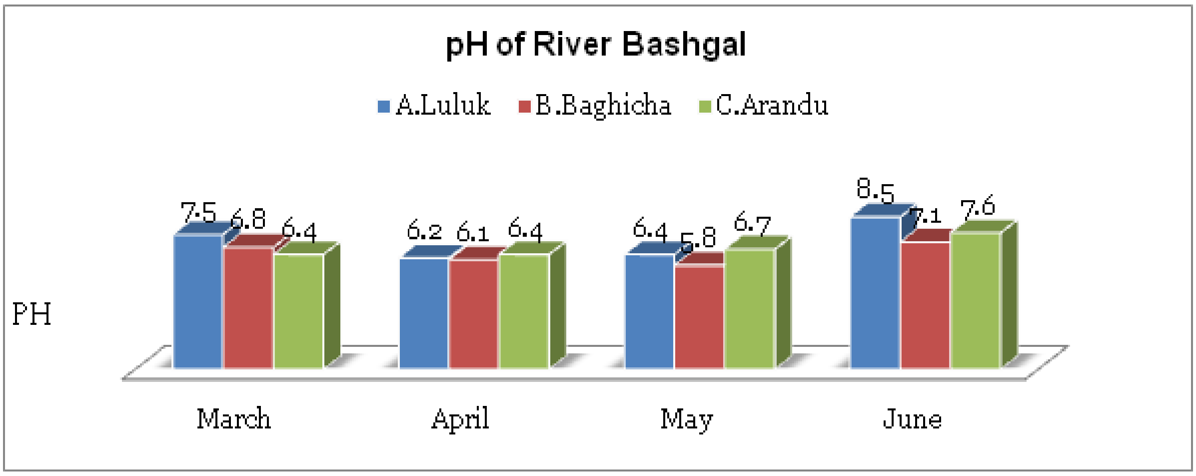

Fig. 1. Showing monthly variations in pH of River Bashgal at different station.

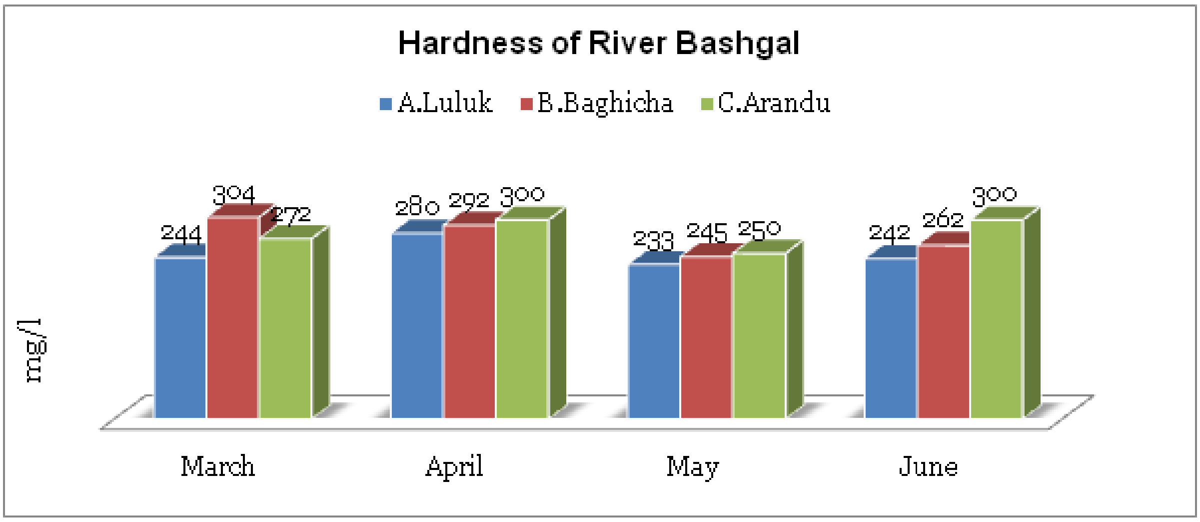

Fig. 2. Showingmonthly variation in Hardness of River Bashgal at different stations.

Stream having good mixed fisheries have a conductivity range between 150 and 500 µS/cm while conductivity of distilled water ranges between 0.5 to 3.0. Conductivity beyond 500 µS/cm is considered not suitable for certain fishes and invertebrates (USEPA, 1999).

The Conductance of water samples from the selected stations of River Bashgal remains within the tolerable range during the study period.

Alkalinity is the acid neutralizing capacity of solutes in water sample. The standard value for Alkalinity is thought to be in the range of 20 to 200 mg/l. Alkalinity vary from 40 mg/l to 76 mg/l in the water samples of River Bashgal from the selected stations during the study period. The highest mean of the four month study was recorded for station (B) Baghicha which is 60 mg/l and lowest mean value is 53 mg/l at Arandu station. Highest value for Alkalinity was also recorded from the said station during March which is 76 mg/l. The highest values for all station were recorded in March where the mean of the three stations is 68.33 mg/l and the lowest is 43 mg/l during April. The variations occur in an irregular manner.

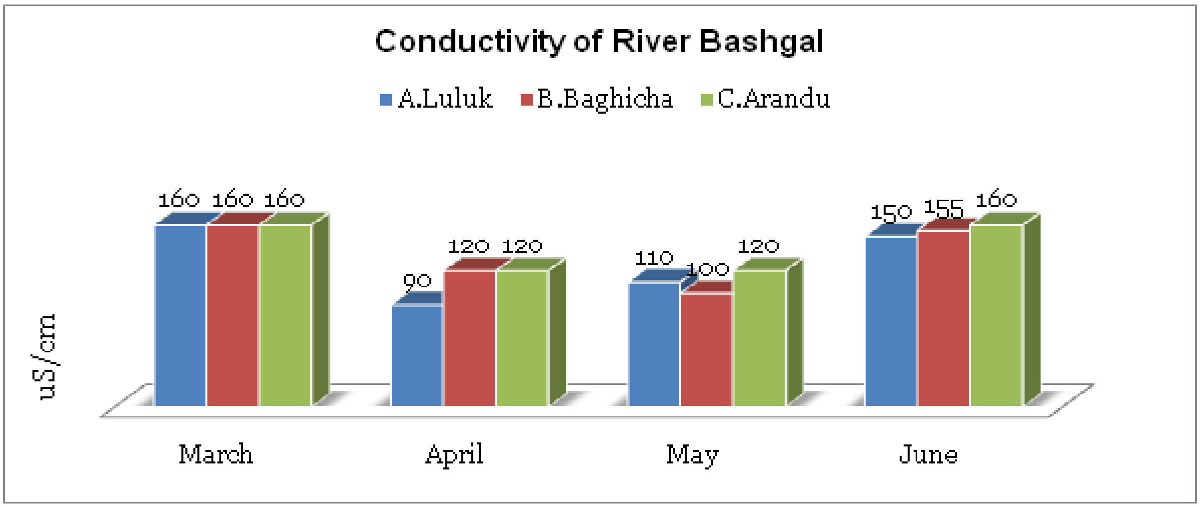

Fig. 3. Showing monthly variations in Conductivity of River Bashgal at different stations.

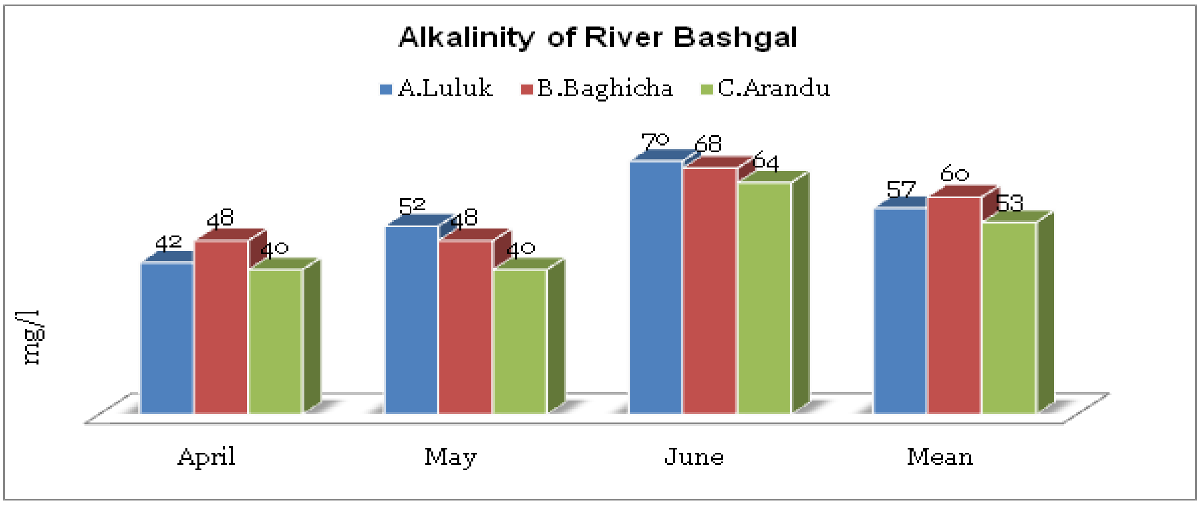

Fig. 4. Showing monthly variations in Alkalinity of River Bashgal at different stations.

According to Meade (1989) standard value for Alkalinity is 0 to 400 mg/l. The variance of Alkalinity in the water samples of River Bashgal remains in the tolerable range at all stations during the study period. All the variations are in close range indicating suitability of the water for drinking and aquatic fauna. Sodium level in the water samples of River Bashgal at the three selected stations vary irregularly between 2.3 to 8.5 mg/l during the study period.

The highest value was recorded during June from station (A) which is 8.5 mg/l and lowest during 2.3 mg/l at station (B) Baghicha. Mean of the three stations during June is 7.73 mg/l which represents the highest month wise mean.

All the stations show highest value during June while lowest mean value of the three stations is 4.13 mg/l during April and all the stations show lowest sodium level during April. Sodium level is comparatively high in March, decreases in April, increases in May and June.

The USEPA advisory limit for sodium in drinking water is 20 mg/l (Ahmad *et al.*, 2010).

Thus the sodium level in the water samples of River Bashgal from the selected stations remains well within the suitable range for drinking water and fish fauna.

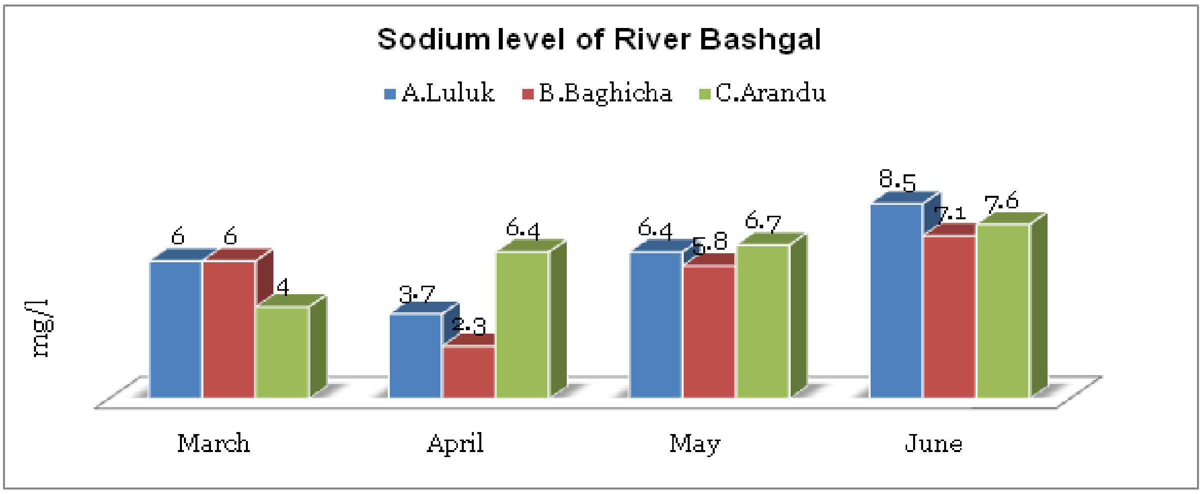

Fig. 5. Showing monthly variations in Sodium level of River Bashgal at different stations.

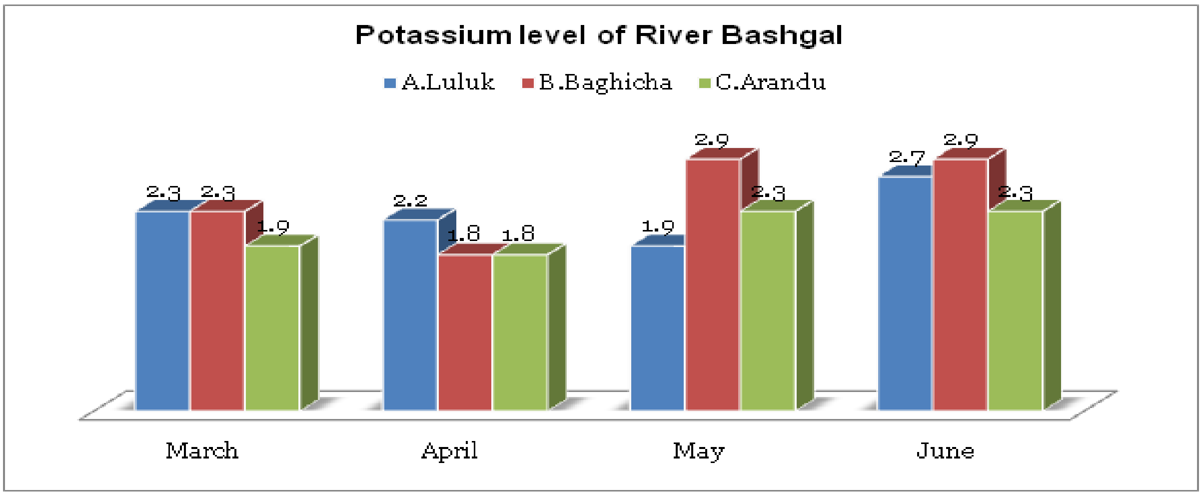

Fig. 6. Showing monthly variations in Potassium level of River Bashgal at different stations.

The level of Potassium varies from 1.8 mg/l to 2.9 mg/l during the study period in the water samples of River Bashgal. The station wise mean value of Potassium is highest at station (C) Arandu which is 6.17 mg/l and lowest mean is at station (B) Baghicha which is 5.3 mg/l. Month wise mean values of the three stations is highest during June which is 7.73 mg/l and lowest mean of the three stations is 4.1 mg/l in April. The level of potassium increases in ascending order from March to June at each station except for station A and B in April. Potassium level is highest in June at all stations. Lowest values were recorded for station A and B in April and for station C in March.

In most of the water bodies Potassium is present in sufficient amounts in water and soil and acts as fertilizer although alone it as negligible effect on productivity of the water body (Ali, 1992). It has a range of 0.5 to 10 mg/l in soil.

The value of Potassium is lower in the water samples of River Bashgal as compared to the water bodies of surrounding areas.

Chloride level in the water samples of River Bashgal at the selected stations vary between a minimum of 12 mg/l and maximum of 70 mg/l. The highest Chloride level was measured from station (A) in June which is 70 mg/l and Lowest 12 mg/l was recorded from station A and B during March. All the variations are in ascending order from March to June at each station. Mean value for Chloride concentration during the four months is highest at station A which is 39.75 mg/l and lowest mean is 34.5 mg/l is at station (C). Mean Chloride value of the three stations is lowest in March which is 13 mg/l and highest mean was recorded in June which is 67.33 mg/l.

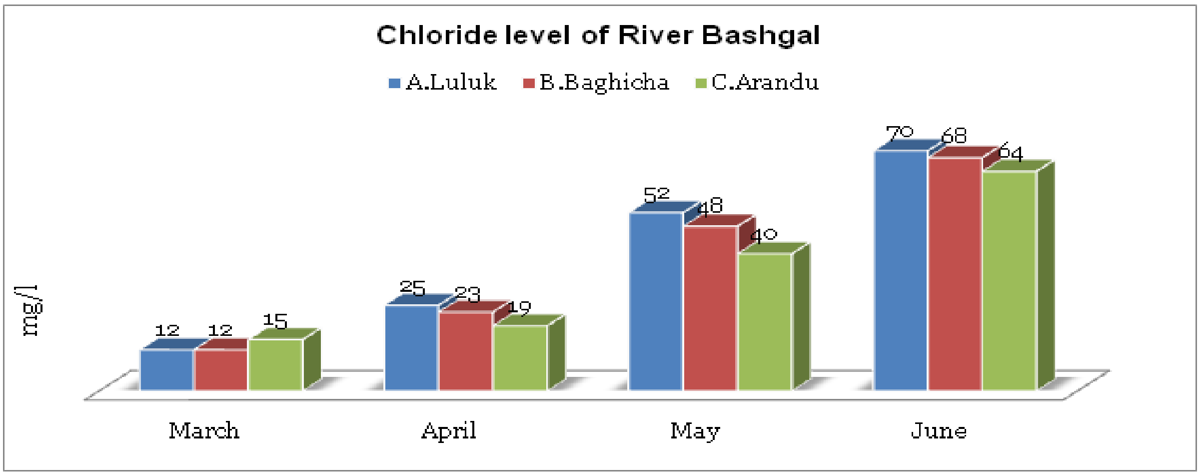

Fig. 7. Showing monthly variations in Chloride level of River Bashgal at different stations.

Chlorides are salts which are formed from the combinations of Chlorine gas with a metal such as sodium potassium etc. Chlorine gas easily dissolves in water. 250 mg/l concentration is thought to be limit for standard level of Chloride in drinking water (EPA, 2000). The above shown results of water samples of River Bashgal show that the water is suitable for drinking.

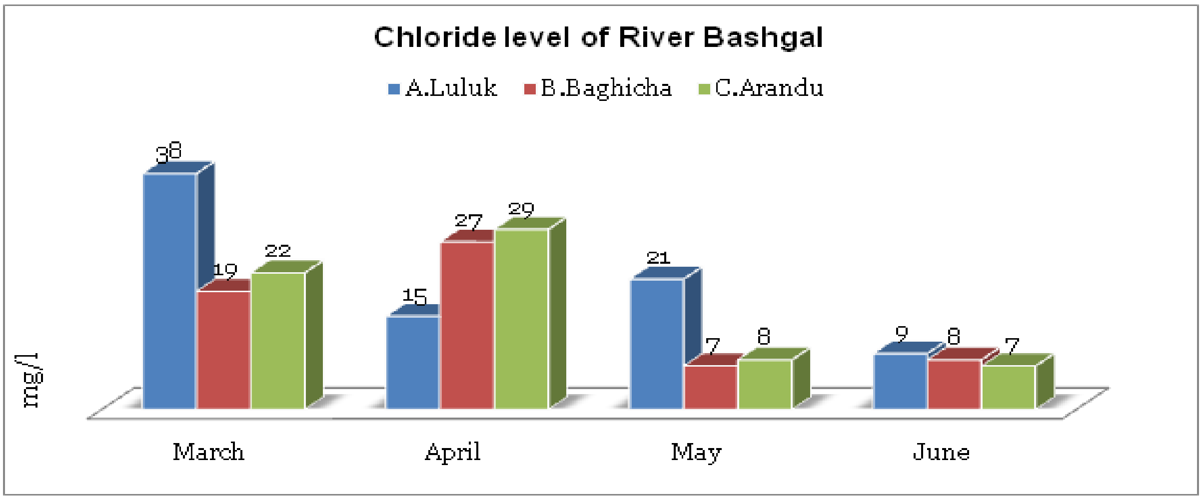

Fig. 8. Showing monthly variations in sulfate level of River Bashgal at different station.

Sulfate variations in the water samples of River Bashgal at the selected stations during the study period vary from 7 mg/l to 39 mg/l, the minimum level was recorded from station (C) during June and maximum from station A during March. The variations are not in any order, occur irregularly.

Mean value of sulfate was recorded for the four month at station A at highest which is 20.75 mg/l and lowest mean value of the four months recorded from station B which is 15.25 mg/l. The mean values of the three stations show highest value during March which is 26.33 mg/l and lowest value was recorded for the three stations in June which is 8 mg/l. Normally the values of sulfate concentrations in the water samples of River Bashgal decrease from March to Jun except at station B and C during April.

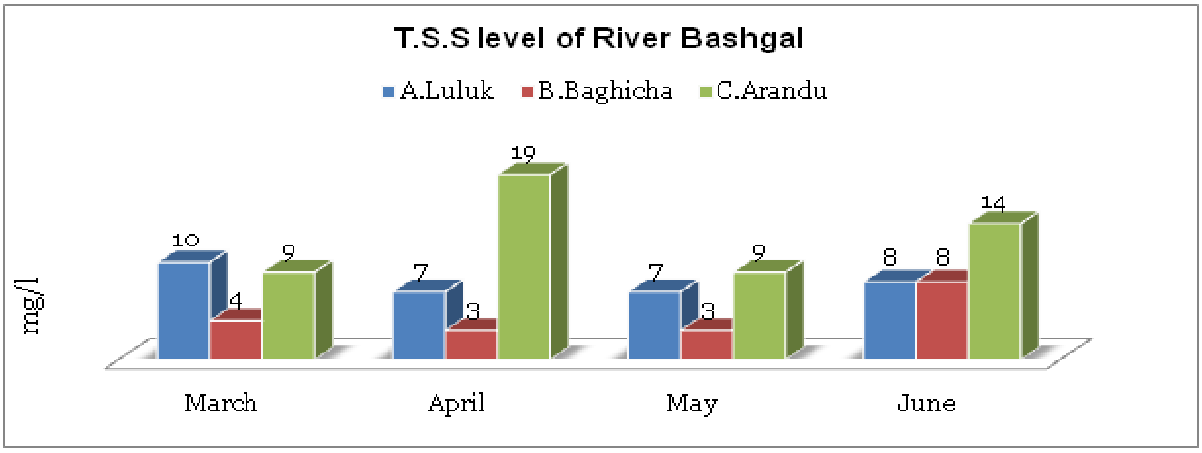

Fig. 9. Showing monthly variations in (Total Suspended Solids) T.S.S level of River Bashgal at different stations.

Usually sulfate value in natural waters is about 5-50 mg/l and for normal functions of aquatic organisms it must not exceed from 250 mg/l (EPA, 2000). The values of sulfate in the water samples of River Bashgal are within the normal range and indicate that the water is suitable for drinking purpose and for aquatic fauna.

Total suspended solids include a variety of materials like salts, decaying plants and animal matter, industrial effluents and sewage. The T.S.S values for the water samples of River Bashgal at the selected stations were between a maximum of 19 mg/l at station C during April while the minimum value was recorded 3 mg/l at station B during April and May. All variations occur irregularly and without any order. Highest mean value of the four month was recorded at station C which is 12.75 mg/l and the lowest 4.5 mg/l which was recorded from station B. The highest mean of the three stations for T.S.S was recorded in June which is 10 mg/l while the lowest was recorded in May which is 9.66 mg/l.

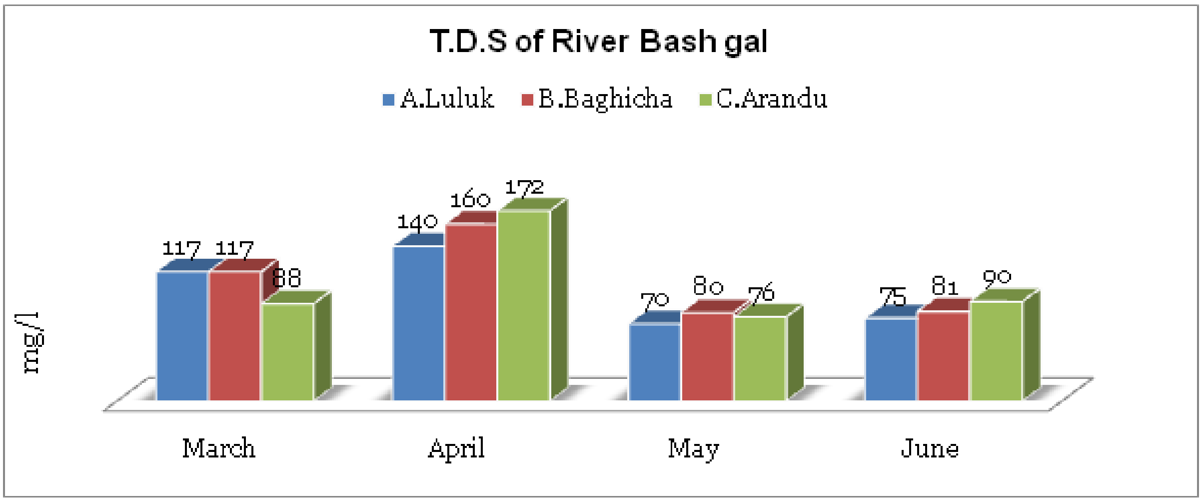

Fig. 10. Showing monthly variations in Total dissolved Solids (T.T.S) of River Bashgal at different stations.

The standard level of T.S.S is considered to be <80 mg/l, intermediate water contain 25-100 mg/l T.S.S but concentration can be greater without adverse effect (Meade, 1989). T.S.S level in the water samples of River Bashgal indicates that the water is suitable for drinking and aquatic fauna without any adverse effects.

During the study periods total dissolved solids in the water samples of River Bashgal from the selected stations vary between minimum of 70 mg/l to 172 mg/l.

The lowest value was recorded from station A in May and highest value was recorded from station C in April. Station B shows highest mean among the three stations during the study period which is 109.5 mg/l and station (A) shows lowest mean value of the four months for T.D.S which is 100.5 mg/l. Lowest mean of the three stations for T.D.S was recorded during May which is 75.33 mg/l while highest mean value of the three station was recorded in 157.33 mg/l.

T.D.S is the total amount of dissolved materials in a given volume of water. Freshwater is considered to contain <1500 mg/l of T.D.S. WHO standard for T.D.S in drinking water is 100 mg/l. T.D.S level in the water samples of River Bashgal at the selected stations during the study period remain very low from the standard limits. It shows that the water is safe for drinking and suitable for aquatic fauna as for as T.D.S level is concerned.

Ammonia could not be detected in the water samples of River Bashgal during the selected stations. The level of Ammonia was not detectable.

Conclusion

Water quality of River Bashgal was studied from February to March 2012. All the studied parameters like pH, Conductance, TDS, TSS, Alkalinity, Potassium, Sodium, Sulfate, Ammonia, hardness and Chloride were within the tolerable range and the water was found safe for drinking during the study period.

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