Physico-chemical Analysis of GudBahri River Water of Wukro, Eastern Tigrai, Ethiopia

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***Abstract*-** The water quality of GudBahri River, an important domestic and potable water source of Wukro, has been assessed. Water samples were collected from the river along different points and analyzed for various physio-chemical quality parameters during winter. Effects of industrial wastes, municipality sewage and agricultural runoff on the river water were investigated. The study was conducted between the Kaziha and Shigar-arho including Adi-akawn. The study involved determination of physical and chemical parameters of surface water at twelve different points. The mean values of Water Temperature, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Total Solids (TS), Turbidity, Dissolved Oxygen (DO), Bio-chemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), pH, Electric Conductivity (EC), Salinity and Chloride content were 26.03^0C, 1233.33 mg/L, 470.17 mg/L, 1703.50 mg/L, 9.60 NTU, 7.89 mg/L, 3.88 mg/L, 7.27 mg/L, 7.90, 672.83µs/cm, 0.33 g/L, 77.5 mg/L, respectively.

***Index Terms*-** Physico-chemical, GudBahri River, pollution, water quality, Ethiopia.

I. INTRODUCTION

Water is essential for the survival of all forms of life. Though 80% of earth's surface is covered by water, the fresh water supply has increasingly become a limiting factor because of various reasons. The expansion of industrialization and exploding population are the major once. Acute short fall of heavy rains, poor water shed management, abundant use of water for household and agricultural purposes have led to the overexploitation of the surface water sources especially from the river bodies. Many perpetual rivers become short-lived and even dried up [1].

Water quality characteristics of aquatic environments arise from a massive amount of physical, chemical and biological interactions. The water bodies: rivers, lakes and estuaries are continuously subjected to a dynamic state of change with respect to their geological age and geo chemical characteristics [2]. This dynamic balance in the aquatic ecosystem is upset by human activities results in pollution which in turn manifests dramatically as fish kill, bad taste of drinking water, offensive odors and unchecked growth of aquatic weeds etc [1]. Quality of water is now a great concern for environmentalists as well as the common publics in all parts of the world. There are numerous sources of pollutants that could deteriorate the quality of water resources [2-3]. Likewise in Wukro, where there is no as such environmental protection practice there are a number of pollutant sources that continuously deteriorate the quality of surface and ground water since the foundation of the city. Based on obtained information, observation made during site visit and analytical results, the following hazard centers have been considered as major category of sources of pollutants in the study area. These are industrial establishment, agricultural activities, municipal wastes, fuel stations, garages and health centers [4].

On the other hand, surface water bodies become the dumping source for industrial effluent and domestic wastes. As a result, the naturally existing dynamic equilibrium among the environmental segments get affected leading to the state of polluted rivers [3-5]. According to World Health Organization's (WHO) decision, water for the consumers should be free from pathogenic organisms and toxic substances [1]. In spite of vast water resources in lakes and rivers and good monsoon, Ethiopia faces perennial problems of floods and droughts and high pollution of fresh water resources [2]. In Eastern Tigray of Northern Ethiopia, the Gudbahri river is situated between latitude 13^0 48'880" N and longitudes 39^0 36'890'' E. It is fed by both monsoons and its tributaries. It originates more than 6577 ft above sea-level in Keziha, near the red rock-cut church of Wukro Chirkos. It flows roughly east and enters the Gunfel River. At 110 km it is a relatively short river serving as the principal source of fresh water for human need.

It is a fact that good water quality produces healthier humans than one with poor water quality [5-10]. Gudbahri River is life line of Wukro and its water is used for domestic and agriculture purposes. Therefore, effective maintenance of water quality is required through appropriate measurements. Physico-chemical and micro-biological characteristics may describe the quality of water [11-18]. Therefore, our previous analysis on heavy metals of Gudbahri water was made [19]. In addition, with increasing number of industries and stakeholders of the river, the concern over the quality has also grown up and hence warranted for the present investigation.

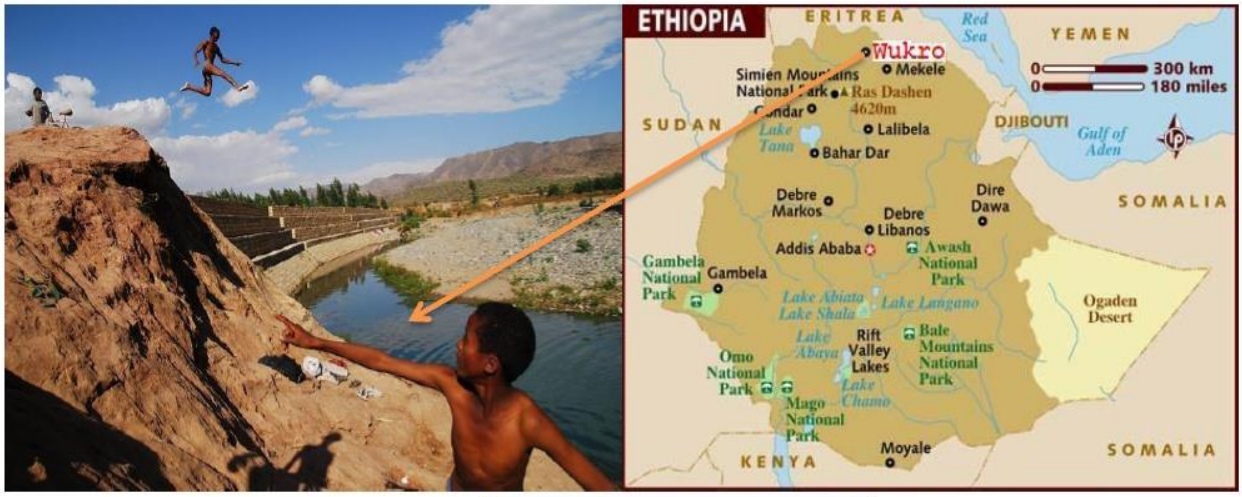

Figure 1: River Gudbahri

In the present study various parameters (Water Temperature, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Total Solids (TS), Turbidity, Dissolved Oxygen (DO), Bio-chemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), pH, Electric Conductivity (EC), Salinity and Chloride content) of water samples from twelve different sites were analyzed.

Table I: Sampling Station in Gudbahri River

Station No.	Location of sampling points	Descrption
1	Keziha	Starting point where domestic wastes and agricultural runoff sources
2	Mybaeto	domestic wastes and agricultural runoff sources
3	Dengolo	domestic wastes and agricultural runoff sources
4	Laelay Wukro	Slaughter wastes, domestic wastes and agricultural runoff sources
5	Mosanu-Gudbahri	domestic wastes and agricultural runoff sources
6	Kalay-Gudbahri	Municipality wastes, car and animal wash, soaps, detergents, domestic wastes and agricultural runoff sources
7	Chirkos church	Toilet wastes, car and animal wash, soaps, detergents, domestic wastes and agricultural runoff sources
8	Kalabih	Municipality wastes, car and animal wash, soaps, detergents, domestic wastes and agricultural runoff sources
9	Alishaday	Municipality wastes, car and animal wash, soaps, detergents, domestic wastes and agricultural runoff sources
10	Shigara-arho	fertilizer, car and animal wash, soaps, detergents, domestic wastes and agricultural runoff sources
11	Adi-akawn	Tannery wastes and agricultural runoff sources
12	Genfel	Tannery wastes and agricultural runoff sources

II. MATERIALS AND METHODS

The water samples were collected in pre-cleaned, acid washed, plastic bottles from the river Gudbahri at twelve different points (Fig.1) starting from Kaziha to Adiakawn on 20th May 2013 to 23rd May 2013 and was later stored in a refrigerator below 4°C until used. Physico-chemical properties such as Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Total Solids (TS), Water Temperature, Turbidity, Dissolved Oxygen (DO), Bio-chemical oxygen demand (BOD), chemical oxygen demand (COD), pH, Electric Conductivity (EC), Salinity and Chloride content were measured using standard methods. The description of sampling sites is provided in Table I.

III. RESULT AND DISCUSSION

Water samples were collected from the Gudbahri River during winter seasons and tested for physical and chemical parameters. The important water quality parameters, such as Color, Odor, Temperature, pH, TSS, TDS, TS, BOD, COD, DO, Turbidity, EC, Salinity and Chloride were analyzed. Assessment of the water samples for pollution is made by comparison of the

assessed values of all the physico-chemical parameters with the corresponding standards prescribed for drinking water by WHO.

Table II: Water Quality of Gudbahri River

Station No.	pH	Temperature (^oC)	EC (µs/cm)	TSS (mg/L)	TDS (mg/L)	TS (mg/L)	Salinity (mg/L)	Turbidity (NTU)	DO (mg/L)	BOD (mg/L)	COD (mg/L)	Chloride (mg/L)
1	7.79	24.5	581	400	397	797	0.28	0.68	7.52	3.47	4	20.8
2	8.39	25.1	540	800	362	1162	0.25	3.142	8.14	2.92	4.8	35.4
3	7.67	26.8	382	400	326	726	0.23	3.192	8.92	3.16	6	18.0
4	7.91	27.5	495	2200	345	2545	0.24	2.719	7.23	3.85	7	51.6
5	7.33	25.5	605	600	411	1011	0.29	2.766	5.37	3	7.8	23.8
6	7.91	26.5	553	800	374	1174	0.26	6.302	8.49	2.77	3	22.2
7	7.85	29.7	488	800	344	1144	0.24	3.038	6.49	3.905	5	53.5
8	8.26	27.7	652	600	443	1043	0.31	19.29	11.48	5.015	12	437.5
9	7.89	26.8	860	800	600	1400	0.42	2.13	10.39	2.485	3.2	27.1
10	7.81	24.8	834	2200	582	2782	0.4	2.648	10.27	3.79	5.6	63.1
11	7.63	23.8	994	1800	688	2488	0.47	4.15	3.54	6.616	12.8	88.6
12	8.33	23.6	1090	3400	770	4170	0.53	65.15	6.82	5.63	16	92.9

Color, Oder and Temperature:

The river water should be colorless. Out of 12 samples 7 are nearly colorless, 1 muddy, turbid color, 2 turbid color, 1 light green and 1 oily & black color. The observation showed that as near the estuary as good in color. The river water should be odorless. 8 water samples are odorless, 1 pungent, 4 high pungent, 2 smile pungent. The observation showed that as near the estuary as good in odor. In the case of temperature, standard for sustaining aquatic life is 20-30 (^{0}C) and as it was winter (26.03^{0}C) all samples complies with the standard.

TSS, TDS and TS:

WHO Standard for TSS in terms of inland surface water is 150 mg/L. Gudbahri River was found to be 1233 mg/L (ranged from 400 to 3400 mg/L) which is above the permissible value. In case of TDS WHO Standard in terms of inland surface water is 1000 mg/L. The mean total dissolved solids concentrations in Gudbahri River was found to be 470.17 mg/L which ranged from 326 to 770 mg/L and it is within the limit. Higher values of total solids are mainly due to the presence of silt and clay particles in the river water. Water high in suspended solid may be aesthetically unsatisfactory for bathing [8-10]. The total suspended solids are composed of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium, manganese, organic matter, salt and other particles. The effect of presence of total suspended solids is the turbidity due to silt and organic matter [11]. The minimum values of the three parameters were recorded in site 3 and maximum values in station 12. The maximum values might be due to the presence of several suspended particles. The higher amount of total solids in site 12 in comparison to others was perhaps due to run off from many bathing ghats, municipality solid garbage dump and other wastages.

DO, BOD and COD:

In the case of dissolve oxygen(DO), the tolerance limit for inland surface waters used as raw water and bathing ghat is 3 mg/l, for sustaining aquatic life is 4 mg/L whereas for drinking purposes it is 6 mg/L. DO value for Gudbahri river is between3.54 to 11.48 mg/L (winter). At all places water has higher DO value than the limit prescribed. So, the contents do not satisfy the public water supply needs.

While in the case of biochemical oxygen demand (BOD), standard for drinking purpose is 0.2mg/L which is exceeded to the permissible value shown by the mean values of 3.88 mg/L. Chemical oxygen demand (COD) is other important parameter of water quality assessment. A standard for drinking purposes is 4 mg/L, which is not acceptable in-terms of Gudbahri river water sample analyzed (7.27 mg/L).

pH, Turbidity, EC and Salinity:

pH is the indicator of acidic or alkaline condition of water status. The standard for any purpose in-terms of pH is 6.5-8.5; in that respect the value Gudbahri River water are 7.33 to 8.39. The overall result indicates slightly basic water. The mean Turbidity of Gudbahri River was found 9.6 NTU which ranges from 0.68 to 65.5 NTU. The mean Electrical Conductivity (EC) of the water samples is 672.83µs/cm (ranged from 382 to 1090 µs/cm) which is above the standard limit of 300 µs/cm. Thus the water has very high electrical conductivity, implying the presence of reduced level of ionic species. However, the conductance of water increases at station 12, which might be due to enrichment of organic conducting species from soaps and detergents of the bathing places [13-14].

The mean Salinity of Gudbahri River was found 0.33 mg/L with a range from 0.23 to 0.53 mg/L. The mean chloride content of Gudbahri River water was found 77.9 mg/L with a range from

18.00 to 92.9 mg/L and it is within the limit. Chloride increases with the increasing degree of eutrophication [5]. The maximum chloride was found in site 12 and the minimum value was recorded in station 1.

The results from data analysis show that, the water is certainly unfit for drinking purposes without any form of treatment recommended by WHO, EU and Bangladish guidelines [3], [20-22] but for various other surface water usage purposes, it still could be considered quite acceptable. But as we know, once a trend in pollution sets in, it generally accelerates to cause greater deterioration. So few years from now, serious water quality deterioration could take place. However, there could be gross differences in the test results of some samples at different laboratories in the country, which could limit the use of these data for sensitive policy issues. The differences might be attributed to the approach adopted by laboratories in sample preservation, quality of chemicals used, testing method applied or qualification or expertise of the technicians or test performers.

The study provides first hand information based on preliminary investigation. A continuous monitoring of the riparian water covering all the seasons over a period time is necessary for fresh water source management. Since the water body serves as potable source as well as for other human needs, periodic monitoring will be helpful to reassure the publics and safeguard the precious common property resource from improper exploitation.

IV. CONCLUSION

The Gudbahri River is one of the most important River of Wukro that feeding the city in many ways. It also contents all kinds of garbage. From the beginning the importance of the river was very much and increasing day by day. But at present that river is under pollution. Like other rivers in the city its water quality is losing day by day. From the above chemical analysis the author saw that most of the water parameters do not comply with the tolerance limit prescribed by WHO and other standards. In addition, the results show that the water is certainly unfit for drinking purposes without any form of treatment. Still it has the time to control the pollution of the river. So it is very much necessary to conduct more research on this river and has to make awareness among the people about the pollution problem.

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