DIJBAR
www.daagu.org
Volume-2 Issue-1

WATER QUALITY ASSESSMENT FOR DRINKING PURPOSE AS AN IMPLICATION TO HUMAN HEALTH IN ARSIS AREA, AFAR, NORTHEASTERN ETHIOPIA

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ABSTRACT

Safe water is a prerequisite for human health and any developmental activities. Water-related diseases are caused by insufficient safe water quality and quantity. The study area is located in the east-central Afar depression which affected mainly by salinity and fluoride. The main objective is to investigate the water quality of the area as an implication for human health. The exposed lithologies of the area are consist of basalt, scoriaceous basalt, and alluvial deposits. These are affected by normal faults with NNE-SSW and NNW-SSE orientation. A total of three water samples are collected from spring, borehole, and river water points and analyzed for about 31 parameters. As a result, the spring water has very low water quality followed by borehole but the river water is freshwater and portable for domestic uses. The long-term effect of the spring water can be kidney and heart diseases, laxative and constipation effects, cardiovascular disease, kidney damage and disinfection, hypertension, headache, coronary artery disease, diabetes, adrenal insufficient, and hyperkalemia. The water types of the springs, borehole, and river are Na-Cl-SO_4, Na-HCO_3, and Ca-Na-HCO_3-SO_4, respectively. The water quality index (WQI) shows the spring water is not recommended for any domestic purpose but the river water needs treatment for the turbidity and total iron concentrations only. As the finding shows, the spring water is strongly recommended to protect from any consumers.

Keywords: Arsis, water quality, human health, waterborne diseases, spring

Citation: Hindeya Gebru, Temesgen Admas, and Mohammed Ahmed (2020). WATER QUALITY ASSESSMENT FOR DRINKING PURPOSE AS AN IMPLICATION TO HUMAN HEALTH IN ARSIS AREA, AFAR, NORTHEASTERN ETHIOPIA. Daagu International Journal of Basic & Applied Research-DIJBAR. Volume2, Issue-1, pp (1-16)

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Received: 14/01/2020

Accepted: 20/04/2020

Published: 29/06/2020

OPEN ACCESS

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1. INTRODUCTION

The human health effect of contaminated water is disseminated in developing countries all over the world including Ethiopia. Safe water is a prerequisite for health and development. It is a basic human right. Access to safe water drinking and sanitation is a series of issues in the world. However, developing countries have suffered from a lack of access to safe drinking water [1]. As a consequence, people are dependent on unprotected and unsafe water sources such as rivers, lakes, boreholes, hand-dug wells, and springs. Meanwhile, these water sources are open, they are susceptible to flood, and animal and human contaminations. The water quality is affected by an increase in anthropogenic activities and any pollution either physical or chemical causes to changes the quality of the water body[2]. Water-related diseases caused by insufficient safe water supplies coupled with poor sanitation and hygiene [3]. All waterborne, water washed, and water-based and water sanitation associated diseases are related to the quality and quantity of water and sanitation available to customers [4]. World health organizations estimated that up to 80% of the human diseases in the world are from water-borne related diseases [5]. About 1.1 billion people lack access to an improved water source globally. Over three million peoples die annually from water-related diseases. The consequences of poor water quality go beyond health, it is difficult to achieve poverty alleviation, millennium development goals (MDG), and sustainable development goals (SDG) without improvements in water quality. For example, Lack of safe water contributes to intestinal helminth infections [6] and chronic diarrheal disease [7]. These diseases cause malnourished and anemic in children which in turn affects cognitive development [8]. The chemicals in drinking water may also a cause for neurobehavioral test problems, for example, Arsenic and Manganese [9]. About 88% of diarrheal deaths are attributed to unsafe water supply, inadequate sanitation, and poor hygiene [10]. Chemical water contaminations are also strongly affecting human health. The sources of chemical contaminations of drinking water supply are classified into naturally occurring, industrial sources and human dwellings, agricultural activities, water treatment or materials in contact with drinking water, pesticides used in water for public purposes, and Cyanobacterial toxins [3]. For example, the naturally occurring groundwater chemical contaminations are arsenic and fluoride which are a series of potential for human health. Metals (Iron and manganese) and salinity are also chemical contamination in water which able to cause water to be rejected for aesthetic purposes. Drinking water should be suitable for human consumption and for all usual domestic purposes [5]. If the dose amount of the parameters is within the permissible values, the water spring point and the nearby area will be protected from any anthropogenic contaminations to give more service systematically for the community. The great majority of health-related water quality problems are the results of bacteriological or other biological contaminations. Nevertheless, a significant number of very serious problems may occur as a result of the chemical contamination of water resources [5]. Moreover, physical contaminations also affect the water quality for consumers. The surface water is susceptible mainly to biological and physical

contamination when it compares with groundwater which is highly affected by chemical contaminations. Both surfaced water and groundwater are contaminated from natural and anthropogenic sources of contaminants.

In Ethiopia over 60 % of the transmissible diseases are due to poor environmental health conditions arising from unsafe and inadequate water supply and poor hygienic and sanitation practices [11]. About 80 % of the rural and 20 % of the urban population have no access to safe water. Three-fourth of the health problems of children in the country are transmissible diseases arising from the environment, especially water and sanitation. 46% of fewer than 5 years of mortality is due to diarrhea in which water-related diseases occupy a high proportion. The Ministry of Health, Ethiopia estimated 6000 children die each day from diarrhea and dehydration [11]. According to [12], 36% by volume of groundwater in Ethiopia is affected by salinity which is not suitable for any purpose. In addition to this, the Ethiopian main rift valley water resources both groundwater and surface water are characterized by enrichment of fluoride concentration which affects adversely for human health.

The community of the study area, Arsis is used water from boreholes, springs, and seasonal rivers for domestic water supply and livestock purposes. The community of the area serves the spring water for spiritual medicinal value. They believe that the spring water is a medicine for different diseases. The patient people drink the spring water more in amount (e.g. 2 liters at one time) continuously. As a result, the patient affected by diarrhea suddenly. According to personal information, the beneficiary believes that the pains and diseases of the person get away with diarrhea. Moreover, the spring water is campaigned for this purpose but not systematically protected. Therefore, this study is conducted to investigate the water quality of the area for drinking purposes and its implication for human health by measuring both physical and chemical parameters.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study area, Arsis is located in the East-Central Afar Depression. It is found southwestern of Samara which is the capital city of Afar Regional State and at a distance of 40km (Fig 1). The climate condition of the study area is Arid with an annual average temperature of 31.45 ^{o}C and an annual average rainfall of 203 mm. The area is a sandwich with two volcanic rock mountains. These mountains are horst of the graven. The geology of the area consists of alluvial deposits and volcanic rocks mainly basalts and scoriaceous basalts. The horsts are covered with basalt formations whereas the graven is covered with alluvial deposits. The alluvial deposits consist of clay, silt, sand, gravels, and rock fragments. The basalts are stratified and vesicular with gray in color. It is affected by columnar joints, normal faults, and generally highly fractured. The scoriaceous basalts are characterized by dome forming formation with black fresh color, red weathered color, and highly vesicular texture. The orientations of the faults

are NNE-SSW and NNW-SSE (Fig. 2). The lineaments also mainly oriented NE-SW direction.

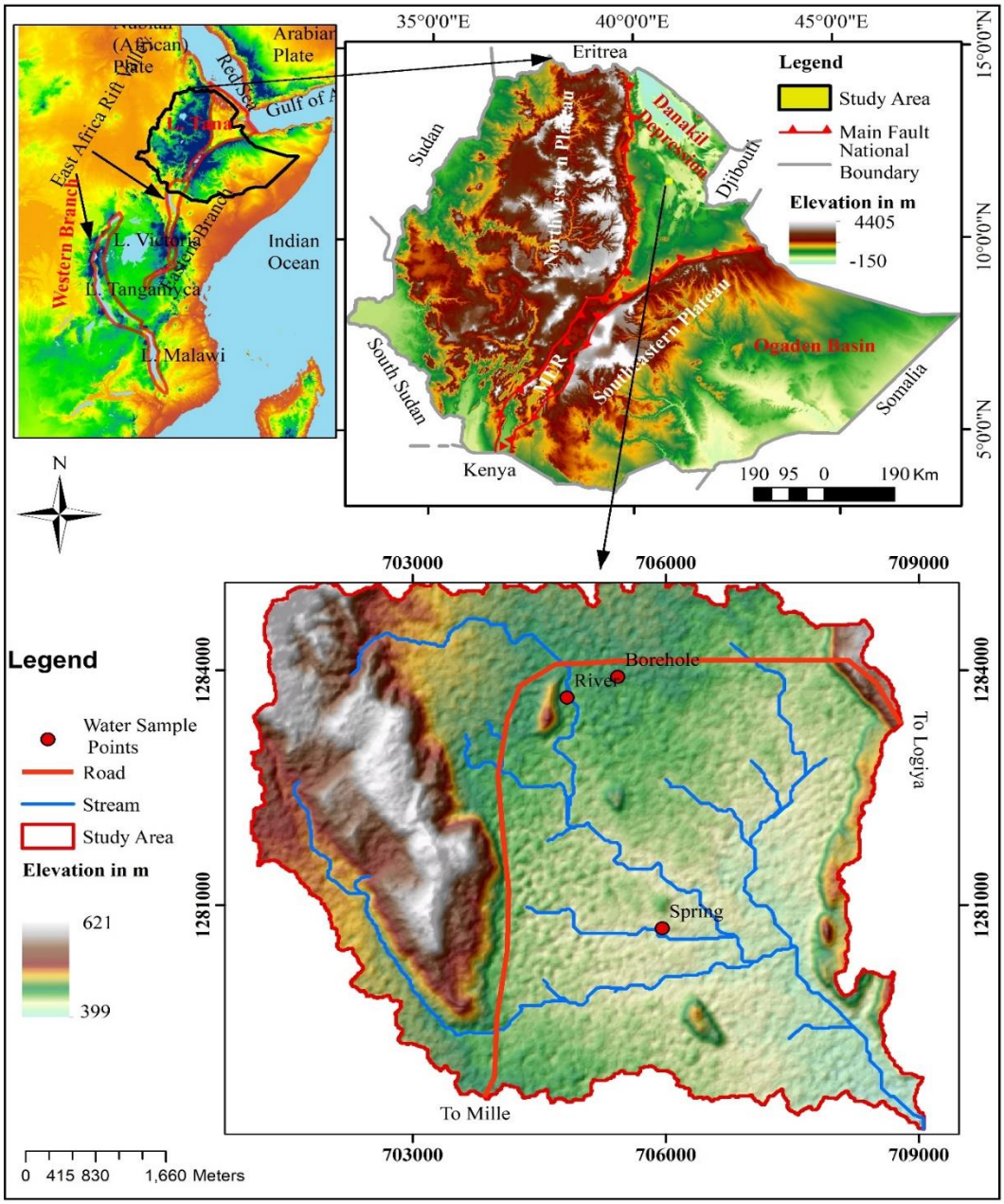


Fig.1. Location map of the study area

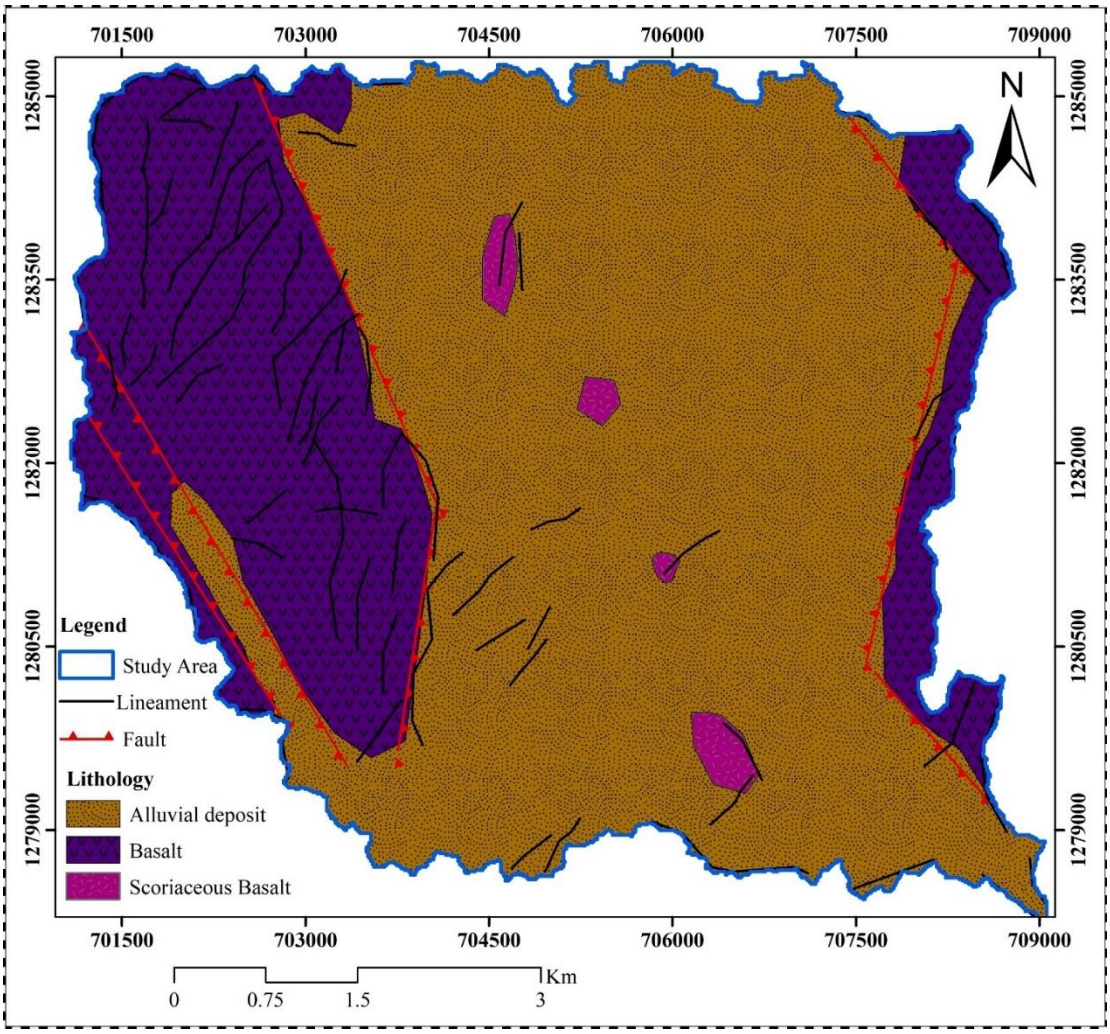


Fig. 2 Geological map

2.2 Methods

A total of three samples were collected from different water points such as borehole, river, and spring (Fig. 3). The water samples are analyzed by Ethiopian Construction Design and Supervision Works Corporation, Water quality laboratory, Addis Ababa. The analyzed parameters are Color, pH, Electrical conductivity (EC), Total solids 105ºC, Total dissolved solids (TDS), Turbidity, Sodium (Na^+) Potassium (K^+), total iron (Fe^{2+} and Fe^{3+}), Manganese (Mn), Ammonia (NH_3-N), total hardness ($CaCO_3$), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Alkalinity ($CaCO_3$), Carbonate (CO_3^{2-}), Bicarbonate (HCO_3^-), Chloride (Cl^-), Sulphate (SO_4^{2-}), Fluoride (F^-), Phosphate (PO_4^{3-} P), Aluminum (Al), Barium (Ba), Copper (Cu), Chromium (Cr^{6+}), Boron (B), Zinc (Zn), Molybdenum (Mo), Nickel (Ni) and Silica (SiO_2). Color is measured using true color as Platinum-Cobalt (Pt-Co) units. pH, Electrical conductivity, and total dissolved solids are conducted using Potentiometric. Turbidity, sulfate, and Barium are tested

using Turbidimeter. Total hardness (as CaCO3), Calcium, magnesium, Alkalinity, Carbonate, and bicarbonate are analyzed using Titrimetric. Sodium and potassium are analyzed using Flame photometric. Total iron and chromium are tested using 1,10-Phenothroline and 1,5-Dephenylcarbonohydrazide, respectively. Aluminum, phosphate, copper, and boron are also conducted using Aluminion, Ascorbic acid-Molybdate blue, Bicinchoninate, and Curcumin, respectively. Manganese is analyzed using Periodate oxidation. Ammonia, chloride, and fluoride tested using Nessler, Mohr Argentometric, and Ion-selective electrode techniques, respectively. Zinc, molybdenum, nickel, and silica are estimated using Zincon, Mercaptoacetic Acid, Heptoxime, and Silicomolybdate methods, respectively. The results are presented and compared with the world health organization's water quality standard guideline for drinking purposes. The laboratory results are checked their accuracy using the cation-anion balances (neutrality) method which determined as the following equation.

$$Balance = \frac{\sum(C-A)}{\sum(C+A)} * 100\% \qquad \text{----Equ.1}$$

Sum of cation and anions are in meq/l and expressed in percent; the acceptable range is from -5% to 5%. The results are presented and interpreted using Aquachem4.0 software.

Besides this, the water quality index of the water points is estimated using the standards of drinking water quality recommended by the world health organization [13] as the following procedures. First, the quality rating is calculated using the following equation.

$$q_n = [V_n - V_{io}]/[S_n - V_{io}] \qquad \text{----Equ.2}$$

q_n = quality rating for the nth water quality parameter, V_n = estimated value of the nth parameter at a given sampling point, V_{io} = ideal value of the nth parameter in pure water (i.e. 0 for all parameters except for pH (7) and dissolved oxygen (14.6 mg/l)), and Sn is standard permissible value.

Unit weight is calculated using the following expression.

$$W_n = K/S_n \qquad \text{----Equ.3}$$

W_n = unit weight is a value inversely proportional to the recommended standard. K is constantly proportion (1) and S_n is recommended standard value.

Finally, the water quality index of the sample is determined using the next formula.

$$WQI = \sum q_n W_n / \sum W_n \qquad \text{----Equ.4}$$

WQI = the overall water quality index of the water sample.



Fig. 3 Water samples from (A) borehole, (B) River and (C) Spring

3. RESULTS AND DISCUSSION

3.1 Color and Turbidity

Color in drinking water is due to the presence of organic matter, industrial wastes, and chemicals. So, drinking water should be ideally colorless. The spring water is observed with a yellowish color because of physical contaminations in the area. The color of the river and spring are beyond the recommended standard by the US which is 15 Pt-Co but the borehole is within the standard value. The turbidity of the water is affected due to the presence of suspended matters. Both the spring and river water samples are exceeded 5 NTU which is the maximum permissible level for consumers.

3.2 pH and Electrical Conductivity

pH is a measure of acidity or alkalinity of the water and provides vital information in any type of geochemical equilibrium or solubility calculation in water [14]. According to [15], the permissible pH value ranges from 6.5 to 8.5. The pH value of water samples from the area is 7.74 in the river, 7.81 in the spring, and 7.94 in the borehole waters. This result indicates the groundwater and river water sources are slightly basic in nature

due to the weathering nature of basalt. All water samples are within the permissible range for drinking use. The EC value of the borehole, river, and springs is 956, 230, and 44,200µS/cm, respectively. Freshwaters are an insulator rather than the conductor of electric current. It is the property of water with the ability to conduct an electric current and a function of dissolved solids. High ions in water can have high electrical conductivity. The desirable limit of EC for drinking purposes is 1,000 µmhos/cm [1]. The spring water is observed with very high electrical conductivity enrichment which indicates the salt enrichment is very high. Except for the spring water, all samples are permissible for drinking water supply.

3.3 Total dissolved solids

The total dissolved substance of the borehole, river, and spring is 327, 110, and 24,800mg/l, respectively. TDS is a measure of the total amount of dissolved minerals in the water. Based on who1984, waters can be classified into four in terms of TDS value such as Excellent (TDS < 300), Good (300-600), Fail (600-900), poor (900-1200) and unacceptable (TDS > 1200 mg/l). According to this classification, the river water is laying in excellent, the borehole is within a good, and spring water is in the unacceptable water type. As a result, the spring water is not permissible for drinking purposes because it exceeds the maximum allowable level which is 1000 mg/l [16]. However, Since a TDS value exceeds 500 mg/l result in excessive scaling in water pipes, water heaters, boilers, and household appliances such as kettles and steam irons [17] According to the [18] discussion, the high value of TDS in groundwater are not harmful to human being but it affects for who suffering by kidney and heart disease. Moreover, high solid in water may cause laxative and constipation effects [19].

3.4 Total Hardness

Water hardness is a measure of the relative abundance of bivalent cations [20]. Calcium and magnesium are the principal cations that can cause water hardness. Total hardness is estimated as:

$$\text{Hardness} = 2.5(Ca^{2+}) + 4.1(Mg^{2+}) \quad (5)$$

Where Ca^{2+} and Mg^{2+} are concentrations in mg/l.

[21] have classified water based on total hardness into soft (TH < 75), moderately hard (75-150), hard (150-300), and very hard (TH> 300 mg/l of $CaCO_3$. Accordingly, the borehole and river samples are soft waters while the spring water sample is very high and not permissible for domestic water supply. Drinking waters should not be hard. However, health studies in several countries in recent years indicate that mortality rates from heart diseases are lower in areas with hard water [22].

3.5 Cations (Calcium, Magnesium, Sodium, and Potassium)

3.5.1 Calcium

The calcium concentration is 22 mg/l in the river, 14.08 mg/l in the borehole, and 589 mg/l in the spring waters. Calcium is the most important and abundant in the human body and stored in bones and teethes [22]. An adequate intake of calcium is very

essential for growth and health. Shortage of calcium in humans may cause rickets, poor blood clotting, bone fracture while an excess of calcium develops cardiovascular diseases. According to [23], the maximum limit in drinking water is 75 mg/l. Accordingly, the spring water is not permissible water for drinking in the study area.

3.5.2 Magnesium

The river, borehole, and spring waters have a magnesium concentration of 2.64, 8.45, and 266.64 mg/l, respectively. It is also one of the most abundant and major dietary requirements for humans (0.3-0.5 g/day) [22], very essential for function living organisms and the human body contains 25 grams in muscles and tissues. Magnesium is very important when combining with sulfate and use medically as "Epsom salt" a laxative. Geologically, it found mainly in dolomite and magnetite minerals. According to the WHO standards, the permissible range of magnesium in drinking water is 50 mg/l. As a result of this study, the magnesium concentration of the spring water is not permissible for drinking water whereas the rivers and boreholes are with the allowable limit.

3.5.3 Sodium

The sodium concentration of the river is 8.6 mg/l, of the borehole is 162 mg/l and of the spring is 9750 mg/l. The common sources of sodium in groundwater are the erosion of salt deposits, weathering of sodium bearing rocks, brackish aquifers, and intrusion of seawater to aquifers. It is a very essential parameter for human food when it combines with chloride as sodium chloride. Excess of sodium in water is not recommendable for human health especially when it associates with sulfate [22]. High sodium concentration causes kidney damage, hypertension, and headache but it protects from these fatal diseases when the proper amount of sodium use. According to [24], the maximum allowable sodium concentration in drinking water is 200 mg/l. Hence, the spring water in the study area has a huge amount of sodium concentration which unable to consume for domestic water supply. It causes also for the groundwater to be unpleasant salty taste [3].

3.5.4 Potassium

The potassium concentration value of the river, borehole, and spring are 2.8, 5.4, and 16.40 mg/l, respectively. Naturally, potassium is occurring in silicate minerals like orthoclase, microcline, hornblende, muscovite, and biotite in igneous and metamorphic rocks and evaporate deposits gypsum and sulfate [25]. Potassium is very important for human and it is a concern for health in excess amount in water. The importance of potassium as potassium chloride and potassium permanganate is to treat saline water to remove sodium chloride from water. The high dose of drinking water cause kidney dysfunction, heart disease, coronary artery disease, hypertension, diabetes, adrenal insufficiency and pre-existing hyperkalemia [13]. According to the WHO standard, the permissible limit of potassium in drinking water is 12 mg/l. The spring water is not fit for domestic purposes in the study area. As a consequence, this may cause the heath of the consumers in the area.

3.6 Anions (Chloride, Fluoride, sulfate, carbonate, and bicarbonate, Phosphate and Ammonia)

3.6.1 Chloride

The chloride concentration in the river, borehole, and spring waters are 2.19, 61.23, and 952.88 mg/l, respectively. Chloride is obtained from the dissolution of salts in the form of sodium chloride and added from industrial influents sewage and seawater intrusions. Groundwater is a high concentration of chloride as compared to surface water and confirmed in the study area. Excess concentration of chloride in water able to damage pipelines and structures and very harmful for growing plants [18]. The maximum permissible limit of chloride concentration in drinking water is 250 mg/l. The chloride concentration of the spring water is too huge and not meet the world health organization standard.

3.6.2 Fluoride

The concentration of fluoride in the river, borehole, and spring water of the study area are 0.17, 1.4, and 1.6 mg/l. Fluoride naturally occurs in rocks in many geological environments [14]. Fluoride concentration is very high in groundwater that associated with acidic volcanic rock. Ethiopia is one of the countries affected by a high concentration of fluoride in groundwater [1]. The fluoride concentration in drinking water is very important for bones and teeth at normal intake or low concentration. However, in excess amounts, it is toxic to human health. The adverse effect of fluoride concentration in water for human health depends on the amount of fluoride. The maximum permissible limit of fluoride concentration in drinking water is 1.5 mg/l [24]. The fluoride concentration below 1.5 mg/l is very important for teeth health, from 1.5 to 3 mg/l cause dental fluorosis (mottling of teeth), from 4 to 10 mg/l which cause dental and skeleton fluorosis (pain in back and neck bones) and much higher than 10mg/l able to cause crippling fluorosis [26]–[28]. As a result of fluoride concentration in the area, the spring water is slightly affected which can cause dental fluorosis (mottling of teeth) for the consumers. However, the borehole and river waters are meet the world health organization standard.

3.6.3 Sulfate

The sulfate concentration in the river, borehole, and spring waters in the study area are 25.72, 85.80, and 12.039.48 mg/l, respectively. The sulfate concentration in spring water is much higher than the other water resources in the area. Sulfateoccurs naturally from the dissolution of sulfate-rich minerals like pyrite and discharge from industrials. The high concentration of sulfate has a laxative effect especially when it combines with magnesium and sodium. The permissible value of sulfate concentration in drinking water is established as 250mg/l [15]. The spring water in the study area has an unacceptable concentration of sulfate for domestic purposes whereas the borehole and river waters are falls within the permissible value.

3.6.4 Carbonate and bicarbonate

The carbonate concentration values of the river, borehole, and spring waters in the study area are nil. The concentration of bicarbonate of the river, borehole, and springs waters in the study area are 73.20, 366, and 280 mg/l. The surface water has low bicarbonate as compare with groundwater in the study area. The high concentration of bicarbonate has no adverse human health effect unless it combined with a large amount

of calcium and magnesium which cause carbonate hardness, affect the taste and corrosiveness of water.

3.6.5 Phosphate and ammonia

The concentration values of phosphate in the river, borehole, and spring water of the area are 0.13, 0.36, and 0.06 mg/l. The concentration of ammonia also reported as 0.34 in the river, 0.03 in the borehole, and 0.07 mg/l in the spring water of the study area. These concentrations are very low in the area and do not have any human health impact for the consumers in the study area.

3.7 Heavy Metals

The concentration values of heavy metals such as Aluminum, copper, chromium, lead, zinc, molybdenum, barium, boron, nickel, iron, and silica are a trace in the water samples from the study area. Except for boron in the spring water found with 2.2 mg/l which exceeds the maximum allowable level in drinking water that is 0.3 mg/l [29]. But the other heavy metals have no significant impact on human health.

3.8 Water types and hydrochemistry facies

The water types of the springs, borehole, and river are Na-Cl-SO_4, Na-HCO_3, and Ca-Na-HCO_3-SO_4, respectively (Fig. 4). This indicates that the groundwaters are highly dominated by sodium concentration from cations whereas surface water is by calcium. The source of the waters found in the area is not from the same. The piper diagram shows the spring water is alkalis exceed alkaline earth and strong acids exceed weak acids. The spring water is characterized by non-carbonate alkalinity (primary salinity) exceeds 50% and chemical properties are dominated by alkalis and strong acids. This spring water is fitted in the area of ocean waters and many brines plot near the right-hand vertex of the piper diagram (Fig. 4).

The river water is characterized by alkaline earth exceed alkalis, weak acids exceeds strong acids and carbonate hardness exceeds 50%. The chemical of borehole water has a property of alkalis exceed alkaline earth, weak acids exceed strong acids and no one pair cation-anion exceeds 50% (Fig. 4).

3.9 Water quality index

The water quality index affords a single number that defines a total water quality of the samples at a certain location and time, based on several water quality parameters. The water quality index, river, and borehole water bodies are determined. The results are 366.07 in spring water (Table 1), 166.86 in river water (Table 2), and 32.92 in the borehole water body (Table 3). Chaterjee and Raziuddin (2002) classified water quality status based on the water quality index level as 0 – 25 (excellent water quality), 26-50 (good water quality), 51-75 (poor water quality), 76-100 (very poor water quality) and greater than 100 (unsuitable for drinking) [30]. Based on this classification the river and spring waters are categorized in the unsuitable for drinking purposes. Theses water bodies are needed for further treatment. The spring water is unsuitable for drinking purposes because of all parameters except pH, total iron, and phosphate. The river water becomes unsuitable for drinking purposes because of turbidity and total iron only. The river water sample result indicates that it carries suspended substances and

passes through iron-rich geological material. The water from the borehole is grouped in the good water quality for drinking purposes.

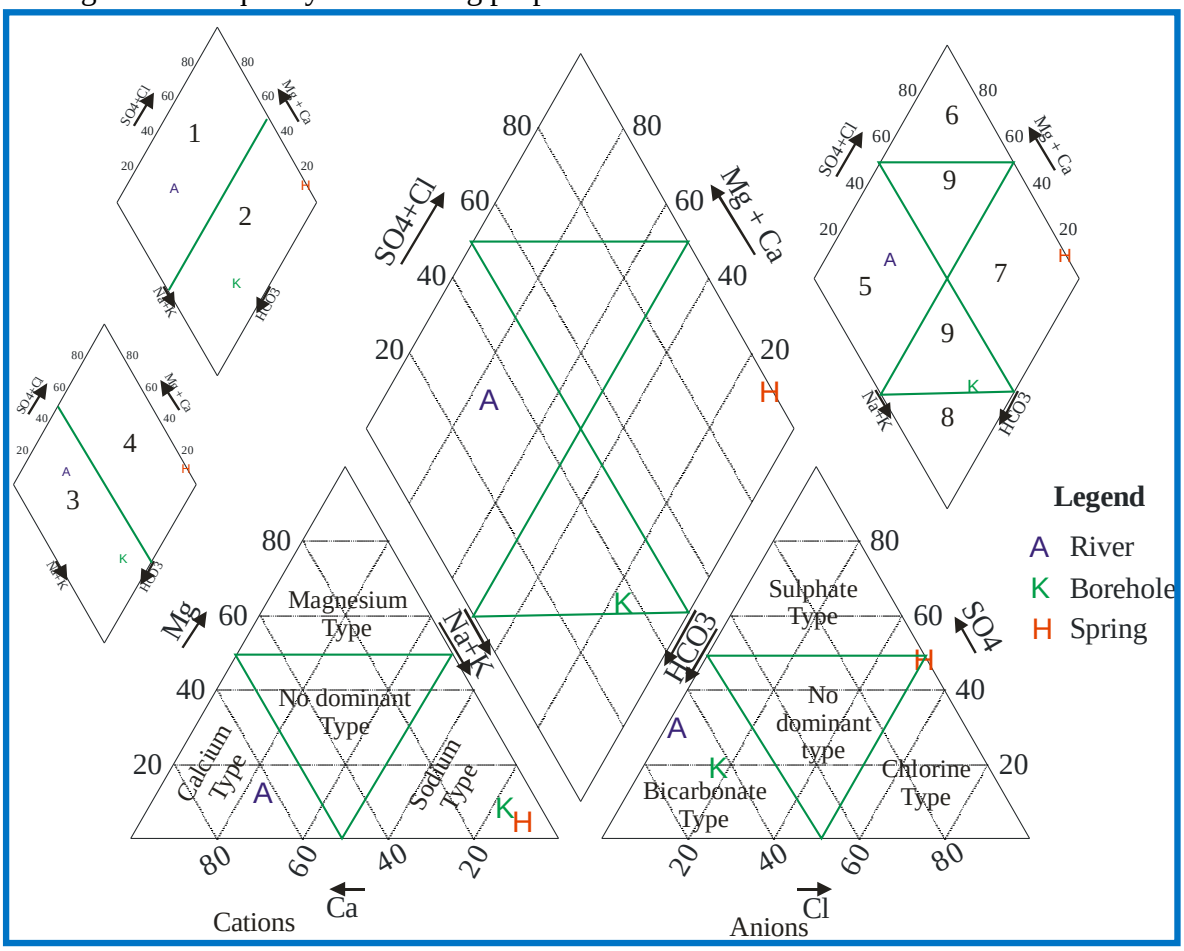


Fig. 4 Piper diagram

Table 1. Water quality index of the spring water in Arsis area

No	Parameters	V_n	S_n	W_n	q_n	W_nq_n
1	pH	7.81	8.5	0.12	54.00	6.35
2	EC	44200	1000	0.00	4420.00	4.42
3	TDS	24800	500	0.00	4960.00	9.92
4	TU	29	5	0.20	580.00	116.00
5	Na^+	9750	200	0.01	4875.00	24.38
6	K^+	16.4	12	0.08	136.67	11.39
7	Fe	0.13	0.3	3.33	43.33	144.44
8	TH	2585	500	0.00	517.00	1.03

9	Ca^{2+}	589	75	0.01	785.33	10.47
10	Mg^{2+}	266.64	50	0.02	533.28	10.67
11	TA	230	120	0.01	191.67	1.60
12	HCO_3-	280.6	120	0.01	233.83	1.95
13	Cl^-	9562.88	250	0.00	3825.15	15.30
14	SO_4^{2-}	12039.48	250	0.00	4815.79	19.26
15	F^-	1.6	1.5	0.67	106.67	71.11
16	PO_4^{3-}-P	0.06	10	0.10	0.60	0.06
17	B	2.2	0.3	3.33	733.33	2444.44
$WQI = \sum Wnqn / \sum Wn = 366.07$				$\sum Wn = 7.90$		$\sum Wnqn$ =2892.80

Table 2. Water quality index of river water in Arsis area

No	Parameters	V_n	S_n	W_n	q_n	W_nq_n
1	pH	7.74	8.5	0.12	49.33	5.80
2	EC	230	1000	0.00	23.00	0.02
3	TDS	110	500	0.00	22.00	0.04
4	TU	79	5	0.20	1580.00	316.00
5	Na^+	8.6	200	0.01	4.30	0.02
6	K^+	2.8	12	0.08	23.33	1.94
7	Fe	0.37	0.3	3.33	123.33	411.11
8	TH	66	500	0.00	13.20	0.03
9	Ca^{2+}	22	75	0.01	29.33	0.39
10	Mg^{2+}	2.64	50	0.02	5.28	0.11
11	TA	60	120	0.01	50.00	0.42
12	HCO_3-	73.2	120	0.01	61.00	0.51
13	Cl^-	2.19	250	0.00	0.88	0.00
14	SO_4^{2-}	25.7	250	0.00	10.29	0.04
15	F^-	0.17	1.5	0.67	11.33	7.56
16	PO_4^{3-}-P	0.13	10	0.10	1.30	0.13
$WQI = \frac{\sum Wnqn}{\sum Wn} = 162.86$				$\sum Wn$ =4.57		$\sum Wnqn = 744.13$

Table 3. Water quality index of borehole water in Arsis area

No	Parameters	V_n	S_n	W_n	q_n	W_nq_n
1	pH	7.94	8.5	0.12	62.67	7.37
2	EC	956	1000	0.00	95.60	0.10
3	TDS	327	500	0.00	65.40	0.13
4	TU	1	5	0.20	20.00	4.00
5	Na^+	162	200	0.01	81.00	0.41
6	K^+	5.4	12	0.08	45.00	3.75
7	Fe	0.06	0.3	3.33	20.00	66.67
8	TH	70.4	500	0.00	14.08	0.03
9	Ca^{2+}	14.08	75	0.01	18.77	0.25
10	Mg^{2+}	8.45	50	0.02	16.90	0.34
11	TA	300	120	0.01	250.00	2.08
12	HCO_3-	366	120	0.01	305.00	2.54
13	Cl^-	61.23	250	0.00	24.49	0.10
14	SO_4^{2-}	85.8	250	0.00	34.32	0.14
15	F^-	1.4	1.5	0.67	93.33	62.22
16	PO_4^{3-}-P	0.3	10	0.10	3.00	0.30
$WQI = \frac{\sum Wnqn}{\sum Wn} = 32.92$				$\sum Wn = 4.57$		$\sum Wnqn = 150.42$

4. CONCLUSION AND RECOMMENDATION

The river and borehole waters are freshwaters as compare with the spring water. The water quality of the spring is highly affected by naturally occurring contaminates. Except for the trace elements, all parameters in the water spring have adversely affected human health and exceeds the world health organization standards. The spring water contains substances that can distress who suffering from kidney and heart diseases, cause laxative and constipation effects, cardiovascular disease, kidney damage and disinfection, hypertension, headache, coronary artery disease, diabetes, adrenal insufficient, and hyperkalemia. The hydrochemistry facies of the water points indicates the water sources are from different aquifer nature. The borehole water is recharged from shallow aquifer whereas the spring is obtained from a deep. The movement of the spring water is due to geological structures control. The water quality index of the spring water indicates that to not consume for domestic water supply for long terms.

The river water needs some treatment mechanism to remove the turbidity and total irons. The borehole water is potable water and suitable for any purpose.

5. REFERENCES

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ACKNOWLEDGMENT

The authors acknowledge the Samara University Research and Community Services office for financial funding for this project.