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Evaluation of Drinking Water Quality in Midre Hagua Town, North East Ethiopia

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Abstract

The primary source of water in Midre Hagua Town is groundwater. Five groundwater samples were gathered for this investigation, and the water quality index was used to assess the groundwater's appropriateness for drinking. Ten physicochemical parameters (temperature, pH, conductivity, turbidity, total alkalinity, TDS, TH, nitrate, phosphate, and sulfate) and five heavy metals (Fe, Cu, Pb, Mn, and Zn) were used to determine the groundwater WQI of the research. The outcome demonstrated that all physical and chemical criteria were nearly below Ethiopian drinking water recommendations and World Health Organization (WHO) guidelines. Conversely, in every measured area, lead (Pb) surpassed the maximum permissible limit. Three sites in the study area were categorized as "Poor Water," one as "Fine Water," and one as "Better Water." Furthermore, in this investigation, lead, pH, and turbidity were shown to be the most useful indicators for determining WQI. A small number of heavy metals and physico-chemical characteristics of water samples were found to be beyond the WHO's recommended safe levels, according to the research. In order to maintain high water quality, this calls for routine borehole water cleaning and observation.

***Keywords:** Water Quality Index; Drinking Water; Physico-Chemical Parameters; Heavy Metal; Turbidity*

Introduction

Groundwater is a major and important source of water for domestic use in urban and rural areas and is believed to be among the most pure water species found in nature [1]. Quality drinking water is important for health but the occurrence of physico-chemical restrictions and heavy metals in excess of legal standards makes it unsafe to drink [2]. Drinking water affects people's health due to the presence of various solvents in it [1].

Compared to surface water, groundwater is thought to be considerably cleaner and less contaminated. Groundwater quality can be affected by a variety of human activities, including commercial, industrial, residential, and agricultural operations, as well as natural pollution [3]. Water quality plays an important role in promoting agricultural productivity and human health. Groundwater pollution depends on the local hydro geologic environment, agricultural land use and planting processes [4]. Low levels of drinking water, water loss, high cleaning expenses, high expenditures for alternate water supplies, and/or possible health issues can all be caused by groundwater contamination.

Thus, in order to take the required actions to reduce the growth of environmental concerns, it is important to carry out research on pollution problems and water quality. Horton introduced the WQI concept of water quality for many purposes [5]. This is one of the best methods for keeping an eye on surface water pollution and indicates the corresponding effects of the standards that have been evaluated on checking the quality of the water [6]. Because it presents a single value rather than a plethora of data that might be confusing to the reader, both professionals and non-professionals can understand it [7].

To the best of my knowledge, an assessment of groundwater quality in Ethiopia using water quality indicators has not yet been conducted. Therefore, the main objective of the current study was to assess the suitability of groundwater in the large watersheds of the town of Midre hagua for drinking purposes based on a water quality indicator approach. Special emphasis was placed on the exploration of physicochemical structures and heavy metals in groundwater in large underground aquifers. The second objective was to identify key parameters that could affect groundwater quality in each vessel tested (i.e. the effect of each water quality parameter on WQI values). The results of this study will allow water managers and policymakers to interpret groundwater quality conditions in order to take appropriate measures to control groundwater quality.

Description of the study area

Midre hagua is a fast growing town emerging from a hamlet status into a town within a short period of time because of its strategic location within the North Central Region of Ethiopia (Figure 1). The area is located between latitude 10° 35’ 22.70” North of the Equator and Longitude 39° 26’ 15.61” East. The elevation of the area is 2730 meters above sea level. The climate of Midre hagua is the equatorial type four seasons such as autumn (March to May) summer (June to August) spring (September to November) and winter (December to February). The maximum rainfall is 1250 mm with the peak annual rainfall experienced in the months of July and August. There is a strong influence of climate on the water sources during the dry season especially in the flow of drinking water sources.

The Midre hagua town drinking water supply collected from five point sources were purposely selected for this study. The two ground water sites are located in the northwest one water sources are located in the southwest one in the East and the other ground water site in the West directions of the town. These water point sources are indicated in table 1 and figure 1.

Sample number	Point Coordinates	Sample Locations	Designation
1	10° 34’ 21.6”N & 39° 25’ 5.2” E	Mume	S1
2	10° 34’ 13.4” N & 39° 26’ 28.4” E	Abazinab	S2
3	10°35’ 27.9”N & 39° 26’ 10.9” E	Konteb	S3
4	10° 36’ 56.9”N & 39° 25’ 47.2” E	Jegola	S4
5	10° 35’ 2.7” N & 39° 25’ 45.9” E	Agamti	S5

Table 1: *Sampling locations and their respective point co-ordinates.*

Methodology

Calculation of the WQI

According to the WHO drinking water standards [8], the weighted arithmetic mean approach developed by Brown., *et al*. [9] was used in this investigation to compute the WQI for groundwater. The following five stages can be used to summarize the WQI calculation methodology.

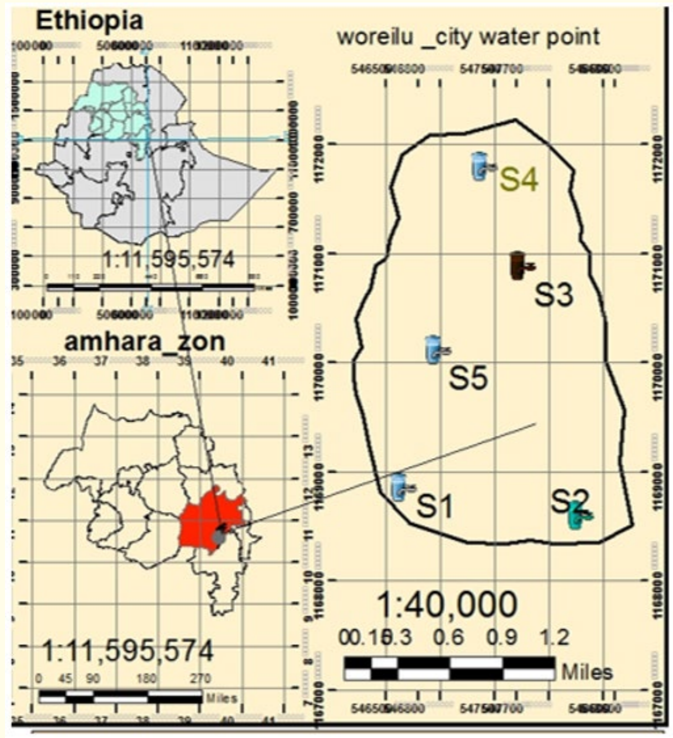

Figure 1: *Location map of drinking water sampling sites.*

Parameter selection

The World Health Organization (WHO) states that criteria that have a major influence on health and are frequently found to be the primary focus of drinking water are the most crucial to take into account in any testing of the quality of drinking water. Thus, temperature, pH, electrical conduction (EC), total dissolved solid (TDS), total hardness (TH), turbidity (Turb), alkalinity, sulphates (SO_4^{2-}), and nitrates (NO_3^-) are the fifteen parameters used in this study to compute WQI. (NO_3^-), phosphate (PO_4^{3-}), copper (Cu), zinc (Zn), lead (Pb), iron (Fe), and manganese (Mn). During the lease's one-year period, which runs from January to August 2019, groundwater samples are taken at certain places. Standard water and wastewater practices are followed during all sampling procedures, including sample preservation and parameter analysis [10].

The unit weight distribution is per parameter

First, the unit weight is assigned to each estimated parameter (wi) depending on its health effects in drinking water (Table 2). One weight is allocated the least weight (little influence on drinking water quality) and five is assigned the maximum weight (greatest effect on drinking water quality). Next, using the following formula to divide the unit weight by the total unit weight of all the parameters, one may get the relative weight of each parameter (Wi).

$$Wi = \frac{wi}{\sum_{i=1}^{n} wi}$$

Where: Wi is the relative weight, wi is the unit weight of each parameter and n is the number of selected parameters (n = 15 in this study) and calculated relative weight (Wi) value of each parameter are also given in table 2.

Parameters	Standard	Unit weight	Relative weight
Temperature (°C)	25.00	1.0	0.02130
P^H	6.50-8.50	4.0	0.08510
EC (µS/Cm)	1000.00	4.0	0.08510
Turbidity (NTU)	5.00	3.0	0.06380
TDS (mg/L)	1000.00	4.0	0.08510
Th (mg/L)	500.00	3.0	0.06380
Alkalinity (mg/L)	200.00	2.0	0.04260
Nitrate (mg/L)	50.00	5.0	0.10640
Phosphate (mg/L)	5.00	1.0	0.02130
Sulphate (mg/L)	250.00	4.0	0.08510
Fe (mg/L)	0.500	3.0	0.06380
Cu (mg/L)	2.00	2.0	0.04260
Pb (mg/L)	0.01.	5.0	0.10640
Mn (mg/L)	0.40	4.0	0.08510
Zn (mg/L)	4.00	2.0	0.04260
		∑ wi = 47.00	∑Wi=0.99830

Table 2: *The unit weight and relative weight of each parameter used for WQI computation with WHO standard for drinking water quality.*

Calculation of the rating scale for each parameter

The rating scale simplifies the many dimensions and units of the water quality criteria into a single scale. Each parameter's rating scale (Qi) is determined by dividing its concentration by the WHO-defined allowable limit value. The resulting number is then multiplied by 100 using the following formula:

$$Qi = \frac{Ci}{Si} x100$$

Where, Qi is the quality rating, Ci is the concentration of each parameter in each water sample, and Si is the WHO drinking water standard for each parameter.

Developing sub-indices

For every parameter, the relative weight (Wi) and rating scale (Qi) are multiplied to obtain the water quality sub-index value (SIi) as follows:

$$SIi = WixQi$$

Where: *SIi* is the sub-index value for i^{th} parameter.

Aggregation of sub-indices

The water quality index (WQI) in this study is obtained by the application of additive aggregation. Accordingly, the WQI is determined by adding up all of the specified parameters' sub-indices using the formula below:

$$WQI = \sum SIi$$

The calculated WQI values were used to determine the different categories of groundwater quality. The five types of ground water are presented in table 3 [11].

WQI values	< 50	50 - 100	100.1 - 200	200.1 -300	> 300
Degree	I	II	III	IV	V
Category	Excellent	Good	Poor	Very poor	Unsuitable

Table 3: *The WQI range and water quality classification for drinking purposes.*

Effective weight calculation

The second goal was achieved by calculating each water quality parameter's effective weight effect on the WQI values. Sahu and Sikdar were found that how the effective weight (EWi) for each parameter was calculated by dividing its sub-index value (SIi) by the WQI value at a specific sample point. The resulting value was then multiplied by 100.

$$\text{EWi} = \frac{SIi}{WQI} x100$$

Where: *EWi* is the effective weight value for i^{th} parameter

Results and Discussion

It is crucial to comprehend groundwater quality as it plays a major role in deciding whether it is suitable for a variety of uses, including industrial, agricultural, and residential. The reaction between water and geology (aquifer) fluxes causes geochemical processes that determine the chemical makeup of groundwater. The quality of groundwater is also influenced by other man-made and environmental elements.

The high temperature of the drinking water may give off an unpleasant taste and smell and the ability to rust for water [8]. This may also aid in the growth of microorganisms, thus affecting water quality [8]. In this study, the sample temperature was between 11 and 16°C (Table 4). These temperatures were all within the WHO high temperature of 25°C. The low sample temperature recorded can be attributed to the time of early morning sample collection. Nkansah and Ephraim [12] were found that low temperatures have been reported in Ghana's water-based physicochemical analysis, which they say is due to sampling time. The temperature of the drinking water is usually not a major concern for consumers especially in terms of quality. The water quality is usually left to the individual's taste and preferences in relation to temperature.

The slightly alkaline condition of the groundwater in all studied areas is shown by pH values ranging from 7.8 to 8.3, all of which are within the WHO-approved drinking water standards. Water pH is important because it controls many geochemical reactions or melting points in groundwater. The pH should be kept within a range that is compatible with the chemical procedures used in rust control, lubrication, disinfection, and compounding. If rust is not reduced, it can cause difficulties with appearance and contaminate drinking water since rust forms at low pH.

Electrical conductivity provides an estimation of all the soluble ions in the ground water. In this study, the EC of the drinking water in each sampling sites ranged from 0.3 to 0.35 μS/cm (Table 4) which is below WHO threshold limit of 1000 μS/cm for drinking water and therefore, it did not pose a potential health risk to consumers. It is considered a good measure and speed to determine the amount of TDS as reported by Quaitto [13].

Water clearance is indicated by turbidity. Water sample impairment varied greatly, ranging from 3.1 to 6.8 NTU (Table 4). All samples met the WHO criterion for tolerable turbidity levels, with the exception of those from S4 (Jegola), which had a turbidity value of 6.8 NTU. Generally, ground water has a low turbidity rate as surface water flowing as groundwater would be naturally filtered from the soil as it flows into the aquifer. However, significant figures found in other analyzed wells indicate the potential for clay and groundwater to interact with other subsoil potential. Tiimub., *et al*. [14] reported turbidity of 0.59 - 23.3 in groundwater analysis is also attributed to the formation and interaction of groundwater.

Natural resources, sewage, industrial wastewater, urban runoff, and chemicals used in the water treatment process have all been connected to total dissolved solids (TDS) in drinking water [15]. High TDS concentrations can give the water an unpleasant flavor, odor, or color, which might make the consumer respond negatively [16]. Total dissolved solids in this study showed wide differences with a low dose of 193 mg/L and a high dose of 234 mg/l (Table 4). All TDS values were below the legal threshold of 1000 mg/L determined by WHO (2011). Every sample area was identified as having fresh water (TDS <1000 mg/L). Moreover, excellent (< 300 mg/L), good (300 - 600 mg/L), fair (600 - 900 mg/L), negative (900-1200 mg/L), and unsatisfactory (> 1200 mg/L) tastes can be assigned to drinking water based on TDS [17]. This rating allows for the designation of all researched locations as good water.). According to this classification, all the studied areas can be classified as excellent water.

In chemical terms, total hardness can be expressed as the total concentration of Mg^{2+} and Ca^{2+} milligrams per liter, or $CaCO_3$ [18]. Hardness can also be referred to as lather soap and water resistance [19]. Total concentration concentrations ranged from 148 to 263 mg/L in all samples analyzed (Table 4). The dosage strength for all samples was less than 500 mg/L recommended by WHO for drinking water (Table 4), suggesting that all were in accordance with WHO guidelines and were safe to drink. Groundwater is categorized as soft (TH < 75), moderately hard (75 < TH < 150), hard (150 < TH < 300), and very hard (TH > 300) based on TH, according to Sawyer., *et al*. [20]. Considering this method of classification, the ground water in all the sampling sites was hard. Hard water does not have health problems as it is below WHO recommended the permissible limits (500 mg/mL) but may affecting the intake of drinking water [21]. Hard water can have problem in the home. Because it binds soap, total hardness more than 80 mg/L is not recommended for use in home settings [22]. Furthermore, solid water can cause hot water consumption and the water distribution system to scale up [23].

According to water United States Environmental Protection Agency [15], Alkalinity is a chemical measurement of water's ability to neutralize acids. Ions such HCO_3^-, CO_3^{2-}, or OH^- that are present in groundwater are the primary cause of water alkalinity. The alkalinity of the water in each sampling sites were very low and within the WHO standard (Table 4) with an average alkalinity value of 121 to 179 mg/L. The results of the analysis showed that the total alkalinity of borehole water content in the town of Midre hagua at all sample sites was within the WHO limit of 200mg/L and suitable for drinking purposes.

Nitrate concentrations vary from 0.170 - 0.230 mg/l in the sampling sites. All the ground water have good nitrate levels that were still below the WHO [8] allowable limit of 50 mg/l and thus they don't pose a significant risk to consumers' health. The negative impact of nitrate can only occur at levels of above 50 mg/L, particularly in children with methemoglobinemia blue baby syndrome [24]. The occurrence of nitrate at a reasonable rate for all the boreholes analyzed represents the same nitrate source for all samples that are allegedly derived from normal farming practices in the study area. All boreholes analyzed were in the field area including organic fertilizer application and inorganic fertilizer. Mancy [25] reported that the detection of nitrates in the analyzed water sample and identified agricultural activities that include fertilizer application and the application of natural fertilizers as potential sources of contamination.

The three primary forms of phosphorus in ground water are organically bound phosphate, condensed phosphate, and orthophosphate. Microbial depletion of organic matter releases phosphorus form phosphate. Phosphorus is found naturally in rocks, soil, animal dung, plant material, and even the atmosphere. Phosphorus can also be obtained using human activities, including agriculture, the removal of industrial and municipal waste, and the discharge of surplus water from residential and urban areas, in addition to these natural resources. The importance of phosphorus is in its ability to cause water eutrophication in the presence of other nutrients, especially nitrogen [26]. In the study area, the concentration of phosphate in the sampling sites ranged from 0.10 - 0.650 mg/l (Table 4).

The amount of phosphate that is found in the natural aquatic ecosystem is not usually sufficient to cause harmful health effects to humans or animals. Phosphate like any other nutrient is not harmful to low concentrations but is only harmful at high doses. High doses of Phosphate are known to interfere with the digestion of both humans and animals. The phosphate concentration in the sampling sites was within the acceptable range and hence did not cause health impact to consumers. The existence of phosphate in all of the examined ground water may suggest that the source of phosphate in the water samples have the same origin.

Sulphate is one of the principal anions usually found in freshwater sources. Sulphate concentrations in the study areas are between 4.40 and 23.0 mg/l. Sulphate can have negative impact on human health at concentrations higher than 500 mg/L and cause a laxative effect when combined with calcium and magnesium, the two most common components of hard water. 250 mg/L doses or above are formulated with sulfates based on taste care and not for health reasons [27]. Therefore, sulfates do not cause a health risk to sample water consumers as all the values of the sampling sites were below the health risk factor (500 mg /l).

High concentration of iron in groundwater may not be harmful to health but may not be considered by consumers due to the unpleasant odor and taste that is often associated with high iron content [28]. The average concentrations of iron in the sampling sites were varied ranged from 0.15 - 0.53 mg/L (Table 4). The highest concentration (0.53 mg/L) was seen at S_5 and the lowest concentration (0.15 mg/l) was documented at S_2 (Table 4). At Agamti, the values exceeded the WHO's permissible limit. The analysis indicated that twenty percent of the ground water contains higher iron concentrations above the WHO proposed drinking water level. A lot of iron in groundwater is widespread and sometimes barriers under water supply. This may be due to the optimal amount of iron found in all samples may be the result of a common source of possible contamination from iron ore minerals in rocks as they come in contact with water below the borehole. Pipes used in the construction of boreholes may be a potential source of contamination.

The range of copper concentrations in water samples was 0.09 to 0.13 mg/L (Table 4). Maximum Copper concentrations were found in S_4 and the lowest concentrations of copper were recorded in S_1. The results were within the acceptable ranges set by WHO [8]. Copper can be obtained from water by natural mineral diffusion routes, industrial extraction, by its use as sulphate of copper to control biodiversity growth in other lakes and by the distribution system or by the corrosion of copper alloy water pipes but much copper contamination in drinking water occurs in the water supply system due to corrosion of pipes or copper connectors [29].

The average concentrations of lead in the drinking water among the sampling sites were varied from 0.020 - 0.10 mg/L (Table 4). A very high concentration was recorded in S_1 and very low concentrations were recorded in S_2 and S_3. It is found in all the five sampling sites and above WHO [8] proposed levels for drinking water. Due to Pb's recognized toxicity, even at low concentrations, and its documented adverse effects, including developmental problems in children, this makes water unsafe for human consumption [30]. The possible causes of lead flooding in these wells are surprisingly rural. However, the increase in the use of chemical fertilizers due to the rapid decrease in soil fertility in the study is likely to have significant lead exposure to groundwater. In addition, the high recorded level of lead in sample water indicates the possible interaction of minerals with rocks in the ground. Groundwater may contain lead-forming minerals that can affect groundwater.

The average concentration of manganese in ground water sampling sites was varies from 0.040 - 0.110 mg/L (Table 4) which are below the WHO approved limit for drinking water. The presence of manganese found in all sampling sites could mean that having common source of contamination for all sites and is possibly due to the depletion of manganese minerals in to groundwater. Manganese occurs due to the melted manganese from the soil and sub soil [31].

Zinc has mean concentrations in the sampling sites varied from 0.270 - 1.10 mg/l (Table 4). Maximum average concentration was found at S_5 and minimum average concentrations were observed at S_3. However, the concentration zinc in the five sampling sites were within the WHO recommended limits for drinking water. Considered as an important metal, zinc serves as a catalyst for the body's enzymatic processes.

In general, due to the extreme toxicity of heavy metals, even at very low quantities, their presence in drinking water generally poses a health risk to humans. The type of heavy metal determines the degree of toxicity and the adverse consequences. Major side effects of heavy metals include damage to the nervous system, reduced growth and development, autoimmunity development and damage to the liver or kidneys. A few heavy metals can build up in the body such as in lipids and the digestive system and cause cancer [32]. Heavy metal exposure at high concentrations can result in fatalities or lasting brain damage [33].

Parameters	Sampling Sites					Max	Min	Mean
	S1	S2	S3	S4	S5			
Temp (^oC)	13.550 ± 0.290	12.820 ± 0.90	11.0 ± 0.050	15.0 ± 0.350	16.0 ± 0.490	16.0	11.0	13.70
P^H	7.80 ± 0.700	8.10 ± 0.400	7.90 ± 0.030	7.90 ± 0.40	8.30 ± 0.00	8.30	7.80	8.0
EC (µS/Cm)	0.30 ± 0.010	0.330 ± 0.000	0.350 ± 0.010	0.300 ± 0.010	0.350 ± 0.020	0.350	0.30	0.330
Turbidity (NTU)	3.890 ± 0.030	3.80 ± 0.010	4.10 ± 0.110	6.80 ± 0.170	3.10 ± 0.050	6.80	3.10	4.30
TDS (mg/L)	198.50 ± 0.710	210.0 ± 0.00	234.0 ± 0.500	193.0 ± 5.200	207.0 ± 5.100	234.0	193.0	208.50
Th (mg/L)	178.50 ± 0.00	263.0 ± 1.040	215.0 ± 0.050	197.0 ± 0.150	148.0 ± 3.060	263.0	148.0	200.30
Alkalinity (mg/L)	165.0 ± 0.210	121.0 ± 0.00	169.0 ± 0.800	179.0 ± 0.200	140.0 ± 1.380	179.0	121.0	154.80
Nitrate (mg/L)	0.180 ± 0.00	0.190 ± 0.020	0.230 ± 0.070	0.190 ± 0.00	0.170 ± 0.010	0.230	0.170	0.190
Phosphate (mg/L)	0.650 ± 0.050	0.250 ± 0.00	0.100 ± 0.00	0.580 ± 0.030	0.270 ± 0.010	0.650	0.10	0.370
Sulphate (mg/L)	22.0 ± 0.580	14.40 ± 0.350	23.0 ± 0.230	5.50 ± 0.030	4.40 ± 0.570	23.0	4.40	13.90
Fe (mg/L)	0.210 ± 0.0010	0.150 ± 0.0040	0.170 ± 00.20	0.280 ± 0.02	0.530 ± 00.030	0.530	0.150	0.270
Cu (mg/L)	0.090 ± 0.0020	0.100 ± 0.0010	0.100 ± 0.00	0.13 ± 0.00	0.110 ± 0.000	0.130	0.090	0.110
Pb (mg/L)	0.100 ± 0.0020	0.020 ± 0.0010	0.020 ± 0.00	0.080 ± 0.010	0.090 ± 0.0030	0.10	0.020	0.070
Mn (mg/L)	0.110 ± 0.00	0.050 ± 0.0020	0.040 ± 0.010	0.040 ± 0.00	0.070 ± 0.00	0.110	0.040	0.060
Zn (mg/L)	0.510 ± 0.0020	0.690 ± 0.0050	0.270 ± 0.030	0.380 ± 0.010	1.10 ± 0.0050	1.10	0.270	0.590

Table 4: *Measured groundwater quality among the sampling locations.*

Assessment of the groundwater quality using WQI

Water quality index data sets varied from 49 - 136 among the five sampling sites and were classified as excellent, fresh and poor water as observed in table 5. Three of them (60%) were categorized as "poor" while one of them (20%) was categorized as "good" and one of them (20%) was categorized as "very good water". Moreover, sampling sites S_1 and S_2 are described as poor water and expected to be unfit for usage. This would be due to floods, lack of effective source protection, insufficient treatment or the presence of anthropogenic contaminants within the sampling sites. The table also indicated high quality rating (qi) in many of the studied sites, concentration of lead (Pb) most notably which increased the water value sub index (Sli) and consequently to be reflected in the water quality index (WQI). This degradation of groundwater quality in Midre hagua town is mainly due to an increase in concentration of lead and high concentrations of salt, including total hardness, total alkalinity, and total dissolved solids as shown (Table 5).

Parameters	S1		S2		S3		S4		S5	
	Qi	SIi	Qi	SIi	Qi	SIi	Qi	SIi	Qi	SIi
Temp.	54.20	1.1540	51.280	1.9020	44.0	0.93720	60.0	1.2780	64.0	1.3630
P^H	104	8.850	108	9.191	105.3	8.961	105.3	8.961	110.7	9.4206
EC	0.03	0.0026	0.033	0.0028	0.035	0.0030	0.03	0.0026	0.035	0.0030
Turbidity	77.8	4.96	76	4.85	82	5.23	136	8.68	62	3.96
TDS	19.58	1.67	21	1.79	23.4	1.99	19.3	1.64	20.7	1.76
Th	35.7	2.28	52.6	3.36	43	2.74	39.4	2.51	29.6	1.89
Alkalinity	82.5	3.51	60.5	2.58	84.5	3.60	89.5	3.81	70	2.98
Nitrate	0.36	0.038	0.38	0.040	0.46	0.049	0.38	0.040	0.34	0.036
Phosphate	13	0.277	5	0.107	2	0.043	11.6	0.247	5.4	0.115
Sulphate	8.8	0.749	5..76	0.490	9.2	0.783	2.2	0.187	1.76	0.150
Fe	42	2.68	30	1.91	34	2.17	56	3.57	106	6.76
Cu	4.5	0.192	5	0.213	5	0.213	6.5	0.278	5.5	0.234
Pb	1000	106.4	200	21.28	200	21.28	800	85.12	900	95.76
Mn	27.5	2.34	12.5	1.06	10	0.851	10	0.851	17.5	1.49
Zn	12.75	0.543	17.25	0.735	6.75	0.288	9.5	0.405	27.5	1.17
∑(SIi)=WQI	136		50		49		118		127	
Water type	Poor		Good		Excellent		Poor		Poor	

Table 5: *The quality rating, sub index and WQI values of the studied under ground water for drinking purposes.*

For each water quality parameters, the effective weight values, for the five sampling sites were presented in table 6. From the table pH, lead and turbidity represent the highest effective ratio with a percentage weight 11.67, 62.58 and 6.92 in sequence and considered as the most effective parameters to determine the water quality index. The approximate weight of these three parameters also confirms this fact (Table 2). On the other hand, the effective weight values of the $NO3^-$, PO_4^{3-}, EC, SO_4^{2-}, Cu and Zn are low as to the other parameters. This observation was mainly due to the estimated concentration values of these parameters in the five sampling site were water very small as compared to their maximum WHO permissible values.

Parameters	Effective weight (%)								
	Sampling Sites					Max	Min	Mean	SD
	S1	S2	S3	S4	S5				
Temperature (°C)	0.85	3.84	1.91	1.15	1.07	3.84	0.85	1.76	1.09
P^H	6.52	18.56	18.24	7.62	7.41	18.58	6.52	11.67	5.50
EC (µS/Cm)	0.002	0.006	0.006	0.002	0.002	0.0065	0.002	0.004	0.002
Turbidity (NTU)	3.66	9.80	10.64	7.38	3.12	10.64	3.12	6.92	3.07
TDS (mg/L)	1.23	3.62	4.02	1.39	1.38	4.02	1.23	2.33	1.22
TH (mg/L)	1.68	6.79	5.58	2.13	1.49	6.79	1.49	3.53	2.21
Alkalinity (mg/l)	2.59	5.21	7.33	3.24	2.34	7.33	2.34	4.14	1.89
Nitrate (mg/L)	0.028	0.081	0.10	0.034	0.028	0.1	0.028	0.054	0.030
Phosphate (mg/L)	0.20	0.22	0.09	0.21	0.09	0.22	0.09	0.162	0.059
Sulphate (mg/L)	0.55	0.99	1.59	0.16	0.12	1.59	0.12	0.682	0.552
Fe (mg/L)	1.98	3.86	4.42	3.04	5.32	5.32	1.98	3.72	1.14
Cu (mg/L)	0.14	0.43	0.43	0.24	0.18	0.43	0.14	0.284	0.123
Pb (mg/L)	78.44	42.98	42.98	72.39	76.13	78.44	42.98	62.58	16.12
Mn (mg/L)	1.73	2.14	1.73	0.72	1.17	2.14	0.72	1.49	0.496
Zn (mg/L)	0.40	1.48	0.59	0.35	0.92	1.48	0.35	0.748	0.418

Table 6: *Summary statistics of effective weight values for each water quality parameter.*

Conclusion

Water is essential to life, and in order to maintain life, there should be an adequate quantity of clean drinking water. Therefore, it is crucial to regularly monitor or test the quality of drinking water before it is delivered to customers. The drinking water in Midre hagua town has a WQI of 96, which indicates a minor pollution level based on water quality tests. It has been classified as Class II, which means that conventional treatment is necessary before using the water source at the sample locations for drinking water.

The parameters that were clearly beyond the limit were lead and turbidity, both of which were higher than the WHO-approved threshold for drinking water. It is recommended that a particular study be carried out to investigate the reasons behind the increased Pb and turbidity concentrations in the water samples.

It is important to do routine testing on drinking water sources to identify their physicochemical characteristics, heavy metal content, and microbiological quality in order to prevent the spread of enteric illnesses and other associated health problems. It is important to inform residents about the widespread incidence of water-borne disease and how to prevent them.

Author's Contributions

Melese Damtew Asfaw and Werk Temare Asefa: Idea generation, Methodology, Investigation, Method Validation and funding acquisition, data analysis, Formal analysis, Conceptualization, Writing - original draft and editing, review and editing.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

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Conflicts of Interest

The author declares that there are no conflicts of interest.

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