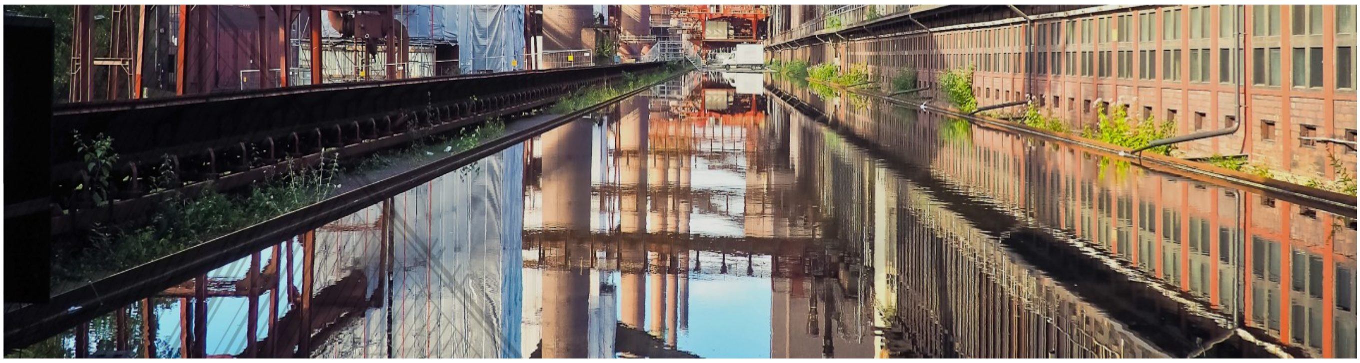
Determination of the pot ability of subsurface water by using Water Quality Index (WQI) method of different wells- A case study of East Wollega zone, Western Ethiopia.



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ABSTRACT

Water quality and human health are inextricable linked. . The present study assessed the water quality index (WQI) based on physicochemical analyzed of six subsurface water sampling stations of different wells in east Wollega zone. This has been determined based on the physico-chemical water sample analyzed during past time when the well-developed measured at the water works design and supervision Enterprise laboratory of Addis Ababa. For calculating the WQI, the following 12 parameters have been considered: pH, total hardness, calcium, magnesium, sodium, chloride, nitrate, sulphate, total dissolved solids, iron, manganese and fluorides. The WQI for these wells ranges from 8.484 to 372.2. The high value of WQI has been found to be mainly from the higher values of iron, nitrate, total dissolved solids, hardness, fluorides and manganese in the subsurface water. The results of analyses have been used to suggest models for predicting water quality. The analysis reveals that the some subsurface water of the area needs some degree of treatment before consumption, and it also needs to be protected from the perils of contamination. The computed WQI for point W_4' w_5 and w_6 indicates Excellent quality of water while the value of w_2 (67.1) falls within (51-75) of the classification of water quality based on weighted arithmetic WQI method. It is observed that falls in poor quality, indicating subsurface water not fit for drinking purpose. So it follows that untreated water from the Gulfa is poor quality and must therefore be treated before use to avoid water related diseases. The WQI for the well point W1 and w3 ranges above 100 that indicate unsuitable for drinking. We already concluded that the WQI method is a very effective tool for determining the quality of water susceptible to leachate pollution and communicating it in an unambiguous manner to the stakeholders in the water industry.

Keywords: Contamination, Parameters, Subsurface water, Water Quality Index, Weighted Arithmetic method.

I. INTRODUCTION

Water is one of the most important major natural resources of the ecosystem, necessary for human consumption, domestic services, agriculture, industry, manufacturing and other sectors. The quality of the subsurface water receivers is influenced by pollution of soil and air, industrial and domestic waste disposal, organic components, pathogenic microorganisms, application of fertilizers and pesticides in agriculture .The subsurface water quality is normally characterized by different physico-chemical characteristics. These parameters change widely due to the various types of pollution, seasonal fluctuation, subsurface water extraction, The nature of the rock formations, topography, soils, atmospheric precipitation, quality of the recharged water and subsurface geochemical process and affects subsurface water quality (Todd, D.K. 2005), (Fetter, C.W. 1998). Hence a continuous monitoring on subsurface water becomes mandatory in order to minimize the subsurface water pollution and have control on the pollution-caused agents. Water quality index is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers. It, thus, becomes an important parameter for the assessment and management of subsurface water.

WQI is defined as a rating reflecting the composite influence of different water quality parameters. The use of water quality index (WQI) in determining the quality of both surface and subsurface water bodies have increased tremendously since the initial WQI developed by (Horton, R. K.1965) and improved version by (Brown, R. K. et.al, 1970).

This is owing to the ability of WQI to provide a number, simple enough for the public to understand, that states the overall water quality at a certain location and time using the measured values of selected water quality parameters. In most cases, it is used to determine the pot ability of subsurface water. WQI is calculated from the point of view of the suitability of subsurface water for human consumption. Water quality index (WQI) is valuable and unique rating to depict the overall water quality status in a single term that is helpful for the selection of appropriate treatment technique to meet the concerned issues. Also, WQI depicts the composite influence of different water quality parameters and communicates water quality information to the public and legislative decision makers.

The objective of the study was to calculate the Water Quality Index (WQI) of six different wells in case of east Wollega zone in order to assess its suitability of subsurface water for drinking purposes. To determine the suitability of subsurface water for human consumption based on computed water quality index values for subsurface water of six different wells in study area. Calculate water quality index (WQI) by using the weighted arithmetic index method (WAWQIM) and compare measured values of the physic-chemical properties of water with standard permissible values.

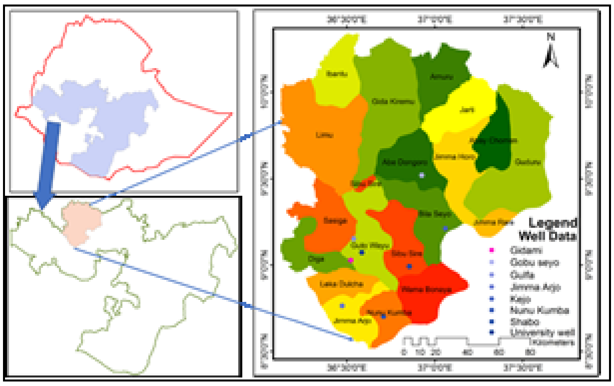
1.1 Location of the study area

The study area is located in East Wollega zone of Oromia regional state which is bounded in 036^0 00′00″ to 40^0 0′ 00″ longitude and 08^{0}0′00″ to 10^0 0′00″ latitude. According to the Ethiopian altitude climate relationship, the average elevation of these East Wollega Zone is around 2100m.MSL. It is connected to the capital city of the country by recent constructed asphalt road.

In this study, there are six different wells where selected. These wells are: Gidami, Gulfa, Shabo 2nd,Kejo, Birikas and Gobo wells.

Table 1: The location sites of the six wells

No	Well	X value or Longitude	Y value orLatitude
1	Gidami	0282346 **or**37°1′9″	1017637 **or**9°12′23″
2	Gulfa	0276849 **or**36°58′10″	1008228 **or**9°6′55″
3	Shabo 2nd	0274859 **or**36°30′40″	1006925 **or**9°0′45″
4	Kejo	0281303 **or**37°0°36″	1008842 **or**9°7′16″
5	Birikas	0275049 **or**36°40′00″	1001028 **0r**8°46′00″
6	Gobo	0272936 **0r**36°28′50″	1001124 **or**8°48′30″



"Figure:1" Map of the study area.

II. LITERATURE REVIEW

"Water is life", "Health is Wealth" and "Waste to Wealth" are popular sayings relating to life and wealth. Water is the most important natural resources of the ecosystem, having an important role for both drinking as well economic sectors. Subsurface water is one of the most important major natural resources necessary for human consumption, domestic services, agriculture, industry, manufacturing and other sectors (Alemayehu, T. 2006) The subsurface water quality is normally characterized by different physic-chemical characteristics. These parameters change widely due to the various types of pollution, seasonal fluctuation, subsurface water extraction, etc. Water quality index is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers. It, thus, becomes an important parameter for the assessment and management of subsurface water.

2.1 Concept of subsurface water quality

Water from beneath the ground has been exploited for domestic use, livestock and irrigation since the earliest times. Although the precise nature of its occurrence was not necessarily understood, successful methods of bringing the water to the surface have been developed and subsurface water use has grown consistently ever since. It is, however, common for the dominant role of subsurface water in the freshwater part of the hydrological cycle to be overlooked. Subsurface water is easily the most important component and constitutes about two thirds of the freshwater resources of the world and, if the polar ice caps and glaciers are not considered, subsurface water accounts for nearly all usable freshwater. Subsurface water quality as one of the most important aspects in water resource studies is largely controlled by discharge and recharges pattern, nature of host and associated rocks, and contaminated activities (Ackah, M. et al.2011). The nature of the rock formations, topography, soils, atmospheric precipitation, quality of the recharged water and subsurface geochemical process are some of the parameters affecting groundwater quality (Todd, D.K. 2005), (Fetter, C.W. 1998). Subsurface water quality has been deteriorating day by day because of shrinking water table, improper sanitation, introduction of chemical compounds, inefficient or less efficient irrigation practices, bad industrial waste management practices, and mixing of leachate being produced by indiscriminate disposal of industrial waste on land. The quality of the subsurface water receivers is influenced by pollution of soil and air, industrial and domestic waste disposal, organic components, pathogenic microorganisms, application of fertilizers and pesticides in agriculture.

2.2 Water Quality Index

WQI is well known method as well as one of the most effective tools to express water quality that offers a simple, stable, reproducible unit of measure and communicate information of water quality to the policy makers and concerned citizens. It thus, becomes an important parameter for the assessment and management of ground water (Chauhan, A. et. al, 2010) and (Akhter, T. et.al, 2016). The use of water quality index (WQI) in determining the quality of subsurface water bodies have increased tremendously since the initial WQI developed by (Horton, R. K.1965) and improved version by (Brown, R. K. et.al, 1970). This is owing to the ability of WQI to provide a number, simple enough for the public to understand, that states the overall water quality at a certain location and time using the measured values of selected water quality parameters. In most cases, it is used to determine the pot ability of subsurface water. The Water Quality Index represents a numerical expression that is used in the flowing water quality assessment in the United States of America, Canada, Spain, France, Germany, Austria, Italy, Poland and Turkey and has been widely applied and accepted in European, African and Asian countries. Starting with, (Horton, R. K.1965) proposes the first computation formula with the intention of promoting an index that would comprise all data necessary for the establishment of the subsurface water quality (Horton, R. K.1965). The basic methodology used in the establishment of the value classes of the Water Quality Index was described for the first time by the (EPA, 1979, 1980), it used various value intervals in order to set out the importance of each parameter in the computation of the index and, subsequently, it stipulated the establishment of a unique value that of the index (ARONER, E, 2002). The water quality class is defined depending on the values of the physical, chemical and biological parameters and the establishment of the quality before the usage is crucial for various purposes, such as: drinking water, water used in agriculture, water used for leisure (fishing, swimming), or water used in industry (Alemayehu, T. 2006).

2.3 Weighted Arithmetic Water Quality Index Method (WAWQIM)

A general WQI approach is based on the most common factors, which are described in the following two steps:

The calculation of the WQI was done using weighted arithmetic water quality index which was originally proposed by (Horton, R. K.1965) and developed by (Brown, R. K. et.al, 1970). The WQI, which is calculated using the weighted arithmetic index method (WAWQIM) is commonly used among researchers in developing countries where data collection infrastructure is not extensive for the database of the water quality parameters to be vast, and reliable rating curves are rare (Akhter, T. et.al, 2016). It is especially useful for determining the water quality at a place where data have been collected over a period of time for the specific purpose of determining the water quality. Weight arithmetic water index method classified the water quality according to the degree of purity, using the most commonly measured water quality variables, such as temperature, pH, turbidity, fecal coli form, dissolved oxygen, biochemical oxygen demand, total phosphates, nitrates and total solids.

The water quality data are recorded and transferred to a weighting curve chart, where a numerical value of WQI is obtained (Breabăn, I.G.et.al, 2012) by using the following equation:

$$\mathbf{WQI}=\frac{\sum_{i=1}^{n} qiwi}{\sum_{i=1}^{n} wi}$$

Where: qi=quality rating (sub index) of i^{th} water quality parameter.

WI= unit weight of i^{th} water quality parameter

III. MATERIALS AND METHODS

The water samples were collected from six different well locations of ($_{W1,W2,W3,W4,\ W5}$ and $_{W6}$), in the vicinity of the east Wollega zone. Water samples were collected randomly from six wells at different locations during well completion and were sent to the water works design and supervision Enterprise laboratory for physico-chemical analysis. The water physico-chemical parameter data is collected from six different wells (W1, W2, W3, W4, W5, and W6) in the vicinity of east Wollega zone water offices.

3.1 Water quality measurements

The physico- chemical characteristic of water samples have been determined according to the standard methods of (APHA, 1992) and (W.H.O.2008) standards methods .The concentration of calcium, magnesium, bicarbonate, chloride and total hardness determined by titri-metric method. Calcium and magnesium determined by EDTA titration, for $HCO_{3,}$ Hcl titration to a methyl orange point. Chloride also determined by titration with $AgNo_3$ solution. Flame emission photometry used for the determination of sodium and potassium. In this method water sample of the light emitted by a particular spectral line measured with the help of photoelectric cell and a galvanometer. Sulphate analyzed by gravimetric method. The concentration of nitrate and fluoride determine with the help of double beam U.V. spectrophotometer.

3.2 Calculation of WQI.

Water quality index (WQI) is valuable and unique rating to depict the overall water quality status in a single term that is helpful for the selection of appropriate treatment technique to meet the concerned issues. WQI is defined as the rating that reflects the composite influence of the different parameters. The WQI, which is calculated using the weighted arithmetic index method (WAWQIM), is commonly used among researchers in developing countries where data collection infrastructure is not extensive for the database of the water quality parameters to be vast, and reliable rating curves are rare.

➤ ***Weighted Arithmetic Water Quality Index Method*** *:*

Weighted arithmetic water quality index method classified the water quality according to the degree of purity by using the most commonly measured water quality variables. The method has been widely used by the various scientists, for calculating WQI, the sub index (SI) is first determined for each parameter, which is used to determine WQI as per the following equation:

$$\mathbf{WQI}=\frac{\sum_{i=1}^{n} qiwi}{\sum_{i=1}^{n} wi}$$

Where: qi=quality rating (sub index) of i^{th} water quality parameter.

wi= unit weight of i^th water quality parameter qi, which relates the value of the parameter in polluted water to the standard permissible value is obtained as follows:

According to (Brown, R. K. et.al, 1970), the value of qi is calculated using the following equation:

$$qi=100\left[\frac{(Vi-Vio)}{(Si-Vio)}\right]$$

Where, Vi= estimated (observed) value of the i^{th} parameter.

Vio= ideal value of the i^{th} parameter in pure water
Si= standard permissible value of the i^{th} parameter

All the ideal values (Vio) are taken as zero for drinking water except pH and dissolved oxygen (Sahu, B.K. et. al 1991). For pH, the ideal value is 7.0 (for natural/pure water) and a permissible value is 8.5 (for polluted water). Therefore, the quality rating for pH is calculated from the following equation:

$$qpH=100\left[\frac{(VPH-7)}{(8.5-7.0)}\right]$$

Where, = observed value of pH.

For dissolved oxygen, the ideal value is 14.6 mg/L and the standard permissible value for drinking water is 5 mg/L. Therefore, its quality rating is calculated from the following equation:

$$qDO=100\left[\frac{(VDO-14.6)}{(5-14.6)}\right]$$

WhereVDO = observed value of dissolved oxygen

The unit weight or Relative weight (wi) was calculated by a value which is inversely proportional to the recommended standard (si) of the corresponding parameter.

$$Wi=\frac{k}{Si} \quad \text{or} \quad Wi=\frac{\frac{1}{\sum\frac{1}{si}}}{si}$$

Where, K = proportionality constant and can also be calculated by using the following equation:

$$K=\frac{1}{\sum\frac{1}{si}}$$

The rating of the water quality using the above method is shown below table

Table 2: Rating of Water Quality for various WQI values (Brown, R. K. et.al, 1970)

WQI	Rating of water quality	Grading
0-25	Excellent	A
26-50	Good	B
51-75	Poor	C
76-100	Very poor	D
Above 100	Unsuitable for drinking	E

IV. RESULTS AND DISCUSSION

4.1 Results

Table 3: The Measured Values of the Water Quality Parameters and (W.H.O.2008) Guidelines .

Physico-chemical parameter water analyzed results								
Parameter	**Measured values**						**Ethiopian standard (mg/l)**	**WHO maximum allowable concentration (mg/l)**
	Well.1	**Well.2**	**Well.3**	**Well.4**	**Well 5**	**Well 6**		
	Gidami	**Gulfa**	**Shabo 2 nd**	**Kejo**	**Birikas .N**	**Gobo.J**		
T.D.S (mg/l)	260.00	200.00	310.00	160.00	394	174.78	1000	1000-is used for palatability
E.C us/cm	442.00	332.00	501.00	252.00	550	900.36	-	-
PH	6.95	7.11	6.20	6	7.28	6.25	6.5-8.5	6.5-8.5
Sodium (mg/l Na)	12	47	20.50	7.10	84	32.85	200.00	200.00
Potassium (mg/l K)	3.80	6.00	4.30	2.40	2.7	1.25	15	12
Total hardiness(mg/l $caco_3$)	216.00	89.30	230.00	126.00	174	210	300.00	500.00
Calcium (mg/l Ca)	41.60	15.20	56.00	29.60	32.8	14.7	75.00	200-Expressed as hardness
Magnesium (mg/l Mg)	26.88	12.31	21.60	12.48	22.08	8.025	50.00	150-Expressed as hardness
Iron (mg/l Fe)	0.09	0.11	0.75	0.25	0.08	0.23	0.3	0.3
Manganese (mg/l Mn)	0.14	0.08	0.44	Trace	Trace	Trace	0.5	0.1
Fluoride (mg/l F)	0.54	0.54	0.53	0.50	0.59	1.02	-	1.5
Chloride (mg/l Cl)	8.19	1.82	4.55	2.73	6.37	7.9	250.00	250.00
Nitrate (mg/l NO_3)	0.35	0.39	0.60	0.52	0.83	0.455	-	50.00
Carbonate (mg/l CO_3)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	-
Bicarbonate (mg/l HCO_3)	287.92	224.48	305.00	163.48	451.4	74.74	-	-
Sulphate (mg/l so_4)	9.42	1.55	36.01	17.51	0.1	1.505	250.00	250.00
Phosphate(mg/l po_4)	0.39	0.36	1.14	0.38	0.37	0.65	-	-
Total coliform per 100 ml	-	-	-	-	-	-	-	-
Fecal coliform per 100 ml	-	-	-	-	-	-	-	-

Source: *Water Mineral and Energy Department, East Wollega Zone; Nekemte; Ethiopia,*

The quality ratings, unit weights, standard permissible values, and the calculated WQI of the subsurface water of different wells are presented in Table 4. It is seen that the subsurface water in the wells in the vicinity of the different wells in east Wollega zone is classified as different groups

Table 4: Calculated Values of WQI

Parameter	Si	⅟si	Wi	W_1	W_2	W_3	W_4	W_5	W_6	W_1	W_2	W_3	W_4	W_5	W_6
				q_1	q_2	q_3	q_4	q_5	q_6	Wiqi	Wiqi	Wiqi	Wiqi	Wiqi	Wiqi
PH	8.5	0.12	0.008	3.33	7.33	53.3	66.7	18.7	50.0	0.027	0.059	0.34	0.534	0.15	0.4
Sodium	200	0.005	0.0004	6	23.5	10.25	3.55	42	16.425	0.024	0.094	0.041	0.014	0.168	0.066
Iron	0.3	3.3	0.2333	3	36.67	250	83.33	26.67	76.67	0.699	8.55	58.32	19.44	6.22	17.88
Manganese	0.1	10	0.7	140	80	440	Trace	Trace	Trace	98	56	308	Trace	Trace	Trace
Fluoride	1.5	0.66	0.047	36	36	35.33	33.33	39.33	68	1.69	1.69	1.66	1.566	1.85	3.19
Chloride	250	0.004	0.0003	3.27	0.73	1.82	1.09	2.55	3.16	0.00098	0.00011	0.0005	0.0003	0.0007	0.0009
Nitrate	50	0.022	0.0014	0.7	0.78	1.2	1.04	1.66	0.9	0.00098	0.001	0.0017	0.0015	0.0023	0.0013
Sulphate	250	0.004	0.0003	3.77	0.62	14.4	7.00	0.04	0.602	0.00113	0.00018	0.0043	0.002	$1.2e^{-5}$	0.0002
Calcium	200	0.005	0.0004	20.8	7.6	28	14.8	16.4	7.35	0.0083	0.003	0.0112	0.0059	0.0066	0.0029
Magnesium	150	0.0067	0.00047	17.9	8.2	14.4	8.32	14.7	5.35	0.0084	0.0038	0.0068	0.0039	0.0069	0.0025
Hardness	500	0.002	0.00014	43.2	17.86	46	25.2	34.8	42	0.006	0.0025	0.0064	0.0035	0.0049	0.0058
TDS	1000	0.001	$7.07e^{-5}$	26	20	31	16	39.4	17.48	0.0018	0.0014	0.00217	0.0011	0.0027	0.0012
	$K=\frac{1}{\Sigma\left(\frac{1}{si}\right)}=0.07$		$\sum wi=0.99$					$\sum wiqi$		100.46	66.41	368.48	21.57	8.4	21.55
								$WQI=\frac{\Sigma WiQi}{\Sigma Wi}$		101.47	67.08	372.2	21.78	8.484	21.76

4.2 Discussion

This study was done to check the water quality in different wells in case of east Wollega zone on assessment of drinking water. This has been determined based on the twelve physic-chemical parameter measurements of: pH, total hardness, calcium, magnesium, sodium, chloride, nitrate, sulphate, total dissolved solids, iron, manganese and fluorides.

4.4 Water Chemical Parameters

The most common chemical parameters of water: major cations (Na^+, $Mn^{2+,}$ Ca^{2+} and Mg^{2+}) and major anions (Cl^-, SO_4^{2-}, No_3^-) and in addition to Fe and F- which are naturally very variable due to local geological, climatic and geographical conditions have been determined.

- The analytical result of sodium concentration in the study area ranges from 7.1 mg/l to 84 mg/l. The value of sodium W.H.O has prescribed highest permissible limit of 200mg/l in drinking water. The concentration of sodium is observed under the permissible limit of in the study area in all the wells.
- The analytical result of calcium concentration in the study area ranges from 14.7mg/l to 56mg/l. The highest desirable limit of calcium in drinking water is 75 mg/l and maximum permissibility limit is 200 mg/l in drinking water. The value of calcium ranges under desirable limit of in the study area.
- The analytical results of magnesium concentration in the study area ranges from 8.025 mg/l to 26.88 mg/l. Magnesium deficiency is associated with structural functional changes in the study area.
- The Chloride concentration in the study area is ranges from 1.82mg/l to 8.19mg/l. this is less than' permissible limits, 250 mg/l.
- There is no wide variation of fluoride content in the study area, ranges between 0.5mg/l to 1.02 mg/l. The whole study area is showing under the permissible limits of drinking water standards.
- The nitrate content in ground water in study are varies from 0.35mg/l to 0.83 mg/l. it is observed that all wells are having under the permissible limit W.H.O of 50mg/l. Drinking water standard indicated no subsurface water pollution.
- The analytical results of sulfate slow concentration between 0.1 mg/l to 36.01mg/l in the study area. It is observed that all wells are having under the permissible limit W.H.O. The concentration limits of sulfate presided highest desirable limits of 200 mg/l and maximum permissible limit of 250 mg/l in drinking water.

Generally from the above physico-chemical parameter measurement results of table 5, both physical parameters: pH, TH and total dissolved solids (TDS) and chemical parameters : major cations (Na^+, $Mn^{2+,}$ Ca^{2+} and Mg^{2+}) and major anions (Cl^-, SO_4^{2-}, No_3^-) and in addition to Fe and F- are less than the world Standard Desirable limits.

But the concentration of manganese (Mn^{2+}) is greater than W.H.O standard permissible limits at well one and three. This indicates the subsurface water of this well is unsuitability for drinking purposes and human healthy.

4.5 Based on the above WQI calculation results

Water quality of any specific area or specific source can be assessed using physical, chemical and biological parameters. The values of these parameters are harmful for human health if they occurred more than defined limits. Therefore, the suitability of water sources for human consumption has been described in terms of Water quality index (WQI), which is one of the most effective ways to describe the quality of water. In this research, the computed value of WQI from table 5 ranges from 8.484 to 372.2.

The minimum value has been recorded from w_4, $w_5$and $w_6$that means 21.78, 8.48 and 21.76 respectively. While maximum value has been recorded from, w_1, w_2, and w_3 that means 101.47, 67.08 and 372.2 respectively. The computed WQI values of this are classified into three types according to shown above Table 2 water quality classifications. These classifications are excellent, poor and unsuitable for drinking.

The computed value of WQI for the wells of w_4, w_5 and w_6 indicates excellent quality of subsurface water because the computed WQI value falls less than 50.Whilethecomputed value of w_2 (67.1) falls within (51-75) of the classification of water quality based on weighted arithmetic WQI method as given in Table 2. It is observed that falls in poor quality, indicating subsurface water not fit for drinking purpose. So it follows that untreated water from the Gulfa is poor quality and must therefore be treated before use to avoid water related diseases. The WQI for the well point w_1 and w_3 ranges above 100 that indicates that unsuitable for drinking. So, the wells those of Gidami and shebo 2nd are already avoid for drinking purpose because its quality is unsuitable for drinking and developing another well rather than treating this well for fitting drinking purpose.

In general, the average value of WQI for the subsurface water of the three excellent well is 17.34. This indicates that the quality of water is excellent while the calculated value of subsurface water wells of Gulfa falls in poor quality, indicating subsurface water not fit for drinking purpose. Only three subsurface water wells have excellent water quality and good for drinking purpose. The high value of WQI has been found due to Magnesium, sulphate and manganese in subsurface water. The higher values of Total Solids, Total hardness and alkalinity are due to mixing of sewage and leaching from waste sight. All these factors may pose health hazard on long term and can degrade quality of drinking water, therefore required to be treated for drinking purpose.

V. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The use of the Water Quality Index in the determination of the water quality on the different wells in east Wollega zone corresponds to the present tendencies within the field of water resources management; thus, it is attempted at a more important scale to assign chemical and ecological importance to the classical parameters related to the physical and chemical quality. The advantages of using this method were numerous, given the fact that the Water Quality Index:

- includes more variables in only one number;
- brings to the same measuring unit more parameters related to the water quality;
- offers the possibility to compare in temporal and spatial terms the quality of more water bodies or that of a single one;
- Offers an image of the water usage degree is various fields/purposes.

This study has shown that WQI is a powerful, yet a simple tool, that can be used to accurately determine the quality of subsurface water. Whereas the quality of subsurface water of East Wollega zone in the vicinity of different wells is determined by this methods and three wells are excellent, those gets A grades , one well is poor it get C grades and two wells are unsuitable for drinking purpose those gets E grades.

5.2 Recommendation

- Some required minerals are under the desirable limits but for human life the need of these minerals are not meeting in the permissible limits, hence the concentration of the minerals should be added up to permissible limits as per W.H.O standards for the human health.
- The essential minerals are should be added to the desirable limits in the ground water to improve the quality for the drinking purpose.
- The wells those of Gidami and shebo 2nd are already avoid for drinking purpose because its quality is unsuitable for drinking and developing another well rather than treating this well for fitting drinking purpose, However for Gulufa well its quality is poor but it's better to treating rather than developing another well for drinking purpose and the three wells Birikas, Gobo and Kejo those have excellent quality so keep it as it is and use it drinking purpose.
- The national and international agencies can help the improvement of the subsurface water quality those wells unsuitable for drinking.

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