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Physico-chemical analysis of surface and ground water quality of Meriema Village, Kohima

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Abstract: *The water quality assessment was conducted in Meriema Village, Kohima, Nagaland, The study region under consideration is located in Chiephobozou Tehsil of Kohima district in Nagaland situated 21km away from sub-district headquarter Chiephobozou and 5km away from district headquarter of Kohima. Water has become a necessity for all sources of life. Growing population, accelerating industrialization and urbanization exert heavy pressure on the vast but limited water resources and thus leading to the deterioration of good quality of water resulting in water pollution. So there was a necessity to test the ground and surface water pollutants. Clean plastics bottles were used to collect samples in various locations. The collected samples were analyzed for their physiochemical parameters – pH, temperature, T.D.S, total hardness, Calcium, Magnesium, Electrical conductivity and Dissolved Oxygen.*

Keywords*: water quality, ground water, surface water, physiochemical parameters.*

I. Introduction

Water is appraised as a necessary resource and life preservative. It is required for most human activities like – drinking, cooking, bathing, washing, agricultural, industry, recreation, and fisheries etc. About 75% of the world's surface area is covered with water. Out of which 97% of the earth's water is in the ocean, not fit for human use due to its high salt content. Remaining 2% is locked in polar ice caps and only 1% is available as fresh water in rivers, lakes, streams, reservoirs and ground water, suitable for human consumption. Now-a-days, water quality issues have become a significant concern due to the growth of human population, urban expansion and technological development. Water can be easily contaminated in different ways through unregulated or regulated but not well designed and monitored disposal practices [1]. Human activities interfere in many ways with natural water cycle and affect the society water relationship. Constant increase of human population and its expectation regarding the standard of living increase demands on exploitation of existing resources including water [2]. According to the scientists of National Environmental Engineering Research Institute, Nagpur, India, about 70 % of the available water in India is polluted.

Water remains one of the most poorly managed resources on earth. Division of types of water according to their occurrence reflects only the instantaneous state and location while the real state and its dynamics in nature is not considered. Upon contact with soil, the rain water becomes surface water and after soaking it may be called groundwater. Thus insufficient protection of surface water against contamination with human and animal wastes may cause major water supply problems [3].

In the state of Nagaland, the predominant sources of water are surface water from rivers, streams, ponds and natural springs and subsurface water occurring as ground water. Information of water quality in Nagaland is very scanty, as there is very little documentation on the state of rivers/ water bodies and thus monitoring is a very recent phenomenon and so far has been taken up on a very limited basis [4].

1.1. Water Pollution and types of water pollutants

Water pollution occurs when energy and other materials are released, degrading the quality of the water for other users. Water pollution includes all of the wastes materials that cannot be broken down by water.

There are two main sources of water pollutants: point sources and non-point sources. Point sources include wastewater treatment facilities, septic systems and other sources that are clearly discharging pollutants into water sources. Non-point sources are more difficult to identify, because they cannot be tracked back to a particular location. Non-point sources include runoff including sediments, fertilizers, chemicals, and animal wastes from farms, fields, construction sites. Landfills can also be a non-point source of pollution, if substances leach from the landfill into water supplies [5].

1.2 Study Area:

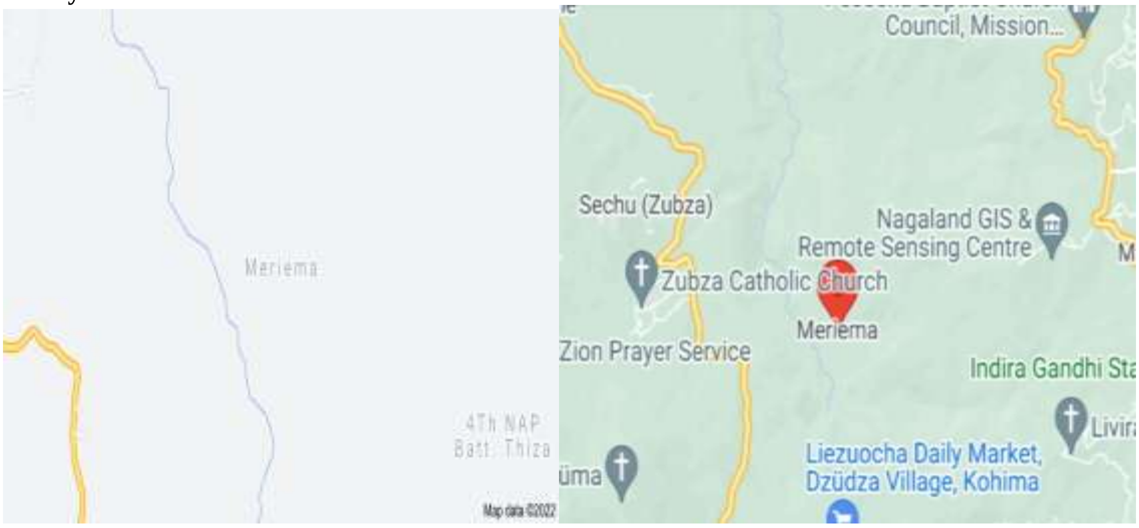

Fig.1: Map of Mereiema Village

Meriema is a medium size village with latitude of 25.7070°N and longitude of 94.0569°E located in Chiephobozou Circle of Kohima district, Nagaland with total 239 families residing. The approximate distance between Meriema and Kohima is 7kms or 4.3 miles. Meriema village has population of 1233 of which 576 are males while 657 are females as per Population Census 2011. Expected Meriema population of 2020/2021 is between 1,196 and 1,356.

Literate people are 860 out of it 443 are male and 417 are female. People living in Meriema depend on multiple skills, total workers are 555 out of which men are 264 and women are 291. Cultivators are depended on agricultural farming out of 121 are cultivated by men and 172 are women [6].

Table 1: Meriema Populations.

Population (2020/2021)	1,196-1356
Population (2011)	1233
Males	576
Females	657
Households	239


Fig.2. Image of Tsakou site1


Fig.3. Image of Tsakou site2

Fig.4. Image of Vütsa site1

Fig.5. Image of Dzüdza

Fig.6. Image of Hienuorü

Fig.7. Image of Vürü

Fig.8. Image of Basa site 1

Fig.9. Image of Basa site2

Fig.10. Image of Vütsa site2

Fig.11. Image of Basa site3

II. Methods and Methodology

Water sampling procedure and analysis

The water samples collected were analyzed for various parameters like Temperature, pH, Total Dissolved Solids (TDS), Total Hardness, Calcium, Magnesium, Chloride, Electrical Conductivity and Dissolved Oxygen.

Clean plastic bottles of 500ml capacity were used to collect the water samples. Each bottle was washed/rinsed with the water to be sampled for at least two to three times, and then filled with water samples leaving no air space. The bottles were labeled to prevent sample misidentification and were preserved in a clean place.

Table 2: Details of sampling locations

Sample No.	Sample Location	Type of water
1	Tsakou site 1	Surface water
2	Tsakou site 2	Ground water
3	Vütsa site 1	Surface water
4	Dzüdza	Surface water
5	Hienuorü	Surface water
6	Vürü rü	Surface water
7	Basa site1	Ground water
8	Basa site 2	Ground water
9	Vütsa site 2	Ground water
10	Basa site 3	Ground water

Table 3: Methods of analysis

Parameters	Method of determination
pH	pH meter
conductivity	Conductometry
Total Dissolved Solids	Evaporation
Total Hardness	EDTA -Titrimetry
Calcium	EDTA -Titrimetry
Magnesium	EDTA -Titrimetry
Chloride	Titrimetry
Dissolved Oxygen	Titrimetry

Field Measurements:

- Temperature: measured at the sample collection with a good digital thermometer (MAXTECH DT-9).
- Electrical Conductivity: Values are estimated by using calibrated conductivity cell (LABMAN- LMCM-20 – direct reading).
- pH: should be measured within 2hours of sample collection as the pH of the sample can change due to carbon dioxide from the air dissolving in the water sample. Values are determined by using standardized pH meter (AQUASOL-AM-P-PH).

Table 4: Drinking water quality standards as recommended by BIS and WHO

Parameters	BIS Standards		WHO Standards
	Desirable	Max. Permissible	
pH	6.5-8.5	6.5-8.5	6.5-9.2
TDS	300	500	500
Total Hardness	300	600	300
Calcium	75	200	100
Magnesium	30	100	150
Chloride	250	1000	250
DO	4.0 to 6.0	-	-
EC	-	-	2500

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Table 5: Values of various parameters at different sampling sites

Sampling Site	pH	Temp.	EC	TDS mg/l	TH mg/l	Ca mg/l	Mg mg/l	Cl mg/l	DO
Tsakou site 1	7.9	28.5°C	118.4	11.72	80	16.03	9.74	36.92	4.73
Tsakou site 2	6.9	19.9°C	264	11.64	90	28.05	4.87	49.7	1.57
Vütsa site1	5.3	22.1°C	122	11.92	60	16.03	4.87	31.24	4.46
Dzüdza	6	26.3°C	213	13.08	90	24.04	7.30	25.56	5.88
Hienuorü	6.2	24.9°C	470	12.36	220	48.09	24.36	21.3	4.73
Vürü rü	6.6	26.5°C	509	12.08	240	43.28	32.16	18.46	5.31
Basa site 1	5.5	17.7°C	172.1	15.24	90	19.23	10.23	25.56	1.73

Basa site2	6	20.8℃	218	10.84	120	34.46	8.28	22.72	3.15
Vütsa site 2	6.3	19.9℃	248	16.08	480	25.65	25.45	28.4	2.89
Basa site 3	5.9	20℃	319	9.84	206	38.47	26.80	38.34	2.73

III. Results and Discussion

pH: It is a measure of how acidic or basic water is. The range goes from 0-14, with 7 being neutral. A pH of less than 7 indicates acidity, whereas a pH of greater than 7 indicates a base [7]. In most natural water, pH is controlled by the carbon dioxide-bicarbonate- equilibrium system. An increased carbon dioxide concentration will therefore lower pH, whereas a decrease will cause it to rise [8].

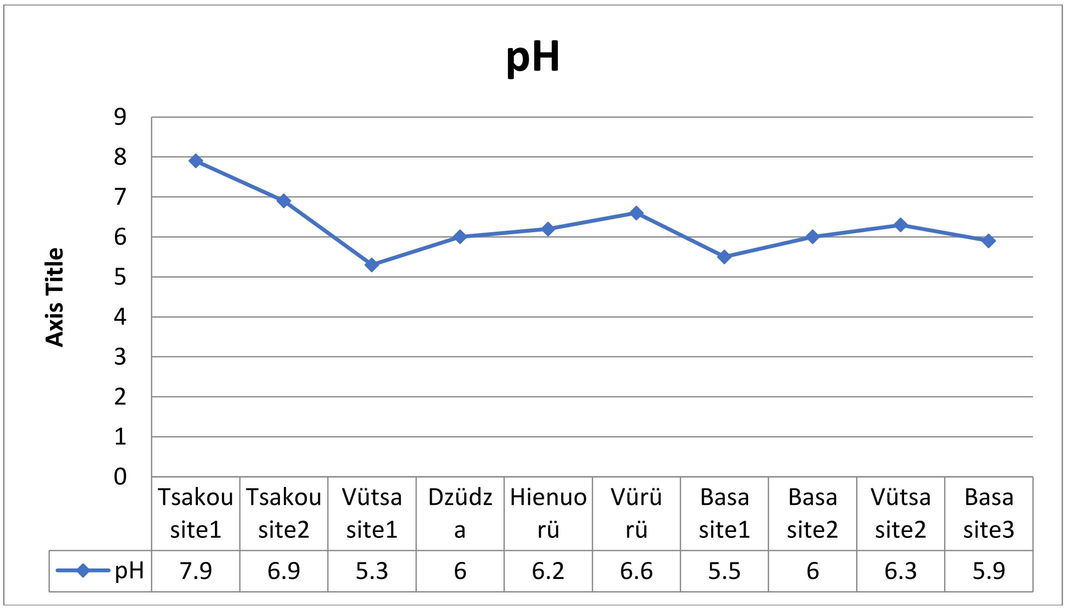

Fig.12. Variation of pH in different water samples.

From the graph, we observe that there are no uniform variations of the samples. This may be attributed to the carbonate-bicarbonate water abundantly found in the soil. It is also observed that only Tsakou site2 and Vürü fulfills the desirable limits set by the BIS and WHO standards.

Electrical Conductivity: EC measures the ability for a material to transmit an electrical current over a certain distance. EC of water is determined by the concentration of ions present in it. More the concentration of ions in the sa mple, more is its conductivity [9]. Conductivity is represented in microSiemens (µS/cm) in water analysis.

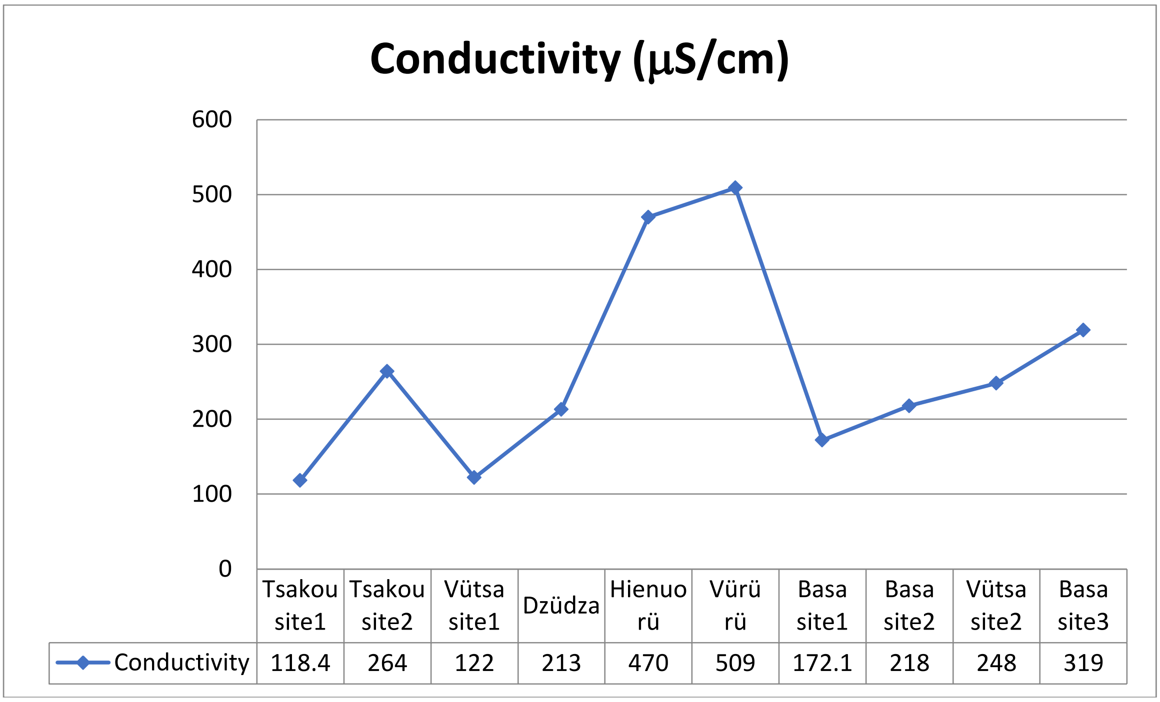

Fig.13. Variation of conductivity in different water samples.

It is observed that the values obtained ranges from 118 - 509 µS/cm, which are all within the permissible limits set by the WHO Standards.

Total Dissolved Solids: TDS is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The principle constituents are usually calcium, magnesium, sodium and potassium cations and carbonate, hydrogencarbonate, chloride, sulfate and nitrate anions [10]. TDS is expressed in mg/L. TDS is not generally considered a primary pollutant (e.g. it is not deemed to be associated with health effects). It is used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of the presence of a broad array of chemical contaminants.

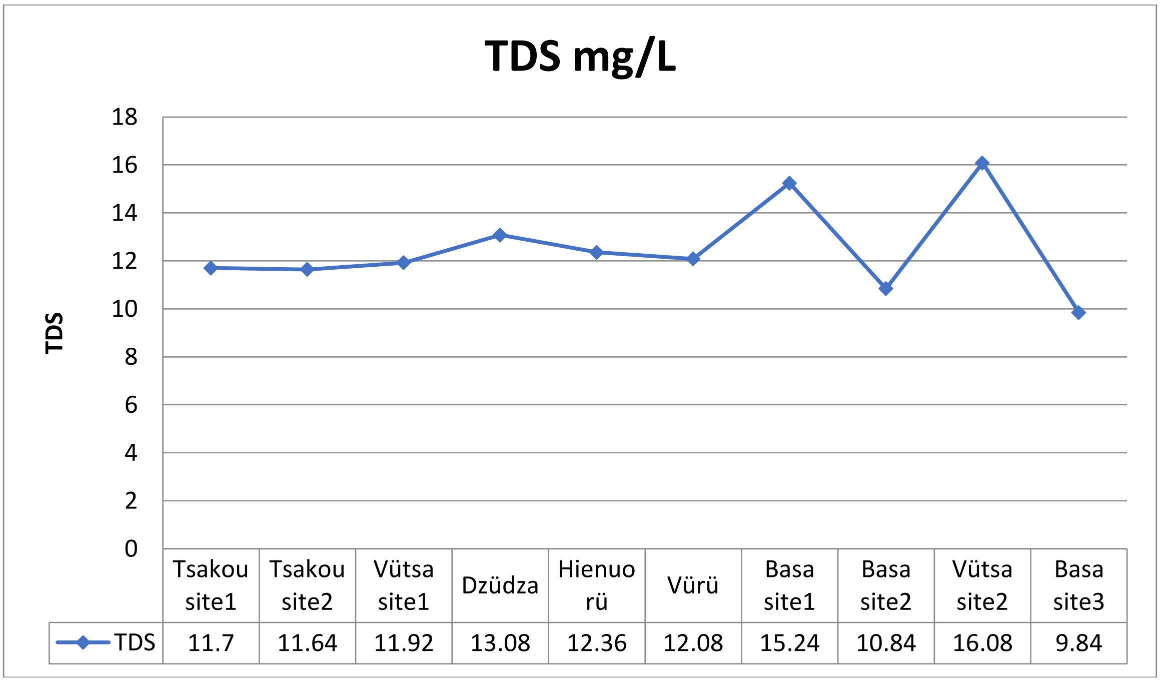

Fig.14. Variation of TDS in different water samples.

The Bureau of Indian Standards has set the acceptable limit of TDS in drinking water at 500 mg/L. The BIS report also mentions that if TDS is higher than 500 mg/L then this may result in a decrease in palatability (acceptable taste) and may cause gastrointestinal irritation [11]. In the present study the TDS values varied from 9.84 to 16.08 mg/L. As such since all the values are less than 50, it is not acceptable and suitable for drinking purposes as water with low TDS level does not contain the essential minerals.

Total hardness: Total hardness is determined by the concentration of multivalent cations in water (Mg^{2+} and Ca^{+}). Hardness is most commonly expressed as milligrams of calcium carbonate equivalent per litre. Water containing calcium carbonate at concentrations below 60 mg/L is generally considered as soft; 60-120 mg/L moderately hard; 120-180 mg/L hard and more than 180 mg/L very hard [12].

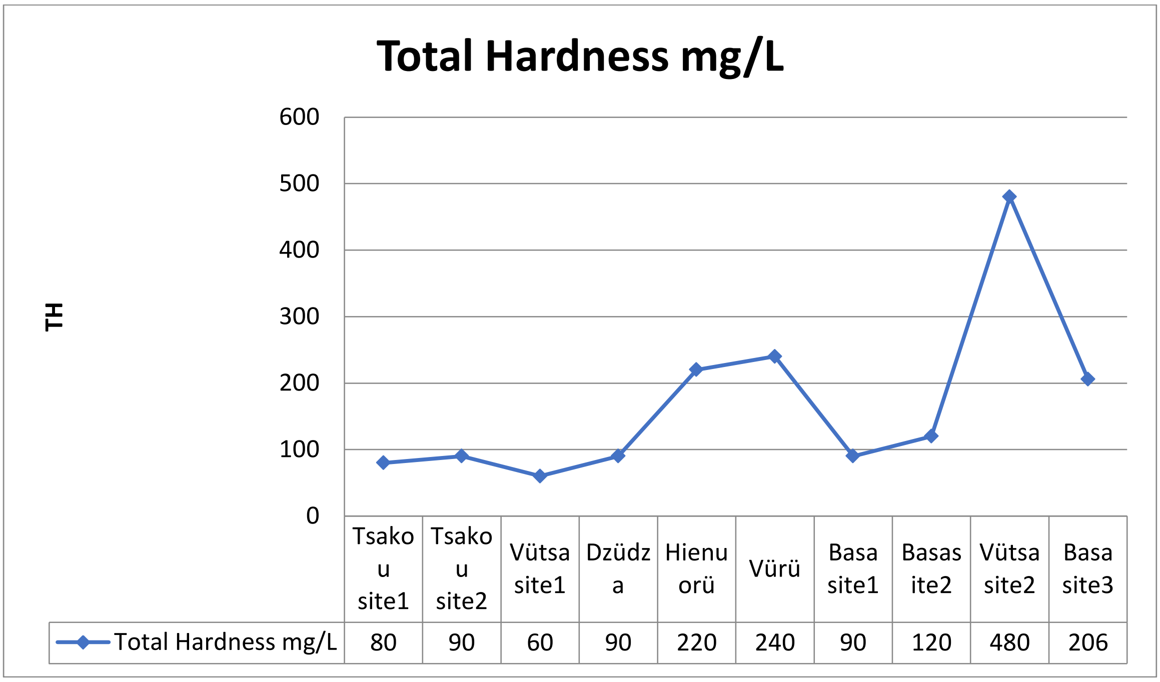

Fig.15. Variation of Total hardness in different water samples.

Hardness can pose a potential problem if it is too high or too low. If the water hardness is too low, such as <50 mg/L, the water may be corrosive to metal piping, fixtures and appliances. If the hardness is high, it is possible for the multivalent cations to react with the carbonates in the water to produce chemical precipitates or “soap scum” [13]. The total hardness for the samples under study were found to vary between moderately hard and hard category with their hardness values in the range of 60-480 mg/L. Though all the values are within the permissible limits, the water samples may be utilized only for domestic purposes excluding the water sample for Vütsa site 2.

Calcium: Calcium occurs in water naturally where it usually comes from leaching of rocks. One of the main reasons for the abundance of calcium in water is its natural occurrence in the earth's crust. Calcium is an important determination of water hardness, and it also functions as a pH stabilizer, because of its buffering qualities. Calcium is largely responsible for water hardness. Hard water may assist in strengthening bones and teeth because of its high calcium concentration. Calcium carbonate has a positive effect on lead water pipes, because it forms a protective lead (II) carbonate coating. This prevents lead from dissolving in drinking water, and thereby prevents it from entering the human body [4].

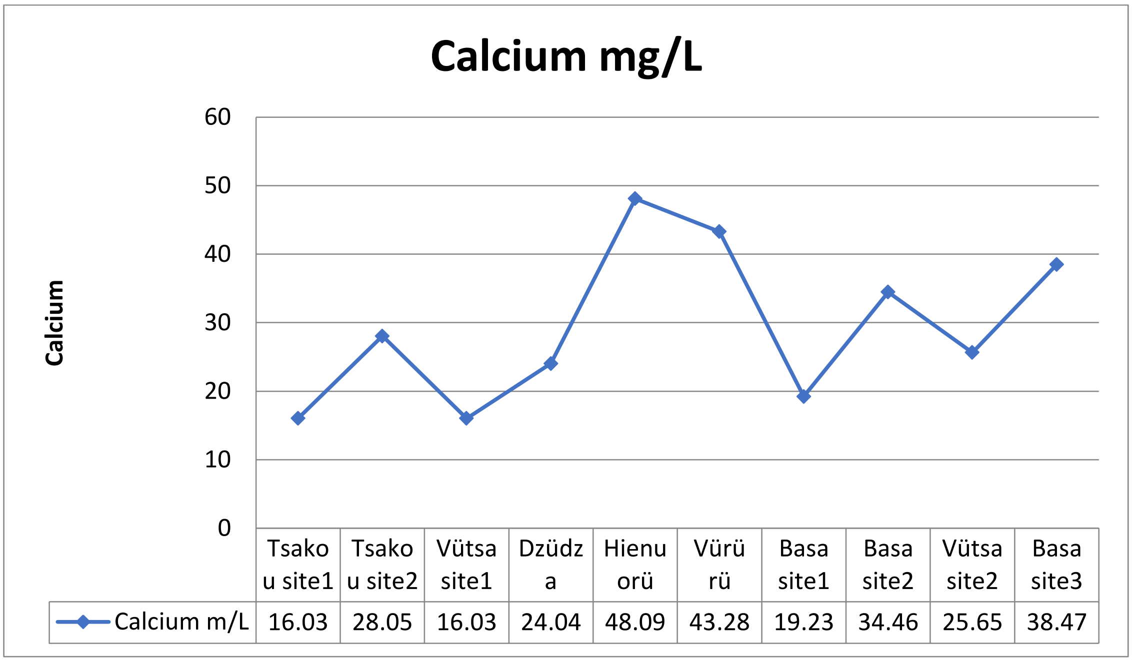

Fig.16. Variation of Calcium in different water samples.

A level of 75 mg/L is recommended as the upper limit for drinking water (BIS). High levels are not considered a health concern. For calcium, the samples under study were found to vary between moderately hard and hard category with their values ranging from 16.03 to 48.9 mg/L.

Magnesium: Magnesium is also present with calcium in natural water albeit in lower concentration than calcium. Large number of minerals contains magnesium where it is washed from rocks and subsequently ends up in water. Both magnesium and calcium are responsible for water hardness [4].

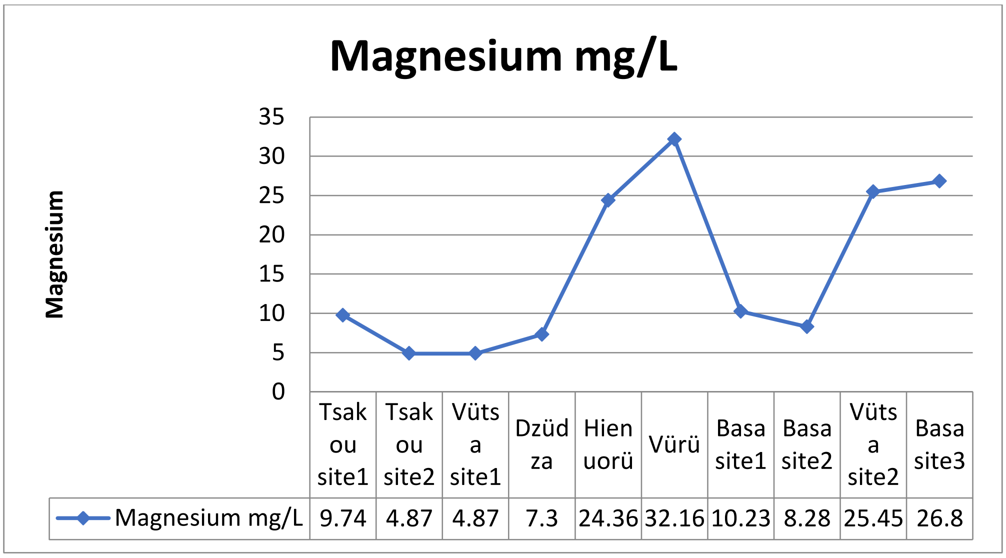

Fig.17. Variation of Magnesium in different water samples.

A level of 30 mg/L is recommended as the upper limit for drinking water (BIS). For magnesium, the samples under study were found to vary between moderately hard and hard category with their values in the range of 7.3 to 32.36 mg/L.

Chloride: Chlorides are widely distributed in nature as salts of sodium (NaCl), potassium (KCl), and calcium ($CaCl_2$). Chlorides are a naturally occurring element that is common in most natural waters and is often found as a component of salt (sodium chloride). Chloride increases the electrical conductivity of water and thus increases its corrosivity. In metal pipes, chloride reacts with metal ions to form soluble salts, thus increasing levels of metals in drinking-water [15].

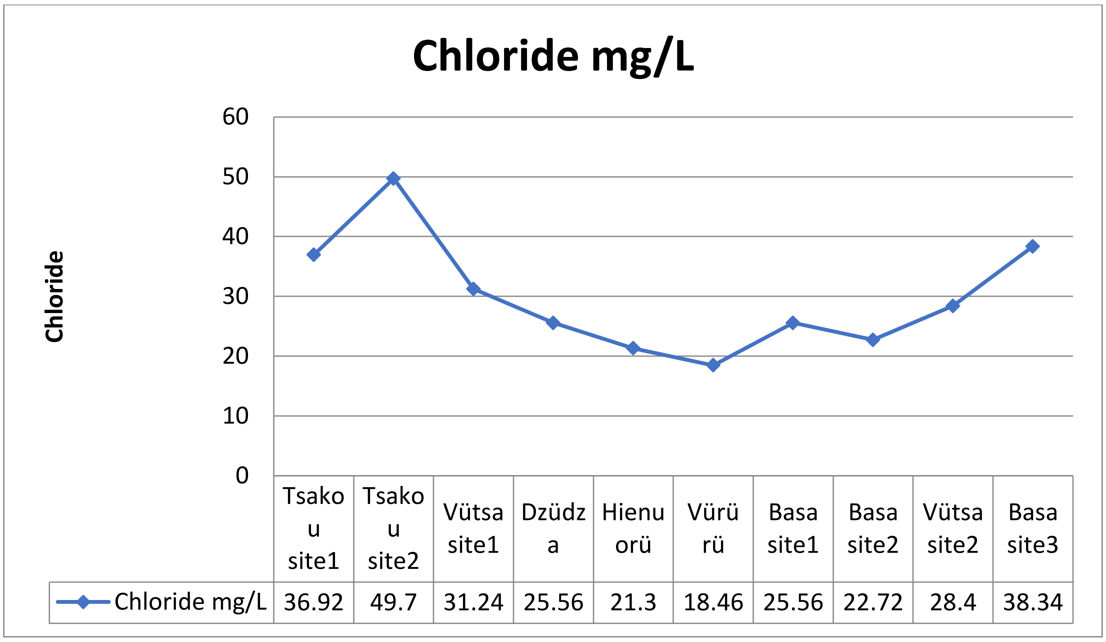

Fig.18. Variation of Chloride in different water samples.

Chloride is generally not considered a health risk but at relatively low concentrations the ion in drinking water can affect its taste, however, a high chloride intake can result in high levels of chloride in bloodstream i.e., hyperchloremia. In the study area, the chloride concentration ranged from 18.46 to 49.7 mg/l.

Dissolved Oxygen: DO is the amount of oxygen present in water. DO is considered as an important measure of water quality as it a direct indicator of an aquatic resource's ability to support aquatic life. While each organism has its own DO tolerance range, generally, DO levels below 3 mg/L are of concern and waters with levels below 1 mg/L are considered hypoxic and usually devoid of life [14].

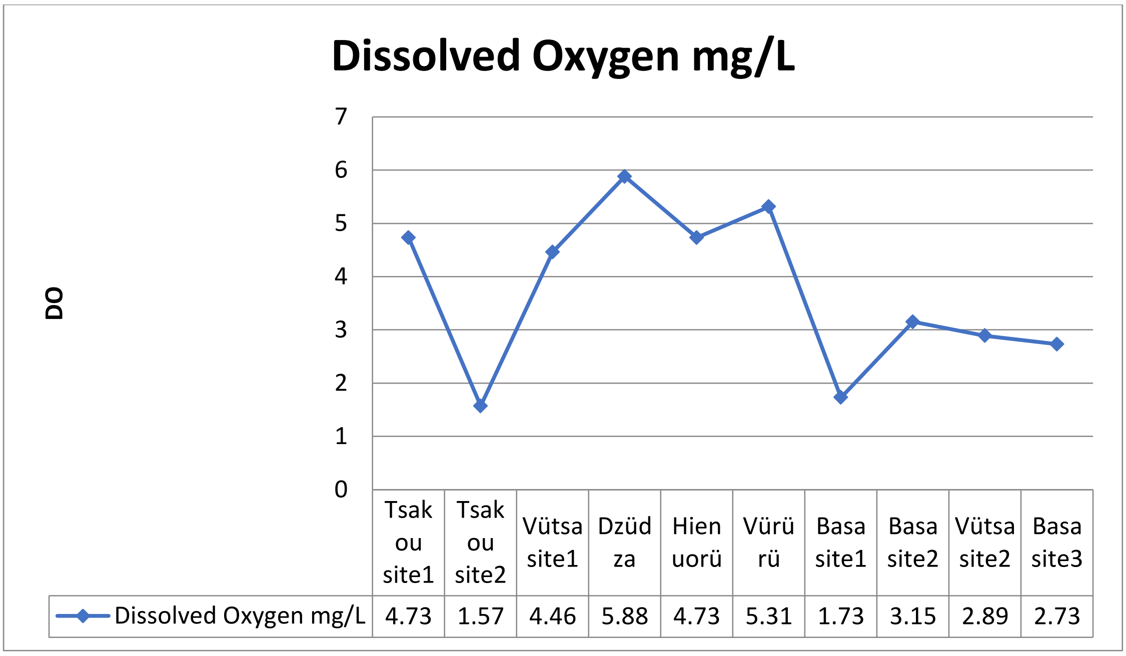

Fig.19. Variation of DO in different water samples.

The amount of dissolved oxygen in water is largely dependent upon the water temperature; colder water can carry more dissolved oxygen than warmer water [14]. Dissolved oxygen can be expressed either as a concentration (in mg/L), which is an absolute value, or as percentage saturation, which is an expression of the proportion of dissolved oxygen in the water relative to the maximum concentration of oxygen that water at a particular temperature, pressure, and salinity can dissolve [16]. In the present study, except for Tsakou site2, basa site1, basa site2, Vütsa site2, Basa site3, the DO value ranges within the permissible limit as per BIS standards. DO content of the water sample ranged from 1.57 to 5.88 mg/L. High temperature may be responsible for the low value of DO.

IV. Conclusion

The present study was conducted to assess the physiocochemical properties of surface and ground water collected from 10 different sampling sites in Meriema Village and the data were compared with BIS and WHO standards. The pH ranged from 5.3 to 7.9. EC, TDS, calcium, magnesium and chloride ranged from 118-509 µS/cm, 9.84-16.08 mg/L, 16.03- 48.9 mg/L, 7.3- 32.36 mg/l and 18.46- 49.7 mg/L respectively. Hardness ranged from 60- 480 mg/L, which can be stated that the water samples studied were hard. Do was in the range of 1.57 to 58.88 mg/L (Since DO was tested after 72 hours; the low level of DO may be contributed to this reason). Hence, based on the data analysis, the water samples are not suitable for consumptions but can be utilized for certain domestic purposes. Thus, it can be concluded that the water samples analyzed does not pose hazardous threat to the human health. However, it is recommended that proper planning and monitoring of the water quality should be executed and people awareness campaigning should be organized/ implemented by the government and non-government organization, in order to maintain the quality of the water.

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