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Evaluation of Physicochemical Parameters of Groundwater Atmicheweni District, Pemba – Zanzibar, Tanzania

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Abstract
This paper deals with analyzing the physicochemical parameters of groundwater from different locations of the Micheweni district found in Pemba – Zanzibar Tanzania. The physicochemical parameters of groundwater samples were analyzed to determine their quality and suitability for people's usage. The physicochemical parameters that were analyzed were temperature, total dissolved solids (TDS), pH, electric conductivity (EC), salinity, chlorine ion, total iron, phosphorus reactivity, nitrate, nitrite, and total hardness (TH). According to the result, it seemed that some parameters such as pH and EC were within the permissible level of the World Health Organization (WHO), others like Cl_2, NO_3, and TH were below the permissible limit and TDSwas above the permissible limit.

Keywords: Physicochemical Parameters, Groundwater, BOD, TDS, Conductivity, Ph and Salinity

Introduction
Water is acritically important source for the living organisms for both aquatic and terrestrial organisms. In general, water is derived from a variety of sources, depending on the availability of surface water Example Rivers, lakes, reservoirs, and ponds, and ground water example aquifers [1]. Groundwater is used in different areasof the world for development purposes, this means that it is used for the domestic purpose, industry development as well as for irrigation process.Those sectors, need water to be quality, but the water quality can be affected by various factors such as pollution, industrial activities, anthropogenic parameters such as geological factors, drought and population growth, and urbanization [2-4]. The pollution factor comes from different sources like industrial sewage rubber factories, and mining operations. On the other hand, the water quality decreases through farming processes like the excess usage of chemical fertilizer where by leeching process will occur, and road construction [5]. In general, there are different Physico-chemical parameters used for determining the quality of water among them are biochemical oxygen demand (BOD), chemical oxygen demand (COD), turbidity of the water, dissolved oxygen (DO), suspended solid (SS), pH, conductivity, temperature, acidity as well as alkalinity [4]. These parameters make water to be good for domestic purposes as well as for industrial purposes. Other scholars report that the physicochemical parameters within the same location vary seasonally and in geographical areas [6,7]. For the variations bring the physical-chemical parameter also to be different. Therefore,the results of the researchers indicate that good water quality conditions were critical during the dry season [8].

The Micheweni district which is available at Pemba Island is indeed surrounded by different geographical areas. Some of the areas in this district are participating in mining activities which is one of the factors affecting the water quality and others are not concerned with this activity but are concerned with agriculture only. Therefore, there is a need to researchto determine the amount ofphysic-chemical parameters of water. This can help understandthe quality of water whereby people in suchareas use for different purposes. Hence this research aimedto analyze of physic-chemical parameters of groundwater by comparing them with world standards.

Materials and Methods

Description of the Study Area

Micheweni district is located in the north region of Pemba Island. Whereby, this region is comprised of two districts, that is Wete and Micheweni districts. The location of this district in the Global Positioning System (GPS) is about -4° 58' 0.01" S and 39° 49' 59.99" E latitude and longitude respectively.The sample within that district was collected in different villages such as Kiuyu, Sizini, Micheweni, Wingwi mapofu, Tumbe, Msuka and Finya. From this location, twelve samples were collected from tap water and a wellholeto analyze water quality. Figure 1 shows the map of Pemba Island and Micheweni district that identifies the location where the water samples were collected.

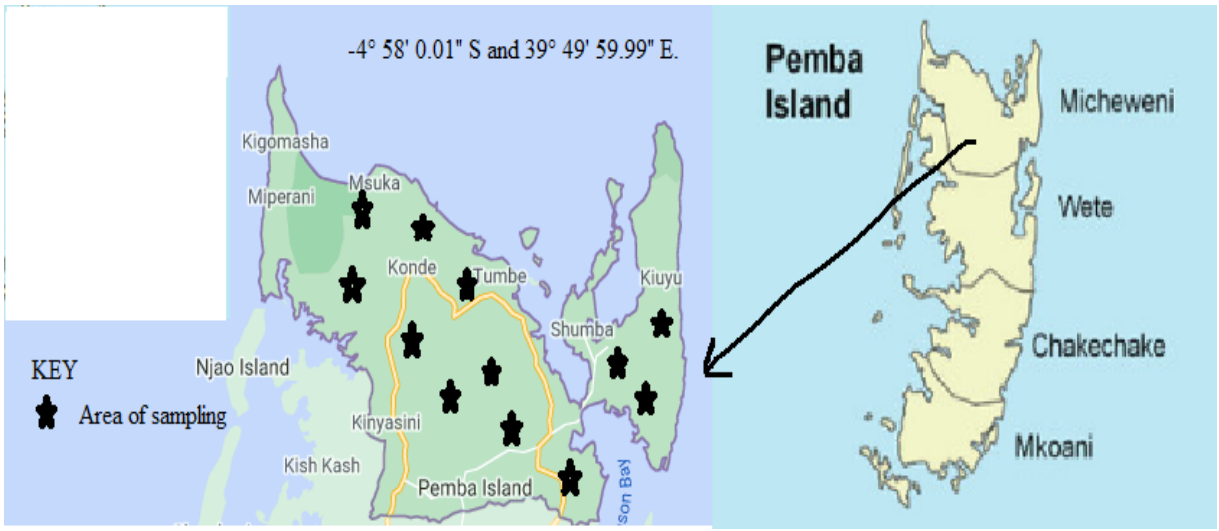

Figure 1: Map of Micheweni District with Sampling Area

Methods

In this study, the methods used for the estimation and identification of various physicochemical parameters shown in the table below:

S.No.	Parameter	Methods
1	pH	pH meter (Elico Make)
2	Electrical Conductivity	Conductivity meter (Elico)
3	Total Hardness	Strip
4	Salinity	Conductivity meter
5	TDS	Conductivity meter
6	Free and total Chlorine	PDP or Accu Vac Ampuls
7	Nitrate	Cadmium reduction
8	Iron	Ferro Ver or Accu Vac Ampuls
9	Temperature	pH metre
10	Phosphorous	Ascobic acid or Phos Ver 3
11	Nitrite	Diazotizatio

Table 1: Methods for Estimation of Physic-Chemical Parameters

Sampling Collection

About 12 groundwater samples were collected from the sampling point of Micheweni district. Out of the collected samples, 8 were from the wellhole, and 4 were from the water tap supplied by Zanzibar Water Authority (ZAWA) from different sources. The collection of samples was performed using plastic bottles. During the time of collection, the temperature, salinity, total dissolved solid (TDS),electrical conductivity,and pH of the sample were determined immediately after the collection of samples. After that, the samples were stored in the ice box for further analysis in the laboratory [9].

Water Analysis

The collected water samples were stored in an ice box, and delivered on the same day to the laboratory (Public Health Laboratory (PHL). The pH meter was switched on and then press stabilization button and waited for a few seconds until the alarm shouted out. Thereafter, the pH electrodes were immersed into the beaker which contains a sample of water, and then allowed to read the pH and the temperature simultaneously.

The conductivity meter (Elico) was switched on, and then the stabilization button was pressed and waited for a few seconds until the alarm shot out. Subsequently, the terminal wires of the conductivity meter were immersed in water samples. Then the programs required for specific readings were pressed and the conductivity meter device was ready

to read. By pressing the salinity button the salinity measurement was read, by pressing the TDS button the TDS value was recorded, and by pressing the conductivity button the conductivity reading was recorded.

The cadmium reduction method by using a powder pillowwas used for the analysis of Nitrate. Then the program button was pressed,and the mg/l, NO3- -N, and zero icons were displayed. Then two test tubes with 10ml of sample of each were filled. One of them prepared the sample and the other with a blank. Then the contents of the one Nitra ver 5nitrate reagent powder pillow were added to the test tube (the prepared sample), and then capped. The TIMER ENTER button was pressed within a minute for the reaction to occur. The sample was shaken vigorously until the TIMER beeps. The test tubes werewiped off from any liquid of fingerprint once the TIMER was beeped and the blank test tube was placed into the cell holder. The sample cell was covered tightly with the instrument cap. Thereafter zero button was pressed the screen displayed 0.00mg/l NO3- -N and the blank tube was removed then the prepared sample was placed into the cell (machine) and the READ button was pressed finally the data was displayed on the screen. The Nitrite was analyzed from the samples by using the diazotization method. The same proceduresthat were used for the analysis of nitrate were performed for the analysis of nitrite.

The free chlorine and total chlorine were analyzed by using a powder pillow. Then the program (9 ENTRE) button was pressed and mg/l, Cl2, and zero icons were displayed. Then two test tubes with 10 ml of sample of each were filled. One of it was prepared the sample by the addition of a DPD-free chlorine reagent and the other was the blank, the blank aside was setting. The blank sample was placed in the cell holder which was tightly covered the sample with the instrument cap. Then the test tubes were wiped off from any liquid of fingerprint once the TIMER was beeped and the blank tube was placed into the cell holder. The sample cell was covered tightly with the instrument cap. Thereafter zero button was pressed the screen displayed 0.00 mg/l Cl2 the blank tube was removed and then the prepared sample was added into the cell (machine) and the READ button was pressed finally the data was displayed on the screen.

Phosphorous reactive was analyzed by using over 3 (ascorbic acid) methods, the same way which was used for the analysis of chlorine as performed for the analysis of phosphorus in the sample. Also, the iron was analyzed by using the Ferro ver method the same procedure for the analysis of chlorine was performed for analysis of iron. Finally, the hardness test paper (strips) was taken and dipped in the container thatcontaineda water sample for analysis total hardness of the water. Then was removed immediately and waited 15 seconds to read the value on the chart. After that, the result was occurred after compared with the bar strip.

Results and Discussion

The descriptive statistical results of physicochemical analyses in groundwater samples have been shown in Table2.

Sample ID	T (0C)	pH	EC µS/ cm	TDS mg/l	Salinity ppt	Fe mg/l	P mg/l	Cl- mg/l	NO_3- mg/l	NO_2- mg/l	Total hardness mg/L
WS1	27.1	8.6	69.7	33.1	0.00	0.11	0.13	0.05	3.4	0.005	50
TS1	27.7	8.81	184.4	94.4	8.7	0.21	0.63	0.01	0.2	0.002	120
WS2	27.7	8.61	7.44	3.97	4.1	0.05	0.24	0.05	1.0	0.068	425
WS3	27.7	8.61	41.2	34.4	0.00	0.08	0.14	0.03	5.5	0.006	50
WS4	27.9	8.61	3.33	1712	1.7	0.03	0.18	0.03	5.5	0.006	425
WS5	27.6	8.36	849	1052	1.2	0.10	1.17	0.04	5.5	0.003	425
TS2	29.5	7.32	182.7	85.6	0.1	0.97	2.43	0.04	0.2	0.000	120
WS6	27.7	6.69	120.5	57.2	0.10	0.11	0.22	0.05	2.8	0.006	50
WS7	28.3	6.08	556	270	0.3	0.11	0.18	0.08	5.5	0.003	120
TS3	26.8	7.50	419	201	0.2	0.08	0.18	0.09	0.1	0.002	250
WS8	26.2	5.93	92.2	43.3	0.00	0.15	0.15	0.03	0.6	0.004	50
TS4	27.4	7.22	130.1	61.3	0.1	0.23	0.46	0.05	0.7	0.007	42
WS = wellholesample; TS =tap sample.											

Table 2: The AnalyzedResults of the Selected Physicochemical Parameters of the Study Area

Ph

The pH of any substance refers to the measurement of the acidity or alkalinity of the substance [5]. It is expressed as a negative logarithm of the hydrogen ion. The pH of the studied samples ranged from 5.93 to 8.81as presented in Table 2. Sample WS8 has a lower value (5.93), while sample TS1 has the highest pH value of 8.81. According to WHO guidelines in 1993 assessment of pH ranges from 6.5 to 9.5 [6]. According to such guidelines, all samples were within the permissible limit except for the WS8 sample. The variation in the pH is due to changes in the value of carbonate and bicarbonate in the water. The high pH value is due to the presence of a high amount of carbonate salt which results from the increase in alkalinity of water [10].

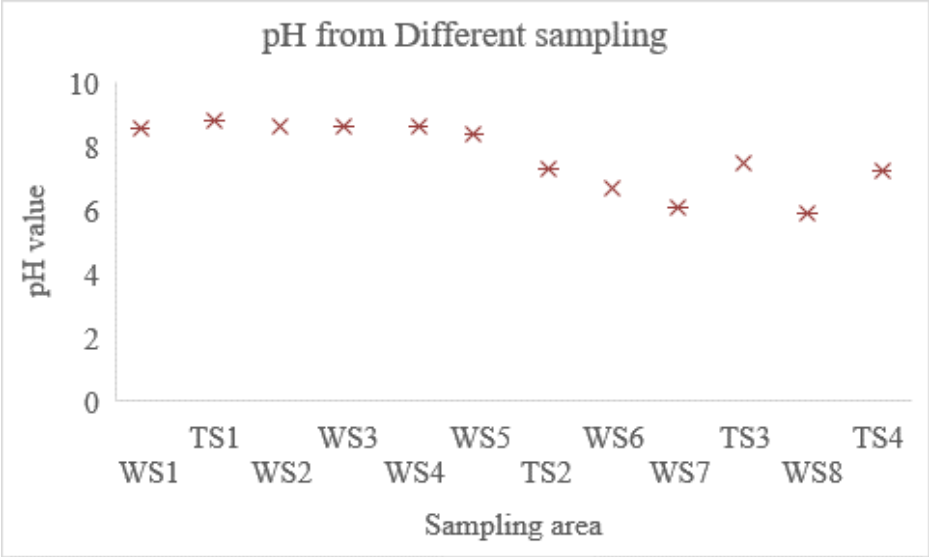

Figure 2: Ph Concentration

Temperature

Temperature is essential for its effects on the other properties of wastewater[9]. Generally, temperature measures the degree of hotness or coldness of the body or place. Water with cool conditions is more palatable than warm water. High water temperature enhances the growth of microorganisms and may increase taste, odor, color, and corrosion problems [11]. The result show that the temperature ranges from 26.2 0C to 29.5 0C, the TS2 has higher) temperature (29.5 0C) and WS8 has lower temperature (26.2 0C).

Electrical Conductivity (EC)

This is the capacity or ability of water to transport electric current. Some of the literature shows that the electric conductivity of groundwater is directly proportional to the dissolved mineral matter present in it[9]. Also, electrical conductivity is useful for the determination of the purity of water.Pure water is not a good conductor of electric current but is a good insulator [12]. An increase in ion concentration influences the electrical conductivity of water. The amount of dissolved solids in water determines the electrical conductivity. According to WHO standards, the electrical conductivity should not exceed 400 µS/cm and not less than 20µS/cm [13]. The result indicates that almost all the groundwater samples are within the permissible limits except the samples from TS3 (419 µS/cm) and WS5 (849 µS/cm).

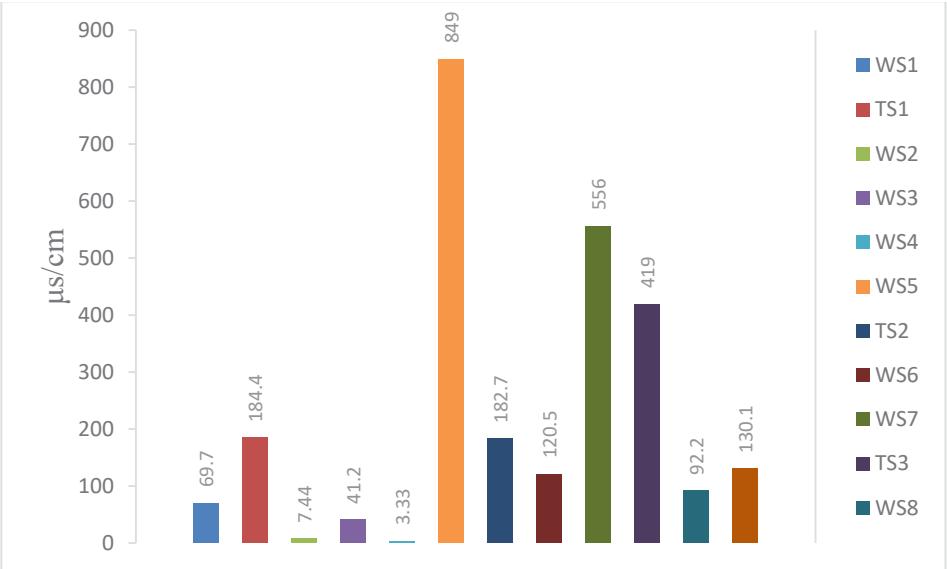

Figure 3: Electric Conductivity in Groundwater of Micheweni District

Total Dissolved Solids (TDS)

The ability of water to dissolve inorganic or organic minerals is known as TDS. The minerals or salt where water dissolves are calcium, sodium, bicarbonates, chlorine, magnesium,etc. TDS measures the overall mineral such as sulphate, calcium carbonate, and some of the heavy metals [3]. The purpose of this mineral in water is to produce unwanted taste and diluted color for the water's appearance [13]. The results show that TDS ranges from 3.97 mg/l (WS2) to 1712 mg/l (WS4). Two samples from the study exceeded the permissible limit by WHO (1000 mg/l) and the remaining ten samples were under the permissible limit.

Figure 4: TDS in Ground Water of Micheweni District

Chloride

Generally, chloride is used as an oxidizing agentthat can react quickly with reducing materials or unsaturated organic molecules in water. Hence, appears in in industries as effluent and is used as a disinfectant in drinking water treatments, in swimming pools, and cooling water. Chlorine is used as a disinfectant to control the growth of microorganisms. In this study, the amount of chloride found in the test samples ranged from 0.01 to 0.09 mg/L, which was very far below the WHO value of 250 mg/L. Hence, does not result in any immediate health risk to consumers [14].

Nitrate

The concentration of nitrate in all sampling points varied between 0.1 mg/l to 5.5 mg/l as shown in Table 2 above. The level of nitrate was below the limit of WHO which is 45 mg/l [9]. This research shows that WS3, WS4, WS5, and WS7 sampling points have the highest amount of nitrate (5.5 mg/l) while the TS3 sampling point hasa low amount of nitrate. The level of nitrate in the water can be caused by using fertilizer composed of nitrate compounds [15]. Also, nitrate is a compound of nitric acid, which is the most highly oxidized form of nitrogen found in aquatic environments which can increase the level in water.

Phosphorus

Phosphorous is one of the essential nutrients of life that occurs in different areas such as in soil, natural and waste waters also in the bodies of plants and animals [16]. The phosphorus in water can occur in the form of phosphate ions which can be derived from natural minerals as well as from pollution through the application of fertilizers and sewage from industries [17]. Through these factors that cause the presence of phosphorus, it can be experienced that groundwaterhas more phosphorus than other sources of water. According to the findings, TS2 and WS5 have more phosphorus content than other samples.

Total Hardness (TH)

The total hardness in water reveals the presence of calcium and magnesium ions [3]. The WHO permissible limit for TH of drinking water is about 120 mg/L. It is shown that three samples were within WHO limit, six samples were above permissible limit and four samples indicate that TH was under the limit of WHO.

Conclusion

The study of physicochemical parametersof water "Micheweni District" has shown that the levels of temperature, TDS, pH, total hardness, salinity, phosphorus, chloride, NO2-, NO3−, and electrical conductivity were under the acceptable limit of drinking water quality standards. Whereas, the level of TH was above the guideline values. This may have a direct association with beneficial effects on the human and animal health of the "Micheweni district" water. The level of chlorine was very low on the permissible limit but according to literature no effect on their life. However, the present study has made a complete water quality assessment for understanding physicochemical parameters which nobody has ever tried before, further studies in the area of microbiology should be conducted in the future. Meanwhile, measures should be taken to improve the quality of drinking water through treatment of the water beforehand.

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Declaration of Interests
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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