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Evaluation of the physical parameters of water obtained from some groundwater sources of Tabuk city, Kingdom Saudi Arabia

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Abstract

After air, water is the second most important element for life, based on that, water quality parameters (physical, chemical and biological) should be concerned to detect contamination. The aim of this study was to evaluate the physical parameter of water brought from some groundwater sources of Tabuk City. A cross-sectional design was followed to collect groundwater from 12 sites (randomly selected) within Tabuk City to measure water temperature, color, odor, taste and turbidity, in addition to record the groundwater depth. In aseptic and clean plastic sample containers, 250 ml of the groundwater were collected. Water temperature was measured using a manual thermometer, immediately when it was collected. The data concerned the depth of the groundwater was obtained directly from the owners during groundwater sampling. The water color, odor, taste, in addition to turbidity were measured using the general human sense. The obtained physical parameters were compared with the local standards of the drinking water suggested by MEWA (2022). The results of this study show that, the groundwater temperature for the 12 samples obtained from Tabuk City ranged between 26°C and 33°C, with a mean of 29.33°C, while the groundwater depth (in meter) ranged between 120 m and 700 m with a mean depth of 479.2 m. The physical parameters of drinking water compared to the Saudi standards of quality showed that, all tested samples were agreed with the quality standards on color, odor, taste and turbidity. This work recommends for the prudent use of groundwater resources to keep its quality for long term usage as a drinking water.

Keywords: Physical parameters; Drinking water; Groundwater; Tabuk city

1. Introduction

It was estimated that, about 30% of the world available freshwater is groundwater, also, about 2 billion worldwide rely on it as a primary water source. Groundwater is the water found in rock and soil pore spaces and in the fractures of rock formations beneath Earth's surface. An aquifer can yield a usable quantity of water that used for public water supplies (e.g. agricultural, municipal, and industrial use). The study concerned with distribution and movement of groundwater is called hydrogeology or groundwater hydrology [1][2].

The depth at which soil pore spaces or fractures and voids in rock become completely saturated with water is called the water table. Groundwater is recharged from the surface; it may discharge from the surface naturally at springs and seeps, and can form oases or wetlands [2].

Groundwater may or may not be a safe water source, it may be contaminated with arsenic, fluoride and salinity that reduces the suitability of groundwater as a drinking water source. Salinity of groundwater is often highly variable because it makes the water unpalatable and unusable [3][4].

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Saudi Arabia is one of the driest regions with shallow groundwater and where rainfall is irregular and unpredictable. Groundwater is the most important sources of water supply to meet the demand for drinking and irrigation. In KSA, 80% of water-supply demand is met through groundwater. The rapid increase in urbanization, growth in the industrial sector and the population, resulted in pollution cases as a result of industrial effluent discharge, use of fertilizers in agriculture and domestic sewerage. Some elements contained within groundwater are essential for humans and are part of dietary intake (micronutrients), if present within the permissible limits, but when it consumed beyond these limits, they may induce adverse health implications (e.g., chronic toxicity, nervous dysfunction and carcinogenesis). The spatio–temporal variations of naturally occurring elements in groundwater are increased as a result of the anthropogenic activities in the surrounding environment [5].

The Saq aquifer can be considered as the major one in the Kingdom of Saudi Arabia, and it extends over 1200 km northwest of Tabuk to Jordan and comprises area of about 2/3 of the Kingdom. In Tabuk, about 260 wells with an average depth of 750 m were drilled by Tabuk Agricultural Development Company (TADCO), which irrigate most of the agricultural area. The thickness of this aquifer is ranged from 200 m to 600 m, whereas, the depth of some of the drilled wells reached 1223 m [6].

2. Materials and methods

2.1. Study site

Tabuk City which located the northern part of Kingdom Saudi Arabia (28^{o} 23 50 N and 36^{o} 34 44 E) was selected to conduct the present study because of its location within the groundwater stream of Saq aquifer of Saudi Arabia. 12 groundwater wells were randomly selected for this study.

2.2. Study design

A cross-sectional design was followed to collect groundwater from 12 sites within Tabuk City to measure water temperature, color, odor, taste and turbidity, in addition to record the groundwater depth.

2.3. Sampling of groundwater

In aseptic and clean plastic sample containers, 250 ml of the groundwater were collected directly from the main outlet pipe of each well and then kept in a large sample-container for the further evaluations.

2.4. Measuring water temperature

By using a manual thermometer, the groundwater temperature was immediately measured when it was collected in order to avoid change in temperature level as a result of thermal equilibrium with the surrounding environment.

2.5. Groundwater depth

The data concerned the depth of the groundwater was obtained directly from the owners during groundwater sampling.

2.6. Physical parameters

It involved the water color, odor and taste which were measured using the general human sense, in addition to observe any obvious sign of turbidity. Color was termed as colored or colorless, odor was termed as odorous or odorless, while taste was termed as acceptable or not acceptable, while water turbidity was recorded as turbid or transparent.

2.7. Data processing

Data obtained from this study was subjected to data presentation through graphs and tables. Simple descriptive statistics (mean, standard error, minimum, and maximum was used to describe the data concerned Tabuk City groundwater. The obtained physical parameters were compared with the local standards of the drinking water suggested by MEWA [7] to evaluate their qualities.

3. Results

3.1. Groundwater temperature

It was found that, the water temperature for the 12 samples obtained from Tabuk City ranged between a minimum of 26°C and a maximum of 33°C, as was shown in Figure (1). The mean groundwater temperature was 29.33°C and the standard error was 0.62.

3.2. Groundwater depth

Figure (2) show that, the groundwater depth (in meter) for the 12 locations from which the water samples were obtained from within Tabuk City ranged between a minimum of 120 m and a maximum of 700 m. The mean groundwater depth was 479.2 m and the standard error was 57.8.

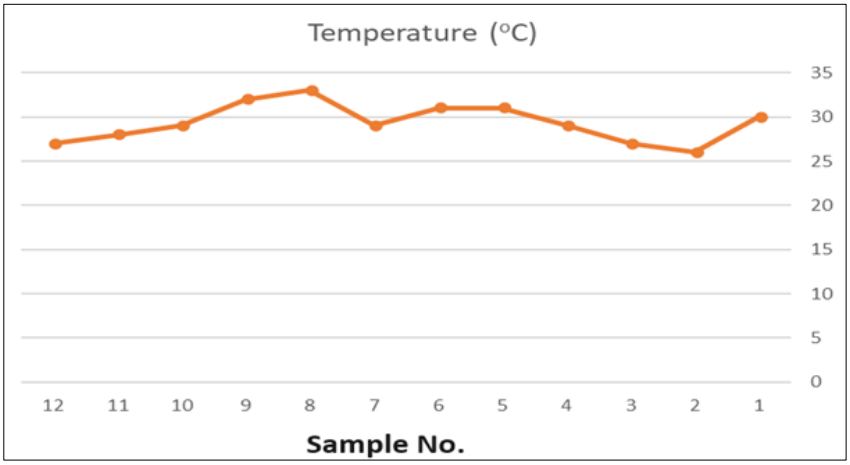

Figure 1 Groundwater temperature (°C) of the samples collected from Tabuk City

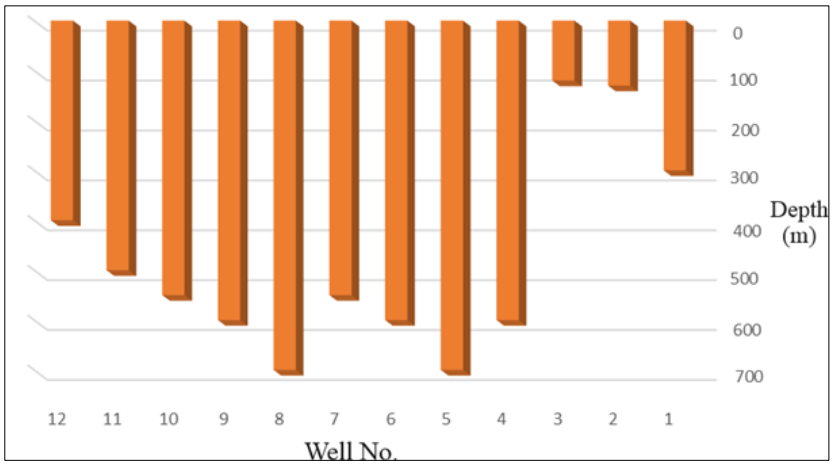

Figure 2 Groundwater depth (m) in the location where the samples were collected from Tabuk City

3.3. Physical parameters of groundwater

Table (1) show the obtained data of the physical parameters of drinking water compared to the Saudi standards of quality suggested by (MEWA. 2022). It was cleared that, all tested samples were agreed with the quality standards that depended on the acceptance of odor, taste and turbidity of the drinking water, in addition to being colorless, which were noticed in the obtained results.

Table 1 The physical parameters of drinking water quality collected from 12 sites in Tabuk City

Sample No.	Color	Odor	Taste	Turbidity
1	Colorless	Odorless	Acceptable	Transparent
2	Colorless	Odorless	Acceptable	Transparent
3	Colorless	Odorless	Acceptable	Transparent
4	Colorless	Odorless	Acceptable	Transparent
5	Colorless	Odorless	Acceptable	Transparent
6	Colorless	Odorless	Acceptable	Transparent
7	Colorless	Odorless	Acceptable	Transparent
8	Colorless	Odorless	Acceptable	Transparent
9	Colorless	Odorless	Acceptable	Transparent
10	Colorless	Odorless	Acceptable	Transparent
11	Colorless	Odorless	Acceptable	Transparent
12	Colorless	Odorless	Acceptable	Transparent
Standards suggested by (MEWA, 2022)	Colorless	Acceptable	Acceptable	Acceptable

4. Discussion

This study was conducted in Tabuk City to evaluate the quality of the physical parameters of the groundwater samples collected from 12 randomly selected sites. The results of this study shows that, the topographical structure of Tabuk Saq aquifer supported the physical parameters of groundwater (odor, color, taste, and turbidity) which are still acceptable for drinking compared to the Saudi quality standards of MEWA [7]. In addition to that, the measured water temperature in Tabuk samples were still under 40^{o}C for all samples which agreed to the same standard.

The quality of groundwater usually depends on its interaction with soil contents, sediments, flow path, rock types, in addition to the geochemical conditions such as dissolution, redox condition, precipitation, and leaching, ion exchange. Once contaminated it is difficult for groundwater to recover. The occurrence of metals in surface water and groundwater can be attributed to the dissolution of rock minerals, aquifer materials, industrial activities (e.g., fuels, mining, smelting), and improper disposal of industrial waste [5].

In a study published during 2020, concerned with water quality, Summers [8] stated that, turbidity usually used to raise the cost of water treatment. The same study also mentioned that. most people preferred drinking water at temperature of 10-15 ^{o}C, and the materials decayed from organic or inorganic matters impart color to water which is objectionable for esthetic reasons not for health reasons. Taste and odor can be caused in water by the presence of foreign organic and inorganic materials or dissolved gases that came from natural, domestic or agricultural sources, hence it evaluated as colored or colorless, odor or odor less, taste or taste-free, and turbid or transparent.

It was found that, groundwater depth (in meter) ranged between 120 m and 700 m with a mean depth of 479.2 m. These values agreed with the findings of Al Ahmadi [9] during 2009 in the same area in which the depth was found to be between 150- 750 m. During 2012, Al Harbi and El Bastawesy [10], conduct a similar study at the same City and they found that, the depth ranged between 200 – 900 m with a mean of 606 m, and they attributed the increase in the depth to the pumping of great amount of groundwater in this area for many purposes which ought to lower the water level, also the northern part was deeper.

There was an obvious increase of about 730 km^2 of barren land in Tabuk (464 km^2 of rural and 266 km^2 of urban) which were converted to an agricultural land (mainly for maize crop), accordingly, the consumption increased approximately to 4.2 x 1010 m^3 during 1985-2015 (by more than 8 times in 2015 compared to 1995). The unsustainable use of groundwater puts Tabuk at high risk of groundwater depletion. Further the current irrigation practices could increase soil salinity, which may result in the loss of ecosystem services and enhance land degradation [11]. This work hammering for the prudent use of groundwater resources to keep its quality for long term usage as a drinking water.

5. Conclusions

The groundwater temperature for the 12 samples obtained from Tabuk City ranged between 26°C and 33°C, with a mean of 29.33°C, while the groundwater depth (in meter) ranged between 120 m and 700 m with a mean depth of 479.2 m. The physical parameters of drinking water compared to the Saudi standards of quality showed that, all tested samples were agreed with the quality standards on color, odor, taste and turbidity.

Compliance with ethical standards

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Disclosure of conflict of interest

There was no conflict of interest between the authors.

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