



Assessment of Groundwater Quality and its Implications for Drinking Purposes in Najran Southern Saudi Arabia

Abdulnoor A.J. Ghanim

Associate Professor of Water Resources Engineering

aaghanim@nu.edu.sa



Overview

- Introduction
- Objectives
- Methodology
- Results
- Conclusions
- Recommendations

Introduction

- Groundwater is the main water source for domestic and agricultural use in Saudi Arabia due to scarce surface water resources
- However, groundwater quality can vary depending on the region's geology, climate, and human activities.
- Each year, an estimated 1.9 million people die as a result of contaminated drinking water.
- According to the World Health Organization (WHO), improving water, sanitation, and hygiene may prevent almost 9.1% of global illnesses and 6.3 percent of all fatalities
- Monitoring and assessing groundwater quality are essential to ensure its suitability for different purposes and protect it from contamination and depletion.

- Najran, a region in southern Saudi Arabia, relies heavily on groundwater from the Wadi Najran aquifer, which may be affected by factors like salinization, agricultural activities, urbanization, and industrial development
- While some studies have evaluated groundwater quality in Saudi Arabia, there is a need for a more comprehensive and updated assessment of the groundwater quality along the Wadi Najran basin and its implications for drinking and irrigation purposes
- This study aims to fill this gap by investigating the groundwater quality variations along Wadi Najran using a large number of samples and a wide range of parameters

Objectives

- The main goal of this study was to assess the quality of groundwater and investigate the characteristics of water wells in Najran City, Saudi Arabia
- to evaluate the physical, chemical, and microbial properties of groundwater in the Wadi Najran basin...
- to provide a comprehensive assessment of groundwater quality variations along the Wadi Najran basin
- to identify the suitability of this groundwater resource for different purposes, with a focus on its potability for drinking
- To identify the potential sources and mechanisms of groundwater contamination along Wadi Najran

Methodology

- The study collected groundwater samples from 10 operational wells located along the Wadi Najran basin, extending from west to east
- A total of 20 groundwater samples were collected (2 samples from each well) using 1-liter polyethylene plastic bottles to minimize contamination
- The samples were divided into two sets:
 - The first set (10 samples) was used for on-site physical tests.
 - The second set (10 samples) was sent to the Najran Water and Sanitation Lab for chemical and microbial analysis.
- The physical parameters tested on-site included pH, turbidity, temperature, electrical conductivity (EC), and total dissolved solids (TDS).

- The chemical parameters analyzed in the lab included cations (ammonia, calcium hardness, magnesium hardness, total alkalinity) and anions (nitrite, nitrate, chloride, sulfate) using ion chromatography.
- Microbial parameters, such as total bacterial count, total coliforms, and fecal coliforms, were determined using the membrane filtration technique
- The results were then compared with the World Health Organization (WHO) and Saudi Arabian Standard Organization (SASO) drinking water quality standards
-

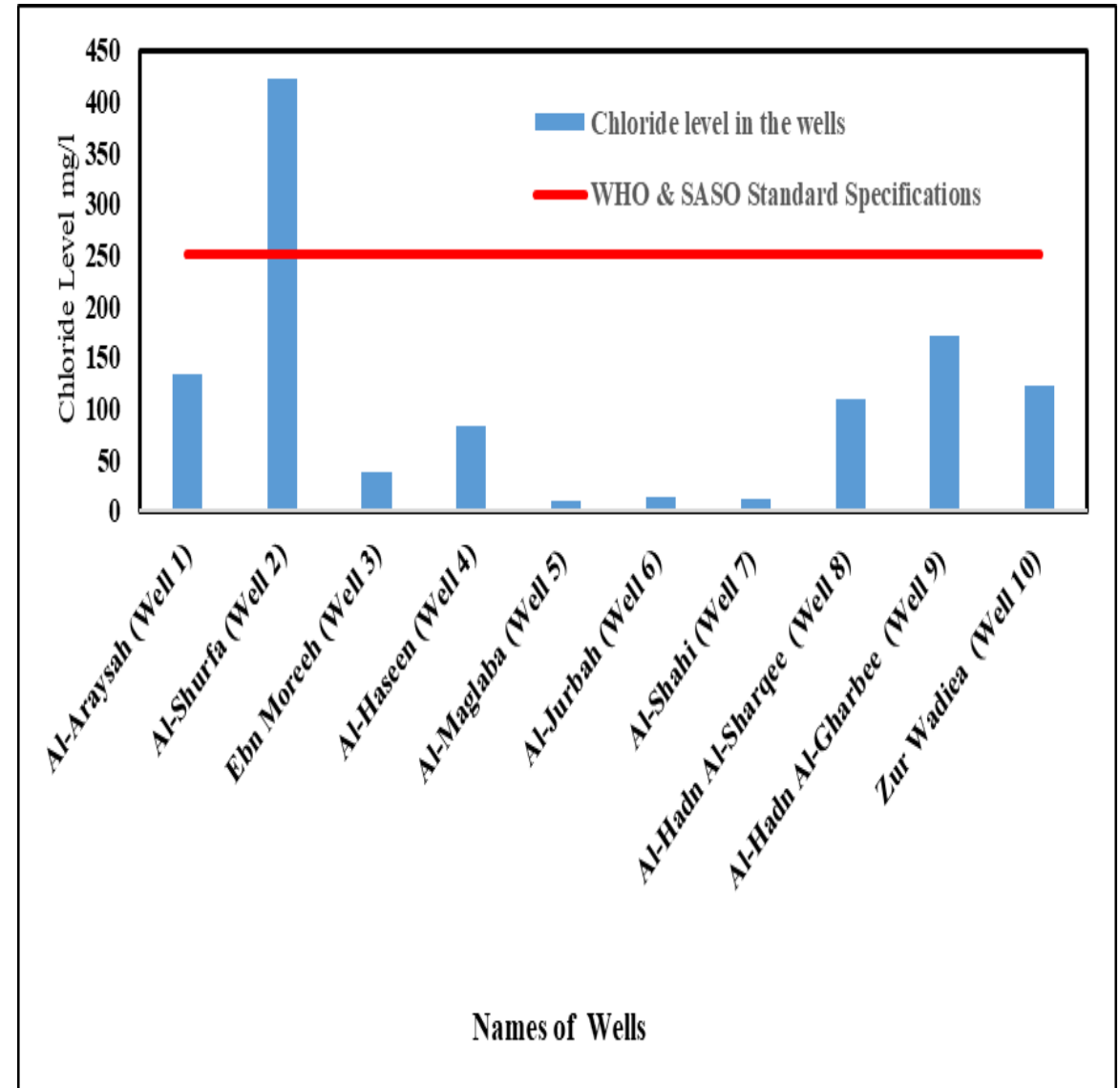
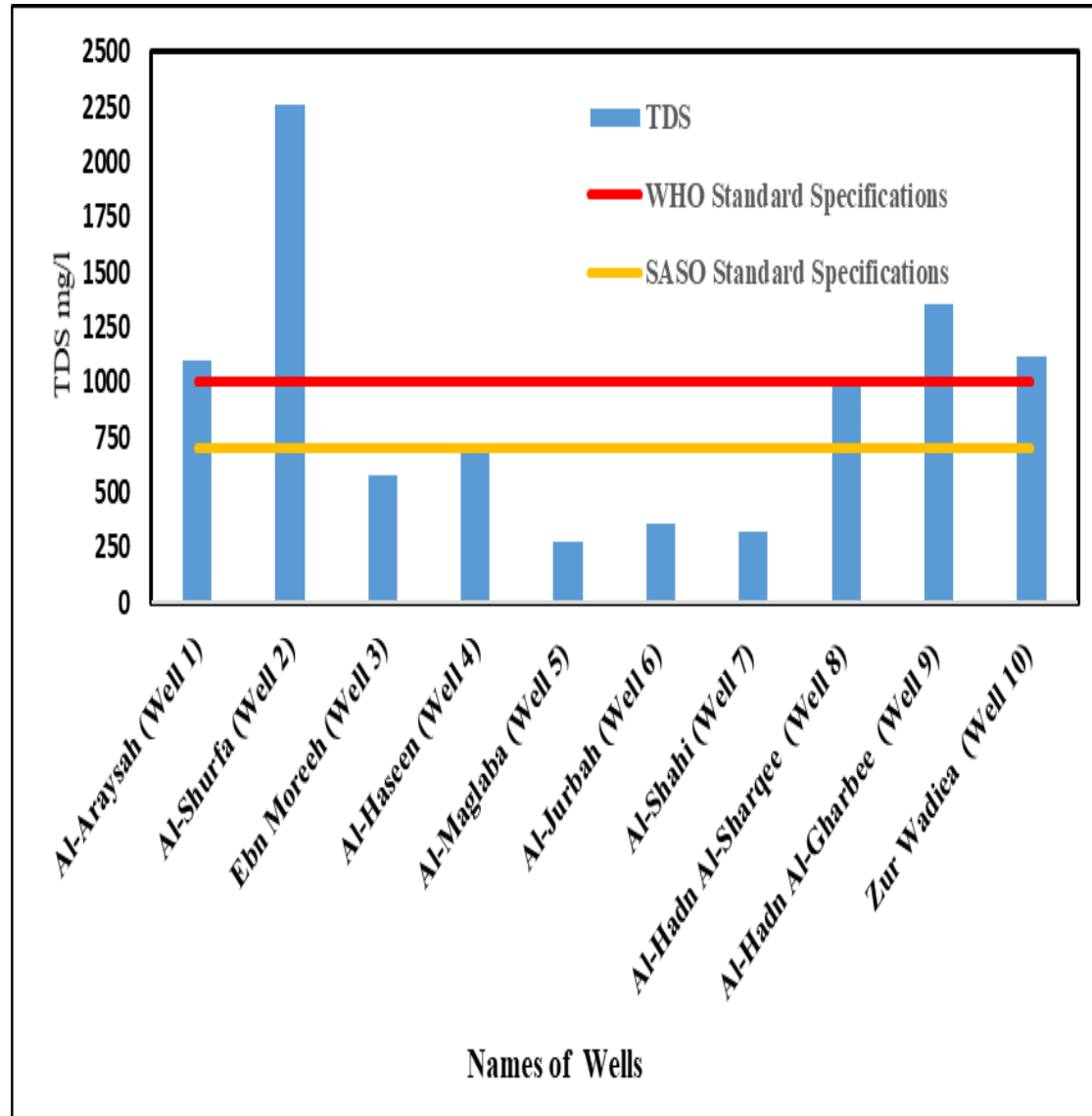
Results

- **Physical and microbial properties:**

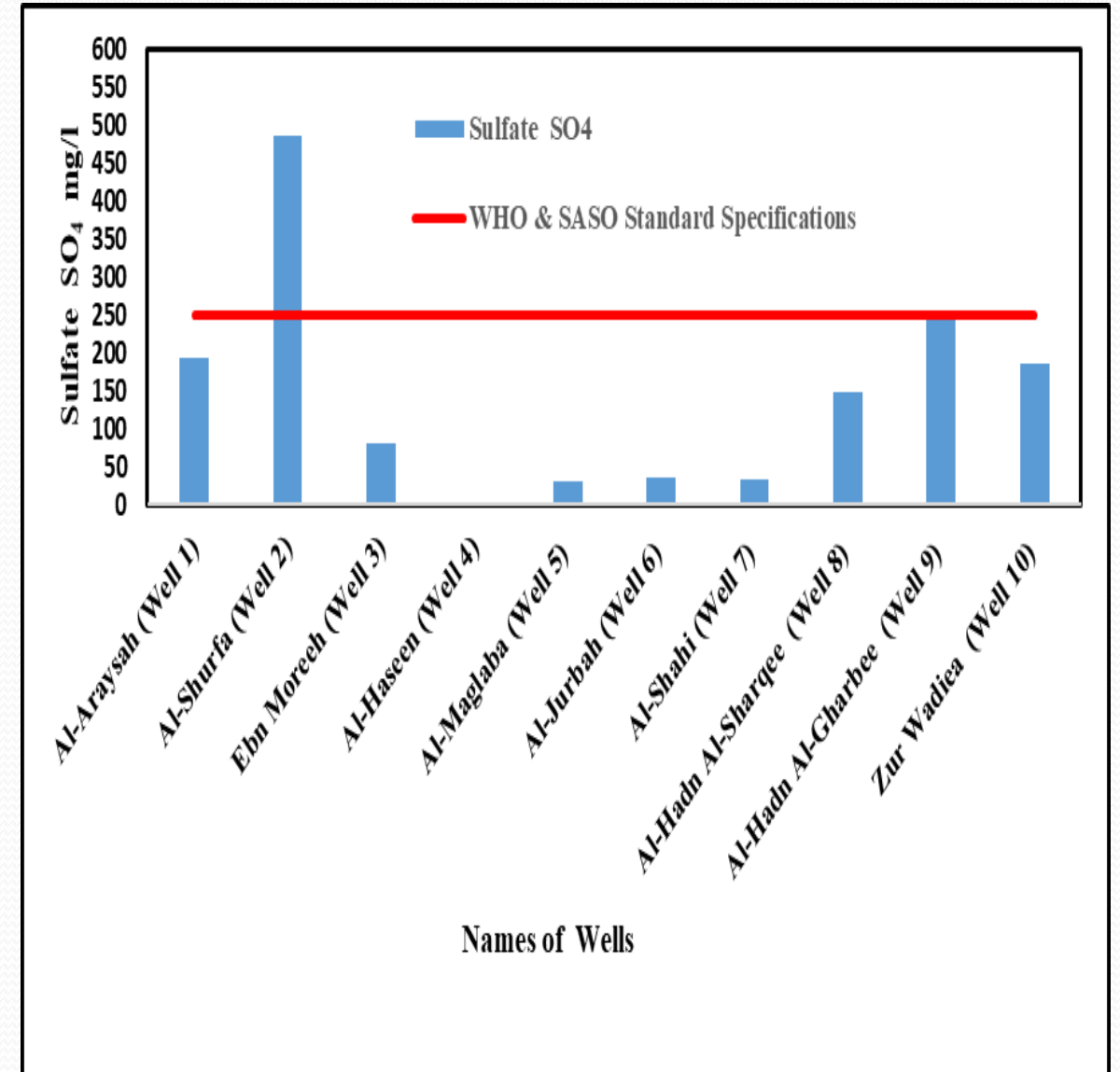
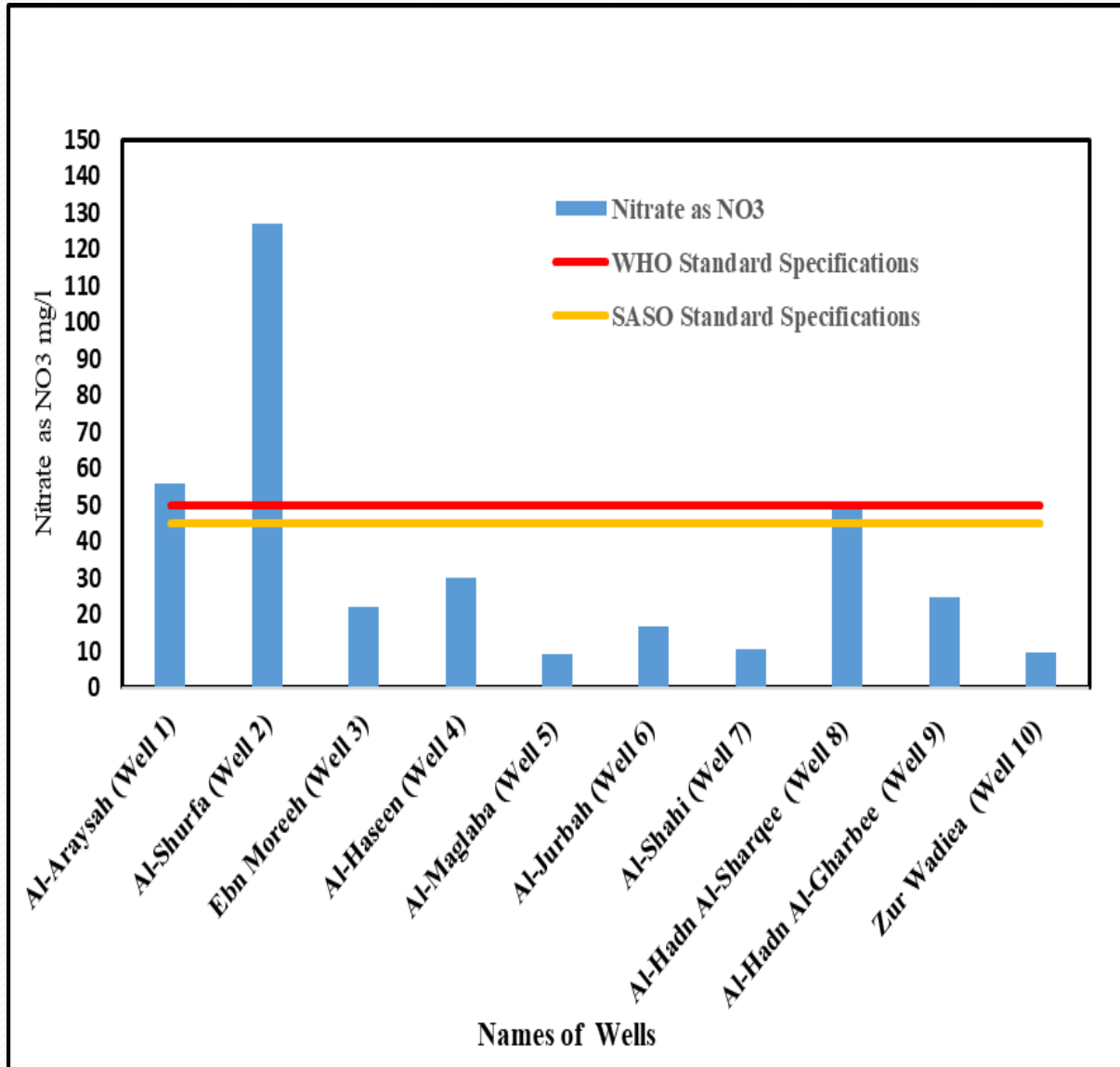
- The physical and microbial properties of all 10 wells were within the recommended limits set by WHO and SASO

- **Chemical properties:**

- Total Dissolved Solids (TDS): Ranged from 280 to 2,260 mg/L, with an average of 1,270 mg/L. Five wells exceeded the allowable limit of 1,000 mg/L.
 - Electrical Conductivity (EC): Ranged from 210 to 1,530 $\mu\text{S}/\text{cm}$, with three wells exceeding the 750 $\mu\text{S}/\text{cm}$ limit.
 - Chloride (Cl): Ranged from 10.5 to 421.9 mg/L, with one well (Al-Shurfa) exceeding the 250 mg/L limit.
 - Nitrate (NO_3): Ranged from 9.3 to 126.9 mg/L, with three wells exceeding the 50 mg/L limit.
 - Sulfate (SO_4): Ranged from 0 to 485.8 mg/L, with one well (Al-Shurfa) exceeding the 250 mg/L limit.
 - Total Hardness: Ranged from 144.6 to 1,266.7 mg/L as CaCO_3 , with 60% of the wells classified as extremely hard (>300 mg/L).



Cont., Results



Descriptive statistics of water quality parameters of water samples of the study area

Parameters	Concentration in the water samples of the study area					
	Range	Minimum	Maximum	Mean	SD	Skewness
TDS	1980	280.0	2260.0	908.0	605.6	1.20
Total Alkalinity as CaCO ₃	85	112.0	197.0	154.3	33.3	-0.12
Iron (Fe)	0.04	0.01	0.05	0.03	0.01	0.50
Chloride (CL)	411.4	10.5	421.9	111.4	123.1	1.99
Nitrate (NO ₃)	117.6	9.3	126.9	36.1	38.1	2.01
Sulfate (SO ₄)	485.8	0.0	485.8	143.5	146.5	1.50
Magnesium (Mg)	270.9	20.8	291.7	123.8	91.7	0.55
Calcium (Ca)	851.2	123.8	975.0	383.3	266.8	1.22
Total Hardness as Ca CO ₃	1122.1	144.6	1266.7	507.1	353.4	1.03

* All values are in mg/L.

Conclusions

- Except for 3 wells, the groundwater in the Najran region showed concerning levels of chemical contaminants, making it unsuitable for drinking
- 3 wells had excessive nitrate levels, potentially posing health risks
- 1 well (Al-Shurfa) had extremely high TDS, EC, sulfate, nitrate, chloride, and hardness, indicating severe contamination
- Increased electrical conductivity and total dissolved solids in several wells suggest elevated salinity and dissolved ions
- The high salinity and ion concentrations are likely due to natural geological sources (salt deposits) as well as anthropogenic activities

Recommendations

- Regular monitoring and treatment of groundwater wells in Najran is crucial to ensure safe drinking water
- Controlling potential pollution sources, such as agricultural activities, septic systems, and industrial practices, is essential
- More in-depth and frequent research is needed to identify the precise contamination sources and factors influencing the pollution levels
- Implementing long-term monitoring systems to track changes in water quality and evaluate the effectiveness of any mitigation measures
- Exploring alternative water sources and improving sanitation practices to protect the health of the Wadi Najran community
- Making informed decisions to ensure a sustainable supply of clean, plentiful water for the future



Thank you for your attention