International Journal of Multidisciplinary Research and Growth Evaluation.

Comparative Assessment of Groundwater and Surface Water Quality in Dalanj Area, South Kordofan State: Compliance with WHO and SSMO Standards

Ali Abdurahman Hassan
El Rodeo de Mora, San José, Cd Colón, Costa Rica

* Corresponding Author: **Ali Abdurahman Hassan**

Article Info

ISSN (online): 2582-7138
Volume: 06
Issue: 01
January-February 2025
Received: 25-11-2024
Accepted: 26-12-2024
Page No: 1098-1100

Abstract
Access to clean and safe drinking water is essential for public health, especially in rural regions where water sources are often limited to groundwater and surface water. This study evaluates the physicochemical and microbial quality of groundwater (artesian wells) and surface water (Hafirs) in the Dalanj area, South Kordofan State, Sudan. Key water quality parameters were analyzed and compared to the World Health Organization (WHO) and Sudanese Standards and Metrology Organization (SSMO) guidelines. The findings revealed significant non-compliance in certain parameters, including turbidity, fluoride, and microbial contamination. Groundwater exhibited better physicochemical characteristics but was found to have higher fluoride levels, while surface water showed elevated turbidity and microbial contamination. The study provides actionable recommendations for improving water quality to safeguard public health.

Keywords: Clean water, Water quality, Groundwater

1. Introduction

Clean and safe drinking water is critical for public health and sustainable development. Many rural areas, including South Kordofan State, Sudan, face significant challenges in ensuring water quality due to reliance on untreated groundwater and surface water sources. These challenges are compounded by limited access to water treatment facilities and the growing impact of agricultural and population expansion (Van Winckel *et al.*, 2021) [1].

Groundwater in artesian wells and surface water stored in Hafirs (artificial reservoirs) are the primary water sources for domestic and agricultural use in Dalanj. Groundwater benefits from natural filtration processes, though it often contains elevated dissolved mineral levels such as fluoride (Wang *et al.*, 2013) [8]. Surface water, in contrast, is more prone to contamination from agricultural runoff and animal activity (Gobelius *et al.*, 2018) [3]. This study aims to provide a comprehensive assessment of water quality in the region, with a focus on compliance with WHO and SSMO standards.

2. Materials and Methods

2.1 Study Area

The Dalanj area, situated in South Kordofan State, Sudan, experiences semi-arid climatic conditions characterized by low annual rainfall and high evapotranspiration rates. These environmental conditions make water resources scarce and precious. Hafirs and artesian wells are vital for meeting the water needs of the community, but growing agricultural and urban activities have heightened pollution risks (Escalante & Casas, 2020) [4].

2.2 Sampling and Analysis

Water samples were collected from five Hafirs (surface water) and five artesian wells (groundwater) during the dry season to capture worst-case contamination scenarios. Samples were collected in sterilized polyethylene bottles, stored at 4°C, and transported to the laboratory for analysis.

2.3 Parameters Measured

1. **Physicochemical Parameters**: Turbidity, pH, total dissolved solids (TDS), fluoride (F^-), chloride (Cl^-), and nitrate (NO_3^-).
2. **Microbial Contamination**: Total coliforms and E. coli.

2.4 Analytical Methods

- **Turbidity**: Measured using a calibrated turbidimeter (Van Winckel *et al*., 2021) [1].
- **Fluoride**: Analyzed using an ion-selective electrode (Su *et al*., 2017) [5].
- **Microbial Contamination**: Determined using the membrane filtration method (Gobelius *et al*., 2018) [3].

3. Results and Discussion

3.1 Physicochemical Parameters

Turbidity: Surface water samples exhibited turbidity levels ranging from 15 to 40 NTU, far exceeding the WHO guideline of 5 NTU. Elevated turbidity is attributed to suspended particles from soil erosion and agricultural runoff. In contrast, groundwater turbidity remained below the permissible limit of 5 NTU, highlighting the natural filtration benefits of artesian wells.

Fluoride: Fluoride levels in groundwater ranged from 1.5 to 2.3 mg/L, exceeding the WHO guideline of 1.5 mg/L. Chronic consumption of fluoride-contaminated groundwater can lead to dental and skeletal fluorosis. Surface water fluoride levels were significantly lower, ranging from 0.5 to 1.0 mg/L, due to dilution effects (Su *et al*., 2017) [5].

pH and TDS: Both surface and groundwater were within the acceptable pH range of 6.5–8.5. TDS concentrations in groundwater (600–1,200 mg/L) occasionally exceeded the SSMO limit of 1,000 mg/L, likely due to mineral dissolution from geological formations. Surface water TDS values were lower (200–400 mg/L) due to less direct contact with mineral-rich substrates.

Chlorides and Nitrates: Chloride levels were within acceptable limits for both water sources, with concentrations ranging from 25 to 150 mg/L. However, nitrate levels in some surface water samples approached the WHO limit of 50 mg/L, posing risks of eutrophication and waterborne illnesses (Mashi *et al*., 2023) [6].

3.2 Microbial Contamination

Surface water samples exhibited significant microbial contamination, with total coliforms and E. coli present in all samples. These findings highlight contamination from fecal matter, likely due to livestock grazing and poor sanitation around Hafirs. In contrast, groundwater showed minimal microbial contamination, suggesting that artesian wells provide safer drinking water in terms of microbial quality. Similar findings were reported in other arid regions, where protected groundwater sources displayed better microbial quality (Ramos *et al*., 2023) [7].

4. Recommendations

4.1 Water Treatment for Hafirs

- **Sedimentation and Filtration**: Install sedimentation tanks and filtration systems to reduce turbidity.
- **Disinfection**: Introduce chlorination systems to eliminate microbial contaminants (Van Winckel *et al*., 2021) [1].

4.2 Fluoride Management in Groundwater

- **Defluoridation Units**: Install affordable defluoridation technologies in communities reliant on fluoride-contaminated groundwater.
- **Blending Strategies**: Encourage mixing of high-fluoride groundwater with low-fluoride surface water to achieve acceptable levels (Su *et al*., 2017) [5].

4.3 Community Awareness

- Educate local communities on boiling or filtering water before consumption to reduce exposure to microbial contaminants.
- Train local water management personnel on proper maintenance of water systems.

4.4 Policy and Infrastructure Development

- Strengthen water quality monitoring frameworks by establishing periodic testing programs.
- Invest in centralized water treatment facilities to ensure compliance with WHO and SSMO standards (Escalante & Casas, 2020) [4].

4.5 Addressing Agricultural Impacts

- Promote the use of organic farming practices and controlled fertilizer application to minimize nitrate and chloride runoff.
- Create riparian buffer zones around Hafirs to filter runoff before it enters the water sources (Nyenje *et al*., 2010) [8].

5. Conclusion

This study highlights significant differences between groundwater and surface water quality in the Dalanj area. While groundwater generally complies with physicochemical standards, its high fluoride levels present a long-term health risk. Surface water, on the other hand, suffers from turbidity and microbial contamination, rendering it unsuitable for direct consumption. These findings underscore the urgent need for targeted interventions, including water treatment, agricultural runoff management, and enhanced community awareness. Addressing these issues holistically will ensure access to safe and sustainable water resources for the residents of South Kordofan State.

6. References

1. Van Winckel T, Cools J, Vlaeminck SE, Joos P. Towards harmonization of water quality management: A comparison of chemical drinking water and surface water quality standards around the globe. Science of The Total Environment. 2021. [Link]
2. Wang J, Cheng H, Lu Y. Fluoride contamination in groundwater and its impacts on human health in China. Environmental Pollution. 2013. [DOI]
3. Gobelius L, Hedlund J, Dürig W. Per-and polyfluoroalkyl substances in Swedish groundwater and surface water: Implications for environmental quality standards and drinking water guidelines. Environmental Science & Technology. 2018. [DOI]
4. Escalante EF, Casas JDH. Regulations and guidelines on water quality requirements for managed aquifer

recharge: International comparison. Semantics Scholar. 2020. [Link]
5. Su J, Ji D, Lin M, Chen Y, Sun Y, Huo S, Zhu J. Developing surface water quality standards in China. Ecological Indicators. 2017. [Link]
6. Mashi SA, Inkani A, Jenkwe E, Etuk N. Environmental and public health hazards of disposal of treated sewage on surface waters: An assessment using a parametric quality index. SSRN. 2023. [Link]
7. Ramos E, Bux RK, Medina DI, Barrios-Piña H. Spatial and multivariate statistical analyses of human health risk associated with the consumption of heavy metals in groundwater. Water. 2023;15(6):1243. [DOI]
8. Nyenje PM, Foppen JW, Uhlenbrook S, Kulabako R, Muwanga A. Eutrophication and nutrient release in urban wastewater wetlands in sub-Saharan Africa. Water Science and Technology. 2010;61(4):927-936. [DOI]