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Nitrate Contamination Risk of Drinking Water in Elfasher, North Darfur State, Sudan

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Abstract The main goal of this study is to assess the concentration of NO_3 in drinking water sources in Elfasher, in both dry and wet seasons. Forty groundwater samples were collected from different water sources; which were distributed throughout the study area; for each season. Analysis of samples was carried out to determine the concentrations of NO_3 using Palintest photometer.

The mean concentration of NO3 in dry season was found as follows: 37.13±40.10 mg/l, while the mean concentration of NO_3recorded in wet season was found as follows: 54.14±67.01 mg/l. The concentration of NO_3 was found higher in the wet season than their concentration values in the dry season.

A statistical test (*t*-test) was applied to the data obtained for the two seasons; it was found that; there is no significant difference between the two seasons. Moreover, the results obtained were compared with the maximum limits of nitrate in drinking water issued by the World Health Organization (WHO) and the maximum permissible level issued by the Sudan Standards and Metrology Organization (SSMO). This comparison showed that 2/3 of the samples it has a concentration of NO_3 was found a higher than the recommended values by WHO. Only 1/3 of samples were found less than these recommended values. On the other hand, the comparison to SSMO values showed that half of samples were found less than maximum permissible level of NO_3 concentration.

Surfer-10 software was used to show the spatial distribution of NO_3 concentration in different seasons. The average concentrations of NO_3 were calculated and compared with data from the literature.

Index Terms - Nitrate contamination; groundwater; drinking water, Photometer; Elfasher.

I. INTRODUCTION

The provision of safe drinking water is a fundamental human right and is necessary for good health and an efficient health protection strategy. Positive health outcomes have been related to consuming clean and safe drinking water, and vice versa [1].

Aquifers are the home of groundwater, which is a significant source of drinking water worldwide. Geographically, aquifer hydrological recharge varies greatly and is heavily influenced by a variety of elements, including climate, geology, soil type, vegetation, and land use. Groundwater is recharged from precipitation, which is complemented by natural infiltration by surface water or by artificial recharge. Groundwater sources provide drinking water to a large number of people worldwide, especially in rural areas [2].

In many parts of Sudan, particularly those beyond the Nile valley, groundwater provides a valuable source of water for drinking, residential, agricultural, and irrigation requirements [3]. Some of the chemicals can cause water pollution [4]. 80% of human diseases are brought on by water [5]. If the biological, chemical, and physical parameters at the maximum permissible level established by the government regulators are achieved, the water is of good quality. Because it is always available and less polluted than surface water, groundwater is recommended as a source of drinking water [6].

Research in both rich and developing nations has discovered that groundwater nitrate levels have been raising, posing a serious health problem. Water quality is significantly impacted by nitrate, a substantial groundwater pollutant. In arid and semi-arid places around the world, groundwater pollution is the most common source of sickness and has the potential to be harmful to human health. Because of the rapid population increase and rising consumption, recent research has shown that nitrate poisoning of groundwater is an issue that is spreading around the globe [7].

Nitrate concentrations in groundwater sources and is easily soluble in water, penetrating the soil profile [8]. Nitrite can undergo a nitrosation reaction in the stomach with amines to create a range of N-nitro's compounds after becoming endogenously converted to nitrate (NOCs). These NOCs are carcinogens that also induce gastrointestinal cancer, Alzheimer's disease, vascular dementia, thyroid hypertrophy, multiple sclerosis, non-lymphoma, Hodgkin's disease, and adsorptive secretive functional abnormalities of the intestinal mucosa. Abortions, blue baby syndrome, a higher risk of methemoglobinemia and gastric cancer, stomach lining damage, mouth ulcers, and reproductive harm are only a few of the health issues that excessive nitrate in drinking groundwater has been linked to [9].

Because it is relatively soluble, nitrate contamination can enter the soil and groundwater through the leaching of fertilizers, septic tank leachate, pit latrines, animal waste, or human waste. It can also enter the soil through the mineralization or oxidation of decaying matter by soil microorganisms. Another source of groundwater nitrate is unused urea that has been leached into the ground for microbial oxidation [10]. The World Health Organization states that 50 mg/L of nitrate ion is the maximum permissible nitrate content for drinking water (WHO, 2011).

The best way to reduce nitrate levels, especially in groundwater, is to prevent source water contamination. This can be done by managing agricultural activities (such as how much fertilizer and animal manure is applied and stored) and sanitation practices (such as how pit latrines and septic tanks are positioned and how much sewer leakage is controlled. In agricultural settings, shallow wells are especially vulnerable to pollution and nitrates. Septic tanks and pit latrines should not be located close to or where a well is to be excavated. Additionally, animal manure should be kept at a sufficient distance so that runoff cannot reach the well or the ground around it. In order to prevent potential contamination, it is crucial to regulate household fertilizer and manure use on small plots close to wells carefully. The well needs to be adequately shielded to stop runoff from getting inside[11].

This study is attempt to find out the pollution associated with nitrates from drinking water sources in Elfaser, to compare the recorded values of NO_3 concentrations (mg/l) observed in this study with the maximum limits of nitrate in drinking water (WHO) and Max. Permissible level Sudan (SSMO), and compared the obtained results with data from the literature.

II. RESEARCH METHODOLOGY

2.1 Sampling

2.1.1 Study area

El Fasher (North Darfur state) is located at latitudes 13037'N and 25022'E, at an altitude of about 740 m above mean sea level, and on a surface area of about 140 km2. It lies over a basement complex area and apparently built around a shallow depression known as Fula, which collects and stores surface water from WadiHaloof and the drainage from the town during the rainy season, Wadi El Ku constitutes the main drainage channel which runs from north to south. It is characterized by sandy soil whereas the clay soils around the seasonal wadies, within the arid and semi-arid climatic zone in which availability of water is limited [12]. Over 60% of the population lives in rural regions, and there are three IDP camps (Abo Shouk, Al Salam, and Zamzam). Geological maps of the study area is shown in Figure (1). The geological cross-section through the subsurface of the study area are shown in Figure (2).

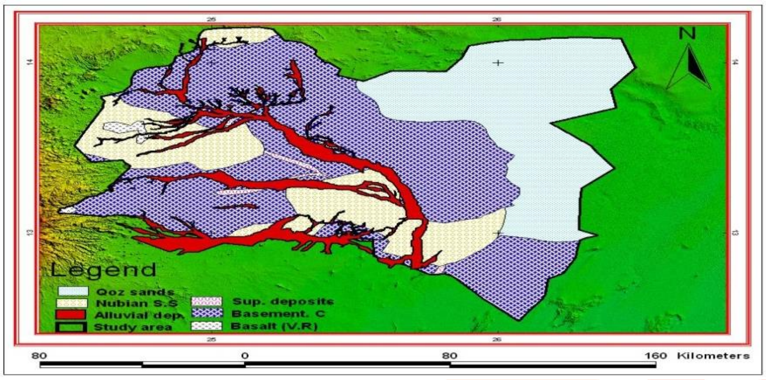


Figure 1 Geological map of the study area.

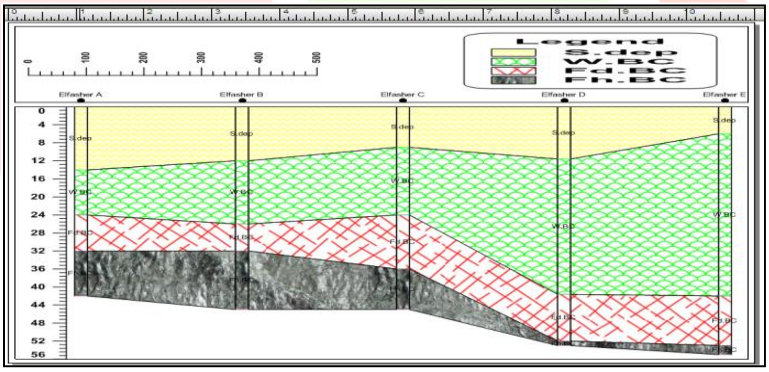


Figure 2 Geological cross-section through the subsurface of the study area.

2.1.2 Samples collection

For this investigation, forty water samples were collected from different water sources; in different seasons: dry and wet; in Elfaser. Forty samples for each season. Figure (3) shows the water samples sites.

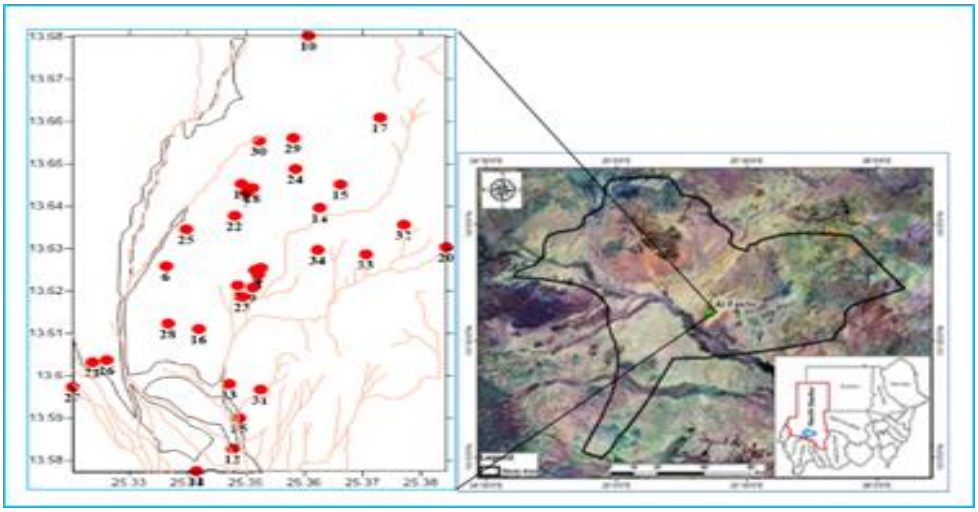


Figure 3 Water samples sites.

2.1.3 Sample measurement

A Palintest photometer (Model 7500) was used to determine nitrate concentration. Firstly, the photometer was calibrated. For any measurement, a clean nitrates tube was filled with 20 ml of the water sample. At first, one level spoonful of Nitratest powder and one tablet of Nitratest were added to the tube, after that the tube is capped and shaken well for a minute and then allowed to stand for another one minute. For several times, it was again inverted and allowed flocculation and then allowed to stand for extra two minutes for the complete settlement. The clear solution was decanted into a clean test tube (10 ml). The volume was filled to the mark. Secondly, one tablet of Nitricol was crushed. This tablet was added to the test tube. The test tube was shaken very well, so as the tablet to be dissolved. Then allowed to stand for an extra 10 minutes for the color development. Selected photo 63 for the result as mg/L NO3 on the Photometer and the tube was inserted into the chamber and reading was then taken. The Nitratetest calibration chart was used to determine the nitrate-nitrogen on photo 23 and to obtain the concentration (mg/l) of NO3 the nitrate-nitrogen was multiplied by 4.4.

III. RESULTS AND DISCUSSION

3.1 Nitrate concentration

Table (1) shows the summary statistical data of nitrate concentration (mg/l) of water samples graphically displayed in Figure (2). In dry season, the concentration of nitrate ranges from 0.8 to 380 mg/l with mean of 37.13 mg/l and a standard deviation of 40.10 mg/l. On the other hand, the concentration of NO_3 ranges from 0.05 to 200 mg/l with mean of 54.14 mg/l and a standard deviation of 67.01 mg/l in wet season.

In dry seasons, the results indicated that the lowest concentration of NO_3 found was (0.05 ppm) in water samples taken from well No. 27. This well is located on the southwestern side of the study area, whereas the highest concentration found was (200 ppm) in well no. 38 which lies at the northwestern part of study area.

In the wet season, the results showed that the lowest concentration value of NO_3 found was (0.8 mg/l) in water samples taken from well No. 20. This well is located on the eastern side of the study area, while the highest concentration found was (380 mg/l) in well no. 38 lies in the northwestern part of the study area.

3.2 Distribution of NO_3

Figures 5 & 6 show the spatial distribution of NO_3 visualized in the dry season decreasing toward the southwestern side of the study area, whereas, increasing at the northwestern side part of the study area, while in the wet season the increasing at the northwestern side of the study area, whereas showed decreasing toward the eastern part of the study area.

Numerous areas in Elfasher have been discovered to have high nitrate concentrations.65% of groundwater samples showed nitrate concentrations above the WHO acceptable range.According to the study, numerous well sources in the Elfasher area are extensively nitrate contaminated. Numerous human activities, including the excessive use of fertilizers, manures, and insecticides in agriculture, the age of septic tank leaks, organic matter, incorrect disposal of animal and human waste, and seasonal effects, may have contributed to nitrate contamination. Humans who depend on these water supplies for their drinking water demands are at hazardous concentrations. All land use activities that can contaminate wells should be under control to slow the rate of contamination. These wells' water can be used for anything besides drinking. That many of the groundwater samples, especially during the wet season, were unfit for drinking without any treatment.

Similar circumstances were discovered in the Mahitsy Commune, Central Highlands of Madagascar, where groundwater testing revealed nitrate concentrations as high as 580 mg/L [13]. The characteristics of the season, the hydro geochemistry of the environment, the properties of the wells, and related land use activities can all be used to explain the nitrate concentrations in these wells. For instance, during the rainy season, percolation recharges groundwater through precipitation, causing a general rise in the water level.

The existence of pit latrines close to the dug wells' surrounds, as is typically seen in many developing nations [14], is the most likely reason for the high nitrate content, which was noted in several of the wells included in this study. The location of pit latrines to wells that have been dug and the presence of animal waste nearby are likely factors in the higher nitrate content. Water in nearby dug wells is contaminated by nitrate that seeps into groundwater from point sources (pit latrines) and travels with the groundwater flow. Due to the same depth of wells, approximately 51–78 meters, it was not possible to evaluate the statistical significance between the depth of wells and nitrate concentration. Gruszecka-Kosowska's study, has shown that the concentration of nitrate decreases as well as depth increases, suggesting that the source of nitrate was primarily in the surface and subsurface strata, and this may be related to sewage area, a community of animals, and agriculture practices in the area [15].

3.3 Comparison of NO_3 concentration between this study and data from literate

A comparison of the average of NO_3 concentration of water samples with data from literature was listed in Table (2). The average concentration of NO_3 was higher in Madagascar, Netherland, and this study than the recorded values in India, Ecuador and Ghana.

Table 1 Summary statistical data of nitrate concentration (mg/l) of water samples

Locations	Dry season	Wet season
Mean	37.13	54.14
Std. Deviation	40.10	67.01
Median	3.2	3.5
Minimum	0.05	0.80
Maximum	200	380

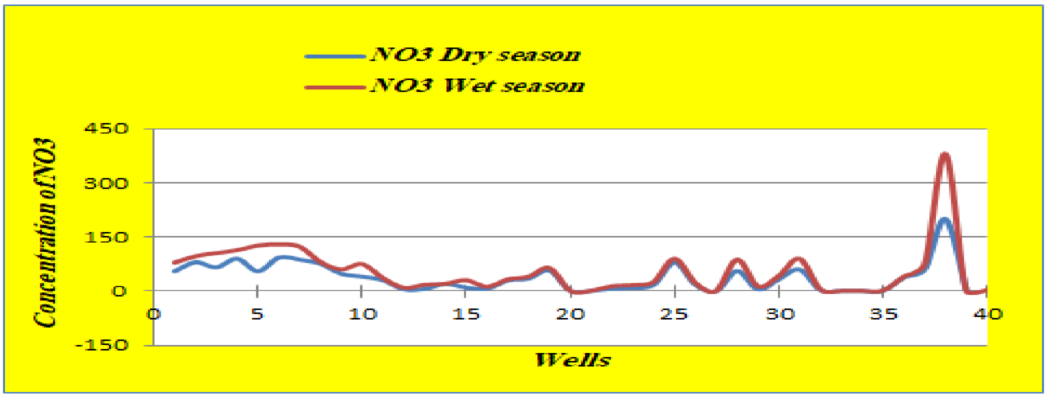
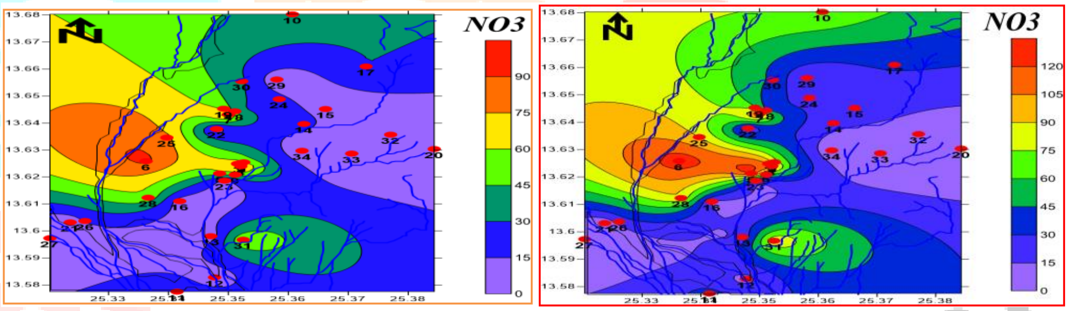


Figure 4 Distribution of NO_3 (mg/l) in dry &wet seasons.



Figures (5 & 6). Spatial distribution of NO_3(mg/l) in dry & wet seasons.

Table 2 Comparison of NO_3 (mg/l) concentration with data from the literature

Country	NO_3 (mg/l)
This work	45.63
Ecuador [16]	0.51
India [17]	9.00
Netherlands [18]	20.36
Ghana [19]	1.20
Madagascar [20]	190

IV. Conclusions and Recommendations

Concentrations of NO_3 were analyzed in drinking water samples using a Palintest photometer. Water samples were collected from Elfasher in different seasons: dry and wet seasons. The results obtained showed no significant difference between both seasons. Nitrate concentration in the wet season was found higher than their concentration in the dry season.

The results obtained showed that about 2/3 of water samples have a concentration of NO_3 higher than the maximum limits of nitrate in drinking water (WHO), while only half of the water samples have a concentration of NO_3 less than the Max. Permissible level (SSMO) values.

The distribution of NO_3 showed a big difference between the different seasons. In the dry season, by decreasing toward the southwestern and increases at the northwestern side of the study area, while in the wet season increasing in the northwestern and decreases toward the eastern side of the study area this may be due to the sewage area, the community of animals, and agriculture practices in the study area.

Recommendations

To prevent spending money on the building of unneeded wells, it is also advised that rigorous groundwater quality investigations be conducted before drilling wells. Future groundwater development should locate regions on acceptable groundwater chemical boundaries using the maps of spatial variation created by this work as a guide.

Best management techniques must be followed to safeguard water quality by lowering the nitrate level of water sources in urban and rural areas, best management techniques must be followed to safeguard water quality. It may be possible to start water treatment procedures to lower groundwater nitrate concentrations.

V. Acknowledgment

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VI. References

[1]Irenosen, O. 2012. Water Quality Assessment of the Owena Multi-Purpose Dam, Ondo State, Southwestern Nigeria. Journal of Environmental Protection, 3(1): ID: 16864, 12 pages.

[2]Scanlon, B. 2002. Choosing appropriate techniques for quantifying groundwater recharge. Journal of Hydrogeology Journal, 10(1):18–39.

[3] Carrard, T. 2016. Groundwater as a Source of Drinking Water in Southeast Asia and the Pacific: A Multi-Country Review of Current Reliance and Resource Concerns. Water, 11(8): 1605

[4] Isiuku, B. 2020. Pollution and health risks assessment of nitrate and phosphate concentrations in water bodies in South Eastern, Nigeria. Journal of Environmental Advances, 2(12): 100018, D.

[5] Ahmed, T. 2020. Climate Change, Water Quality and Water-Related Challenges: A Review with Focus on Pakistan. International Journal of Environmental Research and Public Health, 17(22): 8518.

[6] Amujo, B. 2022. Evaluation of Seasonal Water Quality of Drinking Water in Six Residential Estates across Ogun State in Nigeria. Journal of Applied Sciences and Environmental Management, 26(2): 349–356.

[7] Karunanidhi, P. 2021. Sources and Consequences of Groundwater Contamination. Journal of Arch Environmental Contamination Toxicology, 80(1): 1-10.

[8] ElBaba, M. 2020. Groundwater Vulnerability and Nitrate Contamination Assessment and Mapping Using DRASTIC and Geostatistical Analysis. Journal of Water, 12(7): . 2022.

[9] Breda, S. 2019. Impact of high drinking water nitrate levels on the endogenous formation of apparent N-nitroso compounds in combination with meat intake in healthy volunteers. Journal of Environmental Health, 18(1): 87-95.

[10]Ehteshami, M. 2013. Simulation of Nitrate Contamination in Groundwater Caused by Livestock Industry (Case Study: Rey). Journal of Environmental Protection, 4(1): 91–97.

[11] Graham, J. 2013. Pit Latrines and Their Impacts on Groundwater Quality: A Systematic Review. Environmental Health Perspectives, 121(5): 521–530.

[12] Walsh, R. 1988. Recent Rainfall Changes and Their Impact on Hydrology and Water Supply in the Semi- Arid Zone of the Sudan, The Geographical Journal, 154(2): 181–197.

[13] Pradagar, J. 2020 .Nitrate contamination of groundwater: An issue for livelihood in Jaffna Peninsula, Sri Laranka. African Journal of Agriculture Research, 16(7): 1025–1032.

[14] Templeton, M. 2015. Nitrate Pollution of Groundwater by Pit Latrines in Developing Countries. AIMS Environmental Science, 2 (4):302–313.

[15] Gruszecka-Kosowska, A. 2017. Concentration and health risk assessment of nitrates in vegetables from conventional and organic farming. Journal of Human Ecology Risk Assess 23:727–740.

[16] Fernando Garcia-Avila, F. 2022. A comparative study of water quality using two quality indices and a risk index in a drinking water distribution network. Journal of Environmental Technology Reviews. 11(1): 49-61.

[17] Saleem, M. 2016. Analysis of groundwater quality using water quality index: A case study of greater Noida (Region), Uttar Pradesh (U.P), India, Cogent Engineering, 3(1): 1237927.

[18] Brand, D. 2020. Assessment of the combined nitrate and nitrite exposure from food and drinking water: application of uncertainty around the nitrate to nitrite conversion factor, Food Additives & Contaminants: A, 37(4): 568-582.

[19] Mohammed, S. 2021. Water quality indicators of the Nima Creek, and potential for sustainable urban agriculture in Ghana, Water Science, 35(1): 39-48.

[20] Ramaroson, V. 2020. Nitrate contamination of groundwater in Ambohidrapeto-Antananarivio-Madagascar using hydrochemistry and multivariate analysis. Journal of Applied water Science, 10(5):178.