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IMPACT OF SEPTIC TANKS ON GROUNDWATER IN TUNGA, MINNA, NIGER STATE, NIGERIA

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Abstract

Soak-away contains high level of organic matter, however high concentration of this organic matter will definitely have an impact on underground water quality and it can be hazardous to human health. The paper examines the impact of septic tank on groundwater quality in Tunga area of Minna, Niger State. It identifies the physio-chemical and bacteriological quality of the ground water sample obtained from groundwater sources within the study area. It determines the distance septic tank can be from wells and examine the level of contamination in ground water that septic tank contributes to the water table within the study area. The study adopts qualitative and quantitative research approach, with a cross-section of respondent selected from

Keywords: Coliform, Groundwater, Septic Tank and Groundwater Quality

Introduction

Man's environment is under constant threat from his own activities resulting from expanding population and this remains one of the biggest challenges to the quality of environment and health. The situation is even worse in countries of Africa, especially in Nigeria. Excessive unplanned urban growth leads to many vulnerabilities and impacts on the people to varying degrees. Water being one of the earth's most important, renewable and widely distributed resources of which about 97.2 percent constitutes ground water (Rajesh *et al.,* 2023). Groundwater is generally considered to be least polluted compared to other inland water resources. Due to rapid growth of population, industrialization, and urbanization, there have been intense human activities and interference into nature leading to an over-exploitation and severe pollution stress on natural water bodies.

fixed points the study area. Water samples were collected taken to laboratory for test. Questionnaire were distributed to respondent in the sample's areas, response collected were subjected to statistical analysis. The result shows that Cobalt were within the range of 0.01mg/L to 0.23mg/L as indicated in A1 to A5 of the study. This study revealed that majority of the water samples have traces of Cobalt which can cause paralysis in human system. The findings revealed A3 ranked the highest with Lead value of 0.101mg/l, A5 ranked second with Lead value of 0.032mg/L and the least was A1 with Lead value of 0.002mg/L. This Lead presence can lead to damage to the brain and nervous system; it also slow growth and development of human system when consumed in drinking water. The finding also shows that Total Coliform was present in the water samples and the details revealed that A4 ranked the highest with 16cfu/ml, A5 ranked second with 13cfu/ml and A1 ranked the least with 1cfu/ml. This revealed that all the groundwater source require treatment before it can be safe for drinking. This was also the result shown on E.Coli in the study which revealed the presence of E.Coli (9cfu/ml - 34 cfu/ml) in all the groundwater samples collected in the study area. The finding revealed that all the physio-chemical and bacteriological quality of the water samples collected and analyzed from all the locations tested for, are contaminated, having traces of total and faecal coliform counts greater than zero as against the WHO (2003), and NSDWQ (2006) standards for drinking water quality. The study concludes that there was relationship between distance from groundwater source to septic tank and the quality of groundwater in Tunga. It thereby recommends that partners dealing with environmental management issues such as; Niger State Environmental Management Agency should work together each time projects that involve groundwater development and onsite wastewater treatment are to be implemented.

According to Gideon *et al.* (2023), soak-away (water collected from indoor flush toilets, bathrooms, laundries and kitchen etc. via septic tanks) treatment systems are point sources of pollution; therefore, they are expected to exert greatest impact on groundwater sources in their vicinity. Poor environmental management creates havoc on the water supply, hygiene and exacerbating public health (Okoro *et al.,* 2023). Tay and Kortatsi (2024) emphasize on the importance of underground water globally as a source for human consumption and changes in quality with subsequent contamination can, undoubtedly, affect human health. Underground water quality is mainly controlled by the range and type of human influence as well as geochemical, physical and biological processes occurring in the ground.

According to World Health Organization (WHO, 2023) recommended standard, the effective distance between soak-away and domestic water source is estimated to be a minimum of 30m and above. Water quality index (WQI) is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers (Ramakrishnaiah *et al.,* 2019). It, thus, becomes an important parameter for the valuation and management of underground water. Water quality index (WQI) is defined as a rating reflecting the composite influence of different water quality parameters. WQI is calculated from the point of view of the suitability of underground water for human consumption (Ramakrishnaiah *et al.,* 2019). The objective of the present work is to provide information on the distance between soak-away pit and available groundwater in Tunga-

Minna area in order to determine the health risk generated by underground water quality, the impacts of septic tanks on the underground water quality and to discuss its suitability for human consumption from the water quality index values.

Human activities consist of waste - water with varieties of potentially harmful substances. The wastewater is a byproduct of utilized portable water, (domestic wastewater). Soak-away contains high level of organic matter, however high concentration of this organic matter will definitely have an impact on underground water quality and it can be hazardous to human health. In a related study, it shows that improper soak-away pit could lead to transmission of pathogens to human, and are caused by the following bacteria *E- Coli* which can produce a bloody diarrhea due to toxins it secretes when it infect human intestinal tracts, *Bacillus* which is responsible for food poisoning in human and also affect food spoilage of highly acidic, tomato based product, *Salmonella* which are mostly found in cold, and warm blooded animals (including human) and causes illness like typhoid fever, paratyphoid fever (Roberts, 2021). Hence, Tunga area in Minna was chosen because of various nature of septic tanks around the area.

Rapid population growth and urbanization in Tunga, Minna, have led to a high proliferation of residential buildings relying on onsite sanitation systems, primarily septic tanks and soakaway pits, rather than a centralized sewage disposal system. Many of these septic systems are constructed within close proximity to shallow hand-dug wells and boreholes, often violating the recommended safe distance of 30–40 meters.

Due to the porous nature of the soil in many parts of Minna, there is a high likelihood of sewage leachate migrating downward, potentially contaminating the underlying aquifer. Despite the high reliance on these groundwater sources for domestic use (drinking, cooking, washing), there is inadequate documentation on the precise extent of this contamination in the Tunga area. Consequently, residents are exposed to significant health risks, including water-borne diseases such as typhoid, diarrhea, dysentery, and potential heavy metal poisoning. The lack of comprehensive data on the, chemical (nitrates, sulphates), and bacteriological (E. coli, coliform count) pollution of groundwater in Tunga makes it difficult for policymakers to formulate effective, site-specific groundwater protection policies. This gap in knowledge necessitates a thorough investigation into the impact of septic tank leachate on the quality of groundwater in the study area.

Tunga is neighborhood in Minna town in Niger State, North Central of Nigeria. Minna is the capital of Niger State. The study area lies between Latitude $9° 33^1$ and $9° 40^1$ North, and Longitude $6° 29^1$ and $6° 35^1$ East.

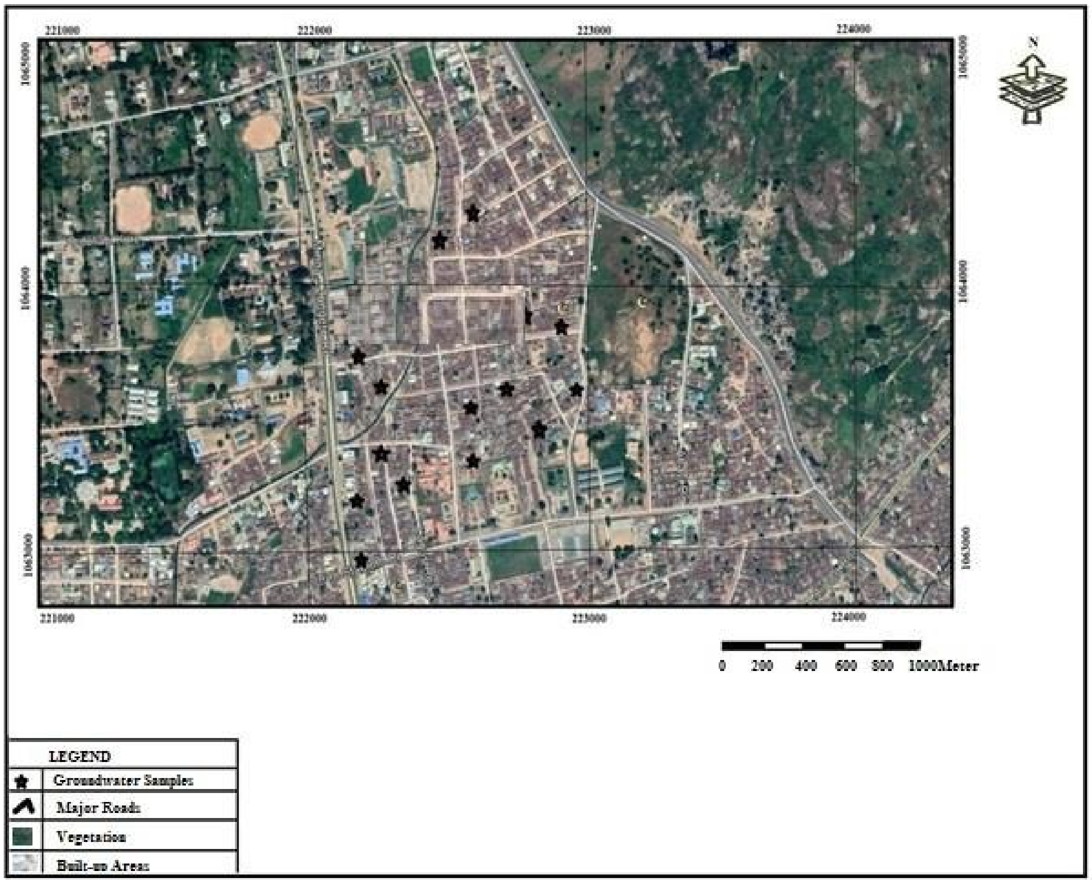

Figure 1: Locational Map of Tunga, Minna, Niger State
Source: Geography Department FUT Minna, (2026)

Materials and Methods

The study was a cross-sectional study with respondent selected from sample points of the study area. Very High-Resolution Satellite imager (Quick Bird Imagery) of Tunga was used to distribute the sampling locations around the study area. Sampling points were selected based on identify groundwater source and the arrangement of septic tank systems and other point sources of contamination around the study location in relation to the water source. Five sampling locations were randomly selected within the study area. Questionnaire was designed and distributed to respondents around the study location in order to get relevant information for the study.

Information regarding the age of soak-away and groundwater source was collected from homes. Records of the septic tank distance from relative groundwater was measured in the field with a measuring line tape of 50meters and the corresponding distances of all the soak-away was recorded. Also, the information regarding the household numbers and soak-away usage was also collected. GPS was used to capture the coordinate of soak-away location and available groundwater source.

Laboratory analysis of water was established in order to ascertain the quality of the water sample. Water samples were collected from the five locations in the study area, and were taken to Niger State Water and Sewage Corporation laboratory in Minna for the physicochemical and bacteriological analysis which involved tests for determining the physical, chemical, and bacteriological impurities present in water samples. Water samples for bacteriological analysis were collected from well water in the households that participated in the study. This was done to ensure that water samples were taken to the laboratory as at the time of collection. An inspection guide was used to check on the environmental conditions around soakaways. Direction of groundwater flow around Tunga was collected from the Department of Water Resources in Minna.

SPSS computer packages were used for both data entry and analysis. Results of microbiological water analysis and observations on the inspection guide were coded. Numerical numbers were assigned to observations prior to being entered into the software.

Results and Discussions

The main indicator used for this study to ascertain the bacteriological quality was the faecal coliform count per100ml of the groundwater sample. Water samples which had a coliform count of zero was considered to be satisfactory, while those containing coliform count greater than zero was considered unsatisfactory based on the WHO (2008) standards set for drinking water quality.

UNOBJ = Unobjectable, BDL =below detection level, CFU = Colony forming unit, TSS =Total suspended solid, TDS = Total dissolve solid, DO = Dissolved oxygen, NSDWQ = Nigeria standard for drinking water quality, (2006). Table 1 shows the result for all the physio-chemical and bacteriological quality of the water samples collected and analysed from all the locations.

Table 1: Physical, Chemical and Bacteriological Water Quality Result

SN	PARAMETERS	A^1	A^2	A^3	A^4	A^5	NIS-554-2015
1	Turbidity (NTU)	1	12	0	0	94	5
2	Conductivity (µs/cm)	139.8	573	155.8	138.5	144.2	1000
3	Total dissolved solids (mg/L)	606	2490	675	600	624	500
4	pH	7.2	8.2	7.3	7.3	8.6	6.5-8.5
5	Mercury (mg/L)	0.000 2	0.000 3	0.000 2	0.000 2	0.001 1	0.001
6	Cobalt (mg/L)	0.01	0.02	0.01	0.00	0.23	0.004
7	Nickel (mg/L)	0.014	0.028	0.008	0.00	0.229	0.02
8	Cadmium (mg/L)	0.000 9	0.001 6	0.000 5	0.000 0	0.014 3	0.03
9	Lead (mg/L)	0.002	0.004	0.101	0.000	0.032	0.01
10	Chloride (mg/L)	22.4	93.2	25	22.1	23	250
11	Total hardness (mg/L)	160	364	356	160	120	150
12	Total Coliform (cfu/100ml)	1	7	3	16	13	No coliform
13	E. Coli (cfu/100ml)	9	13	21	34	13	No E.Coli

Source: Niger State Water and Sewage Corporation laboratory in Minna (2026)

Table 1 shows that Cobalt were within the range of 0.01 to 0.23 as indicated in A^1 to A^5 of the study. This study revealed that majority of the water samples has traces of Cobalt which can cause paralysis in human system. As shown in Table 1 of the study, A^3 ranked the highest with lead value of 0.101, A^5 ranked second with lead value of 0.032 and the least was A^1 with lead value of 0.002. This Lead presence can lead to damage to the brain and nervous system; it also slow growth and development of human system when consume in drinking water.

In Total Coliform of the water analysis, A^4 ranked the highest with 16cfu, A^5 ranked second with 13cfu and A^1 ranked the least with 1cfu. This revealed that all the groundwater source require treatment before it can be safe for drinking. This was also the result shown on E.Coli in Table 1 of the study which revealed the presence of E.Coli in all the groundwater samples collected in the study area. Based on the bacteriological quality result of the water samples extracted from Table 1, it shows that all the water samples collected from all the locations and tested for, are contaminated, having traces of total and faecal coliform counts greater than zero as against the WHO (2023), and NSDWQ (2006) standards for drinking water quality.

The distance of septic tanks from the groundwater source was within the range of 1 – 15m as revealed in Table 2 of the study. 1 – 3m ranked the highest with 51 (55.4percent) sampled population, 8 – 11m ranked second with 23 (25percent) sampled population, 4 – 7m ranked third with 14 (15.2percent) sampled population and 12 – 15m ranked the least with 4 (4.4percent) sampled population. This shows that majority of the sampled wells were within the range of 1 – 3m and this shows the proximity of these water sources to septic tanks which invariably increases the level of groundwater contamination in the study area.

Table 2: Distance of septic tanks from groundwater source

Distance	Frequency	Percentage (%)
1 – 3m	51	55.4
4 – 7m	14	15.2
8 – 11m	23	25
12 – 15m	4	4.4
Total	92	100

The impact of septic tank on groundwater source in the study area include coloration of the water in some cases, reduction in physical and chemical qualities, increased in bacteriological activities and increased in water borne diseases as shown in Table 3 and Table 1 of the study. Increased in bacteriological activities ranked the highest with 37 sampled population, reduction in physical and chemical qualities ranked second with 25 sampled population, increased in water borne diseases ranked third with 17 sampled population and coloration of groundwater ranked the least with 13 sampled population. This revealed that majority of the sampled population perceived that increased in bacteriological activities was major impact of septic tank on groundwater source in the study area.

Table 3: Impact of Septic Tank on Groundwater Source in Tunga Community

Options	Frequency	Percentage (%)
Coloration of groundwater	13	14.1
Reduction in physical and chemical qualities	25	27.2
Increased in bacteriological activities	37	40.2
Increased in water borne diseases	17	18.5
Total	92	100

Ground water is important economically and aesthetically. The livelihood of many communities is hinged to the water bodies around them. Water bodies mirror the environment in which they are found and accumulate substances generated in their catchment. Urbanization and rapidly growing human population results in an increase in waste water discharge into fresh water ecosystems, thus impairing water quality, sometimes to unacceptable levels, thereby, limiting its beneficial use. Plate I to V are typical nature of septic tanks in Tunga community.

Plate I: Septic Tank around Old Custom Barrack in Tunga   Plate II: Toilets Close to Well in Tunga

As revealed in Table 4 of the study, seriously very high ranked the highest with 51 sampled population, high ranked second with 23 sampled population, very high ranked third with 14 sampled population and low ranked the least with 4 sampled population. This shows that majority of the sampled population perceived that the level of contamination in ground water by close septic tanks were seriously very high which required treatment.

Table 4: Level of Contamination in Ground Water by Close Septic Tank

Distance	Frequency	Percentage (%)
Seriously very high	51	55.4
Very high	14	15.2
High	23	25
Low	4	4.4
Total	92	100

Conclusion

The livelihood of many communities is hinged to the water bodies around them. Water bodies mirror the environment in which they are found and accumulate substances generated in their catchment. Urbanization and rapidly growing human population results in an increase in waste water discharge into fresh water ecosystems, thus impairing water quality, sometimes to unacceptable levels, thereby, limiting its beneficial use. It was observed that most of the septic tanks were not well constructed, and is less than 10m to the available ground water source (Well) in the area, polluted water were poured around the septic tanks which have serious negative effect on the groundwater and the inhabitant of the area. Provision of proper effluent disposal in the study area could reduce the environmental impact caused by improper septic tanks construction. From the respondents' view, 75 (82percent) of the sampled population are of the opinion that there is no provision of proper septic tank, while 17 (18percent) of the sampled population are of the opinion that there is provision of proper sock away pit in the study area. Pollution of our water resources might lead to reduction in physical and chemical qualities; pathogens could be transmitted to humans via drinking of contaminated water and this has led to occurrences of some diseases in the study area as it's shown in this study.

Septic tanks, particularly when located in close proximity to shallow hand-dug wells, are a major source of groundwater contamination in the area. The close proximity allows for rapid contamination of shallow aquifers, especially during the wet season, which is characterized by higher concentrations of fecal coliform, E. coli, and total bacteria. Groundwater in Tunga frequently exhibits high concentrations of total coliform and faecal coliform that exceed World Health Organization (WHO) and National Agency for Food, Drugs Administration and Control (NAFDAC) standards. Additionally, chemical parameters such as nitrates, chlorides, and phosphates, which serve as indicators of sewage pollution, are often found in high concentrations in these wells. The contamination of groundwater with septic tank effluent poses significant public health risks to residents who rely on these shallow wells for domestic consumption, as evidenced by the reported incidences of diarrhea, typhoid, and dysentery in Minna.

Based on summary of findings and conclusion of this study, the following were recommended to enhance groundwater quality from the study area.

1. Partners dealing with environmental management issues such as; Niger State Environmental Management Agency should work together each time projects that

involve groundwater development and onsite wastewater treatment are to be implemented.

2. Government should identify areas that are suitable to use septic tanks and boreholes on the same piece of land to avoid groundwater pollution
3. Government should make available groundwater vulnerability maps so that the would-be groundwater developers are aware about the safety of groundwater in Tunga area and in Minna generally.

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