International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume: 11, Issue: 05 "September-October 2025"

# INTERLINKING GROUNDWATER CONTAMINATION AND CROP QUALITY: AN OVERVIEW OF KEY INFLUENCING FACTORS AND THE IMPACT OF BIOGENIC MATERIALS

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**DOI: https://doi.org/10.51193/IJAER.2025.11513**

Received: 26 Sep. 2025 / Accepted: 06 Oct. 2025 / Published: 14 Oct. 2025

## ABSTRACT

Population densities and freshwater resources are not the same everywhere in the world. This has made it necessary for farmers to use wastewater for watering crops. Even though wastewater can provide important nutrients to plants, there are many environmental, health, and sanitation problems linked to using it for irrigation. This is because wastewater can contain harmful microbes and disease-causing bacteria like E-coli, B-coli that can get into the crops. When people eat crops, especially fresh vegetables, they may become sick. The improper sanitation system and improper handling of biogenic wastes in Accra region (Ghana, West Africa) leads to contaminated water for agricultural use by the farmers. Poor sanitation and Open defecation in Kasoa region (Accra, Ghana) are the major problems connected to the microbial entry into soil and groundwater, in general. This leads to human health related issues including diarrhea, Hepatitis A. The pathogenic bacteria derived from open defecation and poor sanitation in the dry surface areas under high temperature and humidity are flourished rapidly. This additionally causes the damage of vegetables like Onion. The bacterial rots are found in vegetables, especially, in Onions, is the risky fact for human health. Hence, the current study had explored to analysis on quality of ground water in the study area. The study provides a comprehensive assessment of groundwater quality in Kasoa, highlighting the urgent need for treatment and policy-level interventions to ensure the provision of safe drinking water. The findings also contribute to the broader understanding of groundwater quality management in similar peri-urban settings across Ghana and Sub-Saharan Africa.

  

**Keywords:** Bacterial Soft Rot, Electric conductivity, Faecal coliforms, Foodborne Illnesses, Ground water contamination**,** Human health, Open defecation, Poor sanitation, Hardness of water, Hepatitis A, Water quality index

## 1. INTRODUCTION

The unimproved conditions in Ghana enforces almost 25% Ghanaians to practice with open defecations especially in the rural areas (1). According to the past record, only 59.3% of residents had toilets (2) and becomes a critical health related issues in Ghana (3).

Contamination of groundwater from wastewater and other dirty water sources can make the water unsafe to use. These sources can spread harmful bacteria into the soil, which can then be carried by rainwater into the ground and into groundwater (4). Once there, these germs can live for a long time and pollute drinking water. Most of the pathogenic bacteria such as B-coli, E-coli (faecal coliforms), Psedomouus etc. are damaging the health of humans (5), (6), (7).

### *1.1 Impacts of Groundwater pollution due to Biogenic wastes*

The problem of biogenic waste (fruits and vegetable peels) is getting worse in the collection, handling, keeping, and getting rid of trash in areas around cities. Many people in these areas throw their garbage into open drains and empty spaces like bushes. These places become perfect spots for insects and flies to lay their eggs. Because of this, many diseases linked to waste and dirty things are spreading quickly in these areas. It also causes the water from wells and boreholes to become polluted (8).

In addition to the effects on human health, a rapidly expanding ground water pollution is highly affecting the quality of vegetables. Foodborne illnesses happen when harmful things like bacteria, viruses, parasites, or chemicals get into the body through foods that are not clean (9). These harmful things can make people sick. But the poor infrastructure has brought a challenge for food security to the local community in Ghana (10).

Large amounts of organic waste cause environmental pollution, harm soil health, and create public health risks. Traditional ways of managing organic waste, like burning it on-site, putting it in landfills, or using chemicals to break it down, require a lot of labor, are costly, use a lot of energy, and harm the environment (11), (12).

Infection and spoilage of fruits and vegetables can start due to various types of known microorganisms (5,13). Bacterial soft rot is a group of diseases that cause more damage to crops around the world than any other bacterial disease. These diseases affect soft parts of plants like fruits, tubers, stems, and bulbs, and they can happen in almost every type of plant. Soft rots often attack vegetables such as Onions, Potatoes, Carrots, Tomatoes and Pumpkins, and cruciferous

  

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crops like cabbage, and cauliflower. These problems can happen both in the field and in storage after crops are harvested. The rot can happen in a wide range of temperatures, but it's worst between 70- and 80-degrees Fahrenheit. It gets worse when there's not much oxygen (13), (14).

The Bacterial Soft rots (Fig.1) are caused by different types of bacteria, including species of Pectobacterium (especially Pectobacterium carotovorum, which used to be called Erwinia carotovora), Dickeya (especially Dickeya dadantii, which used to be called Erwinia chrysanthemi), and some species of Pseudomonas, Bacillus, and Clostridium (15), (16). These bacteria can get into plants through wounds from tools, insects, or bad weather like hail, or through natural openings on the plant. The bacteria can spread from one plant to another through insects, on dirty tools, or by moving infested plant parts, soil, or polluted water (17), (18), (19), (20). But this disease can also happen in the field before the onions are harvested, especially after heavy rains and when the leaves are drying out. The main way the bacteria gets into the onions is from contaminated soil or leftover plant parts. The bacteria spreads through splashing rain, water used for irrigation, and insects (20). The bacteria can only enter the onion bulbs through wounds, like those made by transplanting, physical damage, or sunscald. Also, onion maggots can carry the bacteria and spread it while they feed on the onions. This disease grows best in warm and humid conditions, with temperatures between 20-30°C (68-86°F). However, during storage or transport, soft rot can still happen if the temperature is above 3°C (37°F), (21), (22).

**Fig. 1: Impact of Polluted ground water: Bacterial soft rot in Onion**

### *1.2 Sources and Paths of Damaging microorganisms entering fruits and vegetables*

The environmental circumstances such as the points of organic wastes generation; landfill areas where predispose the fruits and vegetable peels are high prone to the sources and paths of harmful microorganisms where the soil contamination occurs (23), (24).

  

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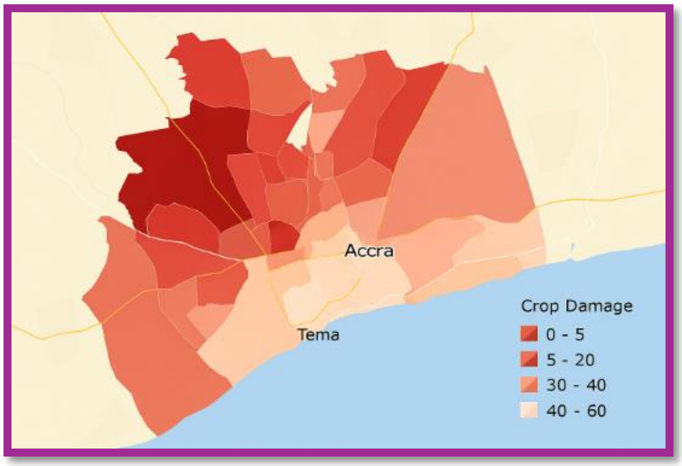


**Fig. 2: Crop damage zones in Accra, Ghana**

Fig. 2 features a geospatial analysis that demarcates regions compromised by polluted subterranean water. The intensity of this environmental affliction is visualized through a graduated scale of crimson, where color saturation directly correlates with the severity of the measured impact.

### *1.3 Improper handling of Biogenic Wastes and Impacts on Environment*

Poor management of Municipal organic wastes like biogenic banana and plantain peels are contributing environmentally unfit species and in turn, damages the sensitive crops like Onions, Carrots, Cabbages etc. Hence, a careful attention and efficient management is required in solid waste management system (25), (26). The use of biogenic wastes in a sustainable way is important to deal with major problems in managing waste and using resources more efficiently (27). The improper handling of biogenic organic wastes such as banana peels is stimulating with the production of highly objectionable landfill gases such as Methane ($CH_4$), Carbon-di-oxide ($CO_2$), Nitrous oxide ($N_2O$) emissions and in turn, responsible for anthropogenic weather and climate variations (28), (29), (30) . The final disposal of solid waste into a landfill that isn't properly built can cause groundwater to become polluted because the leachate from the waste, called leachate, can seep into the ground and reach the water supply (31).

### *1.4 Recycling of Biogenic wastes as resources to counteract their impacts on Ground water*

Using biogenic waste and byproducts as resources, when handled correctly, can greatly help move from a linear economy to a sustainable circular bioeconomy. This approach also helps cut down on greenhouse gas emissions (32). As the demand for sustainability increases, biogenic construction is expected to play a major role in the future of civil engineering. This method helps reduce carbon dioxide emissions, uses less energy, and produces less solid waste. It can also work together with smart technologies, helping to create smarter and more environmentally friendly

  

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building techniques. When paired with smart technologies, biogenic construction can lead to more efficient, sustainable, and eco-conscious building practices (33). The application of Biogenic materials for the construction industries that makes the environment friendlier, reduces the landfill challenges, protects the groundwater and supports long-term sustainability. Bio-based admixtures as admixtures are more useful in the construction industries due to its eco-friendly characteristics (34).

## 2. MATERIALS AND METHODS

Groundwater samples were taken from four specific places (S1 to S4) in Kasoa region. The decision to restrict groundwater investigations to a minimal number of points, often just four or five, frequently stems from pragmatic considerations. This constrained approach is primarily influenced by a convergence of critical factors. Foremost among these are stringent financial limitations. Furthermore, remote or sparsely populated regions often lack the essential infrastructure needed to facilitate more extensive or widespread data collection efforts. The spots were chosen because they were near possible pollution sources, had different numbers of people living nearby, and covered various types of land use, like farms, homes, and waste disposal areas. The strength and dependability of hydrogeological assessments are significantly enhanced by integrating measurements collected throughout different times of the year. Consequently, sampling procedures are strategically executed during the height of the wet season, which typically manifests between May and June. This helped make sure the samples showed the full range of groundwater situations in the area. All the fundamental parameters of ground water samples are tested in the laboratory.

To check the physical, chemical, and biological features of groundwater and decide if it is safe for different uses, certain steps are followed in assessing groundwater quality. These steps help find out if there is pollution, locate where the pollution is coming from, understand the risks, and make choices about managing water. Since groundwater systems are complicated and some pollutants are hard to see, it is important to use accurate and strong methods to protect both the environment and people's health.

The process usually starts with collecting water samples from places that are typical for the area, like hand-dug wells, springs, and boreholes.

It is important to use proper sampling techniques to make sure the samples are not polluted and the results are correct. For example, when checking for microorganisms, it is necessary to use clean containers, rinse them before use, label them properly, and keep them at the right temperature. When deciding where and how many samples to take, factors like how the land is used, how many people live nearby, how close the area is to possible pollution sources, and the type of underground water flow are all taken into account (35).

  

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The first part of the analysis is done in the field, where tests are carried out to measure things like pH, temperature, electrical conductivity (EC), total dissolved solids (TDS), and cloudiness.

These tests are done using portable tools, and they give results right away that show the basic quality of the water. While field tests are fast and easy, laboratory analysis is used to check for more detailed information such as microorganisms, nutrients, and heavy metals. These lab tests follow strict guidelines set by groups like the World Health Organization.

## 3. RESULTS AND DISCUSSION

The physicochemical results of the groundwater samples are summarized in the Table-1.

**Table 1: Physicochemical Analysis Results**

| Parameter | S1 | S2 | S3 | S4 | Ghana Standard (GS 175:2017) | WHO Guideline |
|---|---|---|---|---|---|---|
| Temp. (°C) | 28.4 | 28.5 | 28.3 | 28.4 | - | <30°C |
| pH | 7.30 | 7.22 | 7.28 | 7.25 | 6.5–8.5 | 6.5–8.5 |
| EC (µS/cm) | 1571 | 3015 | 3025 | 2958 | 300–700 | 1500 |
| TDS (mg/L) | 786 | 1510 | 1480 | 1255 | 1000 | 1000 |
| Salinity (ppt) | 0.78 | 1.57 | 0.99 | 1.05 | - | <1.0 |
| Turbidity (NTU) | 0.82 | 0.51 | 0.65 | 0.85 | 5 | 5 |
| Nitrate (mg/L) | 2.1 | 0.3 | 2.3 | 0.9 | 10 | 10 |
| Total Hardness (mg/L as $CaCO_3$) | 483.46 | 585.94 | 528.65 | 539.85 | 500 | 500 |
| Lead (mg/L) | 0.001 | 0.001 | 0.002 | 0.001 | 0.01 | 0.01 |
| Cadmium (mg/L) | 0.001 | 0.002 | 0.001 | 0.001 | 0.003 | 0.003 |

***pH value:*** The **pH values** for all samples were within the WHO guideline range of 6.5–8.5, indicating that the groundwater is neither acidic nor strongly alkaline (WHO, 2017; Todd & Mays,

  

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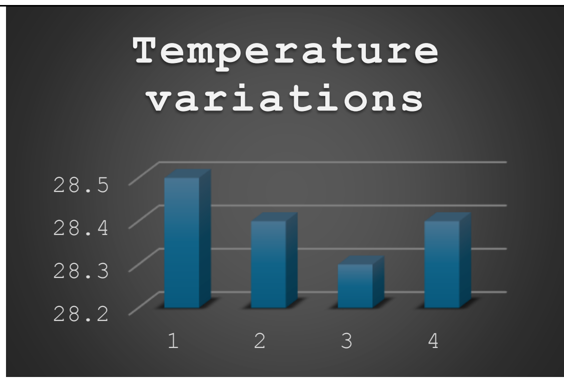
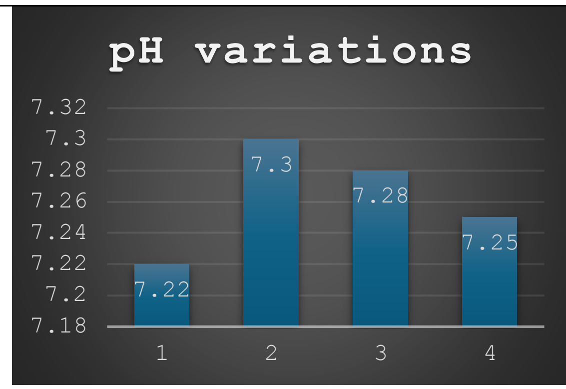
2005). Maintaining a near-neutral pH is essential for preserving the solubility of minerals and preventing corrosion of plumbing systems, as highlighted in reference (36).

***Electrical Conductivity and TDS*****:** All samples recorded **excessively high EC values** (above 700 µS/cm), with TDS levels in S2, S3, and S4 also exceeding the safe limit (1000 mg/L). This implies a high concentration of dissolved salts or ions and suggests possible mineral dissolution or contamination from anthropogenic sources such as fertilizers or waste. These findings align with the reference, that groundwater in many Ghanaian communities, though essential for domestic use, is increasingly threatened by anthropogenic activities (37).




(a)

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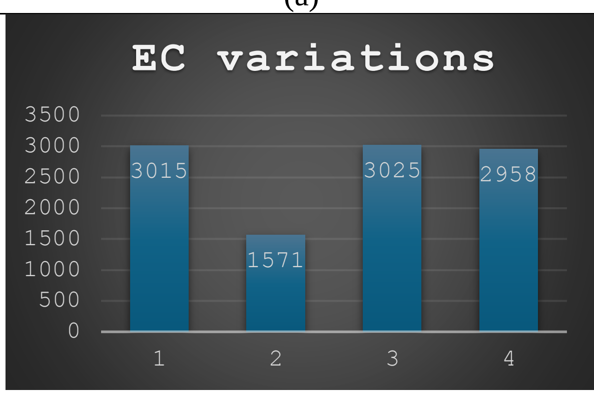


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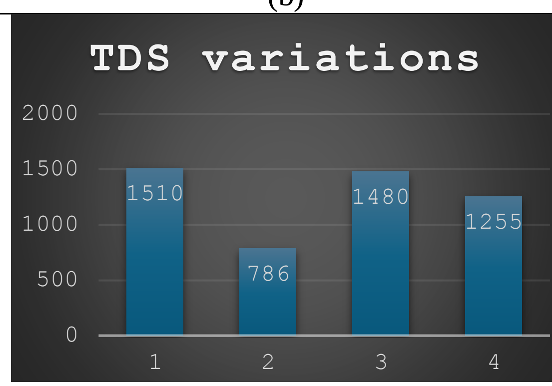


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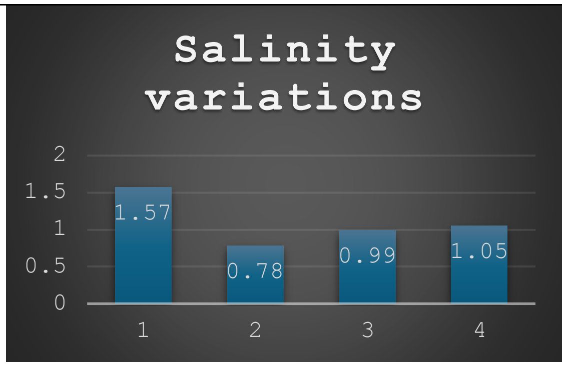


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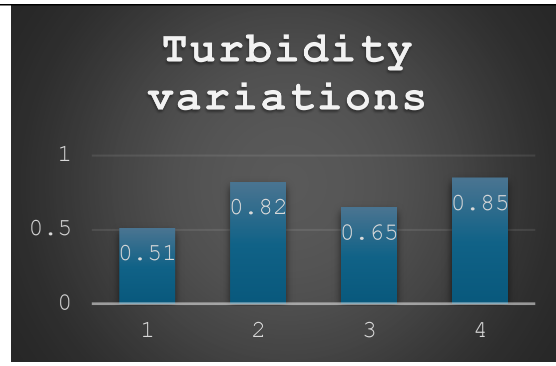


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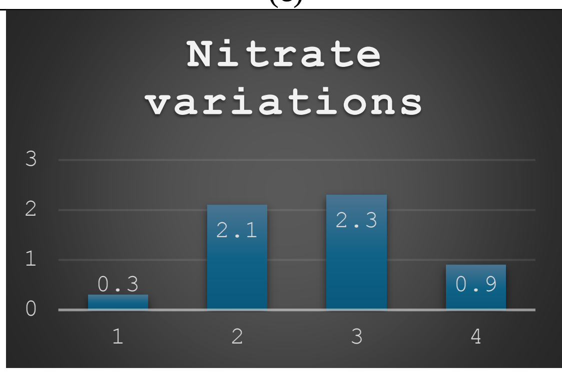


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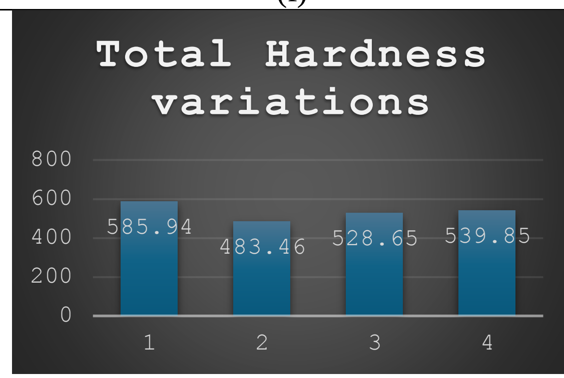


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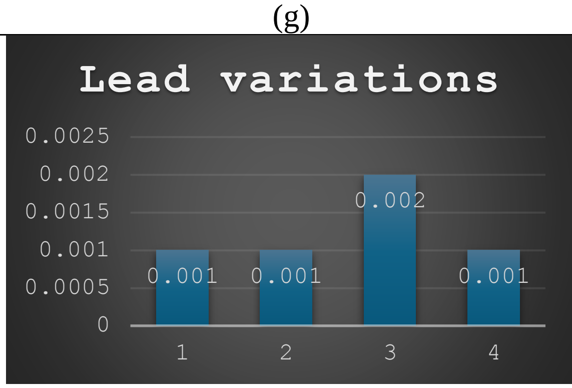
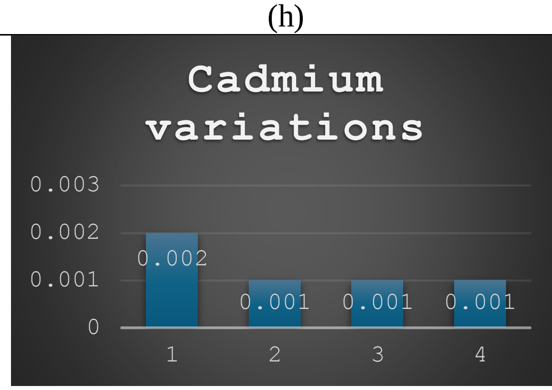



(i)




(j)

**Fig. 3: Variations in concentration for different samples**

***Hardness:*** Three samples (S2, S3, and S4) surpassed the limit for total hardness (500 mg/L), indicating "very hard water," which may affect domestic usability and contribute to scaling in household systems. This trend was similarly noted in groundwater studies in the Central Region of Ghana, where land-use practices contributed significantly to hardness levels (38).

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***Nitrate and Turbidity:*** All values were within the acceptable limit, suggesting minimal contamination from fertilizers or Faecal matter at the time of sampling. However, ongoing agricultural activities in the area could lead to future contamination, as observed in similar studies in Ghana (38). However, **T**urbidity levels can vary seasonally and may rise due to shallow aquifers being exposed to surface runoff, especially in the absence of wellhead protection (39).

***Heavy Metals:*** All lead and cadmium concentrations were well below WHO limits, indicating no significant contamination from industrial sources (39).

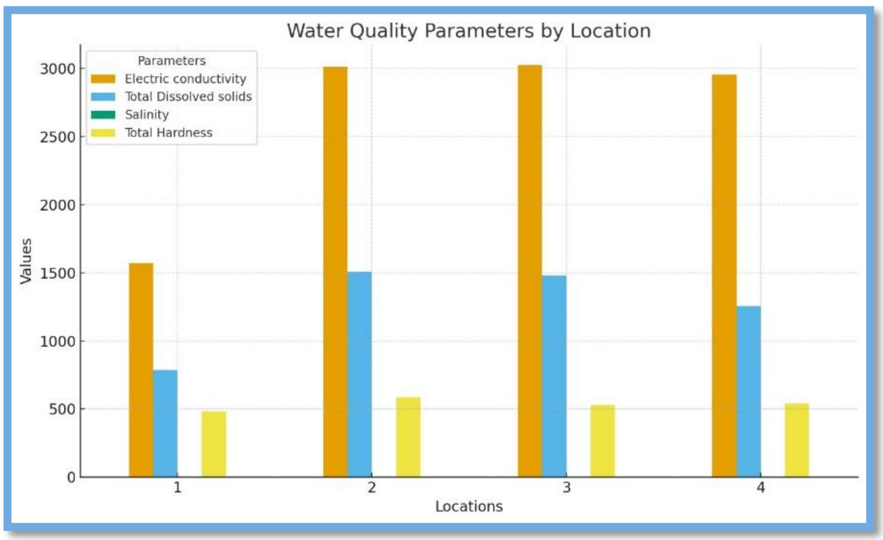


**Fig. 4: Stacked bar chart: Concentration of Water quality parameters by site**

As shown in Fig.3, Temperature, pH, turbidity, nitrate, lead and cadmium are found within the standard of WHO; electric conductivity is beyond the limit in all samples; salinity is high with sample 2 and sample 4; total hardness is higher than the standard value in three samples except sample 1. The stacked bar chart (Fig.4) is obtained using Python 3.10 to collectively represent the general condition of the water, offering insight into its purity or contaminant load. Elevated total bar height could suggest a more compromised aquatic environment or a broader scope of tested elements.

**Table 2: Microbial Analysis Result**

| Sample | Total Coliform (cfu/100mL) | Ghana Standard |
|---|---|---|
| S1 | Not Detected | 0 |
| S2 | Not Detected | 0 |
| S3 | Not Detected | 0 |
| S4 | Not Detected | 0 |

  

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As shown in Table-2, No microbial contamination was detected in any of the samples, suggesting that groundwater sources were microbiologically safe at the time of testing. While this might suggest short-term biological safety, such results do not rule out future microbial intrusion, especially during the rainy season when surface runoff increases. However, continuous monitoring is advised, especially during the rainy season when contamination risk increases (40), (41).

### *3.1 Water Quality Index (WQI) for each sample*

The water quality parameters are chosen because they directly affect the quality of water used for drinking. Weight arithmetic water quality index technique is adopted, as mentioned in reference (42) based on the standards for drinking water, suggested by the Indian Council of Medical Research (ICMR) and the Indian Standards Institution (ISI), are used to calculate the quality rating ($q_n$) and the unit weights ($W_n$).

**Table 3: Classification system (WHO)**

| Water Quality Category | WQI Range | Signs |
|---|---|---|
| Excellent | 0-25 | A |
| Good | 25-50 | B |
| Fair | 50-75 | C |
| Poor | 75-100 | D |
| Very poor | >100 | E |

### *WQI for Sample 1*

The importance assigned to different water quality measurements, often used in tools like the Water Quality Index (WQI), dictates how much each factor contributes to the final assessment of water health. The relative weights to each parameter are assigned based on their importance on quality measurement, as shown in Table-4.

**Table 4: Relative Weight of Parameters**

| Parameter | Measured Value (S1) | WHO Standard | Unit Weight ($W_1$) | Relative Weight ($W_1$) |
|---|---|---|---|---|
| pH | 7.30 | 8.5 | 4 | 0.13333 |
| EC (µS/cm) | 1571 | 700 | 4 | 0.13333 |
| TDS (mg/L) | 786 | 1000 | 4 | 0.13333 |
| Nitrate (mg/L) | 2.1 | 10 | 5 | 0.16667 |
| Total Hardness | 483.46 | 500 | 3 | 0.10000 |
| Lead (mg/L) | 0.001 | 0.01 | 5 | 0.16667 |

  

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| | | | | |
|---|---|---|---|---|
| Cadmium (mg/L) | 0.001 | 0.003 | 5 | 0.16667 |
| | | | $\sum w_1$ =30 | $\sum W_1$ = 1.000 |

Relative Weight = $\frac{W_1}{\sum W_1}$

pH = $\frac{4}{30}$ = 0.13333

Table-4 shows the Quality Rating Index and it is calculated as:

$Q_1 = \left(\frac{C_I}{S_I}\right) \times 100$ pH = $\left(\frac{7.30}{8.5}\right) \times 100 = 85.88$

**Table 5: Quality Rating Index for Sample 1**

| Parameter | Qi |
|---|---|
| pH | $\left(\frac{7.30}{8.5}\right) \times 100 = 85.88$ |
| EC | $\left(\frac{1571}{700}\right) \times 100 = 224.43$ |
| TDS | $\left(\frac{786}{1000}\right) \times 100 = 78.6$ |
| Nitrate | $\left(\frac{2.1}{10}\right) \times 100 = 21.0$ |
| Hardness | $\left(\frac{483.46}{500}\right) \times 100 = 96.69$ |
| Lead | $\left(\frac{0.001}{0.01}\right) \times 100 = 10.0$ |
| Cadmium | $\left(\frac{0.001}{0.003}\right) \times 100 = 33.33$ |

Table-5 shows the sub-index for each parameter. It was calculated as:

$$S_1 = W_1 \times Q_1$$

**Table 6: Computing for sub index for Sample 1**

| Parameter | Wi | Qi | Wi × Qi |
|---|---|---|---|
| pH | 0.13333 | 85.88 | 11.45 |
| EC | 0.13333 | 224.43 | 29.92 |
| TDS | 0.13333 | 78.6 | 10.47 |
| Nitrate | 0.16667 | 21.0 | 3.50 |
| Hardness | 0.10000 | 96.69 | 9.669 |

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| | | | |
|---|---|---|---|
| Lead | 0.16667 | 10.0 | 1.67 |
| Cadmium | 0.16667 | 33.33 | 5.55 |

WQI = 11.45+29.92+10.47+3.50+9.669+1.67+5.55 = 72.22 (Quality: Poor)

***WQI for Sample 2***

Water quality index (WQI) for sample-2 is shown in Table 7.

**Table 7: WQI for Sample 2**

| Parameter | Measured | WHO Std | Wi | Qi | Wi × Qi |
|---|---|---|---|---|---|
| pH | 7.22 | 8.5 | 0.1333 | 84.94 | 11.32 |
| EC (µS/cm) | 3015 | 700 | 0.1667 | 430.71 | 71.80 |
| TDS (mg/L) | 1510 | 1000 | 0.1333 | 151.00 | 20.13 |
| Nitrate (mg/L) | 0.3 | 10 | 0.1333 | 3.00 | 0.40 |
| Hardness | 585.94 | 500 | 0.1000 | 117.19 | 11.72 |
| Lead | 0.001 | 0.01 | 0.1667 | 10.00 | 1.67 |
| Cadmium | 0.002 | 0.003 | 0.1667 | 66.67 | 11.11 |

Total WQI = 128.14 (Quality: Unsuitable for drinking) (43), (44), (45)

***WQI for Sample 3***

Water quality index (WQI) for sample-3 is shown in Table 8.

**Table 8: WQI for Sample 3**

| Parameter | Measured | WHO Std | Wi | Qi | Wi × Qi |
|---|---|---|---|---|---|
| pH | 7.28 | 8.5 | 0.1333 | 85.65 | 11.42 |
| EC (µS/cm) | 3025 | 700 | 0.1667 | 432.14 | 72.04 |
| TDS (mg/L) | 1480 | 1000 | 0.1333 | 148.00 | 19.73 |
| Nitrate (mg/L) | 2.3 | 10 | 0.1333 | 23.00 | 3.07 |
| Hardness | 528.65 | 500 | 0.1000 | 105.73 | 10.57 |
| Lead | 0.002 | 0.01 | 0.1667 | 20.00 | 3.33 |
| Cadmium | 0.001 | 0.003 | 0.1667 | 33.33 | 5.56 |

Total WQI = 125.71 (Quality: Unsuitable for drinking) (43), (44), (45)

***WQI for Sample 4***

Water quality index (WQI) for sample-4 is shown in Table 9.

  

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**Table 9: WQI for Sample 4**

| Parameter | Measured | WHO Std | Wi | Qi | Wi × Qi |
|---|---|---|---|---|---|
| Ph | 7.25 | 8.5 | 0.1333 | 85.29 | 11.37 |
| EC (µS/cm) | 2958 | 700 | 0.1667 | 422.57 | 70.44 |
| TDS (mg/L) | 1255 | 1000 | 0.1333 | 125.50 | 16.73 |
| Nitrate (mg/L) | 0.9 | 10 | 0.1333 | 9.00 | 1.20 |
| Hardness | 539.85 | 500 | 0.1000 | 107.97 | 10.80 |
| Lead | 0.001 | 0.01 | 0.1667 | 10.00 | 1.67 |
| Cadmium | 0.001 | 0.003 | 0.1667 | 33.33 | 5.56 |

*Total WQI = 117.75 (Quality: Unsuitable for drinking)* [43], (44), [45]

**Table 10: Summarized WQI values of All Samples**

| Sample | WQI | Classification | Ref. |
|---|---|---|---|
| S1 | 72.22 | Poor | (43), (44) |
| S2 | 128.14 | Unsuitable for drinking | (43), (44) |
| S3 | 125.71 | Unsuitable for drinking | (43), (44) |
| S4 | 117.75 | Unsuitable for drinking | (43), (44) |

### 3.2 Statistical analysis using GraphPad Prism version 10.6.0

WQI for different sampling locations are shown a bar chart (Fig.5) to interpret the outcomes.

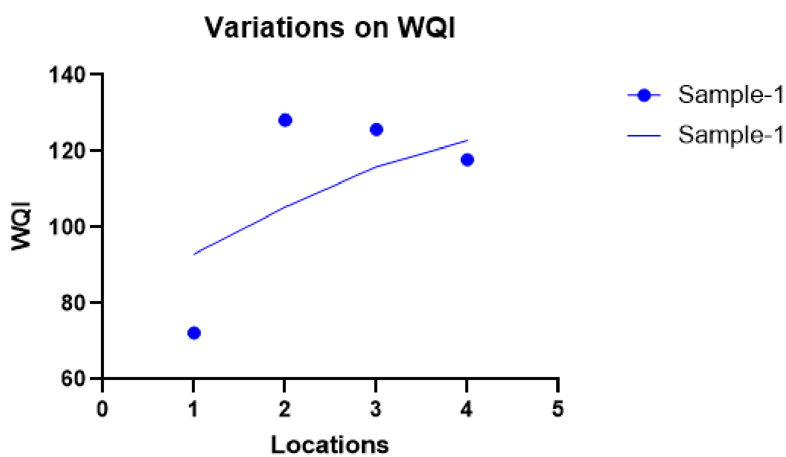


**Fig. 5: Variations on WQI**

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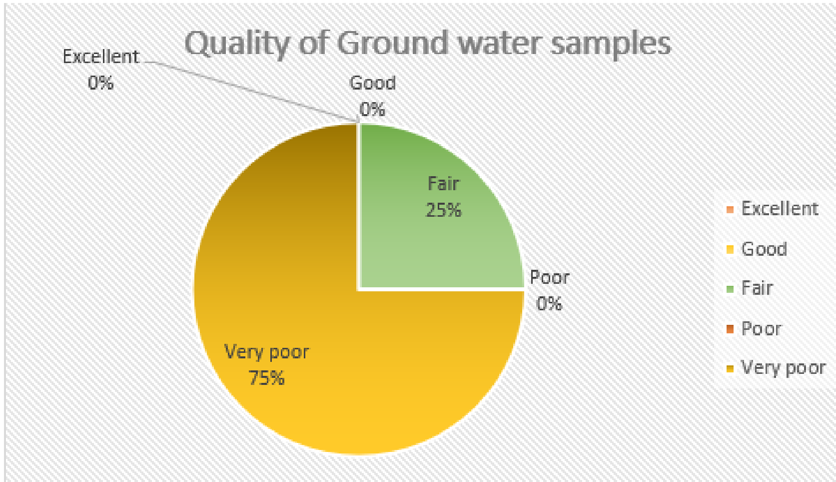


**Fig. 6: Pie chart showing Quality category in %**

The pie chart (Fig.6) clearly shows that 75% of study locations fall under 'very poor' category, totally unfit for drinking in the study area.

### 3.3 Consequences for Agricultural Productivity and Quality

***Hindrance to Growth and Productivity***

Diminished Agricultural Output (Fig.7) due to Saline Stress: The application of irrigation water bearing excessive concentrations of dissolved salts, specifically sodium, chloride, and other mineral solids, triggers the saturation and degradation of the topsoil (a process known as salinization). This chemically hostile root environment severely suppresses plant vigor, resulting in substantially depressed harvest volumes.

**Fig. 7: Field data showing impacts over crop yield, and quality near Kasoa**

  

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***Interference with Essential Nutrient Metabolism:***

Elevated sodium absorption from the irrigation supply actively competes with and disrupts the uptake of critical macronutrients chiefly potassium and calcium. Since these elements are foundational for robust physiological development, their inadequacy stunts the overall health of the crop [46].

***Degradation of Produce Quality***

When crops draw upon polluted subterranean water sources containing elevated levels of nitrates, heavy metals, or specific industrial residues, the flora bioaccumulates these chemical contaminants within their edible tissues. This build-up directly impairs the produce's sensory qualities (such as flavor and texture) and reduces its inherent nutritional density [47].

**Table 11: Undermining farm earnings through land deterioration**

| N: Neutral | L: Low | M: Medium | H: High |
|---|---|---|---|
| 33 respondents | 82 respondents | 64 respondents | 42 respondents |

### *3.4 Interpretation of Results*

- **Sample S1** had a WQI of **72.22**, which falls in the "very poor" category. This indicates that while the water is not extremely contaminated, it is still of **substandard quality**. The high electrical conductivity suggests significant dissolved salts, and although it is not immediately harmful, some form of treatment (such as filtration or reverse osmosis) is recommended before use for drinking purposes.
- **Samples S2, S3, and S4** all recorded WQI values above **100**, categorizing them as **unsuitable for drinking**. These high scores were primarily driven by:
  - Very **high EC values** (above 3000 µS/cm) in S2 and S3, as shown in ref (48)
  - **TDS levels exceeding 1250–1500 mg/L**, which affects taste and may strain the kidneys over long-term use, as reported in ref (49).
- **Hardness levels above 500 mg/L**, which can lead to scaling in pipes and digestive discomfort, as reported in ref (50), (51).

## 4. CONCLUSIONS

This study assessed the groundwater quality in Kasoa (Accra), a peri-urban community in Ghana's Central Region, by analyzing physicochemical and microbial parameters of four groundwater samples. The goal was to evaluate the safety of these sources for domestic use, particularly

  

ISSN: 2455-6939

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drinking, by applying the Water Quality Index (WQI) and comparing results against WHO and Ghana Standards Authority benchmarks.

***Key findings include*:**

1. Physicochemical parameters such as electrical conductivity (EC), total dissolved solids (TDS), and total hardness exceeded acceptable limits in several samples, particularly S2, S3, and S4. These suggest the presence of high concentrations of dissolved ions and minerals, which could pose health risks over time.

2. Microbial analysis detected no total coliform bacteria in any of the samples, indicating an absence of recent Faecal contamination and microbial safety at the time of testing.

3. Heavy metals, specifically lead and cadmium, were present in low concentrations within acceptable limits in all samples.

4. WQI results showed that only Sample S1 fell under the "Poor" category (WQI = 72.22), while Samples S2 (WQI = 128.14), S3 (WQI = 125.71), and S4 (WQI = 117.75) were classified as unsuitable for drinking without treatment.

Hence, the groundwater in Kasoa (Accra) is generally not safe for direct human consumption without treatment, primarily due to elevated TDS, EC, and hardness. Although microbial contamination was absent during this study, continued monitoring is recommended due to seasonal fluctuations and local sanitation challenges.

***Focus on control of EC, Total hardness and Salinity of ground water***

i) Integrated treatment system is essential to overcome the issues of excess concentration of hardness, salinity and electric conductivity. Pre-treatment followed by reverse osmosis and water softener would be the solutions to manage the existing problems of ground water samples.
ii) Biogenic waste can elevate soil and groundwater salinity as water-soluble salts (such as $Na^+$, $Cl^-$, $K^+$, $Ca^{2+}$, and $Mg^{2+}$) leach from decomposing material. The breakdown of organic matter further contributes by releasing dissolved ions into surrounding water sources. Water hardness may also rise due to the leaching of calcium and magnesium salts from deteriorating biogenic waste. Electrical conductivity (EC) indicates water's capacity to carry an electrical current, which escalates with higher ion concentrations. As biogenic waste decomposes, it discharges ions, thereby increasing EC. Additionally, the leaching of nitrates, phosphates, chlorides, and bicarbonates from biogenic materials further amplifies conductivity. Hence, it is advisable to allow for recycling of biogenic wastes, especially, banana, plantain, orange, potato peels so that the landfilling where leachate issues

  

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considerably reduced to counteract their impacts on ground water.

## 5. RECOMMENDATION

Successfully establishing sustainable methods for resource reclamation and effluent purification, especially within specific urban corridors like Kasoa near Accra, depends heavily upon the synchronized deployment of actionable logistics, robust stakeholder participation, and physically adaptable facilities.

***Urban Water Resource Management: Local Strategies for Purity and Efficiency***

*i. Distributed Purification Hubs*

Implement compact water cleansing mechanisms, such as slow sand filtration or basic chlorination units, located directly within residential districts or educational institutions. These localized systems offer significant advantages in terms of financial viability and simplified operational upkeep, particularly when contrasted with expansive, centralized treatment plants.

*ii. Atmospheric Precipitation Capture*

The collection of rainfall from building rooftops, incorporating fundamental filtration, for utility purposes rather than consumption (e.g., horticultural irrigation, general cleaning tasks). Municipalities should institute fiscal encouragement, like grants or tax concessions, to incentivize homeowners to install these water-saving solutions.

*iii. Domestic Water Reclamation*

Advocate for the adoption of straightforward household greywater reprocessing setups, enabling the repurposing of outflow from washbasins and showers for non-potable uses such as toilet flushing or garden watering. Comprehensive public education is vital to inform residents about secure reuse methodologies to preclude any contamination risks.

*iv. Oversight and Compliance Enforcement*

Civic authorities ought to establish dedicated aquatic purity assessment teams to conduct routine inspections and testing of groundwater sources, including boreholes and wells. Concurrently, strict adherence to environmental statutes must be enforced to curtail unauthorized waste deposition and industrial effluent discharge in proximity to vital water reserves.

## ACKNOWLEDGEMENT

Our sincere gratitude to Faculty of Engineering (KAAF University, Ghana) for their valuable support to complete the research on-time.

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