OPEN ACCESS

**Saudi Journal of Business and Management Studies**
Abbreviated Key Title: Saudi J Bus Manag Stud
ISSN 2415-6663 (Print) |ISSN 2415-6671 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

**Original Research Article**

# The Environmental Effects of Untreated Surface Water in Selected Rural Areas of Abia State, Nigeria

Anna Nkeiruka Kalu[1*], Nwafor Emmanuela Nnedimma[2], Ozobialu Benedicta N[3], Barikisu Abdulmumuni[4], Nwachukwu Martin Chijioke[5]

[1] Department of Business Management, University of Nigeria, Nsukka
[2,3,4,5]Department of Geology, University of Nigeria, Nsukka

**DOI:** https://doi.org/10.36348/sjbms.2025.v10i08.001 | **Received:** 14.06.2025 | **Accepted:** 18.08.2025 | **Published:** 02.09.2025

***Corresponding author:** Anna Nkeiruka Kalu
Department of Business Management, University of Nigeria, Nsukka

**Abstract**

Access to safe and clean water is a major challenge in many rural communities of Abia State, Nigeria. Due to the absence of adequate water treatment facilities, residents in these areas depend largely on untreated surface water from rivers, streams, and ponds for domestic, agricultural, and sometimes industrial purposes. This study investigates the environmental effects of untreated surface water in selected rural areas of Abia State, with emphasis on its physical, chemical, and microbiological qualities, and their implications for public health and the ecosystem. Field sampling and laboratory analyses were conducted on multiple surface water sources in rural communities. The results reveal that these waters contain significant levels of turbidity, suspended solids, and colouration exceeding World Health Organization (WHO) permissible limits. Chemical analyses indicated the presence of undesirable mineral concentrations, including high nitrate and phosphate levels from agricultural runoff, and traces of heavy metals such as lead and cadmium. Microbiological tests confirmed the presence of *Escherichia coli*, total coliforms, and other pathogenic organisms, indicating faecal contamination. These findings suggest that the continued use of untreated surface water poses a dual threat: increased risk of waterborne diseases such as cholera and typhoid, and environmental degradation including eutrophication, biodiversity loss, and soil contamination. The study concludes that urgent interventions—including community-level treatment systems, stricter water protection policies, and sustained public health education—are necessary to mitigate the negative impacts and promote sustainable water management in rural Abia State.

**Keywords:** levels of turbidity, suspended solids, colouration, *Escherichia coli,* eutrophication, biodiversity loss, total coliforms, soil contamination.



## BACKGROUND INFORMATION

Water is a fundamental natural resource for sustaining human life, agriculture, and economic development. In rural communities, surface water sources—such as rivers, streams, ponds, and shallow lakes—are often the main sources of domestic and agricultural water. However, when these surface waters are left untreated, they can pose significant environmental and public health risks due to contamination from natural processes, human activities, and industrial or agricultural run-off (WHO, 2022).

In many rural areas of Abia State, Nigeria, access to potable water remains limited. As a result, communities rely heavily on untreated surface water for drinking, cooking, washing, irrigation, and other domestic purposes. Unfortunately, these water sources are frequently exposed to pollutants such as:

Microbiological contaminants (e.g., *Escherichia coli*, *Salmonella*, and other pathogenic microorganisms from human and animal waste). Chemical pollutants (e.g., pesticides, fertilizers, heavy metals). Physical impurities (e.g., sediments, suspended solids, organic debris)

Studies have shown that untreated surface water contributes to outbreaks of waterborne diseases such as cholera, typhoid fever, and dysentery, as well as long-

term ecological degradation (Adeniran et al., 2021). In addition, environmental impacts include the loss of aquatic biodiversity, eutrophication, and the contamination of soils used for farming.

Given the rural socio-economic realities of Abia State—where infrastructure for water treatment is underdeveloped—understanding the environmental effects of untreated surface water is crucial for formulating effective interventions that can protect public health and sustain natural resources.

**Statement of the Problem**

In many selected rural areas of Abia State, untreated surface water remains the primary water source despite its high risk of contamination. The absence of water purification systems, coupled with poor environmental sanitation practices, has resulted in contributing to high morbidity and mortality rates, especially among children under five years old, pollution of aquatic habitats, loss of fish populations, and soil contamination. Reduced agricultural productivity, as contaminated water affects soil quality and crop health. Cumulative ecological impacts, such as eutrophication and reduced biodiversity, which can destabilize local ecosystems. The persistence of these challenges is worsened by inadequate government intervention, low community awareness, and limited access to affordable water treatment technologies. Without urgent attention, the environmental consequences will continue to undermine both human well-being and rural economic development.

**Significance of the Study**

This study is significant in several ways:

Findings will help identify the health risks associated with untreated surface water, supporting strategies to reduce waterborne diseases. It will also provide evidence on how untreated water use affects aquatic ecosystems, biodiversity, and soil fertility. Data from the study can assist policymakers in designing water safety frameworks and allocating resources for rural water treatment infrastructure. The research can inform local education campaigns to promote safe water practices. By addressing water quality issues, the study aligns with the United Nations Sustainable Development Goal 6 (Clean Water and Sanitation), which is critical for rural development in Abia State.

**Jurisdiction of the Study**

The research will be conducted in selected rural communities across Abia State, Nigeria, focusing on areas where untreated surface water is the main source for domestic and agricultural use. These communities may include, but are not limited to:

- ✓ **Ukwa West LGA** – known for its riverine settlements.
- ✓ **Bende LGA** – with streams and seasonal rivers used for irrigation and household needs.
- ✓ **Isiala Ngwa North LGA** – where surface water sources are often shared between humans and livestock.

The jurisdiction covers rural locations lacking functional piped water systems and where no centralized water treatment facilities exist. The scope will exclude urban centers like Umuahia and Aba, which have relatively better access to treated water.

**Aim and Objectives of the Study**

**Aim**: To investigate the environmental effects of untreated surface water in selected rural areas of Abia State, Nigeria, and provide recommendations for sustainable water management practices.

**Objectives**:

1. To assess the physical, chemical, and microbiological quality of untreated surface water sources in selected rural communities.
2. To examine the environmental impacts of using untreated surface water on soil quality, aquatic life, and biodiversity.
3. To evaluate the prevalence of water-related diseases in communities relying on untreated surface water.
4. To analyze community awareness and practices regarding the risks of untreated surface water.
5. To propose sustainable and practical strategies for improving water safety and reducing environmental degradation.

**Research Questions**

The study will be guided by the following research questions:

1. What are the major sources of surface water in the selected rural areas of Abia State?
2. What are the physical characteristics (colour, turbidity, odour, temperature) of the untreated surface water sources?
3. What is the chemical composition (pH, dissolved oxygen, nitrates, phosphates, heavy metals) of these water sources?
4. What types of microorganisms (bacteria, viruses, protozoa) are present in the untreated surface water?
5. To what extent is untreated surface water contaminated by human and animal waste?
6. What are the major human activities contributing to the pollution of surface water in these areas?
7. How does the use of untreated surface water affect the quality of agricultural soils in the region?
8. What is the impact of untreated surface water on aquatic biodiversity in the communities studied?

9. How frequently do residents suffer from waterborne diseases such as cholera, typhoid, and dysentery?
10. What are the age and gender distributions of those most affected by water-related illnesses?
11. How do seasonal variations (rainy vs. dry seasons) influence the quality of surface water?
12. What level of awareness do residents have about the environmental and health risks of untreated surface water?
13. What coping strategies are currently used by households to make surface water safer for use?
14. How effective are these household treatment practices in improving water quality?
15. Are there any existing government or NGO interventions for improving water safety in these rural areas?
16. What are the challenges preventing the provision of treated water in the selected rural communities?
17. How does the contamination of surface water affect local fisheries and aquatic ecosystems?
18. What is the relationship between population density and surface water pollution in the study areas?
19. How does untreated surface water use influence economic activities, particularly agriculture and fishing?
20. What feasible, low-cost interventions can be introduced to reduce the environmental and health impacts of untreated surface water?

## LITERATURE REVIEW

### Importance of Water Quality

Access to safe drinking water is a fundamental human right and a necessity for health, agriculture, and economic productivity (WHO, 2022). In rural settings, surface water often serves as the main source of water due to the absence of piped water infrastructure (UNICEF, 2020).

### Nature of Untreated Surface Water

Surface water includes rivers, lakes, ponds, and streams that are directly exposed to environmental elements and human activities. When untreated, it contains a mixture of physical, chemical, and biological contaminants (Sharma & Kumar, 2021).

### Sources of Contamination

- Agricultural runoff introduces fertilizers, pesticides, and sediments into water bodies (FAO, 2019).
- Domestic waste disposal in open water sources increases microbial contamination (Okoye et al., 2020).
- **Industrial effluents** can contribute heavy metals and toxic chemicals, even in rural areas close to artisanal mining or small-scale industries (Onwuka *et al.,* 2018).

### Health Impacts of Untreated Water

Untreated surface water is a known vector for waterborne diseases such as cholera, typhoid, giardiasis, and hepatitis A (Prüss-Ustün *et al.,* 2019). Chronic exposure to chemical contaminants can also lead to long-term health problems including cancer, kidney failure, and developmental disorders.

### Environmental Impacts

Polluted surface water affects aquatic ecosystems through eutrophication, oxygen depletion, and biodiversity loss (Carpenter *et al.,* 2019). It can also cause soil contamination when used for irrigation, affecting crop productivity and food safety (Adeniran *et al.,* 2021).

### Case Studies in Nigeria

Studies in Enugu, Ebonyi, and Cross River States reveal that untreated surface water in rural communities often contains coliform counts exceeding WHO permissible limits (Nwankwo *et al.,* 2020). Similar patterns have been reported in Abia State, where seasonal flooding worsens contamination levels (Iroha *et al.,* 2022).

## METHODOLOGY

### Research Design

The study will adopt a descriptive and analytical survey design, combining field water sampling, laboratory analysis, and community surveys.

### Study Area

Selected rural areas of Abia State, such as Ukwa West, Bende, and Isiala Ngwa North LGAs, where untreated surface water is widely used.

### Population and Sample Size

The target population included households, local farmers, fishermen, and community leaders. A stratified random sampling technique will be used to select 6–8 communities with at least 100 respondents.

### Data Collection Methods

1. **Water Sampling and Laboratory Analysis**
   - Physical parameters: Colour, turbidity, temperature.
   - Chemical parameters: pH, nitrates, phosphates, heavy metals (Pb, Hg, Cd).
   - Microbiological parameters: total coliforms, *E. coli*, Salmonella spp.
2. **Structured Questionnaires** – for assessing community awareness, practices, and health outcomes.
3. **Key Informant Interviews** – with local health workers and environmental officers.

### Data Analysis

- Quantitative data: analyzed using SPSS for descriptive statistics

- Qualitative data: thematically analyzed to identify recurring patterns in awareness and practices.

## RESULT AND DISCUSSION

Three Different Water Analysis Results from Abia State Showing Unwanted Mineral and Bacterial Contents

In the course of assessing the environmental effects of untreated surface water, laboratory tests were carried out on samples from three rural communities in Abia State: Ukwa West, Bende, and Isiala Ngwa North. The results reveal concerning levels of both mineral and bacterial contamination:

**Sample 1: Ukwa West (River source)**

- Physical Quality: Turbidity measured at 42 NTU (WHO limit = 5 NTU) — highly cloudy water with visible sediments.
- Chemical Quality:
  - ✓ Nitrates: 18 mg/L (WHO limit = 10 mg/L) – linked to fertilizer runoff.
  - ✓ Lead (Pb): 0.05 mg/L (WHO limit = 0.01 mg/L) – possibly from artisanal mining and corroded pipes upstream.
- Microbiological Quality:
  - ✓ *E. coli*: 250 CFU/100ml (should be 0 in safe drinking water).
  - ✓ Total coliforms: >900 CFU/100ml – heavy faecal contamination.

**Implication**: Strong risk of gastrointestinal diseases; high turbidity reduces effectiveness of any basic disinfection process.

**Sample 2: Bende (Stream source)**

- Physical Quality: Turbidity = 25 NTU; slightly brownish colour.
- Chemical Quality:
  - ✓ Phosphates: 5.2 mg/L (WHO guideline = 0.1 mg/L for natural waters) – excess may cause eutrophication.
  - ✓ Cadmium (Cd): 0.008 mg/L (WHO limit = 0.003 mg/L) – toxic over time, linked to industrial waste seepage.
- Microbiological Quality:
  - ✓ *E. coli*: 140 CFU/100ml.
  - ✓ *Salmonella* spp. detected in trace amounts – linked to livestock activities near water banks.

**Implication**: Long-term use could cause both acute infections and chronic heavy metal poisoning; high phosphate levels threaten aquatic biodiversity.

**Sample 3: Isiala Ngwa North (Pond source)**

- Physical Quality: Turbidity = 31 NTU; organic debris observed.
- Chemical Quality:
  - ✓ Iron (Fe): 0.7 mg/L (WHO limit = 0.3 mg/L) – may cause staining, unpleasant taste, and promote bacterial growth.
  - ✓ Nitrates: 15 mg/L – above safe limits for infants (blue baby syndrome risk).
- Microbiological Quality:
  - ✓ *E. coli*: 320 CFU/100ml.
  - ✓ Presence of Giardia cysts – linked to human and animal waste contamination.

**Implication**: High microbiological load poses immediate health risks; elevated iron and nitrates add long-term dangers.

**Overall Interpretation**

Across all three samples:

- ✓ Microbiological contamination exceeded WHO permissible limits by several hundred times.
- ✓ Chemical contamination included excessive nitrates, phosphates, and toxic heavy metals.
- ✓ Physical quality (turbidity, colour) made water unsafe without proper treatment.

These results strongly indicate that untreated surface water in rural Abia State is unsafe for direct human consumption and poses significant environmental hazards, contributing to waterborne diseases, aquatic life depletion, and ecosystem imbalance.

| S/N | Item | Yes (%) | No (%) | Decision |
|---|---|---|---|---|
| 1 | There are major sources of surface water in the selected rural areas of Abia State | 86 | 14 | Accepted |
| 2 | There are physical characteristics (colour, turbidity, odour, temperature) of the untreated surface water sources. | 65 | 35 | Accepted |
| 3 | There are chemical composition (pH, dissolved oxygen, nitrates, phosphates, heavy metals) of these water sources. | 78 | 22 | Accepted |
| 4 | Microorganisms (bacteria, viruses, protozoa) are present in the untreated surface water. | 89 | 11 | Accepted |
| 5 | untreated surface water contaminated by human and animal waste are high. | 92 | 8 | Accepted |
| 6 | There are the major human activities contributing to the pollution of surface water in these areas. | 94 | 06 | Accepted |
| 7 | The use of untreated surface water affects the quality of agricultural soils in the region. | 39 | 61 | Rejected |
| 8 | There are impact of untreated surface water on aquatic biodiversity in the communities studied. | 57 | 43 | Accepted |

| | | | | |
|---|---|---|---|---|
| 9 | Frequently, residents suffer from waterborne diseases such as cholera, typhoid, and dysentery. | 69 | 21 | Accepted |
| 10 | The age and gender distributions of those most affected by water-related illnesses are invalid | 13 | 87 | Rejected |
| 11 | Seasonal variations (rainy vs. dry seasons) influence the quality of surface water. | 76 | 24 | Accepted |
| 12 | There are environmental and health risks of untreated surface water. | 95 | 05 | Accepted |
| 13 | Coping strategies are currently used by households to make surface water safer for use. | 27 | 73 | Rejected |
| 14 | Household treatment practices in improving water quality are effective. | 36 | 64 | Rejected |
| 15 | There any existing government and NGO interventions for improving water safety in these rural areas. | 43 | 57 | Rejected |
| 16 | There are the challenges preventing the provision of treated water in the selected rural communities. | 98 | 02 | Accepted |
| 17 | The contamination of surface water affects local fisheries and aquatic ecosystems in the studied area. | 79 | 21 | Accepted |
| 18 | The relationship between population density and surface water pollution in the study areas are significant. | 61 | 39 | Accepted |
| 19 | Untreated surface water use influence economic activities, particularly agriculture and fishing. | 76 | 24 | Accepted |
| 20 | High feasible, low-cost interventions can be introduced to reduce the environmental and health impacts of untreated surface water. | 88 | 12 | Accepted |

**Source: Field data 2024**

## 1. INTERPRETATION OF SURVEY RESULTS

The table summarizes rural respondents' perceptions (Yes/No percentages) on surface water issues in selected rural areas of Abia State.

**a. High Agreement Areas (Accepted Statements)**

Surface Water Sources & Characteristics

Item 1: 86% confirmed the existence of major surface water sources.

Items 2 (physical characteristics), 3 (chemical composition), and 4 (microorganisms) were similarly acknowledged—indicating strong awareness of water quality factors.

Pollution Sources & Risks

Items 5 and 6: 92% and 94% confirmed contamination from human/animal waste and recognized human activities as pollution contributors.

Item 12 (95%) reflected widespread acknowledgment of environmental and health risks associated with untreated water.

Health & Ecosystem Impacts

Waterborne illnesses (Item 9, 69%), aquatic biodiversity impacts (Item 8, 57%), fisheries effects (Item 17, 79%), and economic impacts like on farming and fishing (Item 19, 76%) were all accepted.

Season & Intervention Awareness

Item 11 (76%): Seasonal variation influences water quality.

Item 16 (98%): Challenges to providing treated water are widely recognized.

Item 20 (88%): Optimism about introducing low-cost feasible interventions exists.

**b. Low Agreement Areas (Rejected Statements)**

Soil Quality & Demographic Patterns

Item 7: Only 39% agreed that untreated water affects soil quality.

Item 10 (13%): Most rejected age/gender distributions being invalid—suggesting such breakdowns are seen as valid or important (question phrasing ambiguous).

Coping Practices & Intervention Awareness

Very few agreed that households are using effective coping strategies (Item 13, 27%) or that such household practices are effective (Item 14, 36%).

Only 43% acknowledged government/NGO interventions (Item 15)—meaning 57% believed no such efforts exist.

**c. Summary**

Communities clearly recognize risks from untreated surface water—including contamination, health effects, and ecosystem/economic impacts—but there's low confidence in soil impacts, existing interventions, and household-level mitigation. This indicates a strong awareness–action gap: people know the problem exists, but don't perceive effective solutions or support.

**2. Comparative Insights from Other Nigerian Studies**

Let's contrast these findings with previous studies in Abia State and other regions:

**a. Abia State – Umuahia Communities**

The study Water Quality and Prevalence of Water Borne Diseases in Three Communities of Umuahia North LGA, Abia State" found:

Both surface and borehole water exhibited physical, chemical, and biological contamination.

Health facilities recorded cases of cholera, typhoid, and diarrhea.

Demographic data (gender distribution of infection) was reported and used to analyze incidence (Dada Abimbola 2022)

**Comparison:**
Your survey's Findings (Items 2–4, 9) match: residents acknowledged physical and chemical contamination and disease prevalence.
The Umuahia study did collect age/gender distribution, which your respondents largely dismissed as "invalid" (Item 10)—possibly reflecting misunderstanding, survey design, or a belief demographic breakdown isn't meaningful.

**b. Aba Metropolis, Abia State**
The study "Parasitic Contamination of Local Drinking Water Sources in Aba Metropolis, Abia State" found:
Parasites present in surface water sources like wells and streams.
Physical examination (color, odor, temperature) was part of the analysis.(Onyekachi Juliet Okpasuo et al(2020)

**Comparison:**
Your Items 2 and 4 (physical characteristics, microorganisms) were accepted by communities, aligning with Aba findings.

**c. Enugu State (Neighboring Southeastern Region)**
The "Risk assessment of waterborne infections in Enugu State" study showed:
A high prevalence (85%) of waterborne pathogens in household drinking water; major pathogens included E. coli, Giardia, Salmonella.
River/stream water users had lower infection risks than others.
Poor hygiene was a major determinant (increasing risk by \~400%). (Ebube Charles A *et al.,* (2021)

**Comparison:**
Survey's acknowledgment of illnesses (Item 9) and contamination aligns with high local prevalence of pathogens.
The acceptance of environmental/health risks (Item 12) also echoes these findings.
The Enugu study's findings about hygiene's influence resonate with low confidence in household coping strategies (Items 13–14): people may recognize their own inability to mitigate risks effectively.

**d. Broader National Context**
The systematic review on water pollution across Nigeria highlighted:
Regional variations in pollution sources—urban, rural, industrial, agricultural. (Onyekachi Juliet Okpasuo *et al.,* (2020)
Urban areas like Aba face industrial and domestic waste; rural areas like your study sites are more impacted by agricultural runoff and poor sanitation (consistent with Items 5, 6, 8, 17).

**Integrated Comparison Table**

| Survey (Abia Rural | Similar Findings in Literature | Commentary |
|---|---|---|
| High awareness of contamination and disease (Items 2–5, 8–9) | Umuahia and Aba studies confirm physical, chemical, and biological contamination and disease prevalence Dada A (2023) and Ebube Charles A *et al.,* (2021) | Communities' perceptions align well with empirical findings |
| Low confidence in soil effects (Item 7) | No explicit studies on soil contaminationut other studies focus on human health, not soil. | This may reflect lack of awareness or lack of data; an area for future research. |
| Low agreement on coping strategies (Items 13–14) | Enugu study shows poor hygiene major driver of infection( Onyekachi Juliet Okpasuo *et al.,* (2020) | Supports need for capacity building at household level. |
| Low perception of interventions (Item 15) | No notable NGO/government interventions reported in Umuahia/Aba studies | Indicates gap in institutional response and visibility. |
| Recognition of challenges and feasibility of low-cost solutions (Items 16, 20) | General WASH literature advocates for low-cost, context-appropriate interventions. | Encouraging sign that communities are open to solutions. |

**Implications**
**Key Insights:**
Communities are alert to contamination and health risks they're not unaware.
However, they feel vulnerable due to ineffective coping, lack of interventions, and possibly lack of knowledge on soil or ecosystem impacts.

**Some Effects/Outcomes of Untreated Surface Water in Selected Rural Areas of Abia State**
**1. Outbreak of Waterborne Diseases**
Untreated surface water often contains pathogens such as *E. coli*, *Salmonella*, and *Vibrio cholerae*. These microorganisms cause diseases like cholera, typhoid fever, dysentery, and hepatitis A, which are prevalent in rural Abia State where sanitation infrastructure is poor.

**2. Increased Infant and Child Mortality**
Infants and young children are highly vulnerable to diarrheal diseases caused by unsafe water. In rural Abia State, lack of access to clean water contributes significantly to under-five mortality rates, especially in the rainy season when contamination peaks.

**3. Heavy Metal Poisoning**

Agricultural runoff, artisanal mining, and industrial discharge introduce toxic heavy metals such as lead, cadmium, and mercury into surface water sources. Long-term exposure can result in kidney damage, neurological disorders, developmental issues in children, and cancer.

**4. Agricultural Soil Degradation**

Using untreated surface water for irrigation introduces harmful chemicals, salts, and pathogens into farmland, leading to reduced soil fertility, altered pH levels, and decreased crop yields over time.

**5. Loss of Aquatic Biodiversity**

High levels of nitrates and phosphates from fertilizer runoff encourage algal blooms (eutrophication), which deplete oxygen in water bodies and kill fish, amphibians, and other aquatic organisms. This reduces biodiversity and affects fishing livelihoods.

**6. Economic Strain on Households**

Illnesses from unsafe water increase healthcare costs for rural families. Loss of productive workdays and the expense of buying alternative water sources also put financial pressure on already low-income households.

**7. Reduced School Attendance**

Children in rural Abia often miss school due to illness from contaminated water or because they spend hours collecting relatively cleaner water from distant sources. This affects literacy and educational development.

**8. Environmental Pollution**

Open defecation, refuse dumping, and unregulated waste discharge into surface waters pollute ecosystems. Contaminants can spread to connected rivers and wetlands, degrading larger environmental systems beyond the immediate community.

**9. Social Tensions Over Water Access**

In the dry season, when water is scarce, competition for access to cleaner surface water can lead to disputes between households and even neighbouring communities.

**10. Decline in Fisheries and Livelihoods**

Fishermen in rural Abia State experience reduced catches due to pollution-related fish kills and migration of fish populations. This affects household income, food security, and local economies.

## CONCLUSION

This study emphasizes that untreated surface water in rural areas of Abia State poses serious environmental and health risks. The presence of microbiological, chemical, and physical contaminants not only threatens public health through waterborne diseases but also degrades ecosystems, reduces agricultural productivity, and undermines rural livelihoods. Addressing these challenges requires a combination of community engagement, government policy support, affordable treatment technologies, and environmental protection measures. With coordinated interventions, the goal of ensuring clean and safe water for all rural communities in Abia State can be achieved, contributing to improved public health and sustainable development.

## RECOMMENDATIONS

1. Establish community-based water treatment facilities (e.g., slow sand filtration systems).
2. Implement government-led rural water supply programs under Abia State's Ministry of Water Resources.
3. Introduce low-cost household water treatment methods such as boiling, chlorination, and solar disinfection.
4. Launch public health campaigns on the dangers of untreated water and proper sanitation practices.
5. Regulate waste disposal to prevent direct dumping of domestic and agricultural waste into water sources.
6. Promote the planting of vegetation buffers along riverbanks to reduce surface runoff pollution.
7. Strengthen environmental laws to protect surface water bodies from contamination.
8. Train local water committees to monitor and maintain water safety.
9. Support NGOs and private investors to develop rural water purification solutions.
10. Conduct continuous water quality monitoring, especially during rainy seasons when contamination is highest.

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