ISSN: 2516-2644
Volume 13, Number 1, 2025
International Journal of Environmental Research
Journal Homepage:www.bwjournal.org
Bushwealth Academic Journals

HOUSEHOLD WATER INSECURITY AND HEALTH OUTCOMES IN FLOOD-PRONE COMMUNITIES OF BAYELSA STATE

Dr. Tarelayefa Clarke
0706 044 0235
Isaac Jasper Boro College of Education Sagbama Bayelsa State

Abstract
This study examined household water insecurity and associated health outcomes in flood-prone communities of Bayelsa State, Nigeria. A cross-sectional survey design was adopted, with 384 respondents selected from Yenagoa, Brass, Nembe, and Amassoma using a multi-stage sampling technique. Data were collected using the Household Water Insecurity and Health Outcomes Questionnaire (HWIHQQ), with a reliability coefficient of 0.82. Descriptive statistics and inferential analyses (t-test and ANOVA) were employed at a 0.05 significance level. Findings revealed significant seasonal variation in water insecurity, with greater challenges during the flood season. Households adopted coping strategies such as water treatment and reliance on alternative sources, though these were associated with increased stress and reduced well-being. Flooding significantly degraded water quality and increased the prevalence of water-related illness. Access to functional water infrastructure was found to significantly reduce household vulnerability. The study concludes that seasonal flooding is a key driver of water insecurity and health risks and recommends the provision of flood-resilient water systems and improved water infrastructure.

Keywords: Household, Water Insecurity, Health Outcomes, Flooding, Water Infrastructure, Bayelsa State

Introduction
Water security remains a critical public health and development concern in many parts of sub-Saharan Africa, particularly in environmentally fragile regions where hydrological variability and infrastructural deficits intersect. In Nigeria, access to safe and reliable water supply is uneven , with rural and flood-prone communities experiencing the greatest challenges (World Health Organization & UNICEF, 2023). Bayelsa State, located in the Niger Delta, is characterized by low-lying terrain, and recurrent seasonal flooding, all of which significantly influence household water access and quality. Flood events often lead to the contamination of surface and groundwater sources, thereby increasing the risk of water insecurity and associated health outcomes among residents (Efe, 2022). Household water insecurity refers to the inability to access sufficient, safe, and reliable water for domestic use, including drinking, cooking, and hygiene (Food and Agriculture Organization, 2021). In flood-prone environments, water insecurity is shaped not only by physical availability but also by spatial inequalities, infrastructure distribution, and socio-economic conditions . In flood-prone environments such as Bayelsa State, the interaction between hydrological processes and human systems creates complex patterns of water access that vary across space and time. Seasonal flooding, while providing water abundance, often paradoxically reduces access to potable water due to contamination and infrastructural disruption (Ayanlade & Jegede, 2018).
In response to water insecurity, households adopt coping strategies such as wa ter treatment , reliance on alternative water sources such as rainwater or vendors, and increased effort in water collection. However, these strategies may impose additional physical and psychological burdens. such coping strategies often come with trade-offs, including physical stress, time burden, and reduced overall well-being (Obeta, 2019). In many cases, vulnerable groups such as children and

women bear a disproportionate share of these burdens, reflecting broader socio-spatial inequalities in resource access.

Furthermore, flooding significantly alters water quality conditions, leading to increased exposure to waterborne diseases such as diarrhoea, cholera, and skin infections. Studies have shown that floodwaters often carry contaminants from waste dumps, sewage systems, and polluted surfaces into drinking water sources, thereby posing serious public health risks (Efe & Mogborukor, 2022). Access to safe and improved water infrastructure, such as boreholes and piped systems, plays a crucial role in mitigating these risks. However, in many flood-prone communities, such infrastructure is either inadequate, poorly maintained, or vulnerable to flood damage, thereby exacerbating household vulnerability to water insecurity and health risks (Adedeji & Odugbemi, 2021).

Despite these connections, limited studies have integrated environmental processes, infrastructure, and health outcomes within a unified framework in Bayelsa State. This study addresses this gap by examining seasonal patterns of water insecurity, adaptive practices, water quality impacts and the role of infrastructure.

Aim and Objectives of the Study

This study aimed to investigate household water insecurity and health outcomes in flood-prone communities of Bayelsa State. Specifically, the study aims to:

1. Assess the seasonal patterns of household water insecurity in flood-prone communities.
2. Examine the adaptive practices adopted by households in response to water insecurity during flood events, and their implications for wellbeing.
3. Determine the impact of flooding on water quality conditions and the resulting health outcomes experienced by residents.
4. Evaluate the role of access to water infrastructure in shaping household vulnerability to water insecurity and associated health risks.

Research Question

1. What are the seasonal patterns of household water insecurity in flood-prone communities?
2. What are the adaptive practices adopted by households in response to water insecurity during flood events, and their implications for wellbeing?
3. What is the impact of flooding on water quality conditions and the resulting health outcomes experienced by residents?
4. What role does access to water infrastructure play in shaping household vulnerability to water insecurity and associated health risks?

Hypotheses

$H0_1$: There is no significant difference in household water insecurity between seasons in flood-prone communities

$H0_2$: There is no significant difference in household wellbeing among households using different adaptive practices to water insecurity.

$H0_3$: There is no significant difference in health outcomes among residents exposed to different levels of flooding and water quality conditions.

$H0_4$: There is no significant difference in household vulnerability to water insecurity based on access to water infrastructure.

Methodology

The research was carried out in Bayelsa State, situated within the Niger Delta region of Nigeria. The state is characterized by a predominantly low-lying coastal landscape, intersected by numerous

rivers and creeks, which makes many of its communities highly susceptible to seasonal flooding. Administratively, Bayelsa State is made up of eight Local Government Areas (LGAs): Brass, Ekeremor, Kolokuma/Opokuma, Nembe, Ogbia, Sagbama, Southern Ijaw, and Yenagoa. These environmental and geographical characteristics provide an appropriate context for examining household water insecurity and its associated health implications.

The study adopted a cross-sectional survey design, which enabled the systematic collection of data on household experiences, environmental conditions, and health outcomes across selected flood-prone communities. This design is particularly suitable for geographical investigations that seek to understand spatial patterns and human-environment interactions without experimental manipulation.

The population comprised 1,704,515 residents based on the 2006 national census. From this population, a sample of 384 respondents was selected using a multi-stage sampling technique. the study. The sample was drawn from four communities identified as highly vulnerable to flooding: Yenagoa (Yenagoa LGA), Brass Town (Brass LGA), Nembe Town (Nembe LGA), and Amassoma (Ogbia LGA). These locations were selected to reflect variations in hydrological exposure, settlement characteristics, and access to water infrastructure.

A purposive sampling approach was first used to identify communities with pronounced flood risk and water access challenges. Subsequently, simple random sampling techniques were employed within each community to select participating households. The respondents were mainly household heads or adult members with sufficient knowledge of domestic water use, coping mechanisms, and health conditions within their households.

Primary data were collected through a structured instrument titled the "Household Water Insecurity and Health Outcomes Questionnaire (HWIHOQ)". The questionnaire was organized into thematic sections covering seasonal variations in water availability, household coping strategies during flood events, water quality conditions, and reported health outcomes. Responses were measured on a four-point Likert scale ranging from Strongly Agree (4) to Strongly Disagree (1). A decision threshold of 2.50 was adopted for interpreting mean responses.

To ensure the validity of the instrument, it was reviewed by specialists in Geography, Environmental Science, and Public Health, who assessed its relevance, clarity, and coverage of key variables. The reliability of the instrument was determined using Cronbach's Alpha, which produced a coefficient of 0.82, indicating a high degree of internal consistency.

Field data collection was conducted with the support of trained research assistants who administered the questionnaires directly to respondents in the selected communities. This approach facilitated accurate data capture, particularly in clarifying questions related to water access and health experiences. Completed instruments were retrieved on the spot to enhance response completeness and reliability.

For data analysis, both descriptive and inferential statistical methods were utilized. Descriptive statistics, including means and standard deviations, were used to summarize patterns of w ater insecurity, adaptive behaviours, and health outcomes. To test the formulated hypotheses at a 0.05 level of significance, inferential techniques were applied. The independent samples t-test was used for comparisons involving two groups, while one-way Analysis of Variance (ANOVA) was employed where more than two groups were involved, particularly in assessing variations in water conditions, adaptive practices, and health outcomes across different exposure categories.

Results

Research Question One: What are the seasonal patterns of household water insecurity in flood-prone communities?

ISSN: 2516-2644
Volume 13, Number 1, 2025
International Journal of Environmental Research
Journal Homepage:www.bwjournal.org
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Table 1: Mean and SD of the seasonal patterns of household water insecurity in flood-prone communities

S/N	Items	Responses (n=384)		
		$\bar{x}$	SD	Decision
.1	Water is more difficult to access during the rainy (flood) season than the dry season	3.10	0.94	Agree
.2	My household experiences frequent shortages of safe water during flood periods	3.01	0.92	Agree
.3	The main sources of water for my household vary significantly across seasons	3.26	0.81	Agree
.4	Flooding disrupts our regular sources of drinking water	3.34	0.68	Agree
.5	The distance travelled to obtain water increases during the flood season	3.21	0.85	Agree
.6	The cost of accessing water increases during certain seasons	3.09	0.91	Agree
.7	Water stored during the dry season is often insufficient during the rainy season	3.33	0.71	Agree
.8	Seasonal flooding reduces the reliability of available water sources	3.25	0.80	Agree
	Grand Mean	**3.20**		

(Criterion Mean = 2.5, Mean ≥ 2.5, Agree, Mean < 2.5, Disagree)

Table 1 shows that a large proportion of respondents agreed with all items (1–8), as their mean scores (3.01–3.34) exceeded the criterion mean of 2.5, while only a few disagreed. The results indicate that water access becomes more difficult during the rainy season, with increased shortages, disruption of sources, higher costs, and longer distances to obtain water. Respondents also agreed that flooding reduces the reliability of water sources and that dry-season storage is often insufficient. With a grand mean of 3.20, the findings imply a high level of seasonal variation in household water insecurity, with the flood season posing greater challenges.

Research Question Two: What are the adaptive practices adopted by households in response to water insecurity during flood events, and their implications for wellbeing?

Table 2: Mean and SD of the adaptive practices adopted by households in response to water insecurity during flood events, and their implications for wellbeing

S/N	Items	Responses (n=384)		
		$\bar{x}$	SD	Decision
.9	My household treats water (e.g., boiling, filtering) more frequently during flood periods	3.09	0.87	Agree
.10	I rely on alternative water sources (e.g., rainwater, vendors) during flooding	3.03	0.91	Agree
.11	Household members spend more time sourcing water during flood events	3.09	0.87	Agree
.12	Water scarcity during floods disrupts daily household activities	3.01	0.92	Agree
.13	The strategies I use to cope with water shortages are effective in meeting our needs	3.18	0.87	Agree
.14	Coping with water scarcity causes stress among household members	3.20	0.78	Agree

ISSN: 2516-2644
Volume 13, Number 1, 2025
International Journal of Environmental Research
Journal Homepage:www.bwjournal.org
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.15	Children and vulnerable members of the household are most affected by water shortages	2.99	0.92	Agree
.16	My coping strategies help to reduce health risks associated with unsafe water	3.08	0.87	Agree
	Grand Mean	**3.08**		

(Criterion Mean = 2.5, Mean ≥ 2.5, Agree, Mean < 2.5, Disagree)

Table 2 revealed that a large proportion of respondents agreed with all items (9–16), as their mean scores (2.99–3.20) were above the criterion mean of 2.5, while only a few indicated disagreement. The results show that households adopt various coping strategies such as treating water, relying on alternative sources, and spending more time sourcing water during floods. However, these strategies are associated with disruptions to daily activities and increased stress, particularly affecting vulnerable household members. Respondents also agreed that these adaptive measures help to reduce health risks linked to unsafe water. With a grand mean of 3.08, the findings indicate that households actively employ adaptive practices during flood events, but these come with notable well-being implications.

Research Question Three: What is the impact of flooding on water quality conditions and the resulting health outcomes experienced by residents?

Table 3: Mean and SD of the impact of flooding on water quality conditions and the resulting health outcomes experienced by residents

S/N	Items	Responses (n=384)		
		$\bar{x}$	SD	Decision
.17	Floodwater often contaminates our main sources of drinking water	3.22	0.85	Agree
.18	The quality of water available during flooding is generally poor	3.25	0.75	Agree
.19	I have observed changes in the colour, taste, or smell of water during floods	3.08	0.88	Agree
.20	Household members frequently experience water-related illnesses during flood periods	3.04	0.92	Agree
.21	Cases of diarrhoea or stomach-related illnesses increase during flooding	3.05	0.89	Agree
.22	Skin infections or irritation are common during flood events.	2.99	0.92	Agree
.23	Poor water quality during floods negatively affects household health	3.09	0.92	Agree
.24	Access to clean water reduces the occurrence of illness in my household	3.07	0.89	Agree
	Grand Mean	**3.10**		

(Criterion Mean = 2.5, Mean ≥ 2.5, Agree, Mean < 2.5, Disagree)

Table 3 revealed that a large proportion of respondents agreed with all items (17–24), as their mean scores (2.99–3.25) were above the criterion mean of 2.5, while only a few expressed disagreement. The findings indicate that flooding significantly contributes to contamination of drinking water sources, deterioration in water quality, and observable changes in water characteristics such as colour, taste, and smell. Respondents also reported increased cases of water-related illnesses during flood periods, including diarrhoea, stomach ailments, and skin infections. In addition, poor water quality was widely acknowledged as a key factor negatively affecting household health, while access to clean water was seen to reduce illness occurrence. With a grand mean of 3.10, the result implies that flooding has a pronounced negative impact on water quality conditions, which in turn contributes to increased health risks among residents in flood-prone communities.

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Research Question Four: What role does access to water infrastructure play in shaping household vulnerability to water insecurity and associated health risks?

Table 4: Mean and SD of the role access to water infrastructure plays in shaping household vulnerability to water insecurity and associated health risks

S/N	Items	Responses (n=384)		
		$\bar{x}$	SD	Decision
.25	My community has adequate water infrastructure (e.g., boreholes, piped water).	3.17	0.83	Agree
.26	Available water facilities function effectively throughout the year	3.09	0.87	Agree
.27	Flooding often damages or disrupts water infrastructure in my community	3.06	0.87	Agree
.28	Households with better access to water facilities experience fewer water shortages	3.11	0.87	Agree
.29	Lack of water infrastructure increases the risk of using unsafe water sources	3.17	0.83	Agree
.30	Households without reliable water infrastructure are more vulnerable during floods	3.09	0.87	Agree
.31	Access to improved water sources reduces health-related risks in my household	3.06	0.87	Agree
.32	Government or community interventions have improved access to safe water	3.11	0.87	Agree
	Grand Mean	**3.11**		

(Criterion Mean = 2.5, Mean ≥ 2.5, Agree, Mean < 2.5, Disagree)

Table 4 revealed that a large proportion of respondents agreed with all items (25–32), as their mean scores (3.06–3.17) were above the criterion mean of 2.5, while only a few respondents disagreed. The findings indicate that although some water infrastructure exists within the communities, its functionality is often affected by flooding. Respondents also agreed that households with better access to water facilities experience fewer water shortages, while inadequate infrastructure increases reliance on unsafe water sources and heightens vulnerability during flood periods. Furthermore, access to improved water sources was widely acknowledged to reduce health-related risks, and interventions by government or communities were perceived to have contributed to improved water access. With a grand mean of 3.11, the result implies that access to water infrastructure plays a significant role in reducing household vulnerability to water insecurity and associated health risks in flood-prone communities.

Hypothesis One: There is no significant difference[in household water insecurity between seasons in flood-prone communities.

Table 5: ANOVA summary on the disparity in household water insecurity between seasons in flood-prone communities

ANOVA

Sources	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	73.16	2	36.58	6.31	0.00
Within Groups	2208.00	381	5.80		
Total	2281.16	383			

ISSN: 2516-2644
Volume 13, Number 1, 2025
International Journal of Environmental Research
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The result of Table 5 revealed that there is no significant difference in household water insecurity between seasons in flood-prone communities (F_2 = 6.31, df = 381, p < 0.05). Hence, the null hypothesis was rejected at the 0.05 alpha level.

Hypothesis Two: There is no significant in household wellbeing among households using different adaptive practices to water insecurity.

Table 6: ANOVA summary on the disparity in household wellbeing among households using different adaptive practices to water insecurity

ANOVA

Sources	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	402.15	3	134.05	12.01	0.00
Within Groups	4242.16	380	11.16		
Total	4644.31	383			

The result of Table 6 revealed that there is no significant difference in household wellbeing among households using different adaptive practices to water insecurity (F_3 = 12.01, df = 380, p < 0.05). Hence, the null hypothesis was rejected at the 0.05 alpha level.

Hypothesis Three: There is no significant difference in health outcomes among residents exposed to different levels of flooding and water quality conditions.

Table 8: Independent sample t-test on the disparity in health outcomes among residents exposed to different levels of flooding and water quality conditions

Water Quality Conditions	n	$\bar{x}$	SD	df	t_{cal}	t_{tab}	Sig.	Decision
High Flood Exposure	221	24.88	2.62	382	0.83	1.96	0.41	Retain: H_{03}
Low Flood Exposure	163	24.67	2.31					

Table 7 indicates that t_{cal} = 0.83, df = 382, and t_{tab} = 1.96. Therefore, since $t_{cal} < t_{tab}$ and P > 0.05, there is no noteworthy disparity in health outcomes among residents exposed to different levels of flooding and water quality conditions. Hence, the null hypothesis is retained at the 0.05 alpha level.

Hypothesis Four: There is no significant difference in household vulnerability to water insecurity based on access to water infrastructure.

Table 8: Independent sample t-test on the disparity in household vulnerability to water insecurity based on access to water infrastructure

Water Infrastructure	n	$\bar{x}$	SD	df	t_{cal}	t_{tab}	Sig.	Decision
Good Access	249	25.27	3.86	382	2.94	1.96	0.00	Reject: H_{04}
Poor Access	135	24.06	3.84					

ISSN: 2516-2644
Volume 13, Number 1, 2025
International Journal of Environmental Research
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Table 7 indicates that t_{cal} = 2.94, df = 382, and t_{tab} = 1.96. Therefore, since $t_{cal} > t_{tab}$ and $P < 0.05$, there is a noteworthy disparity in household vulnerability to water insecurity based on access to water infrastructure. Hence, the null hypothesis is rejected at the 0.05 alpha level.

Discussion of Findings

The findings for research question one revealed that household water insecurity in flood-prone communities of Bayelsa State exhibits strong seasonal variation, with greater difficulties experienced during the rainy (flood) season. This indicates that water access, availability, and reliability fluctuate significantly across seasons, particularly under conditions of flooding. The corresponding hypothesis showed noteworthy disparity in household water insecurity between seasons in flood-prone communities. This finding is consistent with the work of Olorunfemi and Oladipo (2020), who reported that seasonal flooding in the Niger Delta significantly alters household water availability, leading to increased dependence on unsafe water sources during wet seasons. It is also supported by Nnodim and Amadi (2021), who found that rural riverine communities in southern Nigeria experience pronounced seasonal water stress, with peak insecurity occurring during periods of heavy rainfall and inundation.

The result of research question two showed that households adopt multiple adaptive practices in response to water insecurity during flood events, including water treatment, reliance on alternative sources, and increased effort in water acquisition. However, these coping strategies are accompanied by notable implications for well-being, such as increased stress and disruption of daily activities, even though they are perceived as moderately effective in reducing health risks. The hypothesis indicates a noteworthy disparity in household well-being among households using different adaptive practices to water insecurity. This finding aligns with the study of Ayanlade and Jegede (2018), who observed that households in flood-prone areas of Nigeria adopt similar coping strategies such as water boiling, rainwater harvesting, and reliance on vendors, regardless of socio-economic differences. It is also supported by Obeta (2019), who reported that while coping mechanisms help households manage water shortages, they often impose additional physical and psychological burdens, particularly on vulnerable groups such as children and women.

The findings for research question three indicated that flooding has a significant impact on water quality conditions, leading to contamination of drinking water sources, deterioration in water characteristics, and increased prevalence of water-related diseases such as diarrhoea, stomach ailments, and skin infections. Although the hypothesis suggests no noteworthy disparity in health outcomes among residents exposed to different levels of flooding and water quality conditions. This finding is supported by Adegoke et al. (2020), who reported that flood events in coastal Nigeria significantly degrade water quality and increase exposure to waterborne diseases due to contamination of shallow wells and surface water sources. Similarly, Efe and Mogborukor (2022) found that communities in the Niger Delta experience heightened incidences of diarrhoeal diseases and skin infections during flood periods, largely attributable to polluted water sources.

The result of research question four showed that access to water infrastructure plays a significant role in shaping household vulnerability to water insecurity and associated health risks. Households with better access to functional water facilities experience reduced water shortages and lower reliance on unsafe sources, while those with inadequate infrastructure are more exposed to water insecurity and related health challenges, particularly during flood events. The corresponding hypothesis indicates a noteworthy disparity in household vulnerability to water insecurity based on access to water infrastructure. This finding aligns with the work of Adedeji and Odugbemi (2021), who found that improved water infrastructure significantly reduces household exposure to unsafe water and waterborne diseases in flood-prone communities of southwestern Nigeria. It is also supported by Nwokoro and Eze (2020), who reported that inadequate and poorly maintained water

infrastructure increases vulnerability to environmental hazards and intensifies health risks during flood events in the Niger Delta.

Conclusion

The study concluded that household water insecurity in flood-prone communities of Bayelsa State is strongly influenced by seasonal flooding, which disrupts water access, reduces reliability, and increases dependence on alternative sources. Households adopt coping strategies such as water treatment and alternative sourcing, but these come with well-being challenges, including stress and disruption of daily activities. Flooding also degrades water quality, contributing to increased water-related illnesses, while access to functional water infrastructure significantly reduces vulnerability and health risks. Overall, environmental conditions, household responses, and infrastructure jointly shape water insecurity and health outcomes in the study area.

Recommendations

1. Government and water agencies should provide flood-resilient water supply systems.
2. Public health officials and community leaders should promote safe water practices and basic support measures.
3. Environmental and health agencies should ensure regular water quality monitoring and emergency response.
4. Government and development partners should invest in and maintain resilient water infrastructure.

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