INTERNATIONAL JOURNAL OF RESEARCH AND SCIENTIFIC INNOVATION (IJRSI)
ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

# Exploring the Effectiveness of Post-Flood Water, Sanitation and Hygiene (WASH) Interventions for Flood-Prone Communities in Makurdi, Benue State, Nigeria

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**DOI: https://doi.org/10.51244/IJRSI.2026.1305000140**

**Received: 11 May 2026; Accepted: 16 May 2026; Published: 04 June 2026**

## ABSTRACT

This study explored the effectiveness of post-flood Water, Sanitation and Hygiene (WASH) interventions in Makurdi, Benue State, Nigeria. A cross-sectional survey of 286 respondents conducted in eight flood-prone communities in Makurdi was complemented by the Delphi technique involving 15 WASH experts from government and non-governmental organizations. The results identified heavy rainfall, blocked drainage systems, and unregulated urban development as the major causes of flooding. Housing destruction, public health risks, and community displacement recorded the highest Delphi mean score of 4.00, with public health risks achieving 82% agreement among experts. Short-term reactive and tactical emergency interventions such as water treatment stations, emergency sanitation facilities, and PHAST programmes were rated "Very Effective," recording 83%, 84%, and 85% agreement, respectively. The study recommends integrated flood management and strengthened rapid-response WASH interventions in flood-prone communities to improve public health outcomes, disaster preparedness, and community resilience.

**Keywords:** Water, Sanitation and Hygiene (WASH), Public Health, Flood Resilience, Post-Flood Interventions, Benue State.

## INTRODUCTION

Flooding remains one of the most recurrent and destructive environmental hazards in Nigeria today, with severe implications for public health, livelihoods, and urban infrastructure. Globally, approximately 1.81 billion people, 23% of the world's population, are exposed to significant risk from 1-in-100-year flood events, with 89% of those affected living in low- and middle-income countries (Rentschler, Salhab & Jafino, 2022). At the same time, about 2.3 billion people lack access to basic drinking water, and 844 million remain without adequate sanitation facilities. This deficit contributes to an estimated 842,000 deaths annually (WHO, 2017; UNICEF & WHO, 2019; WaterAid, 2024). Evidence suggests that improving WASH services could prevent up to 9% of the global disease burden (Yaya et al., 2018).

In recent years, flood events in Makurdi have become increasingly frequent and severe, resulting in loss of life, infrastructure damage, and widespread displacement (Agada, 2020; Clement, 2012). Makurdi, the capital of Benue State, is particularly vulnerable due to its location along the Benue River floodplain, rapid urban expansion, and inadequate drainage infrastructure. Post-flood conditions often involve the breakdown of water supply and sanitation systems, increasing the risk of waterborne diseases. This risk is especially acute in flood-prone communities, where outbreaks are more frequent and difficult to control. Shimi et al. (2010) note that floodwaters are often contaminated, heightening the incidence of cholera, typhoid, diarrhoea, and other water-related illnesses.

To address flood-related waterborne diseases, effective WASH practices are essential for preventing and controlling illnesses linked to unsafe water and poor sanitation (Kwamande, 2023). These interventions play a critical role in protecting environmental public health, reducing vulnerability, and promoting overall well-being. Recognizing these challenges, the United Nations declared access to safe sanitation a human right in 2012 and reinforced this commitment in the 2015 Sustainable Development Goals (SDGs), where Goal 6 calls for universal access to adequate and equitable sanitation and hygiene by 2030. WASH interventions are therefore central to tackling waterborne diseases and sanitation challenges in flood-prone areas. They reduce diarrhoeal mortality among children under five, limit the spread of epidemics such as cholera, and improve nutrition and school attendance among vulnerable groups, including women, children, and persons with disabilities (UNICEF, 2020). Beyond emergency response, they are also vital for preparedness, survival, and long-term resilience.

Despite increasing recognition of flooding and the importance of WASH interventions in Nigeria, empirical evidence evaluating the effectiveness of post-flood WASH interventions in urban settings, particularly in Makurdi, remains limited. This study addresses this gap by systematically assessing intervention types, perceived effectiveness, and institutional arrangements. Specifically, it asks: How effective are post-flood WASH interventions in reducing vulnerability and building resilience among flood-affected communities in Makurdi? The study is grounded in resilience theory(Liao, 2012; McClymont, ett al., 2020) and guided by the Sendai Framework for Disaster Risk Reduction (Chisty et al., 2022) and the SPHERE Minimum Standards for WASH in emergencies (Griekspoor & Collins, 2022). These frameworks emphasize preparedness, adaptive capacity, and the integration of short-term emergency responses with long-term risk reduction strategies.

**A Review Of Key Flood Disasters In Nigeria And Benue State, Nigeria (2012 - 2024)**

Table 1 reviews major flood disasters in Nigeria, highlighting Benue State, especially its capital, Makurdi, as one of the most consistently affected areas. The event and figures presented in this article were chosen and validated based on the availability of verifiable data across multiple credible sources (e.g., government reports, humanitarian agencies, or international media such as Reuters, ReliefWeb, NIHSA, NEMA, IOM-DTM). Second, they were also chosen based on temporal relevance (e.g., 2012–2024) to capture major flood cycles and recent climate variability trends. Lastly, due to incomplete reporting at subnational levels, Displacement estimates were derived using reported state-level figures directly where available, applying proportional allocation (e.g., Benue’s share of national impacts), and inferring from affected population against displacement ratios (typically 20–40% in flood contexts). While Hectares impacted were estimated using reported farmland loss where available and proxy scaling based on severity (minor, moderate, severe floods) and historical benchmarks (e.g., 2012 flood as baseline) were used respectively.

In 2012, the country experienced one of its worst flood disasters in decades, which displaced more than 2.1 million people nationwide and claimed over 430 lives. Benue was severely affected, with about 700,000 people displaced and thousands of farmlands, houses, and huts destroyed or submerged (Toure, 2012; Clement, 2012; Agada, 2020). Another devastating flood occurred in 2017, displacing more than 110,000 people, destroying 2,000 houses, and affecting 2,769 households across the state (Sambo, 2017; Daka, 2017).

Seasonal floods in 2020 were similarly widespread, displacing over 2.3 million people nationwide and causing 69 deaths (Table 1). Benue alone recorded 865,829 displaced persons and the destruction of nearly 979,054 hectares of farmland (FloodList, 2020; NIHSA, 2021). In 2022, severe flooding led to the loss of more than 100,000 hectares of farmland in Benue, displacing numerous families in Makurdi and surrounding local government areas (Reuters; ReliefWeb). The following year, elevated river levels and dam releases caused flooding in 10 states, affecting 33,983 people and displacing 7,353, including communities in Makurdi (NEMA Nigeria, 2023). Most recently, in 2024, intense rainfall and blocked drains triggered urban flooding in Makurdi, displacing thousands and affecting 76,348 people across 13,312 households. The disaster also caused significant damage to infrastructure, shelters, and farmland (Environews, 2024; IOM/DTM, 2024).

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Table 1: Key Flood Disasters in Nigeria and Makurdi, Benue State, Nigeria (2012-2024)

| | | | | | | |
|---|---|---|---|---|---|---|
| 2012 | Nationwide floods; severe impact in Benue | ~2.1 million displaced (Nigeria); ~700,000 in Benue | ~700,000 (reported) | ~150,000–250,000 ha (estimated) | Water supply, hygiene kits, sanitation | (Agada, 2020; Clement, 2012) |
| 2017 | Major flooding in Benue incl. Makurdi | 110,000 displaced; 2,000 houses destroyed | ~110,000 (reported) | ~20,000–35,000 ha (estimated) | Water treatment, toilets, hygiene kits | Sambo(2017); Daka (2017) |
| 2020 | Nationwide floods affecting Benue | 865,829 displaced (Benue); farmland damage reported | ~865,829 (reported) | ~979,054 ha (reported) | Hygiene kits, water systems, hygiene promotion | FloodList (2020); NIHSA 2021 outlooks. (floodlist.com, nihsa.gov.ng<br><br>https://nihsa.gov.ng/wp-content/uploads/2021/05/2021-AFO.pdf<br><br>https://www.christianaid.org.uk/sites/default/files/2022-08/nigeria-e4e-benue-contingency-plan-june2019.pdf |
| 2022 | Severe flooding; major crop loss | >100,000 ha farmland affected | ~150,000–250,000 (estimated) | >100,000 ha (reported) | (Implicit emergency response) | Reuters field report; ReliefWeb satellite inundation map. (Reuters, ReliefWeb) |
| 2023 | Elevated river levels; monitored flooding | 7,353 displaced (10 states) | ~1,000–2,000 (Benue share estimated) | ~5,000–10,000 ha (estimated) | Monitoring/early warning | NEMA / NIHSA updates. (NEMA Nigeria, Facebook). https://dailypost.ng/2023/08/30/lagdom-dam-nigeria-gears-up-for-looming-flood-disaster/ |
| 2024 | Urban flooding in Makurdi | 76,348 affected persons | ~15,000–25,000 displaced (estimated subset) | ~3,000–8,000 ha (urban/peri-urban est.) | Emergency water, sanitation | Environews (Jul 2024), IOM/DTM post-flood report.<br><br>https://dtm.iom.int/es/node/46441 |

Table 1 presents trends in types of Water, Sanitation, and Hygiene (WASH) Interventions implemented in Makurdi from the 2012 floods by state agencies and international donor organisations to mitigate health risks and prevent the spread of waterborne diseases. According to the table, provision of improved water sources, household water purification kits, hygiene kits, rehabilitated boreholes, and installed emergency sanitation facilities (Toure, 2012; Agada, 2020). Similar responses were implemented in 2017, post-flood WASH response. These included distributing aqua tablets and chlorine sachets, supplying mobile toilets for men, women, and persons with disabilities, providing hygiene kits such as soap, and establishing waste disposal sites (Sambo, 2017; Daka, 2017). By 2020, interventions had expanded to include hygiene kits with water guard sachets, soap, jerrycans, and buckets, as well as the construction and maintenance of water systems to

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improve safe water access (Table 1). Hygiene promotion efforts increasingly targeted women and girls, emphasizing practices such as handwashing and safe food preparation (FloodList, 2020; NIHSA, 2021).

While WASH interventions in 2022 were less well documented, reports stressed the urgent need for clean water and sanitation facilities for displaced populations (Reuters; ReliefWeb). In 2023, preparedness efforts centered on monitoring and early warning systems, coordinated by NEMA and NIHSA, particularly in response to the risks from Lagdo Dam releases (NEMA Nigeria, 2023). The 2024 floods again prompted emergency WASH measures, including the delivery of treated water via tankers and mobile units, hygiene promotion campaigns on safe water handling and handwashing, and the deployment of temporary sanitation facilities such as portable latrines and safe waste disposal systems (Environews, 2024; IOM/DTM, 2024).

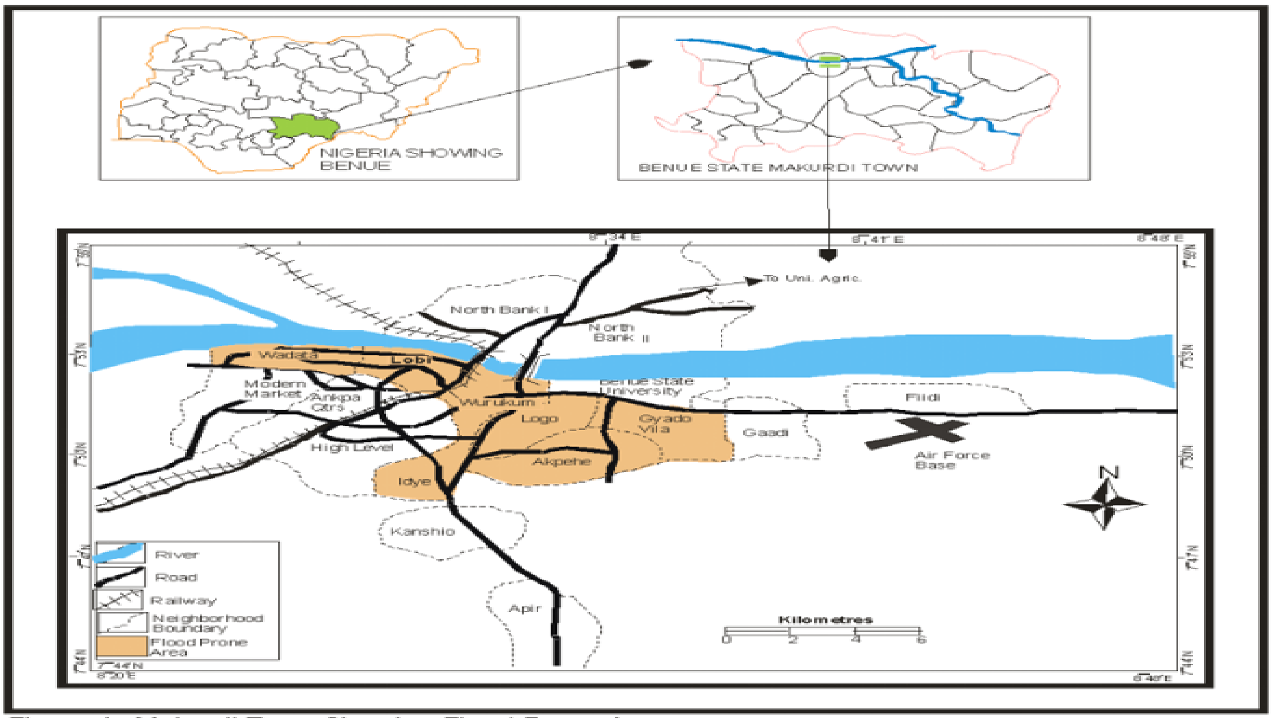
Across the 2012–2024 flood events in Benue State, WASH interventions exhibit a high degree of continuity, characterized by predominantly reactive, short-term relief measures such as hygiene kit distribution, temporary sanitation provision, and emergency water supply. Despite significant variations in the scale of flood impacts (e.g., during high-impact years (2012, 2020, 2022) or lower-impact years (2023, 2024), the intervention model remains largely standardized, with limited evidence of scalability, anticipatory action, or transition toward resilience-oriented infrastructure. This persistent alignment of high-impact disasters with routine response packages suggests potential inefficiencies in both targeting and outcomes. Consequently, these trends underscore the need to systematically evaluate the effectiveness of WASH interventions, particularly in terms of their ability to reduce vulnerability, enhance adaptive capacity, and deliver sustained improvements in water, sanitation, and hygiene access in flood-prone contexts.

## METHODOLOGY

### Study Area

Makurdi, the capital city of Benue State, is situated between latitudes 7° 33' 00" N and 7° 47' 00" N, and longitudes 8° 27' 00" E and 8° 4' 00" E. It is located in Nigeria's North-Central geopolitical zone. The local government area shares borders with Guma to the north, Gwer-East to the south, Gwer-West to the west, and Nasarawa State to the northwest (Figure 1). The town covers a circular area with a radius of approximately 16 kilometres, totalling about 804 square kilometres.

Figure 1: Makurdi Town Showing Flood-Prone Areas



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Makurdi's climate is classified as tropical, characterised by a sub-humid wet and dry season. The rainy season begins in April and extends through October, while the dry season lasts from November to March. The area receives annual rainfall ranging from 775mm to 1792mm. Relative humidity varies monthly, with averages from 43% in January to 81% during July and August. The mean temperature of the town is 28 °C (Tyubee, 2005).

The geological composition of Makurdi is predominantly sedimentary rocks, with sandstone being the most common type. Low-lying regions such as Wadata are overlain by shale deposits. The sandstone formations are mainly divided into micaceous and feldspathic types, some of which are exposed in parts of the town. The terrain is generally gently undulating, with low-lying relief averaging between 100 meters and 250 meters, featuring inselbergs, laterite formations, and knolls. The soil types in the area are reflective of its underlying geology (Hilakaan and Ogwuche, 2014).

**Methods of Data Collection**

A cross-sectional research design was employed for this study. This design allows for the collection of data from a population, or a representative subset, at a single point in time to analyze prevalence, trends, and other characteristics, specifically, the effectiveness of post-flood WASH interventions. Accordingly, the study was conducted in eight flood-prone communities in Makurdi town: Idye, Wadata, Wurukum, Nyiman, Logo I and II, Achusa, and Gyado Villa. These areas had a population of 297,398 in 2006, projected to increase to approximately 514,258 by 2024 (Isma'il & Kersha, 2018).

A sample size of 384 was determined using the Yamane (1967) formula (see also Shabu & Terese, 2013; Ikyapa et al., 2020). Based on this, 384 structured questionnaires were randomly administered to residents across the eight flood-prone communities at a ratio of 1:48, that is, 48 questionnaires per community, ensuring broad coverage of the study population. The questionnaire items were designed to assess the effectiveness of post-flood WASH interventions in the study area. Of the 384 questionnaires distributed, 286 were returned and deemed usable, representing a response rate of 74.5%. This response rate is considered adequate for generating meaningful analysis and inferences.

**Methods of Data Analysis**

Two data analysis techniques were employed. First, descriptive statistics and percentage calculations were used for the preliminary analysis. In addition, the Delphi technique (Steurer, 2011), involving a panel of 15 experts, was used to strengthen the findings by incorporating expert opinions to rank the effectiveness and impacts of the interventions across four levels. The panel comprised researchers, government officials from the Benue State Emergency Management Agency (SEMA), and professionals, particularly NGO personnel with experience and involvement in WASH interventions in Makurdi. Experts were purposively selected to ensure diversity of perspectives and expertise. To qualify for participation, individuals were required to have a minimum of five years of professional or research experience in WASH, active involvement in policy, practice, or decision-making related to the study topic, and a willingness to participate in multiple consultation sessions.

The Delphi process was conducted in two rounds. In the first round, experts independently rated the effectiveness of each post-flood WASH intervention and the impacts of floods using a four-point scale, while also providing comments and recommendations. Experts assessed flood impacts and post-flood WASH interventions according to their perceived level of effectiveness using the following scale: Not Effective (1), indicating that the item was considered unsuitable, irrelevant, impractical, or incapable of achieving the intended objective, with little or no positive impact if implemented; Less Effective (2), indicating that the item had limited usefulness and contributed minimally to the intended objective due to significant weaknesses, limitations, or contextual constraints; Effective (3), indicating that the item was considered appropriate, relevant, and capable of achieving the intended objective under normal conditions, with meaningful positive outcomes likely despite the need for some improvements; and Very Effective (4), indicating that the item was regarded as highly relevant, reliable, practical, and capable of producing strong positive outcomes,

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representing a best-practice approach with high applicability and minimal limitations. Responses were aggregated and anonymised to minimize dominance effects and reduce bias.

In the second round, experts reviewed and summarised group responses and reconsidered their ratings in light of the collective feedback, thereby promoting convergence and consensus of opinion. Consensus was evaluated using predefined agreement criteria. An item was considered to have achieved consensus when at least 70–80% of experts rated it as either "Effective" or "Very Effective," with low response dispersion measured using indicators such as median scores and interquartile range (IQR). Items that failed to meet the consensus threshold were revised, re-evaluated, or excluded from the final framework and recommendations.

The results of the Delphi exercise are presented in tables. The first column, S/N, represents the serial number of the items evaluated, followed by the column on the type of WASH intervention deployed, which contains the variables, indicators, strategies, or statements assessed by the experts. The Mean Score column represents the average expert rating on the four-point scale, while the Median column presents the middle value of responses and is often preferred in Delphi studies because it is less affected by outliers. The IQR (Interquartile Range) column measures the dispersion of responses, with lower IQR values indicating stronger consensus. The % Agreement column shows the percentage of experts who rated an item as "Effective" or "Very Effective." The Interpretation column is derived from the mean score range, while the Decision column indicates whether an item was accepted, modified, or rejected.

The interpretation of the mean scores for the four-point scale was as follows: 1.00–1.49 = Not Effective; 1.50–2.49 = Less Effective; 2.50–3.49 = Effective; and 3.50–4.00 = Very Effective. Consensus was considered achieved when an item recorded at least 70% agreement among experts and an IQR of ≤ 1.0. Items with mean scores of ≥ 2.50 were retained, while those with scores below 2.50 were rejected.

## RESULTS

This section presents the results of the analysis of data. The first subsection presents the descriptive statistics on the causes of flooding in Makurdi. This is followed by subsections that present an assessment of the perceived effects of flooding and WASH intervening agencies and the effectiveness of the post-flood WASH interventions on safe water access, sanitation, and hygiene among residents of vulnerable communities in Makurdi using the Delphi panel. The results are based on expert consensus using a four-point effectiveness or devastating scale, supported by measures of central tendency and percentage agreement.

### Causes of Flooding in Makurdi

Figure 2 presents the major causes of flooding in Makurdi based on the frequency of responses obtained from respondents. The results indicate that heavy rainfall is the most significant cause of flooding, recording the highest frequency of approximately 100 responses. This suggests that intense and prolonged rainfall is widely perceived as the primary trigger of flood events in the area. The high rainfall intensity likely overwhelms available drainage systems and increases surface runoff, thereby contributing significantly to recurrent flooding in Makurdi. (see plates 1 and 2 in the appendix).

**Figure 2: Causes of flooding in Makurdi**

**Source:** Fieldwork, 2025

Moreover, Figure 2 revealed that the blocking of drainages emerged as the second major cause, with a frequency of about 62 responses. This finding indicates that poor waste disposal practices and inadequate drainage maintenance contribute substantially to flooding by obstructing the free flow of water during rainfall events. Similarly, silting up of drainage channels recorded approximately 53 responses, showing that sediment accumulation in drainage systems reduces their carrying capacity and increases the likelihood of overflow during heavy rains.

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Building structures on water channels was also identified as a significant factor, with about 41 responses. This result suggests that unregulated urban development and encroachment on natural waterways obstruct the normal flow of water, thereby increasing flood vulnerability in affected communities. The construction of buildings along drainage paths and floodplains limits water movement and contributes to water accumulation during rainfall.

The least reported cause of flooding was the massive inflow of water from the River Benue catchment and Lagdo Dam in Cameroon, which recorded approximately 27 responses. Although fewer respondents identified this factor compared to the others, the result still indicates that transboundary water inflow contributes to flooding in Makurdi, particularly during periods of increased river discharge and dam releases.

**Effects of Flooding on Residents in Makurdi**

Table 2 presents the Delphi panel results on the effects of flooding in Makurdi based on expert evaluations of five identified impact areas. The findings indicate a strong consensus among the experts that flooding has severe socio-economic and public health consequences in the study area.

Table 2: Effects of Flooding in Makurdi

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Housing devastation (destruction of homes) | 4.00 | 4 | 0.50 | 78% | Very Devastating | Accepted |
| 2 | Infrastructure disruption (destruction of road networks and drainage systems) | 3.00 | 3 | 0.75 | 73% | Devastating | Accepted |
| 3 | Public health risks (breeding of pests and diseases; increased waterborne illnesses) | 4.00 | 4 | 0.25 | 82% | Very Devastating | Accepted |
| 4 | Environmental hazards (accidental release of toxic materials) | 2.00 | 2 | 1.25 | 56% | Less Devastating | Rejected |
| 5 | Community displacement | 4.00 | 4 | 0.50 | 79% | Very Devastating | Accepted |

Source: Fieldwork, 2025

The results on Table 2 also show that housing devastation, public health risks, and community displacement all recorded the highest mean score of 4.00, with median values of 4 and low IQR values ranging from 0.25 to 0.50, indicating a high level of agreement among the experts. These items were interpreted as "Very Devastating / Very Effective" and were accepted based on the established decision criteria. Public health risks recorded the highest percentage agreement (82%), suggesting that experts strongly agreed that flooding significantly contributes to the spread of pests, diseases, and waterborne illnesses in Makurdi. Similarly, housing devastation and community displacement, with agreement levels of 78% and 79% respectively, demonstrate that flooding severely affects shelter conditions and forces residents to relocate from affected communities.

Infrastructure disruption, particularly the destruction of road networks and drainage systems, recorded a mean score of 3.00, a median of 3, and an IQR of 0.75, with 73% agreement among the experts. This result indicates that flooding has a substantial effect on physical infrastructure in Makurdi, although the impact was considered less severe or devastating compared to housing destruction, public health risks, and displacement. Nevertheless, the item met the consensus threshold and was therefore accepted as a significant effect of flooding.

Unlike, environmental hazards associated with the accidental release of toxic materials recorded a lower mean score of 2.00, a median of 2, and a relatively high IQR of 1.25, with only 56% agreement among the experts. The higher IQR value reflects weaker consensus and greater variation in expert opinions regarding the extent

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of this impact. Consequently, the item was interpreted as “Less Devastating /Effective” and was rejected because it did not meet the minimum agreement and consensus criteria established for the study.

**WASH Intervening Agencies in Makurdi**

The results presented in Table 3 shows the Delphi panel’s assessment of the effectiveness of different institutions involved in implementing post-flood WASH interventions in Makurdi. The findings indicate varying levels of effectiveness among the organisations, with international organisations and NGOs receiving the highest ratings from the experts.

Table 3: WASH Intervening Agencies in Makurdi

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | International organisations implementing strategic and long-term WASH interventions | 4.00 | 4 | 0.50 | 81% | Very Effective | Accepted |
| 2 | Government agencies (Federal, State, and Local Governments) implementing reactive/strategic short- and long-term WASH interventions | 3.00 | 3 | 0.75 | 74% | Effective | Accepted |
| 3 | Non-Governmental Organisations (NGOs) implementing reactive and short-term WASH interventions | 4.00 | 4 | 0.50 | 79% | Very Effective | Accepted |
| 4 | Community-Based Organisations (CBOs) implementing reactive and short-term WASH interventions | 2.00 | 2 | 1.25 | 58% | Less Effective | Rejected |

Source: Fieldwork, 2025

*Reactive interventions are employed after the flood occurs, which aim to cushion the effects of the disaster.

**Tactical interventions are short-term interventions aimed at addressing WASH challenges

***Strategic interventions aim to address the long-term WASH challenges and build resilience to future floods.

****Anticipatory or preventive interventions are employed well before the flood disaster occurs.

From the results (Table 3), the international organisations implementing strategic and long-term WASH interventions recorded the highest mean score of 4.00, with a median of 4, an IQR of 0.50, and 81% agreement among the experts. This result indicates a strong consensus that international organisations are highly effective in addressing post-flood WASH challenges through sustainable and long-term intervention strategies. The low IQR value further reflects consistency in expert opinions regarding their effectiveness. Consequently, the intervention was interpreted as “Very Effective” and accepted based on the study’s consensus criteria.

Similarly, Non-Governmental Organisations (NGOs) implementing reactive and short-term WASH interventions also recorded a mean score of 4.00, a median of 4, an IQR of 0.50, and 79% agreement. This finding suggests that NGOs play a significant role in responding promptly to flood-related WASH emergencies in Makurdi. Experts generally agreed that NGOs are effective in providing immediate relief and short-term support to affected communities. The item was therefore interpreted as “Very Effective” and accepted.

Government agencies at the federal, state, and local levels implementing reactive, strategic, short-term, and long-term WASH interventions recorded a mean score of 3.00, a median of 3, an IQR of 0.75, and 74% agreement among the experts. Although the rating was lower than that of international organisations and NGOs, the result still indicates that government agencies are perceived as effective in managing post-flood

WASH interventions. The level of agreement met the required consensus threshold, leading to the acceptance of the item as "Effective."

On the other hand, Community-Based Organisations (CBOs) implementing reactive and short-term WASH interventions recorded a lower mean score of 2.00, a median of 2, an IQR of 1.25, and only 58% agreement among the experts. The relatively high IQR value indicates weak consensus and considerable variation in expert opinions concerning the effectiveness of CBOs. As a result, the intervention was interpreted as "Less Effective" and rejected because it failed to meet the minimum consensus and agreement criteria established for the study.

**WASH Interventions on Safe Water Access**

Table 4 presents the Delphi panel's assessment of the effectiveness of various WASH interventions on safe water access in Makurdi following flooding events. The findings reveal that short-term reactive and tactical interventions were generally perceived as more effective in improving access to safe water than long-term strategic interventions.

Table 4: Effectiveness of WASH Interventions with Respect to Water Access in Makurdi

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Rehabilitation of water infrastructure such as wells, boreholes, and water networks as long-term strategic interventions | 2.00 | 2 | 1.25 | 59% | Less Effective | Rejected |
| 2 | Emergency water treatment stations for production and distribution of safe drinking water as short-term reactive interventions | 4.00 | 4 | 0.50 | 83% | Very Effective | Accepted |
| 3 | Mass distribution of water through trucking and boating short-term reactive interventions | 3.00 | 3 | 0.75 | 76% | Effective | Accepted |
| 4 | Provision of water filters and safe water storage containers as short-term tactical interventions | 4.00 | 4 | 0.50 | 81% | Very Effective | Accepted |

Source: Fieldwork, 2025.

Furthermore, emergency water treatment stations for the production and distribution of safe drinking water, implemented as short-term reactive interventions, recorded the highest level of effectiveness (Table 4). The intervention achieved a mean score of 4.00, a median of 4, an IQR of 0.50, and 83% agreement among the experts. These results indicate a strong consensus that emergency water treatment stations are highly effective in ensuring rapid access to safe drinking water during flood emergencies. The low IQR value further reflects consistency in expert opinions. Consequently, the intervention was interpreted as "Very Effective" and accepted.

Similarly, the provision of water filters and safe water storage containers as short-term tactical interventions recorded a mean score of 4.00, a median of 4, an IQR of 0.50, and 81% agreement among the experts. This finding suggests that experts strongly agreed that household-level water treatment and safe storage measures are highly effective in reducing water contamination risks and improving access to potable water in flood-affected communities. The intervention, therefore, met the required consensus criteria and was accepted as "Very Effective."

Mass distribution of water through trucking and boating, implemented as short-term reactive interventions, recorded a mean score of 3.00, a median of 3, an IQR of 0.75, and 76% agreement. This result indicates that the intervention was considered effective in addressing immediate water supply shortages during flooding incidents. Although its effectiveness rating was lower than that of emergency water treatment stations and

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

water filter distribution, the intervention still met the required consensus threshold and was accepted as "Effective."

Conversely, Table 4 revealed that the rehabilitation of water infrastructure such as wells, boreholes, and water networks as long-term strategic interventions recorded a lower mean score of 2.00, a median of 2, an IQR of 1.25, and only 59% agreement among the experts. The relatively high IQR value indicates weaker consensus and greater variation in expert opinions regarding the effectiveness of the intervention. The findings suggest that experts did not widely perceive infrastructure rehabilitation as sufficiently effective in improving immediate post-flood water access, possibly due to delays in implementation, high costs, or maintenance challenges. As a result, the intervention was interpreted as "Less Effective" and rejected because it failed to meet the minimum consensus and agreement criteria established for the study.

**WASH Interventions on Sanitation**

Table 5 presents the Delphi panel's assessment of the impacts of WASH interventions on sanitation in Makurdi following flooding events. The findings indicate that short-term reactive and tactical sanitation interventions were perceived as more effective in addressing immediate sanitation challenges than long-term strategic interventions.

Table 5: Impacts of WASH Interventions with Respect to Sanitation in Makurdi

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Construction and rehabilitation of latrines, including private and public facilities as strategic long-term interventions | 2.00 | 2 | 1.25 | 58% | Less Effective | Rejected |
| 2 | Emergency sanitation facilities, including defecation fields and community latrines as reactive short-term interventions | 4.00 | 4 | 0.50 | 84% | Very Effective | Accepted |
| 3 | Waste management and vector control measures, including drainage and solid waste collection as tactical short-term interventions | 3.00 | 3 | 0.75 | 77% | Effective | Accepted |
| 4 | Fecal sludge management as tactical short-term interventions | 3.00 | 3 | 0.75 | 74% | Effective | Accepted |

Source: Fieldwork, 2025

The table (5) further revealed that emergency sanitation facilities, including defecation fields and community latrines implemented as reactive short-term interventions, recorded the highest effectiveness rating among the interventions assessed. The intervention achieved a mean score of 4.00, a median of 4, an IQR of 0.50, and 84% agreement among the experts. These results demonstrate a strong consensus that emergency sanitation facilities are highly effective in addressing urgent sanitation needs during and after flood events. The low IQR value further indicates consistency in expert opinions. Consequently, the intervention was interpreted as "Very Effective" and accepted based on the study's consensus criteria.

Waste management and vector control measures, including drainage maintenance and solid waste collection as tactical short-term interventions, recorded a mean score of 3.00, a median of 3, an IQR of 0.75, and 77% agreement among the experts. This finding suggests that experts considered these measures effective in reducing environmental contamination, minimizing disease outbreaks, and improving sanitation conditions in flood-affected communities. Since the intervention met the required consensus threshold, it was interpreted as "Effective" and accepted.

Similarly, fecal sludge management as a tactical short-term intervention recorded a mean score of 3.00, a median of 3, an IQR of 0.75, and 74% agreement. The result indicates that experts regarded fecal sludge

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

management as effective in maintaining sanitary conditions and preventing the spread of sanitation-related diseases during flooding incidents. The intervention achieved the required level of agreement and was therefore accepted as "Effective."

In contrast, the construction and rehabilitation of latrines, including private and public facilities as strategic long-term interventions, recorded a lower mean score of 2.00, a median of 2, an IQR of 1.25, and only 58% agreement among the experts (Table 5). The relatively high IQR value reflects weaker consensus and greater variation in expert opinions regarding the effectiveness of the intervention. The findings suggest that experts did not widely perceive the construction and rehabilitation of sanitation infrastructure as sufficiently effective in addressing immediate post-flood sanitation challenges, possibly due to the time, resources, and logistical requirements involved in implementation. Consequently, the intervention was interpreted as "Less Effective" and rejected because it failed to meet the established consensus and agreement criteria.

**WASH Interventions on Hygiene**

Table 6 presents the Delphi panel's assessment of the impacts of WASH interventions on hygiene in Makurdi following flooding events. The findings indicate that awareness creation, hygiene education, and behavioural change interventions were perceived as more effective in improving hygiene conditions than the direct distribution of hygiene materials alone.

Table 6: Impacts of WASH Interventions with Respect to Hygiene in Makurdi

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Distribution of hygiene kits and soaps as reactive short-term interventions | 2.00 | 2 | 1.25 | 57% | Less Effective | Rejected |
| 2 | Mass hygiene awareness campaigns and Participatory Hygiene and Sanitation Transformation (PHAST) programmes as tactical short-term interventions | 4.00 | 4 | 0.50 | 85% | Very Effective | Accepted |
| 3 | Promotion of good hygiene practices, including handwashing techniques and safe water storage as tactical short-term interventions | 3.00 | 3 | 0.75 | 76% | Effective | Accepted |
| 4 | Handwashing stations and hygiene education sessions as reactive short-term interventions | 3.00 | 3 | 0.75 | 73% | Effective | Accepted |

Source: Fieldwork, 2025

In Table 6, mass hygiene awareness campaigns and Participatory Hygiene and Sanitation Transformation (PHAST) programmes implemented as tactical short-term interventions recorded the highest effectiveness rating among the interventions assessed. The intervention achieved a mean score of 4.00, a median of 4, an IQR of 0.50, and 85% agreement among the experts. These results demonstrate a strong consensus that hygiene awareness and participatory education programmes are highly effective in promoting improved hygiene behaviour and reducing health risks in flood-affected communities. The low IQR value further indicates consistency in expert opinions. Consequently, the intervention was interpreted as "Very Effective" and accepted based on the study's consensus criteria.

The promotion of good hygiene practices, including hand washing techniques and safe water storage as tactical short-term interventions, recorded a mean score of 3.00, a median of 3, an IQR of 0.75, and 76% agreement among the experts. This finding suggests that experts considered hygiene promotion activities effective in encouraging behavioural changes that reduce the spread of waterborne and sanitation-related diseases during flood emergencies. Since the intervention met the required consensus threshold, it was interpreted as "Effective" and accepted.

Similarly, handwashing stations and hygiene education sessions implemented as reactive short-term interventions recorded a mean score of 3.00, a median of 3, an IQR of 0.75, and 73% agreement. The result indicates that experts regarded the provision of handwashing facilities and hygiene education as effective in improving hygiene practices and preventing disease outbreaks in affected communities. The intervention achieved the required agreement level and was therefore accepted as "Effective."

Conversely, the distribution of hygiene kits and soaps as reactive short-term interventions recorded a lower mean score of 2.00, a median of 2, an IQR of 1.25, and only 57% agreement among the experts (see Table 6). The relatively high IQR value indicates weaker consensus and greater variation in expert opinions regarding the effectiveness of the intervention. The findings suggest that experts did not widely perceive the distribution of hygiene kits and soaps alone as sufficiently effective in achieving sustained hygiene improvements in flood-affected communities, possibly because behavioural change and consistent awareness programmes are required to complement material distribution. Consequently, the intervention was interpreted as "Less Effective" and rejected because it failed to meet the minimum consensus and agreement criteria established for the study.

## DISCUSSION

The results highlight that flooding in Makurdi is not only a natural hazard driven by heavy rainfall but is significantly worsened by human activities such as blocked drainage, unregulated construction, and poor waste management. The predominance of reactive and tactical WASH interventions, such as emergency water treatment, hygiene campaigns, sanitation facilities, and PHAST programmes, demonstrates that most interventions prioritize immediate relief. This is more so that reactive and tactical interventions were more effective in addressing immediate post-flood WASH challenges than long-term infrastructure rehabilitation. This implies that emergency response policies in Nigeria should prioritize rapid-response and community-based WASH strategies during flood disasters, while simultaneously integrating long-term infrastructure development into recovery and resilience-building programmes. These findings are similar to other studies that emphasize the impact of human activities on flood vulnerability. For instance, a study on the Kereke and Ukoghor river basins in Makurdi town found that morphometric parameters, such as drainage density and relief ratio, influence flood vulnerability (Oyatayo et al, 2017; Agada, 2020).

While these short-term measures were effective in reducing acute health risks and displacement, the limited effectiveness of long-term strategic measures, such as the rehabilitation of water infrastructure and latrine construction, signals weaknesses in planning, maintenance, and sustainability. In addition, the dominance of short-term interventions reflects a response-oriented approach rather than one focused on prevention. Furthermore, the findings revealed that the limited effectiveness of long-term strategic measures in water infrastructure rehabilitation and latrine construction highlights significant weaknesses in planning, maintenance, and sustainability. This is echoed in research on water main rehabilitation, which emphasizes the need for robust design standards, regular condition assessments, and effective data analysis to mitigate emerging problems and ensure the longevity of rehabilitated infrastructure (Wu et al, 2021; Sambo, 2017). This has important policy implications. First, without addressing governance and institutional capacity gaps, investments in resilience-building infrastructure may continue to fall short. Furthermore, the fragmented effectiveness across agencies indicates a need for stronger coordination between government, NGOs, and international actors to ensure that short- and long-term measures complement rather than duplicate one another. Addressing governance and institutional capacity gaps is crucial for effective disaster risk management and resilience-building infrastructure. Research highlights the importance of strong governance and institutional capacity in ensuring investments yield desired outcomes (UNDESA, 2019).

Crucially, the findings reveal a complete absence of anticipatory or preventive interventions, those employed well before floods occur. This gap underscores a major policy weakness in disaster risk reduction for Makurdi. Proactive measures such as flood forecasting systems, early warning dissemination, enforced land-use regulations, and preventive drainage maintenance are essential for reducing disaster impacts before they materialize. Embedding such anticipatory strategies into policy frameworks, alongside emergency responses and infrastructure development, would shift the city's approach from reactive crisis management toward sustainable resilience-building.

## CONCLUSION

This study explores the effectiveness of post-flood WASH interventions in selected vulnerable communities in Makurdi, Benue State, Nigeria. The findings revealed that flooding in Makurdi is shaped by both climatic forces and human-induced vulnerabilities, with heavy rainfall as the leading cause, compounded by blocked drainage, unregulated development, and inflows from the Lagdo Dam. Its effects are most pronounced in public health risks, housing devastation, and community displacement, underscoring the multidimensional nature of flood impacts on lives and livelihoods. WASH interventions have played a critical role in mitigating these challenges, with reactive and tactical measures such as emergency sanitation facilities, water treatment stations, hygiene awareness campaigns, and PHAST programmes, proving most effective in addressing public health risks and improving disaster preparedness and response capacity in flood-prone communities. International organisations and NGOs were identified as the most effective actors in implementing these interventions.

However, the study also reveals persistent weaknesses in long-term strategic measures and, most critically, the complete absence of anticipatory or preventive interventions. Without proactive actions such as early warning systems, preventive drainage maintenance, and land-use regulation, communities remain locked in a cycle of repeated vulnerability and emergency response. The findings, therefore, call for policies that not only strengthen coordination and sustainability of WASH interventions but also prioritize anticipatory strategies to reduce risks before disasters occur. Such a shift would enhance resilience, safeguard public health, and ensure a more sustainable response to recurrent flooding in Makurdi. Therefore, future research should evaluate the long-term sustainability and cost-effectiveness of short-term WASH interventions in flood-prone communities. It should also examine the barriers limiting the effectiveness of Community-Based Organisations (CBOs) and long-term infrastructure rehabilitation in post-flood response efforts. Furthermore, comparative studies across other flood-prone states in Nigeria would provide broader evidence for developing context-specific WASH policies and disaster response frameworks capable of improving public health outcomes and community resilience during flood emergencies.

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## APPENDIXES

Plate 1: Flooded Community in Makurdi

Source: Fieldwork, 2025

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue V May 2026

Plate 2: Flood Effect in Nyiman - Makurdi

Source: Fieldwork, 2025