

Research Article

Assessing Poor Water and Sanitary Infrastructure and The Plight of Low-Income Urban Dwellers Across Osogbo, Osun State, Nigeria

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ABSTRACT

Rapid urbanization in Osogbo, the capital of Osun State, Nigeria, has outpaced the development of water supply, drainage, wastewater, and sanitation infrastructure, placing a disproportionate burden on lower-income residents. This study assesses the economic impact of poor water and sanitary infrastructure on low-income households across four urban neighbourhoods in Osogbo, Nigeria. A questionnaire was administered to 612 households selected via purposive sampling of flood-prone settlements, followed by systematic random sampling within each settlement. A Loss Index, adapted from the min-max transformation used in the WEF Global Competitiveness Index, was used to standardise disparate loss indicators onto a common 0-100 scale, enabling direct comparison of infrastructure conditions across settlements. Findings show that water quality (24% of reported issues), water supply interruptions (23%), and drainage/flooding problems (16%) are the top challenges across the study area, with Odi-Olowo recording the most inadequate sanitation services (22.8%) and the highest Loss Index score (38.6), while Oke-Baale is least inadequate (18.4). A 1% decline in sanitary quality is associated with a 1.4% rise in household medical expenditure, a 0.7% increase in lost workdays, and a 0.5% increase in lost school days. Women bear a disproportionate burden: 51% attributed health problems to WASH conditions, and 29% lost productive time to water collection. Limitations include reliance on self-reported, 12-month recall data, exclusion of publicly funded hospital expenditures (suggesting underestimated societal costs), and the need for longitudinal data to strengthen causal claims. The study concludes that long-term savings in medical expenditures substantially exceed upfront infrastructure investment costs. It recommends prioritizing sanitation and drainage improvements, particularly in Odi-Olowo, as a cost-effective preventive healthcare and urban development strategy, alongside longitudinal monitoring to better capture causal impacts over time.

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1 Introduction

Increased urbanization in Nigeria has led to many benefits and economic and infrastructure challenges. The growth of secondary urban centers has led to limitations in services and worsening of the health and economic productivity of urban low-income populations from waterborne diseases and flooding. These burdens were documented by Prüss-Ustün et al. (2014) and the Federal Ministry of Water Resources et al. (2021). Of the populations in Nigeria in 2021, 54% did not have basic sanitation systems, and 33% did not have access to safe water. The most affected populations are urban residents with low income and no access to formal housing systems.

Despite well-documented global health and economic consequences of poor sanitation estimated at 40 million disability-adjusted life-years (DALYs) annually (Prüss-Ustün et al., 2014), empirical evidence on the economic costs imposed specifically on low-income urban households in secondary Nigerian cities such as Osogbo remains very limited. Most existing studies focus on large metropolitan centres such as Lagos or Abuja, revealing a clear geographic and contextual gap, since urbanisation dynamics, infrastructure governance, and socioeconomic

conditions in secondary cities such as Osogbo differ markedly from those in major metropolitan centres.

There is also an empirical gap: existing WASH research in Nigeria has largely documented health and infrastructure deficits without quantifying their household-level economic costs, and a methodological gap, given the near-absence of standardised, comparable loss indices for benchmarking infrastructure conditions across settlements. This study fills these gaps by conducting a structured household survey across four urban neighbourhoods to investigate the economic impact of water and sanitation infrastructure deficiencies on urban low-income people in Osogbo, and computes a Loss Index enabling comparative assessment of infrastructure conditions and associated economic losses across settlements.

A broader body of international and Nigerian research substantiates the mechanisms linking inadequate WASH conditions to household-level economic hardship. Studies of urban wastewater pollution (Odigie, 2014; Lubbad & Alfarrar, 2004) and its public-health consequences (Akpór & Muchie, 2011; Aleruchi et al., 2023) show that untreated wastewater elevates gastrointestinal and dermatological

disease burdens and associated medical costs, a pattern reflected in the high out-of-pocket healthcare costs documented for Nigeria (World Bank, 2022) and the severity-linked health costs reported in Ethiopia (Yilma et al., 2021). Azeez et al. (2023) further show that socioeconomic status is the strongest predictor of WASH access among Nigeria's urban poor, while flood-hazard studies confirm Osogbo as a persistent hotspot driven by inadequate drainage and uncontrolled solid-waste disposal (Adegboyega et al., 2018; Echendu, 2020; Kolawole et al., 2023; Olatunji et al., 2021, 2024). Collectively, this literature establishes the health and infrastructural mechanisms of WASH-related hardship but leaves the geographic, contextual, empirical, and methodological gaps identified above unaddressed, which the present study directly targets.

2 Materials and Methods

2.1 Study Area

Osogbo, the capital of Osun State, is located at approximately latitudes 7° 40' N to 7° 59' N and longitudes 4° 22' E to 4° 39' E (Figure 1). Population growth following the city's promotion to state capital in 1991 has been substantial. The Osogbo Local Government Area had a 2006 census population of 156,694. By 2016, the urban agglomeration population was estimated to exceed 820,000 (National Population Commission, 2006). That growth has spread people out from the urban core to the low-lying peripheral areas, many of which are adjacent to rivers. This situation has made residents more vulnerable to flooding. Evidence from flood hazard mapping indicates that Osogbo's central and western communities are flood vulnerability hotspots. The Ayetoro community suffers from urban flooding that occurred repeatedly in 2015 and 2016.

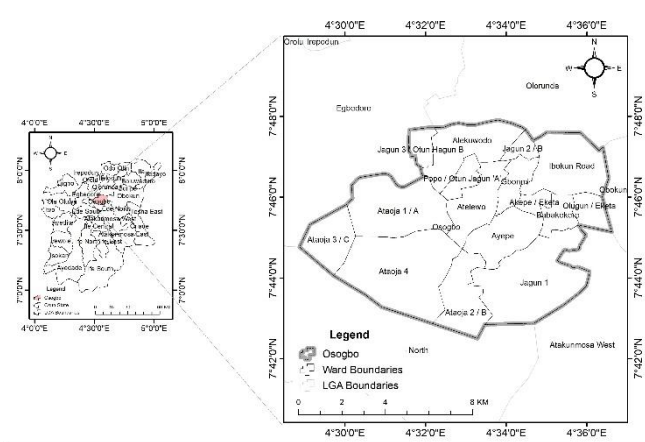


Figure 1: Study Area

Other communities along the Gbodofofon River floodplain experience uncontrolled flooding due to illegal occupation of mandated riparian setbacks (Kolawole et al., 2023). The focus of the present study is

the Oke-Baale, Igbona, Alekuwodo, and Odi-Olowo urban neighbourhoods, which experience flooding and poor infrastructural and other service provision.

2.2 Reconnaissance Survey and Settlement Selection

Instead of being random, survey settlements were determined using a two-step reconnaissance method. This allowed for selecting the neighborhoods most likely to be affected by the WASH deficiencies. For the first step, some of the pertinent secondary data were analyzed while consulting the relevant government officials. This included records of the Osun State Ministry of Environment and Sanitation and records of Water Quality Monitoring. This step helped identify neighborhoods that lacked WASH infrastructure and had a higher incidence of waterborne disease. Field reconnaissance visits were conducted in the second step to confirm the findings and included searching/opening for proximity to open canals or flood-prone waterways and the presence of temporary/substandard housing construction. The study settlements of Oke-Baale, Igbona, Alekuwodo, and Odi-Olowo were selected to provide sufficient data for WASH deficiencies and flood exposure for record comparison for each of the settlements, from the least affected to the most affected (Oke-Baale to Odi-Olowo, respectively).

2.3 Sample Size and Sampling Technique

Based on the reconnaissance listing of the settlements, a sample of approximately 600 households (150 for each of the settlements) was selected. The settlements were determined using a proportionate quota of households that were located within approximately 200 meters of an open canal or flood-prone waterway and constructed using temporary (or substandard) construction. To offset anticipated non-response, questionnaires were administered to 660 households (165 per settlement), yielding 612 valid, fully completed returns overall: a response rate of 92.7% (612/660). Eight trained enumerators administered questionnaires within each settlement using systematic random sampling, in which every *n*th household on the reconnaissance listing was approached, with a replacement household drawn from the same listing where a selected household was unavailable or ineligible after three visit attempts. In summary, the sample selection proceeded in four stages: (i) reconnaissance listing of qualifying households per settlement; (ii) proportionate quota allocation of 165 households per settlement; (iii) systematic random selection of respondent households from each settlement's listing; and (iv) enumerator-administered interview, with replacement sampling used to address non-response.

2.4 Method and Instruments of Data Collection

Households with a monthly income below ₦70,000, the threshold for a low-income household under the 2023 Nigerian minimum wage benchmark, were eligible for inclusion, in addition to the settlement- and dwelling-level eligibility criteria described above. The survey instrument captured a range of household characteristics, including demographics, work and income, history of waterborne disease, access to and type of WASH facilities, assessment of drainage and flooding, and losses due to flooding, as well as costs incurred to purchase water, seek medical aid, and repair flood damage in the last year. The survey was available in both English and Yoruba, and the enumerators made direct observations of the household WASH facilities. This was done to support and confirm the self-reported responses.

2.5 Data Sources

The study also incorporated public-sector data, collecting information on water, drainage, and sanitation investment by consulting urban and local council accounting departments in Osun State. Budgetary allocations and expenditures were compared with community feedback and survey data to assess the impact of government efforts.

2.6 Methodology of the Loss Index

To formulate a comparative assessment model for the

settlements, a Loss Index was constructed using a modified min-max approach as described by the World Economic Forum (2019) in the World Competitiveness Index. The model incorporates eleven survey items: eight (with a value from 1 to 4, where 1 = no issue and 4 = unacceptable issue) eliciting the respondent's assessment of the level of issues with water supply, drainage, and sanitation, and three describing the number of work, school, and income hours lost to health-related issues and expenses incurred in the last year. The transformation takes the following form:

$$\text{Score} = (\text{Settlement average value} - \text{bestMin}) \times 100 / (\text{worstMax} - \text{bestMin}) \quad (1)$$

The range of transformed values is from 0 (best: no loss) to 100 (worst: maximum loss). For the loss value of these variables, the bestMin is 0, and the worstMax is defined by the most frequently cited worst values for the worst settlement (Odi-Olowo), which are 14 lost workdays, 9 lost school days, and ₦18,000 of lost income due to health-related expenses.

3 Results

3.1 Socio-demographic Characteristics

Table 1 presents the socio-demographic profile of 612 respondents.

Table 1: Socio-demographic characteristics of respondents in the four settlements

Variables	Item	Oke-Baale	Igbona	Alekuwodo	Odi-Olowo	Average (%)
Sex	Male	34.1	28.6	31.2	26.8	30.2
	Female	65.9	71.4	68.8	73.2	69.8
Age (years)	15–20	9.4	11.2	10.8	12.1	10.9
	21–40	73.6	68.4	74.2	76.1	73.1
	41–60	13.8	17.1	12.4	9.8	13.3
	>60	3.2	3.3	2.6	2.0	2.8
Education Level	No education	41.2	47.8	38.6	55.3	45.7
	Primary school	22.6	24.1	26.3	21.7	23.7
	Secondary/High school	28.9	20.4	26.1	17.4	23.2
	Tertiary	7.3	7.7	9.0	5.6	7.4
Employment Status	Petty trader/Small business	31.4	36.2	29.8	38.4	33.9
	Unemployed	28.6	31.4	26.2	38.6	31.2
	Daily paid labour	22.4	18.6	26.4	14.8	20.6
	Civil servant (low cadre)	9.6	8.4	11.2	4.6	8.5
	Other	8.0	5.4	6.4	3.6	5.8
Religion	Christianity	48.2	44.6	51.3	31.4	43.9
	Islam	46.4	50.7	43.8	65.2	51.5
	Other	5.4	4.7	4.9	3.4	4.6
Household Size	1–5 persons	38.4	41.2	42.6	35.8	39.5
	6–10 persons	46.8	43.6	44.2	49.7	46.1

	>10 persons	14.8	15.2	13.2	14.5	14.4
The results in Table 1 revealed that respondents were predominantly female. Females on average constituted 69.8% of respondents, while males accounted for 30.2%. This consolidated their position as managers of households and principal WASH service managers. This was also noted by Graham et al. (2016) and Sweetman and Medland (2017). This sample being predominantly female was a significant factor when defining the gendered WASH burdens after this, including time loss for water collection, which was grossly more by women. It was noted that the respondents were predominantly in the 21 – 40 years age group (73.1%), which demonstrated that the respondents had a relatively young, adult, and working population. The level of education attained by respondents was low. It was noted that in the sample population, on average, 45.7% had no formal education, and in Odi-Olowo, this figure was 55.3%. The respondents' most dominant livelihood strategy was petty trading and small business (33.9%), followed by unemployment (31.2%), and daily paid labour (20.6%), while 8.5% were employed in the low-cadre civil service. Together, these figures indicate that over 85% of respondents rely on informal, unemployed, or daily-wage livelihoods with little income security. For daily-wage earners in particular, even a few days of incapacitation from waterborne illness constitutes immediate and severe income loss, with no savings buffer or employer-provided sick pay, a vulnerability pattern consistent with findings by Azeez et al. (2023) for low-income urban households in south-western Nigeria. This combination of low educational attainment, precarious employment, and predominantly female-headed WASH responsibility describes a population with limited capacity to absorb the health and income shocks documented in the sections that follow.						

3.2 Water Quality and Supply Interruptions

Across the four settlements (Table 2), the most frequently reported issues (24% of reported issues) are concerns with water quality (supply) and water supply interruptions (23%), which exceed four hours on a daily basis. In Odi-Olowo, issues with water quality (supply) account for 32.4% of reported issues, the highest of all settlements. For households that do not have consistent access to safe (potable) water, the only alternative is the purchase of either sachet water or water from vendors, both of which are unacceptable and impose a disproportionate burden on the household. Women carry 84% of the burden for alternative water procurement: 29% of women indicated that economically productive work time is lost because of the time spent in water collection activities. This finding aligns with the evidence collected in sub-Saharan Africa by Graham et al. (2016).

Table 2: Key issues reported by respondents across settlements (percentage of total quantified responses)

Issue Category	Oke-Baale (%)	Igbona (%)	Alekuwodo (%)	Odi-Olowo (%)
Water quality concerns	19.4	26.8	17.2	32.4
Water supply interruptions (>4 hrs/day)	18.6	24.2	16.8	28.6
Drainage and flooding issues	16.2	18.4	14.6	22.8
Waste management and disposal	14.8	16.2	13.4	18.4
Open defecation and sanitation deficits	12.4	18.6	10.8	28.2
Waterborne disease incidence	10.2	14.6	9.4	16.8
Flooding-induced property damage	5.4	8.4	4.2	12.6
Other concerns	3.0	3.2	2.6	3.4

3.3 Drainage Issues, Flooding, and Waste Management

About 16% of respondents reported problems with drainage and flooding, with the most severe drainage failures in Odi-Olowo (22.8%). It is located on the periphery and is close to low, flood-prone areas of the River Osun with no built stormwater drainage, making it susceptible to flooding, as shown in the spatial flood hazard studies of Adegboyega et al. (2018). Odi-Olowo sees flooding during even light rains since drainage systems are clogged with solid waste from irregular municipal waste collection. Kolawole et al. (2023) cite this as a state-level example. Waste management issues, making up 15% of issues reported, reveal poor delivery of services by the Osun State Waste Management Agency (OSWMA) in these urban neighborhoods. This governance failure, after a significant budget is allocated, portrays service delivery failures documented

at the national level by the Federal Ministry of Water Resources et al. (2021).

3.4 Issues Expressed by Respondents

The Loss Index is greater than zero for all studied settlements, confirming that economically measurable losses due to inadequate water and sanitation infrastructure are present in all four urban neighbourhoods of Osogbo. All settlements show measurable losses.

Odi-Olowo in Table 3 has the highest Loss Index (38.6) due to drainage system failures and the highest open defecation and sanitation issues (28.2% of reported issues), with the lowest sanitary quality (48.2%). Oke-Baale has the lowest Loss Index (18.4) due to greater proximity and partial investment of the government in water infrastructure.

There is a significant positive correlation between the quality index and sanitary healthcare expenditure, with a fall of 1% in sanitary quality resulting in a rise of 1.4% in household healthcare expenditure. This indicates a strongly preventive healthcare improvement with a

reduction in household healthcare expenditure by 1.4% for a 1% increase in sanitary quality.

Table 3: Loss Index by settlement and component indices

Settlement	Loss Index	Sanitary Quality	Workdays Lost	School Days Lost	Med. Exp. Index	Rank
Oke-Baale	18.4	14.2	16.8	22.4	12.8	1st (Best)
Alekuwodo	21.6	28.4	16.8	22.4	12.8	2 nd
Igbona	24.8	30.6	18.2	26.4	16.4	3 rd
Odi-Olowo	38.6	48.2	28.4	36.2	24.6	4th (Worst)
Overall Average	25.9	30.4	20.1	26.9	16.7	–

Note. Loss index range 0–100, zero = best outcome, 100 = worst outcome. Medical expenditure index reflects private (out-of-pocket) expenditure only.

The decline in quality of sanitation has a statistically significant impact on workdays lost and school days lost. A decline in quality of sanitation by one percent results in a loss of workdays and school days by 0.7 and 0.5, respectively.

The Loss Index positively correlates with the quality of sanitation index, and the correlation is 0.87. This means the quality of sanitation drives economic loss in the communities in the study the most.

4 Conclusion

This study set out to quantify the economic impact of poor water and sanitary infrastructure on low-income households across four urban neighbourhoods in Osogbo. The findings show that water quality, water supply interruptions, and drainage/flooding are the most frequently reported deficiencies, and that these deficiencies translate directly into measurable household costs: a 1% decline in sanitary quality is associated with a 1.4% rise in medical expenditure, a 0.7% increase in lost workdays, and a 0.5% increase in lost school days. The Loss Index indicates that the burdens were in fact unequally distributed across the settlements. This was particularly noted in Odi-Olowo (Loss Index = 38.6), with Oke-Baale the least affected (18.4). This disparity reflected unequal exposure of the settlements to land that was flood-prone with poor drainage. The socio-demographic profile of respondents was predominantly female, of low education, and employed in informal or daily wage employment. This profile further illustrates that the households that incurred the losses had the least ability to absorb them.

The collected data suggests that WASH deficiencies in Osogbo relate to service delivery gaps and the impoverishment of Osogbo's poor people, and that the impoverishment of people, measurable at the household level, is enhanced by additional burdens on public health finances.

Osun State is at a crucial point in time where policy innovations and active participation of the community

and real changes in the system may reduce the economic burden put on the most disadvantaged households and give additional benefits to the public health finances of the state.

4.1 Recommendations

Based directly on the study's findings, the following actions are recommended:

First, because of the largest burden of public health expenditures that is measurable in terms of time lost to work and school due to illness, investment in sanitation and drainage should be concentrated on Odi-Olowo and other settlements with the highest Loss Index scores. Given that a 1% improvement in sanitary quality is associated with a 1.4% reduction in household medical expenditure, and that the estimated capital cost of infrastructure upgrades is a one-off expense while medical-expenditure savings accrue annually, sanitation and drainage improvement represents a cost-effective preventive-healthcare investment for the state.

Second, because water quality and supply interruptions were the single most frequently reported issue (24% of reported issues, rising to 32.4% in Odi-Olowo), improving the reliability and safety of piped water supply should be treated as an immediate priority alongside drainage works, to reduce households' reliance on costly and unregulated alternative water sources.

Third, given that flooding and drainage failures were linked in this study to uncollected solid waste blocking drainage channels, municipal waste-collection services should be strengthened and enforced in the affected neighbourhoods, consistent with the governance gaps identified in the budgetary comparison conducted in this study.

Fourth, because women in the sample bore a disproportionate share of WASH-related burden (51% of respondents reporting health impacts and 29% reporting lost productive time attributable to water collection were women), WASH governance and community consultation processes should explicitly include women

as decision-makers, not only as service recipients.

Finally, infrastructure investment should be accompanied by targeted compensatory support for the most severely affected households identified in this study, to offset losses already incurred while longer-term infrastructure improvements take effect.

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