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Physical and socio-economic factors responsible for poor WASH services in Onitsha urban Area, Anambra State, Nigeria

[1]Emeka Emmanuel Ezenwaji, [2]Theresa Nwakaego Nwoye
[1]Geography and Meterology Department, Faculty Of Environmental Sciences in Nnamdi Azikiwe University Awka, Anambra State, Nigeria. [2]Geography department, Nwafor Orizu College of Education, Nsugbe, Anambra State, Nigeria.

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Corresponding Author
Emeka Emmanuel Ezenwaji

ABSTRACT

Access to clean water, adequate sanitation, and proper hygiene (WASH) services remains a persistent challenge in many rapidly urbanizing cities, particularly in Nigeria. This study examines Water, Sanitation, and Hygiene (WASH) practices in Onitsha Urban Area, Nigeria, using a mixed-methods approach. Onitsha, a densely populated commercial hub, faces rapid urbanization, environmental degradation, and inadequate WASH infrastructure. The study sampled 400 residents using Taro Yamene's formula and collected data via structured questionnaires validated through direct observation. Reliability was confirmed with a Cronbach's Alpha of 0.82. Data analysis included Two-way ANOVA, Principal Component Analysis (PCA), and multiple regression to assess the influence of physical and socio-economic factors on WASH services, revealing critical gaps and contributing to evidence-based interventions for improved WASH access. The result showed that Poor WASH services in Onitsha Urban Area result from various physical and socio-economic factors. Using data from (20) variables across (12) layouts, Principal Component Analysis (PCA) identified (7) dominant components explaining (89.67%) of the variance. Major factors include uncontrolled urbanisation (eigenvalue = 4.431), degraded water infrastructure (3.471), poor access due to low income (3.013), flooding (2.637), poor environmental planning (1.837), lack of community ownership (1.345), and inadequate investment (1.198). Principal Component Regression (PCR) revealed a strong correlation ($R = 0.902$; $R^2 = 81.3\%$) between these factors and poor WASH services, showing their significant contribution to deteriorating sanitation in the area. In conclusion, the study highlights the urgent need for government and community-driven interventions to strengthen WASH services. It recommends infrastructure upgrades, public awareness campaigns, and the integration of WASH planning into urban development policies to promote healthier living conditions in Onitsha.

Keywords:
WASH services, Onitsha, urbanization, socio-economic factors, infrastructure

INTRODUCTION

Access to safe water, sanitation, and hygiene (WASH) services is a fundamental human right and a crucial determinant of public health and socio-economic development. However, many urban areas in developing countries, including Onitsha in Nigeria, experience significant deficiencies in WASH services. The growing challenges are linked to a mix of physical and socio-economic factors that hinder effective service delivery and sustainability. The statement of the problem revolves around the persistent failure to provide equitable and sustainable WASH services in urban centers like Onitsha. Despite governmental and international efforts to improve water and sanitation access, many residents still rely on informal and unsafe sources. This situation contributes to disease outbreaks, environmental degradation, and economic hardship, particularly for vulnerable populations. The root of the problem lies in physical constraints such as topography and poor infrastructure, alongside socio-economic limitations like poverty, poor governance, and rapid population growth (Uguru et al, 2021).

Physical factors significantly affect WASH services in urban areas. Geographic and climatic conditions, such as terrain, soil type, and rainfall patterns, can hinder infrastructure development and water supply sustainability. For example, areas with high water tables or unstable soil conditions may face challenges in constructing latrines or water pipelines (Anthonj et al, 2020). Onitsha, with its sedimentary formations and flood-prone zones, often suffers from drainage issues and poor waste management. Additionally, the pressure on groundwater from excessive borehole drilling, often due to the collapse of public water supply systems, leads to aquifer depletion and water quality issues (Anukwonke, 2014). Poorly planned settlements and lack of access roads further complicate the maintenance and expansion of WASH infrastructure.

The socio-economic dimensions of poor WASH services are even more pronounced. Poverty, a major barrier, affects both access and affordability. Households in low-income urban communities often cannot afford basic sanitation facilities or safe drinking water, relying instead on open defecation or contaminated water sources (Chandrasekaran et al, 2022). Additionally, rapid urbanization without corresponding infrastructural growth has led to overcrowding and slum development, overwhelming the limited WASH facilities (UN-Habitat, 2016). In Onitsha, population density increases the burden on existing water and waste management systems, making them ineffective and unsustainable.

Moreover, governance issues, such as weak institutional frameworks, inadequate funding, and poor policy implementation, have been widely identified as major contributors to WASH failures. Decentralization without capacity building has often led to poor coordination among agencies and limited community engagement in service planning and maintenance (Butera et al, 2022). In many Nigerian cities, local governments lack the technical and financial capacity to sustain WASH services, leading to over-reliance on donor-funded projects with limited longevity. Cultural and behavioral practices also influence the uptake and sustainability of WASH services. Poor hygiene awareness, resistance to change, and gender disparities in WASH-related decision-making all affect the success of interventions (WaterAid, 2019). For instance, women and children, who are primary users and managers of household water, often have limited voices in policy and infrastructure decisions, despite being the most affected by poor WASH conditions.

The motivation for this study stems from the persistent inadequacy of Water, Sanitation, and Hygiene (WASH) services in Onitsha Urban Area, despite multiple national and international interventions. Onitsha, a rapidly urbanizing commercial city in Anambra State, Nigeria, faces increasing challenges in ensuring equitable access to clean water and sanitation, particularly for vulnerable populations. Studies have documented that poor urban planning, environmental degradation, and weak institutional structures undermine WASH service delivery in many Nigerian cities (Kwong et al, 2020; UN-Habitat, 2016). However, there is limited localized research focusing specifically on the combined physical and socio-economic factors affecting WASH in Onitsha. While national surveys often highlight broad patterns (World Bank, 2020), they overlook contextual nuances such as the impact of Onitsha's topography, flooding, and unregulated urban sprawl on sanitation infrastructure. Furthermore, socio-economic dimensions like poverty, governance lapses, and population pressure are underexplored in the specific context of Onitsha. This study is therefore motivated by the need to bridge these gaps and provide empirical evidence to guide sustainable urban WASH interventions. Understanding the local interplay of these factors will aid policymakers and stakeholders in designing more effective, inclusive, and context-specific solutions to the WASH crisis in the region. To determine the physical and socio-economic factors responsible for poor WASH services in Onitsha urban Area. The following research Questions were formulated to guide the study: what physical and socio-economic factors are responsible for poor WASH services in Onitsha urban area?

METHOD

This study evaluates Water, Sanitation, and Hygiene (WASH) practices in Onitsha Urban Area, Anambra State, Nigeria, using a mixed methods design. Both quantitative and qualitative approaches are employed to examine WASH coverage, nature, and management. The goal is to understand the structure and functioning of WASH systems within the complex urban environment of Onitsha.

Onitsha is a vital commercial center located on the eastern bank of the Niger River. It encompasses parts of Onitsha North and South LGAs and stretches into neighboring LGAs like Idemili North, Idemili South, Oyi, and Ogbaru. Prominent urban districts include GRA, Inland Town, Fegge, and Omagba. The area spans about 200 square kilometers at an altitude of 300 meters, bordered by Nsugbe (north), Nkpor (east), Ogbaru (south), and the Niger River (west).

Onitsha has a tropical wet and dry (Köppen AW) climate with mean annual rainfall of 1,886.88 mm. The wet season runs from March to November, while the dry season extends from November to March, influenced by Harmattan winds. Temperatures range from 20°C to 32°C with consistently high humidity.

Geologically, Onitsha lies within the Niger-Benin trough and consists of Bende-Ameki sedimentary rocks and alluvial deposits. Its gently rolling topography, shaped by the Niger River and tributaries, contributes to fertile soils and supports both agriculture and WASH infrastructure development.

The population of Onitsha according to the National Population Commission (https://www.nigerianstat.gov.ng/pdfuploads/ABS%202010.pdf) in 1991 is 70,834 male and 64,456 female, totaling 135,290 while in 2006 the population increased to 132,936

male and 130,173 female totaling 263,109. The Malthusian formula for population growth is expressed as follows:

$$P(t) = P_o \times e^{(rt)}$$

Where:

$P(t)$: Total population in time

P_o: Initial population size

e: The base of the natural logarithm (approximately 2.71828)

r: The population growth rate

t: The time elapsed

The population of Onitsha North is 125,918 persons and Onitsha South is 137,191 according to the National population Commission (2006). Therefore, the total population in 2006 is 263,109 persons. Using the Malthusian formula:

Where:

P_t = Population in 2006

P_o = 263,109

R = 2.83%

t =17 years

$P(t) = 263{,}109 \times e^{(0.083\times17)}$

$P(t) = 796{,}592$

Therefore, the population of the study is 796,592

Onitsha sources its groundwater from the middle aquifer of the Ameki group (40–90 m deep). Excessive extraction from numerous boreholes has created a depression in the aquifer due to high demand. Surface drainage includes major rivers such as the Niger, Nkisi (north), Idemili (south), and Anambra. These rivers support agriculture, biodiversity, and local livelihoods.

Soil types in the area include coastal plain sands (well-drained and fertile), alluvial soils (nutrient-rich, along riverbanks), and hydromorphic soils (poorly drained swamps). Natural vegetation, originally tropical savanna with tall grasses and scattered trees, has been largely degraded by urbanization, leaving only remnants of riparian and forest patches.

Strategically located at a key crossing of the Niger, Onitsha developed into a major commercial hub. However, rapid unregulated urbanization has caused congestion, loss of vegetation, and poor infrastructure. The city also suffers from severe air pollution.

The area features red sedimentary sand and lowland cuestas. It is bordered by the Nkisi and Idemili rivers and other minor streams. Onitsha hosts West Africa's largest market and several industries, including breweries and manufacturing firms. Trade and industrialization drive the city's economy.

Water, sanitation, and hygiene infrastructure in Onitsha is dysfunctional. There is an urgent need for improved access to safe water, especially in schools, health centers, and underserved communities. The sample size of 400 residents from the Federal Housing Estate and Environs of Onitsha Urban Area is justified using the 'Taro Yamene' sampling technique. The Taro Yamene' technique is detailed as follows:

$$n = \frac{N}{1 + Ne^2} = \frac{796{,}592}{1 + 796{,}592\ (0.05)^2} = 399.8 \approx 400$$

Where

n = the sample size

N = population

e = level of significance (0.05)

I = unity (a constant)

Data for the study were collected through a structured questionnaire administered to 400 randomly selected residents of Onitsha Urban Area. A team of seven trained research assistants delivered the questionnaires by hand and also inspected household WASH facilities to validate responses. This approach ensured accuracy and completeness of the data collected.

To ensure reliability, the instrument was trial-tested in Ngozika Housing Estate, Awka, with 40 copies administered to residents. The responses were analyzed using Cronbach's Alpha (α), which yielded a reliability index of 0.82. This value exceeds the commonly accepted threshold of 0.50, indicating a high level of internal consistency and reliability of the questionnaire for measuring the intended variables.

A direct delivery and retrieval method was employed for administering the instrument. Seven research assistants were briefed extensively using prepared materials shared weeks in advance. During briefing sessions, the researcher explained procedures, answered questions, and emphasized strict adherence to the methodology.

The data was analyzed using Two-way ANOVA, while the principal component analysis will be employed to establish the major factors giving rise to poor WASH situation and its special arrangement in Onitsha. Multiple regression analysis was conducted to examine the relationship between physical and socio-economic factors and WASH services in Onitsha. PCA was applied to reduce the dimensionality of the dataset and identify underlying patterns or factors contributing to WASH services. This helped in selecting the most relevant variables for inclusion in the regression model. Principal components were extracted from the dataset, and those components with eigenvalues greater than one were retained. The loadings of variables on the principal components were examined to identify the key factors influencing WASH services.

RESULTS

Demographic Characteristics of the Respondents

The demographic characteristics of the respondents are presented below. The age brackets of the respondents, administered questionnaire, is shown in table 1. Out of 100% of the number of respondents, 17% of them respondents were between 18 and 28 years of age; 28% of the respondents, were between the ages of 29 and 39 years; 36% had ages ranging from 40 to 50 while 19% of the respondents were in the age group of above 50. The age distribution of the respondents showed that the over 60% are above 30 years of age and understands the content of the questionnaire.

Table 1: Age distribution of the respondents

Age bracket	Frequency	Percentage age distribution
18 – 28	68	17%
29 – 39	112	28%
40 – 50	144	36%
51 and above	76	19%
Total	400	100%

The educational qualification of the respondents revealed the ability of the respondents to understand the content of the questionnaire. Table 2 illustrates the level of educational exposure of respondents. About 20% had primary school education as their highest education. Also 48% of the respondents attest that they had secondary education as their highest level of formal education while 24% of the respondents identified as having undergone different forms of tertiary education in various fields. It also reveals that 8% of the respondents identified as having no form of formal education. It is evident that the educational characteristics of most of the respondents had good understanding of the subject of the questionnaire when administered.

Table 2: Educational qualification of the respondents

Level of Education	Frequency	Percentage distribution
No formal education	32	8%
Primary	80	20%
Secondary	192	48%
Tertiary	96	24%
Total	400	100%

The ethnic distribution of the respondents was sought in order to highlight the cultural diversity of the respondents. Figure 1 shows the ethnic diversity of the respondents. From the questionnaire gathered, 1.85% of the respondents identified that they are the percentage of the respondents that are of Yoruba ethnic group, 3% of the respondents are Hausa, 5% of the respondents belong to other groups of ethnic nationalities while 90.15% of the respondents are Igbos.

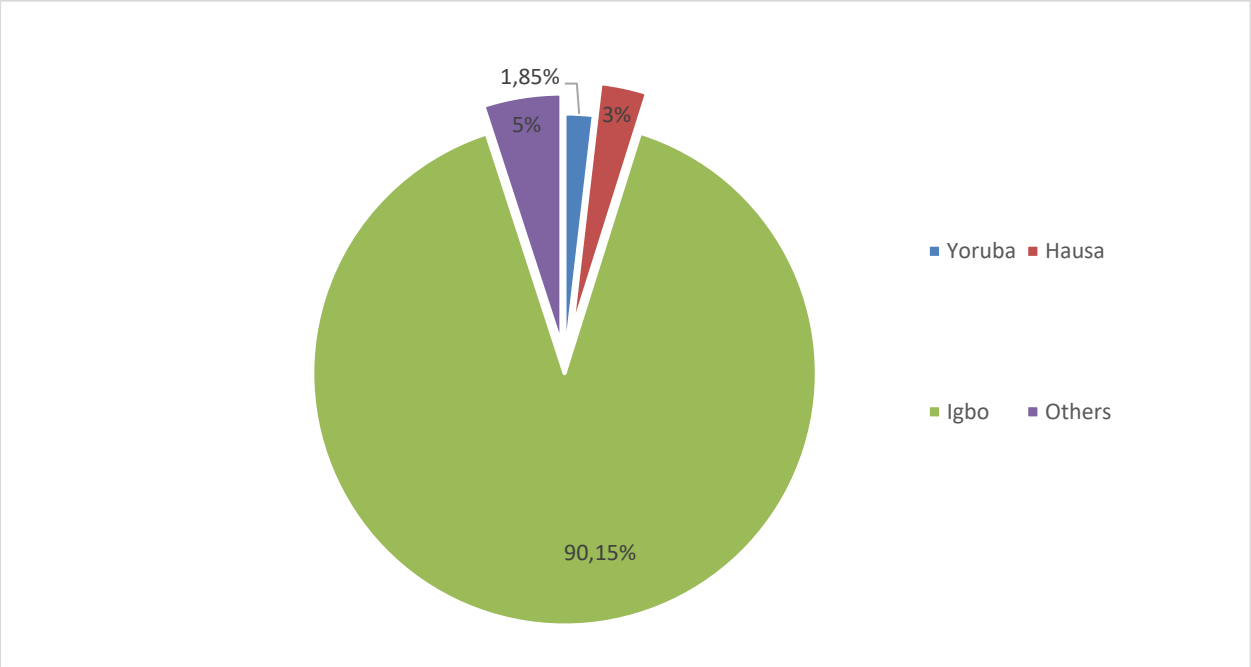

Fig 1: Ethnic distribution of the respondents

Additionally, the questionnaire was used to explore the number of children per household was sought in order to showcase the household size as defined in the

questionnaire. Table 3 below presents the number of children in each of the respondents' households. From the information generated, 38% of the respondents have between 1 and 3 children in the households, 42% had between 4 and 6 children, 16% had between 7 and 9 children in their households while 4% of the respondents had more than 9 children in their households.

Table 3: Number of children per household

Children per household	Frequency	Percentage distribution
1 – 3	152	38%
4 – 6	168	42%
7 – 9	64	16%
Others	16	4%
Total	400	100%

Physical and socio-economic factors responsible for the poor WASH services in Onitsha Urban Area

The second objective of this study sought to identify and evaluate the physical and socio-economic factors responsible for the poor WASH services in Onitsha Urban Area. The questionnaire was designed to obtain this information from the respondents in Onitsha. A total of 20 factors were isolated from literature search and deployed through questionnaire to obtain the perception of the respondents on these factors (table 4). The summary of the responses on the questionnaire distributed across the 12 layouts in Onitsha are shown in table 5. To further provide meaning to the obtained data, PCA was employed to analyse the factors with the intention of identifying, by means of data reduction, the core and dominant factors clearing affecting the status of WASH services in Onitsha urban area. To achieve this objective and to make data handling easier, the physical and socio-economic factors were defined and parameterized in Table 6.

Table 4: Physical and socio-economic factors responsible for the poor WASH services in Onitsha Urban Area.

S/N	Factors affecting water quality	SD	D	A	SA
1.	Overpopulation in Onitsha Urban Area strains existing water and sanitation infrastructure, leading to poor services.	47	94	122	137
2.	Inadequate investment in WASH infrastructure contributes to service deficiencies.	60	105	118	117
3.	Aging and poorly maintained water supply systems result in frequent breakdowns.	32	91	123	154
4.	The rapid urbanization of Onitsha has outpaced the expansion of WASH services.	22	99	133	146
5.	Socio-economic disparities lead to unequal access to improved sanitation facilities.	20	33	182	165
6.	Limited public awareness of proper hygiene practices affects WASH outcomes.	10	9	200	181
7.	Pollution from industrial activities and waste disposal contaminates water sources.	10	23	167	200
8.	Inadequate waste management and disposal systems exacerbate sanitation issues.	21	30	140	209

S/N	Factors affecting water quality	SD	D	A	SA
9.	Flooding and water-related disasters disrupt water and sanitation services.	11	43	195	151
10.	The absence of a comprehensive WASH policy hampers planning and coordination.	16	19	144	221
11.	High poverty levels hinder residents' ability to afford and access improved WASH services.	0	0	212	188
12.	Informal settlements lack basic WASH infrastructure, leading to poor hygiene conditions.	5	12	170	213
13.	Weak regulatory enforcement allows for substandard sanitation practices.	3	1	153	243
14.	Limited government funding for WASH programs affects service expansion.	14	11	191	184
15.	Land tenure issues hinder the development of water and sanitation infrastructure.	40	85	122	153
16.	Climate change impacts, such as droughts and extreme weather events, affect water availability.	108	98	87	107
17.	Lack of community involvement in WASH projects reduces ownership and sustainability.	45	76	98	181
18.	Displacement due to urban development disrupts existing WASH services.	64	54	87	195
19.	Political factors, including corruption, can divert resources from WASH projects.	21	76	81	222
20.	Inadequate capacity and training of WASH service providers impede service delivery.	11	73	185	131

Table 5: Physical and socio-economic factors responsible for the poor WASH services in Onitsha Urban Area

LAYOUTS	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20
GRA	13	20	33	10	38	23	41	25	30	32	30	29	47	22	19	13	19	21	22	22
INLAND TOWN	29	18	29	27	30	27	43	19	25	19	21	40	43	31	21	17	29	27	30	20
OTU	20	20	21	23	22	28	25	31	31	32	34	37	21	29	23	19	31	23	19	18
3-3	25	22	22	29	21	24	23	29	26	33	29	24	14	34	29	16	29	29	21	25
TRANS NKISI	37	21	19	24	36	33	20	26	28	31	21	37	18	41	30	18	22	22	23	30
OMAGBA 1	25	12	21	26	30	41	39	30	27	34	38	26	39	37	24	13	20	21	25	32
OMAGBA 11	23	19	37	29	26	34	36	32	33	24	34	30	45	25	22	14	22	23	31	32
WOLIWO	20	25	25	24	23	40	33	40	28	38	42	30	37	35	23	22	17	23	24	29
OKPOKO	14	22	15	13	23	36	24	31	23	24	33	49	30	27	15	19	26	23	26	35
AWADA	29	17	12	25	22	42	31	30	31	30	46	40	32	30	25	15	24	25	28	34
ODOAKPU	13	23	23	26	47	29	21	20	30	43	41	21	36	33	25	12	19	29	27	19

Table 6: Coding and labeling of the variables

S/N	Name of variable	Variable label	Variable code
1	Overpopulation in Onitsha Urban Area strains existing water and sanitation infrastructure, leading to poor services.	OVERPOP	X1
2	Inadequate investment in WASH infrastructure contributes to service deficiencies.	INVEST	X2
3	Aging and poorly maintained water supply systems result in frequent breakdowns.	AGING	X3
4	The rapid urbanization of Onitsha has outpaced the expansion of WASH services.	RURBA	X4
5	Socio-economic disparities lead to unequal access to improved sanitation facilities.	DISPAR	X5
6	Limited public awareness of proper hygiene practices affects WASH outcomes.	PUBAW	X6
7	Pollution from industrial activities and waste disposal contaminates water sources.	POLLU	X7
8	Inadequate waste management and disposal systems exacerbate sanitation issues.	WASTE	X8
9	Flooding and water-related disasters disrupt water and sanitation services.	FLOOD	X9
10	The absence of a comprehensive WASH policy hampers planning and coordination.	POLICY	X10
11	High poverty levels hinder residents' ability to afford and access improved WASH services.	POVERTY	X11
12	Informal settlements lack basic WASH infrastructure, leading to poor hygiene conditions.	lnSETL	X12
13	Weak regulatory enforcement allows for substandard sanitation practices.	REGENF	X13
14	Limited government funding for WASH programs affects service expansion.	LFUND	X14
15	Land tenure issues hinder the development of water and sanitation infrastructure.	LATEN	X15
16	Climate change impacts, such as droughts and extreme weather events, affect water availability.	CLIMATE	X16
17	Lack of community involvement in WASH projects reduces ownership and sustainability.	LACOM	X17
18	Displacement due to urban development disrupts existing WASH services.	DISPLA	X18
19	Political factors, including corruption, can divert resources from WASH projects.	CORRUPT	X19
20	Inadequate capacity and training of WASH service providers impede service delivery.	INADEQ	X20

Part of PCA analysis requires that correlation analysis be conducted in order to justify clearly the necessity for a PCA analysis. The presence of serial autocorrelation or multicollinearity justifies the need for PCA. From the result of the correlation statistical analysis is presented in table 7, a 20 x 20 correlation matrix is shown. The correlation showed some autocorrelation in the result as seen where X8 correlated highly with X16 and X18 and making it necessary to employ PCA analysis. The PCA analysis collapsed the 20 factors into significant and orthogonal components that explained the observed data obtained from the respondents in the study area. Following transformation, the dominance of seven components revealed (table 8).

Table 7: Correlation of perceived physical and socio-economic factors responsible for the poor WASH services in Onitsha Urban Area

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20
X1	1.000																			
X2	-.164	1.000																		
X3	-.133	.086	1.000																	
X4	.504	-.158	.047	1.000																
X5	-.187	.054	.255	-.145	1.000															
X6	.348	-.148	-.370	.154	-.298	1.000														
X7	-.020	-.506	.560	-.085	-.038	.042	1.000													
X8	-.198	.032	-.167	-.011	-.639	.368	-.033	1.000												
X9	-.237	-.221	.228	.173	.139	-.159	.063	.270	1.000											
X10	-.167	.361	-.136	.072	.379	.144	-.389	.029	.104	1.000										
X11	-.311	.009	-.277	.068	-.143	.588	-.046	.400	.290	.537	1.000									
X12	.337	.111	-.309	-.336	-.388	.358	-.034	-.086	-.497	-.493	-.160	1.000								
X13	-.337	-.271	.601	-.204	.313	.099	.808	-.109	.204	-.183	.187	-.114	1.000							
X14	.559	-.019	-.425	.514	.101	.296	-.383	.020	-.252	.361	-.101	-.171	-.506	1.000						
X15	.681	.096	-.146	.640	.100	.081	-.406	-.169	.045	.467	-.049	-.283	-.563	.701	1.000					
X16	.157	.469	-.263	-.075	-.570	.192	-.229	.508	-.323	-.147	-.129	.483	-.390	.230	-.079	1.000				
X17	.274	-.033	-.200	.167	-.505	-.293	-.184	-.227	-.308	-.471	-.387	.469	-.505	-.113	.044	.258	1.000			
X18	.258	.437	.016	.387	.073	-.034	-.256	-.550	-.418	.268	.071	.089	-.211	.107	.422	-.108	.358	1.000		
X19	.045	-.278	.208	.296	.111	.265	.383	-.152	.127	-.463	.097	.075	.605	-.176	-.285	-.291	-.192	.045	1.000	
X20	.360	-.108	-.281	-.032	-.388	.801	-.013	.363	-.273	-.133	.285	.431	-.004	.115	.015	.117	-.195	-.094	.257	1.000

The screen plot of these components is shown in Fig 2.

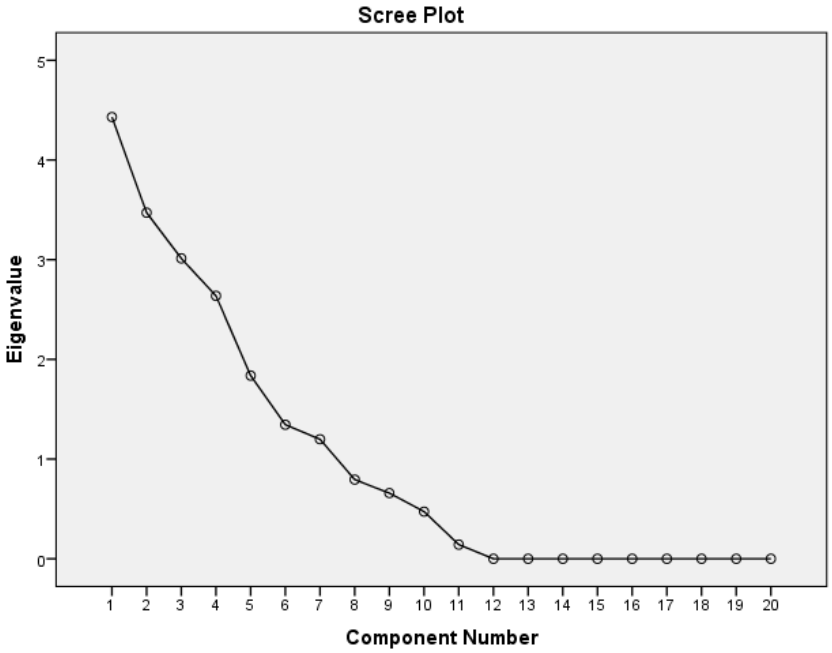

Fig 2: Screen Plot for perceived factors responsible for poor water quality

Table 8: Varimax Rotated Component Matrix of the physical and socio-economic factors responsible for the poor WASH services in Onitsha Urban Area

S/N	Perceived environmental factors	Components							h^2
		I	II	III	IV	V	VI	VII	
X1	Overpopulation in Onitsha Urban Area strains existing water and sanitation infrastructure, leading to poor services.	.832	.027	.117	-.384	.003	-.174	-.112	.897
X2	Inadequate investment in WASH infrastructure contributes to service deficiencies.	-.121	-.212	-.159	-.187	.280	.201	.825*	.920
X3	Aging and poorly maintained water supply systems result in frequent breakdowns.	-.028	.767	-.454	.154	.028	.163	.219	.895
X4	The rapid urbanization of Onitsha has outpaced the expansion of WASH services.	.814	.131	.092	.389	-.034	-.273	.145	.937
X5	Socio-economic disparities lead to unequal access to improved sanitation facilities.	-.030	.060	-.287	.031	-.662	.637	.040	.934
X6	Limited public awareness of proper hygiene practices affects WASH outcomes.	.208	.057	.917*	-.166	.172	.119	-.054	.962
X7	Pollution from industrial activities and waste disposal contaminates water	-.124	.818	-.014	-.001	-.005	.005	-.293	.771

S/N	Perceived environmental factors	Components I	II	III	IV	V	VI	VII	h^2
	sources.								
X8	Inadequate waste management and disposal systems exacerbate sanitation issues.	-.117	-.087	.335	.316	.848*	.049	-.164	.982
X9	Flooding and water-related disasters disrupt water and sanitation services.	-.066	.123	-.075	.803*	.054	.060	-.237	.733
X10	The absence of a comprehensive WASH policy hampers planning and coordination.	.111	-.437	.163	.368	-.131	.595	.436	.927
X11	High poverty levels hinder residents' ability to afford and access improved WASH services.	-.219	-.094	.763	.504	.004	.105	.234	.959
X12	Informal settlements lack basic WASH infrastructure, leading to poor hygiene conditions.	-.172	-.031	.275	-.772	.123	-.408	.000	.884
X13	Weak regulatory enforcement allows for substandard sanitation practices.	-.364	.839*	.134	.095	-.195	.254	-.084	.973
X14	Limited government funding for WASH programs affects service expansion.	.775	-.394	.093	-.120	.054	.316	-.088	.889
X15	Land tenure issues hinder the development of water and sanitation infrastructure.	.856*	-.336	-.036	.147	-.117	.109	.182	.926
X16	Climate change impacts, such as droughts and extreme weather events, affect water availability.	.037	-.216	-.006	-.392	.802	-.111	.177	.889
X17	Lack of community involvement in WASH projects reduces ownership and sustainability.	.087	-.241	-.280	-.245	-.007	-.873*	.067	.971
X18	Displacement due to urban development disrupts existing WASH services.	.304	-.055	.045	-.131	-.423	-.274	.781	.979
X19	Political factors, including corruption, can divert resources from WASH projects.	.046	.685	.353	.016	-.273	-.163	-.086	.705
X20	Inadequate capacity and training of WASH service providers impede service delivery.	.126	.074	.773	-.345	.203	.023	-.146	.801

**Component defining variables (CDV)*

Table 9: Total variance explained

Component	Initial Eigenvalues	Extraction Sums of Squared Loadings	Rotation Sums of Squared Loadings

	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.431	22.155	22.155	4.431	22.155	22.155	3.123	15.616	15.616
2	3.471	17.356	39.511	3.471	17.356	39.511	3.104	15.522	31.138
3	3.013	15.065	54.576	3.013	15.065	54.576	2.810	14.052	45.190
4	2.637	13.187	67.763	2.637	13.187	67.763	2.513	12.564	57.755
5	1.837	9.187	76.949	1.837	9.187	76.949	2.296	11.478	69.232
6	1.345	6.724	83.673	1.345	6.724	83.673	2.183	10.914	80.146
7	1.198	5.992	89.665	1.198	5.992	89.665	1.904	9.519	89.665
8	.794	3.970	93.635						
9	.658	3.292	96.927						
10	.473	2.364	99.291						
11	.142	.709	100.000						
12	9.775E-16	4.887E-15	100.000						
13	5.308E-16	2.654E-15	100.000						
14	1.702E-16	8.510E-16	100.000						
15	1.115E-16	5.577E-16	100.000						
16	6.476E-17	3.238E-16	100.000						
17	-2.148E-16	-1.074E-15	100.000						
18	-2.954E-16	-1.477E-15	100.000						
19	-4.301E-16	-2.150E-15	100.000						
20	-7.093E-16	-3.547E-15	100.000						

Extraction Method: Principal Component Analysis.

Table 8 shows the outcome of the varimax rotation which reveals the dominance of seven components with each having eigen values greater than 1.00. This rotation technique maximizes the covariance loadings on each component in order to achieve as many high and as many low loadings as possible while maintaining the orthogonality (i.e., the uncorrelation of the original components. The first component reveals an eigen value of 4.431, second component shows 3.471, third component has 3.013, fourth component is

2.637, fifth component is 1.837, sixth component has eigen value of 1.345 while seventh component is 1.198. Table 4.19 shows the total variance explained and revealed that the seven components explained 89.67% of the variance. The variables with the highest loadings on each of the components were selected and grouped in tables 10 – 16 with their corresponding variables.

Table 10: Variables with high loadings on Component I

Variables	Variable Name	Loadings	
X15	Land tenure issues hinder the development of water and sanitation infrastructure.	0.856	Uncontrolled urbanization
X1	Overpopulation in Onitsha Urban Area strains existing water and sanitation infrastructure, leading to poor services.	0.832	
X4	The rapid urbanization of Onitsha has outpaced the expansion of WASH services.	0.814	

Table 11: Variables with high loadings on Component II

Variables	Variable Name	Loadings	
X3	Aging and poorly maintained water supply systems result in frequent breakdowns	0.767	Degradation of water supply infrastructure
X7	Pollution from industrial activities and waste disposal contaminates water sources.	0.818	
X13	Weak regulatory enforcement allows for substandard sanitation practices.	0.839	

Table 12: Variables with high loadings on Component III

Variables	Variable Name	Loadings	
X11	High poverty levels hinder residents' ability to afford and access improved WASH services.	0.763	Poor access to WASH facilities
X20	Inadequate capacity and training of WASH service providers impede service delivery.	0.773	

Table 13: Variables with high loadings on Component IV

Variables	Variable Name	Loadings	
X9	Flooding and water-related disasters disrupt water and sanitation services.	0.803	Natural disaster
X12	Informal settlements lack basic WASH infrastructure, leading to poor hygiene conditions.	-0.772	

Table 14: Variables with high loadings on Component V

Variables	Variable Name	Loadings	
X8	Inadequate waste management and disposal systems exacerbate sanitation issues.	0.848	Poor environmental planning
X16	Climate change impacts, such as droughts and extreme weather events, affect water availability.	0.802	

Table 15: Variables with high loadings on Component VI

Variables	Variable Name	Loadings	
X17	Lack of community involvement in WASH projects reduces ownership and sustainability.	-0.873	Lack of community ownership

Table 16: Variables with high loadings on Component VII

Variables	Variable Name	Loadings	
X2	Inadequate investment in WASH infrastructure contributes to service deficiencies.	0.825	Poor level of investments in WASH
X18	Displacement due to urban development disrupts existing WASH services.	0.781	

From the extracted component tables 10 to 16, it is observed that three factors load highly on component 1 while the characteristics of the factors that load high in this component simply points to the effect of uncontrolled urbanisation. In component 2, three factors loaded highly, suggesting that degradation of water supply infrastructures contributes to poor state of WASH services in Onitsha. For component 3, poor access to WASH facilities, contributes to poor state of WASH services in the study area. Based on the factors with high loadings on this component, it is clear that poor income status of some of the residents in the study area is limiting their ability to have access to better and improved WASH services in their homes and market places. In component 4, the factors loading highly here highlights the contributions of natural disaster in the resulting poor state of WASH in Onitsha. Flooding loads high and points to the contribution of such natural disaster in further destroying and disrupting the limited and aged WASH infrastructures in the study area. Excessive flooding has led to the development of gullies which destroys underlain water pipes. Component 5 points to poor environmental planning as a major contributor to the poor state of WASH services in the study area. There have been cases where people were caught disposing their household wastes into drainages leading to blockages and flooding in some parts of Onitsha. In addition, these wastes have been observed to destroy the aesthetic appeal of the study area after heavy downpours, polluting the environment and resulting to outbreaks of water related diseases. Component 6 highlights the contribution of the inability of most of the communities in the study area taking ownership of completed WASH projects as a factor that has ensured that these WASH services are in poor conditions. Component 7 reflects on the contribution of inadequate investments in WASH projects on the poor WASH services currently witnessed in parts of the study area.

Component Scores on physical and socio-economic factors responsible for the poor WASH services in Onitsha

The component scores on physical and socio-economic factors responsible for the poor WASH services in Onitsha were examined. Examination of these component scores revealed locations within Onitsha where each of these isolated components have high or low contributions towards poor WASH services in Onitsha. From table 17, component I, uncontrolled urbanisation, contributes highly to poor WASH services in Trans-Nkisi, followed by 3-3, Omagba Phase 1 and Awada given their component scores of 5.757,

4.332, 1.963 and 1.545 respectively. Its lowest contribution to poor WASH services is evident in GRA, and Okpoko.

Table 17: Component Scores of on physical and socio-economic factors

Communities	Scores on Components						
	I	II	III	IV	V	VI	VII
GRA	-6.384	3.939	-3.855	1.390	-2.256	2.909	-0.806
INLAND TOWN	0.876	4.519	-3.169	-3.713	-2.485	-3.612	-0.448
OTU	-0.404	-3.825	-2.232	-0.007	1.831	-2.273	1.051
3--3	4.332	-4.808	-2.392	-0.392	0.210	-2.051	3.053
TRANS NKISI	5.757	-4.467	65.507	-3.016	0.300	0.642	0.243
OMAGBA 1	1.963	1.367	3.357	1.160	-1.030	1.751	-2.831
OMAGBA 11	-0.789	5.882	64.210	1.354	0.863	-0.615	-1.105
WOLIWO	0.087	-0.930	3.367	0.597	4.461	2.501	1.820
OKPOKO	-4.460	-1.052	2.521	-5.356	2.746	-2.217	0.125
AWADA	1.545	-0.531	5.422	-0.208	0.377	-1.640	-0.864
ODOAKPU	0.525	-1.181	-1.437	3.721	-5.418	4.198	3.873

Degradation of water supply infrastructures, component 2, exhibits its lowest concentration in contributing to poor WASH services in 3-3 and Trans-Nkisi given the relatively low component score values. Highest values of this component are dominant in Omagba Phase 2, Inland Town and GRA. Further, component 3, poor access to WASH facilities, is shown to display contribution to poor WASH services in Trans-Nkisi and Omagba Phase 2 given their extremely high component scores of 65.507 and 64.210 respectively. The component has its lowest presence in GRA and Inland Town. Component 4, natural disaster such as flood, is a major contributor to poor WASH services in Odoakpu while the effect of this factor on WASH services is lowest in Okpoko, Inland Town and Trans-Nkisi. For component 5, It shows that the contribution of poor environmental planning to poor WASH services is dominant in areas where it ranked highest component scores such as Woliwo and Okpoko and least in areas of low component scores like Odoakpu, GRA and Inland Town. For component 6, Lack of community ownership of WASH projects, a contributor to poor WASH services, has its highest occurrence in Odoakpu, GRA and Woliwo and lowest contribution in Inland Town, Otu Onicha, Okpoko and 3-3 suggesting that these communities have taken ownership of WASH projects in their environs. Lastly, for component 7, contribution of inadequate investments in WASH projects on the poor WASH services, was highly evident in Odoakpu and 3-3 areas of Onitsha and least in Omagba Phase 1 and Omagba Phase 2.

Contribution of the isolated factors to poor WASH services in Onitsha Urban Area.

The contribution of the isolated factors to poor WASH services in Onitsha was examined using principal component regression (PCR). The PCR technique explains the extent to which the explanatory factors affect poor WASH services in the study area. The highest loadings from each component called the component defining variables (CDV) are selected and employed in principal component regression analysis. The result of the PCR is summarized in table 18.

Table 18: Result of PCR Analysis Statistics

Statistics	Result
Multiple Correlation (R)	0.902
Co-efficient of Multiple Determination (R2)	0.813
Standard Error of Estimates (mm)	5.0881

The result showed that the strength of the relationship between the seven CDV and the poor WASH services expressed by the multiple correlation coefficient (R) of 0.902 which indicates a strong correlation coefficient and the coefficient of multiple determination (R^2) of 81.3%. The PCR equation expressing the relationship between the poor state of WASH services in Onitsha (given by the observed Aging and poorly maintained water supply systems) and the seven specified CDVs is:

$$Y(X_3) = -48.907 + 0.564(X_2) - 0.624(X_6) + 0.533(X_8) - 0.295(X_9) + 0.95(X_{13}) + 1.253(X_{15}) + 0.589(X_{17})$$

From the equation, X_2, X_8, X_{13}, X_{15} and X_{17} in the equation which are inadequate investment in WASH infrastructure contributes to service deficiencies, inadequate waste management and disposal systems exacerbate sanitation issues, weak regulatory enforcement allows for substandard sanitation practices, land tenure issues hinder the development of water and sanitation infrastructure, and lack of community involvement in WASH projects reduces ownership and sustainability means that increase in these variables will result to increase in poor WASH services in Onitsha. Also, given the outcome of the coefficients of X_6 and X_9, any increase in public awareness of proper hygiene practices and reduction in flooding and water-related disasters disrupt water and sanitation services will lead to a reduction or improvement in the condition of poor WASH services in Onitsha.

Discussion of results

The findings of this study identified several physical and socio-economic factors contributing to poor WASH (Water, Sanitation, and Hygiene) services in Onitsha Urban Area. Principal Component Analysis (PCA) revealed seven dominant components: uncontrolled urbanization, degradation of water supply infrastructure, poor access to WASH facilities, natural disasters, poor environmental planning, lack of community ownership, and insufficient investment in WASH projects. Uncontrolled urbanization significantly affected WASH services, with overpopulation and rapid urbanization overwhelming existing infrastructure. In contrast, a study on Lagos Urban Area reported that while urbanization strained infrastructure, government policies partially mitigated its effects (Akoteyon et al, 2021). The degradation of water supply infrastructure due to aging systems, pollution, and weak regulation was another critical factor. This finding agreed with research from Kano State, which also highlighted pollution and poor maintenance as major challenges (Aruf et al, 2024).

Limited access to WASH facilities was linked to high poverty levels and inadequate capacity of service providers. In a related study in Aba, similar socio-economic disparities were reported as hindering equitable access to WASH services (Ezeh et al, 2023). Natural disasters, especially flooding, significantly disrupted WASH infrastructure in Onitsha. This finding was consistent with research in Delta State, where flooding exacerbated sanitation issues (Eniwotu & Otite, 2023). Poor environmental planning, including inadequate waste

management and climate change impacts, emerged as another factor. This result aligned with findings in Port Harcourt, where poor waste disposal practices and rising sea levels contributed to sanitation problems (Ogbonna & Udotong, 2021). However, the role of community involvement was less emphasized in Port Harcourt, contrasting with Onitsha's results, where a lack of ownership of WASH projects was significant.

Hence, inadequate investments in WASH infrastructure and displacement due to urban development were highlighted. This finding agreed with research in Enugu State, where insufficient funding hampered the expansion of WASH services (Odo et al, 2023). The study underscores the multifaceted nature of WASH challenges in Onitsha, reflecting a combination of physical and socio-economic factors that require integrated policy responses.

CONCLUSION

This study has highlighted the multifaceted physical and socio-economic factors contributing to poor Water, Sanitation, and Hygiene (WASH) services in Onitsha Urban Area. Rapid urbanization, population growth, unplanned settlements, poor drainage systems, inadequate public infrastructure, and socio-economic disparities were identified as key drivers of the current WASH challenges. The overdependence on boreholes, absence of functional public water systems, and low-income levels among residents have further worsened access to safe water and adequate sanitation. The study also revealed that physical geography, such as topography and soil types, influences the effectiveness of WASH infrastructure. These findings confirm that poor WASH conditions in Onitsha are not the result of a single factor, but rather a complex interaction between environmental, infrastructural, and socio-economic elements. Addressing these challenges requires an integrated approach involving government agencies, community stakeholders, and development partners. Investment in resilient water infrastructure, enforcement of urban planning regulations, and sensitization on hygiene practices are crucial for sustainable improvement. If these issues remain unaddressed, the health, productivity, and well-being of Onitsha's growing population will continue to be at risk. Therefore, a collective and sustained effort is essential to ensure equitable and safe WASH services for all residents of Onitsha Urban Area.

REFERENCES

Akoteyon, I. S., Aliu, I. R., & Soladoye, O. (2021). Household levels of deprivation to WaSH and residential conditions in slum settlements of Lagos, Nigeria. *Journal of Water, Sanitation and Hygiene for Development*, *11*(1), 60-74.

Anthonj, C., Setty, K. E., Ezbakhe, F., Manga, M., & Hoeser, C. (2020). A systematic review of water, sanitation and hygiene among Roma communities in Europe: Situation analysis, cultural context, and obstacles to improvement. *International journal of hygiene and environmental health*, *226*, 113506.

Aruf, M., Muhammad, A., Sulaiman, M., Usman, H. M., Panda, S. L., & Idris, I. M. (2024). Water quality assessment and health implications: A study of Kano metropolis, Nigeria. *Journal of Science and Technology*, *9*(6), 33-52.

Butera, A., Gallo, S., Pascadopoli, M., Maiorani, C., Milone, A., Alovisi, M., & Scribante, A. (2022). Paraprobiotics in non-surgical periodontal therapy: Clinical and microbiological aspects in a 6-month follow-up domiciliary protocol for oral hygiene. *Microorganisms*, *10*(2), 337.

Chandrasekaran, M., Cook, J., & Jeuland, M. (2022). The Evidence Base for Time Savings Benefits in Water and Sanitation Interventions. In *Oxford Research Encyclopedia of Global Public Health*.

Eniwotu, A. R., & Otite, A. (2023). The Ripple Effects of Flooding On Women in Isoko-Nation, Delta State, Nigeria. *The Indonesian Journal of Social Studies*, *6*(2), 164-180.

Ezeh, J. O., Iheanacho, I. L., & Ani, N. R. (2023). Economic Determinants and Cultural Determinants of Menstrual Hygiene Behaviour of In-School Female Adolescents in Aba Education Zone, Abia State. *ESUT Journal of Education*, *6*(1), 162-171.

Anukwonke, C. (2014). Impacts of urbanisation on groundwater quality: A case study of Onitsha North LGA, Anambra State. *Environmental Management Association of Nigeria (EMAN)*, 124-138.

Kwong, L.H., Ercumen, A., Pickering, A.J., Arsenault, J.E., Islam, M., Parvez, S.M., Unicomb, L., Rahman, M., Davis, J. and Luby, S.P., 2020. Ingestion of fecal Bacteria along multiple pathways by young children in rural Bangladesh participating in a Cluster-Randomized trial of water, sanitation, and hygiene interventions (WASH benefits). *Environmental science & technology*, *54*(21), pp.13828-13838.

Odo, C., Onalu, C., Nwatu, U., Nwafor, N., & Ebimgbo, S. (2023). Factors associated with the prevalence of diarrhoea among children in rural areas of Enugu State, Nigeria: Practice considerations for social workers. *International Social Work*, *66*(2), 518-533.

Ogbonna, D. N., & Udotong, I. R. (2021). An Appraisal of the Waste Crisis, Urban Floods and municipal Solid Waste Management in Port Harcourt City, Nigeria. *Open Access Journal of Waste Management & Xenobiotics*, *4*(1), 1-14.

Uguru, N., Onwujekwe, O., Uguru, C., Ogu, U., Okwuosa, C., & Okeke, C. (2021). Oral health-seeking behavior among different population groups in Enugu Nigeria. *PLoS One*, *16*(2), e0246164.