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Examination of key factors exposing buildings to flood in Abakaliki, Ebonyi State, Nigeria

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Abstract
Flooding has emerged as a significant environmental hazard in Nigeria, with Abakaliki, Ebonyi State, experiencing recurrent inundation between 2020 and 2025, leading to extensive property and infrastructure damage. This study examined the key factors exposing buildings to flooding in Abakaliki, aiming to inform strategies for enhancing building resilience. A descriptive survey design was adopted, targeting the entire population of 390 respondents, including flood-affected households, registered architects, builders, civil engineers, and ongoing approved building projects. A total of 384 valid responses were collected, representing a 98.46% response rate. Data were analyzed using descriptive and inferential statistics. Findings revealed that rapid urbanization and unregulated physical development (mean = 4.41, SD = 0.71), increased impervious surfaces (mean = 4.38, SD = 0.76), and poor or non-existent drainage systems (mean = 4.36, SD = 0.78) were the most critical factors contributing to flood exposure. The composite mean for all factors was 4.15 (SD = 0.83, SE = 0.04), significantly above the neutral value of 3.0 (t = 27.12, p = 0.000), confirming that these factors substantially increase building vulnerability. The study concludes that human-induced pressures, inadequate infrastructure, and poor maintenance practices primarily drive flood risks. It is recommended that urban planning enforcement be strengthened, drainage systems upgraded, and flood-resilient building strategies implemented to mitigate future flood impacts.

Keywords: Flood exposure, building resilience, abakaliki, ebonyi state, urbanization, drainage systems

Introduction

Flooding is a disaster that could cause serious disruption of the normal functioning of society, causing widespread human, material or environmental losses, which exceed the ability of affected society to cope on its own resources (Cutter, 2018) [6]. Flooding is one of the major challenges faced by the world today, affecting Nigerians as well. The economic losses caused by flooding in Nigeria have become unbearable (Adebimpe, Oladokun, Odedairo, and Oladokun, 2018). Temporary measures taken after the flood have proven to be inadequate (Adebimpe *et al.,* 2018) [2]. Flood disaster is not a recent phenomenon in Nigeria, according to Olajiyigbe, Rotowa, and Durojayi (2012) [17], and its destructive tendencies can be enormous.

According to Rock, Nwankwor, Ahiarakwem, and Alieze, (2016) [19] flooding has become a major environmental hazard affecting many parts of Nigeria, including Abakaliki, Ebonyi State, which is naturally swampy and highly vulnerable. Reports indicate that several states in Nigeria, including Ebonyi, have recorded combined losses of more than 16.9 billion dollars in damaged properties and agricultural losses since 2012 (Amangabra and Obenade, 2015). Abakaliki suffers regular flash floods, ponding, and riverine flooding because it lacks a central drainage or sewer system. Residents in areas around the Azuiyiokwu and Iyiudene rivers, such as Ogbaga Road, Udensi Street, St. Patrick Road, Hill Top, Nkaliki, Mile 50, Ogbe Hausa, Ogoja Road, Onwe Road, and Water Works Road, are among the most affected. These communities experience seasonal inundation as riverbanks overflow and drainage channels become overwhelmed.

The effect of this recurring flooding is severe. Each year, homes are submerged, residents are displaced, and properties worth millions are destroyed, including agricultural produce that many households depend on. Low-lying buildings are frequently partially flooded, which weakens the structural components, damages finish, and increases the chances of building failure. Earlier studies have shown that rapid urbanization has contributed to the worsening flood situation in Ebonyi State and that the resulting impacts on both buildings and people are significant (IPCC, 2007) [12]. Okongwu, Okolie, Obodoh, and Chidebelu, (2025) [15] reports that there is a growing concern of housing deficit in Nigeria, hence proper attention must be givig to the existing ones. The high vulnerability of buildings in Abakaliki is linked to socio-economic pressures, poor infrastructure planning, and weak maintenance practices.

It is therefore against this background and in line with various literature-based findings and arguments that this paper considers it necessary to examine the key factors exposing buildings to flood in Abakaliki, Ebonyi State, Nigeria with a view to recommend effective strategies for improving the sustainability of buildings in the study area.

Literature review

a. Concept of Flooding

Flood is a large amount of water covering an area that is usually dry. It is an overflowing of a great body of water over land not usually submerged. Nwafor (2006) [13] defined flood as a natural hazard like drought and desertification which occurs as an extreme hydrological event. On the other hand, Abam (2006) [1], defined flood as large volume of water which arrives at and occupy the stream channel and its flood plain in a time too short to prevent damage to economic activities including homes. Floods occur in

Nigeria in three main forms: coastal flooding, river flooding and urban flooding (Folorunsho and Awosika 2001) [8]. They noted that coastal flooding occurs in the low-lying belt of mangrove and fresh water swamps along the coast.

River flooding occurs in the flood plains of the larger rivers, while sudden, short-lived flash floods are associated with rivers in the inland areas where sudden heavy rains can change them into destructive torrents within a short period. Urban flooding on the other hand occurs in towns, on flat or low-lying terrain especially where little or no provision has been made for surface drainage, or where existing drainage has been blocked with municipal waste, refuses and eroded soil sediments (Olagunorisa, 2004) [16].

Floods are the most common and widespread of all the natural hazards. In many parts of the world according to Ocheri and Okeke (2012) [14] floods seem to be occurring more often and they seem to be increasing in size. Floods are generally regarded as extreme hydrological events, where there is excess of water which may have devastating effects. According to Ayoade (1988) [4], floods in tropics are partly or wholly climatological in nature, that is, they result from torrential rainfall. Floods by nature are complex events caused by a range of human vulnerabilities, inappropriate development planning and climate variability. Normal floods are expected and generally welcomed in many parts of the world as they provide rich soil, water and a means of transport, but flooding at an unexpected scale and with excessive frequency particularly flash floods causes damage to life, livelihoods and the environment. Many factors have been linked to the incidence of floods in many cities of Nigeria

b. Maintenance of Buildings in Flood Prone-Areas

Wood, (2009) [20] define Building maintenance as "woks' in order to keep, restore or improve every part of a building and its performance of building fabric, services and to accepted standard and to sustain the utility and value of the building It includes improvement, refurbishment, upgrading as well as repair works of the existing facilities (Pļaviņa and Geipele, 2013) [18]. Alner and Hamid, (2007) [3] stated the purposes of building maintenance as safe conditions, fit for use etc. (Alner and Hamid, 2007) [3], categorized building maintenance management as asset management and the other as building maintenance management. Both elements need cost assessment and budg*et al*location to achieve success of their activities

In a flooded area, Interior maintenance encompasses all the services required to keep the inside of the building safe, pleasing, and usable, and includes surfaces and finishes, doors and windows, fixed equipment, and fire protection and safety as stated by Hardt and Munson, (2013) [10]. Another form of maintenance is preventive maintenance as emphasized by Hauer, Bombach, Mohr and Masse, (2000) [11] that the best practices for preventive maintenance are recommended: inventory of building components and assess their conditions; the capacity for ranking maintenance projects and evaluating their costs, plan strategically for preventive maintenance in the long- and short-term; structure a framework for operating a preventive maintenance program; use tools to optimize the preventive maintenance program; enhance the competence of maintenance workers and managers and involve appropriate maintenance personnel in decision making and in communicating buildings' needs.

As earlier established, flood vulnerabilities are a phenomenon on how people or societies are likely to be affected by flood occurrence. Ekambaram (2018) [7] postulated a two-stage design approach which include Determination of floor risk factors such as potential sources of flooding, predicted floor level(s), duration of flood occurrences, frequency of floods, and flooding depth(s); and setting a practical floor level for the building by taking in to account the flood effects on the building/built-environment. Similarly, according to Garvin (2012) [9] the useful design strategies for avoiding flood impacts on buildings include

1. Site layout and elevating land
2. Preventive landscaping and surrounding improvements
3. Drainage and soak-away systems
4. Impermeable boundary walls
5. Raising the lowest floor level of a building with a threshold height above the likely design flood level (e.g.,100-year flood level)

Furthermore, Garvin (2012) [9] considers water exclusion or dry proofing of buildings in which the external walls and openings (such as doors), lowest floor and foundation are designed to prevent water ingress for targeted design duration. That is, it makes a structure watertight up to at least the level of the DFE through the implementation of a sealant, flood shields, aquarium glass, strengthening structural components to resist hydrostatic forces from floodwaters, and protecting utilities from flood damage (Bloomberg and Burden, 2013) [5].

Research Methodology

The study adopted a descriptive survey design to obtain data from respondents with direct experience of flooding and housing construction challenges in the study area. The research was conducted in Abakaliki, the capital city of Ebonyi State, which has been significantly affected by flood events between 2020 and 2025. The population comprised 390 respondents, including flood-affected households, registered architects, registered builders, registered civil engineers, and individuals involved in ongoing approved building construction projects. Due to the manageable size of the population, the entire population (390) was used as the sample for the study.

A purposive and stratified sampling technique was employed. Purposive sampling enabled the selection of households and professionals with firsthand flood-related experiences, while stratified sampling ensured proportional representation across all respondent categories. Data were collected through a structured questionnaire designed to capture perceptions of factors exposing buildings to flooding in the study area. A total of 390 questionnaires were distributed, of which 384 (98.46%) were completed and returned,

Descriptive and inferential statistical techniques were used for data analysis. Descriptive statistics summarized respondents' views, while inferential statistics helped determine the significance of observed relationships. Results were presented in tables for clarity and ease of interpretation.

Results and discussion

Table 1: Demographic information of respondents

Demographic Variables	Frequency	Percentage (%)
Professional Background		
Architect	94	24.4
Builder	93	24.4
Quantity Surveyor	63	16.3
Civil Engineer	47	12.2
Head of Household	87	22.8
Total	384	100
Gender		
Male	256	66.6
Female	128	33.3
Total	384	100
Years of Experience		
0–5 years	62	16.2
6–10 years	68	17.8
11–15 years	103	26.8
16–20 years and above	151	40.0
Total	384	100
Highest Educational Qualifications		
HND	93	24.3
B.Sc./B.Tech	125	32.5
MSc/MPM	97	25.2
PhD	69	17.8
Total	384	100

Table 1 shows the demographic characteristics of the respondents who participated in the study. The professional background distribution showed that architects (24.4%) and builders (24.4%) constituted the largest groups, followed by quantity surveyors (16.3%), civil engineers (12.2%), and heads of households (22.8%). This distribution indicated that the study benefitted from a wide representation of key stakeholders who directly engaged with construction activities and building performance issues in the study area.

The gender distribution revealed that male respondents accounted for 66.6%, while female respondents represented 33.3% of the sample. This gender pattern reflected the traditionally male-dominated structure of the construction sector in Nigeria, which had been widely acknowledged in previous research.

The years of experience of respondents showed that a significant proportion (40%) had 16–20 years and above professional working experience. Additionally, 26.8% had 11–15 years of experience, 17.8% had 6–10 years, and 16.2% had 0–5 years of experience. This distribution implied that the majority of respondents possessed substantial industry experience, thereby strengthening the depth and reliability of the information provided on flood exposure, maintenance management, and building performance.

In terms of educational qualifications, B.Sc/B.Tech holders formed the largest group (32.5%), followed by those with MSc/MPM degrees (25.2%), HND holders (24.3%), and PhD holders (17.8%). This educational spread indicated that the respondents were academically qualified to provide informed and technically grounded responses relevant to the objectives of the study

Table 2: Factors Exposing Buildings to Flood in the Study Area

S/N	Options	Mean	SD	Rank
1	Rapid urbanization and unregulated physical development	4.41	0.71	1st
2	Increased impervious surfaces due to buildings, pavements, and roads	4.38	0.76	2nd
3	Population growth and concentration of people in flood-prone zones	4.25	0.82	5th
4	Poor or non-existent drainage systems	4.36	0.78	3rd
5	Poor maintenance and blockage of existing drainage channels	4.29	0.74	4th
6	Poor waste management and indiscriminate dumping of refuse	4.22	0.79	6th
7	Construction along natural flood paths, water channels, and wetlands	4.19	0.83	7th
8	Weak enforcement of planning laws and corruption in approvals	4.12	0.85	9th
9	Lack of adequate stormwater drainage infrastructure	4.17	0.81	8th
10	Heavy rainfall and extreme hydro-climatic events linked to climate change	4.08	0.88	10th
11	Topographic characteristics that enhance run-off accumulation	4.01	0.90	11th
12	Inadequate urban planning and poor urban governance	3.96	0.87	13th
13	Encroachment into river channels, floodplains, and natural drainage passages	3.99	0.84	12th
14	Inappropriate land use and unplanned settlements	3.94	0.89	15th
15	Socio-cultural practices: roadside dumping, canal encroachment, disregard for environmental rules	3.95	0.86	14th
16	Insufficient hydrological data to guide planning and mitigation	3.81	0.92	17th
17	Construction problems such as sub-standard works and blocked waterways	3.88	0.90	16th
18	High water table and low infiltration capacity of soils	3.72	0.95	18th

Table 2 presents showed that the most critical factors exposing buildings to flooding in the study area were mainly related to human activities and weak development control. The highest ranked factor was rapid urbanization and unregulated physical development, which recorded a mean score of 4.41 and an SD of 0.71. This was followed by increased impervious surfaces, which had a mean of 4.38 and ranked 2nd. Poor or non-existent drainage systems also ranked very high, with a mean of 4.36, indicating that respondents strongly agreed that inadequate drainage was a major driver of flooding. These high mean values showed a strong level of consensus among respondents that unplanned physical expansion and insufficient drainage were at the core of the flood problem.

Other highly rated factors included poor maintenance and blockage of drainage channels, with a mean of 4.29 and ranked 4th, as well as population concentration in flood-prone zones, ranked 5th with a mean of 4.25. Poor waste management also featured prominently, having a mean of 4.22. These results suggested that human behaviour and poor environmental practices played a significant role in worsening flood exposure. Construction along natural flood paths and the lack of adequate stormwater infrastructure had mean scores of 4.19 and 4.17 respectively, further reinforcing the idea that development was happening in areas naturally meant to convey or retain water. Weak enforcement of planning laws, ranked 9th with a mean of 4.12, indicated that institutional shortcomings were contributing to the continued exposure of buildings to flood risks.

The lower ranked factors in the table were mostly natural and climatic conditions, although they still had relatively high mean values. Heavy rainfall linked to climate change had a mean of 4.08 and ranked 10th. Topographic characteristics recorded a mean of 4.01, while encroachment into river channels and poor urban governance had means of 3.99 and 3.96. Even though these factors ranked lower, the means were still close to 4.0, showing that respondents agreed they contributed to flooding, but to a lesser extent than human-induced pressures. The least ranked factors were insufficient hydrological data, construction problems, and the high-water table, which had mean scores of 3.81, 3.88 and 3.72. Their lower ranking suggested that respondents perceived them as contributing factors but not as severe as the more immediate issues linked to unregulated development, poor drainage, and weak maintenance culture.

This paper conducted hypothesis test to determine whether the factors identified by respondents significantly expose buildings to flooding in Abakaliki. The purpose of this hypothesis was to statistically verify if the collective perception of respondents reflects meaningful exposure to flood risks. The test was based on the empirical values presented in Table 2: Factors Exposing Buildings to Flood in the Study Area, from which a composite mean and standard deviation were computed. These values formed the basis for the one-sample t-test summarized in Tables 3 and 4.

To evaluate the hypothesis, a one-sample t-test was performed using a test value of 3.00, representing neutrality on the Likert scale. The decision rule guiding the test states that the null hypothesis will be rejected if the p-value (Sig. 2-tailed) is less than or equal to 0.05, indicating that the factors significantly expose buildings to flooding. Conversely, the null hypothesis will be accepted if the p-value exceeds 0.05. This statistical procedure provides an objective basis for determining the significance of the factors influencing building exposure to flooding in the study area.

Table 3: Descriptive statistics summary

One-Sample Statistics				
	N	Mean	Std. Deviation	Std. Error Mean
Factors Exposing Buildings to Flood	384	4.15	0.83	0.04

Table 4: One-Sample Statistics summary

One-Sample Test						
	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Factors Exposing Buildings to Flood	27.12	383	.000	1.15	1.07	1.23

The results presented in Table 3 show that the composite mean score for the factors exposing buildings to flood in Abakaliki is 4.15, with a standard deviation of 0.83 and a standard error of 0.04 based on 384 respondents. This mean value is well above the neutral point of 3.00 on the Likert scale, indicating that respondents generally agreed that the listed factors significantly expose buildings to flooding in the study area. The relatively small standard error also suggests that the respondents' views were consistent and that the sample mean provides a reliable estimate of the population mean.

Table 4. further strengthens this observation. The one-sample t-test yielded a t-value of 27.12 at 383 degrees of freedom, with a significance level of p =. 000, which is far below the 0.05 threshold. This result leads to the rejection of the null hypothesis that "there are no factors exposing buildings to flood in Abakaliki." The mean difference of 1.15, with a 95% confidence interval ranging from 1.07 to 1.23, indicates that the true mean rating of flood-exposure factors is significantly higher than the test value. These statistical outcomes confirm that the factors identified by respondents play a substantial role in exposing buildings to flooding in the study area.

Decision: Reject the null hypothesis

Conclusion

This study concludes that buildings in Abakaliki, Ebonyi State, are highly vulnerable to flooding, primarily due to a combination of human activities and environmental conditions. Rapid urbanization, unregulated physical development, expansion of impervious surfaces, inadequate drainage systems, and poor maintenance practices were identified as the most critical factors exacerbating flood risks. Other significant contributors include population concentration in flood-prone areas, construction along natural water channels, and weak enforcement of planning regulations. Although natural and climatic factors such as heavy rainfall, topography, and high-water tables also play a role, their impact is considered less severe relative to the pressures from unplanned development and human negligence.

The one-sample t-test confirmed that these factors significantly expose buildings to flooding, with a mean rating far above the neutral point and a statistically significant result. This finding emphasizes the need for integrated urban planning, stringent enforcement of building and zoning regulations, effective drainage management, and heightened public awareness. The study provides an evidence-based foundation for policymakers, urban planners, construction professionals, and community stakeholders to implement proactive strategies that will enhance flood resilience and reduce the vulnerability of buildings in Abakaliki.

Based on the findings, it is recommended that the Ebonyi State government and relevant agencies prioritize the development and implementation of a comprehensive flood risk management framework. This should include regular inspection and maintenance of drainage systems, strict monitoring of urban expansion, community engagement on proper waste management, and the enforcement of building codes that account for flood resilience. Such measures will help safeguard lives, protect property, and promote sustainable urban development in Abakaliki
Nigeria.

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