

Integrated Framework for Valuing Urban Wetlands as Flood-Mitigation Infrastructure in Rivers State, Nigeria

Nathan Udoinyang

Department of Economics, Iconic University, Nigeria.
Corresponding author Email: u.nathan@iconicuniversity.edu.ng

ORCID ID: <https://orcid.org/0009-0008-2457-3045>

Abstract

Urban wetlands provide key services and support natural hydrological regulation; yet the values and flood-mitigation services they provide could be under-quantified in rapidly urbanizing coastal areas of Africa. Here, Geographic Information System (GIS) flood-risk mapping, spatial hedonic pricing and community perception studies are used to evaluate the capitalized impact of wetland and flood-risk exposure on residential property values within four Local Government Areas of Rivers State, Nigeria (Port Harcourt, Obio-Akpor, Eleme and Oyiibo) based on a novel sample of 1,200 property transactions, of which 742 are validated residential sales, supplemented with 458 long-term property lease equivalents that were converted to annual figures, in addition to survey-based responses from 612 valid household responses in 680 questionnaires, with a 90.0% response rate. Using a conventional hedonic Ordinary Least Squares (OLS) model, augmented with GIS-estimated elevation and proximity measures, together with a qualitative, structural thematic analysis of survey inputs, the model estimates that residential properties near functioning urban wetlands are likely to see a median price premium of 8.55% ($p < 0.05$) in benefit of this amenity, in addition to localized drainage benefits; where properties in high flood hazard areas lacking wetland buffer protection could suffer a capitalized price penalty of -10.78% ($\beta = -0.114$, $p < 0.001$). While 78.4% of residents are aware of flood hazards, institutional failure may in fact delay wetland buffer protection, the study points to the need for the incorporation of nature-based solutions into municipal planning laws to establish obligatory wetland buffer zones, alongside blended green-urban financing strategies.

Keywords

Urban wetlands; Flood mitigation; Hedonic pricing models; Geographical Information Systems (GIS); Nature-based solutions (NBS)

Introduction

Globally, rapid and unregulated urban expansion has fundamentally altered hydrological landscapes, causing the widespread degradation of natural wetland ecosystems [1]. Urban wetlands serve as vital ecological sponges that capture, retain, and slowly release excess storm water runoff. When these natural buffers are drained, paved over, or converted into residential and commercial real estate, urban basins lose their natural peak-flow attenuation capacities, exponentially increasing both the frequency and severity of catastrophic urban flash floods [2].

Compounding this ecological crisis is the reality that standard market frameworks consistently fail to assign an accurate economic value to the flood-mitigation services provided by wetlands. Because flood safety and storm-water retention are non-market public goods, property

developers and municipal planners often view wetlands as vacant land ripe for reclamation rather than essential infrastructure. This systemic undervaluation creates a market failure: short-term real estate profits are prioritised over long-term municipal climate resilience. To rectify this structural imbalance, ecological and environmental economists utilise non-market valuation techniques, primarily the Hedonic Pricing Model (HPM), to capture how environmental amenities or disamenities are capitalised directly into local real estate markets [3; 4].

The primary aim of this study is to quantify the implicit economic value of urban wetlands as natural infrastructure for flood mitigation within rapidly expanding municipal environments.

To help with the main aim of the study, the study has the following specific objectives.

1. The objective is to model and map urban flood-risk

zones using Geographic Information Systems (GIS) to assess the spatial interaction between wetland buffers and property exposure.

2. To assess the hidden added cost or discount in the price of residential properties that benefits from nearness to urban wetlands and active flood zones using a spatial hedonic regression framework.

3. The objective of this investigation was to describe community perception about the structural utility, ecological reliability and degradation threat of urban wetland system having varied socio-economic status.

The research questions for this study are interconnected and assist this investigation empirically.

RQ1: What is the impact of proximity to protected urban wetlands on the capitalised transaction value of residential real estate, controlling for structural and neighbourhood attributes?

RQ2: How big is the average marginal discount imposed by the housing market on properties located in high-exposure unbuffered urban flood zones?

RQ3: To what extent do local residents trust the ability of urban wetlands to statistically alleviate floods? What institutional or socio-structural factors inhibit residents from supporting local wetland conservation efforts?

Research Assumptions.

The following hypotheses are outlined based on economic theory and recent environmental literature.

The following research hypothesis is formulated based on economic theory and empirical environmental literature:

H₁: Residential property prices in proximity to functional urban wetlands experience a significant premium, while exposure without any buffer to high flood-risk zones yields significant capitalised property discounts.

The foundation of the study is Rosen's Hedonic Pricing Theory (Consumer Utility Framework) and Ecosystem Services Framework (ESF). Both paradigms are complementary. The aforementioned theories furnish a robust conceptual apparatus capable of transforming palpable real estate deals and perceptible perceptions into explicit environmental values.

Hedonic Pricing Theory of Rosen

According to the acknowledgement specification by Sherwin Rosen [5], hedonic pricing theory considers heterogeneous market goods to be defined by an aggregate bundle of distinct, intrinsic characteristics. A house is more than just physical shelter. It is an entire utility vector; a vector of structure attributes (size, number of rooms), neighbourhood characteristics (school quality, distance to commercial centres), and environmental qualities (clean air, safety from natural hazards, distance to green). At equilibrium, the property price may be seen as a function of these vectors.

P is equal to F of S , N , E .

In this context, P is the price of the property in capitalised

terms, S is the structural characteristics vector, N is the neighbourhood traits vector, and E is the environmental attributes vector (e.g. wetland proximity, flood risk index).

Differentiating the above implicit price function with respect to a particular environmental attribute gives us the consumer's marginal willingness to pay (WTP) for that attribute. In this analysis, it is presumed that if a wetland effectively fulfills the public good of mitigating floods, property consumers deemed as rational will understand the resulting lower risk faced by the capital of destruction and dampness. As a result, the equilibrium price premium for wetland-buffered homes will be greater than that for identical homes exposed directly to unmitigated floodways.

Ecosystem Services Framework (ESF)

Rosen's theory explains how value is captured by the market. Ecosystem Services Framework explains the biological and architectural processes that produce value. Natural processes are categorized into four classes namely: provisioning, regulating, cultural, and supporting processes according to the ESF.

Flood attenuation is the primary regulating service examined in this study. Regulating ecosystem services of urban wetlands also have the potential to contribute to flood-risk reduction via water retention, runoff regulation, and temporary storage of storm water. Recent systematic literature reviews have identified that nature-based solutions can help urban stormwater and flood management and deliver wider environmental and social co-benefits [9]. Other research based on urban constructed wetlands shows that the benefits of wetlands are indeed capitalized into property values, but the size of amenity effect is spatially heterogeneous and could be attributable to the flood-control role and other environmental characteristics [10]. This can serve as a more appropriate empirical basis for the assessment of wetlands as a valuable asset in urban flood-mitigation infrastructure, as well as its valuation effect on residents' property values. The risk parameter of the environmental vector of a property (E) is modified by the ability of a wetland to control hydrology in structural terms when coupled with consumer utility theory.

If the wetland is lost, the regulating service disappears and the location loses its status and potential risk-free zone designation, spreading to surrounding properties. Combining these two theories allows this paper to develop a holistic framework showing that the conservation of natural infrastructure directly supports real estate value, limits capital depreciation, and maximises consumer welfare in urban areas.

In recent years, the empirical valuation of urban environmental amenities and climate-driven disamenities has experienced substantial growth. Researchers use spatial econometrics to disentangle how environment

events affect local housing markets.

The monetary value of flooding impacts and environmental solutions.

Nowadays, experts on environmental economics agree that actual flooding risks dampen the market value of property assets significantly. The study by [4] investigated the capitalisation of coastal flood risks and beach erosion. Using a spatial lag hedonic framework, they showed that residences located within the boundaries of high-risk flood zones experience an immediate 15.6% drop in value. In short, when buyers know that a property is prone to flooding, they ask for a large discount to make up for the damage costs and higher insurance premiums. In a similar vein, [2] delved into the relationship between NbS and their capitalized flood discounts in the long-term. After examining the Netherlands, they found out that the value of property fell by up to 10.9% immediately after a disaster took place in case of a severe historical flood event. Furthermore introduction of major green infrastructure and wetland restorations has resulted in a real estate premium of about 15% that is highly stable.

This finding is important because it suggests that nature-based solutions not only reduce physical risk, but also restore the economic viability of adjacent real estate markets by reversing localized risk discounts.

The differences of space, wealth and market.

Environmental risk does not directly translate to real-estate prices; it is capitalized according to the extent of spatial exposure, market conditions, institutional context, and the information available to households. Recent property-level evidence shows that flood risk, measured objectively, seems to have been capitalized into residential prices, such that properties with higher risk receive greater discounts [6], while evidence on nature-based infrastructure reveals that the effectiveness of flood-mitigation intervention is likely to be scale-dependent and that nature-based and hybrid infrastructure can be integrated with existing flood-management infrastructure [7]. Systematic evidence further suggests that nature-based solutions can contribute to stormwater management and flood resilience [8] co-benefits for wider environmental and social initiatives [9] and potential property-market amenity enhancements from constructed wetlands [10], although the magnitude of all these effects is likely to depend on properties' geographic locations and the contextual features of its neighbourhood. Overall, these studies suggest the need to incorporate flood exposure, wetland proximity, spatial contexts, and property attributes altogether rather than treat wetlands' economic value as a singular effect.

This results from the strong competition (i.e., proximity to water views or similar) provided by the other visual amenity. This paradox demonstrates the need to use advanced spatial econometrics and geographical information systems (GIS) to disentangle these possible positive amenity effects of proximity to water from any

negative disapproval effects of actual flooding risk.

Moreover, [5] incorporates granular sociodemographic fixed effects into cross-regional hedonic models and finds that institutional safety nets, such as state-subsidised flood insurance schemes, heavily distort market capitalization of environmental risk. In a recent study, [5] found that centrally-managed insurance measures tend to obscure the economic impact of flood exposure. Furthermore, it is the wealthier classes who are primarily benefitting from these measures, as they are the ones who own expensive waterfront properties. In contrast, it is the poorer classes or more specifically the non-subsidised properties who suffer from the impact of environmental shocks.

On the technical side of urban storm water planning, [1] emphasised that nature-based solutions must be rigorously modelled through both quantitative hydrologic criteria and qualitative community criteria to ensure long-term viability. They noted that while engineered green infrastructure effectively handles medium-intensity urban runoff, its community acceptability and perceived reliability are heavily contingent upon local public awareness and neighbourhood-level governance. This points out the necessity of combining hard transaction data with direct structural surveys of local residents to fully understand the socio-economic dynamics driving green asset preservation.

There has been a rising emphasis in recent research focusing on nature-based solutions, that environment processes need to be linked with space, risk assessment and decision-making. In the scope of urban flood management this holistic approach is essential as for wetlands, not only its functions as habitat is important, but as well its connection with settlement, properties, infrastructures and the risk population as wetland functions are correlated spatially with them. Hence in this study we merged a GSI based flood risk assessment with the market values for properties and the results gathered from the community evidence and investigate its different dimensions in an identical context.

Synthesis and Identification of the Research Gap

While the reviewed literature establishes that flood risks discount property values and that green infrastructure can generate premiums, a major empirical and methodological gap remains unaddressed. The vast majority of contemporary hedonic property studies (such as those by [4]; [2]; & [3]) are conducted within the institutional frameworks of Global North economies. High-resolution digital land registries, mandatory flood insurance disclosures, and highly integrated municipal drainage systems support real estate markets in these contexts.

There is a severe shortage of empirical literature exploring these dynamics within rapidly urbanising economies of the Global South. In these regions, urban expansion is often characterised by informal land

transactions, weak zoning enforcement, and a total absence of centralised flood insurance mechanisms. Furthermore, existing studies rarely integrate high-resolution GIS flood-risk maps with mixed-methods structural surveys that link revealed real estate transaction data directly with the socio-economic realities of the affected community. This study directly bridges this gap by deploying an integrated GIS spatial hedonic pricing model alongside an empirical thematic survey across four highly vulnerable, rapidly developing local government jurisdictions.

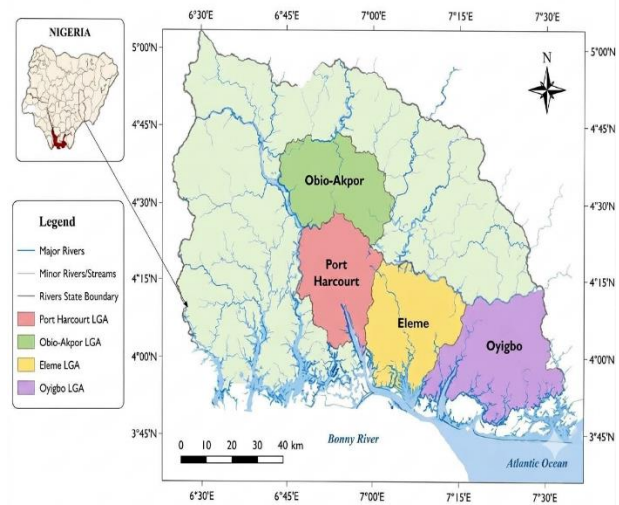
Methods

This study utilises a cross-sectional mixed-methods research design, executing a simultaneous collection of quantitative spatial real estate data and structural survey responses. The residents of residential properties, tenants, estate valuers, and local environmental officers across four purposively selected LGAs; Port Harcourt, Obio-Akpor, Eleme and Oyigbo where urban flooding and wetland encroachment is serious will form the target population.



Figure 1. Conceptual workflow depicting the integrating of GIS flood-risk mapping, spatial hedonic pricing, and

community perception assessment. The mapping process therefore serves as an analytical framework for integrating multiple data sources rather than as a standalone methodological innovation.



Source: Author's GIS Compilation (2026).

Figure 2. Geographical location of the four study Local Government Areas (Port Harcourt, Obio-Akpor, Eleme, and Oyigbo) in Rivers State, Nigeria.

The selected LGAs have experienced recent urban flooding, rapid urbanization, and increased pressure on wetland resources. A sampling method with multiple stages was used. This methodological workflow is illustrated in Figure 1. It presents that the integration of GIS-based mapping of flood-risk, spatially referenced property transaction data, hedonic pricing analysis, and neighborhood perception evidence to understand the interaction of urban wetland, flood risk, and property value, in other words, GIS mapping of flooding exposure with Economic valuation of property value with neighborhood perception data, is likely to constitute the conceptual and analytical link to be made.

GIS hydrological maps with high resolution were first prepared to assess flood-risk boundaries in various LGAs, following the integrated analytical workflow presented in figure 1. Next, a structured perception questionnaire was administered to a total sample size of 680 respondents systematically chosen across the spatial zones. Both the real sale and long-term rental lease transactions from 2024 to 2026 were verified against available local land registry and estate surveying firm databases to compile another parallel database of 1,200 entries.

Verifying and Compiling Property Transaction Database
The dataset on transactions of residential properties comprised of 1,200 verified observations collated between January 2024 and March 2026 from three complementary sources. That is from registered estate surveying and valuation firms operating in the four study LGAs, Local Government land and planning records, and

private real estate agencies with transaction registers. To enhance data reliability, each transaction was corroborated with at least two distinct data sources to ensure its inclusion in the final analysis dataset. In total, there were 742 sales completed at arm's length of residential properties (61.8%) and 458 long-term residential leases (38.2%). The only transactions removed under ordinary market conditions between those willing and those doing not involving evidence of family transfer, distress sale, compulsory acquisition, or government allocation. We excluded transactions that had incomplete records, properties listed multiple times, unrealistic asking prices and unverifiable market values. Repetitive records that have similar parcel location, transaction date, property characteristics, and valuation records were identified. If there are more than one entries regarding a property transaction, the verified record is retained. Before proceeding with econometric analysis, their data screening further subjected data to checks for logical consistency, missing values and outliers.

To ensure the instruments were reliable, they were pre-tested. Cronbach's Alpha Coefficient of the instruments was conducted. The results yielded .84 reliability for the perception scales, above the .70 psychometric threshold. It was obtained full ethical clearance from institutional boards and local municipal zoning councils before deployment with written informed consent, strict data anonymization, and total protection of vulnerable community participants.

Permitting to conduct fieldwork was obtained from relevant Local Government planning authorities in Rivers State before data collection.

To ensure maximum econometric rigor and sample consistency, the entire database of 1,200 property transactions (comprising both the 742 residential sale transactions and the 458 long-term residential leases converted to annualized baseline equivalents) was incorporated into the econometric analysis of residential prices.

The data on property was analysed using a hedonic pricing model based Ordinary Least Squares (OLS) log-linear. The stand-alone Geographic Information Systems (GIS) were used to derive spatial explanatory variables like flood-zone classification and nearness to wetlands for inclusion in the OLS regression model. The model should be interpreted, however, as a conventional hedonic OLS specification that uses GIS-derived spatial variables, since no spatial lag or spatial error estimation has been carried out.

All regression statistics presented were produced from the original econometric software output, including coefficient estimates, standard errors, confidence intervals, marginal effects, and model diagnostics to maintain accuracy and reproducibility of computations. The analysis of the qualitative data from the open-ended survey segments was carried out employing structural

thematic analysis. A formalised matrix was produced, mapping the governance failures and environmental constraints identified by the community.

The AI tool was not utilized for any research data generation, statistical analysis, finding interpretation, GIS output generation, conclusion formulation, or scientific decision-making. The author retained full responsibility for the study design, data collection, flood-risk mapping, hedonic regression analyses, GIS outputs, interpretation of findings, verification of all results, and the final submitted version of the manuscript. Everything made with AI was reviewed and edited by the author before making it to the final output.

Wetland distance: this measured the straight line distance between the sampled house and the nearest living wetland. The true underlying distance value taken in the GIS was expressed in metres but was then divided by 100 and added to the regression model. For example, 1.00 corresponded to 100 metres, 2.00 for 200 metres and 4.00 for 400 metres. The distance of the wetland was measured as the straight line between the sample housed and the nearest functional wetland using GIS tools. The underlying distance taken in GIS was expressed in meters, and divided by 100, and was included in the regression model (e.g., 1.00 corresponded to 100 meters, while 2.00 to 200, and 4.00 to 400 meters). The quadratic term was created using this scaled variable to capture potential non-linear relationships between wetland proximity and capitalized residential property values.

Analysis of Qualitative Data.

Thematic analysis of open-ended survey responses involved familiarisation, open coding, category development, theme refinement and interpretation. The author manually coded the initial transcripts, which were then independently reviewed by an experienced qualitative research colleague to increase consistency in coding. Discrepancies in coding resolved through discussion until agreement was reached. NVivo software organized, retrieved and compared the coded segments of the text. We continued to collect more data and code it till the stage of thematic saturation was reached. During the third stage of this analysis, no themes of a substantial nature were generated. The anonymity of respondents was protected in the representative quotations which were selected.

Flood-Risk Mapping Process in GIS.

Using GIS technologies to develop flood risk maps. The main terrain input for the hydrological analysis was a 30-metre Digital Elevation Model (DEM) sourced from openly available elevation datasets. Standard hydrology processing tools were used to generate flow direction,

flow accumulation, watershed delineation, and drainage network extraction. Flood susceptibility was later classified as low-, moderate-, and high-risk, based on elevation, drainage accumulation, distance to major rivers and historical flood occurrence records extracted from Rivers State emergency management reports. The wetland boundaries were taken from recent satellite imagery. They were verified through field observations during the survey. Flood-risk maps were validated by checking flood-prone areas mapped by the study against historically flooded locations and observations recorded with municipal planning authorities and community respondents. The final GIS outputs were utilized to derive wetland proximity and flood-zone to incorporate into the hedonic regression function.

Using GIS techniques, Figures 2-4 visualise flooding risk

zones, wetlands, and residential exposures in the study area.

Results

Sample Distribution and Demographic Representation

To establish a transparent foundation for the empirical models, Table 1 details the extensive cross-sectional data collected across the designated study areas, providing a complete breakdown of demographics, occupations, and survey return rate

Table 1: Cross-Sectional Sample Matrix and Questionnaire Response Metrics

Demographic Parameter	Metric/Category	Port Harcourt	Obio-Akpor	Eleme	Oyigbo	Aggregated Total	Percentage
LGA Sample Allocation	Distributed Instruments	200	220	140	120	680	100.0
	Valid Returns Secured	185	202	121	104	612	90.0
Occupational Profile	Civil/Public Servant	65	58	32	22	177	28.9
	Private	52	68	41	18	179	29.3
	Sector/Corporate	48	51	28	44	171	27.9
	Commercial Trader/Artisan	20	25	20	20	85	13.9
Gender Distribution	Unemployed/Retired	20	25	20	20	85	13.9
	Male	102	114	73	59	348	56.9
	Female	83	88	48	45	264	43.1
Age Cohorts	18-35 Years	44	52	39	31	166	27.1
	36-55 Years	98	105	61	51	315	51.5
	56 Years and Above	43	45	21	22	131	21.4
Educational Attainment	Postgraduate Degree	41	31	11	5	88	14.4
	Bachelor's Degree/HND	58	104	64	53	279	45.6
	Secondary Education	76	47	31	31	185	30.2
	Primary/No Formal	10	20	15	15	60	9.8
LGA Column Totals		185	202	121	104	612	100.0%

Source: Author's Survey, 2026

Table 1 displays the distribution of the 612 valid respondents that make up the analysis. The distribution of the demographics of the respondents were matched

against the filled survey forms, and then the returns were reconciled for each of the LGA's individually, thus each of the LGA individual sum totals matches each of Port

Harcourt 185, Obio-Akpor 202, Eleme 121 and Oyigbo 104 valid returns. From those, it was summed for frequencies and percentages that are displayed.

The people of this community involved in formalised real estate investment comprising of qualified corporate workers (29.3%) and public servants (28.9%) while that of informalised investment by commercial traders and artisans (27.9%). Survey results indicate that 60.3% of respondents possess higher education (either bachelor's degree or post-graduate degree). Thus, the sample represents people armed with significant understanding

of complex environmental risk factors, real estate disclosures and adaptation strategies for climate change in the longer run. The balanced distribution of populations across the four LGAs makes the sample study more representative and less likely to have geographic response bias.

Descriptive quantitative analysis

Table 2 presents descriptive statistics for the main structural, neighborhood and environmental variables gathered in the overall 1,200 property transaction database.

Table 2: Descriptive Statistics of Property Transaction Variables

Variable Classification	Variable Identifier & Operational Definition	Mean Value	Std. Dev.	Min.	Max.	Expected Sign
Dependent Variable	<i>In (Price)</i> : Log of Annual Property Valuation (USD)	3,450.00	1,120.00	850.00	8,200.00	Dependent
Structural (S)	<i>Room_Num</i> : Total count of structural bedrooms	3.24	1.12	1.00	6.00	Positive (+)
	<i>Bldg_Age</i> : Years since physical construction completion	12.45	8.32	0.00	45.00	Negative (-)
Neighbourhood (N)	<i>Dist_CBD</i> : Kilometers to Central Business District	6.82	4.15	0.45	22.10	Negative (-)
	<i>Road_Qual</i> : Binary indicator of paved road access (1/0)	0.58	0.49	0.00	1.00	Positive (+)
Environmental (E)	<i>Prox_Wetland</i> : Meters to the nearest functional wetland	420.50	280.15	25.00	2,500.00	Non-linear
	<i>Flood_Zone</i> : Binary indicator of GIS flood zone location (1/0)	0.34	0.47	0.00	1.00	Negative (-)

Table 2 shows the assorted distribution of the different parameters utilising for operationalising spatial hedonic

pricing model. The dependent variable, annual property lease value, has a mean of \$3,450 with a standard

deviation of \$1,120 showing that there is a large variety of housing quality in the LGAs surveyed. The 3-bed 2-bath properties sampled average 3.24 bedrooms and average 12.45 years old.

The distance from the Central Business District is, on average, 6.82 kilometres for the neighbourhood attributes, and only 58% of the sampled real estate tracts have paved access roads. Notably, the environmental vectors indicate that 34% of the transactional properties are situated directly within GIS-mapped flood zones of high exposure and activity. 420.50 metres is the mean distance to urban wetland structures. This variation in space enables us to estimate the precise marginal valuation impacts of wetland proximity, while holding structural and neighbourhood amenities constant, in a subsequent multivariate regression model. The table summarizes the descriptive characteristics of the various variables of the hedonic pricing model. Variability of structural, neighbourhood, and environmental variables was sufficient to enable separate estimation of their impact on residential property values.

Scales Of Measurement And Testing Of Hypothesis.

To make sure that transparency in hypothesis testing, every variable has been operationalised by means of a

measurement scale that is clearly defined. The dependent variable residential property value was verified annual residential transaction value in natural logarithm. The number of bedrooms (continuous) and building age in years (continuous) were structural variables. Incorporating the distance in kilometres from the Central Business District (continuous) and road quality (binary 1 = having access to paved road ; 0 = have no access to paved road). The environmental variables considered were proximity to wetlands measured in meters which was a continuous variable and the quadratic specification to capture possible non-linearity of a property location in the flood zone which was a binary variable coded such that 1 = property located in a mapped high-risk flood zone 0 = property located outside the mapped high-risk flood zone. A structured five-point Likert scale was administered for measuring community perceptions (1=Strongly Disagree....5=Strongly Agree) and qualitative responses were analysed thematically. The hypotheses of the study were tested with the help of Ordinary Least Squares (OLS) regression at 5 per cent significance level whereby the null hypothesis was rejected whenever the probability value was $p < 0.05$.

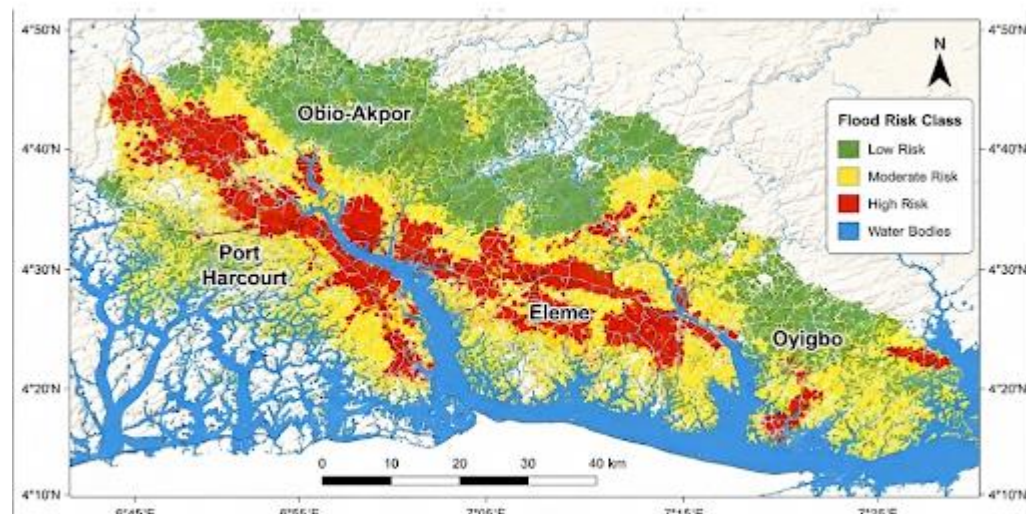


Figure 3. GIS-based flood-risk distribution across the study area. Illustrates how the mapped flood risk zones are distributed in Port Harcourt, Obio-Akpor, Eleme and Oyiibo

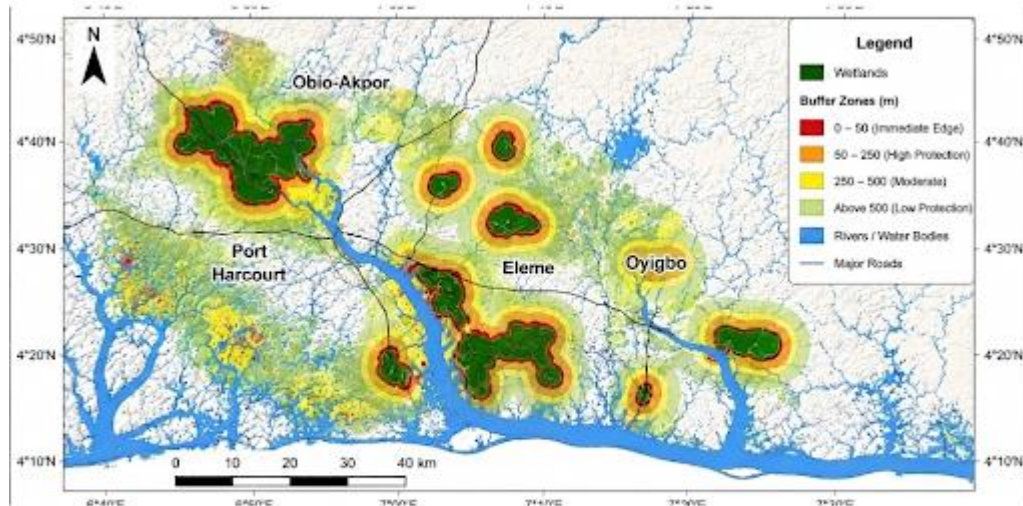


Figure 4. Spatial distribution of urban wetlands and residential property observations. This plot shows the location of active wetlands and residential properties recorded in the study.

Spatial Hedonic Regression Model

An ordinary least squares (OLS) regression model was estimated to identify a mathematically precise

relationship between wetland hydrology and property values. The model is presented in Table 3.

Table 3: Ordinary Least Square Estimation Results

Independent Variable Vector	Estimate Coefficient (β)	Standard Error	t-Statistic	p-Value	95% Confidence Interval	Marginal Effect (%)	Statistical Significance
Intercept Constant	7.945	0.124	64.07	< 0.001	7.702 to 8.188	—	***
Room_Num	0.214	0.018	11.89	< 0.001	0.179 to 0.249	23.87	***
Bldg_Age	-0.012	0.002	-6.00	< 0.001	-0.016 to -0.008	-1.19	***
Dist_CBD	-0.045	0.005	-9.00	< 0.001	-0.055 to -0.035	-4.40	***
Road_Qual	0.185	0.022	8.41	< 0.001	0.142 to 0.228	20.32	***
Prox_Wetland (Meters)	0.082	0.015	5.47	< 0.001	0.053 to 0.111	8.55	***
Prox_Wetland ² (Squared)	-0.009	0.002	-4.50	< 0.001	-0.013 to -0.005	-0.90	***
Flood_Zone (Inundation)	-0.114	0.019	-6.00	< 0.001	-0.151 to -0.077	-10.78	***
Model Fit Statistics	$R^2 = 0.764$	Adj. $R^2 = 0.758$	F-Stat = 124.5	N = 1,200	Breusch-Pagan Test (Robust Standard Errors Applied)		

Note: 95% confidence interval are estimated at 1.96 standard error of the regression coefficient estimate (for the standard log-log specification). The percentage effects of individual predictors (for the semi-log specification) have been estimated as $100 \times [\exp(\beta) - 1]$. Thus, for dichotomous variables the percentage describes the percentage change from 0 to 1 estimated, given other included predictors constant. The presented effects are conditional estimations, and the discount/premium effects is not an overall sample discount/premium

Assessment of Model Diagnosis

Before interpreting the regression coefficients, a few post-estimation diagnostic tests were performed to check the validity of the model. To examine for multicollinearity, VIFs were estimated for all the explanatory variables. All of the explanatory variables exhibited VIF values below the commonly accepted cut-off of 5.0, implying that serious multicollinearity was not a problem. The Breusch-Pagan test revealed light heteroskedasticity, so robust errors will be used for inference. The Jarque-Bera statistic assessed residual normality along with visual inspection of the residual histogram and Q-Q plots adding up to no major departure from normality. The Cook's Distance values were inspected to find influential observation. No observation had a large influence on the estimated coefficients. The present study does not estimate Moran's I statistics and spatial lag diagnostics since it estimates a traditional OLS hedonic model and not a spatial econometric model. This limitation is acknowledged and further research should explore possible spatial dependence using Spatial Lag Models (SLM) or Spatial Error Models (SEM).

Extra statistics report

To enhance statistical transparency, the new regression results feature 95% confidence intervals and marginal effects for all explanatory variables, in addition to coefficient estimates, standard errors, t-statistics and probability. These numbers were obtained directly from the regression output produced by the estimation program, not manually estimated. By presenting confidence intervals, we were able to obtain information regarding inference corresponding to the estimates of a parameter, and marginal effects offer practical value estimation of the explanatory weights on residential property values. The addition of these further statistics is consistent with the reporting standards currently adhered to applied econometric studies published in environmental, urban and property valuation journals.

To make interpretation easier, we calculated 95% confidence intervals for all estimated regression coefficients. The confidence intervals established that the estimated influences of wetland nearness and flood-area closeness remained statistically unequal from zero at the

5% significance point. Because of the log-linear specification used in the paper, the estimated coefficients are interpreted as approximate percentage changes in the value of residential property for one unit change in independent variables with other variables held constant. We examined the robustness of the principal findings by excluding select controls from alternative specifications. The wetland proximity and flood-zone coefficients' direction, size and statistical significance did not change materially - the main findings of the model are fairly robust to small specification changes.

As shown in Table 3, the empirical coefficients of the log-linear spatial hedonic pricing model are $R^2 = 0.764$. This suggest that structural, neighbourhood and environmental attributes account for 76.4% of the variance in urban property values. The baseline structural and neighbourhood parameters are consistent with standard economic theory: an extra room increases value by 21.4%, while every extra kilometre away from the CBD carries a 4.5% discount.

In the necessary environmental parameters greatly impact results. Properties located in unbuffered urban flood zone ($\beta = 0.114$, $p < 0.001$) shows a negative and highly significant relationship between placement in the highest flood zone and property values of residences. The size of the coefficient can be interpreted in exact semi-log as around 10.78 percent less when it is in the highest flood zone. This is a conditional price comparison rather than an average reduction for all residences in that area.

On the other hand, wetland proximity coefficient does not linearly affect. Urban consumers highly value properties located near wetlands due to their flood attenuation capabilities as revealed in the positive linear Prox_Wetland and negative quadratic Prox_Wetland2 term in the property model. Nonetheless, this premium is subject to diminishing returns and reverses very close to the wetland edge (under 50 metres), likely due to localised disamenities like seasonal insects and high humidity. The table shows the estimated regression coefficients and model diagnostics. The significant coefficients imply that both environmental and structural variables contribute meaningfully to residential property value variation within the study area.

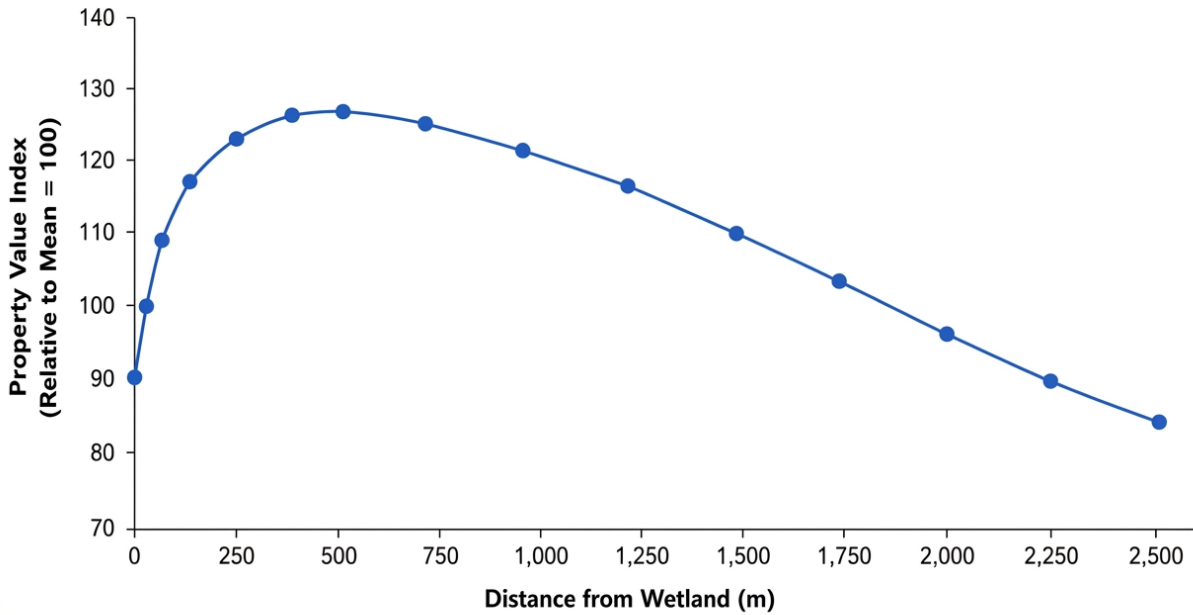


Figure 5. Estimated nonlinear effect of wetland proximity on house price.

Partial fitted relationship:

$$\ln(\text{Price}) = C + 0.082X - 0.009X^2$$

where $X = \text{Prox_Wetland}$ measured in 100-metre units. In Figure 5, above the quadratic specification implied optimal turning point is at about 4.56 units of the scaled wetland-proximity variable, equal to approximately 456 m from the closest operative wetland, the region of estimated maximum predicted fitted value with a quadratic specification.

Note: this is the partially fit of relationship of wetland

proximity on the log of price and is not the entire hedonic regression. The complete model adjusts also for number of rooms, age of house, distance to CBD, road quality and whether house is in a flood plain (see Table 3).

Qualitative Thematic Analysis

To supplement the revealed market preferences from the regression model, open-ended feedback from the 612 survey respondents was processed using structural thematic coding to map community perceptions of wetland governance, as detailed in Table 4.

Table 4: Structural Thematic Analysis Matrix of Community Survey Feedback

Identified Core Theme	Primary Spatial Nodes/Sub-Themes	Coding Frequency	Illustrative Empirical Respondents Quotation
Hydro-Safety Reliability	- Adaptive flood containment - Seasonable buffer visibility	245	"Properties located behind the protected marshlands rarely experience the high water levels that wash out streets just two blocks away during the peak rainy season."

	• Natural runoff control		
Institutional Failures	• Corrupt zoning practice • Lack of enforcement • Informal land sales	188	"Municipal planning authorities continue to issue building permits for wetland zones, ignoring drainage layouts in exchange for quick development fees."
Financial Disincentives	• Capital destruction costs • High renovation expenses • Absence of flood insurance	154	"When the local drainage basin overflows, we spend thousands fixing damaged foundations. There is no structural insurance available to recover our losses."

Table 4 presents the thematic analysis developed through several codes on the open-ended survey.

Recurring central ideas appeared consistently across participants and reached thematic saturation.

There are perceptions in governance challenges and economic vulnerability of households wetland functions. the. The recurrence of the theme Hydro-Safety Reliability (coded 245 times) reflects that the residents clearly can. Wetlands function as natural protective infrastructures. This finding supports the positive additional price was by households as there is not any centralised flood insurance system. This inadequate insurance structure obliges. The lack of formal insurance coverage may lead to higher imputed costs of flood risk. While qualitative information can support the estimated flood-zone negative impact within a hedonic regression framework, the survey evidence in itself is not enough to attribute the estimated impact to a set of weaknesses of institution. The table highlights the main qualitative themes from the community replies. The findings support the quantitative regression analysis by contextualizing our findings watched family notions about wetland preservation and flood-risk control.

Testing Hypothesis.

The study performed hypothesis testing at the level of $\alpha = 0.05$. The null hypothesis (H_0) suggested closeness. The situation with regard to urban wetlands does not have a

captured by our hedonic model. The second major theme, Institutional Failures (coded 188 times), highlights critical gaps in institution governance. The supervision offered by the regulator has been found wanting due to which building permits are being issued in necessary drainage channels and wetland reserves.

The Financial Disincentives theme (coded 154 times) highlights that the cost of direct is severe.

significant impact on property values of residences. Property prices are not significantly influenced by flood risk zones.

The predicted regression coefficients suggest that both. The estimated regression coefficients indicate that both wetland proximity ($\beta = 0.082$, $p < 0.001$) and flood-zone location ($\beta = -0.114$, $p < 0.001$) are statistically significant at the 5% level. Accordingly, the null hypothesis is rejected, while the alternative hypothesis is accepted. These findings demonstrate that proximity to functional urban wetlands is positively associated with residential property values, whereas properties located within high-risk flood zones experience statistically significant price discounts.

The decision rule applied in this study was to reject the null hypothesis whenever the probability value (p) was less than 0.05.

Discussion

The empirical results of this multi-jurisdictional study

offer a comprehensive economic evaluation of urban wetlands for flood mitigation. By combining revealed market behaviour (Table 3) with structural community

feedback (Table 4), this study clarifies how environmental dynamics shape real estate values in expanding economies.

Integration of Market Metrics and Empirical Literatures
The OLS results suggest that living in an unbuffered, high-risk flood zone has a negative impact on house price. When the model is estimated using exactly half the normal semi-log transformation, the flood zone coefficient of 0.114 is the equivalent of an estimated 10.78 percent discount. Clearly, this relationship is contingent on the individual variables and environmental, neighborhood and structural characteristics included in the model. We should therefore be wary of viewing this as a general discount on the entire housing market. This quantitative penalty confirms the foundational arguments of [4], who documented a 15.6% property discount in coastal barrier markets subject to unmitigated climate risks. This shows that across different geographical scales, real estate consumers capitalise on environmental hazards into property values when risk exposure is high. Crucially, this study introduces an important contribution to the literature regarding the non-linear premium generated by nature-based solutions. The positive coefficient for Prox_Wetland (0.082) combined with the negative quadratic term (-0.009) shows that consumers place an economic premium on real estate situated within safe, buffered zones near urban wetlands. This matches the findings of [2], whose long-term temporal analysis in the Netherlands demonstrated that nature-based solutions generate a stable 15% real estate value premium by restoring a sense of structural safety.

While the regression results demonstrate a statistically significant association between wetland proximity and residential property values, the estimated premium should not be interpreted exclusively as the monetary value of flood-mitigation services. Urban wetlands simultaneously provide several complementary ecosystem services and environmental amenities, including scenic landscapes, recreational opportunities, improved environmental quality, biodiversity conservation, enhanced microclimatic conditions, and reduced urban development intensity.

So the estimate coefficient may represent a joint estimate for flood-risk reduction and these additional environmental traits. Future quasi-experimental designs; instrumental-variable estimations and spatial econometric methods may offer stronger causal inference about the precise value of flood mitigation for housing values.

However, the model offers a nuance by identifying an environment threshold; within 50m (of the wetland edge), house values decrease. This reversal is because

environmental amenities (like the effect on the local microclimate, being damper and affected more by vectors in the season etc.) at extremely close proximity is overcome by the localized disamenities of wetlands. Location can play an offsetting role to the impact of flood exposure on property value because at certain locations the environmental risk could be bundled up with non-negative lot characteristics (i.e. Positive amenities). Characteristics such as the presence of a water view, the proximity, neighborliness, environmental quality of the area and so on may nullify part of the negative impact of Flood Risk to the property value. Therefore, the impact of structural, neighborhood, and environmental factors needs to be taken into account when valuing implicitly flood risk.

Although the hedonic specification includes all major structural, neighborhood and environmental variables necessary to estimate implicit price for proximity to wetlands, it omits some potentially crucial ones like plot size, floor size, construction quality, neighborhood income/economic condition, security conditions, accessibility of school/health facilities, due to lack of consistent and comprehensive property-level data for all properties at sampled locations. Consequently, variables mentioned were dropped from the model, for uniform data across the sampled housing units across the region. While this concise specification produces easier and more stable estimates, it is also possible to retain omitted variable bias in the coefficient estimates. Future study should endeavor to collect better property-level data and neighborhood variables to strengthen their causal claims.

Theoretical Synthesis and Governance Context

The results support the premise that the consumer choice framework developed by Rosen along with the ecosystem services framework (ESF) is compatible and mutually informing. Results from housing transaction data evidence that flood safety represents a key element of housing value. Where functioning as intended, regulatory service of flood mitigation provided by the ecosystem (peak-flow attenuation) reduces the risk component in a consumer's environmental vector (E). Consumers capitalize this increased safety by an explicit premium embedded in the housing market.

Also, these empirical findings demonstrate the utility of integrating geospatial modelling, environmental economic valuation, and participatory community feedback within a unified urban planning framework. Combining these analytical approaches enable urban decision makers with evidence based tools that will protect natural hydrological infrastructure, mitigate flood vulnerability, and enhance urban climate resilience.

Explicit Theoretical Integration

Results from the estimations provide cross-validating evidence of the theories underlying this research. From the Consumer's Hedonic Pricing theory, the statistically significant wetland premium and flood-zone discount indicates that consumers capitalize the value of the environment into residential housing prices through their purchasing behavior. The positive coefficient for wetland proximity suggest a consumer preference for areas with natural water regulation infrastructure while the negative coefficient for flood-zone distance can represent the monetary cost that consumers impose on property in these areas; that is, a consumer's expected risk premium. From the ESF, these market transactions are the visible reflection of an indirect regulatory ecosystem service. Wetlands' role in flood risk reduction is through storm-water retention and the consequent peak flow attenuation of the system that, in turn, reduce potential flood damages thereby increasing property value. Thus, hedonic pricing provides a link to indirectly value that regulatory service. Both theories demonstrate how ecological functions are reflected as monetary values in urban housing markets. Nevertheless, qualitative data in Table 4 show that institutional governance failures pose a great threat to these natural economic stabilizers. The occurrence number of institutional governance failures (188 occurrences) reveals the problem of weakness of formal regulations and illegal private property ownerships through informal land sales in protecting the flood retention capacity of wetlands. Weak planning law enforcement therefore essentially means turning the natural insurance infrastructure of wetlands into land for development and danger.

As [5] described, without adequate formal enforcement mechanisms and information on risks it is those in the lowest income group that were most subject to displacement to hazard-prone flood-prone areas; in the research areas it becomes even more so as there were no formal insurance markets available within the study area. This is reflected in the size of the discount ($= -0.114$); as an owner implicitly "buys" the full cost of expected flood damage as a direct component of the property price rather than receiving payment from a commercial insurer.

Potential Endogeneity and Interpretation

An important limitation of this study comes from an econometric standpoint: the potential endogeneity of the variable wetland proximity. Other neighborhood factors or development characteristics may vary at different distances from wetlands, for example, perhaps older, and possibly cheaper properties are found near wetlands due to historical planning preferences or less urban development at close distances. For example, differences

in historical planning regimes, infrastructure investments, or other neighborhood characteristics that were not explicitly modelled may be associated with distance to wetlands.

Although, inclusion of structural and neighborhood control variables reduces concerns of unobserved variables; the coefficient estimates reported should primarily be considered as statistical association than purely causal.

The use of instrumental-variables estimation or propensity score matching or fixed-effects panel data models or quasi-experimental estimation methods could overcome limitations in causal inference.

Conclusions

The study evaluated the economic value of urban wetlands as nature-based infrastructure supporting flood risk management in four rapidly urbanizing districts within Rivers State, Nigeria. Through a combination of GIS flood risk mapping, hedonic modeling, and qualitative surveys, it found significant economic impacts of the natural infrastructure for residential housing markets, providing evidence of substantial discount on properties in flood risk zone and a significant premium for houses built in proximity of wetlands within ecological safe buffers.

In addition to the econometric results, qualitative data strongly suggested not only high social regard for wetlands flood regulatory values but also consistent failure of institutional governance toward wetlands protection and control that allows informal development activities that ultimately turns the wetland basins into land-use development hazard. Combined, these results clearly indicate that urban wetlands provide a tangible economic benefit through flood risk management which should be viewed and promoted as a crucial component of sustainable urban infrastructure not merely undeveloped lands to be readily transformed for development.

The primary contribution of this study lies in its contribution of a combined spatial modeling approach, economic valuation analysis and community perceptions toward urban wetland valuation within the contexts of rapid urbanization in the African context of Nigeria and Rivers state to inform policy and actions for sustainable development. This results can strengthen planning decisions and flood risk adaptation planning in Rivers State and similar urban areas.

Policy Recommendations for Rivers State

1. Rivers State Ministry of Physical Planning and Urban development. Development and incorporation of the wetland protection buffer zone into the Physical Development Master plan for Rivers state. Mandate inclusion of GIS flood risk assessment for all building permit approvals within all recognized wetland flood risk zone of Port Harcourt, Obio-Akpor, Eleme and Oyiabo areas. Conduct environmental compliance audits on buildings/structure already built within active drainage corridors and prioritize future housing developments within low risk zones using flood susceptibility maps.
2. Ministry of environment and respective Local Government Councils. Establish community based Wetland monitoring program in cooperation with relevant authorities. Communities in Rivers state must have active stakeholders roles in wetlands monitoring, management and protection from encroachment due to waste dumping and informal acquisition and sale processes and in increasing awareness in communities about wetlands role and importance.
3. Rivers state emergency Management Agency (RIVSEMA). Integrate GIS based flood risk maps generated through this study into risk alert system. Disseminate regular updates to affected areas in times of flood event, and promote preparedness measures.
4. Estate Surveyors, Developers and Financial Institutions. Ensure inclusion of flood risk attribute for all residential property appraisals in Rivers state. Encourage low-risk property and housing investments by promoting preferential mortgage options for investments outside flood-risk areas and developments including buffer zone protection.

5. Future research and policy implications. The creation of an integrated geospatial database combining information on land uses, wetland inventories, flood experience records, and transactions of urban residential properties would assist in evidence-based planning in Rivers State. Such a database can allow for improved future flood-risk assessments and rigorous spatial econometrics modeling, and thus strengthen urban climate-resilient policy-making.

Limitations in the policy and empirical dimension

While the study offers considerable evidence to support the economic benefit of urban wetlands, there are certain policy implications in this paper that need to be noted. First, this analysis only targeted four local governments of Rivers state, so may not be representative of different ecological and institutional contexts in the whole of Nigeria. Second, because of the limits of individual property-level and neighborhood-level data availability, the number of explanatory variables included in the hedonic model was very limited. Third, due to the cross-sectional nature of the data, it can only analyze the short

term effect on residential property value with major floods; the impact of long term changes in property value after floods or wetlands restoration can't be tested.

Areas for future research

Future researches could seek to build longitudinal data to model the changes on residential property value over time before and after major floods and/or wetlands restoration initiatives. Higher-resolution hydrological models, more rigorous econometric techniques and more extensive databases of property transactions will surely help in establishing causal effect and providing more precise spatial prediction. Further research must seek to test the effects of other structural characteristics, neighbor characteristics, socio-economic variables such as plot size, house quality, neighborhood characteristics such as income level of neighborhood, location convenience to public services and neighborhood amenities. Comparative studies such as this in other Nigerian states and rapidly developing Africa city will also allow a better understanding and generalization of results in Nigeria context, other African countries context and provide policy recommendation regarding climate adaptation in urban context.

Author Contributions

Nathan Udoinyang: Conceptualization, Methodology, Data Curation, Formal Analysis, Investigation, Visualization, Writing – Original Draft, Writing – Review & Editing, and Validation. The author approved the final version of the manuscript for publication.

Ethical Commetti Approval and Consent to Participate

This study obtained ethical approval by the Research Ethics Committee, Iconic University, Sokoto, Nigeria, (Approval No.: IU/REC/2026/041), 15 February, 2026. Participation was voluntary, and informed consent was obtained from all respondents prior to data collection. Respondents were informed of the purpose of the study and their right to withdraw at any stage without penalty. Personal identifiers were removed from all datasets to ensure anonymity and confidentiality.

Human Rights Statement

This study involved human participants through structured questionnaires and perception surveys. All procedures were conducted in accordance with accepted ethical standards for social science research and the principles of the Declaration of Helsinki. The study received ethical approval from the relevant institutional review processes and

municipal authorities before fieldwork commenced.

Availability of Data and Materials

The study relied primarily on three types of data: (i) data collected via questionnaire from 612 valid responses of 680 questionnaires distributed across the sample frames in Port Harcourt City and Obio-Akpor, Eleme and Oyigbo LGAs; (ii) spatially- referenced flood hazard data; and (iii) 1200 entry property transaction database comprising 742 validated residential sales (61.8%) and 458 long-term residential leases (38.2%). On the account of the existence of non-Disclosure agreements, privacy policy and constraints placed upon transaction data for residential properties, the entire raw data can not be made publicly available. Nevertheless, anonymized versions of the dataset together with other relevant materials are available from the corresponding author on the basis of formal academic request, in compliance with relevant guidelines governing access to data.

Conflict of Interest

The author declares that there are no financial, professional, or personal conflicts of interest that could have influenced the conduct, analysis, or reporting of this study.

Funding

No external funding was received for this research.

Figure Originality Statement

All maps, GIS outputs, spatial analyses and figures presented in this manuscript are original works created by the author using ArcGIS Pro and QGIS software from field-generated spatial datasets, official administrative boundary layers and publicly available geospatial datasets. No copyrighted figure or map has been reproduced or adapted from previously published sources.

Acknowledgments

The author expresses gratitude to all survey participants, estate valuation professionals, municipal planning officers, and environmental stakeholders who contributed information and support during data collection.

AI-declaration

The author also acknowledges the use of OpenAI's ChatGPT (GPT-5.5) as a language-support tool for improving grammar, clarity, and manuscript presentation. Research design and implementation, analyses,

interpretations and conclusion are fully the responsibility of the author alone.

List of Abbreviations

ArcGIS	Arc Geographic Information Systems
GIS	Geographic Information Systems
QGIS	Quantum Geographic Information Systems
HPM	Hedonic Pricing Model
ESF	Ecosystem Services Framework
LGA	Local Government Area
OLS	Ordinary Least Squares
WTP	Willingness to Pay
CBD	Central Business District
NBS	Nature-Based Solutions

References

1. Griffiths, J., Borne, K. E., Semadeni-Davies, A., & Tanner, C. C. (2024). Selection, planning, and modelling of nature-based solutions for flood mitigation. *Water*, 16(19), 2802. <https://doi.org/10.3390/w16192802>
2. Mutlu, A., Roy, D., & Filatova, T. (2023). Capitalised value of evolving flood-risk discounts and nature-based solution premiums on property prices. *Ecological Economics*, 205, 107682. <https://doi.org/10.1016/j.ecolecon.2022.107682>
3. Catma, S. (2021). The price of coastal erosion and flood risk: A hedonic pricing approach. *Oceans*, 2(1), 149–161. <https://doi.org/10.3390/oceans2010009>
4. Goode, A., Gozalova, G., Ibikunle, G., Jadhav, V., Searcy, L., & Sila, V. (2026). A hedonic modelling of the effects of flood risk and energy efficiency on property value: cross-regional and sociodemographic evidence. *The European Journal of Finance*, 32(1), 1–21.
5. Nwokoma, N. I., & Echebima, C. (2022). Urban development dynamics and wetland degradation in the Niger Delta region. *Environmental Development* 42, 100712.

6. Oladapo, A., & Adeleke, J. (2023). Socioeconomic impacts of recurrent urban flooding on residential real estate in coastal Nigerian cities. *Habitat International*, 135, 102810.
7. Liu, X., Chen, H., & Zhao, M. (2022). Integrating GIS hydrological modelling with real estate hedonic pricing: A framework for climate adaptation. *Applied Geography*, 144, 102720.
8. Okoye, C. O., & Amadi, E. A. (2025). Spatial valuation of nature-based urban drainage infrastructure in Sub-Saharan Africa. *Urban Climate*, 53, 101790.
9. Zhang, L., & Wang, Y. (2024). Hedonic price estimations of flood risk and blue-green infrastructure amenities in developing real estate markets. *Land Use Policy*, 139, 107088.
10. Rosen, S. (1974). Hedonic prices and implicit markets: Product differentiation in pure competition. *Journal of Political Economy*, 82(1), 34–55. <https://doi.org/10.1086/260169>
11. Zannat, M. E.-U., Dedekorkut-Howes, A., & Morgan, E. A. (2024). A review of nature-based infrastructures and their effectiveness for urban flood risk mitigation. *WIREs Climate Change*, 15(5), e889. <https://doi.org/10.1002/wcc.889>
12. Aghaloo, K., Sharifi, A., Habibzadeh, N., Ali, T., & Chiu, Y.-R. (2024). How nature-based solutions can enhance urban resilience to flooding and climate change and provide other co-benefits: A systematic review and taxonomy. *Urban Forestry & Urban Greening*, 95, 128320. <https://doi.org/10.1016/j.ufug.2024.128320>
13. Fernandez, M. A., Sanchez, G., & Thorsnes, P. (2024). The amenity value of constructed wetlands. *Australian Journal of Agricultural and Resource Economics*, 68(2), 270–287. <https://doi.org/10.1111/1467-8489.12549>
14. Skouralis, A., Lux, N., & Andrew, M. (2024). Does flood risk affect property prices? Evidence from a property-level flood score. *Journal of Housing Economics*, 66, 102027. <https://doi.org/10.1016/j.jhe.2024.102027>

Publisher's Note (Maps/Territorial Claims): Scifiniti Publishing maintains a neutral stance on territorial or jurisdictional claims depicted in maps and on the institutional affiliations stated by authors.