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Flood Risk Capitalisation in Malaysia's Residential Property Market: An Integrated Hedonic Pricing Analysis of Microeconomic and Macroeconomic Determinants

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ABSTRACT Flooding is one of the most frequent and costly natural disasters affecting residential property markets in Malaysia. Rapid urbanisation, climate change, and the expansion of housing developments in flood-prone areas have raised concerns about property values, investment security, and sustainable urban development. Previous studies have mainly focused on specific housing types, locations, or either microeconomic or macroeconomic factors separately. This study addresses these gaps by developing an integrated framework that examines the combined effects of flood exposure, microeconomic variables, and macroeconomic variables on residential property values.

The study focuses on four flood-prone regions in Malaysia: Kelantan, Kota Damansara, Selangor, and the Klang Valley, covering terrace houses, general residential properties, and semi-detached (Semi-D) houses. Secondary data from 2004 to 2024 were collected from the National Property Information Centre (NAPIC), Valuation and Property Services Department (JPPH), Department of Statistics Malaysia (DOSM), Bank Negara Malaysia (BNM), and the Department of Irrigation and Drainage (DID). The data were analyzed using the Hedonic Price Model (HPM) with Multiple Linear Regression (MLR).

The findings show that flood exposure significantly reduces residential property values, although the effects differ by housing type and location. Flood duration and depth have the greatest negative impact on Semi-D houses in the Klang Valley; while recurring floods most strongly affect terrace houses in Kelantan. The integrated model provides a better understanding of the determinants of property value and offers practical guidance for policymakers, planners, investors, developers, and insurers to improve flood resilience and support sustainable urban development.

KEY WORDS: Flood risk; Residential property values; Hedonic Price Model; Housing market; Macroeconomic factors; Malaysia.

I. INTRODUCTION

Housing represents one of the most valuable economic assets owned by households and constitutes a major component of national wealth. Residential property markets play a fundamental role in economic development by stimulating construction activities, generating employment, supporting financial institutions through mortgage lending, and contributing significantly to national Gross Domestic Product (GDP). Consequently, any environmental hazard capable of disrupting residential property markets has far-reaching implications for households, governments, financial institutions, investors, and urban planners. Among the numerous natural hazards affecting property markets worldwide, flooding has emerged as one of the most destructive, costly, and increasingly frequent disasters under the influence of climate change.

Globally, flood disasters have intensified over the past three decades as a consequence of rapid urbanisation, changing rainfall patterns, deforestation, and increasing climate variability. According to the Intergovernmental Panel on Climate Change (IPCC), the frequency and severity of extreme precipitation events are projected to increase considerably during the twenty-first century, exposing millions of households to greater flood risks. Residential properties located within flood-prone areas experience repeated physical damage, declining market attractiveness, rising insurance costs, and increasing uncertainty regarding future investment returns. These factors collectively influence buyers' willingness to pay, ultimately affecting residential property values through market mechanisms.

Malaysia has experienced similar trends. Due to its tropical monsoon climate, geographical characteristics, extensive river

networks, and rapid urban expansion, flooding has become one of the country's most frequent natural disasters. States such as Kelantan, Selangor, and regions within the Klang Valley experience recurring floods almost annually, causing substantial economic losses and disrupting residential communities. The catastrophic floods of December 2021 further demonstrated the vulnerability of Malaysian cities and residential developments, with thousands of homes severely damaged and billions of Malaysian Ringgit lost in property damage and infrastructure rehabilitation.

Flooding affects residential property markets through both direct and indirect mechanisms. Direct impacts include structural damage to buildings, deterioration of foundations, destruction of household assets, interruption of public utilities, and increased maintenance costs. Indirect impacts involve declining buyer confidence, higher insurance premiums, reduced mortgage accessibility, neighbourhood deterioration, and increased uncertainty regarding future flood occurrences. These impacts often persist long after floodwaters have receded, influencing both current market transactions and long-term investment expectations.

Economic theory provides a useful framework for explaining these market responses. Hedonic Pricing Theory (Rosen, 1974) argues that residential property prices represent the combined value of numerous structural, locational, neighbourhood, and environmental attributes. Within this framework, flooding constitutes a negative environmental characteristic that reduces the utility derived from residential properties. Similarly, Risk Capitalisation [1] . Theory suggests that homebuyers incorporate anticipated future flood damages into their purchasing decisions by discounting the prices they are willing to pay for flood-prone properties. Consequently, flood risks become capitalised into residential property prices through normal market transactions.

While environmental risks significantly influence residential housing markets, they do not operate independently. Residential property values are simultaneously affected by broader macroeconomic conditions including economic growth, employment, inflation, interest rates, household income, and population dynamics. Strong economic performance generally stimulates housing demand by increasing household purchasing power and improving consumer confidence. Conversely, rising unemployment, inflationary pressures, and tighter monetary policies reduce housing affordability and suppress residential property markets.

Previous Malaysian studies have acknowledged the importance of both environmental and economic factors in explaining residential property prices. However, most investigations have adopted relatively narrow perspectives by focusing on individual housing categories, single geographical locations, or isolated explanatory variables. Several studies have examined terrace houses in Kelantan, while others have investigated Semi-D houses in Selangor or residential properties within Kota Damansara. Likewise, many studies examine flood occurrence without simultaneously incorporating macroeconomic indicators such as GDP, inflation, income, employment, and interest rates within a unified analytical framework. Such fragmented approaches provide valuable localised evidence but offer limited understanding of how flood risks interact with broader economic conditions across Malaysia's diverse residential housing markets.

Moreover, previous research has primarily treated flood occurrence as a single environmental indicator, with comparatively less attention given to multiple dimensions of flood exposure such as flood duration, flood depth, and flood frequency. These characteristics influence structural damage differently and may therefore exert varying effects on residential property prices. Similarly, relatively few Malaysian studies have compared the sensitivity of different housing categories—including terrace houses, Semi-D houses, and general residential properties—to flood risks across multiple geographical regions. Such comparative analyses are essential for improving housing market resilience and supporting evidence-based policymaking.

Against this background, the present study develops an integrated empirical framework that combines environmental risk variables, structural housing characteristics, demographic factors, and macroeconomic indicators within a single Hedonic Pricing Model. Rather than examining one housing category or one geographical location, this study integrates evidence from Kelantan, Kota Damansara, Selangor, and the Klang Valley to provide a broader understanding of flood risk capitalisation within Malaysia's residential property market.

The study employs multiple linear regression analysis to estimate the relative contribution of flood occurrence, flood duration, flood depth, housing characteristics, Gross Domestic Product, inflation, unemployment, employment, household income, population growth, and monetary policy variables to residential property values. By combining these diverse determinants into one comprehensive analytical framework, the study seeks to improve both theoretical understanding and practical decision-making regarding residential property valuation under increasing climate uncertainty.

The findings are expected to contribute not only to housing economics literature but also to environmental economics, urban planning, disaster risk management, and sustainable development policy. As Malaysia continues to experience rapid urban growth and increasing climate-related hazards, understanding how flood risks influence residential property markets has become increasingly important for maintaining housing affordability, protecting household wealth, and promoting resilient urban development.

1.1 Research Gap

Although flood risk has received increasing attention within Malaysian housing market research, several important gaps remain unresolved.

First, previous studies have predominantly investigated flood impacts within individual housing markets or specific geographical locations, limiting the generalisability of their findings. Most empirical investigations focus on a single housing category—such as terrace houses or Semi-D houses—or concentrate on one flood-prone region without considering broader regional differences in flood exposure and housing market dynamics.

Second, existing studies frequently analyse either environmental variables or macroeconomic indicators independently. While flood occurrence, flood duration, and flood depth have been examined in several studies, these variables are rarely integrated simultaneously with macroeconomic determinants such as GDP, inflation, employment, household income, population growth, and the Overnight Policy Rate within one comprehensive econometric framework.

Third, previous Malaysian research has placed greater emphasis on estimating whether flooding influences residential property prices than on understanding how different housing categories respond to varying dimensions of flood exposure. Comparative evidence across terrace houses, Semi-D houses, and general residential properties remains scarce despite considerable differences in construction characteristics, buyer preferences, and market behavior.

Fourth, many existing studies rely on relatively simple regression models without conducting comprehensive diagnostic testing for multicollinearity, heteroscedasticity, autocorrelation, model specification, or robustness. Consequently, concerns remain regarding the statistical reliability and robustness of estimated flood-related price effects.

Finally, there is limited evidence examining how flood risks interact with macroeconomic conditions over time to influence residential property values under changing economic environments. Housing markets respond not only to environmental hazards but also to fluctuations in income, employment, monetary policy, and economic growth, yet these interactions remain insufficiently explored within the Malaysian context.

Addressing these limitations provides the primary motivation for the present study.

1.2 Research Contributions

This study makes several important theoretical, methodological, empirical, and practical contributions.

From a theoretical perspective, the research extends Hedonic Pricing Theory and Risk Capitalisation Theory by integrating environmental risk variables with macroeconomic and microeconomic determinants into a unified residential property valuation framework.

From a methodological perspective, the study develops a comprehensive hedonic pricing model incorporating flood occurrence, flood duration, flood depth, structural housing characteristics, demographic indicators, and macroeconomic variables within a single econometric framework supported by rigorous diagnostic testing.

From an empirical perspective, the research provides one of the first comparative analyses integrating multiple housing categories and flood-prone regions in Malaysia. By combining evidence from Kelantan, Kota Damansara, Selangor, and the Klang Valley, the study offers broader insights into the heterogeneous effects of flood risks across different residential property markets.

From a policy perspective, the findings provide evidence-based recommendations for government agencies, urban planners, financial institutions, insurers, property developers, and investors regarding flood mitigation, housing policy, sustainable urban development, and climate adaptation strategies.

Ultimately, this study contributes to a more comprehensive understanding of how environmental risks and economic conditions jointly determine residential property values in Malaysia, providing a stronger foundation for future research and more informed decision-making in the country's increasingly climate-sensitive housing market.

II. LITERATURE REVIEW

2.1 Theoretical Foundation

Understanding the relationship between flood events and residential property values requires integrating theories from environmental economics, urban economics, and real estate valuation. This study is primarily grounded in Hedonic Pricing Theory (HPT) and Risk Capitalisation Theory (RCT), which collectively explain how environmental hazards influence housing prices through market mechanisms.

The Hedonic Pricing Theory introduced by Rosen (1974) argues that residential property values represent the implicit prices of numerous housing attributes, including structural characteristics, neighborhood quality, accessibility, environmental amenities, and environmental disamenities [1]. Residential properties are therefore viewed as bundles of characteristics rather than homogeneous goods. Buyers evaluate each attribute simultaneously when determining their willingness to pay for a particular property.

Flooding constitutes one of the most significant environmental disamenities because it reduces both the utility and expected

future benefits derived from residential properties. According to HPT, the presence of flood hazards lowers market value because buyers discount expected future repair costs, insurance premiums, inconvenience, and uncertainty associated with recurring flood exposure.

Complementing HPT, Risk Capitalisation Theory suggests that housing markets incorporate perceived environmental risks into transaction prices. When flood risks become publicly recognised through previous flood events, official flood maps, insurance requirements, or media coverage, buyers adjust their valuation accordingly. Consequently, expected future flood losses become capitalised into current housing prices.

These theories provide the conceptual foundation for analysing how flood exposure, together with structural housing characteristics and macroeconomic conditions, determines residential property values in Malaysia.

2.2 Flood Risk and Residential Property Markets

Flooding has become one of the most economically damaging natural disasters worldwide. The frequency and intensity of flood events have increased considerably over recent decades due to climate change, rapid urbanisation, deforestation, and land-use transformation. According to the Intergovernmental Panel on Climate Change (IPCC) (2023), extreme rainfall events are expected to become increasingly frequent across Southeast Asia, exposing millions of residential properties to greater flood risks [2].

Residential housing markets respond to flood risks through several channels. Direct impacts include structural damage to buildings, deterioration of foundations, destruction of household contents, interruption of public utilities, and increased maintenance costs. Indirect impacts include reduced buyer confidence, neighbourhood deterioration, higher insurance premiums, increased mortgage restrictions, and declining investment attractiveness.

Economic consequences extend well beyond immediate physical damage. Flood-prone properties frequently experience reduced market liquidity, longer selling periods, lower capital appreciation, and weaker investment performance compared with comparable properties located in safer areas.

International evidence consistently demonstrates that flood exposure negatively influences residential property values. Ahmed et al. similarly observed that residential properties affected by flood events consistently sell at a discount relative to comparable unaffected properties, reinforcing the view that flood exposure is priced by the market [3]. Harrison et al. reported significant price discounts for floodplain properties in the United States. Similarly, Bin and Polasky found that flood risk reduced single-family housing prices through market risk capitalisation [4], [5]. More recent studies by Beltrán et al. and Hsieh indicate that flood risks are increasingly incorporated into housing prices even before official flood maps become publicly available, suggesting that buyers actively assess environmental risks during housing transactions [6],[7].

Nevertheless, the magnitude of flood-related price discounts varies considerably across countries, property types, and institutional settings. Factors such as insurance availability, government compensation programmes, market maturity, and public awareness significantly influence the extent to which flood risks are reflected in residential property values.

2.3 Flood Exposure Characteristics

Flood exposure is multidimensional and cannot be adequately represented by flood occurrence alone. Previous studies identify three principal dimensions of flood exposure that influence residential property values: flood frequency, flood duration, and flood depth.

2.3.1 Flood Frequency

Flood frequency refers to the number of flood events experienced by a property or geographical area over a specified period. Repeated flooding increases buyer awareness and reinforces perceptions of environmental risk. Frequent flood events create expectations of recurring repair costs, insurance claims, temporary relocation, and future financial losses.

Studies consistently demonstrate that repeated flood events reduce residential property values more substantially than isolated flood incidents because buyers perceive recurring floods as long-term rather than temporary environmental problems.

2.3.2 Flood Duration

Flood duration represents the length of time floodwaters remain within residential areas. Longer inundation periods typically result in greater structural deterioration, mould growth, foundation damage, corrosion of building materials, and prolonged disruption of household activities.

S. Armal et al. reported that prolonged flood duration significantly increases restoration costs and extends market recovery periods [8]. Similarly, Hirsch and Hahn found that housing markets are particularly sensitive to flood duration because longer exposure substantially increases expected future maintenance expenditures [9].

In Malaysia, prolonged monsoon flooding frequently affects low-lying residential developments in Kelantan and several urban areas within the Klang Valley, making flood duration an essential variable in residential property valuation.

2.3.3 Flood Depth

Flood depth measures the vertical height of floodwaters affecting residential properties. Among flood characteristics,

flood depth is widely recognised as the strongest determinant of physical building damage.

Ismail et al. and Ismail et al. demonstrated that increasing flood depth significantly reduces residential property values in Peninsular Malaysia [10], [11]. Similar findings were reported by Chang et al., who concluded that deeper floodwaters generate disproportionately higher structural repair costs [12].

From an economic perspective, buyers perceive deeper flooding as an indicator of severe future financial losses, leading to greater price discounts during residential property transactions.

Collectively, flood occurrence, duration, and depth represent complementary measures of flood exposure and should therefore be analysed simultaneously within residential property valuation models.

Furthermore, Zulkarnain et al. employed the Delphi method to establish expert consensus on the most appropriate attributes for valuing residential properties exposed to flood risk [13]. Their study identified flood occurrence, flood frequency, flood depth, flood duration, proximity to flood-prone areas, historical flood information, and neighbourhood characteristics as critical variables influencing property valuation. The findings provide strong methodological support for integrating multiple flood-related attributes within hedonic pricing models rather than relying on a single indicator of flood risk. This expert-based framework strengthens the reliability of residential property valuation in flood-prone environments and supports the inclusion of multidimensional flood exposure variables in the present study

2.4 Housing Characteristics and Residential Property Values

Besides environmental risks, residential property prices are influenced by structural housing characteristics that determine the utility and functionality of individual dwellings.

Housing attributes commonly incorporated into hedonic pricing models include built-up area, land size, number of bedrooms, number of bathrooms, building age, construction quality, parking facilities, neighborhood amenities, accessibility, and proximity to commercial centers.

Among these characteristics, built-up area consistently exhibits one of the strongest positive relationships with residential property prices. Larger homes provide greater living space and therefore command higher market values.

Similarly, the number of bedrooms positively influences residential property prices because larger households generally require more accommodation space. Chen et al. and Yeee et al. found that room configuration significantly contributes to housing values across both residential and commercial property markets [14], [15].

Property type also affects market behavior. Terrace houses, Semi-Detached (Semi-D) houses, detached houses, and apartments respond differently to environmental risks due to differences in construction design, market segmentation, and buyer preferences.

Terrace houses generally experience greater flood vulnerability because of shared foundations and relatively lower floor elevations. Semi-D houses often occupy larger land parcels and may therefore experience different mechanisms of flood damage. Understanding these differences is essential when evaluating heterogeneous housing markets.

2.5 Macroeconomic Determinants of Residential Property Values

Residential property markets operate within broader macroeconomic environments. Housing demand depends not only on property characteristics but also on national economic performance, household purchasing power, labor market conditions, demographic change, and monetary policy.

2.5.1 Gross Domestic Product (GDP)

GDP represents overall economic performance and is widely recognized as a major determinant of housing demand.

Economic growth stimulates employment, household income, consumer confidence, and investment activities, thereby increasing demand for residential properties. Kok et al. demonstrated that positive GDP shocks contribute significantly to house price appreciation through improved macroeconomic conditions [16].

In Malaysia, sustained GDP growth has supported rapid urban expansion in Selangor and the Klang Valley, although environmental risks continue to moderate property market performance within flood-prone areas.

2.5.2 Household Income

Household income directly influences housing affordability and purchasing power. Higher income levels enable households to purchase larger and higher-quality residential properties, increasing overall housing demand. Wong et al. concluded that Malaysian residential property prices are largely income-driven rather than speculative [17]. Consistent with this, Fraser et al. found that both permanent and temporary changes in disposable income exert significant effects on house prices, suggesting that the relationship between income and residential property values is sensitive to whether income changes are perceived as lasting or transitory [18].

Income also influences buyers' willingness to pay for environmental quality, implying that higher-income households may exhibit stronger preferences for properties located outside flood-prone areas.

2.5.3 Employment and Unemployment

Labor market conditions significantly influence housing markets through household income stability and consumer confidence.

Higher employment increases mortgage eligibility and purchasing capacity, thereby stimulating housing demand. Conversely, rising unemployment reduces household income and delays homeownership decisions.

Mohan et al. reported that unemployment exerts a significant negative influence on residential property prices through declining affordability and weaker consumer confidence [19].

2.5.4 Inflation

Inflation influences residential property values through multiple channels.

Moderate inflation may increase housing demand because real estate serves as an inflation hedge. However, excessive inflation increases construction costs, reduces household purchasing power, and often leads to higher interest rates that suppress mortgage demand.

Empirical evidence suggests that inflation exhibits a complex and nonlinear relationship with residential property prices.

2.5.5 Interest Rates (Overnight Policy Rate)

Monetary policy affects residential housing markets primarily through mortgage financing costs.

Bank Negara Malaysia uses the Overnight Policy Rate (OPR) as the benchmark for influencing commercial lending rates. Lower OPR levels reduce borrowing costs and stimulate housing demand, whereas higher OPR levels discourage mortgage borrowing and reduce residential property prices.

Previous Malaysian studies consistently report negative relationships between interest rates and residential property values. Razak et al. further demonstrated that housing prices are closely linked to mortgage debt in Malaysia, indicating that changes in borrowing costs transmit directly into household financing decisions and, in turn, residential property demand [20].

2.5.6 Population Growth

Population growth remains one of the strongest long-run determinants of housing demand.

Rapid urbanisation and internal migration increase residential housing demand, particularly within metropolitan regions such as Selangor and the Klang Valley. However, when housing supply fails to expand accordingly, increasing population pressures contribute to rising property prices.

Yeap and Lean et al, identified population growth as one of the primary drivers of long-term residential housing price appreciation in Malaysia [21].

2.7 Climate Change, Urbanization, and Housing Market Vulnerability

Climate change has fundamentally altered flood risk dynamics worldwide. Rising sea levels, more intense rainfall events, and changing precipitation patterns have substantially increased the frequency and severity of flooding.

Malaysia's rapid urbanisation further amplifies flood risks. Expansion of impervious surfaces, inadequate drainage systems, river modifications, and encroachment into floodplains have increased runoff volumes and reduced natural water retention capacity.

The interaction between climate change and urban development creates complex challenges for residential housing markets. Urban properties located within economically vibrant regions may continue attracting buyers despite higher flood risks because accessibility, employment opportunities, and public infrastructure offset some environmental disadvantages.

Consequently, housing markets increasingly reflect trade-offs between economic opportunities and environmental risks, highlighting the importance of integrating environmental and macroeconomic variables within residential property valuation models.

2.8 Synthesis of the Literature and Research Gap

The existing literature demonstrates broad consensus that flood events negatively influence residential property values. Environmental risk is generally capitalised into housing prices through reduced buyer willingness to pay, higher expected maintenance costs, and increased financial uncertainty. Likewise, macroeconomic variables—including GDP, income, employment, inflation, population growth, and monetary policy—play fundamental roles in determining residential property demand.

Despite these advances, several important research gaps remain.

First, most empirical studies investigate individual housing categories or isolated geographical regions, limiting the generalisability of findings across Malaysia's diverse residential property markets.

Second, relatively few studies integrate multiple flood exposure dimensions—flood occurrence, flood duration, and flood depth—with structural housing characteristics and macroeconomic indicators within a unified econometric framework.

Third, comparative analyses examining differential responses across terrace houses, Semi-Detached houses, and general residential properties remain scarce despite substantial differences in construction characteristics, buyer preferences, and market behaviour.

Fourth, many previous studies emphasise local case studies without providing integrated national evidence capable of informing broader housing policies and climate adaptation strategies.

To address these limitations, the present study develops a comprehensive hedonic pricing framework that simultaneously incorporates environmental risk variables, housing characteristics, demographic factors, and macroeconomic indicators across multiple housing categories and flood-prone regions in Malaysia. By integrating evidence from Kelantan, Kota Damansara, Selangor, and the Klang Valley, this study provides a more comprehensive understanding of flood risk capitalisation in Malaysia's residential property market while contributing to the broader literature on housing economics, environmental risk, and sustainable urban development.

III. CONCEPTUAL FRAMEWORK, HYPOTHESES DEVELOPMENT AND RESEARCH METHODOLOGY

3.1 Conceptual Framework

The residential property market is influenced by a complex interaction of environmental, structural, demographic, and macroeconomic factors. Drawing upon Hedonic Pricing Theory (HPT) (Rosen, 1974) and Risk Capitalisation Theory (RCT), this study proposes an integrated conceptual framework that explains how flood risks are capitalised into residential property values while simultaneously considering the influence of housing characteristics and broader macroeconomic conditions.

According to HPT, the market value of a residential property reflects the implicit prices of its individual attributes, including structural features (e.g., built-up area and number of bedrooms), locational characteristics, neighbourhood quality, and environmental conditions. Environmental hazards such as flooding represent negative amenities that reduce buyers' willingness to pay because they increase expected repair costs, insurance premiums, and investment uncertainty.

Risk Capitalisation Theory further explains that market participants incorporate perceived flood risks into transaction prices through rational expectations. Buyers discount the value of properties located within flood-prone areas because of anticipated future economic losses associated with recurring flood exposure. Consequently, flood occurrence, flood duration, and flood depth are expected to exert negative influences on residential property values.

However, residential property prices are not determined solely by environmental risks. Macroeconomic variables—including Gross Domestic Product (GDP), household income, employment, inflation, population growth, and monetary policy—shape housing demand and affordability by influencing household purchasing power and investment behaviour. Strong economic performance generally stimulates residential property markets, whereas economic instability weakens housing demand and market confidence.

This study therefore proposes an integrated framework in which residential property values are jointly determined by three groups of explanatory variables:

1. **Flood Exposure Variables**
   - I. Flood occurrence
   - II. Flood duration
   - III. Flood depth
2. **Microeconomic (Property) Variables**
   - I. Built-up area
   - II. Number of bedrooms
3. **Macroeconomic Variables**
   - I. Gross Domestic Product (GDP)
   - II. Household income
   - III. Employment rate
   - IV. Unemployment rate
   - V. Inflation rate
   - VI. Overnight Policy Rate (OPR)
   - VII. Population growth

The conceptual framework assumes that these variables jointly influence residential property values through both direct and indirect pathways. Flood risks reduce housing demand by increasing expected future losses, whereas favourable macroeconomic conditions stimulate market demand through improved affordability and investment confidence.

The framework in Figure 1 illustrates that residential property values are simultaneously influenced by environmental, structural, microeconomic and macroeconomic determinants. The integration of these variables provides a more comprehensive explanation of housing market behaviour than previous studies that considered these factors separately.

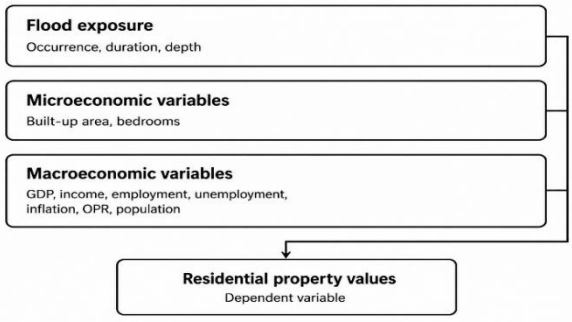

Figure 1. Conceptual Framework of the Study

3.2 Hypotheses Development

Based on the theoretical foundations and previous empirical studies, the following hypotheses are proposed.

Flood Exposure Variables

Flood Occurrence

Flood occurrence increases the probability of future property damage and financial losses. Buyers therefore discount the value of flood-prone properties.

H1: Flood occurrence has a significant negative effect on residential property values.

Flood Duration

Longer flood duration increases structural deterioration, mould growth, repair costs, and disruption to household activities.

H2: Flood duration has a significant negative effect on residential property values.

Flood Depth

Flood depth represents the severity of flooding and strongly influences structural damage.

H3: Flood depth has a significant negative effect on residential property values.

Microeconomic Variables

Built-up Area

Larger houses provide greater living space and generally command higher market prices.

H4: Built-up area has a significant positive effect on residential property values.

Number of Bedrooms

Properties with more bedrooms provide greater accommodation capacity and are expected to have higher market values.

H5: The number of bedrooms has a significant positive effect on residential property values.

Macroeconomic Variables

Gross Domestic Product (GDP)

Economic growth improves employment opportunities, consumer confidence, and housing demand.

H6: GDP has a significant positive effect on residential property values.

Household Income

Higher household income increases purchasing power and housing affordability.

H7: Household income has a significant positive effect on residential property values.

Employment

Higher employment rates increase household financial stability and mortgage eligibility.

H8: Employment has a significant positive effect on residential property values.

Unemployment

Higher unemployment reduces housing demand through declining household income.

H9: Unemployment has a significant negative effect on residential property values.

Inflation

Inflation increases construction costs and borrowing costs while reducing purchasing power.

H10: Inflation has a significant negative effect on residential property values.

Overnight Policy Rate (OPR)

Higher interest rates increase mortgage costs and reduce housing demand.

H11: The Overnight Policy Rate has a significant negative effect on residential property values.

Population Growth

Population growth increases demand for residential housing.

H12: Population growth has a significant positive effect

3.3 Research Methodology

Research Design

This study adopts a quantitative research design to examine the determinants of residential property values in Malaysia. A quantitative approach is appropriate because it enables the estimation of relationships between residential property prices and multiple explanatory variables using econometric techniques. The study applies the Hedonic Price Model (HPM) estimated through Multiple Linear Regression (MLR) to quantify the effects of flood exposure, property characteristics, and macroeconomic conditions on housing prices.

The research employs an explanatory research design because its primary objective is to explain the causal relationships between environmental risks and residential property values. Unlike descriptive studies, explanatory research allows hypothesis testing and the estimation of the relative contribution of individual determinants to residential property prices.

Study Areas

The empirical analysis focuses on four major flood-prone regions in Malaysia:

I. **Kelantan**, representing the East Coast region characterized by recurrent monsoon flooding and extensive terrace housing developments.

II. **Kota Damansara**, representing an urban residential area within the Greater Kuala Lumpur metropolitan region.

III. **Selangor**, Malaysia's most economically developed state, containing diverse residential housing markets.

IV. **Klang Valley**, representing the country's largest metropolitan housing market with significant flood exposure resulting from rapid urbanization and changing land use.

These study areas were selected because they exhibit varying flood characteristics, housing types, and socioeconomic conditions, enabling comparative analysis across different residential property markets.

Data Sources

The study utilises secondary data collected from multiple authoritative sources to ensure data reliability and consistency. Residential property transaction data were obtained from the National Property Information Centre (NAPIC) and the Valuation and Property Services Department (JPPH). Macroeconomic indicators, including GDP, household income, employment, unemployment, inflation, population, and the Overnight Policy Rate (OPR), were obtained from the Department of Statistics Malaysia (DOSM) and Bank Negara Malaysia (BNM). Flood-related data, including flood occurrence, flood duration, and flood depth, were sourced from the Department of Irrigation and Drainage (DID), official flood reports, and state disaster management agencies.

The study integrates these datasets to create a comprehensive panel of residential property market indicators covering the period 2004–2024. The selected period captures multiple major flood events, economic cycles, and policy changes, allowing the analysis of both environmental and macroeconomic influences on residential property values.

Variable Measurement

Dependent Variable

The dependent variable is the **average residential property transaction price**, representing the market value of terrace houses, Semi-Detached (Semi-D) houses, and general residential properties.

Independent Variables

The explanatory variables are grouped into three categories:

Flood Exposure Variables

I. Flood occurrence (number of flood events)

II. Flood duration (days)

III. Flood depth (metres)

Microeconomic Variables

I. Built-up area (square metres)

II. Number of bedrooms

Macroeconomic Variables

- Gross Domestic Product (GDP)
- Household income
- Employment rate
- Unemployment rate
- Inflation rate
- Overnight Policy Rate (OPR)
- Population

Table I. Measurement of Variables

Variable	Symbol	Measurement	Expected Sign
Residential property value	PV	Average transaction price (RM)	Dependent
Flood occurrence	FLOOD	Number of flood events	–
Flood duration	FDUR	Number of days	–
Flood depth	FDEP	Metres	–
Built-up area	BUA	Square metres	+
Bedrooms	BED	Number of bedrooms	+
GDP	GDP	RM billion	+
Household income	INC	RM/month	+
Employment rate	EMP	Percentage	+
Unemployment rate	UNEMP	Percentage	–
Inflation	INF	CPI (%)	–
OPR	OPR	Percentage	–
Population	POP	Number of persons	+

Econometric Model

The Hedonic Price Model is specified as:

$$PV_i = \beta_0 + \beta_1 FLOOD_i + \beta_2 FDUR_i + \beta_3 FDEP_i + \beta_4 BUA_i + \beta_5 BED_i + \beta_6 GDP_i + \beta_7 INC_i + \beta_8 EMP_i + \beta_9 UNEMP_i + \beta_{10} INF_i + \beta_{11} OPR_i + \beta_{12} POP_i + \mu_i$$

where:

- PV_i = residential property value,
- β_0 = intercept,
- β_1 – β_{12} = coefficients to be estimated,
- μ_i = stochastic error term.

To examine the incremental contribution of different groups of variables, four nested models are estimated:

- **Model 1:** Flood exposure variables only.
- **Model 2:** Flood exposure + microeconomic variables.
- **Model 3:** Flood exposure + macroeconomic variables.
- **Model 4:** Full integrated model including flood exposure, microeconomic, and macroeconomic variables.

This hierarchical modelling strategy allows assessment of the additional explanatory power contributed by each set of determinants.

Diagnostic and Robustness Tests

To ensure the reliability of the econometric results, several diagnostic tests are performed:

I. **Variance Inflation Factor (VIF)** to assess multicollinearity among explanatory variables.

II. **Breusch–Pagan and White tests** to detect heteroscedasticity.

III. **Durbin–Watson statistic** to examine autocorrelation in the regression residuals.

IV. **Ramsey RESET test** to evaluate model specification.

V. **Jarque–Bera test** to assess the normality of residuals.

VI. **Robust standard errors** to account for any remaining heteroscedasticity.

VII. Where spatially referenced data are available, Moran's I statistic can be employed to assess spatial dependence in residuals.

These diagnostic procedures strengthen the validity and robustness of the empirical findings and ensure that the estimated coefficients provide reliable evidence for hypothesis testing.

This integrated conceptual framework, hypothesis development, and methodological design provide a rigorous basis for examining how environmental hazards, housing characteristics, and macroeconomic conditions jointly shape residential property values in Malaysia. The following section presents the empirical results and discusses their implications for housing market resilience, flood risk management, and sustainable urban development.

IV. RESULTS, COMPARATIVE DISCUSSION AND POLICY IMPLICATIONS

5.1 Overview of Empirical Results

This study estimates the determinants of residential property values in Malaysia using an integrated Hedonic Price Model (HPM) that combines flood exposure variables, structural housing characteristics, and macroeconomic indicators. The empirical analysis synthesizes evidence from three residential housing markets representing different geographical and socioeconomic contexts: terrace houses in Kelantan, residential properties in Kota Damansara, and Semi-Detached (Semi-D) houses in Selangor and the Klang Valley.

5.2 Results for Terrace Houses in Kelantan

The regression results for terrace house prices in Kelantan indicate that the **employment rate** is one of the strongest determinants of terrace house values (β = 19,521.054, t = 3.809, p = 0.002), suggesting that improved labour market conditions increase household purchasing power and stimulate housing demand. Similarly, **population** exerts a positive and statistically significant effect (β = 0.499, t = 2.321, p = 0.036), indicating that demographic growth continues to place upward pressure on residential property prices.

In contrast, flood occurrence does not reach conventional levels of statistical significance (p = 0.625), although the coefficient remains positive. Likewise, the Overnight Policy Rate (OPR) exhibits a negative coefficient but is statistically insignificant (p = 0.843). Household income also fails to achieve statistical significance, despite its theoretical importance.

The absence of statistically significant flood effects does not necessarily imply that flooding does not influence terrace housing prices. Rather, the regression diagnostics reveal exceptionally high Variance Inflation Factor (VIF) values for income (30.12) and population (34.92), indicating severe multicollinearity. Such multicollinearity inflates standard errors and reduces the precision of coefficient estimates, suggesting that future research should employ alternative estimation strategies such as Principal Component Regression, Ridge Regression, or Partial Least Squares to mitigate this issue.

5.3 Results for Residential Properties in Kota Damansara

The Kota Damansara analysis provides additional insights into the heterogeneous effects of flood risks across different market segments.

Four separate regression models were estimated according to residential property value categories. The explanatory power varies considerably across models, with R^2 values ranging from 0.14 to 0.58, indicating that flood impacts differ across price segments. The Mid-Low Value housing segment demonstrates the highest explanatory power ($R^2 = 0.58$), suggesting that flood-related and structural variables explain a substantial proportion of housing price variation within this market.

Across all market segments, floor area consistently exhibits positive and statistically significant coefficients, confirming that larger residential properties command higher market values. This finding is fully consistent with Hedonic Pricing Theory; whereby additional housing space contributes positively to buyer utility.

Flood variables exhibit heterogeneous effects. Properties located within the 10-year flood zone experience the largest negative price adjustments, particularly within lower-priced housing markets, while certain flood-zone classifications are statistically insignificant in higher-value segments. These findings suggest that buyers of lower-priced residential properties are more sensitive to frequent flooding than buyers operating within higher-end housing markets.

Educational attainment, represented by the percentage of graduates, generally exhibits positive coefficients, implying that neighbourhood socioeconomic characteristics contribute positively to residential property values. Although statistical significance varies across housing categories, the results indicate that local human capital may partially offset perceived environmental risks.

5.4 Results for Semi-Detached Houses in Selangor and the Klang Valley

The regression analysis for Semi-Detached (Semi-D) houses provides further evidence regarding the interaction between flood exposure and housing characteristics.

Among the flood-related variables, flood duration demonstrates a statistically significant negative relationship with Semi-D house prices ($\beta = -3.512$, $t = -2.523$, $p = 0.027$). This finding indicates that prolonged inundation significantly reduces residential property values by increasing structural deterioration and restoration costs.

Conversely, flood depth exhibits a negative coefficient but remains statistically insignificant ($p = 0.090$). Although deeper flooding increases expected physical damage, the available evidence suggests that flood duration has a stronger influence on buyer perceptions than flood depth within this particular housing market.

Among structural housing characteristics, built-up area (square feet) is highly significant ($p = 0.001$), confirming that larger Semi-D houses command substantially higher prices. Population also demonstrates a strong positive effect ($t = 8.008$, $p = 0.001$), reinforcing the importance of demographic demand within rapidly urbanising regions.

Interestingly, several macroeconomic variables—including GDP, inflation, and unemployment—do not achieve statistical significance within this regional model. This result suggests that local housing characteristics and demographic pressures dominate broader macroeconomic influences within the Klang Valley's Semi-D housing market.

VI. COMPARATIVE DISCUSSION

The comparative analysis reveals substantial heterogeneity in the effects of flood risks across Malaysia's residential housing markets.

First, flood exposure influences residential property values differently according to housing type. Terrace houses in Kelantan appear more responsive to regional socioeconomic conditions than to flood occurrence itself, although multicollinearity may partially obscure flood effects. Semi-D houses, by contrast, are significantly affected by flood duration, suggesting that buyers of higher-value properties place greater emphasis on prolonged structural exposure than on simple flood occurrence.

Second, urban market resilience differs considerably across study areas. Residential properties in Kota Damansara exhibit relatively stronger recovery patterns following flood events compared with Kelantan. The higher explanatory power observed in several Kota Damansara models reflects the interaction between environmental risks and stronger urban economic fundamentals.

Third, structural housing characteristics remain among the strongest determinants of residential property values. Built-up area consistently demonstrates positive and statistically significant effects across all three studies, confirming that physical housing attributes continue to dominate residential property valuation despite increasing environmental risks.

Fourth, macroeconomic variables exert varying degrees of influence depending upon regional housing market characteristics. Employment and population significantly affect terrace housing prices in Kelantan, whereas GDP, inflation, and unemployment appear less influential within the Semi-D housing market. These findings indicate that local market conditions moderate the transmission of broader macroeconomic shocks into residential property values.

Collectively, these results demonstrate that flood risk capitalisation is neither uniform nor constant across

Malaysia's residential property market. Instead, housing market responses depend upon the interaction between environmental hazards, structural housing characteristics, demographic pressures, and regional economic conditions.

6.1 Policy Implications

The empirical findings have several important implications for housing policy, flood management, and sustainable urban development.

Federal Government

Flood mitigation should become an integral component of Malaysia's national housing policy. Investment in flood retention systems, river basin management, early warning systems, and climate adaptation infrastructure can reduce long-term housing market vulnerability.

State Governments and Local Authorities

Planning authorities should incorporate updated flood hazard maps into zoning regulations and residential development approvals. Restricting high-density housing developments within high-risk floodplains would reduce future exposure.

Property Valuation Agencies

The Valuation and Property Services Department (JPPH) and the National Property Information Centre (NAPIC) should incorporate flood exposure variables into standard property valuation practices. More comprehensive transaction databases that include flood history would improve market transparency.

Financial Institutions

Banks should integrate flood-risk assessments into mortgage lending decisions. Risk-based lending policies should balance financial stability with continued access to affordable housing, particularly in regions experiencing increasing climate-related hazards.

Insurance Industry

The findings support wider adoption of risk-based flood insurance products. Improved insurance availability would reduce household financial vulnerability while encouraging greater investment in flood-resilient housing.

Property Developers

Developers should incorporate resilient construction technologies, elevated floor levels, improved drainage systems, and flood-resistant materials into residential housing developments located within flood-prone regions.

Urban Planners

Future urban development should adopt integrated watershed planning that combines engineering solutions with sustainable land-use management, green infrastructure, and nature-based flood mitigation strategies.

Homeowners and Investors

Residential property buyers should consider flood duration, flood frequency, and historical flood exposure alongside traditional housing characteristics when making investment decisions. Increased public awareness of environmental risks will contribute to more efficient housing markets and improved long-term investment outcomes.

The empirical results demonstrate that flood risks significantly influence residential property values in Malaysia, although the magnitude of these effects varies across housing types and geographical locations. The following section synthesises these findings by presenting the overall conclusions, theoretical contributions, practical implications, limitations of the study, directions for future research, and the complete reference list. This final section will position the manuscript as a cohesive, publication-ready contribution to the literature on housing economics, environmental risk, and sustainable urban development.

VII. CONCLUSIONS, LIMITATIONS, FUTURE RESEARCH

7.1 Conclusions

This study investigated the impact of flood events on residential property values in Malaysia by integrating flood-related variables, microeconomic housing characteristics, and macroeconomic indicators within a unified Hedonic Pricing Model (HPM). Unlike previous Malaysian studies that examined individual housing types or isolated geographical locations, this research developed a comprehensive comparative framework covering terrace houses in Kelantan, residential properties in Kota Damansara, and Semi-Detached (Semi-D) houses in Selangor and the Klang Valley. By integrating evidence from multiple housing markets, the study provides a broader understanding of how environmental hazards interact with economic conditions to influence residential property prices.

The study was motivated by the increasing frequency and severity of flood events resulting from climate change, rapid urbanisation, and expanding residential developments in flood-prone areas. These changes have intensified concerns regarding housing affordability, market resilience, investment security, and sustainable urban development throughout Malaysia. The findings demonstrate that flood risks have become an increasingly important determinant of residential property values and should therefore be incorporated into both housing policy and property valuation practice.

Consistent with Hedonic Pricing Theory and Risk Capitalisation Theory, the empirical evidence indicates that environmental risks are capitalised into residential property prices through market mechanisms. Buyers incorporate expected future flood losses into their purchasing decisions by discounting properties exposed to repeated flooding,

prolonged inundation, or severe flood damage. However, the magnitude of flood-related price effects varies considerably according to housing type, geographical location, and local market conditions.

The comparative analysis demonstrates that residential housing markets respond differently to flood exposure. Terrace houses in Kelantan are strongly influenced by demographic and labour market conditions, with employment rate and population exhibiting statistically significant positive relationships with property values. Although flood occurrence itself was not statistically significant within the regression model, the presence of severe multicollinearity suggests that the estimated coefficient should be interpreted cautiously rather than viewed as evidence that flooding has no economic consequences. The exceptionally high Variance Inflation Factor (VIF) values indicate that the explanatory variables are highly correlated, reducing the precision of individual coefficient estimates.

For residential properties in Kota Damansara, flood impacts vary according to market segment. Lower- and middle-priced housing markets appear more sensitive to flood exposure than higher-value residential properties, while structural housing characteristics—particularly floor area—remain consistently significant determinants of property values. These findings suggest that buyers within lower-income housing markets place greater emphasis on environmental risks because they possess fewer financial resources to absorb future flood-related losses.

Within the Klang Valley and Selangor, the analysis of Semi-Detached (Semi-D) houses demonstrates that flood duration exerts a statistically significant negative effect on residential property values, whereas flood depth remains statistically insignificant. These findings indicate that prolonged flood exposure has a greater influence on market perceptions than the physical depth of floodwaters. Larger built-up areas and higher population levels significantly increase property values, highlighting the continued importance of structural housing characteristics and urban housing demand despite increasing environmental risks.

Collectively, the findings demonstrate that flood occurrence, flood duration, and flood depth should not be interpreted independently. Instead, flood risks interact with structural housing characteristics, demographic conditions, and macroeconomic environments to shape residential property values. The study therefore supports the proposition that residential property markets represent complex systems in which environmental, economic, and social factors jointly determine market behaviour.

Beyond the empirical findings, this research contributes to housing economics in several important ways. The study extends the application of Hedonic Pricing Theory by integrating multiple flood exposure indicators with macroeconomic variables within a single econometric framework. While previous Malaysian studies generally examined environmental risks or macroeconomic conditions separately, this study demonstrates that combining these dimensions substantially improves understanding of residential property valuation under climate-related uncertainty.

The study also contributes methodologically by synthesising evidence from multiple housing categories and geographical regions rather than relying on a single case study. This broader comparative approach enhances the generalisability of findings and provides more comprehensive evidence for policymakers responsible for flood management, urban planning, housing policy, and disaster risk reduction.

From a practical perspective, the findings emphasise the importance of incorporating environmental risks into property valuation, mortgage lending, insurance pricing, and residential development planning. As climate change continues to increase the frequency and severity of flooding throughout Malaysia, ignoring environmental risks within housing markets may expose households, financial institutions, and governments to substantial long-term economic losses.

7.2 Theoretical Contributions

This study makes four principal theoretical contributions. **First,** it extends Hedonic Pricing Theory by demonstrating that residential property values are simultaneously determined by structural housing characteristics, environmental risks, demographic factors, and macroeconomic conditions rather than by any single group of variables.

Second, the research strengthens Risk Capitalisation Theory by providing comparative evidence that flood risks are incorporated differently across housing types and geographical locations. The study demonstrates that market responses depend upon local economic conditions, housing characteristics, and flood exposure rather than being uniform across all residential property markets.

Third, the study introduces an integrated Malaysian framework combining flood occurrence, flood duration, flood depth, GDP, employment, inflation, population, and housing characteristics into one unified analytical model. This integrated framework provides a stronger theoretical basis for future research examining environmental risks within emerging property markets.

Finally, the comparative analysis contributes to environmental economics by demonstrating that climate-related risks increasingly influence residential housing markets alongside traditional macroeconomic determinants.

7.3 Practical and Policy Contributions

The findings have important implications for multiple stakeholders.

For policymakers, the study provides empirical evidence supporting greater investment in flood mitigation infrastructure, sustainable urban planning, and climate adaptation strategies. Improved drainage systems, river basin management, flood retention facilities, and nature-based flood solutions will reduce long-term housing market vulnerability.

For local planning authorities, updated flood hazard maps should become mandatory components of land-use planning and residential development approval processes. Housing developments within high-risk floodplains should incorporate stricter engineering standards and resilient construction practices.

Financial institutions should integrate flood-risk indicators into mortgage assessment procedures while avoiding excessive restrictions that reduce housing affordability. Risk-based lending frameworks can improve financial stability while encouraging more informed investment decisions.

Insurance providers may also use the findings to improve flood insurance pricing, encourage risk reduction measures, and expand insurance coverage within vulnerable communities.

Property developers should increasingly adopt resilient building technologies, elevated floor levels, sustainable drainage systems, and flood-resistant construction materials to improve long-term housing resilience.

Finally, homeowners and investors should consider flood exposure alongside conventional housing characteristics when evaluating residential property investments.

7.4 Limitations of the Study

Although this study makes significant contributions, several limitations should be acknowledged.

First, the analysis relies exclusively on secondary data collected from government agencies and published databases. While these sources are considered reliable, they may not capture individual household perceptions, behavioural responses, or post-flood adaptation strategies that influence residential property values.

Second, the study combines evidence from multiple housing categories and geographical regions. Although this broadens the scope of analysis, differences in local housing market structures, planning regulations, and flood management practices may introduce regional heterogeneity that cannot be fully captured within a single integrated model.

Third, certain explanatory variables exhibit multicollinearity, particularly within the Kelantan dataset. Although diagnostic testing identified these issues, multicollinearity reduces coefficient precision and limits interpretation of individual regression parameters.

Fourth, the study primarily applies multiple linear regression techniques. More advanced econometric approaches—such as spatial econometric models, panel data estimation, quantile regression, or machine learning algorithms—may capture spatial dependence and nonlinear housing market behaviour more effectively.

Finally, flood exposure is measured using occurrence, duration, and depth. Other environmental indicators—including flood velocity, contamination, drainage capacity, proximity to rivers, and climate change projections—could further improve future residential property valuation models.

7.5 Future Research

Several opportunities exist for extending the present research.

Future studies should incorporate spatial econometric techniques such as Spatial Lag Models (SLM), Spatial Error Models (SEM), or Geographically Weighted Regression (GWR) to account for spatial dependence among residential properties.

Panel data models covering longer time periods would provide stronger evidence regarding dynamic housing market adjustments following major flood events. Longitudinal analyses may also examine whether flood-related price discounts diminish as communities recover or whether repeated flood events produce permanent market effects.

Machine learning techniques—including Random Forest, Gradient Boosting, Support Vector Regression, and Artificial Neural Networks—could complement traditional hedonic pricing models by identifying complex nonlinear relationships between flood risks and residential property values.

Future research should also investigate behavioural dimensions of flood risk by incorporating homeowner perceptions, risk awareness, insurance decisions, adaptation behaviour, and willingness to pay for flood-resilient housing.

Comparative studies involving other Southeast Asian countries, such as Indonesia, Thailand, Vietnam, and the Philippines, would provide valuable regional evidence regarding climate adaptation and housing market resilience.

Finally, future research should integrate climate change projections, satellite imagery, remote sensing data, and Geographic Information Systems (GIS) to improve flood exposure measurement and support more accurate property valuation under future climate scenarios.

References

[1] Rosen, S. Hedonic prices and implicit markets: Product differentiation in pure competition. *Journal of Political Economy, 82*(1), pp. 34–55 (1974).

[2] Intergovernmental Panel on Climate Change (IPCC). (2023). *Sixth Assessment Report: Climate Change 2023*.

[3] Ahmed *et al.*, "Flood events and residential property valuation," *Journal of Real Estate Research / Working Paper Series*, 2019.

[4] D. M. Harrison, G. T. Smersh, and A. L. Schwartz, "Environmental determinants of housing prices: The impact of flood zone status," Journal of Real Estate Research, vol. 21, no. 1–2, pp. 3–20, 2001, doi: 10.1080/10835547.2001.12091045

[5] Bin, O., & Polasky, S. (2004). Effects of flood hazards on property values: Evidence before and after Hurricane Floyd. *Land Economics, 80*(4), 490–500.

[6] Beltrán, D. Maddison, and R. Elliott, "Is flood risk capitalised into property values?" Ecological Economics, vol. 146, pp. 668–685, 2018, doi: 10.1016/j.ecolecon.2017.12.015.

[7] L.-H. Chiang Hsieh, "Is it the flood, or the disclosure? An inquiry into the impact of flood risk on residential housing prices," Land Use Policy, vol. 106, art. 105443, 2021, doi: 10.1016/j.landusepol.2021.105443.

[8] S. Armal, J. R. Porter, B. Lingle, Z. Chu, M. L. Marston, and O. E. J. Wing, "Assessing property level economic impacts of climate in the US, new insights and evidence from a comprehensive flood risk assessment tool," Climate, vol. 8, no. 10, p. 116, 2020, doi: 10.3390/cli8100116

[9] J. Hirsch and J. Hahn, "How flood risk impacts residential rents and property prices: Empirical analysis of a German property market," Journal of Property Investment & Finance, vol. 36, no. 1, pp. 50–67, 2018, doi: 10.1108/JPIF-11-2016-0088

[10] N. H. Ismail, M. Z. Abd Karim, and B. Hasan Basri, "A Hedonic Modelling of Land Property Value Based on the Effect of Flooding: A Case for Peninsular Malaysia," in Proceedings of the Second International Conference on the Future of ASEAN (ICoFA) 2017 – Volume 1: Business and Social Sciences, Singapore: Springer, 2019, pp. 167–179, doi: 10.1007/978-981-10-8730-1_17.

[11] N. Ismail *et al.*, "Flood impacts on residential property values in Malaysia: A study of willingness to pay," *Malaysian Journal of Economic Studies*, vol. 56, no. 1, pp. 63–84, 2020

[12] L.-F. Chang, C.-H. Lin, and M.-D. Su, "Application of geographic weighted regression to establish flood-damage functions reflecting spatial variation," Water SA, vol. 34, no. 2, pp. 209–216, 2019, doi: 10.4314/wsa.v34i2.183641

[13] S. H. Zulkarnain, M. N. Razali, and co-authors, "The Delphi method to identify attributes for a valuation approach for residential property exposed to flood risk," *Property Management*, vol. 40, no. 2, pp. 228–245, 2022. doi: 10.1108/PM-10-2020-0067

[14] H. Chen, R. Chen, S. Bernard, and I. Rahman, "US hotel industry revenue: an ARDL bounds testing approach," *International Journal of Contemporary Hospitality Management*, vol. 31, no. 4, pp. 1720–1743, 2019, doi: 10.1108/IJCHM-01-2018-0031.

[15] G. F. Yeee, S. F. Sufahani, M. H. Abd Wahab, and S. Z. S. Idrus, "Factors influence the housing price in Kuala Lumpur by using AHP," *Journal of Physics: Conference Series*, vol. 1793, art. 012027, 2021, doi: 10.1088/1742-6596/1793/1/012027.

[16] S. H. Kok, N. W. Ismail, and C. Lee, "The sources of house price changes in Malaysia," International Journal of Housing Markets and Analysis, vol. 11, no. 2, pp. 335–355, 2018, doi: 10.1108/IJHMA-04-2017-0039.

[17] W. L. Wong, C. Lee, and S. S. Koong, "Housing prices in peninsular Malaysia: supported by income, foreign inflow or speculation?" International Journal of Housing Markets and Analysis, vol. 12, no. 3, pp. 424–441, 2019, doi: 10.1108/IJHMA-01-2018-0001.

[18] P. Fraser, M. Hoesli, and L. McAlevey, "House prices, disposable income and permanent and temporary shocks: The NZ, UK and US experience," Journal of European Real Estate Research, vol. 5, no. 1, pp. 5–28, 2012, doi: 10.1108/17539261211215987

[19] S. Mohan, A. Hutson, I. MacDonald, and C. C. Lin, "Impact of macroeconomic indicators on housing prices," International Journal of Housing Markets and Analysis, vol. 12, no. 6, pp. 1055–1071, 2019, doi: 10.1108/IJHMA-09-2018-0070

[20] S. A. Razak, M. A. Rahman, and N. A. Rahim, "The effects of housing price on the mortgage debt in Malaysia: New evidence from FMOLS method," *International Journal of Housing Markets and Analysis*, vol. 17, no. 1, pp. 60–78, 2024, doi: 10.1108/IJHMA-11-2022-0167.

[21] G. P. Yeap and H. H. Lean, "Can the housing policies sustain house prices in Malaysia?" *Malaysian Journal of Economic Studies*, vol. 54, no. 2, pp. 301–314, 2017