~~An a~~Assessment of multiple variables predicting the psychological effects of flooding: Case study in Peninsular Malaysia

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ABSTRACT

Floods are among the most disastrous environmental hazards, causing devastating tangible and intangible impacts. The psychological impact, which can be classified as intangible damage, is ~~an~~ a ~~important~~crucial ~~aspect of~~part of ~~human's~~ well-being assessment. The psychological impact of flooding has begun to receive attention in recent years, however,~~but~~ the complexity of measuring it makes it less attractive to be considered ~~in actual flood damage~~the damage empirical assessment and risk studies. The present study seeks to evaluate willingness to pay for the psychological impact of flooding experienced by households and business premises, and the different factors that could be ~~the~~ determining variables of the psychological impact. A total of 217 respondents have participated in the empirical face-to-face survey conducted in different vulnerable places in Peninsular Malaysia. Through the willingness-to-pay (WTP) method, only 107 and 34 respondents from residential and business premises, respectively, expressed their agreement to spend on flood ~~risk reduction~~management ~~-~~efforts. The study found that flood durations and family sizes are statistically significant contributors to ~~intangible damages~~psychological impact for households, reflecting the intangible damages to the residential sector. The results suggest a greater investment to support affected people's welfare by improving ~~communities~~communities'~~y~~ resilience ~~status with awareness and shelter facilities~~and consolidated management during flood events from different authorities. These will ~~enhance~~ enhance flood risk reduction efforts ~~management efforts planning~~ and reduce the psychological impacts ~~to~~ on people at risk of flooding. The findings also revealed a key challenge of ~~: the inability to reliably~~ inferring ~~on~~ intangible flood damages for business sectors through empirical evidence.

Keywords: Intangible damage, Flood characteristics, Flood psychological effect, Socioeconomic variables, Willingness-to-pay.

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~~1.~~1 Introduction

Flooding remains one of the greatest threats, with its unprecedented impact ~~which brought~~ to the society. A comparison of flood events across different return periods reveals that the impact of flooding on both residential properties and business premises ~~has intensified~~ can be extremely severe ~~over time~~ (Merz et al., 2010). A post-flood survey by DOSM (2021) of 2021 flood in Malaysia has reported that flood damages on residential buildings (living quarter loss) amounts up to US$3954 million, while US$123~~2~~ million damages from business premises (DOSM, 2021). Numerous studies have attempted to quantify ~~the~~ tangible flood damages ~~to those two types of~~ on residential and business properties (Van Ootegem et al., 2015; Kabirzad et al., 2024), given their essentials~~ity~~ for ~~the local~~ community's well-being and economy. Studies that attempt to provide the correlation of the socio-economic and building characteristics to flood damages often apply regression-based modelling given the multi-faceted nature of flood consequences (Foudi et al., 2017; Hudson et al., 2017;Sulong & Romali, 2022).

Over the past decade, analysis of flood consequences has evolved beyond conventional tangible economic damages to intangible impacts, such as psychological effects, as a critical subset of adverse flood consequences (Stanke et al., 2012; Yoda et al., 2017). Psychological effects can be defined as the emotional and mental responses individuals experience due to disruptions in daily life, such as anxiety, depression, and stress, exacerbated by isolation and changes in routine (Veale, 1987). The psychological impact of flooding stemmed from people's experience during or after the devastating event, which may involve losing possessions, physical health, livelihoods, or even worse, the lives of loved ones (Law et al., 2025). During the disastrous flooding in 2014 and 2021 in Malaysia, severe psychological effects on individuals and community have been reported (Ridzuan et al., 2022). ~~In fact, the flood in 2021 in Malaysia alone has shown that US$4 million in flood damages of residential buildings, while half of the damage was on business premises (DOSM, 2021), emphasising the need for targeted interventions. Malaysia's flood prone regions are experiencing frequent and severe flooding that is inevitably expensive to manage, yet could endure greater losses in the future due to climate change.~~

~~The Southeast Asian region suffered almost every year adverse mental health due by to extreme weather induced~~~~hazards and floodings that have resulted in , which caused high depressions, anxiety, and stress among other extreme weather hazards (Patwary et al., 2024). One of the consequences of flooding is the psychological impact to exposed groups of people, where they endure unprecedented experiences of losing possessions, physical health, livelihoods, or even worse, the lives of loved ones (Law et al., 2025). Psychological effects can be defined as the emotional and mental responses individuals experience due to disruptions in daily life, such as anxiety, depression, and stress, exacerbated by isolation and changes in routine (Veale, 1987). In Malaysia alone, flooding has caused billions of~~

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~~economic losses to the country over the years and has caused significant harm beyond immediate physical damage (DID annual flood reports). Historical events, such as the 2014 and 2021 disastrous flooding in Malaysia, have demonstrated the extensive psychological effects on individuals and the community (Ridzuan et al., 2022). Flooding caused significant harm beyond immediate physical damage, causing long lasting psychological effects on affected communities~~

~~In the past decade, analysis of flood consequences has expanded from the primarily conventional tangible damages, such as physical and economic losses, to understanding the psychological effects as a subset of adverse consequences of flooding (e.g.,(Stanke et al., 2012; Yoda et al., 2017). Another study found that measuring intangible damage could be a very useful social innovation for those who suffered from flooding; however, there were no multiple cultures' intangible damage assessment (Nazilah et al., 2019). Some factors influencing the resilience of the protected community by formulating a method to improve family and community emotional support when the community is facing disaster risk (N Akhir et al., 2021). Factors contributing to the coping capacity of a community, such as strong social networks among the community members and organized shelter systems, have caused less anxiety and stress during flood recovery periods (Zahari & Hashim, 2018; Akhir et al., 2021). The c~~Current scholarly consensus have emphasizes ~~shows~~ that ~~understanding the~~ the psychological effects of flooding ~~of flooding~~ is important to be integrated in ~~to enhance decision-making in~~ flood management decision-making (Ti et al., 2016; Nawi et al., 2021; Sulong & Romali, 2022). ~~In some studies, intangible flood damages were claimed to be more severe than tangible losses (Nga et al., 2018; Han et al., 2023). It is widely accepted that intangible damage is an important factor in risk assessment, particularly for households(Joseph et al., 2015).~~ In fact, addressing psychological impacts of flooding and establishing ways to enhance emotional support systems during periods of high disaster risk can bolster the community resilience. For instance, robust social networks and organized shelter systems have been shown to significantly reduce anxiety and stress during post-flood recovery (Zahari & Hashim, 2018; Akhir et al., 2021). Some studies have even found that intangible flood damages could be more severe than tangible losses (Nga et al., 2018; Han et al., 2023; Joseph et al., 2015).

Among the critical factors that influence the intangible damages of flooding are the socio-economic characteristics, specifically the income levels (e.g., Fatemi et al., 2020), and the spatial elements, such as proximity to riverine systems (e.g., Yang et al., 2020). The intangible damage could also increase with flood depth and duration (Lekuthai & Vongvisessomjai, 2001). In addition to flood characteristics, flood experience and building height could improve the accuracy of flood intangible damage assessment (Darnkachatarn & Kajitani, 2025). Limited studies have attempted to investigate the relation of these factors in terms of how they influence psychological effects.~~However, t~~To include the psychological effects as part of the integral component of flood damage ~~under~~ using the ~~standard~~

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measurementeconometrics methods ~~unit explicitly~~ remains a challenge due to the ethical and social complexities (Frongia et al., 2016; Nafari & Mendis, 2018, Babcicky et al., 2021).~~-~~ The subjectivity of the valuation and the difficulty in obtaining coherency in determining the psychological effects of flooding further contribute to the complexity. The aforementioned has result in higher potential dismissal of psychological effects of flooding integration into the cost-benefit analysis (CBA) framework alongside the tangible economic losses, which~~In some studies, intangible flood damages were claimed to be more severe than tangible losses (Nga et al., 2018; Han et al., 2023). It is widely accepted that intangible damage is an important factor in risk assessment, particularly for households(Joseph et al., 2015).~~

could lead to malinvestment in flood risk mitigation efforts. Even if investments were allocated for reducing mental burden, justifications were difficult to be made in terms of how much public spending a case would require. Moreover, allocations to reduce psychological effects are usually prompted reactively.

~~The psychological impact includes stress, anxiety, fears, and worry.~~ . ~~Climate change exacerbates this impact by increasing the frequency and intensity of flooding, thereby causing psychological effect among vulnerable~~ Flood ~~impact is increased by climate change, which increases the frequency and intensity of flooding, causing a psychological impact on residents~~ (Law et al., 2025). ~~The psychological impact includes stress, anxiety, fears, and worry.~~ ies, with Vvulnerable populations, particularly ~~the elderly, children, and women, mostly suffering~~ suffer ~~greater effects~~ (Salleh & Mustaffa, 2016; Law et al., 2025). ~~These impacts are very common among the flood victims (Yoda et al., 2017). Historical event of flooding, like the 2014 disastrous flooding in Malaysia, highlights the extensive psychological impact on individuals and the community, underscoring the importance of intangible damage in flood risk assessment (Ridzuan et al., 2022).~~

~~In assessing flood damages using an empirical approach, socio-economic characteristics have been considered to be decisive factors in determining flood damages to households and businesses. In particular, income levels have been shown to have an impact on flood vulnerability (e.g., Fatemi et al., 2020). Spatial elements, such as living closer to the river and exposure location, are also found to be important factors (e.g., Yang et al., 2020). The possible multi-faceted influence of flood damage, including flood characteristics and building conditions, requires integration of multiple variables in flood damage analysis. Through regression based analysis, important factors to improve disaster preparedness and recovery strategies for residential households and businesses can be identified (Foudi et al., 2017; Hudson et al., 2017;Sulong & Romali, 2022).~~ One of the approaches used in valuation of non-marketable intangible flood damages is the willingness-to-pay (WTP) through contingent valuation method (CVM).

In the CVM, the monetary amount that is willing to be provided for a particular goods or services that can alleviate flooding is considered (e.g., Foudi & Osés-Eraso, 2022; Rodríguez Castro et al., 2025). The method is particularly useful for valuing flood risk mitigation, as it estimates the economic value of non-market assets or services by determining the maximum amount an individual is willing to pay for them (Entorf &

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Jensen, 2020). Since late 20th century, studies have employed CVM, though their initial application to disaster economics was controversial. After years of refinement and evaluation, the method is acknowledged as one viable way to measure non-market value. However, the application of non-market valuation in flood damage assessment, particularly for informing decision-making agencies in damage management, is infrequently used and remains relatively new (Rogers et al., 2019).

~~In assessing flood damages using empirical approach, socio economic characteristics have been considered to be decisive factors in determining flood damages to households and businesses. In particular, income levels have shown to have impact on flood vulnerability (e.g., Fatemi et al., 2020). Spatial elements, such as living closer to the river or in a low lying zone, also found to be an important factor (e.g., Yang et al., 2020). The possible multi facets influence of flood damage, including flood characteristics and building conditions, requires integration of multiple variables in flood damage analysis. Through regression based analysis, important factors to improve disaster preparedness and recovery strategies for residential households and businesses can be identified (Foudi et al., 2017; Hudson et al., 2017;Sulong & Romali, 2022).~~

~~Therefore, the psychological impact of flooding requires effective management and identification of initial symptoms of mental distress(Nazilah et al., 2019).Conventional flood risk damage models have primarily focused on tangible damages, such as physical and economic losses; however, psychological damages impact are frequently neglected. This omission has resulted in an incomplete assessment of a how flood's affect impact the on community's well-being. Psychological impact is important to address to achieve an more holistic understanding of long lasting flood impacts (Yoda et al., 2017);(e.g., Akhir et al., 2021);. For instance, Sstudies have shown that communities with strong social networks and organized shelter systems experience less anxiety and stress during flood recovery periods (Zahari & Hashim, 2018). Therefore, It it is important to consider both tangible and intangible damage to better manage flood impacts.~~

~~impacts. Recently, studies have increased focus on mental well being due to its growing interest in psychological impact (Nazilah et al., 2019).~~

~~A comparison of flooding events across different periods reveals that the impact on both residential and business properties has intensified over time (Merz et al., 2010). Numerous studies have quantified the tangible damage to those two types of properties (Van Ootegem et al., 2015; Kabirzad et al., 2024). However, intangible damage to residential and business properties has often been overlooked due to challenges in assessment and valuation, as well as ethical and social complexities (Frongia et al., 2016; Nafari & Mendis, 2018, Babcicky et al., 2021). Intangible damage is critical for understanding the full impact of floods on individuals and communities (Babcicky et al., 2021). Research emphasizes that~~

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~~intangible flood damages can, in many cases, be more severe than tangible losses (Nga et al., 2018;Han et al., 2023). There is a need for flood risk models that integrate physical, socioeconomic characteristics, and psychological impact (Ti et al., 2016;Nawi et al., 2021; Sulong & Romali, 2022).~~

~~Flood risks and their impact are disproportionately spread across various socioeconomic groups. Elements such as building age, closeness to flood prone areas, and family income levels play an important role in determining flood vulnerability (Fatemi et al., 2020). (Fatemi et al., 2020). Vulnerable communities often live in poorly maintained homes, heightening the physical damage and psychological damage impact due toring floodsflooding(A.M.Nawi et al., 2021). Location Geographic factors, such as living closer to the river or in a low-lying zone, face severe flood impacts (Yang et al., 2020). The socio-spatial inequalities require focused strategies that address both physical and social vulnerabilities.~~

~~Recent advancement in flood risk assessment emphasizes the importance of integrating multiple variables to understand the interaction between flood characteristics, socioeconomic characteristics, building characteristics, and psychological effectsflood damage(Sulong & Romali, 2022). Research utilizing the multivariate methods has shown that assessing multiple variables, such as flood depth characteristics and building conditions, provides a more precise evaluation of community vulnerability and resilience (Hudson et al., 2017). This holistic multivariate approach assists in identifying important factors affecting both physical building and individual well-being psychological impacts, thereby improving disaster preparedness and recovery strategies (Foudi et al., 2017). This study has recommendsed models that capture these complex relationships to support more effective and fair policy making.~~

~~A comparison of flooding events across different periods reveals that the impact on both residential and business properties has intensified over time (Merz et al., 2010). Numerous studies have quantified the tangible damage to those two type of properties (Van Ootegem et al., 2015; Kabirzad et al., 2024). However, intangible damage to residential and business properties has often been overlooked due to challenges in assessment and valuation, as well as ethical and social complexities (Frongia et al., 2016; Nafari & Mendis, 2018, Babcicky et al., 2021). Intangible damage is critical for understanding the full impact of floods on individuals and communities (Babcicky et al., 2021). Research emphasizes that intangible flood damages can, in many cases, be more severe than tangible losses (Nga et al., 2018;Han et al., 2023). There remains a need for flood risk models that integrate physical, social, and psychological dimensions.~~

~~A comparison of flood events across different periods reveals that the impact on both residential properties and business premises has intensified over time (Merz et al., 2010). Numerous studies have attempted to quantify the tangible damage to these two types of properties (Van Ootegem et al., 2015; Kabirzad et al., 2024), given the essentiality for the local community's well-being and economy. In fact, the flood in 2021 in Malaysia alone has shown that US$4 million in flood damages of residential buildings, while half of the damage was on business premises (DOSM, 2021), emphasising the need for targeted interventions. Malaysia's flood prone regions are experiencing frequent and severe flooding that is inevitably expensive to manage, yet could endure greater losses in the future due to climate change.~~

~~A comparison of flood events across different periods reveals that the impact on both residential properties and business premises has intensified over time (Merz et al., 2010). Numerous studies have attempted to quantify the tangible damage of residential properties and business premises (Van Ootegem et al., 2015; Kabirzad et al., 2024) given the essential of both for the local community's wellbeing and economy. In fact, flood in 2021 in Malaysia alone has shown that MYR 1.6 billion flood damages of residential buildings, while MYR half a billion damages on business premises (DOSM, 2021), emphasising the needs for targeted interventions. Rough estimates have shown that Aapproximately 10% of Peninsular Malaysia is vulnerable to flooding, impacting 21% of the total population (Department of Drainage and Irrigation, 2012). Due to climate change, Malaysia's historically flood-prone regions are now experiencing more frequent and severe flooding that is inevitably expensive to manage, yet could endure greater losses in the future due to climate change..~~

~~This~~The present study aims to assess intangible flood damage represented by the psychological effects of flooding experienced by households and businesses in Peninsular Malaysia. Current studies in Malaysia ~~focusing~~ on the two elements at risk in the context of psychological losses~~,~~ alongside other flood damage factors~~,~~ are absent. The ability to understand their influence on flood damages through an empirical lens and to be able to identify key drivers would provide evidence to support refinement of ~~in~~ flood damage modelling and flood management options~~ decision-making~~. The present study elicited the monetary value of psychological impact from respondents through empirical surveys at affected locations to better understand and address future flood impacts. Based on respondents' flooding experiences and their recollection of its effects on their well-being, the study ~~Multiple factors, including flood, building, household and business socio-economic characteristics, were considered. The intangible damage is quantified using the willingness to pay (WTP) approach through empirical surveys at affected locations~~attempts to incorporate the subjective experiences of people exposed to flooding in the risk-based flood investment decision-making. ~~The psychological health impact is framed in the context of cost-benefit analysis CBA, where a monetary metric was used as the decision support metric. The present study attempts to incorporate the subjective experiences of people exposed to flooding in the risk-based flood investment decision-making.~~(~~e.g., (Foudi & Osés-Eraso, 2022; Rodríguez Castro et al., 2025). A previous study found that, in addition to flood characteristics, other variables such as flood experience~~

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~~and building height could improve the accuracy of flood intangible damage assessment (Darnkachatarn & Kajitani, 2025).~~

There are two mechanisms for the information of WTP can be acquired: through stated or revealed preference approach. The first one is elicited by directly asking the respondent on the amount, whilst the second is by observing the behaviour (Foudi & Osés-Eraso, 2022; Tomoi et al., 2024). WTP can also be elicited by adding a portion of expenses to bills to cover the WTP to improve the quality of life, and shows that the socio-economic factors could contribute to determining the WTP, particularly the income and education, to reduce respondents' health risk (Jianjun et al., 2016).

~~The psychological health impact is framed in the context of cost-benefit analysis CBA, where a monetary metric was used as the decision support metric. The CBA often neglects the intangible damages that could lead to malinvestment in flood risk mitigation efforts. Even if investments were allocated for reducing mental burden, justifications were difficult to be made in terms of how much public spending a case would require. Moreover, allocations to reduce psychological effects are usually prompted reactively. The present study attempts to incorporate the subjective experiences of people exposed to flooding in the risk-based flood investment decision-making.~~

~~To determine the willingness to pay (WTP) for risk reduction, the amount that flood victims are willing to pay for particular goods or services. There are two types of WTPs: stated and revealed. The first one is elicited by directly asking the respondent, and the second is determined by observing the behaviour (Foudi & Osés-Eraso, 2022); Tomoi et al., 2024). Another study used the WTP by adding a portion of expense to bills to cover the WTP to improve the quality of life, and shows that the socio-economic factors could contribute to determining the WTP, particularly the income and education, to reduce respondents' health risk (Jianjun et al., 2016). The conventional damage assessment is used for tangible damage assessment only, but intangible damage was not assessed to identify the flood characteristics in the damage assessment. The intangible damage could be increased with flood depth and duration, and socio-economic characteristics could propose discrepancies in different regions (Lekuthai & Vongvisessomjai, 2001). A previous study also showed that multiple flood characteristics, including building height, could influence the intangible damage in the commercial sector. However, considering additional variables in multivariate analysis could improve the predictive and applicability of the damage model (Darnkachatarn & Kajitani, 2025).~~

~~This study aims to assess intangible flood damage represented by the psychological effects of flooding experienced by households and businesses in Peninsular Malaysia. The present study regard psychological health impacts, such as stress, emotional instability, wariness, and anxiety that people exposed to because of floods as intangible damage. Current studies in Malaysia focusing on the two elements at risk in the context of intangible psychological losses alongside other physical flood damage factors are absents. The ability to understand their influence on flood damages through empirical lens and to be able to identify key drivers would provide evidence to support refinement in flood damage modelling and flood management decision making. The contribution of multiple variables was analysed to gain insights into the factors governing the intangible losses. The m~~Multiple factors, variables including flood characteristics, building, household and /business /socio-economic physical

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~~characteristics, and socioeconomic characteristics were considered. The intangible damage is quantified using the the willingness-to-pay (WTP) approach through empirical surveys at affected locationsbased on the flooded area, and its relationship is assessed with a linear regression model.~~

2 Study Areas and Surveys

The study aims for in-person interviews with individuals from residential and businesses premises with prior flood experience and still living in the flood-prone areas. The study areas were first identified through desk study and secondary information review by focusing on the regions in Peninsular Malaysia that are often flooded, one from the northeast, and another from the southwest of Peninsular Malaysia. Within the two specific regions, identification is then made on viable territory and states for the ground survey to be made, which led to Kuala Lumpur Federal Territory, Selangor state, and Kelantan state to be selected for further review. A description of what is the damage generation process that the study would want to focus on led to specifying only cases of fluvial flooding. Common flood cases due to extreme storms in Peninsular Malaysia that leads to devastating damages can be distinguished between those that are ultimately caused by water that exceeds a riverbank, and those that are mainly caused by attenuation of runoff exacerbated by impermeable surface and exhaustion of existing storage spaces. The former sometimes referred to as fluvial flood, whilst the latter referred to pluvial floods. Flooded areas to be surveyed

were set to be those that are located adjacent to rivers ~~,~~within a radius of ~~xx~~1.3 km, such that the distance from river can be incorporated as part of the possible decisive factors to psychological intangible damage.

Demarcations of areas were made to limit samples only from areas where fluvial floods are the primarily cause of the damage generation process. This is assisted by rigorous reviews of authorized documents and reports related to floods at territory and states levels, such as those published by the Department of Irrigation and Drainage (2012), Kuala Lumpur City Hall (2015), and the National Statistics Department. Grey literature and open-source websites were also consulted to verify and confirm the suitability of areas. Finally, exact villages or towns affected by fluvial floods for face-to-face interviews were identified. In-person interviews were conducted between July and September 2020. Within the selected locations, each respondent was approached individually at their residential or business premises. To ensure relatively recent experiences with flood damage, only individuals who had experienced at least one flood event in the past 10 years preceding 2020 were included. Descriptions of intangible losses were provided in length to respondents during the interview prior to the other specific questions.

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~~The area is also suffering from flooding and has been reported to have flood damage by relevant agencies. whereare the Peninsular,geographically confirm~~Figure 2 ~~displays~~illustrates the study area ~~chosen main territory and states, with~~ highlights of Kota Bharu ~~city~~ in Kelantan, Kuala Lumpur Federal Territory, and Dengkil and Kajang districts in Selangor, where the ground surveys were ~~made~~conducted. ~~Based on the reported evidences, statestateevidence~~ F~~f~~requent flooding and large-scale evacuations have been reported ~~experienced by the residences~~in these location ~~in the city and districts~~. For instance, in the 2013 flood event, as ~~large~~many as 2000 residents ~~have~~ evacuated from the area (Khairi et al., 2013). These reports are consistent with information obtained from~~e facts are supported with~~ interviews ~~made~~ with the Kuala Lumpur City Hall (DBKL) in 2020. ~~Similarly,~~ Kajang and Dengkil ~~with~~in ~~the~~ Selangor ~~state~~ were selected as ~~areas for~~ sample locations because they have experienced multiple ~~collection since these areas have faced a number of~~ flood events, ~~with~~ some of which ~~result~~resulted in large-scale evacuations. Both Kajang and Dengkil~~areas~~ are situated within the Langat River basin. F~~Based on f~~lood reports indicate that~~,~~ approximately 200 people were evacuated in Kajang, and ~~while~~ nearly 500 residents were relocated to public shelters from various inundated areas in Dengkil during the ~~year~~ 2020 flood event. In ~~Kelantan state,~~ Kota Bharu city, Kelantan experienced particularly devastating floods in 2014, which led to the evacuation of 20,000 residents (Abdullah, 2014).

~~conductedTo ensure only individuals dat least one event preceding 2020 were included.~~

~~Descriptions of intangible losses were provided in length to respondents during the interview prior to the other specific questions.~~ Historical evidence has shown that Kelantan faces higher flood risks as compared to Selangor and Kuala Lumpur study area. During the site visits, respondents in Kelantan often exhibit strong religious beliefs, perceiving flooding as predetermined and beyond human control. This belief may reduce reported distress and lower engagement in the WTP initiative. In addition, some respondents displayed a lack of interest in interviews, possibly due to diminished trust following repeated flood events across Peninsular Malaysia. In contrast, respondents in Kuala Lumpur showed stronger interest and support for WTP based on flood risk reduction initiatives. Several families express a willingness to allocate part of their monthly income to mitigate flooding risks, often driven by distress and fear resulting from repeated flood experiences between 2010 and 2020. This suggests that the WTP values may be influenced by emotional response to past events. Emotion-driven valuations may bias stated preference estimates and were therefore excluded from the final analysis, consistent with previous methodological recommendations (Joseph et al, 2015).

~~For residential buildings, intangible damages primarily focused on personal well-being, including family or self related worries, stress, and sleep disturbances, as well as the difficulty in managing possessions and recovery to normal. For businesses, the intangible damages are centred on concerns about employees' well being, which affects daily operations and services, as well as the difficulty in managing loss in assets, sales, and recovery to the normal state.~~ ~~Therefore, comparing the intangible~~

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~~damage assessment of the individual and the business is challenging, and they have different evidence to assess the impact.~~

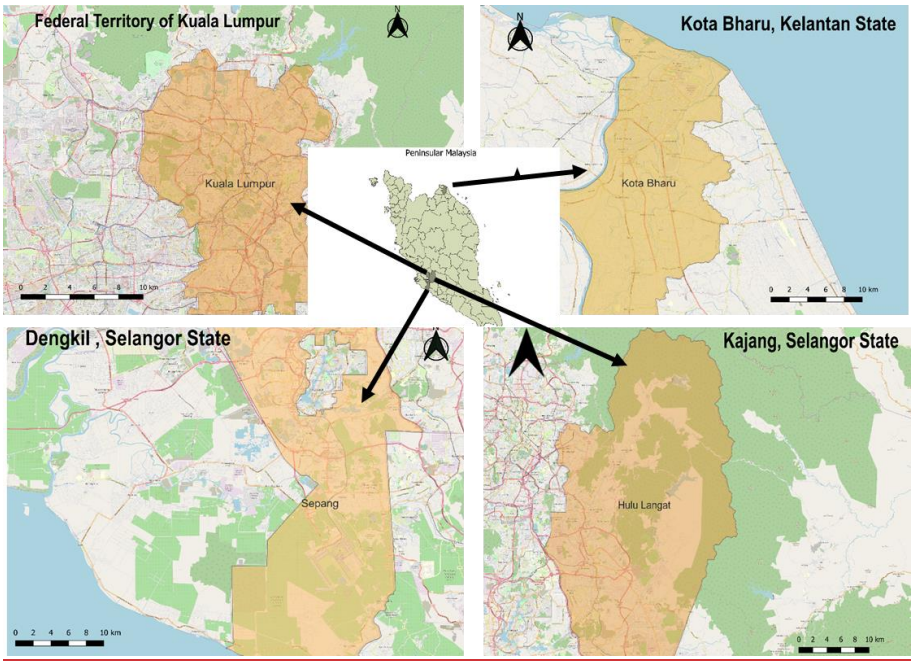

Figure ~~2~~1. The map was created using OpenStreetMap and the Malaysian district and territory boundaries file. Areas where surveys were conducted in Peninsular Malaysia, and the yellow area is the district or territory boundaries. Top left: Kuala Lumpur Federal Territory; Top right: Kota Bharu district, Kelantan; Bottom left: Dengkil, Sepang district.~~inwithbetween JulySeptemberdamage~~

~~Classifications of residential and businessesbusiness~~

~~Residential buildings were classified as village-type, terraced, or bungalow, while businesses were categorized as micro, small-to-medium, or large businesses, similar to that proposed in KTA (2003). These classifications represent the primary building structure types prevalent in Malaysia. The categorization of business premises type was based on the total number of workers, as specified by SME Corporation Malaysia (2022). Businesses were categorized into micro and small businesses based on the number of full-time permanent employees. Micro businesses were defined as having fewer than five employees, while small-to-medium businesses included those with five to thirty employees (SME Corporation Malaysia, 2022).~~

~~As for the socio-economic characteristics, three classifications were used for the demarcation of the residential sector. Thesector income level. The classification is y are B40 (bottom 40%), M40 (middle 40%), and T20 (top 20%). The B40 group included those earning less than US$ 11301 per month, the M40 group covered incomes between US$ 1130 and US$ 2553.45 per month, and the T20 group consisted of households earning more than US$ 2553.45 per month. For business, micro business income is between US$ 73,367- US$3,668,380, and small-medium~~

~~[1] US$ values have been exchanged from Malaysian currency (MYR) used in the Survey(s).~~

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~~income is US$ 3,668,380 - US$ 7,333,170 (SME Corporation Malaysia, 2022). This classification followed national standards and the parent study (e.g. Kabirzad et al., 2024), but remains open to revision as socio-economic conditions change (Department of Statistics Malaysia, 2020). The classification according to income categories and business sizes allows the variation of the monetised intangible losses to be made from the collected samples.~~

~~DescriptionDescriptions of intangible losses were describedprovided in length to respondents during the interview prior to the other specific questions. For residential buildings, intangible damages primarily focused on personal well-being, including family- or self-related worries, stress, and sleep disturbances, as well as the difficulty to managein managing possessions and recovery to normal. For businesses, the intangible damages are centred on concerns about employees' well-being, which affects daily operations and services, as well as the difficulty to managein managing loss in assets, loss in sales, and recovery to the normal state. Therefore, comparing the intangible damage assessment of the individual and the business is challenging, and they have different evidence to assess the impact.~~

3 -Data and M~~M~~ethods

This section explains the data and methods applied for the analysis. Variables considered for the establishment of the decisive factors to intangible damage is explained in Section 3.1. Section 3.2 continues to describe the method of WTP, continued by Section 3.3 on data pre-processing, and lastly Section 3.4 on regression and model specification.

~~Classifications of residential and business~~

~~Residential buildings were classified as village-type, terraced, or bungalow, while businesses were categorized as micro, small-to-medium, or large businesses, similar to that proposed in KTA (2003). These classifications represent the primary building structure types prevalent in Malaysia. The categorization of business premises type was based on the total number of workers, as specified by SME Corporation Malaysia (2022). Businesses were categorized into micro and small businesses based on the number of full-time permanent employees. Micro businesses were defined as having fewer than five employees, while small to medium businesses included those with five to thirty employees (SME Corporation Malaysia, 2022).~~

~~As for the socio-economic characteristics, three classifications were used for the demarcation of the residential sector income level. This classification followed national standards and the parent study (e.g. Kabirzad et al., 2024), but remains open to revision as socio-economic conditions change (Department of Statistics Malaysia, 2020). The classification is B40 (bottom 40%), M40 (middle 40%), and T20 (top 20%). The B40 group included those earning less than US$ 1130 per month, the M40 group covered incomes between US$ 1130 and US$ 2553.45 per month, and the T20 group consisted of households earning more than US$ 2553.45 per month. For business, micro business income is between US$ 73,367 – US$3,668,380, and small medium income is US$ 3,668,380 – US$ 7,333,170 (SME Corporation Malaysia, 2022). This classification followed national standards and the parent study (e.g. Kabirzad et al., 2024), but remains open to revision as socio-economic conditions change (Department~~

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~~of Statistics Malaysia, 2020). The classification according to income categories and business sizes allows the variation of the monetised intangible losses to be made from the collected samples.~~

~~Descriptions of intangible losses were provided in length to respondents during the interview prior to the other specific questions. For residential buildings, intangible damages primarily focused on personal well-being, including family- or self-related worries, stress, and sleep disturbances, as well as the difficulty in managing possessions and recovery to normal. For businesses, the intangible damages are centred on concerns about employees' well-being, which affects daily operations and services, as well as the difficulty in managing loss in assets, sales, and recovery to the normal state. Therefore, comparing the intangible damage assessment of the individual and the business is challenging, and they have different evidence to assess the impact.~~

~~2.~~

3.1 Variables for intangible flood damage analysis

A range of variables, identified based on expert knowledge and literature review, are considered important for estimating intangible flood damage. The variables are grouped by flood characteristics, building factors, and socio-economic characteristics. ~~This study defines intangible damage as psychological health impacts such as stress, emotional instability, wariness, and anxiety that befall people exposed to flooding. Questionnaires and interviews were used to survey respondents and gather information on flood damage~~intangible damage, and its independent variables. ~~Figure 1 shows briefly the methodology of this study. The dependent variables focused on intangible damages (psychological impact), while a total of eleven independent variables were considered: flood depth, flood duration, building type, proximity to water bodies, business type, household size, years of living/operation duration, ownership, income, and the presence of elderly individuals or children. during the flood event only~~~~eleven~~~~The recovery rates are not explicitly informed, but is assumed to be implicit in other variables.~~ Figure 1~~Figure 1~~ shows the eleven~~11~~ independent variables; flood depth, flood duration, building type, proximity to water bodies, business type, household size, years of living (residential) ~~or~~ years of operation duration (business), ownership, income, ~~and~~ the presence of elderly individuals, ~~or~~and the presence of children. ~~The recovery rates are not explicitly informed, but is assumed to be implicit in other variables.~~ Despite the number of possible exogenous variables that could have influenced the psychological effects of flooding, we limit to only eleven subset variables to take the opportunity of the contact time with respondents and the quality of responses. All of the explanatory variables were used to assess their correlation with the intangible damage. Whilst some of the respondents shared their recovery experiences of post-flooding during the interview, the recovery rates were not being considered explicitly as one of the variables in the multivariate analysis.

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The survey questionnaire was designed to allow for separate analysis of residential and businesses. Residential buildings were classified as village-type, terraced, or bungalow, while businesses were categorized as micro, small-to-medium, or large businesses, similar to that proposed in KTA (2003). These classifications represent the primary building structure types prevalent in Malaysia. The categorization of business premises type was based on the total number of workers, as specified by SME Corporation Malaysia (2022). Businesses were categorized into micro and small businesses based on the number of full-time permanent employees. Micro businesses were defined as having fewer than five employees, while small to medium businesses included those with five to thirty employees (SME Corporation Malaysia, 2022).

~~(the effect) a payand then for missing values and duplicationdetailedwillingness to pay and this $Of the aforementioned variables, seven were specifically applied to business premises.~~ As for the socio-economic characteristics, three classifications were used for the demarcation of the residential sector income levels following the national standard and the parent study (i.e., Kabirzad et al., 2024) (Department of Statistics Malaysia, 2020). The classification is B40 (bottom 40%), M40 (middle 40%), and T20 (top 20%). The B40 group included those earning less than US$ 1130 per month, the M40 group covered incomes between US$ 1130 and US$ 2553.45 per month, and the T20 group consisted of households earning more than US$ 2553.45 per month. For business, micro business income is between US$ 73,367- US$3,668,380, and small-medium income is US$ 3,668,380 - US$ 7,333,170 (SME Corporation Malaysia, 2022).

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As the dependent variable, the intangible suffering due to the psychological effects of flooding were valued using the WTP approach. The monetary values that the respondents are willing to pay to alleviate flood damages were taken as proxy. The absolute value of WTP originally in Malaysian Ringgit (MYR) was converted to US Dollars (US$). The study aimed to assess damage using multiple variables and understand the multiple variables' contributions. The process in which the surveyed was made in person, and then data was screened for missing values and duplication, is shown in Figure 3. Further explanation on the process is discussed in the next sub-sections. Ultimately, a multivariate regression analysis was undertaken to identify the contributing factors of intangible damage to residential buildings and business premises.

~~The method applied to assess the non-market value of the intangible damage is the Contingent Valuation Method (CVM) through the willingness-to-pay (WTP) approach. Ultimately, a multivariate regression analysis was undertaken to identify the contributing factors to the intangible damage of residential and commercial premises. All of the assess and understand the multiple variables' contributions to intangible damage. The respondent shares their recovery experiences during the interview, which are post-flooding; therefore, the assessment consisted of the recovery concept of the flood impact. The workflow of the analysis is presented in Figure 3.~~

~~this assessment may cover some recovery costs but not the complete recovery process, which is a distinct and important topic in disaster management. Consequently, flood recovery presents a valuable direction for future research.~~

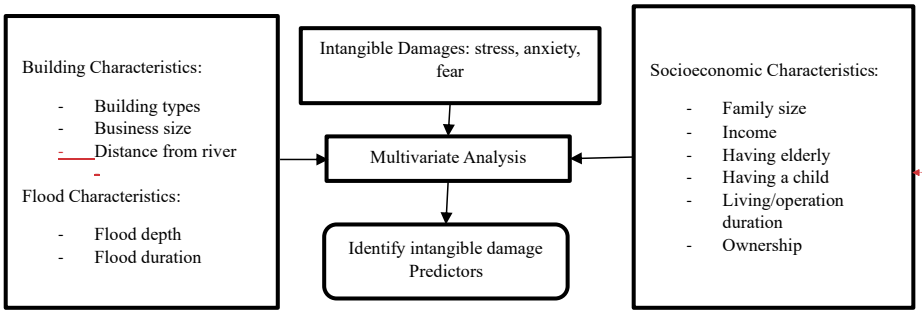
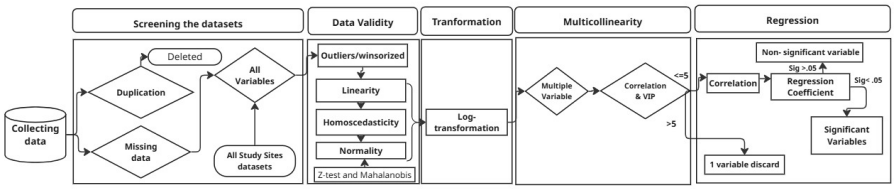


Figure ~~1~~2. The intangible damage assessment and the independent variables used in the multivariate analysis for the damage model.

~~The workflow of the analysis is presented in Figure 3. [explain the steps, then cross-refer to the data preprocessing section]~~



* Winsorization, Empirical rule,Z-test (Normality) and Mahalanobis distance

Figure ~~1~~3. The data process and analysis flowchart

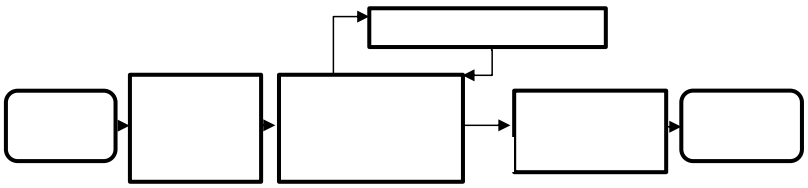


Figure ~~2~~1. The intangible damage assessment and the independent variables used in the multivariate analysis for the damage model.

~~3.1.~~

~~The data underwent outlier treatment using skewness and a three-standard-deviation~~

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SO the variable is already implicit in the survey of intangible lossess. Please revise the paragraph.

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~~cutoff, followed by necessary preparation before model fitting. To ensure no data fell outside the acceptable range, further cleaning was performed using the Mahalanobis distance method. This included transformations (e.g., Svenningsen et al., 2020) to accommodate non-Gaussian variables in their original form (e.g., Svenningsen et al., 2020) . For residential buildings, the datasets were log-log transformed, except for categorical independent variables such as building type, presence of elderly residents, presence of children, and ownership status. For commercial buildings, the datasets remained untransformed (except for income data, which was log-transformed), as the other variables met Gaussian distribution criteria. Microbusinesses were defined as those with fewer than five employees, while small-to-medium enterprises (SMEs) were classified as having up to 30 permanent full-time employees.~~

3.2. Study Area and Respondents

Approximately 10% of Peninsular Malaysia is vulnerable to flooding, impacting 21% of the total population (Department of Drainage and Irrigation, 2012). Survey locations were identified through a rigorous review of authorized documents and reports, such as those published by the Department of Irrigation and Drainage (2012), Kuala Lumpur City Hall (2015), and the National Statistics Department. Grey literature and open-source websites were also consulted to verify and supplement case study area selection. Surveys were conducted in 2020 across various locations. Each respondent was approached individually randomly at their residential or business premises, where only those who had lived in the flood-affected areas within the last ten years and had experience of flooding. Figure 2 displays the study sites where the data were collected: Kuala Lumpur Federal Territory, Selangor, and Kelantan states. In Kuala Lumpur, the Segambut area was chosen because of its history of frequent flooding and significant past evacuations. For instance, the worst flooding in 2013, 2000 residents evacuated from the area (Khairi et al., 2013). This flood-prone zone was again identified as vulnerable during a 2020 interview with DBKL staff. In Selangor, survey locations included Kajang and Dengkil, where previous flood events had led to large-scale evacuations. The Selangor study locations include Kajang and Dengkil, both situated within the Langat River basin, where previous flood events had triggered large-scale evacuation. During the 2020 floods, approximately 200 people were evacuated in Kajang, while nearly 500 residents were relocated to public shelters from various inundated areas in Dengkil.

Surveys were conducted in 2020 across various locations. Each respondent was approached individually at their residential or business premises, where only those who had lived in the flood-affected areas within the last ten years and had experience of flooding.

In Kelantan state, Kota Bharu city experienced particularly devastating floods in 2014, which led to the evacuation of 20,000 residents (Abdullah, 2014). The catastrophe peaked between December 2014 and January 2015. These nationwide flood events resulted in 319,156 evacuations and nine fatalities across multiple states (Malaysian Department of Irrigation and Drainage, 2017), marking it as the worst in the country's history.

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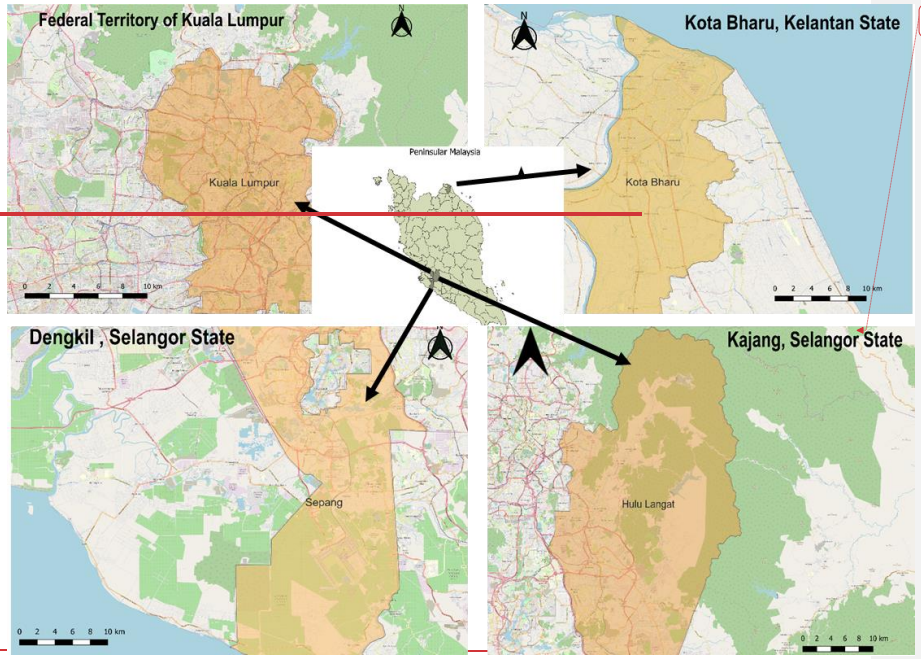

~~Figure 2. The map was created using OpenStreetMap and the Malaysian district and territory boundaries file. Areas where surveys were conducted in Peninsular Malaysia, and the yellow area is the district or territory boundaries. Top left: Kuala Lumpur Federal Territory; Top right: Kota Bharu district, Kelantan; Bottom left: Dengkil, Sepang district.~~

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~~Within the capacity of the study, 380 face-to-face interviews were successfully conducted. From the total, 217 were valid responses. Out of the 217 respondents, only 141 (107 residential and 34 businesses) expressed willingness to pay for disaster risk reduction measures to reduce their psychological distress. The remaining 76 respondents denied the willingness to pay due to~~for ~~different reasons.~~ Most business operators were unavailable due to time constraints and excessively ~~long wait times: Some businesses that suffered flood damage had also relocated. Consequently, the~~ majority of the interviews were conducted with residents of the residential buildings. ~~Tab.1 shows the number of buildings, both residential and business, where households and business owners were interviewed. Forty-two percent of residential respondents and 67% of business respondents were from the Kota Bharu (Kelantan) study area, where terrace buildings constituted the majority, accounting for almost 40% of the total, followed by low-cost houses. The respondents from the Segambut district of Kuala Lumpur were minimal, mostly living in terraces and low-cost houses. This indicates that respondents from the Kajang and Dengkil area of Selangor and the Kota Bharu district of Kelantan reside in terrace building types. In the business premises, the predominant type of businesses were micro-sized enterprises, followed by small-medium-sized businesses.~~ ~~The small-to-medium size represents businesses (SMEs), which accounted for 24% of the study sample, while micro-businesses comprised the remaining 76%.~~ ~~The Kota Bharu study site recorded the highest flood depth for both residential and commercial buildings, attributed to a significant flooding event in 2014. The case study sites and flooding events occurred in different years, but these locations have experienced severe flooding over the past decade, affecting both residential and business.~~

~~**Table 1. Summary of the respondents in residential and business premises categories across the study sites**~~

	Respondents' flood-year experiences	Residential building type				Business Type		
Study Site		Bunga	Terrace	low-	Total	Micro	Small-	Total
Segambut	2010-2020	2	8	17	[illegible]	2	2	4
Kajang & Dengkil	2020	5	21	9	[illegible]	6	1	7
Kota Bharu	2014	16	14	15	[illegible]	18	5	23
Total respondents (%)	Sample size	23(21%)	43(40%)	41(38%)	[illegible]	26(76%)	8(24%)	34(100)

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~~Classification of Premises~~

~~Initially, a preliminary inquiry identified individuals with prior flood experience to establish the target demographic (Poussin et al., 2015). The subsequent section addresses building attributes, including various typologies and supplementary details for residential and business premises. KTA (2003) reported that damage evaluation involved categorizing premises into several types. Residential buildings were classified as village-type, terraced, or bungalow, while businesses were categorized as micro, small-to-medium, or large. These classifications represent the primary building structure types prevalent in Malaysia.~~

~~The categorization of business premises was based on the total number of workers, as specified by SME Corporation Malaysia (2022). Businesses with more than five permanent employees were classified as small-to-medium, while those with fewer than five were categorized as micro. For residential buildings, intangible damages primarily focused on personal well-being, including family or self-related worries, stress, and sleep disturbances. For businesses, these damages centered on concerns about employees' well-being, which affects daily operations and services.~~

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~~Most respondents were from residential buildings, with fewer businesses represented due to limited commercial activity in the surveyed regions. Engaging with the business sector was challenging because of their demanding schedules. Additionally, some retailers and service shops had relocated to safer areas. During the interviews, efforts were made to ensure that the cost of intangible losses was accurately estimated. First, household heads, business managers, and owners in the exposed area to flooding were asked about the psychological impact they faced during previous flood events. After listening to their description, they were then explained about the effects of stress, wariness, and the various flood mitigation efforts that can help reduce flood impacts that their facing. Despite the efforts, getting the respondents' positive response to the issue and in valuing the psychological impacts proved to be challenging and even sensitive to some. When they were asked about their willingness to contribute monetarily to safeguard themselves from the psychological effects by flooding, some expressed their contribute, and others did not. Respondents also shared their reasons for not contributing, such as: "I do not have enough income," "It is the government's responsibility," "I cannot trust anyone," and "The flood impact is not very severe" The survey evaluated various factors essential for assessing flood-related intangible damage.~~

3.2 Intangible losses by the ~~the~~ contingent valuation method~~Willingness to Pay~~

Intangible damages of flooding for households primarily involved diminished well-being, stress, anxiety and sleep disturbances linked to the difficulty int~~o~~ managing~~e~~ possessions and to recovery. For businesses, the intangible damages centre on employee well-being and the subsequent disruption of operations and recovery (Lekuthai and Vongvisessomjai, 2001). To quantify the non-market values for alleviating psychological health resulting from flooding, the present study adopts the contingent valuation method (CVM) to estimate the WTP of people who have experienced flooding and could experience flooding again, similar to the work by Foudi & Osés-Eraso (2022).

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well-beingThe method used for valuing intangible damages is the whose samenities. (Foudi & Osés-Eraso (, 2022) stated that the value is asked for the collective flood defence system to mitigate mental health. stated preference method, which establishes a hypothetical market (Messner et al., 2007; Hammond et al., 2013). flood damage(Foudi & Osés-Eraso, 2022)flood damage assessment, particularly for informing decision-making agencies in damage management, is frequently used and

While the open-ended WTP format is subject to uncertainty and bias, it remains valid for revealing factors that influence respondents' ability to pay (Donaldson et al., 1997; Hanley et al., 2009) . (WTP)whoDuring the in-person engagement, conversations with household heads, business managers, andor owners in flood-exposed areas were generally conducted in Malay, as many residents felt more comfortable speaking their native language. Initially, tThe conversations were informal at first but shifted to a more formal tone once participants were willing to engage further. The engagement was conducted cautiously to ensure interviewees received sufficient information about the study's purpose before delving deeper into the willingness-to-pay (WTP) questions. The purpose was to learn how much the respondents were willing to pay for risk management (Foudi & Osés-Eraso, 2022). WTP .

The WTP approach is used to quantify the value individuals place on reducing impacts to human health (Frew et al., 2004).

the willingness to pay Ask individuals for mitigation measures, such as constructing flood levees to prevent flooding, and how much they are willing to pay for protecting their residences(Rogers et al., 2019;Foudi & Osés-Eraso, 2022). Studying the socioeconomic and demographic information could affect respondents' willingness to participate in the risk management (Vegh et al., 2025). [state several examples of strategies from published papers]. ThisA sequential information-sharing process was applied to ensure that respondents received sufficient information and were gradually being brought into the topic and questions regarding WTP. Respondents can be emotionally affected by their passpast devastating flood experiences (Joseph et al., 2015) and this can be attended to by validating respondents psychological experiences prior to questions being asked.

After listening to and validating their stories, they were briefed on the effects of stress and anxiety. Additionally, they were informed about the challenges of monetizing intangible flood damage, which requires the adoption of the contingent valuation method as well as various flood mitigation efforts that could help reduce the impacts they face. Explaining what it means by intangible flood losses in terms of psychological and mental health is important for flood victims to be able to relate to their own experience and to express their perceived values of efforts in mitigating the bad experience (Markantonis et al., 2012; Semrau et al., 2016;(Joseph et al., 2015)). To avoid confusing intangible losses with tangible losses (as seen in Kabirzad et al., 2024), and to focus willingness-to-pay (WTP) responses solely on psychological and mental health effects, the distinction between the two was clearly explained to the interviewees. They were advised not to include financial or asset losses in their WTP values (e.g., Foudi et al., 2022). Respondents were then presented with a dichotomous choice question on their willingness to pay for flood mitigation that could reduce the intangible damage of flooding that they experienced before.

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Information on goods can condition the WTP. How does the goods being described during the survey?

e.g. from Foudi (2022) paper: respondents are sked to value a collective flood defence program that mitigates physical health and secondary stressors of mental health.

e.g. from Foudi (2022): financial impacts are offset to focus on psychological impacts.

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Respondents who answered "yes" were then asked with an open-ended question on how much they are willing to pay. Those who stated "no" were asked for their reasons. Interviews for open-ended questions were only continued for respondents who answered 'yes'. From the face-to-face conversations, those who refused to pay were influenced by their strong views about the payment vehicle that should be part of the government responsibility. Such a protest bid is common in similar social studies and exclusions of the protest bids are necessary to reduce bias in the analysis.

Meanwhile, a number of questions were adopted to guide responses on WTP values associated with alleviating psychological burden. For instance, Ssome of the interviewees have ~~actually~~ built concrete barriers at the opening of their house to protect from ~~flooding~~flood intrusion. Such a real case was used as a surrogate ~~proxy of~~ to the ~~willingness to pay~~WTP value but with emphasise on alleviating their psychological burden ~~in reducing the psychological effects of flooding~~. ~~The case used was linked to the worst flood event that they have experienced in the past 10 years, at the time when the interviews were conducted. Some of the interviewees have actually built concrete barriers at the opening of their house to protect from flooding. Such a real case was used as a proxy of the willingness to pay value in reducing the psychological effects of flooding. Example question~~Example questions are: ~~(s are:~~ 1) how~~How~~ much they are ~~you~~ willing to allocate to ~~make yourself better prepared and~~ reduce ~~your~~ their stress and anxiety if the same flood event were to occur?~~'~~, (2) ~~'~~If the same event as the worst that they had experience is ~~going~~ to happen in the future~~,~~ and ~~you~~ they were not at home, will ~~are~~ the property-level protection barriers that they have ~~you~~ constructed able to ease their psychological burden ~~bring you peace of mind,~~ of not be able to save possessions ~~and not be affected as much as when~~ while they are not there? If yes, then the costs for the barriers were asked, or (3) if the respondents do not yet have property-level barriers, they will be asked if they are ~~How much~~ willing to spend on one and by how much to alleviate the same psychological burden as they have experienced during the worst flood experienced before. ~~did you spend to prevent flooding?'~~

~~While the descriptions of psychological and mental health effects of flooding were well prepared beforehand, providing them time to express their feelings is one of the ways to validate and not dismissing the respondent's own experiences. survey based approach directly asks respondents their willingness to pay (WTP) for flood risk reduction (Hammond et al., 2013). The willingness-to-pay (WTP) approach, a non-market valuation method, is used to quantify the economic value of psychological impacts. This method is applied in natural hazard damage assessments, particularly for evaluating psychological and mental health effects. Since the late 20th century, studies have employed contingent valuation methods, though their initial application to disaster economics was controversial. After years of refinement and evaluation, the method gained acceptance as a reliable way to measure non-market value. In risk assessment, this non-market value is referred to as intangible damage (Rogers et al., 2019). However, the application of non-market valuation in risk assessment – particularly for informing decision-making agencies in risk management – remains relatively new (Rogers et al., 2019).~~

~~To distinguish tangible losses and other direct tangible damages, financial impacts were set aside to focus on psychological impacts (e.g., Foudi et al., 2022). This distinction was made clear during the interviews, where respondents' willingness to pay to alleviate psychological and mental burdens during floods was explicitly separated from the tangible losses they had experienced. Additional factors related to intangible damage were then collected from respondents who were willing to participate.Tangible flood damages refer to the impacts on the financial and economic conditions of structures exposed to flooding, whether directly or indirectly (e.g., Kabirzad~~

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et al., 2024). In contrast, intangible damages relate to the psychological effects experienced by people exposed to floods impacting their homes or business premises. These effects include enduring unprecedented experiences such as losing possessions, impacts on physical health, disruptions to livelihoods, or even the loss of loved ones (e.g., Stanke et al., 2012; Yoda et al., 2017). The WTP method is particularly useful for valuing flood risk mitigation, as it estimates the economic value of non-market assets or services by determining the maximum amount an individual is willing to pay for them (Entorf & Jensen, 2020).

The willingness to pay (WTP) approach, a non-market valuation method, is used to quantify the economic value of psychological impacts. This method is applied in natural hazard damage assessments, particularly for evaluating psychological and mental health effects. Since the late 20th century, studies have employed contingent valuation methods, though their initial application to disaster economies was controversial. After years of refinement and evaluation, the method gained acceptance as a reliable way to measure non-market value. In risk assessment, this non-market value is referred to as intangible damage (Rogers et al., 2019). However, the application of non-market valuation in risk assessment—particularly for informing decision-making agencies in risk management—remains relatively new (Rogers et al., 2019).

While the open-ended WTP format is subject to uncertainty and bias, it remains valid for revealing factors that influence respondents' ability to pay(Donaldson et al., 1997; Hanley et al., 2009) . The WTP approach is used to quantify the value individuals place on reducing impacts to human health (Frew et al., 2004). Before employing this method, it is essential toRespondentsprovide respondents with information on mental health issues and to explain the disaster's effects on well-being, particularly stress and anxiety (Semrau et al., 2016). This approach allows flood victims to understand their mental health concerns and express their perceived values through their stated WTP (Markantonis et al., 2012).

The survey began with a dichotomous choice questionmitigation. Respondents who answered "yes" were then asked how much they were willing to pay. Those who were unwilling to pay were asked to provide their reasons.

Data Collection Process and Respondent Feedback

Respondents who answered "yes" were then asked how much they were willing to pay.

Respondents who answered "yes" were then asked with an open-ended question on how much they are willing to pay. Those who were unwilling to pay were asked to provide their reasons. The other considered information that could be a factor in the intangible damage. The data was collected from the respondents who were willing to participate. It was obvious that most of those who refused to pay were because of disagreement with the payment vehicle—they argued that investment in flood measures should come from the government and not from the people. Such a protest bid is common in social studies where people are given the choice to either participate or not in interviews. Exclusions of protest bids are also necessary to reduce bias in the analysis. The,afactor,was were

Commented [BBMR24]: What is the 'flood risk mitigation' that your study used when asked the people their WTP?

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Despite these efforts, obtaining positive respondent engagement on the issue and eliciting valuations for psychological impacts proved challenging and, in some cases, sensitive. When asked about their willingness to make a monetary contribution to safeguard themselves from the psychological effects of flooding, some agreed while others did not. Respondents who declined shared reasons such as: insufficient income, the belief that it is the government's responsibility, a lack of trust, and the perception that flood impacts were not severe. The survey successfully evaluated various factors essential for assessing flood-related intangible damages.The present study elicited the monetary value of psychological impact from respondents to better understand and address future flood impacts. The elicited value is assumed to represent the economic value of the health impact, based on respondents' flooding experiences and their recollection of its effects on their health. Theis value price of WTP is presented as an absolute figure in US dollars (US$) for each flood event. Furthermore, the results were adjusted for the inflation rate using the Malaysian Consumer Price Index calculator to maintain consistency and comparability across different periods (Malaysia CPI Inflation Calculator, 2021). -Furthermore, the results were presented as an absolute figurevalue in US dollars (US$) for a flood event. Information on the selected variables for the multivariate analysis, such as building types, income level, etc. of the respondents was then collected. All information was stored using an online standard form, including the coordinates of the building's location where the interview took place.

The collected information of the WTP represents the anxiety and stress at their personal level related to the businesses that they are managing, and the stress and anxiety stemming from impacts on productivity and disruption of sales, etc., manifested from the condition of flood events that they are in. For example, concerns about employees' well-being, which affects daily operations and services (Lekuthai and Vongvisessomjai, 2001). Whilst the description is not exhaustive and re are overlapping pathways of intangible damages on individuals and the businesses that they own or work in may be overlapped, the present study does not express a distinction. between the two as iIt is perceived that the intangible damages can be of any disturbance to the running of the businesses that cannot be monetised, whether it stems from a personal level of the business owner/worker related to the businesses, or from a more specific losses to business, such as loss of opportunity that they are stress and anxious about. Moreover, Tthe WTP does not consider economic losses that can be monetised indirectly, for example, due to business downtime, and this was made clear during the interview (e.g., Darnkachatarn & Kajitani, 2025)

TO PUT SOMEWHERE: Therefore, comparing the intangible damage assessment of the individual and the business is challenging, and they have different evidence to assess the impact.

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~~1.1~~

~~1.1 Classification of Premises~~

~~1.1 Initially, a preliminary inquiry identified individuals with prior flood experience to establish the target demographic (Poussin et al., 2015). The subsequent section addresses building attributes, including various typologies and supplementary details for residential and business premises. KTA (2003) reported that damage evaluation involved categorizing premises into several types. Residential buildings were classified as village type, terraced, or bungalow, while businesses were categorized as micro, small to medium, or large. These classifications represent the primary building structure types prevalent in Malaysia.~~

~~1.1~~

~~1.1 The categorization of business premises was based on the total number of workers, as specified by SME Corporation Malaysia (2022). Businesses with more than five permanent employees were classified as small to medium, while those with fewer than five were categorized as micro. For residential buildings, intangible damages primarily focused on personal well being, including family or self related worries, stress, and sleep disturbances. For businesses, these damages centered on concerns about employees' well being, which affects daily operations and services.~~

3.3 Data Pre-processing

~~After d~~Data that has been collected ~~ion has completed, the database~~ was filtered to identify duplicates and missing information for all variables. The data pre-processing was conducted for both types in preparing for the correlation and regression analysis. ~~The interview information was filled out online, and some interview forms were submitted multiple times. In some cases, the form was incomplete. The m~~Missing ~~value~~information was imputed with ~~a~~

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values having similar characteristics to the ones recorded (e.g., ~~(~~Rodríguez Castro et al., 2025).~~ After screening of each study site's dataset, a~~All datasets of the same type of variable from different areas were combined into a single database.~~ for assessment. The dataset's o~~ Building type, business size, the presence of elderly or children, and ownership status were treated as binary variables, whilst others as continuous variables. Outliers in all continuous variables were identified ~~winsorized~~ and ~~were~~ treated using winsorization, ~~a~~ z-test, ~~or~~ three-standard-deviation cutoff~~ for each variable~~, and ~~. Then the~~ Mahalanobis distance method~~ was also used for multivariate outlier.~~ After completing this process, the normality, linearity, and homoscedasticity were ~~evaluated~~assessed~~ to check the statistical assumptions of the data.~~ Subsequently, multicollinearity assessment between the variables ~~was checked~~ to identify highly correlated independent variables ~~and prepare~~was undertaken~~prepare for fitting~~. The regression analysis on intangible damage for residential types of buildings indicated multicollinearity between two independent factors, which are flood duration and distance from river. Therefore, the distance from river was excluded to improve the accuracy and reliability of the regression, which leaves only nine independent variables. ~~The workflow of the analysis is presented in Figure 3.~~

For the normality test, ~~the~~some dataset was first transformed to accommodate the variables in normality ~~(Svenningsen et al., 2020)~~using the ~~Some variables were~~ log or log-log transformation (Svenningsen et al., 2020)~~ed to prepare for a linear model fitting~~. For residential buildings, the datasets were log-log transformed, except for independent variables, such as building type, presence of elderly, presence of children, and ownership status. ~~However~~Meanwhile ~~,~~for commercial buildings, the datasets remained untransformed ~~(~~except for income data, which was log-transformed.~~), and o ther variables met the normality (Gaussian-distribution criteria).~~

Linearity was checked to ensure that the dependent variable is linearly related to each independent variable. Violations can reduce model accuracy, though slight deviations may be acceptable depending on context. In this case, residual plots confirmed a generally linear relationship, but some continuous variables did not meet the assumption. Another assumption is that the residuals exhibit constant variance ~~that~~ensure the absence of~~, while eliminates~~ heteroscedasticity (unequal variance), ~~whereby H~~heteroscedasticity ~~-~~can ~~cause~~ bias ~~in the~~ regression estimates and reduce predictive accuracy. ~~Uneven variance patterns, such as fan or cone shapes, indicate violations of this assumption.~~ Therefore, statistical transformation, such as logarithmic adjustment or other methods, is applied.

~~A range of variables, identified based on expert knowledge, are considered important for estimating intangible flood damage. These variables relate to flood characteristics, building factors, socio-economic characteristics, and damages to households and businesses (a full list is provided the previous section). Building type, business size, the presence of elderly or children, and ownership status were treated as binary variables. The analysis was conducted for both binary and continuous variables, and then had correlation and regression coefficients.~~ in ~~residential buildingsnineFor commercial buildings, the datasets remained untransformed (except for income data, which was log-transformed), and other variables met the normality (Gaussian-distribution criteria).~~

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~~The model's performance was evaluated using the coefficient of determination (R^2), which indicates the proportion of variance in the damage explained by the independent variables (e.g., Poussin et al., 2015). However, R^2 is not always recommended as a sole indicator of model accuracy, as it can be artificially inflated by adding more independent variables (Jarantow et al., 2023). Furthermore, a low R^2 does not necessarily indicate a weak relationship, as the statistic is heavily influenced by the variation in the independent variables (Hamilton et al., 2015). Therefore, its interpretation must always be contextualized within the specific research scope (Hair et al., 2018).~~ ~~MOVED HERE FROM SOMEWHERE ELSE, please restructure the entire content of this section:~~ ~~The data underwent outlier treatment using skewness and a three-standard-deviation cutoff, followed by necessary preparation before model fitting. To ensure no data fell outside the acceptable range, further cleaning was performed using the Mahalanobis distance method. This included transformationsto accommodate non-Gaussian variables in their original form(Svenningsen et al., 2020) . For residential buildings, the datasets were log-log transformed, except for categorical independent variables such as building type, presence of elderly residents, presence of children, and ownership status. For commercial buildings, the datasets remained untransformed (except for income data, which was log-transformed), as the other variables met Gaussian-distribution criteria. Microbusinesses were defined as those with fewer than five employees, while small-to-medium enterprises (SMEs) were classified as having up to 30 permanent full-time employees.~~

~~Despite these efforts, obtaining positive respondent engagement on the issue and eliciting valuations for psychological impacts proved challenging and, in some cases, sensitive. When asked about their willingness to make a monetary contribution to safeguard themselves from the psychological effects of flooding, some agreed while others did not. Respondents who declined shared reasons such as: insufficient income, the belief that it is the government's responsibility, a lack of trust, and the perception that flood impacts were not severe. The survey successfully evaluated various factors essential for assessing flood-related intangible damages.~~

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~~Analysed Variables~~

~~of~~~~A total of ten explanatory variables were used to analyze the outcome variable: intangible damage to households and businesses. The absolute value of this damage, originally estimated in Malaysian Ringgit (MYR) and converted to US Dollars (USD), was the focus of the analysis. The study aimed to assess damage using multiple variables; this assessment may cover some recovery costs but not the complete recovery process, which is a distinct and important topic in disaster management. Consequently, flood recovery presents a valuable direction for future research.~~

~~A range of variables, identified based on expert knowledge, are considered important for estimating intangible flood damage. These variables relate to flood characteristics, building factors, socio-economic characteristics, and damages to households and businesses (a full list is provided in the previous section). Building type, business size, the presence of elderly or children, and ownership status were treated as binary variables. The remaining variables were continuous and used for correlation and regression modeling.~~

~~The regression analysis on intangible damage shows indicated the presence of multicollinearity among the twobetween two independent factors: flood duration and distance from the river. Thise presence of multicollinearity poses a significant concernsconcern for about the precision of the results. Therefore, the distance omission of distance from the river was omitted necessary to improve both the accuracy and reliability of the results obtained from the regression analysis.~~

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~~The model's performance was evaluated using the coefficient of determination (R^2), which indicates the proportion of variance in the damage explained by the independent variables (e.g., Poussin et al., 2015). However, R^2 is not always recommended as a sole indicator of model accuracy, as it can be artificially inflated by adding more independent variables (Jarantow et al., 2023). Furthermore, a low R^2 does not necessarily indicate a weak relationship, as the statistic is heavily influenced by the variation in the independent variables (Hamilton et al., 2015). Therefore, its interpretation must always be contextualized within the specific research scope (Hair et al., 2018).~~

~~1.3. Relation of income and business size with WTP~~

~~1.1 The present study elicited the monetary value of psychological impact from respondents to better understand and address future flood impacts. The elicited value is assumed to represent the economic value of the health impact, based on respondents' flooding experiences and their recollection of its effects on their health. This value is presented as an absolute figure in US dollars (US$) for each flood event. Furthermore, the results were adjusted for the inflation rate using the Malaysian Consumer Price Index calculator to maintain consistency and comparability across different periods (Malaysia CPI Inflation Calculator, 2021).~~

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~~In order to assess how the monetary value of WTPs varies according to income categories and business sizes, samples were sorted according to income levels and business sizes of respondents. Residents were divided into three socio-economic groups: B40 (bottom 40%), M40 (middle 40%), and T20 (top 20%). The B40 group included those earning less than US$11302 per month, the M40 group covered incomes between US$1130 and US$2553.45 per month, and the T20 group consisted of households earning more than US$2553.45 per month. This classification followed national standards and previous research (e.g. Kabirzad et al., 2024), but remains open to revision as socio-economic conditions change (Department of Statistics Malaysia, 2020). Businesses were categorized into micro and small businesses based on the number of full-time permanent employees. Micro businesses were defined as having fewer than five employees, while small businesses included those with five to thirty employees (SME Corporation Malaysia, 2022).~~

~~The data visualization methods, such as bar charts, were used to analyse patterns of flood exposure and the extent of damage across different income groups. The study concentrated on assessing whether lower-income households and small businesses suffered high risks and greater intangible losses, especially in terms of psychological health effects and interruptions to business operations. The result aimed to offer empirical evidence to target flood mitigation measures and mental health assistance for at-risk communities.~~

~~1.9.~~3.4 ~~Regression~~Regression Analysis and Model Specification

After the pre-processing of datasets was completed, ~~A m~~multivariate regressions were performed ~~analysis was performed~~ to explore the relationship between intangible flood ~~intangible~~ impacts in terms of victims psychological burdens and the ~~multiple~~ considered factors. ~~Samples were treated based on statistical assessments such as of~~normality, linearity, and collinearity ~~skewness and standard deviation, where outliers with extreme values were winsorized, before the regression. The explanation for the assumption of the statistical assessment is provided in the previous section. The data was also transformed (e.g., Svenningsen et al., 2020) to accommodate non-Gaussian variables in their original form. For residential buildings, the dependent and independent variables~~

[2] ~~US$ values have been exchanged from Malaysian currency (MYR) used in the Survey(s).~~

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~~were log-transformed, except for categorical independent variables, such as building type, presence of elderly residents, presence of children, and ownership status. For commercial buildings, only the income variable was log-transformed, and other variables met the Gaussian distribution criteria.~~

~~The~~The ~~regression models produced coefficients for all significant variables, with equations designed to assess predictors of intangible flood damages.~~ These models enabled the identification of key factors contributing to damage severity related to the three group of factors: flood characteristics, building types, and socio-economic conditions ~~among different socio-economic groups~~ (Lee, 2020). The regression analyses ~~related to statistical significance~~ for this study ~~employed~~ considered ~~different~~ three significance thresholds, such as 10%, 5% and~~or~~ 1 % (e.g., Lamond et al., 2015).

Table 1 presents the detail descriptions of explanatory variables considered. ~~The regression models included both categorical and continuous variables to conduct a thorough analysis of the variables impacting intangible damage (Tab 2Tab 1). Variables such as building and household attributes, including size and distance from rivers, were assessed alongside socioeconomic indicators like income and length of residence (Kabirzad et al., 2024).~~ The goal of the analysis ~~was~~ is to identify predictors that ~~significantly~~ statistically influenced the psychological ~~condition~~ burden of respondents ~~in the face~~ due ~~of~~ to flood events. Meanwhile, standardized coefficients β ~~were~~ utilized to determine the relative significance of each predicting variable (x) , allowing for comparison of their effects on intangible damages (Y). The final models include error (**ϵ**) terms that address unexplained variations. These models were expressed as general equations (equation ~~xx~~1), encompassing all essential variables to ensure reproducibility for future research investigating flood impacts in comparable settings (Svenningsen et al., 2020).

$$Damage(Y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k + \epsilon \ldots . 1$$

~~Include the equation here~~

Table ~~2~~1. The independent variables were used in the multiple regression assessment.

Explanatory Variables	Description	Multivariate analysis
Flood characteristics		
Flood depth	Water depth inside the building from the ground floor, range residential (0.3-2m), business (0.3-1.6m)	Continuous variable
Flood duration	Water duration stays around the house during the day, ranging (1-14 days)	Continuous variable
Building or business characteristics		
Building type (low-cost type, Terrace, Bungalow)	Low-cost, terrace or bungalow	Dummy variable (Low-cost house = 0, Terrace & bungalow =1)
Business size	The micro or small-medium business premise	Dummy variable (Micro = 0, Small to medium = 1)

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Distance from River	Distance of building from the fluvial flood stream, residential(15-1307m) and business(5-1250m)	Continuous variable (meter)
Socioeconomic conditions		
Family Size	Number of members in the household or family (1- 12 persons)	Continuous variable
Ownership	Tenant or owner	Dummy variable (Tenant = 0, Owner=1)
Income (family/Business)	Average monthly income per household or revenue per premise ~~of;~~ residential (from US$122 and more than US$2,554) ~~MYR500-10,000)~~ and commercial (Micro up to US$ 73,307- Small-medium US$ -7,333,170)~~(MYR500-20,000)~~	Continuous variable
Year of living or business operation duration	Number of years the respondent lives in the area or operated a business in the area (1-64Yrs).	Continuous variable
Having children	With children or not.	Dummy variable (Without children under 14 years old = 0, with =1)
Having elderlies	Households with the elderly.	Dummy variable (Without elderly above 65 years old = 0, with =1)

The model's performance was evaluated using the coefficient of determination (R^2), which indicates the proportion of variance in the damage explained by the independent variables (e.g., Poussin et al., 2015). However, R^2 is not always recommended as a sole indicator of model accuracy, as it can be artificially inflated by adding more independent variables (Jarantow et al., 2023). Furthermore, a low R^2 does not necessarily indicate a weak relationship, as ~~the~~ statistically it is heavily influenced by the variation in the independent variables (Hamilton et al., 2015). Therefore, its interpretation must always be contextualized within the specific research scope (Hair et al., 2018).

~~**Independent variables were assessed for multicollinearity, and the regression model also regression model confirmed that the models met statistical assumptions(normality and homoscedasticity). Standardized coefficients were utilized to determine the relative significance of each predicting variable, allowing for a comparison of their effects on intangible damages. The final models include error terms to address unexplained variations. These models were expressed as general equations, encompassing**~~

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all essential variables to ensure reproducibility for future research investigating flood impacts in comparable settings (Svenningsen et al., 2020).

3.4 Results

The results are presented in three stages; first, Section 4.1 elaborates on respondents' characteristics and some of the general feedback from respondents, the face-to-face interviews in Section 4.1. Second, Section 4.2 examines the variations in intangible damages aacross key determinant variables in monetary intangible losses across determinant variable in Section 4. .2 Lastly, Section 4.3 presents a multiple regression analysis to identify decisive factors of intangible damage. in Section 4.3

The results are presented in two parts: The first is to understand the variations of monetary intangible losses over the determinant variables, and the second is on the analysis of multiple regressions.

4.1 Respondents' responses and characteristics and responses SIN!

A total of 380 respondents were approached, of whom 217 provided valid responses. Eliciting monetary valuations for psychological impacts proved challenging, particularly when respondents were asked about their willingness to pay (WTP) to reduce flood-related psychological distress. Despite the use of a sequential and tailored interview approach to build respondents' trust, some participants expressed disagreement when asked about their willingness to make monetary contributions to safeguard themselves from the psychological effects of flooding.

Of the valid respondents, only 141 responses (107 residential and 34 businesses) expressed willingness to pay for disaster risk reduction measures, while 76 respondents (35%) stated zero WTP or refused to contribute. Common reasons included limited income, the belief that flood mitigation is the government's responsibility, lack of trust, and the perceptions that flood impacts were not severe or were primarily emotional. Such "protest zero" responses are common in contingent valuation studies for flood reduction measures (e.g., (Brouwer et al., 2009; Jones et al., 2015), and are typically excluded to reduce bias (Foudi et al, 2022). In this study, zero WTP responses were excluded to focus on identifying the drivers for the non-zero range of WTP. Furthermore, WTP was used as a proxy for the intangible damage, which is unlikely to be zero in the context of damaging flood events.

Despite these efforts, obtaining positive respondent engagement on the issue and eliciting valuations for psychological impacts proved challenging and, in some cases, sensitive. When asked about their willingness to make a monetary contribution to safeguard themselves from the psychological effects of flooding, some agreed while others did not. Respondents who declined shared reasons such as: insufficient income, the belief that it is the government's responsibility, a lack of trust, and the perception that flood impacts were not severe. The survey successfully evaluated various factors essential for assessing flood-related intangible damages.

Despite the efforts, getting the respondents' positive response to the issue and in valuing the psychological impacts proved to be challenging and even sensitive to some. Most respondents were from residential buildings, with fewer businesses represented due to limited commercial activity in the surveyed regions. When they were asked

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about their willingness to contribute monetarily to safeguard themselves from the psychological effects by flooding, some expressed their contribute, and others did not. Respondents also shared their reasons for not contributing, such as: "I do not have enough income," "It is the government's responsibility," "I cannot trust anyone," and "The flood impact is not very severe" The survey evaluated various factors essential for assessing flood-related intangible damage.

Most respondents were from residential buildings, reflecting limited commercial activity in the study areas. Local information indicated that several flood-affected businesses had permanently relocated to safer locations. Time constraints and demanding schedules also limited participation among business owners, resulting in excessively long waiting times and limited interviews. Consequently, the dataset is dominated by residential respondents. Given the difficulty of collecting socio-economic and psychological data, data validity relied partly on expert judgment.

Engaging with the business sector was challenging because of their demanding schedules. Most business operators were unavailable due to time constraints and excessively long wait times. Additionally, some businesses that suffered flood damage had relocated permanently to safer areas. Consequently, the majority of the interviews were conducted with residents of the residential buildings.

Within the capacity of the study, 380 face-to-face interviews were successfully conducted. From the total, 217 were valid responses. Out of the 217 respondents, only 141 (107 residential and 34 businesses) expressed willingness to pay for disaster risk reduction measures to reduce their psychological distress. The remaining 76 respondents denied the willingness to pay for different reasons.

Tab.1 shows summarises the number of buildings, both residential and business respondents, where households and business owners were interviewed. Forty-twoForty-four percent (44%) of residential respondents and sixty-seven percent (67%) of business respondents were only from the Kota Bharu (Kelantan) study area, where terrace buildings constituted the majority, accountingaccounted for almost nearly 40% of the totalall buildings, followed by low-cost housinges. The tRespondents from the the Segambut district of Kuala Lumpur were minimalfew, and primarily mostly livingresided in terrae and terraces and low-cost houses. This indicates that respondents from theIn Kajang and Dengkil area of Selangor and the Kota Bharu district of Kelantan, most respondents also lived reside in terrace buildinghouses, while typesKota Bharu district respondents were more evenly distributed across building types.

. In theAmong business premisesrespondents, the predominant type of businesses is micro-sized enterprisesenterprises (76%), followed by smallsmall to medium-sizedmedium businesses. The small-to-medium size represents businesses (SMEs), which accounted forsmall-to-medium businesses (SMEs) represented 24% of the study sample, while micro-businesses comprised the remaining 76%. The Kota Bharu study site recorded the highest flood depths for both residential and commercial buildingsbusiness premises, largely attributed to a significant the major flooding event in 2014. Although tThe case study sites and flooding events occurred in different years, but these locations have experienced severe flooding in different years, all locations have been severely affected by flooding over the past decade. , affecting both residential and business.

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Commented [SK42R41]: I have provided the reasons in the places for those reasons why they were not willing to pay. The people did reject the questionnaire but they were not willing to pay. IT is different they those who did not want to participate in the interview.

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Table ~~1~~2. Summary of the respondents in residential and business premises categories across the study sites

Study Site	Respondents' flood-year experiences	Bungalow	Terrace	low-cost	Total	Micro	Small-medium	Total
		Residential building type				Business Type		
Segambut	2010-2020	2	8	17	27	2	2	4
Kajang & Dengkil	2020	5	21	9	35	6	1	7
Kota Bharu	2014	16	14	15	45	18	5	23
Total respondents (%)	Sample size	23 (21%)	43 (40%)	41 (38%)	107 (100)	26(76%)	8(24%)	34 (100)

Variations in intangible damage across residential households and businesses were analysed in terms of income groups, business size, and the distance from the river using both total and average WTP values. Total values refer cumulative WTP within each category. Meanwhile, the average values represent the mean WTP. Comparisons across income groups are presented in Figures 4 and 5.

~~3.2.~~4.2 ~~Intangible Damages~~ Variations in Intangible Damages ~~a~~Across ~~over~~ Determinant Variables

Bar charts were used to examine patterns of flood exposure and intangible damage across income groups and business sizes. The analysis focused on whether lower-income households and micro businesses experienced greater exposure and demonstrated higher WTP to reduce psychological impact. Intangible damage was assessed using both total and average WTP across income groups, business size, and buildings' distance from the river categories. ~~The data visualization methods, such as bar charts, were used to analyse patterns of flood exposure and the extent of damage across different income groups. The study concentrated on assessing whether lower-income households and small businesses suffered high risks and greater intangible losses, especially in terms of psychological health effects and interruptions to business operations. The result aimed to offer empirical evidence to target flood mitigation measures and mental health assistance for at-risk communities.~~

Figure 3 presents that most residential respondents belonged to the bottom 40% (B40) income group, followed by the middle 40% (M40) income group, while the top 20% (T20) group had the fewest respondents. Given that the interviewed people are randomly approached based on the criteria of their building's proximity to rivers, this distribution highlights the disproportionate exposure of lower-income households to flooding. Only 13 and 5 respondents belonged to the M40 and T20 groups, respectively, compared with 86 respondents from the B40

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group. Average WTP value ranged from US$46.6 to US$186.4 across all income groups. While the B40 group recorded the highest total losses due to its larger sample size, median WTP values per household were comparable across all income groups.

Figure 4**Error! Reference source not found.** presents results for the business premises. Micro businesses were more exposed to flooding than small to medium businesses, reflected in a larger sample size (24 versus 7). Micro businesses also showed a higher total WTP value, largely due to their greater representation. However, the median WTP value was similar across business sizes, consistent with finding for residential households. This suggests that lower income or smaller business size does not necessarily imply significantly lower WTP.

Residential households reported higher intangible losses than businesses, reflecting their greater perceived need for interventions to reduce psychological and mental effects associated with flooding. However, comparable median WTP values across income and business size categories indicate that income alone cannot be identified as a decisive factor based on single-variable analysis. These findings may change with a larger sample size, highlighting the challenges of collecting data from flood-affected populations. While descriptive analysis provides useful insights, multivariate analysis is required to identify key determinants of intangible flood damage.

~~Intangible damages variations from the residential sector were analysed according to income groups and intangible flood damages. The results show that most respondents with flood experiences are in the bottom 40% (B40) income group, highlighting their vulnerability to floods. The middle 40% (M40) income group has the second-highest exposure level, while the top 20% (T20) group demonstrates significantly lower exposure. Additionally, the sample sizes for the M40 and T20 groups are far smaller than for the B40 group. For instance, there are only 13 and 5 respondents from the M40 and T20 groups, respectively, compared to the B40 group. The B40 group incurred relatively higher total damages than the other income groups. However, the average damages across all income groups for intangible losses are within the range of USD 46.6–186.4, as shown in Fig 3. The maximum value is from the T20 group, reflecting a larger contribution from high-income households. Interestingly, the B40 group shows slightly lower average damages than the other income groups. This is opposed to findings from another study, which observed that high-income households typically incur less damage (Abdullah et al., 2019).~~

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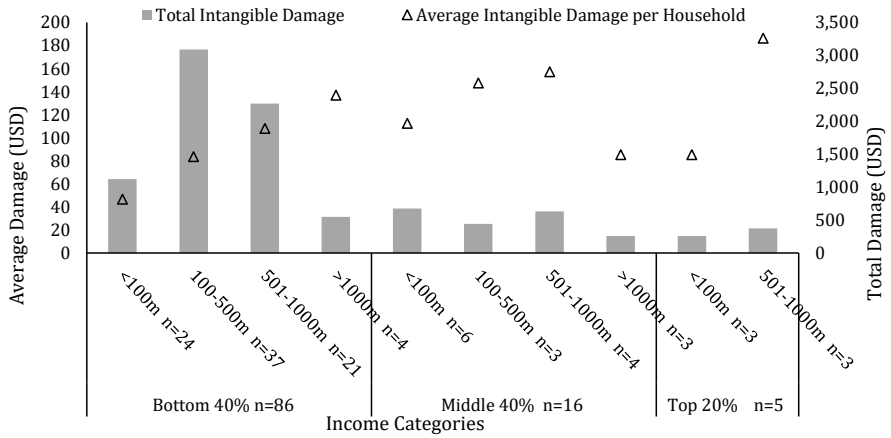

Figure 33. A comparison of the total and average values of intangible damages was conducted across income groups, distance ~~from river~~from the river categories, and the number of samples (n).

~~Figure 4 illustrates the total and average damages reported by respondents from the business sector, categorized by the size of their business premises. The results indicate that micro-sized businesses incurred relatively higher total damages than small-medium-sized businesses. This finding is supported by Kreibich et al. (2010), which suggests that micro-sized businesses implement fewer precautionary measures to mitigate asset damage, making them more susceptible to higher damages. It is worth noting that the magnitude of intangible damage for small-medium-size businesses could vary if a larger proportion of respondents were from this category. Additionally, micro-sized businesses experienced higher damage per premises unit, with most of these businesses located between 501 and 1,000 meters from the flooding source.~~

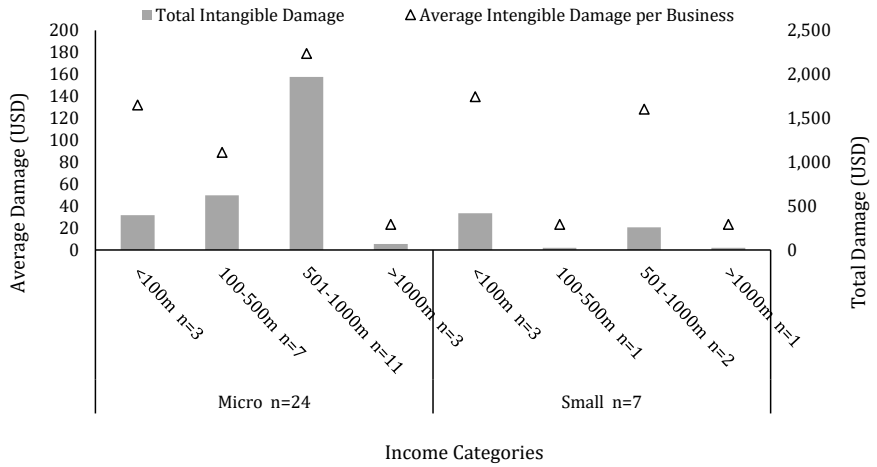

Figure 44. Intangible damage assessment of business premises considering income categories, distance from the river, and the number of samples (n)

~~When comparing residential and business losses, residential properties suffered more intangible damages. This reflects their increased susceptibility to flooding, as highlighted in the Department of Statistics' Special Report on flood damages (Prime Minister Department, 2022).~~

~~3.4.~~4.3 ~~Multiple~~Multiple Regression Analysis of Intangible Damages

This section presents results of multivariate regression for residential and business sectors, examining building characteristics, socio-economic factors, and flood attributes influencing WTP. The objective is to identify the relative strength and significance of intangible damage drivers.

~~The results for multiple regression of the considered factors with intangible damages are distinguished between the residential sector and the business sector.~~

~~3.4.2.~~4.3.1 Residential Building Intangible Damage ~~Regression Analysis~~

Table 1~~Table 3~~ presents the correlation matrix between intangible damage and explanatory factors. Most variables show a positive association with intangible damage at ~~, through~~ varying levels of significance. Flood durations, family sizes, and building types are ~~statistically significant at 5% or 10% level and~~ positively correlated with intangible damage with significance level at 5 or 10%. The relationships are intuitive; longer flood duration increases distress. A similar result was found in a previous study that flood duration has a positive contribution to flood loss (Czajkowski & Cunha, 2020). ~~, and s~~Similarly, the larger the number of family members, the greater the anxiety level and therefore ~~flood impact.~~the positive relationship with WTP. A large family do contribute to greater anxiety during floods according to Babcicky et al. (2021), where there will be greater responsibilities that they have to bear.

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Flood depth and proximity to rivers are not found to be statistically significant to explain the WTP for reduction of intangible damage. However,

Pprevious studies have ~~also report correlations between flood damage and variables, such as flood depth, household age, building type, and ownership(Babcicky et al., 2021). The study illustrated~~ found that flood depth and residence in proximity to rivers can be~~is found to be~~ statistically significant explanatory variable to intangible flood damage (Lamond et al., 2015;~~)~~ ~~. Lower-income families typically reside in lower-cost houses. Individuals of lower socio-economic status living in proximity to the river demonstrated relatively higher vulnerability and experienced greater health impacts(~~ Babcicky et al.,2021)~~. Moreover, previous studies in Peninsular Malaysia have used flood depth as a key indicator to evaluate tangible flood damage (Rehan & Yiwen, 2023; Kabirzad et al., 2024, Fadhil et al., 2025). Another counter intuitive finding from the present study is that ~~. . Lower-income families typically reside in lower-cost houses.~~ families are willing to pay for psychological health that but not defined by their income level. The findings of income level as an insignificant variable to explain the WTP is quite similar to some studies. For example, Ghanbarpour et al., 2014 and Yusmah et al., 2020 show that the middle-income households are more willing to contribute to flood prevention measures, whilst higher-income households are less responsive. Results from the present correlation matrix also indicate that other socio-economic characteristics are also not statistically significant to explain the WTP. This is in contrary with what has been found in Foudi & Osés-Eraso (2022), where older individuals have a lower demand for protection despite being financially vulnerable. ~~I~~

~~presents the correlation matrix, which examines the relationship between intangible damage and each independent variable in terms of direction and strength. The results indicate that there is an association between intangible damage and the explanatory factors considered for households. The majority of the variables exhibited positive correlations with varying levels of statistical significance, as indicated by the correlation coefficients. In the case of intangible damage, three explanatory factors were statistically significant at a 10% significance level. These factors include flood duration, household family size, and building type. Flood duration and family size variables are statistically significant at the 5% significance level, while building type demonstrates statistical significance at the 10% level.~~

Table ~~1~~3. Correlation matrix of flood intangible damages to households with damage predictors.

	IntD	FD	FDu	BT	DfR	HC	HE	Ow	FS	In
Intangible damage, IntD	1									
Characteristics of flood										
Log (Flood depth), FD	.131	1								
Log (Flood duration), FDu [a]	.291***	.171*	1							
Characteristics of Building										
Building Type BT	.163*	.013	.128	1						

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Log (Distance from River) DfR [a]	.123	.172*	.667***	.257***	1				
Socioeconomic characteristics									
Having children, HC	.075	.023	-.230**	-.102	-.340***	1			
Having elderly, HE	-.029	.121	.089	.021	.102	-.172	1		
Ownership, Ow	-.037	.100	.071	.018	.023	-.013	.159	1	
Log (Family size), FS	.262***	-.071	-.004	-.082	-.114	.383***	-.031	-.260	1
Log (Income), Inc	.151	-.108	-.168*	.304***	-.072	.138	.044	.038	.114
Log (Living duration), LDu	-.049	.059	.057	-.321***	-.104	.094	.173	.403***	.214**

Note: *. Correlation is significant at the 0.1

**. Correlation is significant at the 0.05

***. Correlation is significant at the 0.01

[a] Distance from the river and ~~living~~ flood duration variables have multicollinearity issues

~~The intuitive nature of their positive correlation is evident. As flood duration increases, there is an associated increase in intangible damage. Other studies found that, in addition to flood depth, other variables, such as building type and ownership, are correlated (Babcicky et al., 2021). There also appears to be a positive association between the type of building and the intangible damage caused by flooding. Another study by Lamond et al. (2015) showed that household income correlated with stress or mental impact. The finding argued by (Babcicky et al., 2021) that income and building type have a negative correlation with households' mental wellbeing. Individuals of lower socio-economic status residing in proximity to the river demonstrated relatively higher vulnerability but possessed fewer material belongings. Consequently, they may experience comparatively lower losses to the residences.~~

Table 2 presents the multivariate linear regression results after addressing multicollinearity and statistically significant considerations. ~~These findings indicate that a~~Among the components examined, only two variables, flood duration and family size are ~~,~~ significant ~~ly influence the~~ explanatory variables to intangible damage ~~. These variables are statistically significant~~ at 1% significance level.~~ Flood duration has been consistently identified as statistically significant(Czajkowski & Cunha.,2020) , but family size is not (J oseph et al., 2015).~~

The results indicate that a 1% increase in flood duration leads to a 1.12% increase in WTP, while a 1% increase in family size is associated with a proportional rise of 1.5% in intangible damage. For example, adding an individual to a household can lead to a relative increase in intangible damage of approximately 12.5%. In other multiple regression studies, flood duration has been identified as statistically significant to intangible damage of residences (e.g., Czajkowski & Cunha.,2020) but not family size is not (J oseph et al., 2015).

~~. From the remaining independent factors considered, two variables, namely flood duration and family size, present a statistically significant regression in relation to intangible damage. Another study illustrated that flood duration is~~

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Think about intangible losses, wellbeing, higher exposure, income level… how are they (not necessary all) correlated?

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~~not statistically significant with mental health; however, flood depth is statistically significant in the regression model (Lamond et al., 2015).~~

~~The regression analysis results in Tab.4 indicate that among the components examined, two variables, flood duration and family size, significantly influence the outcomes of the multivariate flood study.~~

Table 24. Intangible damage multiple regression results for the residential sector. ~~Variables statistically significant at a 10% significance level for intangible damages are included.~~

Residential Sector				
	Intangible damage (R-squared = 0.231)			
Explanatory variables	Unstandardized Coefficient, B	Standard Error	p-value	Standardized Coefficient, β
Characteristics of flood				
Log (Flood duration)	0.486 1.12 [a]	0.156	0.002	0.299
Socioeconomic characteristics				
Log (Family size)	0.65 1.50 [a]	0.222	0.004	.301

[a] The value represents the percentage increase resulting from a 1% rise.

~~The coefficient of determination (R2) indicates the degree of accuracy of the regression analysis, specifically for intangible damage, with a value of 0.23.~~ The regression model for intangible damage yielded a coefficient of determination (R^2) of 0.23, indicating that ~~the variation of the dependent variable is explained by other variables. The~~ the dependent variable (i.e., the intangible damage) is explained by other variables ~~model explains~~ at 23% of ~~the~~its variance ~~in intangible damage. (R^2 =0.23).~~ Although the value of R^2 is modest, ~~this value~~ it is considered acceptable in studies of intangible flood impact (Hair et al., 2018) because ~~, and comparable with similar research (Wijayanti et al., 2017).~~ R^2 values in such contexts are often constrained by limited variability in explanatory variables (Hamilton et al., 2015) ~~However, the physical and socio-economic variables R2 is lower than 20% without flood perceiving probability (Babcicky et al., 2021). The acceptability of this value is acknowledged for intangible damage, as other studies have reported similar findings, such as an R^2 value close to 25% (Wijayanti et al., 2017).~~ In some research fields, an R^2 of 0.10 or lower is acceptable, as it is entirely context-dependent on the research scope (Hair et al., 2018).

~~Correlation results indicated a positive relationship between flood duration and intangible damage, as well as between family size and damage. Flood duration and intangible flood damage were positively correlated (Lamond et al., 2015). Regression results Specifically, indicate that a 1% increase in flood duration leads to a is associated with a 1.12% increase in willingness-to-pay WTP. The flood duration is a key parameter in quantitative evaluations of intangible damages health impacts caused by flooding. Similarly, The regression results demonstrated that a 1%~~

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You should also relate the low R2 to the nature of surveys and socio-economic analysis. Find from other papers how they 'justified' the low R2?

I have provided those below for the low R2.
An R^2 value of 0.25 can be considered weak. However, a low R^2 does not inherently indicate a weak relationship, as its value is heavily influenced by the variation in the independent variables (Hamilton et al., 2015). In some research fields, an R^2 of 0.10 or lower is acceptable, as its interpretation is entirely context-dependent on the research scope (Hair et al., 2018)

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Commented [BBMR46]: This sentence does not make sense to me because you already incorporate a range of variables prior to this analysis – but they are all not statistically significant and have to be removed! Please revise this sentence so it doesn't backfire what you have actually done in your study.

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~~increase in family size is associated with a proportional rise of 1.5% in intangible damage. For example, adding an individual to a household can lead to a relative increase in intangible damage of approximately 12.50%. Larger families experienced greatermore intangible impacts due to the increased willingness-to-payWTP associated with healthcare interventions.~~

~~3.4.4.~~4.3.2 Business Premises Intangible Damages ~~Regression Analysis~~

Table 3 presents a correlation matrix of business premises, where ~~, Intangible damage shows both positive and negative correlations with explanatory variables at varying significance levels. Among all ten independent variables, only seven were considered for the business regression analysis~~seven variables are considered and ;the other -variables —such as family size, having children, and/or elderly members—were ~~excluded~~not included as they are considered only for the residential building regression analysis. The results show that variables are correlated to~~.~~ intangible damage at varying significance levels. ~~In~~Income is positively correlated ~~with intangible damage~~, while years of business operation ~~show~~is ~~a~~ negatively correlated ~~relationship~~ to the intangible damage. ~~Abdullah et al. (2019) suggested that~~ It is argued that ~~more~~ experienced businesses may ~~have~~ better ~~coping~~ cope with shocks ~~Abdullah et al. (2019)~~and therefore suffer much less compared to those with less experience (Abdullah et al., 2019) ~~suggested that capacity~~. Meanwhile, ~~Meanwhile, multicollinearity was checked to identify highly correlated independent variables. Variables exhibiting multicollinearity, such as flood duration, were excluded based on correlation coefficients and the variance inflation factors.~~ analysis of multiple regression model for business premises shows that the considered variables do not adequately explain intangible damage in the business sector, with p-value above 0.1, suggesting a failure to reject the null hypothesis. ~~Among all considered variables, only income shows a statistically significant relationship with intangible damage.~~ ~~Although~~ Pprevious studies ~~have reported~~supported that ~~income~~ these variables are ~~is~~ not a significant ~~variable for~~to intangible damage ~~into~~ business premises (Czajkowski and Cunha, 2020)

~~The regression model for business premises is not statistically significant (p = 0.15), indicating that the selected variables do not adequately explain intangible damage in the business sector, suggesting a failure to reject the null hypothesis. Among all considered variables, only income shows a statistically significant relationship with intangible damage. Although previous studies have reported that income is not a significant variable for intangible damage to business premises(Czajkowski and Cunha, 2020)~~

~~Intangible damages for businesses primarily relate to employee well-being, operational disruptions, asset management, revenue losses, and recovery challenges. Therefore, comparing intangible damage assessments between households and businesses is difficult, as each context presents distinct forms of evidence for evaluating impact.~~

~~Consistent with earlier findings, residential households exhibit higher WTP than businesses. The higher WTP among residential households reflects their increased perceived need for interventions. However, comparable median WTP values across income groups and business size suggest that income cannot be identified as a decisive~~

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~~factor through single-variable analysis. It is important to note that WTP values across groups might vary with a larger sample size. This represents one of the ongoing challenges in collecting data from first-hand flood victims. Analyses were conducted on intangible flood damage to businesses through correlation and regression analysis. The analysis of intangible damage over the seven independent variables, presented in Tab.5. In the correlational analysis, the factors of years of business operation and income were statistically significant in describing the intangible damage, with a p-value of 0.1. The interaction between flood duration and the length of time (years) a company's operation suggests a significant interrelationship between these two variables. Consequently, the flood duration was excluded from the multiple regression analysis.~~

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Table 35. Correlation matrix of flood intangible damages to business with damage predictors

	IntD	FD	FDu	BS	DfR	Ow	YBO	Inc
Intangible damage (IntD)	1							
Characteristics of flood								
Flood depth (FD)	-.038	1						
Flood duration (FDu [a])	-.052	.404***	1					
Characteristics of Building								
Business size (BS)	.068	-.150	-.231	1				
Distance from river (DfR)	-.238	.322**	.424***	-.231	1			
Socio-economic Characteristics								
Ownership (Ow)	.117	.082	.007	-.028	.137	1		
Years of Business Operations (YBO)	-.320*	.348*	.530***	-.171	.350**	.201	1	
Income (Inc)	.370**	-0.152	-.171	.067	.053	.014	-.114	1

Note: *. Significant at 0.1 level
**. Significant at 0.05 level
***. Significant at 0.01 level
[a] variable was removed due to multicollinearity between the independent variables

~~The regression model for business premises is not statistically significant (p= 0.15), indicating that the selected variables do not adequately explain intangible damage in the business sector, suggesting a failure to reject the null hypothesis. Among all considered variables, only income shows a statistically significant relationship with intangible damage. Although previous studies have reported that income is not a significant variable for intangible damage to business premises(Czajkowski and Cunha, 2020)~~

~~Intangible damages for businesses primarily relate to employee well-being, operational disruptions, asset management, revenue losses, and recovery challenges. Therefore, comparing intangible damage assessments between households and businesses is difficult, as each context presents distinct forms of evidence for evaluating impact.~~

The regression analysis for business premises did not yield statistically significant results, indicating that the proposed model could not reliably predict intangible damage in the business sector. A review of the literature reveals limited empirical evidence on intangible flood damage models for business, reflecting the complexity of capturing non-market losses in the context. Data collection proved particularly challenging, as few business owners were willing to disclose information on psychological or emotional impacts. The small sample size may introduce bias and reduce the accuracy of the damage model in the business sector. On the other hand, comparing intangible damage assessments between households and businesses is difficult, as each context presents distinct forms of evidence for evaluating impact. Intangible damages for businesses primarily relate to employee well-being, operational disruptions, asset management, revenue losses, and recovery challenges.

~~Consistent with earlier findings, residential households exhibit higher WTP than businesses. The higher WTP among residential households reflects their increased perceived need for interventions. However, comparable median WTP values across income groups and business size suggest that income cannot be identified as a decisive factor through single-variable analysis. It is important to note that WTP values across groups might vary with a larger sample size. This represents one of the ongoing challenges in collecting data from first-hand flood victims. A negative correlation exists between the years the business operation and intangible damage, suggesting that older businesses tend to experience more intangible impacts. However, it has been argued that older businesses that have experienced flooding before may have a better coping capacity and preparedness to mitigate flood impacts (Abdullah et al., 2019). Businesses with lower income often possess fewer assets, leading to a reduced vulnerability to flood-related consequences.~~

Commented [BBMR51]: Why suddenly report R^2 here? Where does this come from? Businesses? This paragraph seems to be dislocated. Please revise the paragraph and how the previouse paragraphs explained the results

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~~The regression analysis of intangible damage over the seven independent variables revealed that the p-value associated with the regression model is 0.15, which exceeds the threshold of 0.05. The threshold p-value of 0.05 was used by other flood damage studies (Wijayanti et al., 2017; Svenningsen et al., 2020). This result leads to the acceptance of the null hypothesis, indicating that the factors under consideration do not significantly predict intangible damage within the business sector. This may suggest a gap in understanding how intangible impacts contribute to business losses over extended periods.~~

~~6.~~4.4 ~~Discussion~~ Effects of Sample Size

Despite the insights obtained, the analysis suggests that the current sample size may be insufficient to fully model intangible impacts across both sectors. A primary limitation is the lack of statistically significant associations in the business sector, which is largely attributable to small sample sizes. ~~This study assesses the psychological health impact of flooding — conceptualised as intangible damage — on individuals, families, and businesses. By applying a non-market valuation approach, it estimates stress, distress, and worry associated with flood events. The analysis considers a range of flood, building, and socio-economic variables influencing flood damage considered in this study range , from flood characteristics, building type, business size, and socio-economic features of the affected area. The findings of this research demonstrate that, for residential households, individual variables influence intangible economic flood losses for residential buildings and business premises. For residential, like tangible damage, fflood characteristics, building type, and socialsocio-economic variables contribute also show statisticallyly significant contributions to intangible damage. However, unlike tangible damage, the income variable does not show a statistically significant contribution to intangible damage (Kabirzad et al., 2024). A multivariate linear regression approach was employed to evaluate the contributions of independent variables and examine their associations. Multivariate analysis offers a great potential for pragmatic strategies in managing flood effects.~~

In the residential sector, while flood duration and family size were significant predictors, the distribution of the sample may result in bias and the statistically~~ly~~ insignificance of the other variables. Specifically, smaller sample sizes for middle income (M40) and high income (T20) than the B40 income group may limit the accuracy of the residential findings related to income level. Therefore, ~~Babcicky et al. (2021)~~

~~The results of the multivariate analysis were used to assess for tangible damage before assessing intangible damage. A previous~~Previous ~~studiesy for in~~ Peninsular Malaysia has ~~have~~ confirmed that flood depth ~~asis one of the~~a key physical factors providing a reliable indicator of tangible flood damage for residential buildings (Rehan & Yiwen, 2023; Kabirzad et al., 2024, (Fadhil et al., 2025). In contrast,), where its use in quantitative flood risk analysis has been widely practiced (e.g., Rehan & Yiwen, 2023). ~~However, the present study findsound that flood depth depth does not is correlatedsignificantly explain psychological health impact, as distress can be triggered~~

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Why this Citation?

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You should compared other studies that also assess intangible flood damage and what did they found related to flood depth

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by flooding of any depth. This suggests that the mere occurrence of a flood is sufficient to cause psychological stress. with intangible damage, but not significantly. Other studies found that flood depth is moderately correlated with intangible damages (Lamond et al., 2015; Czajkowski & Cunha, 2020). What was discovered in the current study is that flood duration is a statistically significant explanatory factor and, therefore, it is a reliable contributor to flood damage. This discovery has confirmed that flood duration plays a crucial role in establishing the relationship between flood features and intangible impacts. A similar result was found in a previous study that flood duration has a positive correlation with a moderatepositive contribution to the willingness-to-payflood loss, and of flood mitigation behaviour measures (Czajkowski & Cunha, 2020).

Moreover, the previous study found that among socio-economic variables, family size is a significant factor in determining tangible damage models for risk assessment for residential buildings, and this is also found to be the same for intangible damage. The findingsThe results support support the hypothesis that communities characterized by bigger family sizes have a statistically significant association with the prediction of intangible damages.that a larger family size may lead to anxiety and psychological effects associated with caregiving responsibilities, and that people need a safe place to live. The findings indicate that households with fewer members have a lower propensity to contribute towards the mitigation of intangible damage. Babcicky et al. (2021) support supported the result, stating that household composition is a contributor that household size contribut es to the psychological impact due to flooding, but it is not significant., The larger family size showed low willingness-to-pay for the mitigation measures, therefore, the result produced a lower contribution (Ghanbarpour et al., 2014). Smaller families may show lower WTP for intangible damage reduction, potentially reflecting fewer responsibilities or and limited resources for financing mitigation measures. Low contribution of willingness-to-pay from residents can cause a challenge in supporting financial resources to propose structural mitigation. Hence, the utilization of non-structural measures costs less funding and might serve as a viable option to improve

their potential in mitigation efforts.

The present study results also demonstrated that income does not affect a household's intangible damage. The analysis reveals that households' willingness to pay for addressing psychological impacts caused by flooding is not influenced by households' monthly income. The results indicate that Ffamilies appear to prioritisze addressing the mental psychological health effects on their members regardless of their wealth or income level. However, other studies have foundargued the findings that household monthly income shows statistically significant contribution to the willingness-to-pay for mitigating flood-related mental health impacts (Ghanbarpour et al., 2014; Yusmah et al., 2020). Other studies stated that the middle-income households are more willing to contribute to flood prevention measures; however, higher-income households may be less responsive (Ghanbarpour et al., 2014; Yusmah et al., 2020). The older individuals have a lower demand for protection, despite being financially vulnerable (Foudi & Osés-Eraso, 2022). The present study similarly finds higher participation among middle-income households in mitigating psychological impacts. SuchAddressing intangible damage, particularly psychological effects, may help households mentally prepare for flooding or improve their ability to cope with it. The a contribution may encourage the community-level integration integration of of multiple prevention non-

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These sentences do not explain why you think depth is not the influencing variable to intangible damage

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if you are trying to compare between influencing variables of intangible and tangible, you should dedicate one paragraph just for it. At the moment your points of discussion about the comparison between tangible and intangible is everywhere.

Commented [SK62]: By Dr.
The discussion that you wrote here about why family size result in greater intangible damage is not actually supporting the result. Furthermore, why suddenly the 'nonstructural measures'? discussion on the type of measures for reducing intangible damage can be of a paragraph on its own.

It should be that a large family size could lead to greater anxiety and psychological effects of flooding because of the bigger responsibility and people that are needing the security.

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engineering measures, although effective risk reduction enhances risk reduction strategies. This intervention is an effective additional method for flood management (Van Duivendijk, 2006). It is also cost-effective approach to managing flood risks, but requires the combined effortscoordinated action among of all stakeholders (Mishra & Sinha, 2020).

The connection and prediction of flood physical buildingfeatures, characteristics and socioeconomic conditions are also important contributors to factors, combined with the assessment of intangible damage, can contribute to the quantification of flood intangible flood damagerisk and the identification of various mitigation strategies, particularly Those that require less physical input and cause minimal environmental damage. Nevertheless, assessing intangible damages is a highly intricate activity that necessitates a comprehensive examination of the numerous elements present in flood-prone neighbourhoods. Several, highlighting the need to strengthen social resilience. Policy measures such as improved early warning systems, enhancing public awareness, and better land-use planning could significantly reduce psychological vulnerability. increased sample sizes from diverse flood-prone regions are necessary to improve model prediction and account for the heterogenous nature of these sectors. Nonetheless, this requires laborious efforts and resources to target for both the quality and quantity of sample sizes. studies have employed the willingness-to-payWillingness-to-pay technique techniques have been widely used to measure examine prevention and mitigation strategies for intangible damages (Joseph et al., 2015);,(Foudi & Osés-Eraso, 2022) revealing statistically significant contributions to the overall assessment of flood damage. The long-term psychological impacts underscore the necessity for implementing effective mitigation strategies to alleviate these effects on vulnerable populations.The findings indicate that residents in Kelantan face higher flood risksThis suggests that the WTP values may be influenced by emotional response to past events. Emotion-driven valuations may bias stated preference estimates and were therefore excluded from the final analysis, consistent with previous methodological recommendations (Joseph et al, 2015),. driven by family social and household conditions, highlighting the need to strengthen social resilience. Policy measures such as improved early warning systems, enhancing public awareness, and better land-use planning could significantly reduce psychological vulnerability.

The flood economic damage and multiple potential influencing variables were collected from various states in Peninsular Malaysia. People In contrast, respondents in the Kuala Lumpur area showed stronger interest and in support foring willingness-to-payWTP initiatives based on for flood risk reduction initiatives activities. Some Several families express a willingness to allocate part of their monthly income to mitigate flooding risks, often driven by distress and fear resulting from repeated flood experiences feelings of despair regarding their ability to survive future floods.between 2010 and 2020. This suggests that the WTP values may be influenced by emotional response to past events. Emotion-driven valuations may bias stated preference estimates and were therefore excluded from the final analysis, consistent with previous methodological recommendations (Joseph et al, 2015). Conversely, Additionally, some households have implemented property-level structural mitigation measures to reduce the risks. rRespondents in Kelantan often exhibit strong religious beliefs, perceiving viewing the impact of flooding as predetermined and beyond human control. This belief may reduce reported ey appear less distress

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Again, so many points being discussed in this paragraph. Focus only on discussing about the income level information being insufficient to explain the intangible damage, and why income level is not stat. significant to be one of the influencing variables. And also need to include what others have found related to income level to intangible damage

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and lower engagement in the WTP initiative. In addition, ed by flooding events. Moreover, some respondents displayed a lack of interest in providing informationinterviews, possibly due to diminished trust following repeated flood events a loss of trust because of the more frequent floods they have encountered in the northeastern region of across Peninsular Malaysia, .hence, they were not willing to participate in the interviews.

In most places, flooding exacerbates distress and anxiety, particularly for heads of households concerned about protecting vulnerable members, such as the elderly and children. Elderly individuals experience heightened levels of anxiety and stress as a result of flooding, especially during the night. In terms of the exposed area where the data was collected, the findings indicate that Kelantan residents live with higher flood risks due to family social conditions, emphasizing the need to improve their social resilience. To increase resilience, it is essential to implement measures such as raising awareness, enhancing early flood forecasting systems, and incorporating land-use planning.

The regression analysis for business premises did not yield statistically present study shows that the intangible damage model for businesses is insignificantsignificant results, indicating that for regression analysis andthe proposed model could notannot reliably predict the intangible damage in the business sector. After a thoroughA review of the literature reveals eview,limited empirical evidence on intangible flood damage models for few publications were found addressing business, reflecting the complexity of capturing non-market losses in the context. flood damage models,Data collection proved particularly challenging, as few business owners were willing to disclose information on psychological or emotional impacts. making it challenging to find supporting evidence in the business sector. Additionally, incorporating intangible damage into the business damage model is far more complex compared to residential intangible damage. Understanding intangible losses in the business sector proved difficult, as during observations and interviews, very few individuals were willing to provide relevant data. The smalllimited sample size for the business sector may introduce bias and reduce the accuracy of the damage model.themodel in the business sector micro-sized business may have suffered greater damage., but due to limitations of business respondents, the result could support a biased result to represent the accurate findings.

While conceptual arguments can be made regarding factors influencing psychological health impacts of flooding, this study limits its variables to those manageable within its scope. As one of the few studies attempting to quantify intangible flood damages for both residential and business sectors, it contributes preliminary evidence to this emerging field. Depending on a study's scope, future work could incorporate a broader range of social variables to better capture intangible losses.

As for the results of the present study, a key limitation is the lack of statistically significant associations for business premises, largely attributable to small sample sizes despite the efforts of the in-person interview. Nevertheless, the knowledge about the myriad characteristics of 'flood damage receptors' can influence the intangible economic losses in the business sector. Future studies can look into detailing the determinants, such as (1) the respondent's job title, (2) the type of products or services offered, and (3) the nature of business models (e.g., using an online platform to sell products more than physical) (Joseph et al., 2015;Guntu et al., 2025).

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~~Consequently,~~Overall, the findings suggest that the variables and sample size used in this research are insufficient to fully model~~the~~ intangible impact ~~in the~~ on the business sector cannot be effectively modelled using a multivariate approach. ~~Methodological refinements are therefore necessary, although challenges remain due to the heterogeneous nature of business. The flood's intangible damage cannot yet be effectively predicted using the multiple variables on businesses. In addition to psychological stress, businesses may experience substantial intangible losses The model for intangible damage to businesses failed to reject the null hypothesis, the independent variables do not significantly predict intangible damages. The results highlight the challenges in obtaining reliable and greater returns from respondents to assess the intangible flood damage in business premises.include cultural loss, ecosystem damage, environmental loss, loss of memorabilia, trauma, and loss of trust (Hammond et al., 2013; Nafari & Mendis, 2018; Olesen et al., 2017). These represent other types of intangible damage that can be considered in future research.~~

~~Finally, the smaller sample sizes for middle income (M40) and high income (T20), are lower than the B40 income group, it may introduce biased results and limit the accuracy of the residential findings. The zero WTP respondents limited the multiple variables' contribution, which may lead to present bias results. These limitations need to be considered when interpreting the findings.~~

~~Conclusion.~~

5 Conclusion ~~and recommendation~~ recommendations

This study assesses the psychological health impact of flooding — conceptualised as intangible damage—on residences and businesses. By applying a non-market willingness-to-pay approach, the present study estimates the monetary value of stress, distress, and worry associated with flood events through face-to-face surveys at selected ~~flood prone~~flood-prone locations. The aim is to ~~highlighting~~highlight a critical need to strengthen social resilience by identifying key variables. The analysis hypothetically suggested that building characteristics, socio-economic conditions, and flood characteristics are vital contributions to intangible damage. The findings show that for the residential sector, family size contributes to shaping psychological impacts, as larger households tend to receive greater intangible losses. Moreover, ~~Furthermore,~~ flood duration emerged as a key contributor to intangible damage, suggesting for well-planned and effective response mechanisms in residential communities. In addition, the waiting time of victims in flooded areas and in evacuation centres should be reduced with an effective response and consolidated management from different authorities. In the business sector, while all variables considered did not yield statistically significant results, larger companies appear better able to cope with flood-related psychological impacts, suggesting that experience and adaptive capacity can reduce intangible damages.

To reduce psychological vulnerability and ~~strengthening~~strengthen social resilience, policy measures such as improved early warning systems, enhanced public awareness, and better land-use planning are essential. Timely evacuation planning and targeted protection of the vulnerable are necessary to mitigate the impacts of flood duration. These findings emphasize the value of integrating social characteristics into flood resilience planning

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through active community engagement and the development of context-specific awareness guidelines. Strengthening resilience also requires improved flood forecasting and the integration of social characteristics into planning at multiple spatial scales.

As one of the few studies attempting to quantify intangible flood damages for both residential and business sectors, this research contributes preliminary evidence to an emerging field. However, several avenues for future research remain to advance the understanding of flood risk management. Future work could incorporate a broader range of indicators alongside physical and economic variables in multivariate analyses that would better explain variations in intangible damage. Future studies could also detailing specific determinants in the business sector—such as job titles, service types, and the nature of business models—will further discern the classification and magnitude of intangible losses. However, getting participations from people through face-to-face interviews could be challenging. This emphasis the needs for coordinated efforts in managing flood damage-related data for effective proactive interventions and strategic policy decisions. ~~While conceptual arguments can be made regarding factors influencing psychological health impacts of flooding, this study limits its variables to those manageable within its scope. As one of the few studies attempting to quantify intangible flood damages for both residential and business sectors, it contributes preliminary evidence to this emerging field. Depending on a study's scope, future work could incorporate a broader range of social variables to better capture intangible losses.~~

~~the knowledge about the myriad characteristics of 'flood damage receptors' can influence the intangible economic losses in the business sector. Future studies can look into detailing the determinants, such as (1) the respondent's job title, (2) the type of products or services offered, and (3) the nature of business models (e.g., using an online platform to sell products more than physical) (Joseph et al., 2015;Guntu et al., 2025).~~

~~7.~~

~~This study conducts the analysis on intangible damages caused by flooding based on empirical data collected from multiple places in Peninsular Malaysia. Multiple variables are considered for residential and business premises, and intangible impacts were quantified based on the contingent valuation method. The analysis showed that different income groups suffered varying impacts, and flood characteristics and social variables statistically contribute to the intangible damage.~~

~~The study highlights the importance of socio-economic variables in understanding intangible flood damages, experienced by residential households and family size findings highlight the importance of considering socio-economic variables in decision-making and planning. The findings show that family size contributes in shaping psychological impacts, as bigger households tend to receive greater intangible losses. Meanwhile, flood experiences , having children, and the elderly could be priorities in the intangible damage reduction. It can also increase the resilience of the people familiesat risk, , such as childrenparticularly among vulnerable groups such as children, the elderly, and women. While in In business premises,business, larger companies appear better able to cope with flood-related psychological impact, suggesting that experience and adaptive capacity can reduce intangible damages. the micro-sized business may have suffered greater damage, but due to limitations of business respondents, the result could support a biased result to represent the accurate findings.~~

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FThe flood duration emerged as a key contributor to intangible flood damage, requiring the need for and the intangible damage relation impact on residential communities, which requires community early preparedness and an effective response mechanisms in residential communities. Timely team to evacuation planning and targeted protection of the e the vulnerable are essential. population. Planning preparedness and managing the response team during the flood would be a challenging task. Moreover, it These findings emphasizese the value of integrating social characteristics into importance of incorporating flood resilience planning through social dimensions into resilience-building efforts, such as increaseding public awareness, enhancing preparedness, and active community engagementengaging local communities. Strengthening resilience also requires improved Additionally, it underscores the importance of non-structural measures, including flood forecasting, land use planning, and the development of context-specific preparation of awareness guidelines at multiple spatial the regional and national levelsscales.

Thise present study integrates multiple variables;; however, there may be additional independent variables that could influence the intangible damages. The recovery and reconstruction indicators could provide valuable insights into intangible losses and inform both non-structural and structural mitigation measures to reduce the damage. Future studies should incorporate recovery indicators alongside physical, economic, and environmental variables in multivariate analyses to better explain variation in intangible damage. . Adding additionalAdditional samples and including respondents fromfrom otherother flood-prone regions places would in the country can also improve the prediction accuracy and model robustness.

Future studies should extend beyond the current scope of of the flood damage model, particularly in the business sector's intangible damage model. commercial premises to include other sectors To improve the accuracy of damage models in the commercial sector, others, such as agricultural, construction, and other production or services industries, whereneed to be included in the intangible damages may be substantial assessment. Flooding may have a significant psychological impact on larger companies located in flood-prone areas, which remain underexplored in existing research. .

Although the wide range of extended research avenues remains under the broader theme of flood-related intangible impact, the present study is part of a limited number of studies attempting to provide evidence of intangible flood damages to the residential and business contexts. Depending on a study's perspective, future studies can further discern the classification and magnitude of intangible losses by incorporating a wider range of social variables, thereby advancing understanding and informing more comprehensive flood risk management strategies.

Authors Contribution:

Authors Name	**Contribution**
Shabir Ahmad KabirzadS.A.K	Writing (original draft preparation, review, editing), Conceptualization, Data Curation, Formal Analysis, Investigation and Methodology, Software, Validation, Visualization

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~~Badronnisa Yusuf~~B.Y	Conceptualization, Supervision, and Methodology
~~Bakti Hasan-Basri~~B.H	Conceptualization, Supervision, and Methodology
~~Mohd E Toriman~~M.E.T	Project administration, Conceptualization, and Validation
~~Edmund C Penning-Rowsell~~E.C.P	Review

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