Extreme Weather and Real Estate:

A Case Study of the Jamaican Housing Market

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Abstract[*]

The damaging effects of extreme weather on residential real estate are concerning for many countries around the world. Results from combining hurricane and rainfall events with 16 years of data on sale prices of land, apartments and the value of mortgages across different localities in Jamaica reveal that the housing market should take urgent adaptation measures. While hurricanes play a role in reducing apartment prices, they do not affect residential housing prices and the value of existing mortgages. The study also demonstrates that extreme rainfall reduces the value of new mortgages. The results point to the importance of climate adaptation for the real estate market and property investment.

JEL classifications: Q5, Q54, Q58, D1
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1. Introduction

Disturbingly, over eight million homes globally are projected to be destroyed within the next 20 years if extreme climate events continue to increase (Seabrook, 2021). Concerns about how to adapt to the impacts of extreme weather events are likewise rapidly growing, especially in regard to the housing market. Successful adaptation, however, requires quantifying climate-induced risks and losses to strengthen adaptation policies.

Unfortunately, Jamaica, one of the most vulnerable countries in the Caribbean, is at risk of losing many homes. The country's numerous disasters have drawn the attention of researchers in not only quantifying the impact of these events but also predicting future losses and highlighting the need to implement adaptation techniques (Smith and Mandal, 2014; Burgess et al., 2018; Spencer and Urquhart, 2021; Collalti and Strobl, 2022).

One aspect of adaptation that has received very little attention, however, is the housing market. Post-disaster assessments that survey quantitative losses make is clear that this market is critically affected by extreme events. For example, in just over a decade, intense rainfall and hurricane events caused an estimated US$351 million dollars in damage residential buildings for the period 2001 to 2012 (Smith and Mandal, 2014). Moreover, heavy rains in 2021 caused by tropical storm Elsa flooded many homes and generated approximately US$6 million dollars in damage (Gibbs, 2021; Linton, 2021). Such damages may change perceptions of risk of some housing locations and thereby affect prices and possibly investment in further housing construction (Fang et al., 2021). Worryingly, there is some indication that extreme events may increase with climate change in Jamaica (Knutson et al., 2020; Vosper et al., 2020).

There is thus a need for research to quantify the impact of extreme climate events on the real estate market to accurately inform policy decisions on preparation and adaptation. As indicated above, there is no known research quantifying the impact of extreme climate events specifically on the Jamaican real estate market. Nevertheless, the cross-country study of Apergis et al. (2020) includes Jamaica as part of a panel of 117 countries and estimates a lowering of house prices as a result of natural disasters. A similar directional impact is estimated for specific countries and extreme events throughout the literature. In terms of more recent studies, Rajapaksa et al. (2016), Zhang (2016), and Atreya and Ferreira (2015) find that flooding has a dampening effect on property values in Australia, the Fargo-Moorhead metropolitan area of North Dakota and Minnesota, and Albany, Georgia respectively. Further, van Veelen (2020) reports discounted sale prices on residential properties in Orange County, Florida following the 2004 strike of Hurricane Charley. Such discounted sales would lead to significant reductions in income for property owners, as shown by McAlpine and Porter (2018), who estimated US$465 million dollars in losses for the real estate market in Miami-Dade, Florida. On the other hand, hurricanes and winter weather have been shown to increase house values, albeit in the short term, for coastal cities in the United States and for Colorado, respectively (Murphy and Strobl, 2009; Gourley, 2021).

Although the growing real estate-disaster literature has taken important steps in demonstrating the potential impacts of extreme weather events, it remains deficient in some respects. In particular, Latin America and the Caribbean (LAC) is an under-studied region, even though it is classified as the world's second most disaster-prone region (OCHA, 2020). For example, in the last 20 years, the region has experienced over 1,200 disasters, of which just over 45 percent were floods and 27 percent were and hurricanes. Within the region, Jamaica is cited as one of two countries most exposed to tropical cyclones.

A large majority of studies, moreover, focus on flooding. Although flooding is the most common type of natural disaster, tropical cyclones generate greater economic damages globally and deserve due attention as well (World Meteorological Organization, 2021), and they are not necessarily considered apart from other disasters. Apergis et al. (2020), for instance, aggregate geophysical, meteorological, hydrological, climatological, and biological disasters from the Emergency Events Database (EM-DAT). This aggregated measure fails to disentangle the impact of the main disasters affecting countries in the region. Furthermore, EM-DAT is not the most reliable database for disaster data given the different sources from which data is collected (George et al., 2021).

Jamaica is particularly useful in addressing the shortcomings of the current literature on the LAC region for several reasons. First, it is frequently struck by flooding events induced by excess rainfall, the intensity of which is predicted to increase in the future (Collalti and Strobl, 2022). Data from the Jamaican Office of Disaster and Preparedness Management show that, between 2001 and 2018, excess rainfall resulted in more than 1,000 locations across the island being affected by almost 100 flash-flood events lasting between one and 14 days. Second, Jamaica also experiences numerous hurricanes; data from the Meteorological Service of Jamaica show that the island has experienced at least 60 since 1900. Third, it is possible to separate the effects of different types of disasters on real estate values.

The main aim of this study therefore is to quantify the impact on real estate in Jamaica arising from extreme rainfall and hurricanes. To this end, an exhaustive geo-localized database on mortgage, land and apartment sale values is combined with localized rainfall and hurricane track data. The quantification produces some important findings. The average hurricane reduces apartment sale prices by at least 50 percent but does not affect the value of mortgages taken and that of residential land sales. Further, while extreme rainfall increases the value of apartments by 44 percent, it reduces the value of mortgages by roughly 15 percent but has no impact on residential land sales.

The results of this study are particularly useful for targeting economic inequality given that property ownership represents a major portion of households' wealth holdings and is a symbol of financial security (Goodman and Mayer, 2018). In addition, as the results show, extreme weather events have the potential to reduce property values, which may encourage households to become renters rather than owners and thus not financially responsible for repairs.

The rest of this paper is organized as follows. Section 3 describes the data and method of estimation. The results and their discussion are provided in Section 4. Section 5 concludes.

2. Background

Jamaica has a long history of dealing with extreme climate events, including tropical storms and intense rainfall. The first documented experience dates back to 1559, when a hurricane strike caused considerable damage to the country's infrastructure (National Library of Jamaica, 2012). Since then, the housing sector has suffered immensely. In earlier years, sources indicate that 9,000 homes were lost from Hurricane Charlie (1951), 40,000 from the Gilda floods (1973), 5,000 from Hurricane Allen (1980) and 500,000 from Hurricane Gilbert in 1988 (Norton, 1952; Reyna, 1988). The destruction caused by the hurricanes varied due to their strength, their duration and whether they made landfall.

In the last 20 years, Jamaica has experienced the effects of 15 tropical storms and more than 1,000 flooding events resulting from heavy rains. The effects of these events on housing range from minor damage to total losses, with assessments reporting high replacement costs even though most structures are built with sturdy materials. Hurricane Ivan, for example, a category 5 storm that struck in 2004, reportedly damaged over 700,000 dwellings, generating US$181 million in damages (Planning Institute of Jamaica, 2004). The majority of properties destroyed were uninsured, leaving homeowners to bear the cost of replacement and repair. In addition, eight years later Hurricane Sandy, a category 1 storm, damaged over 16,000 homes and generated over US$42 million in replacement costs (Planning Institute of Jamaica, 2013).

Government assessments of damage from rain-induced flooding are less frequent and thus more limited. Nevertheless, the 2010 flooding assessment reported over 2,169 homes being impacted by heavy rains, with more than US$3 million in damages (Planning Institute of Jamaica, 2010). Further, evidence also points to damages to homes from more recent floods occurring between 2016 and 2021 (Davies, 2016a,b,c; 2017a,b). On a cautionary note, the damage costs presented are based on estimates derived from post-disaster surveys involving residents from affected areas. It is unclear whether all affected properties were included, and so the estimates may be an understatement of the true costs.

3. Data and Methods

3.1 Data

The source for the property sales data is the Jamaican National Land Agency. This database is exhaustive for the years 2003 to 2018. These data are annual deflated individual residential land and apartment sales price and mortgage values. They are collected across the country's 14 parishes, providing at least 172,000, 15,000 and 178,000 observations for residential land sales, apartment sales and mortgages, respectively. Figures 1, 2 and 3 provide the distribution of these variables across parishes and time.

For rainfall data, the Global Precipitation Measurement (GPM) satellite mission database which provides half-hourly observations at the 0.1-degree resolution is used. Thus, high resolution rainfall averages measured in millimeters are used for the estimation. From this, excess rainfall is identified when the daily rainfall exceeds the 90th percentile of a grid's non-zero values over the period of study.

Figure 1. Distribution of Land Sales across Parishes

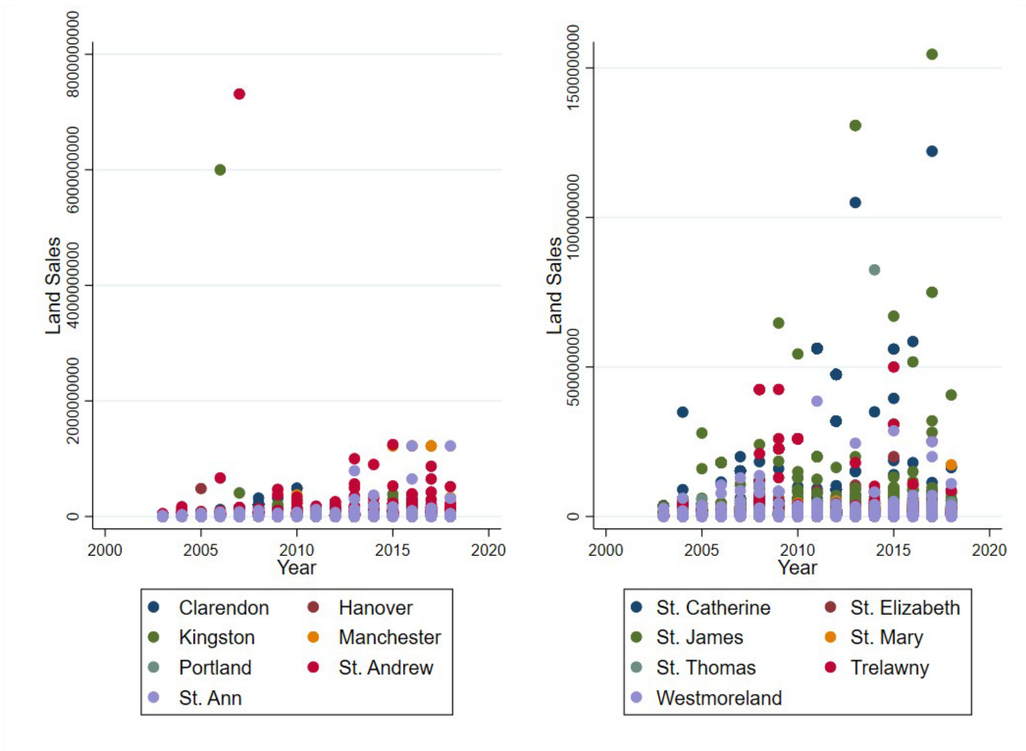


Figure 2. Distribution of Apartment Sales across Parishes

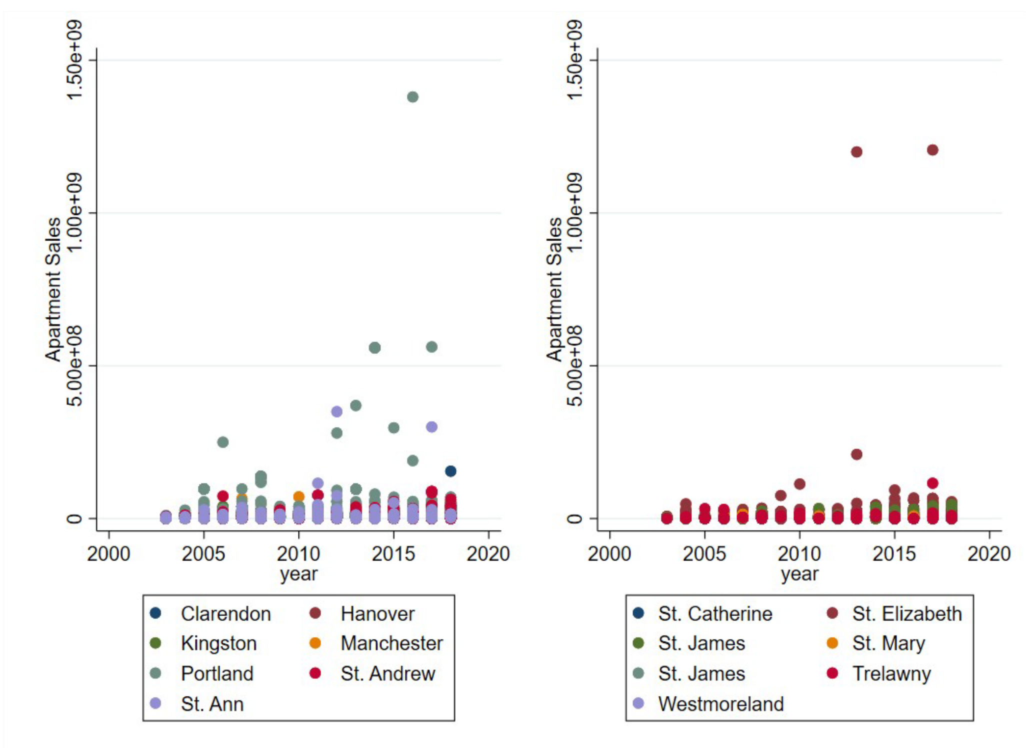
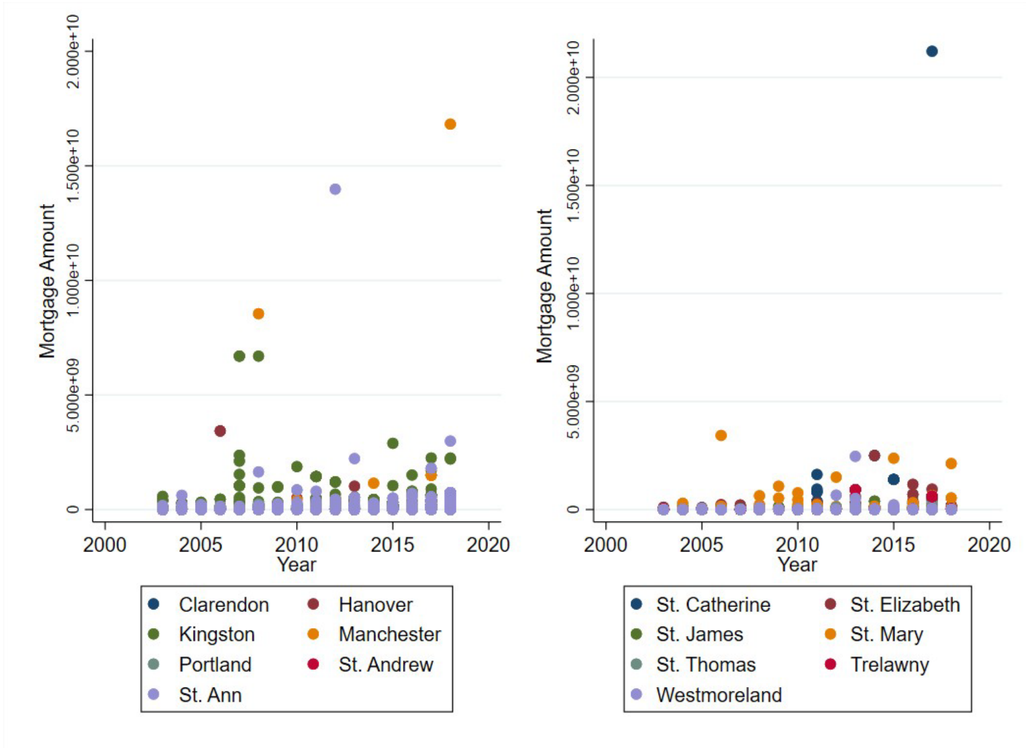


Figure 3. Distribution of Mortgage Amount across Parishes



For hurricanes, data from the National Hurricane Center's database is used with the Boose et al. (2004) form of the Holland (1980) wind field model to construct proxies of localized wind speed damage. Importantly, to convert wind speed into potential damage, the cubic power of wind speed is used since it has been established that the relationship between property damage and a hurricane varies with the cubic power (Emanuel, 2005; Strobl, 2012; Ishizawa and Miranda, 2019; Spencer and Strobl, 2019). This approach to calculating hurricane wind damages is now in the climate change literature and is regarded as advantageous since it accounts for the physical characteristics of a storm which determines the spatially heterogeneous nature of wind speeds experienced locally. This consideration is particularly important in assessing the position of residential properties relative to the storm, the maximum wind speed and movement of a storm, and whether landfall was made. Moreover, the approach is superior to using storm incidence dummies or ex post estimates of destruction (Henry et al., 2020). Consequently, a hurricane wind damage index (H) that considers how storm features impact wind speed locally is defined as:

$$H_{ijt} = \sum_{q=1}^{Q} \sum_{l=1}^{L} W_{iqlst}^{3} \qquad W_{iqlst} \geq W_{ij}^{*} \quad (1)$$

where i=1,....,I properties located in parish j=1,.....,J experience hurricanes q=1,…..,Q with lifetime of l=1,…..L. Note that W is the local wind speed and W*ˆ is the threshold above which wind power is destructive. The threshold choice is 119 km/hr, which corresponds the definition of a category 1 hurricane as defined by the well-known Saffir-Simpson Scale and has been noted by Henry et al. (2020) as the speed at which residential properties in Jamaica start to experience destruction.

3.2 Summary Statistics

Table 1 displays the descriptive statistics for the data used in the analysis. Accordingly, the average sale prices for land and apartments are $7,829,472 and $8,702,789, respectively, while mortgages taken averaged $6,499,516 over the study period. Given that the rainfall and hurricanes are location specific, these values are different for all three types of real estate. Thus, the average extreme rainfall values are 0.0203 (residential land sales), 0.0047 (apartment sales) and 0.0177 (mortgages). Finally, the average non-zero value of the hurricane indexes, that is, when they are destructive, is 0.0072, 0.0069 and 0.0072 in order of their respective listing in Table 1.

Table 1. Summary Statistics

	Mean	**Standard Deviation**
Residential Land Sales	7829472	4.38E+07
Extreme Rainfall	0.0203	0.141
Hurricane	0.0072	0.0007
Apartment Sales	8702789	2.34E+07
Extreme Rainfall	0.0047	0.0682
Hurricane	0.0069	0.0002
Mortgages	6499516	8.73E+07
Extreme Rainfall	0.0177	0.1319
Hurricane	0.0072	0.0006

3.3 Estimation Strategy

The following fixed effects model is used to ascertain how extreme climate events may have affected real estate:

$$\ln(Y_{ijt}) = \propto + \sum_{l=0}^{L} \delta_{R_{t-1}} R_{ijt-1} + \sum_{l=0}^{L} \beta_{H_{t-1}} H_{ijt-1} + \pi_t + \mu_i + \varepsilon_{ijt} \quad (2)$$

where i indicates property, j parish and t the year. Y is either land sale prices, apartment sale prices, or mortgages taken. R and H constitute measures of extreme precipitation and wind exposure as described in Section 3.1. One should note that any persistent effects of these extreme climatic factors is explored using their lagged values. In addition, π and μ capture year and parish fixed effects and ϵ, the error term. One should note that, after controlling for fixed effects, one can consider H and R to be random realizations of their (assumed time invariant) distributions and thus exogenous.

4. Results and Discussion

The model first investigates the individual impact of extreme rainfall and hurricanes on residential land sales. As shown in Table 2, neither excess rainfall nor hurricanes significantly affect residential sales. The estimated rainfall outcome is in congruence with a strand of the flood-risk-property literature which also finds no effect on property; see, for instance, Bin and Landry (2013), Cupal (2015), and Murfin and Spiegel (2020). More specifically, Sawada et al. (2018) find no significant impact on residential land prices despite notable substantial damages after flood shocks in Thailand. According to Sawada et al. (2018), non-significance of estimates possibly relates to illiquidity or other frictions in the real estate market. On the other hand, some studies indicate significant price reductions after flooding, especially for properties with higher flood risks (Zhai et al., 2003; Ismail et al., 2016; Dudzińska et al., 2020; Wei and Zhao, 2022).

Table 2. Effects of Climate Extremes on Residential Land Sales

	(1)	(2)	(3)	(4)	(5)
Excess Rain (it)	0.2161		0.2163	0.2157	0.2154
	(0.1545)		(0.1546)	(0.1544)	(0.1540)
Hurricane (it)		-0.1093	-0.1904	-0.1904	-0.1904
		(0.2564)	(0.2728)	(0.2857)	(0.2857)
Excess Rain (it-1)				-0.0082	0.0081
				(0.0124)	(0.0121)
Hurricane (it-1)				-0.1408	-0.1408
				(0.3314)	(0.3314)
Excess Rain (it-2)					0.0088
					(0.0209)
Hurricane (it-2)					0.3021
					(0.3241)
Observations	172,120	172,120	172,120	172,106	172,092

Notes: (i) Results of the impact of excess rainfall, hurricane and their lagged effects on residential sales are shown in the table. (ii) * Coefficient is statistically significant at the 10 percent; ** at the 5 percent level; *** at the one percent level; no asterisk means the coefficient is not different from zero with statistical significance. (iii) Robust standard errors are in parentheses.

The results for Jamaica in this study must be considered in light of limitations in the available data and literature. Data on residential land, for example, do not include property attributes such as proximity to streams or rivers, the condition of drainage systems close by, the slope or the extent of deforestation, and soil drainability, which can affect risk of flooding. The literature on hurricanes, moreover, does not include work on residential lands. One can assume that the non-existent hurricane impact is reasonable since the construction of the hurricane variable only captures wind destruction and, with no physical structure to destroy, land values would remain unaffected.

Turning to Table 3, the estimates show that both types of climate extremes impact the sale prices of apartments where their directional effects act independently, as shown in models (1) and (2). Interestingly, we observe that extreme rainfall leads to an approximately 45 percent increase in apartment prices. This effect is only short term, however, and disappears in the year following the shock. Of course, it is not surprising that this directional impact is generally at odds with the majority of the literature. Nevertheless, one finds indirect support from (Murphy and Strobl, 2009) and (Gourley, 2021) where contemporaneous increases in property values are estimated albeit for two alternate climate extremes, cold weather and hurricanes. However, in the case of extreme rainfall, one can adopt (Murphy and Strobl, 2009)'s rationale where an excessive amount of rain reduces the stock of livable properties more than they reduce the size of the population in specific localities which in turn drives up their prices. One can also assume another possibility based on Gourley (2021), that is, potential buyers see less apartments in adverse weather so that they lack enough information to negotiate when they are purchasing and as a result, they pay higher prices because sellers have a stronger selling position. Along with Murphy and Strobl (2009) and Gourley (2021), the positive impact of weather extremes on property values estimated in this study stands in contrast to the extensive literature which presents discounted values resulting from flood incidences (see, for instance Zhang, 2016; Beltrán et al., 2019; Apergis et al., 2020; Miller and Pinter, 2022).

Table 3. Climate Extremes and Apartment Sales

	(1)	(2)	(3)	(4)	(5)
Excess Rain (it)	0.4411**		0.4478**	0.4571**	0.4501**
	(0.1958)		(0.1946)	(0.1963)	(0.1991)
Hurricane (it)		-0.0687**	-0.5164**	-0.5257**	-0.5180**
		(0.0307)	(0.1923)	(0.1938)	(0.1985)
Excess Rain (it-1)				0.1043	0.1172
				(0.2805)	(0.2867)
Hurricane (it-1)				-0.2528	-0.2683
				(0.2652)	(0.2714)
Excess Rain (it-2)					0.0413
					(0.1688
Hurricane (it-2)					-0.4017**
					(0.1675)
Observations	15, 081	15, 081	15,081	15,068	15,056

Notes: (i) Results of the impact of excess rainfall, hurricane and their lagged effects on apartment sales are shown in the table. (ii) * Coefficient is statistically significant at the 10 percent; ** at the 5 percent level; *** at the one percent level; no asterisk means the coefficient is not different from zero with statistical significance. (iii) Robust standard errors are in parentheses.

Table 3 also shows that, in contrast to the contemporaneous impact of extreme rainfall, the average hurricane reduces apartment sales by over 50 percent. Such negative impacts are quite common in the literature for house prices; see, for instance, Murphy and Strobl (2009) and Ortega and Taşpınar (2018). Possible reasons for such a large decline include i) significant damage to structures, which might require repairs amounting to more than the value of properties; ii) forced migration to avoid future disasters and an accompanying need to quickly liquidate properties; or iii) an increase in the risk perception of living in particular areas, which home buyers or real estate agents use to negotiate prices downwards (Spencer and Urquhart, 2018; Ortega and Taşpınar, 2018; Cohen et al., 2021). In addition, research such as Below et al. (2017) and Komarek and Filer (2020) highlights that homes located in high-risk areas are likely to stay on the market longer, which possibly indicates that in the case of the observed significant reduction in the sale prices of apartments in this study, sellers wanted to avoid the waiting period to sell.

While the housing market literature on hurricanes is quite small, it supports the price-reducing effect estimated in this study. Van Veelen (2020), for instance, finds that Hurricane Charley in Florida lowered prices by 1.9 to 2.4 percent. Assessing the effects of multiple hurricanes in North Carolina, Below et al. (2017) find a price reduction of 3.8 percent. It is worth pointing out that the smaller discount estimates noted in these studies could possibly result from the use of storm and damage indicator variables. In contrast, this study uses a hurricane index, which shows larger discounts on apartment property values. The results indicate the presence of a persistent effect two years after a hurricane strike, that is, a smaller reduction in apartment sale prices of around 40 percent. Regarding this smaller reducing effect, it is possible that repairs would have taken place within the year of the storm strike so that apartment values do not drastically fall, as they do initially.

Table 4 next shows the results from the model estimating weather extremes impact on the value of mortgages taken. From the results, one observes a decline in the value of mortgages taken by approximately 15 percent from the impact of extreme rainfall. Of course, this reducing effect is expected, since higher-risk locations would be denied mortgage loans. In the case of sea level rise, however, as pointed out by Keys and Mulder (2020), denial of mortgage loans is not necessarily the most important consideration. Instead, climate-risk-induced pessimism on the part of potential buyers can result in fewer mortgages being taken. Additionally, as the results show, mortgages taken do not continue to decline, suggesting that either mortgage institutions no longer have climate-related risk reservations or buyers are not pessimistic about the impacts of extreme weather. These explanations support others coming out of the mortgage-finance-climate-change literature. Ouazad and Kahn (2022), for example, provide evidence that mortgage institutions are more willing to approve securitized loans, which transfer climate risk to borrowers.

Table 4. Climate Extremes and Mortgages

	(1)	(2)	(3)	(4)	(5)
Excess Rain (it)	-0.1466***		-0.1466***	-0.1467***	-0.1467***
	(0.0367)		(0.0367)	(0.0367)	(0.0536)
Hurricane (it)		-0.0986	-0.0495	-0.0493	-0.0491
		(0.1511)	(0.1477)	(0.1477)	(0.1479)
Excess Rain (it-1)				0.0096	0.0096
				(0.0061)	(0.0060)
Hurricane (it-1)				-0.0472	-0.0472
				(0.3000)	(0.3000)
Excess Rain (it-2)					0.0004
					(0.0063)
Hurricane (it-2)					0.193
					(0.1288)
Observations	178,312	178,312	178,312	178,297	178,282

Notes: (i) Results of the impact of excess rainfall, hurricane and their lagged effects on mortgages taken are shown in the table. (ii) * Coefficient is statistically significant at the 10 percent; ** at the 5 percent level; *** at the one percent level; no asterisk means the coefficient is not different from zero with statistical significance. (iii) Robust standard errors are in parentheses.

Table 4 additionally shows that there is no hurricane impact. As no studies have directly investigated the impact of natural disasters on mortgages taken, the results of this study will enrich climate-change-real-estate literature and lend support to the studies on climate-induced mortgage risk cited above.

Though unclear, the mechanisms operating behind the negative and positive estimated outcomes in the general literature (see, for example, Atreya and Ferreira, 2015, and Gourley, 2021), can be attributed to several reasons. They include changes in how buyers' sentiments, especially in response to weather conditions. Prospective homeowners may, for instance, postpone searching during a cold winter despite the availability of open houses. Such postponement could increase prices, as buyers may have less information and thus leave sellers with more negotiation power (Gourley, 2021). However, depending on the type of weather, some buyers may not be deterred and continue house hunting, which contribute to lowering prices (Gourley, 2021). Alternatively, damages to nearby properties or facilities can also lower the price of properties (Stull, 1975). Further, decline in property values also could be driven by high reconstruction and psychological costs associated with extreme weather events (Atreya and Ferreira, 2015).

In the case of Jamaica, one can argue that the increase of apartment prices resulting from extreme rainfall can be attributed to buyers postponing house hunting as a result of bad weather so that, upon resumption, they have less bargaining power than sellers. Further, apart from the likelihood of a decline in buyers' mood (Gourley, 2021), buyers can also be affected by flooded roads and landslides. Such degradation of neighborhood assets by extreme weather can reduce property values (Stull, 1975). Further, both implicit (mental health) and explicit (reconstruction) costs could drive down prices if homeowners are unable to bear these costs, especially with no insurance, and decide to sell and migrate, whether internally or externally.

Table 5 provides robustness checks for the climate variables by considering a higher threshold for damaging hurricanes and higher threshold for extreme rainfall. Specifically, a threshold choice of 178 km/hr and daily rainfall exceeding the 95th percentile of a grid's non-zero values are now used to re-estimate model (5) in Tables 2, 3 and 4. In general, the directional impact remains the same but the magnitude changes; for apartments, sale prices are now increased by almost 80 percent and reduced by roughly 86 percent for extreme rainfall and hurricanes, respectively. Further, the model now estimates a smaller reduction (10 percent) in the value of mortgages taken. These differences in magnitude compared to the original model suggest that these alternative measures may not be accurately capturing the destruction of property.

Table 5. Robustness Checks

	(1)	(2)	(3)
Excess Rain (it)	-1.0901	0.7979**	-0.0993**
	(0.6827)	(0.3380)	(0.0359)
Hurricane (it)	0.0825	-0.8654**	-0.0871
	(0.2545)	(0.3381)	(0.1504)
Excess Rain (it-1)	0.0467	-0.2163	0.0113
	(0.0318)	(0.3604)	(0.0088)
Hurricane (it-1)	-0.0129	0.0645	-0.0466
	(0.2747)	(0.3365)	(0.3019)
Excess Rain (it-2)	-0.0067	-0.283	-0.0633
	(0.0404)	(0.3529)	(0.0103)
Hurricane (it-2)	0.3553	-0.0786	0.1911
	(0.1866)	(0.3489)	(0.1307)
Observations	172,092	15,056	178,282

Notes: (i) Results of the impact of excess rainfall, hurricane and their lagged effects are shown in the table where model (1) is for Residential Sales, (2) for Apartment Sales and (3) for Mortgages Taken.(ii) * Coefficient is statistically significant at the 10 percent; ** at the 5 percent level; *** at the one percent level; no asterisk means the coefficient is not different from zero with statistical significance. (iii) Robust standard errors are in parentheses.

5. Conclusion

This paper examines the impact of extreme weather events on the Jamaican real estate market as measured by values of residential land sales, apartment sales and mortgages taken. It is found that extreme rainfall reduces the value of mortgages but increases apartment values. Hurricanes, however, reduce the values of apartments.

These results underscore the role of wealth risk in property ownership. Property is a significant source of wealth and is expected to increase in value over time. Extreme weather events, however, can have serious effects on real estate values, particularly in the short term. This risk means that property owners should possess other sources of wealth or have in place financial sources of recovery such as insurance and personal savings. The latter has been identified by Henry et al. (2020) as an important coping mechanism for Jamaicans.

Further work and improvements in data availability may be needed to address the limitations of the present study. Data on the duration of rainfall events, for example, would have improved the assessment of the effect of excess rain on property. Likewise, specific damage estimates are not available for homes destroyed since available costs related to hurricanes and flooding are lumped together. Finally, the available property data do not include the attributes of properties considered in standard hedonic models, which can affect the magnitude of estimated damages.

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