# The influence of flood evacuation sites on housing prices: an empirical study in Kumamoto City, Japan

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## 1 Introduction

The demand for flood evacuation facilities is increasing due to extreme precipitation events becoming more frequent, particularly in areas prone to flooding. With a history of devastating floods, Japan has accurately recognized the importance and urgency of improving the flood evacuation network. The number of flood evacuation sites is growing to meet the increasing demand and guarantee a quick evacuation process. However, no relevant studies have explored the risk reduction value of these evacuation sites, and it is unclear whether residents are aware of the establishment of nearby flood evacuation facilities. This study explores their value by examining how apartment prices respond to the newly added flood evacuation sites nearby.

By using a difference-in-differences method, we investigate whether the appearance of the new evacuation sites correlates positively with increased housing values in the same neighborhood, thereby underscoring its significance and potential benefits. We also aim to examine whether there exists a discrepancy between actual flood risk and residents' perceptions of this risk. We employ an actual flood disaster as an exogenous shock, to examine the presence of a gap between the real and perceived flood risk among residents.

## 2 Data and Method

This study utilizes a comprehensive multi-faceted dataset to analyze the relationship between new flood evacuation sites and housing prices in Kumamoto. Housing price data from 2015 to 2022 is sourced from the "At Home Dataset" by At Home Co., Ltd., accessed via the IDR Dataset Service of the National Institute of Informatics. Floodplain data from the MLIT, historical evacuation site data from Kumamoto City, and administrative boundary data from e-Stat are also included, enabling a detailed spatial analysis of the property market.

A hedonic price function is estimated to explore the value of the new flood evacuation sites contributing to an apartment's market price in Kumamoto City, Japan,as in equation (1).

$$LnPrice_{ilt} = \alpha X_{it} + \beta Evacuation_i + \gamma Post_t + \delta(Evacuation_i \times Post_t) + \mu_t + \lambda_l + \epsilon_{ilt} \quad (1)$$

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The natural logarithm of price for apartment $i$, located in area $l$, posted at time $t$ is given by $LnPrice_{ilt}$. $X_{it}$ is a vector of structural features and facilities that define the characteristics of each apartment $i$ at time $t$. $Evacuation_i$ is a dummy variable representing whether a new flood evacuation site is added in the neighborhood. $Post_t$ is another dummy variable that distinguishes whether the sale is posted before or after the new flood evacuation site is established. $\mu_t$ and $\lambda_l$ are vectors of spatial and time-fixed effects, respectively, while $\epsilon_{ilt}$ is the error term that captures all idiosyncratic shocks to the price that is not explained by the model. We define $\mu_t$ at both year and year-by-month levels and $\lambda_l$ at both neighborhood (choid) and building (houseid) levels. The equilibrium of apartment prices in a hedonic model is characterized by the coefficients $\alpha$ and $\beta$.

# 3 Result

Table 1: Impact of new flood evacuation sites on apartment prices

| Variables | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Original | Original | Kyushu Flood | Kyushu Flood |
| Evacuation sites*Post(0/1) | 0.117** | 0.116** | 0.085 | 0.081 |
| | (0.055) | (0.055) | (0.054) | (0.054) |
| Spatial FE | cho | cho | cho | cho |
| Time FE | quarter | year | quarter | year |
| Observations | 7,048 | 7,048 | 7,048 | 7,048 |
| R-squared | 0.889 | 0.888 | 0.888 | 0.887 |

Notes: $*p < 0.1; **p < 0.05; ***p < 0.01$

The Table 1 presents the estimation results on the impact of new flood evacuation sites on housing prices in Kumamoto City. The results of the original models indicate a positive and significant effect, which means that the addition of the new flood evacuation sites will lead to an increase in apartment prices nearby. The Kyushu flood models demonstrate positive but not statistically significant results, suggesting that the value realization of the evacuation sites does not depend on the occurrence of an actual disaster.

# 4 Conclusion

Analysis of housing price data reveals that the new flood evacuation sites increase housing prices nearby. We found no gap between the actual flood risk and residents' perceptions in Kumamoto City since the value of these new flood evacuation sites is successfully recognized by nearby residents without requiring a real disaster to prompt this realization. This price increase also justifies Kumamoto City's investment in public disaster facilities to climate adaption, which corresponds to the increase in flood emergency response capabilities as they face higher flood risks.