

Who Gives a Dam? Capitalization of Dam Flood Protection in Fukuoka Japan

Despite 41% of its population living in flood-prone areas, Japan manages flood risk well thanks in part to its extensive network of flood defense. At the center of this defense are more than 2,500 dams nationwide which control water levels across thousands of streams, rivers, and lakes. Many of these dams need to be renewed soon as 24% of Japanese flood control dams are 50 years or older, which is considered a critical threshold of when stress begins to show and action needs to be taken (Perera et al., 2021). The decision to rebuild or reinvest in dams is difficult as policymakers need to weigh the benefits of flood control with the cost of replacement and potentially adding to the \$11 trillion national debt.

We provide insight on this matter by examining whether apartment rental prices (2015 – 2019) responded to the completion of the Gokayama Dam in Fukuoka Prefecture, Japan. Using more than 90,000 listed observations, we find apartments protected by the Gokayama Dam experienced a 1.8% price increase relative to rental prices in other floodplains after Typhoon Prapiroon hit western Japan and tested the dam. Renters used the natural disaster – rather than the completion of the dam – as a learning experience to update their perceptions of flood risk, suggesting a possible disconnect between perceptions of flood risk and objective risk.

Flood protection is also found to heterogeneously capitalize in downstream apartments, with higher premiums observed in first floor units, units closer to rivers, and in areas where floodwaters are expected to exceed two meters, while no premium is observed in rental units designed as temporary housing. Commercial real estate rentals and single-family homes also benefit from added flood protection, increasing in value by 9.5% and 5% respectively. Taken altogether, the capitalized gains from flood protection within the apartment rental market are small in comparison to the premiums paid by homeowners and commercial renters. Apartment renters may be more tolerant of flood risk as they have fewer financial liabilities and can walk away from the disaster more easily. In aggregate, the Gokayama Dam provides \$11.3 million in benefits to downstream apartment renters each year which offsets more than one-third the annualized cost of the dam.

To recover flood capitalization estimates, we collect real estate listing data from the National Institute of Informatics (NII). The NII's database includes a vector of structural characteristics, locational features, amenities, and pricing information for residential and commercial properties listed on the market. An indicator of whether the property is within a 100-year floodplain is also created using shapefiles from the Ministry of Land, Infrastructure, Transport and Tourism and GIS. We use this information to estimate a difference-in-difference hedonic pricing model, where the occurrence of Typhoon Prapiroon is used as an exogenous source of variation. The first difference classifies properties into a treated and control group where group assignment is dependent on whether the property is located in a floodplain protected by the Gokayama Dam. The second difference categorizes properties as being leased/purchased before or after the arrival of Typhoon Prapiroon and controls for any price differential from the natural disaster common to all floodplain properties.

Separate hedonic equilibria – one for each property type – are estimated as apartments, commercial real estate, and homes are transacted in different markets. In a supplementary

specification, we also test for pre-trends in rental prices by allowing the difference-in-difference coefficient to vary across time. The temporal pattern observed from this analysis suggests our estimates are causal as rental prices increased discretely immediately after the arrival of Typhoon Prapiroon, with a positive premium retained until at least the end of the study period. Rental prices were relatively flat, on the other hand, prior to the treatment event.

We make several contributions to the flood risk literature from this analysis. Unlike previous studies which are concerned with measuring homeowner willingness to pay (Bin and Landry, 2013; Oretega and Taspinar, 2018), we focus primarily on how apartment renters responded to flood risk. Apartment renters are an understudied but important stakeholder group as they constitute a large fraction of the population in Japan. Renters are also likely to respond differently to hazards due to their more transitory nature and lack of ownership of the building. In addition, we are the first study to estimate the capitalized value from the completion of an upstream dam. Several studies have focused on the benefits conferred from coastal flood protection (Gopalakrishnan et al., 2011; Landry and Hindsley, 2011), while only one study has examined the link between dam removal and housing prices (Lewis et al., 2008). Finally, we are able to contextualize our apartment capitalization estimates within the broader real estate market by estimating the value of flood protection to homeowners and renters of commercial property. Comparison across these groups allows us to have a more holistic understanding of how inland flood protection impacts nearby communities.

References

- Bin, O., & Landry, C. E. (2013). Changes in implicit flood risk premiums: Empirical evidence from the housing market. *Journal of Environmental Economics and Management*, 65(3), 361-376.
- Gopalakrishnan, S., Smith, M. D., Slott, J. M., & Murray, A. B. (2011). The value of disappearing beaches: a hedonic pricing model with endogenous beach width. *Journal of Environmental Economics and Management*, 61(3), 297-310.
- Landry, C. E., & Hindsley, P. (2011). Valuing beach quality with hedonic property models. *Land Economics*, 87(1), 92-108.
- Lewis, L. Y., Bohlen, C., & Wilson, S. (2008). Dams, dam removal, and river restoration: A hedonic property value analysis. *Contemporary Economic Policy*, 26(2), 175-186.
- Ortega, F., & Taspinar, S. (2018). Rising sea levels and sinking property values: Hurricane Sandy and New York's housing market. *Journal of Urban Economics*, 106, 81-100.
- Perera, D., Smakhtin, V., Williams, S., North, T., Curry, A., 2021. Ageing Water Storage Infrastructure: An Emerging Global Risk. UNU-INWEH Report Series, Issue 11. United Nations University Institute for Water, Environment and Health, Hamilton, Canada.