

Moving out of Harm's Way? An Analysis of the Impacts of Flood Buyouts on Future Land Uses

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Abstract

This study examined the long-term outcomes of flood buyout sites in the City and County of St. Louis area, using socioeconomic data and visual observations of the surrounding areas. The results suggest that 38.8 percent of the flood buyout sites in the City and County of St. Louis area remain non-vacant even though 89.5 percent of the total buyout claims were filed in 1994. The study also found that most commercial, industrial, and institutional property sites remain non-vacant, while residential sites are relatively more vacant.

Research Background

Growing Flood Risks and Flood Buyout Program

- Flooding is among the most prevalent natural hazards. The number of fatalities directly related to floods reached 1,357 in the U.S. from 2010-2022 (NWS, n.d.), and the average annual economic loss associated with floods in the U.S. is estimated to be \$32.1 billion (Wing et al., 2022).
- Flood risk is projected to increase by 26.4 percent in the US by 2050 under the Representative Concentration Pathway (RCP) 4.5 (Wing et al. 2022), and the number of people living in 100-year flood zones is projected to be over 60 million in 2050 (Wing et al., 2018).
- Structural flood mitigation measures have not guaranteed flood damage prevention (e.g., GAO, 2022)
- Flood buyouts are a voluntary, non-structural flood hazard mitigation program to move people out of high-risk floodplains by allowing the government to acquire the properties and make the sites open space.
- The passing of a 1993 amendment to the Robert T. Stafford Disaster Relief and Emergency Assistance Act increased federal funding for flood buyout programs, fueled by extensive devastation from the 1993 Midwest Floods (FEMA, 2021; Zavar et al., 2023).
- In the era of climate change, flood buyouts have become an unavoidable option under intensifying flood events (e.g., Mach et al., 2024)

Impediments and Research Needs of Flood Buyouts

- Despite its potential as an effective form of non-structural hazard mitigation, flood buyouts have had limitations in reducing the risk of flood hazard exposure.
 - More than ten new residential properties were built in floodplains for every property removed through flood buyouts (Hino et al., 2024).
 - A lack of clarity, poor communication across all levels of government, and extended timeframes diminished the public's trust (Schwaller et al., 2022).
- Funding, timing, and the scale of buyouts did not correspond with the household recovery needs (Binder, Greer, & Zavar, 2020).
- Exacerbating social inequalities in flood buyouts led to diminished trust among residents (Nance et al. 2024)
- While flood buyout programs have been implemented for decades, there has been a lack of assessment on the programs' social and built environmental impacts. In particular, there have been limited empirical studies of what has happened to buyout property sites that could demonstrate the effectiveness and impacts of flood buyouts.

Research Questions

- What is the current status of past flood buyout property lots?
- How do pre-buyout land uses affect the current vacancy status?
- How do sociodemographic characteristics affect flood buyout implementation?

Data and Research Method

Data

- The study area is the City of St. Louis and the County of St. Louis in Missouri.
- Missouri is ranked number one in the U.S. in the number of voluntary flood buyout properties.
- The Missouri State Emergency Management Agency (SEMA) provided a buyout property database with xy coordinates. The buyout database is linked to the 2000 decennial census and the 2022 Community Survey (ACS) 5-year data.
- Google Earth Pro and Google Street View were used to examine the conditions of the buyouts.

Statistical Analysis

- A binary logit model was employed for this study to examine the effects of buyout property-related characteristics and demographic and socioeconomic characteristics simultaneously. The model has two alternatives (vacant vs. not vacant).
- The model estimated the propensity toward the buyout sites being vacant over not vacant. Thus, the model estimates the probability of being vacant ($Y = 1$), and the base case is not vacant ($Y = 0$).

$$P_{ni} = \frac{e^{Bx_i}}{1 + e^{Bx_i}}$$

Table 1 Characteristics of Flood Buyout Properties

	n	Non-Vacant		Vacant		Chi-Sq
		Frequency	%	Frequency	%	Pr > Chi-Sq
All buyout properties	783	304	38.8	479	61.2	
Property type						<.0001. (Note: There are cells less than 5 expected values)
Commercial	176	168	95.5	8	4.5	
Industrial	2	2	100.0	0	0.0	
Institutional	67	67	100.0	0	0.0	
Residential	538	67	12.5	471	87.5	
Surrounding block area's primary land use						<.0001 (Note: There are cells less than 5 expected values)
Commercial	193	167	86.5	24	12.4	
Industrial	50	11	22.0	39	78.0	
Institutional	67	67	100.0	0	0.0	
Residential	161	59	36.6	98	60.9	
Vacant	321	0	0.0	318	99.1	
Location						0.0012
Within City of St. Louis	21	1	4.8	20	95.2	
Outside City of St. Louis	762	303	39.8	459	60.2	
Year of claim						<.0001
Year 1994	701	290	41.4	411	58.6	
After 1994	82	14	17.1	68	82.9	

Table 2 Census Block Group Level Information of Flood Buyout Property Locations

	Non-Vacant (n = 304)	Vacant (n = 479)	t-test Pr > t
Pop. change (2000-2022)	-483.80	-435.22	0.3855
Pop. percentage change (2000-2022)	-31.55	-1.32	<.0001
Pop. density in 2022 (per acre)	1.69	2.82	<.0001
Pop. density change (2000-2022)	-0.49	-0.50	0.9396
Percent of White pop. (2022)	79.90	82.73	0.0222
Percent of Black pop. (2022)	10.75	8.17	0.0392
Percent of Hispanic pop. (2022)	1.16	3.86	<.0001
Median household income (\$ in 2022)	69629.93	92096.44	<.0001
Percent of households in poverty (2022)	21.32	27.73	<.0001
Percent of renter-occupied housing units (2022)	18.41	25.62	<.0001
Percent of vacant housing units (2022)	8.95	11.46	<.0001

Table 3 Binary Logit Analysis of Vacant Lots over Non-Vacant Lots

	Estimate	Standard Error	Wald ChiSq	Pr > ChiSq
Constant	0.9842	0.5325	3.4160	0.0646
Commercial property	3.6435	0.4602	62.6892	<.0001
Percent of Hispanic pop. (2022)	-0.1399	0.0346	16.3807	<.0001
Pop. change in percentage (2000-2022)	-0.0305	0.0039	62.9556	<.0001
Pop. density in 2022 (per acre)	0.1015	0.0488	4.3356	0.0373
Median household income in 2022 (in \$1,000)	-0.0459	0.0048	90.6761	<.0001
Claim filed in 1994 (Base: Claim filed after 1994)	1.2144	0.4537	7.1629	0.0074

Pseudo R-square = 0.4998; Max-rescaled R-Square = 0.6781
Likelihood ratio test: Chi-Square = 542.4657, df = 6, Pr > ChiSq = <.0001
Association of Predicted Probabilities and Observed Responses: Concordant = 91.7%, Discordant = 7.9%, Tied = 0.4%

Key Findings and Implications

- A substantial portion (38.8 percent) of buyout property lots were still not vacant.
- Residential properties are much more likely to be cleared, while commercial, industrial, and institutional properties are hardly removed. It is reasonable to prioritize removing residential properties because they are more vulnerable to flooding and are more likely to be occupied. However, those non-residential properties are activity locations. Therefore, they still pose potential risks.
- The binary logit model results reveal that buyout lots in high-density, high-population growth (or low-population loss), and high household income areas are more likely to have properties removed from the lots. This indicates that disadvantaged communities are more likely to be left behind when removing vulnerable building structures. Disadvantaged communities may require further assistance and/or more attention.

Limitations and Future Research

- The lower likelihood of disadvantaged communities having more uncleared buyout properties may require further research on potentially different buyout implementation mechanisms compared to affluent communities.
- One limitation of this study is that it did not examine whether people or businesses still use the uncleared properties. An additional study is warranted to examine whether uncleared properties are still in use. This will require site visits and possibly qualitative interviews.
- Another limitation of this study is that it relied on Google Earth Pro and Google Street View to identify the vacancy status of each buyout site. Further research should confirm these findings with in-person visits to the buyout sites. It would also be useful to examine the tax records of the non-vacant sites to see who is paying the property taxes.

References

- Binder, S. B., Greer, A., & Zavar, E. (2020). Home buyouts: a tool for mitigation or recovery? *Disaster Prevention and Management: An International Journal*, 29: 497-510.
- Federal Emergency Management Agency (FEMA). (2021). Missouri flood buyout saves lives, heartache, and money. <https://www.fema.gov/case-study/missouri-flood-buyout-saves-lives-heartache-and-money>.
- Government Accountability Office (GAO). (2022). FLOOD MITIGATION: Actions Needed to Improve Use of FEMA Property Acquisitions. <https://www.gao.gov/assets/gao-22-106037.pdf>
- Hino, M., BenDor, T. K., Branham, J., Kaza, N., Sebastian, A., & Sweeney, S. (2024). Growing safely or building risk? Floodplain management in North Carolina. *Journal of the American Planning Association*, 90: 50-62.
- Mach, K. J., Kraan, C. M., Hino, M., Siders, A. R., Johnston, E. M., & Field, C. B. (2019). Managed retreat through voluntary buyouts of flood-prone properties. *Science Advances* 5, 10: eaax8995.
- Nance, E., Smith, S. L., Thapa, J. P., & Powers, L. T. (2024). A buyout displacement index for uncovering the effects of disinvestment in Greater Houston Watersheds. *Journal of Planning Education and Research*, 44: 1805-1819.
- National Weather Service (NWS). (n.d.). NWS Preliminary US Flood Fatality Statistics. <https://www.weather.gov/arx/usflood>.
- Schwaller, N. L., Campbell, L., Nguyen, M. T., & Smith, G. (2022). (Mis) trusting the process: how post-disaster home buyout processes can degrade public trust. *Natural Hazards*, 111: 2681-2702.
- Wing, O. E. J., Bates, P. D., Smith, A. M., Sampson, C. C., Johnson, K. A., Fargione, J., & Morefield, P. (2018). Estimates of present and future flood risk in the conterminous United States. *Environmental Research Letters*, 13: 034023.
- Wing, O. E. J., Lehman, W., Bates, P. D., Sampson, C. C., Quinn, N., Smith, A. M., Neal, J. C., Porter, J. R., & Kousky, C. (2022). Inequitable patterns of US flood risk in the Anthropocene. *Nature Climate Change*, 12: 156-162.
- Zavar, E., Binder, S. B., Greer, A., & Breaux, A. (2023). Using the past to understand future property acquisitions: an examination of historic voluntary and mandatory household relocations. *Natural Hazards*, 116: 1973-1993.