THE IMPACT OF SEVERE WEATHER **EVENTS ON HAMPTON ROADS' HOUSING MARKET**



COMMONWEALTH CENTER FOR RECURRENT FLOODING RESILIENCY

PARTNERS -

Ŵ



<u>(</u>) **OLD DOMINION** UNIVERSITY

CCRFR Report 6 June 2018

THE IMPACT OF SEVERE WEATHER EVENTS ON HAMPTON ROADS' HOUSING MARKET

Timothy Komarek

Assistant Professor, Department of Economics, Old Dominion University, 2023 Constant Hall Norfolk, VA 23529. E-mail: tkomarek@odu.edu Phone: (757) 683-4534

Larry Filer

Associate Vice President for Entrepreneurship and Economic Development, Old Dominion University, 1006 E Strome Entrepreneurial Center, Norfolk, VA 23529. E-mail: Ifiler@odu.edu

Timothy Hodge

Assistant Professor, Department of Economics, Oakland University, 413 Elliot Hall, Rochester, MI 48309. E-mail: trhodge@oakland.edu

J. Derek Loftis

Assistant Research Scientist, Center for Coastal Resources Management Virginia Institute of Marine Science, College of William & Mary, 1375 Greate Rd., Gloucester Pt., VA 23062. E-mail: jdloftis@vims.edu

Jennifer Seay

Graduate Research Assistant, Department of Economics, Old Dominion University

R

TABLE OF CONTENTS

Executive Summary	
Introduction and Previous Research	5
Background, Study Area, and Data	6
A. National Flood Insurance Program (NFIP)	6
B. Study Area	6
C. Data	
Methods	10
Results	11
A. Effects on Housing Prices Between Flood Zones	11
B. Effects on Housing Prices Within the High-Risk Flood Zone	12
C. Effects on Time-On-Market	13
Conclusion	14
References	15



EXECUTIVE SUMMARY

This report examines how flooding in Hampton Roads impacts the housing market. In particular, it measures the impact of FEMA flood zone information and two severe weather events, a Nor'easter commonly referred to as Nor'Ida in 2009 and Hurricane Irene in 2011, on residential housing prices and time-on-market. For the purpose of this analysis, the 100-year floodplain, as delineated by Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Maps (FIRMS), was classified as high-risk and included Zones AE, A, AH, AO, and VE. The 500-year floodplain was classified as low-risk and included Zone X. While FEMA flod zone maps are not necessarily predictors of risk, they offer general insight into a given property's flood risk and are easily accessible by the public.

First, the results show that the final sales price decreased by approximately 5% for properties in either a high-risk or low-risk flood zone after a severe weather event. Furthermore, the 5% reduction in sales price after Hurricane Irene (2011) persisted through the end of the sample period in 2016. The reduction in sales price appears to be driven by decreases in properties in low-risk flood zones. Our estimates suggest prices in low-risk zones decreased by 7% in the time period after Nor'Ida and Hurricane Irene (post-2009) and the reduction persisted for 5 years. This may be because high-risk properties already price in the flooding risk premium, and the severe weather events do not provide any additional flooding risk information to potential buyers. However, severe weather events informed buyers who were unaware of the risk of properties in low-risk zones of the associated flood risk, resulting in falling prices.

Second, our results indicate that homes in the highrisk flood zones remained on the market 5-8 days longer in the time period after Nor'Ida (2009-2016), but there is no evidence of an increased time-onmarket for low-risk properties. Our results suggest the housing market in high-risk flood zones cools down after a severe weather event, demonstrating buyers' fears of purchasing a home in a high-risk flood zone.

This study utilized data from the Real Estate Information Network (REIN), a southeast Virginia multiple listing service (MLS), which provided information residential properties sales, time-onmarket and a wide range of housing characteristics including age, school district, architectural style along with interior features and exterior features. We employed geographical information systems (GIS) software to determine the flood zone of each residential property, as determined by the National Flood Insurance Program. Additionally, we utilized a hydrodynamic model created at the Virginia Institute of Marine Science (VIMS) to determine which properties experienced flooding during Hurricane Irene.

INTRODUCTION AND PREVIOUS RESEARCH

According to the Center for Research of the Epidemiology of Disasters (CRED, 2010), flooding accounts for over half of the natural disasters people experience worldwide. In the U.S. alone, flooding caused \$2.8 billion in damages from October 1, 2013 to September 30, 2014¹. Furthermore, rising sea levels have made recurrent flooding events common in many coastal cities. Previous research has suggested that the housing market capitalizes information on severe weather events and flood risk, such as NFIP flood zone designation (Bin and Landry, 2013).

Our study analyzes the impact of the updated risk information that occurs due to weather events on both housing prices and timeon-market. FEMA flood zone information is publicly available, but is not always known, partly due to buyers not seeking out this information. Research by Chivers and Flores (2002) suggests that some homebuyers would have lowered their original offer if they were aware a property was in a flood zone. Furthermore, Pope (2008) examines a North Carolina law that requires sellers to disclose whether or not a property is in a flood zone. He finds that the price of homes within flood zones decreases by 4-5% after the disclosure requirement. The prices diminish due to the information disclosure as potential buyers price in costly damages due to flooding and the potential need to purchase flood insurance.

There is also a robust literature on whether housing prices respond to information regarding flood risk following severe weather events (Skantz and Strickland 2009; Bin and Polasky 2004; Carbone, Hallstrom, and Smith 2006; Kousky 2010; Atreya, Ferreira, and Kriesel 2013; Zhang 2016; Bin and Landry 2013). In general, the literature has shown that homes within an NFIP flood zone following a severe weather event. Research has focused on the impact of information regarding flooding risk on housing prices. However, many homeowners are also concerned about the liquidity of their property, essentially the time it takes for a property to sell. Furthermore, the time-on-market is also a measure used by real estate agents during negotiations (Krainer, 2001; Knight, 2002). Our study analyzes the impact of the updated risk information that occurs due to weather events on both housing prices and timeon-market.

^{1.} Data from the United States Flood Loss Report for the water year 2014. <u>http://www.nws.noaa.gov/hic/summaries/WY2014.pdf</u>

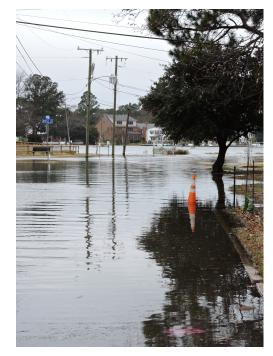
BACKGROUND, STUDY AREA, AND DATA

A. National Flood Insurance Program (NFIP)

Private insurers had difficulty adequately determining flood risk and thus making a profit when providing flood insurance. As such, there was a great need for the federal government to step in to both determine flood risk and provide flood insurance. In 1968 the National Flood Insurance act established the National Flood Insurance Program (NFIP). The NFIP provides insurance for up to \$250,000 for buildings and \$100,000 for their contents against floods caused by hurricanes, tropical storms, and heavy rains. To receive flood insurance, the community a property is in must participate in the NFIP and enforce FEMA standards that reduce the risk of flooding. In exchange, FEMA provides flood insurance for structures in the community.

B. Study Area

The study is the Hampton Roads region in Southeast Virginia, displayed in **Figure 1**. We defined Hampton Roads as the Virginia Beach-Newport News-Norfolk metropolitan statistical area (MSA). Our analysis focuses on the cities with NFIP flood zones (Chesapeake, Hampton, Norfolk, Portsmouth, and Virginia Beach). Hampton Roads has become vulnerable to both significant weather events and nuisance flooding. This comes from a combination of the pervasive water and the underlying geology of the region resulting in sinking land. Furthermore, the location on the eastern seaboard leaves the region vulnerable to severe weather.



Hampton Roads experienced two extreme weather events over our study period (2007-2016). First, a significant Nor'easter, referred to as Nor'Ida, inundated the region with flooding in November 2009. Winds gusted up to 74 mph at Norfolk International Airport, and areas received between 5 and 8 inches of rain (The Virginian Pilot, 2009). Hurricane Irene made landfall on August 2011. According to the Spatial Hazard Events Loss Database for the US (SHELDUS), Hurricane Irene resulted in damages for southeast Virginia of over \$35.8 million². The storm surge flooding was most significant in Hampton Roads and along the Albemarle and Currituck Sounds in northeast North Carolina.

FIGURE 1

Study Area: Hampton Roads, Virginia

Note: Cities used in the analysis highlighted in grey



Homebuyers in Hampton Roads are becoming more cognizant of flood prone areas when searching for a home, which may result in decreased housing prices and a longer time-on-market.

The data on tide readings offers insight as to why buyers may respond to flooding events. Since 2003, flooding in Hampton Roads has been both more frequent and historic. **Table 1** presents the top 10 highest tide readings at Sewells Point, VA using data from the National Oceanic and Atmospheric Administration (NOAA). Seven of the top ten readings have occurred since 2002, while four of the top ten tide readings are related to our two events, three of which are from Nor'Ida. Therefore, it is not surprising that homebuyers in Hampton Roads are becoming more cognizant of flood prone areas when searching for a home, which may result in decreased housing prices and a longer time-on-market.

7

^{2.} More information can be found at: http://hvri.geog.sc.edu/SHELDUS/

TABLE 1

Top Ten Tide Gauge Readings at Sewells Point, VA (1930-2017)

	Date	Tide Level (feet)	Event
1	8/22/33	12.4	Chesapeake-Potomac Hurricane
2	9/18/03	12.27	Hurricane Isabel
3	11/12/09	12.11	Nor'Ida
4	8/28/11	11.94	Hurricane Irene
5	11/13/09	11.7	Nor'Ida
6	10/29/12	11.17	Hurricane Sandy
7	11/12/09	11.11	Nor'Ida
8	9/17/36	11.1	Hurricane 13
9	11/22/06	11.01	TS Ernesto
10	2/5/98	10.96	Hurricane Bonnie

C. Data

The real estate data is from the Real Estate Information Network (REIN), a southeast Virginia multiple listing service (MLS). It includes 137,384 sales, a wide range of housing characteristics, including the selling price and the time-on-market for each property. **Table 2** contains data for selected housing characteristics for NFIP and Non-NFIP properties. We used the postal address to determine the NFIP FIRM zone of each property. In our dataset, 12% of homes sold were in high-risk zones and 14% in low-risk zones. We also incorporated a hydrodynamic model from the Virginia Institute of Marine Science (VIMS) to determine which properties experienced flooding during Hurricane Irene.

Table 2

Selected Summary Statistics

Variables	Non-NFIP Flood	NFIP Flood
	Zone	Zone
	Mean	Mean
Sales Price (dollars)	228,989	238,754
Full Baths	1.933	1.928
Half Baths	0.519	0.493
Bedrooms	3.273	3.188
Colonial	0.058	0.081
Contemporary	0.092	0.117
Ranch	0.303	0.227
Townhouse	0.136	0.096
Traditional	0.200	0.204
Age	36.69	43.93
New Construction	0.128	0.112
Short Sale	0.053	0.049
REO	0.127	0.125
Waterfront	-	0.164
100 Year Flood Zone	-	0.474
500 Year Flood Zone	-	0.526

Notes: The summary statistics are for 144,794 observations from January 1, 2007 to December 31, 2016.

METHODS

We used a statistical model to measure the effect of significant flooding events and NFIP FIRM zones on the residential real estate market. The model compares homes sold within a particular flood zone (treatment group) with comparable homes outside of a flood zone (control group) before and after severe weather events. We also took steps to ensure that our results are due to the weather events and not other factors like the housing collapse during the Great Recession. The analysis captured the effects on housing prices and time-on-market for the time period after Nor'lda (2009-2016), between Nor'lda and Hurricane Irene (2009-2011) and after Hurricane Irene (2011-2016). We thus observed the impacts of the two storms individually and combined.

RESULTS

A. Effects on Housing Prices Between Flood Zones

We first measured the effects of Nor'Ida and Hurricane Irene on housing prices for properties located in either a high-risk or low-risk zone. We denote high-risk areas using the 100-year flood plain and low-risk areas with the 500-year flood plain³. These maps do not perfectly measure risk but were the best indicator available.

Our results show that final sales price decreased by approximately 5% for properties in either a highrisk or low-risk flood zone after a severe weather event.

Our results show that final sales price decreased by approximately 5% for properties in either a high-risk or low-risk flood zone after a severe weather event. Furthermore, the 5% reduction in sales price after Hurricane Irene (2011) persisted through the end of the sample period in 2016. This result differs from the work of Bin and Landry (2013) and Zhang (2016) which finds the price depreciation from severe weather dissipates over time. The information provided by Hurricane Irene also coincided with a broader regional dialogue on recurrent flooding. In 2009, the Hampton Roads State of the Region Report published by the Center for Economic Analysis and Policy at Old Dominion University discussed climate change and rising ocean levels. This shed light on the topic and increased media coverage. Thus, both factors could be driving the persistence of the fall in prices.

We then measured the effects of the severe weather events on low-risk and high-risk properties separately to see if properties with different flooding risk levels reacted differently. Our estimates showed that the decrease in prices for properties in any flood zone, previously discussed, were driven primarily by changes in the low-risk zone. Our estimates indicated that in the period after Nor'Ida (post-2009), the lowrisk zone experienced a 7% decline in sales price. On the other hand, the reduction in sales prices in the high-risk zones was only 2.7%, and not statistically significantly different from zero based on conventional measures. In this light, buyers in the high-risk zone may already price in the flooding risk premium, and severe weather events do not provide any additional flooding risk information. However, severe weather events informed buyers who were unaware of the risk of properties in lowrisk zones of the associated flood risk, resulting in falling prices.

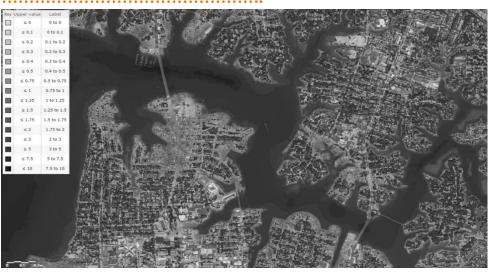
Furthermore, the magnitude of the price decline for the low-risk zone is larger after Hurricane Irene compared to the period between the storms. This could be because Hurricane Irene was a larger and more intense storm than Nor'Ida, or a multiplicative effect from 2 large storms in a close proximity to each other.

^{3.} The 100-year floodplain More information can be found at: http://hvri.geog.sc.edu/SHELDUS/

B. Effects on Housing Prices Within the High-Risk Flood Zone

Next, we studied differences in actual flooding during Hurricane Irene by using a hydrodynamic modeling (**Figure 2**) for Norfolk, VA created by the Virginia Institute of Marine Science (Loftis, Wang, and Forrest, 2015). The hydrodynamic model provided a measure of street-level flooding for properties in both the low-risk and high-risk zones.

Figure 2



Note: Interactive Interactive web map of these flood extents can be viewed online at: <u>http://arcg.is/aibSL</u> A dynamic example of hourly flooding extents in Chesapeake, VA, can be seen here: <u>http://arcg.is/1CuDGn</u>

Table 3 shows the number of homes sold in each NFIP FIRM category in Norfolk based on the amount of flooding from Hurricane Irene. Properties outside of an NFIP FIRM zone experienced very little actual flooding with only 153 homes out of over 14,500 having any street-level flooding (0.4%). Only approximately 1% of the home sales in low-risk zones from our data experienced any level of flooding and only 2 properties had a meter or more of street-level flooding. On the other hand, 33% of home sales in the high-risk area were inundated with some flooding and 310 properties had more than 1 meter of street-level flooding. Thus, the actual flooding was largely contained within the high-risk NFIP FIRM zone.

33% of home sales in the highrisk area were inundated with some flooding and 310 properties had more than 1 meter of streetlevel flooding.

Table 3

Level of Flooding from Hurricane Irene by NFIP FIRM Classification

	No Flooding	Any Flooding	Flooding 1 meter or more	% Experiencing Any Flooding
Non NFIP	14,543	153	1	0.4%
Any-Risk	8,394	1,176	312	14.01%
Low-Risk	5,099	65	2	1.27%
High-Risk	3,295	1,111	310	33.72%

Properties in the high-risk flood zones remained on the market approximately 5 - 8 days longer after Nor'Ida (post-2009) than properties not in a flood zone. Interestingly, our results showed that housing prices in the low-risk zone responded more high-risk prices even though flooding data suggests low-risk zones saw little actual flood inundation from Hurricane Irene. Thus, it seems that at least in terms of flood issues, buyers in the low-risk zones may have overreacted to Hurricane Irene.

We used the hydrodynamic modeling to examine whether there was a difference in the sales price after a severe weather event for properties inundated with flooding. Our results suggest that homes in the high-risk zone with either any or one meter or more of street-level did not sell for a different price than those that did not experience any street-level flooding. However, such properties sell for almost 15% less than other high-risk properties regardless of a weather event. Thus, these areas could conceivably experience recurrent flooding issues outside of hurricanes or tropical storms that caused a reduction in sales price.

C. Effects on Time-On-Market

Our analysis also examined the time-onmarket for residential properties after Nor'lda and Hurricane Irene. On average, the timeon-market for a property within a flood zone, either high-risk or low-risk, increased by 3.8 days after Nor'lda (2009-2016). However, our estimate of the effect of residing in a flood zone on time-on-market is not statistically significant at conventional levels, and thus we are not confident it is actually different from zero.

In contrast, there is a marked difference in the time-on-market between high-risk and low-risk properties. Properties in the high-risk flood zones remained on the market approximately 5 - 8 days longer after Nor'lda (post-2009) than properties not in a flood zone. On the other hand, we did not find a statistically significant effect for time-on-market for properties in the low-risk zone. We also examined if either Nor'lda or Hurricane Irene had a disproportionate effect on the time-on-market. The properties in the high-risk zone displayed an increase in time on market of 7.6 days after Hurricane Irene, the more serious of the two severe weather events.

CONCLUSION

This report summarized work on how the residential real estate market responds to severe weather events in Hampton Roads, Virginia.

The results show that housing prices decline by approximately 5% for properties in either low or high-risk flood zones after a severe weather event. This difference was driven by a price decrease of 7% in the low-risk zones. Our estimates also showed that properties within the high-risk flood zones remained on the market for approximately 5 - 8 days longer than properties not in a flood zone, suggesting that the residential real estate market cools down at a localized level after a severe weather event.

Given the increasing prevalence of recurrent flooding in Hampton Roads, observing the effects of severe weather events on the residential real estate market provides a better understanding of how citizens are perceiving and responding to the region's flooding risk. Based on our analysis, it appears buyers in the Hampton Roads real estate market are taking into consideration a property's flood risk when purchasing a home. This provides yet another signal that the issue of flooding is one of significant importance in the Hampton Roads region of Virginia.

REFERENCES

- Anglin, P. M., Rutherford, R., & Springer, T. M. (2003). The trade-off between the selling price of residential properties and timeon-the-market: The impact of price setting. *The Journal of Real Estate Finance and Economics*, 26(1), 95-111.
- Atreya, A., Ferreira, S., & Kriesel, W. (2013). Forgetting the flood? An analysis of the flood risk discount over time. *Land Economics*, 89(4), 577-596.
- 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.
- Bin, O., & Polasky, S. (2004). Effects of flood hazards on property values: evidence before and after Hurricane Floyd. *Land Economics*, 80(4), 490-500.
- Burby, R. J. (2001). Flood insurance and floodplain management: the US experience. *Global Environmental Change Part B: Environmental Hazards*, 3(3), 111-122.
- Center for Research of the Epidemiology of Disasters (CRED). 2010. *EM-DAT: International Disaster Database*. Brussels: Universite Catholique de Louvain. Available at <u>www.emdat.be</u>.
- Chivers, J., & Flores, N. E. (2002). Market failure in information: the national flood insurance program. *Land Economics*, 78(4), 515-521.
- Dixon, L., Clancy, N., Seabury, S. A., & Overton, A. (2006). The National Flood Insurance Program's market penetration rate: estimates and policy implications. *Santa Monica, CA: RAND Corporation*.
- Kousky, C. (2010). Learning from extreme events: Risk perceptions after the flood. Land Economics, 86(3), 395-422.

Krainer, J. (2001). A theory of liquidity in residential real estate markets. Journal of Urban Economics, 49(1), 32-53.

Knight, J. R. (2002). Listing price, time on market, and ultimate selling price: Causes and effects of listing price changes. *Real* estate economics, 30(2), 213-237.

- Loftis, J. D., Wang, H. V., & Forrest, D. R. (2015). Towards Predicting Street-Level Inundation: using Operational Forecast Modeling Techniques during 2011 Hurricane Irene. VIMS 75th Anniversary Research Symposium. Virginia Institute of Marine Science, College of William and Mary. <u>http://doi.org/10.21220/V56C7P</u>.
- Loftis, J. D., Wang, H. V., DeYoung, R. J., & Ball, W. B. (2016). Integrating Lidar Data into a High-Resolution Topobathymetric DEM for Use with Sub-Grid Inundation Modeling at Langley Research Center. Journal of Coastal Research, SI 76, 134-148.
- Michel-Kerjan, E. O. (2010). Catastrophe economics: the national flood insurance program. *Journal of Economic* Perspectives, 24(4), 165-86.
- Parmeter, Christopher F., & Pope, Jaren C., (2013). Handbook on experimental economics and the environment. In: John A., Price, Michael K. (ed.), Edward Elgar Publishing. Chap. Quasi-Experiments and Hedonic Property Value Methods.
- Pope, J. C. (2008). Do seller disclosures affect property values? Buyer information and the hedonic model. *Land* Economics, 84(4), 551-572.
- Pryce, G., Chen, Y., & Galster, G. (2011). The impact of floods on house prices: an imperfect information approach with myopia and amnesia. Housing Studies, 26(02), 259-279.
- Skantz, T., & Strickland, T. (2009). House prices and a flood event: an empirical investigation of market efficiency. *Journal of* Real Estate Research.
- Smith, V. K., Carbone, J. C., Pope, J. C., Hallstrom, D. G., & Darden, M. E. (2006). Adjusting to natural disasters. *Journal of Risk and* Uncertainty, 33(1), 37-54.
- The Virginian Pilot. (2009). Power out, homes evacuated as nor'easter bears. *Pilot Online*. Retrieved from <u>https://pilotonline</u>. <u>com/news/local/weather/article_4852ef74-7e3b-5302-8aad-4e58fa7126b5.html</u>.
- Virginia Department of Emergency Management. (2016). *History: Virginia Hurricanes*. Retrieved from <u>http://www.vaemergency.gov/news-local/hurricane-history/</u>
- National Weather Service: National Oceanic and Atmospheric Administration. (2016). *The hurricane history of Central and* Eastern Virginia. Retrieved from <u>https://www.weather.gov/media/akq/miscNEWS/hurricanehistory.pdf</u>
- Wetherald, R. T., & Manabe, S. (2002). Simulation of hydrologic changes associated with global warming. *Journal of Geophysical Research: Atmospheres*, 107(D19).
- Zhang, L. (2016). Flood hazards impact on neighborhood house prices: A spatial quantile regression analysis. *Regional Science and Urban Economics*, *60*, 12-19.



COMMONWEALTH CENTER FOR RECURRENT FLOODING RESILIENCY

- PARTNERS _





f

floodingresiliency.org | 757-683-5031 |