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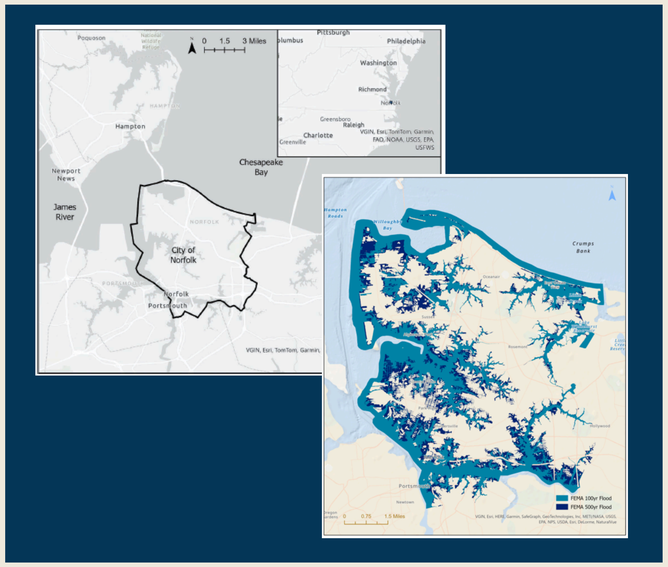
Integrating flood loss data into an empirical model for community estimates of risk

ACKNOWLEDGEMENTS

This research was made possible with financial assistance from the Commonwealth Center for Recurrent Flooding Resiliency (CCRFR).

CCRFR
COMMONWEALTH CENTER FOR RECURRENT FLOODING RESILIENCY



01. Introduction

The City of Norfolk is located on the Atlantic coast of the US. The area is encountering accelerated flooding due to a combination of factors such as land subsidence and impacts from tides and storm surges. Leveraging existing relationships with the City of Norfolk, this project sought to obtain and use repetitive loss payout data alongside flood insurance policies to map and identify vulnerable properties along the coast.

02. Objective

This study separates itself from other research studies by using an empirical predictive modeling approach using data on individual property losses from previous flooding events from flood insurance payout data provided by FEMA. The proposed methodology and application in the City of Norfolk demonstrates an advancement in understanding individual property's risk to future flood risk assessment by including data from past storm impacts reflected in the NFIP payout data.

Related literature

- Guo M, Gong J, Whytlaw JL: Large-scale cloud-based building elevation data extraction and flood insurance estimation to support floodplain management. Int J Disaster Risk Reduct. 2022; 69: 102741.
- Wang Y, Sebastian A: Community flood vulnerability and risk assessment: An empirical predictive modeling approach. J Flood Risk Manag. 2021; 14(3): e12739.

For more information

SCAN THE QR CODE

03. Methodology

For this study, a model has been developed to identify properties that may be at higher risk from future flooding events (Eq. 2). This model adapts the following risk analysis calculation equation commonly used where:

R = T × V × C, (1)

is adapted to:

R1 = T × V × C, (2)

where:

R1 = risk score of properties that may be at higher risk from future flooding events.

and:

T = flood zones provided by FEMA 100 and 500-year floodplains;

C = resilience indicator. This metric assumes that properties with insurance coverage are more likely to recover quicker than those without.

Variable measured as yes = 1; no = 0.5;

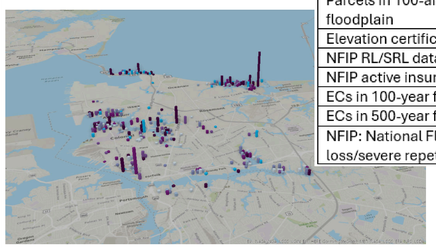
V= structure's vulnerability due to current elevation and previous NFIP payouts received on the property.

Variable measured as L + P;

L = BFE – FFE; P = (number of payouts).

04. Analysis

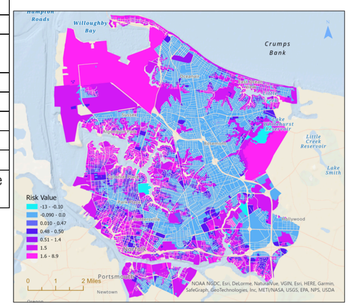
- An initial workflow was developed to select all features that were within the 100- and 500-year floodplains (**T**).
- The output solved from this step, parcel selection within a 100-year or 500-year floodplain, aids in the development of the value for ***L***, which will be calculated as the difference between the BFE and the FFE, taken from available elevation certificates (**V**).
- Two separate spatial joins, one for NFIP payout data and one for elevation certificates (EC), were completed with the original City of Norfolk parcels dataset.
- If a parcel has an active policy, a value of 1.0 is recorded in the field attribution. If a parcel does not have an active insurance policy based on the data available, then a 0.5 is recorded. The output of this process creates the column for the value of (**C**).



3-Dimensional View with hexagons showing total insurance premiums paid within the parcels with elevation certificates.

Input data for model

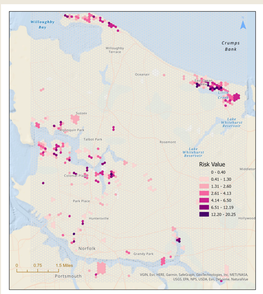
Data name	Total features in dataset
Norfolk parcels	67,608
Parcels in 100-year floodplain	15,736
Parcels in 100-and 500-yr floodplain	20,264
Elevation certificates (EC)	967
NFIP RL/SRL data	963
NFIP active insurance policies	8,822
ECs in 100-year floodplain	1,052
ECs in 500-year floodplain	465
NFIP: National Flood Insurance Program; RL/SRL: repetitive loss/severe repetitive loss	

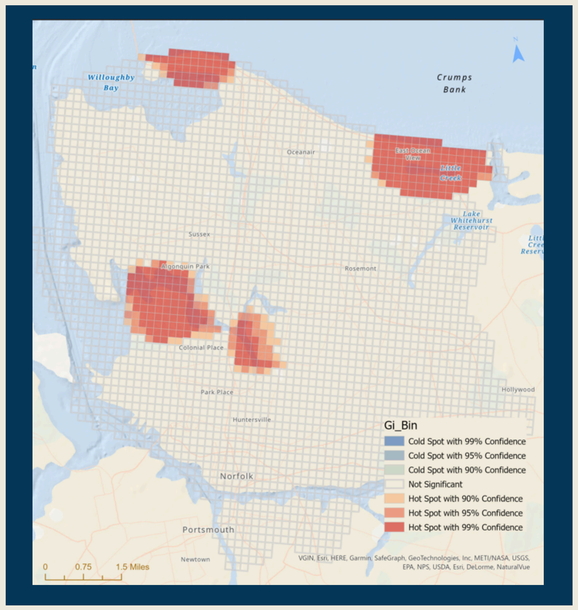


05. Results/Findings

Results of the analysis provide a scale that runs from negative values (indicating lower risk) to positive values (indicating higher risk).

- 353 parcels, or 36.5%, resulted in a risk value greater than zero indicating the parcels have an estimated higher risk to future flooding events and should be individually evaluated for further possible mitigation.
- 74 of the 353 parcels, or 21%, did not have active NFIP insurance policies in place at the time of this analysis.
- All 353 parcels are located within the 100-year floodplain.
- 12 parcels have an "L" value less than zero, ie, a negative value. This indicates that the structure(s) on those properties are elevated higher than BFE with freeboard, ie, elevation +3.
- The Optimized Hot Spot Analysis uses the Gi* statistic to assess each feature individually in relation to the neighboring features.
- Results of the Optimized Hot Spot Analysis are visualized (top right) with features colored according to their z-scores, ie, standard deviations above or below the mean, and significance levels.





06. Conclusion

The outcome of the empirical model is a scale that runs from negative values indicating lower risk to positive values indicating higher overall risk based on the variables evaluated. The result shows parcel level data with individual risk score values associated with them, which highlight specific locations within a community that may be more vulnerable to impacts from the next storm event.

Using the City of Norfolk's Resilient Norfolk Coastal Storm Risk Management areas as another way to identify areas at highest risk while maintaining privacy, it was found that the majority of the higher-risk parcels exist in the Lafayette River watershed area with additional high-risk parcels located in Pretty Lake and the Willoughby Spit areas.

07. Applications

- The methodology from this project would be transferable to any coastal community across the US that has available BFE and FFE data through ECs, or by other survey-based means.
- Incorporating the findings of the model could help communities strengthen their FEMA CRS program applications to receive additional points and potentially improve their overall ranking.