EMERGENCY MANAGEMENT USE CASE

Research Title:	**3D visualization animation of urban flooding in coastal Texas**
Author(s):	Xinyue Ye, Debalina Sengupta
Description:	Urban storm flood simulation is a key factor in flood prevention and mitigation, and an important decision support basis for urban emergency management. However, it can be challenging to visualize the impact of urban floods on buildings and infrastructure considering the scale of data and the complexity of 3 dimensional calculations. Therefore, this research visualizes the impact of hurricane storm surge flooding on houses. With a use case in Galveston, TX in 3D to show each building and road under various storm scenarios, this research is expected to improve the visualization for the city. This tool can also be expanded to include other flooding scenarios in Coastal Texas.
When Applied:	Urban Flooding
Who Applies:	Local government, emergency management related governmental organizations (TDEM, FEMA), insurance industries, and other response and recovery entities.
Disaster Type:	The use case is applicable to find the impact of flooding (flash floods, storm surge, general flooding) on each building and roadway under various scenarios. Currently, the use case serves Galveston TX but can be expanded to include other populated areas in the coastal state.
Infrastructure Affected:	This use case is applicable to roads and buildings. Target detection approach is used to identify the location of building doors, using the flooding of doors as our indicator of whether the flooding damages a house.
Industry Affected:	The use case has the potential to impact the disaster assessment, response, and recovery operations in disaster management. This impacts the housing and built infrastructure industries (including critical facilities), emergency management related governmental organizations (TDEM, FEMA), insurance industries, and other response and recovery entities.
Where Applied:	The use case is applicable to river basins, coastal zones prone to storm surge, flood prone areas in the state and nationwide. The use case currently includes Galveston TX but can be adapted for other regions with the support from local governance.
Agency Affected:	The use case is not targeted for any particular agency. It can be used and adapted for any agency finding value in the 3D visualization.
VOAD Affected:	VOADs are not the primary target of this work. The results can be used by VOADs if they are involved in response and recovery.
Who/What Affected:	Decision making for the built environment infrastructure in the context of urban flooding
How Affected:	efficient and quick decision making taking 3-D factors into account
Timing of Application:	It can be used before, during, or after an urban flooding disaster, for different built environments.
Critical Points:	The research accomplishes three specific objectives: 1) We determine how much storm inundation the houses would experience under different storm scenarios; 2) We calculate the first-floor elevation of the houses to assess damages and then divide the housing damage into three categories; and 3) Using the visualization, we demonstrate the effectiveness of a proposed dike that protects Galveston Island from flooding.
What Benefit:	The 3D model provides benefits in decision making compared to existing 2D models. We visualize the spread of floods in the 3D view. Hence, the users can feel the impact of urban disasters more intuitively. We observe how the flooding spread through different perspectives, and for each

	house we analyze the damage situation. This animation is not only a visual artifact, but it can also reflect the dynamics of urban disasters and assess the city's resilience to them. 3D visualization is the basis for smart cities and urban digital twins. As we use more methods to evaluate urban disasters, we hope to visualize and query urban disaster information in ways that provide increasingly useful decision support for emergency management and planning.
Where Used:	This idea has been implemented in the Galveston TX area. This can be used in other populated and where high density-built infrastructure exists. Many of the benefits identified for our visualization could extend to other low-lying coastal communities with a significant risk of storm surge flooding.
Additional Research:	Future work could expand the scope of our visualization, both thematically (e.g., to include types of structures other than homes, such as businesses) and geographically (to include other coastal communities).
Additional Information:	Our visualization can complement these other technological solutions by helping first responders identify the homes most likely to be flooded or damaged under multiple storm scenarios, enabling them to target their rescue efforts accordingly.
Expert Contact:	Xinyue Ye
Original Research:	https://www.tandfonline.com/doi/abs/10.1080/13658816.2021.1981334
What Risks:	n/a
Partner Agencies/Jurisdictions:	Texas Sea Grant (potential to include Texas A&M AgriLife Disaster Assessment and Recovery Team)
New Question:	How to investigate the risk factors in vertical dimension of housing using street view images?
New Question:	How to link vertical measurements on street view images to vertical coordinate systems and provide accuracy assessment?
New Question:	How to develop a scalable method to estimate Lowest Floor Elevation using publicly accessible Digital Elevation Model data and street view data?

Research with a Technology Component Should Respond to the Following Questions

Research Requested:	The developed 3D visualizations could be used in other coastal communities with high flood vulnerability to meet their need for realistic, building-level depictions of flood impacts under multiple storm scenarios, with benefits across the mitigation, preparedness, response, and recovery phases of the disaster management cycle.
Why Better:	Our visualization provides a detailed, location specific view of likely flood impacts at the household level, it could help improve such simulation exercises by providing damage estimates that are directly relevant to the interests of many stakeholders
Reliability:	In the case study, the recall and precision of houses are 0.8810 and 0.9957, respectively.
Support Needed:	internet access powerful laptop
Citizen Impact:	Urban storm flood simulation is one of the key technologies for urban flood prevention and mitigation and is also an important decision support basis for citizens
Training Required:	As easy as using Google

Public Accountability:	n/a

Please Note: Questions or suggestions regarding the Use Case Template may be directed to Dr. MacGregor Stephenson at the Texas Division of Emergency Management at macgregor.stephenson@tdem.texas.gov.