Georeferencing Analysis of Emergency Evacuation Traffic Capacity Impacted by International Border Crossing

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1. Introduction

The State of Texas, which is located in the Southern area of the United States, frequently faces tropical cyclones and hurricanes. With over 300 miles of shoreline, the areas that face threats due to these natural disasters are plenty.

These threats often cause countless of human and infrastructural damages; which can be observed in the Lower Rio Grande Valley area, as there is an abundance of major bodies of water and a relatively low elevation across the area.

This prevalent flood risk leads to the need for identification of major flooding areas, as the U.S. border faces a variety of binational traffic that is susceptible to risks in these scenarios.

Figure 1. Flooding of the Rio Grande, reaching the bottom of the International Bridge I. Laredo, Texas [1].

2. Purpose

The purpose of this study is to conduct a geospatial analysis, based on watershed flood modeling, to determine the extension of flooding in a variety of scenarios. Furthermore, historical data compiled from a variety of U.S. and Mexican government agencies will be compiled to highlight both international traffic capacity and possible emergency courses of action.

This analysis will be used to analyze the severity of binational traffic affected based on the international entry points at risk.

3. Procedure

The study area will focus on the Cameron and Willacy County, as shown in Figure 2. Important features for the analysis conducted are highlighted.

Previously developed water models of the Gulf of Mexico and the Laguna Madre in Surface-Water Modeling Systems (SMS); Storm Surge and Flooding Prediction Program ADCIRC; and River Analysis System HEC-RAS; are compiled to determine possible water surface level in a geographical location. These models utilize historical data to simulate new potential storm scenarios. This information is then processed with the use of GIS software ArcMap as shown in Figure 5.

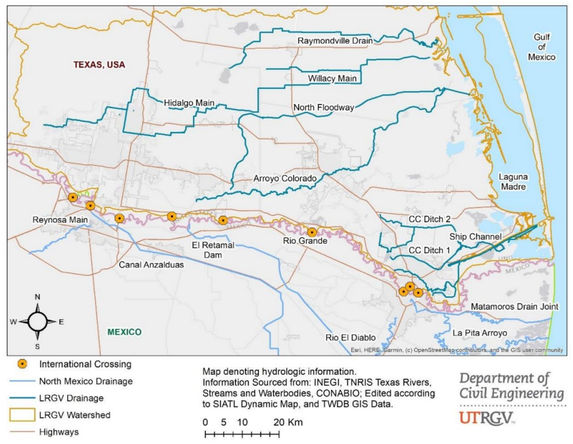

Figure 2. Study Area: Lower Rio Grande Valley [2].

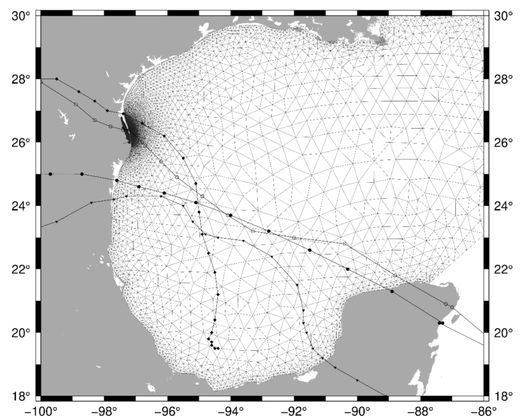

Figure 3. ADCIRC mesh and modelling of Hurricane paths through the Gulf of Mexico [3].

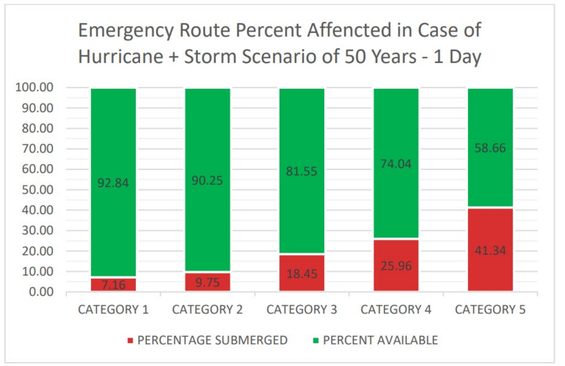

Figure 4. Percentage of affected evacuation routes in case of a 50-year storm scenario [4].

The Geospatial analysis is done utilizing a variety of tools provided by the ArcMap software. Raster calculation was conducted, subtracting the geographical elevation of the area from the water surface elevation; ultimately resulting in the severity of flooding in the areas.

The raster used for the geographical area was sourced from The National Elevation Dataset NED. Further processing and tabulation of data will be done to link geographical shapes to traffic and population data.

4. Analysis of Results

Based on the previously denoted procedure, maps such as the following will be created to denote the results of the analysis. Flooding analysis will extend to denote binational results.

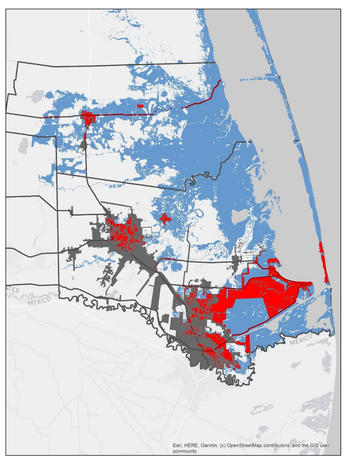

Figure 5. Extension of urban areas and evacuation routes affected in case of a 500-year frequency storm coupled with a category 3 hurricane scenario [2].

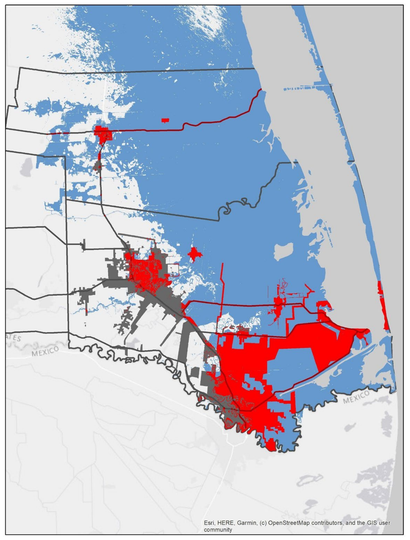

Figure 6. Extension of urban areas and evacuation routes affected in case of a 500-year frequency storm coupled with a category 5 hurricane scenario [2].

5. Conclusion

The developed maps can denote the severity of flooding in different area of the coastal south of Texas. The areas that are closer to the Laguna Madre have a higher severity of flooding due to its proximity to the Hurricane entry route and the relatively low elevation. Further refinement of the model will increase the accuracy of the simulation and provide more detailed information on the impact of the storms on the roads and surrounding areas.

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6. References

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2. Spor Leal, Layda, et al. Geospatial analysis of impact on evacuation routes and urban areas in South Texas due to flood events. Urban Resilience and Sustainability, 2023, 1(1): 20-36.
3. Sara E. Davila, Cesar Davila Hernandez, Martin Flores, Jungseok Ho. South Texas coastal area storm surge model development and improvement. AIMS Geosciences, 2020, 6(3): 271-290.
4. Spor Leal, Layda. Rio Grande Estuary Forecasting Model to Denote Possible Affected Highways in the Coastal Southern Areas of Texas. DDETFP Final Report. 2022.
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