3[RD] INTERNATIONAL WORKSHOP ON
Waves, Storm Surges, and Coastal Hazards
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UNIVERSITY OF GEORGIA Coastal Ocean Analysis and Simulation Team
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Rapid Flood Risk Assessment of Military Installations and Adjacent Communities

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Introduction

Flooding is the deadliest and most costly natural disaster, with global damages exceeding $1 trillion since 1980[1]. Both climate change and the continued development of flood-prone areas may enhance these losses by a factor of 20 by the end of the century (Wing, O. 2020). Assessing coastal hazards in current and future climate change scenarios is highly important for the communities living in coastal areas. In 2021, President Biden's Executive Order on Tackling the Climate Crisis at Home and Abroad (E.O. 14008) was signed, introducing climate change as a national threat. This research aims to develop a methodology for rapid flood risk assessment in coastal areas, focused on military installations and their surrounding communities.

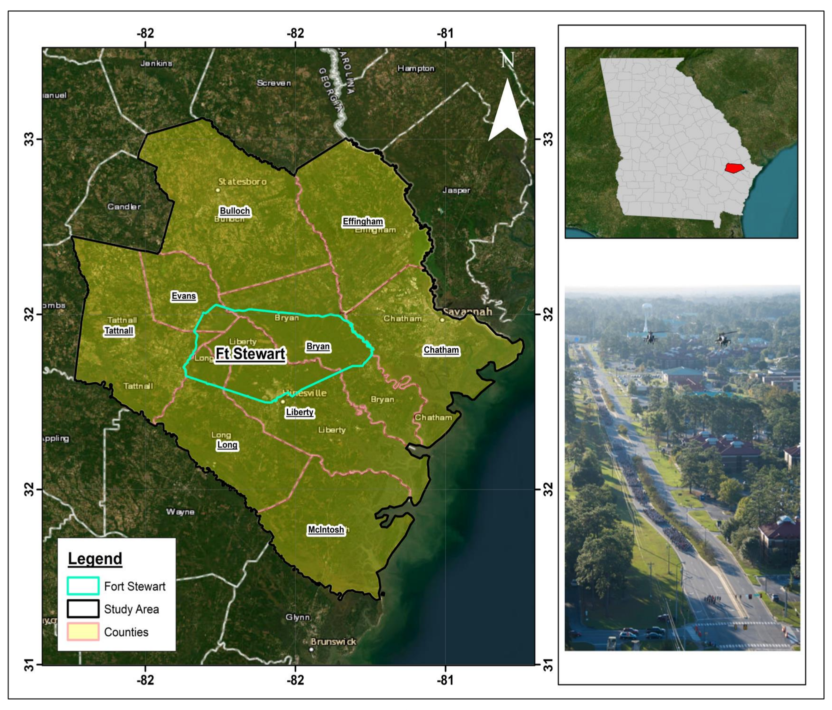

Figure 1: Study Area

[1] Munich Re. NatCatSERVICE https://natcatservice.munichre.com/ (2019).

Our Methods are currently being developed with a case study site in coastal Georgia. Social vulnerability and exposure are being quantified by evaluating critical infrastructure, roadway accessibility, and water depths from different simulated sea level rise scenarios and storm surges, based on the USACE SACS (South Atlantic Coastal Study).

This research is expected to include in its further development the evaluation of compound flooding through hydrodynamic modeling and the potential implementation of natural infrastructure in the study areas for flood mitigation purposes.

SACS: South Atlantic Coastal Study

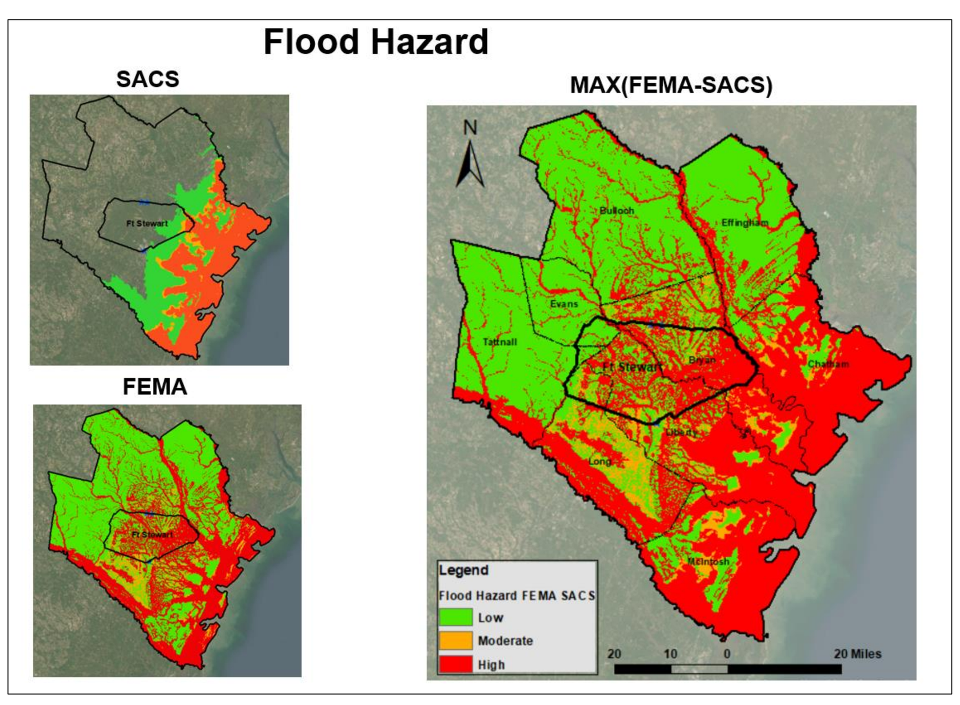

Figure 3: Left, SACS and FEMA flood hazard. Map to the right showing flood hazard combined FEMA-SACS. (Low: Area outside floodplain, moderate: Area in 500 year floodplain, High: Area in 100 year floodplain.

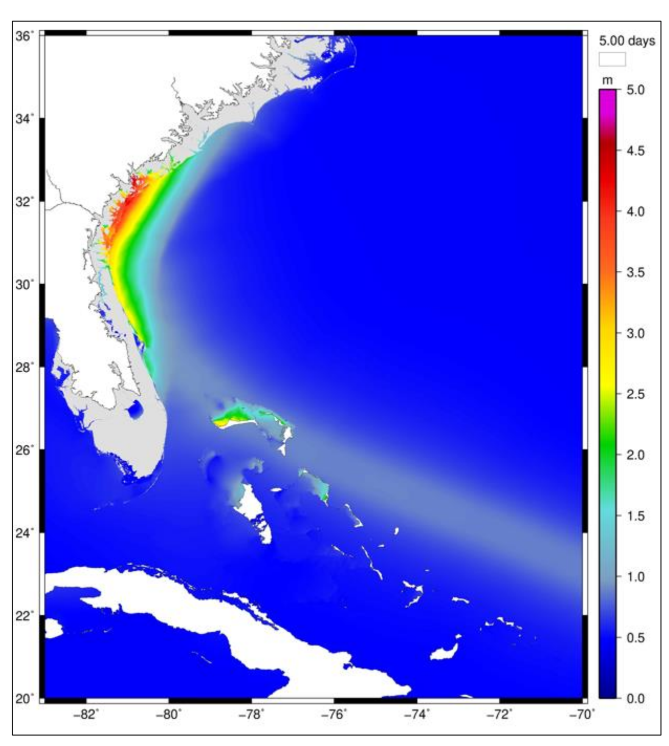

Figure 4: 100 year storm run in ADCIRC using SACS data. Legend shows water depth in meters.

Outputs of the SACS study provide recent wave and water levels derived from numerical modeling (ADCIRC and STWAVE). It accounts for sea level rise projections and probabilistic synthetic storms for various return periods.

Savepoints with flood depths for different return periods are available as an open data source on the SACS website. For this research, aiming to couple FEMA and SACS data, the 1% AEP (100–year flood) and 0.2% AEP (500-year flood) data are considered. The data is analyzed, and flood maps are generated for coastal Georgia through a GIS-based process. Therefore, a combination of FEMA and SACS flood maps is proposed. This is based on maximum pixel value (Figure 8), improving the accuracy of coastal flood maps. The sea level rise scenario considered for this preliminary research is the intermediate 100 years sea level rise (SLR) projection (2.73ft) by the USACE.

Methods

The risk assessment is rendered at a 25-meter scale resolution, classifying each 25m x 25m pixel on the map as a "high," "moderate," or "low" risk. Hazard, vulnerability, and exposure are considered and are normalized to a rating of 1 (low), 2 (moderate), or 3 (high). Then, these values are multiplied to determine an overall risk assessment. This methodology is represented graphically in Figure 2.

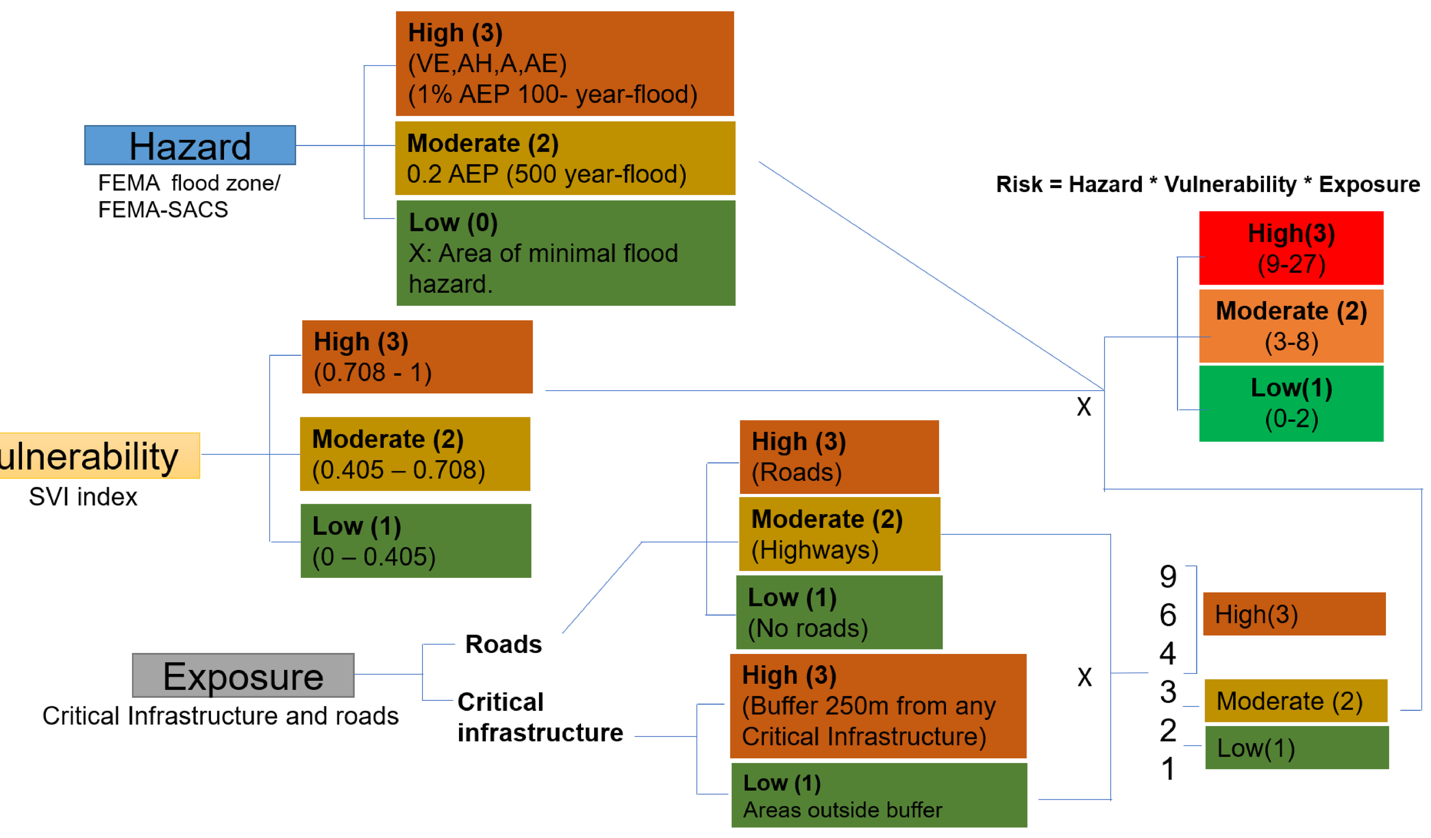

Figure 2: Flood Risk Assessment methodology.

For a pixel to be considered high risk, two of three variables, including flood hazard, should be at high risk.

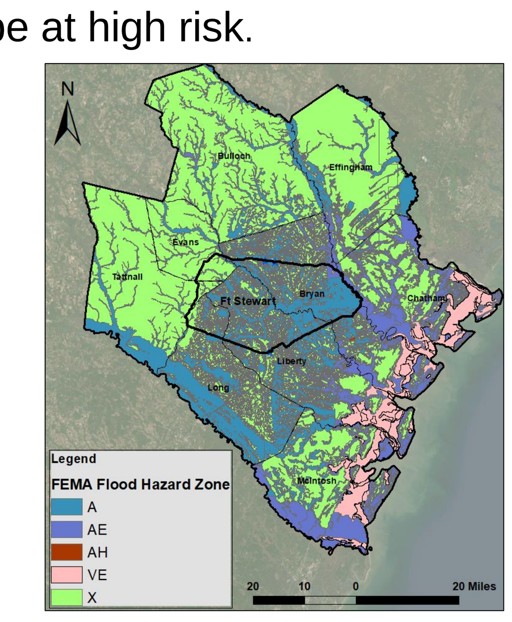

Figure 5: FEMA Flood Hazard zones

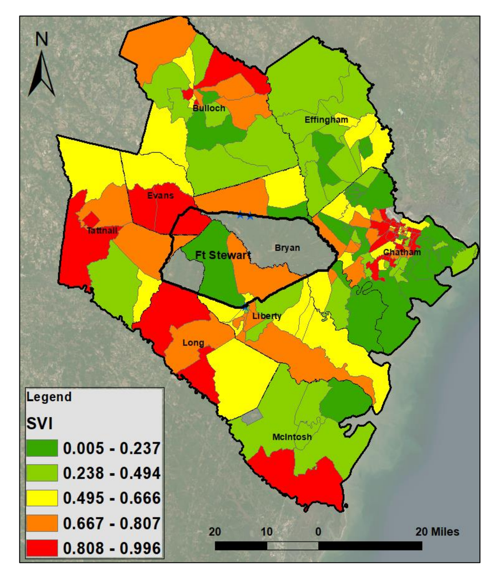

Figure 6: Social Vulnerability Index

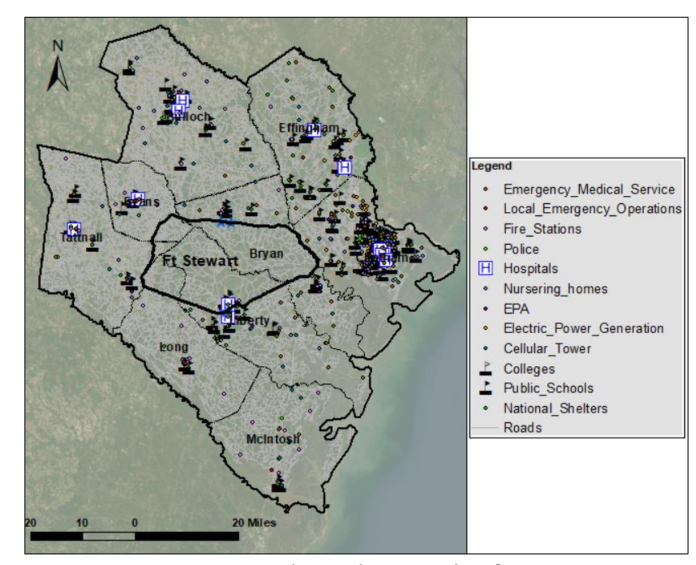

Figure 7: Roads and Critical Infrastructure

The FEMA layer provides data about different flood zones. CDC's Social Vulnerability Index (SVI) is widely recognized as a useful tool for examining community-scale vulnerability, accounting for socioeconomical status, household characteristics, racial and ethnic status, and housing type ad transportation. The critical infrastructure includes hospitals, schools, medical facilities, fire stations, etc.

Table 1: Data Source

Data	Source
Flood Hazard	FEMA
Critical Infrastructure	Mapservice
Roads	U.S. Census Bureau, Department of Commerce
Social Vulnerability Index	CDC

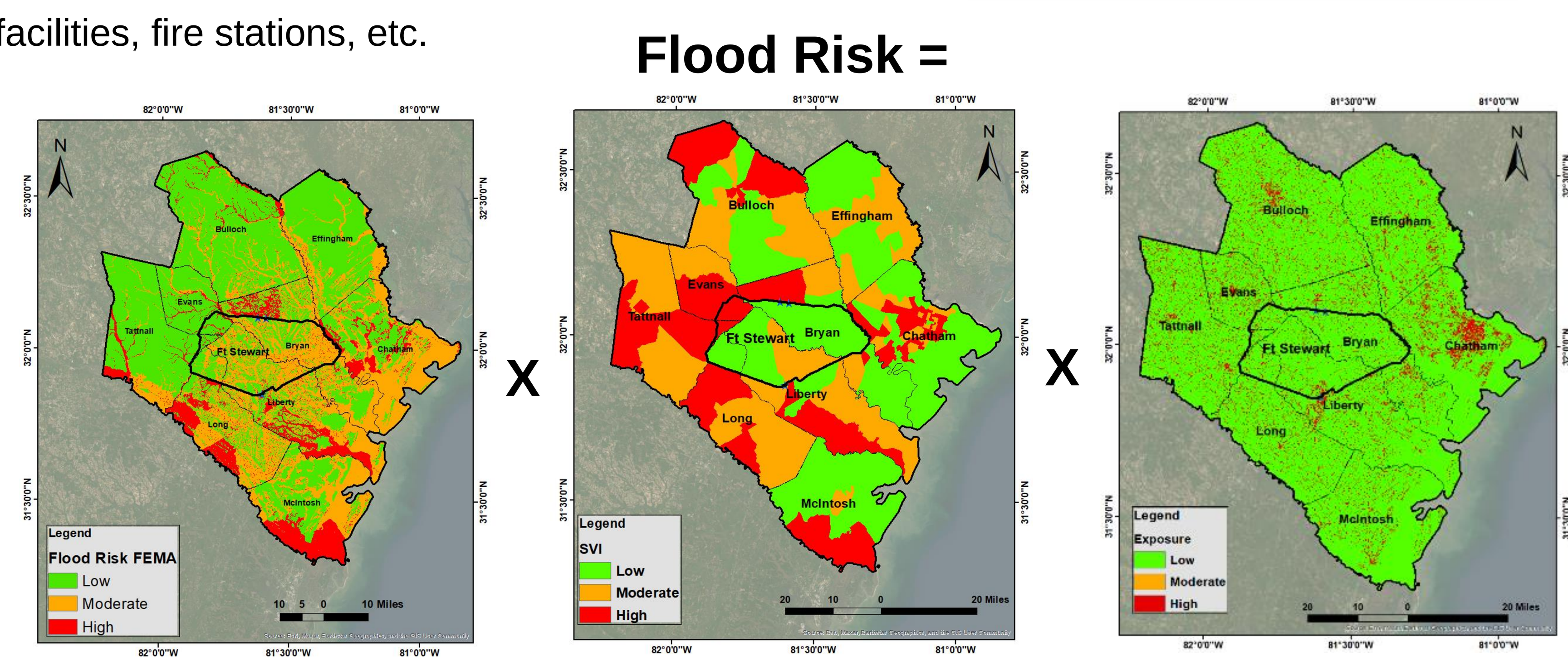

Figure 8: Flood Risk variables categorized as low, medium and high.

Results

As a result, flood risk maps are generated. Figure 9, shows the flood risk map using FEMA hazard layer and figure 10 shows flood risk map using FEMA-SACS flood hazard layer, including the sea level rise projection.

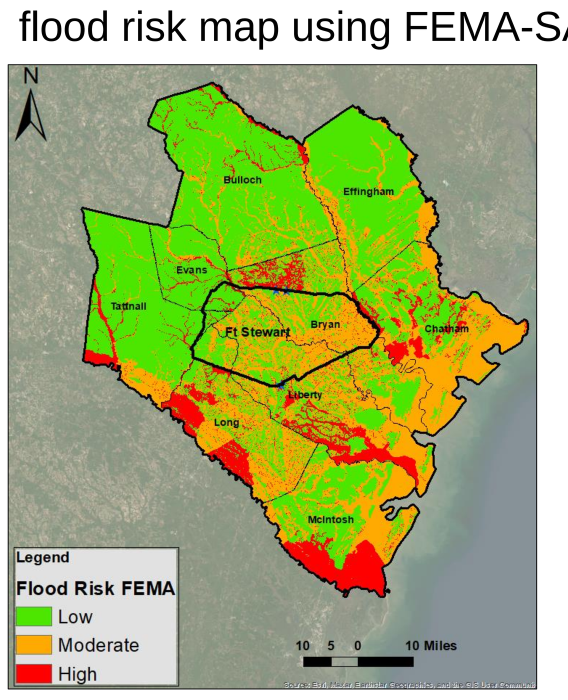

Figure 9: Flood Risk using FEMA hazard.

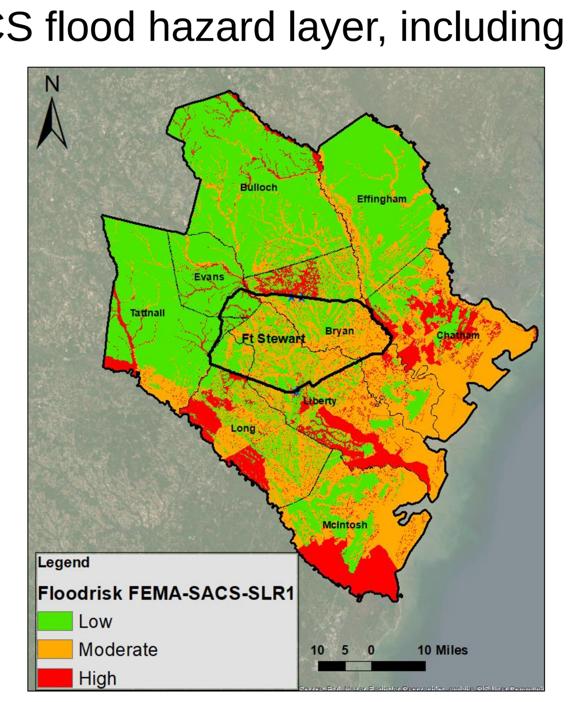

Figure 10: Flood Risk using FEMA-SACS hazard and including sea level rise projection (2.73 ft).

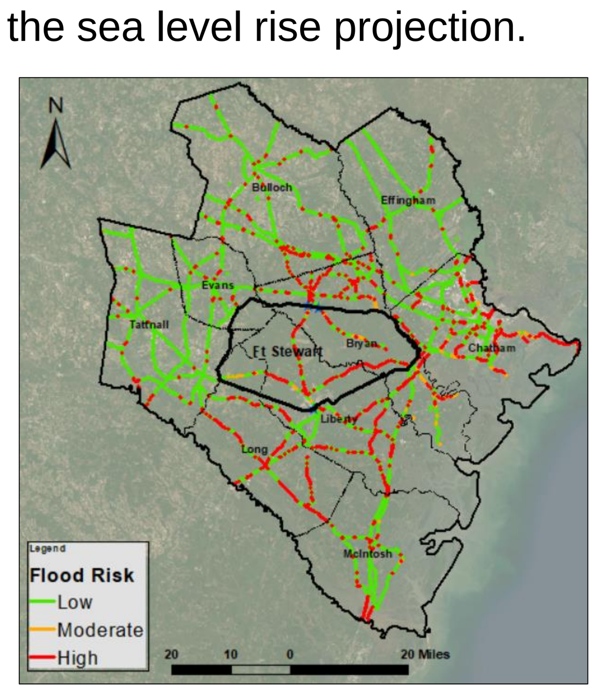

Figure 11: Main roads network flood risk using FEMA hazard.

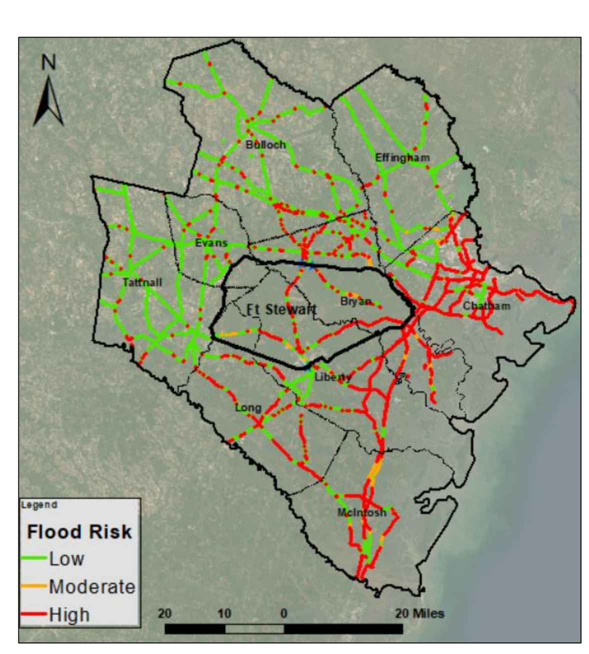

Figure 12: Main roads network flood risk using FEMA-SACS hazard and including sea level rise projection (2.73 ft).

6% decrease in outside of floodplain area and 6% increase in 1% AEP area between FEMA and FEMA-SACS (Sea Level Rise).

65,405 Ha changed from low risk to high risk between FEMA and FEMA-SACS (with Sea Level Rise).

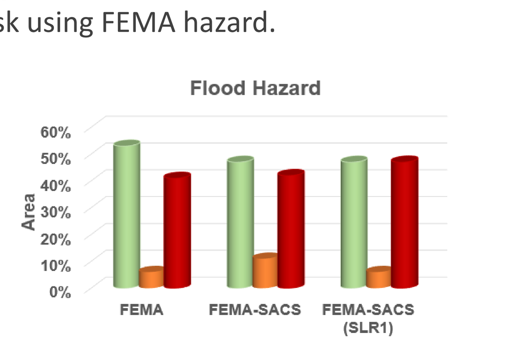

Figure 13: Percentage of area in low, moderate and high flood risk.

2,710 miles of roadways changed from low risk to high risk between FEMA and FEMA-SACS (Sea Level Rise).

Conclusions and future work

The first stage of this research proposes a rapid GIS-based methodology to asses flood risk through public data sources, including sea level rise projections for future decision-making. The social impact of this research considers the social vulnerability of the communities and the accessibility to roads for current and future flood scenarios.

This methodology is the result of the starting research phase, where the main limitation is the understanding of the dynamics behind the transition zone between inland flooding and coastal flooding. Future work will include hydrodynamic modeling for compound flooding, road network analysis in the area, and the assessment of nature-based solutions as a solution to reduce the impact of flooding events. This research aims to increase community resilience against current and future flood events.

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