CENTER FOR TRANSPORTATION RESEARCH

Project 0-7055: An Extreme Weather Risk-Assessment Framework for Port Infrastructure Systems

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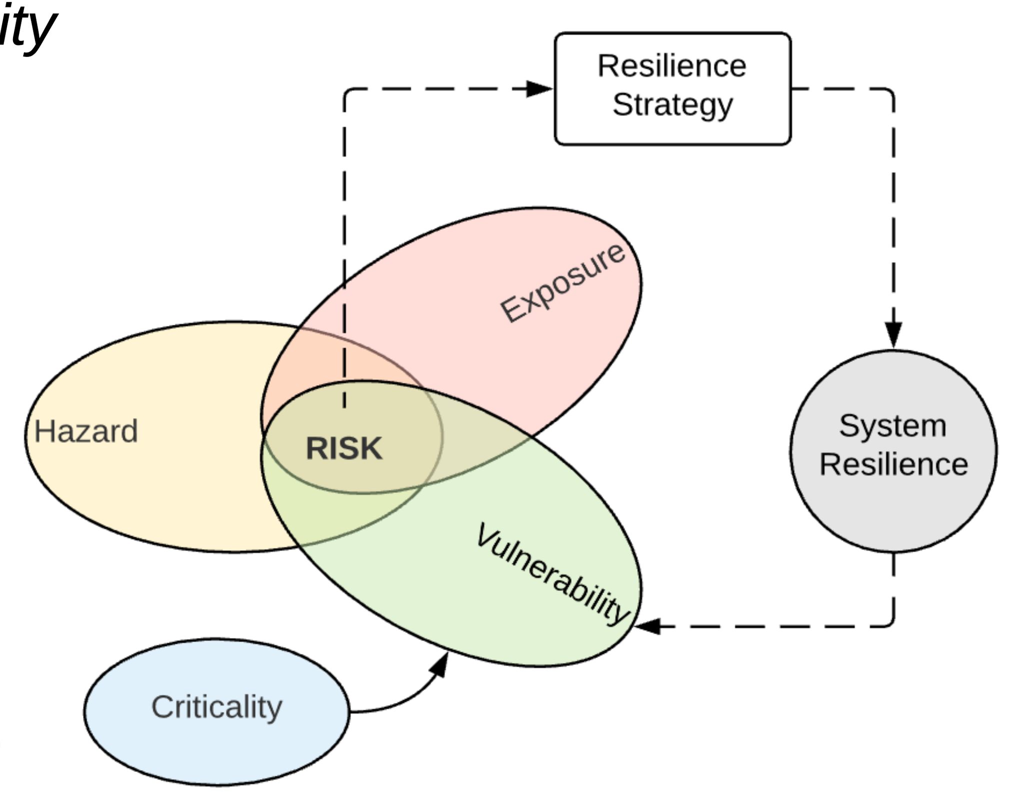
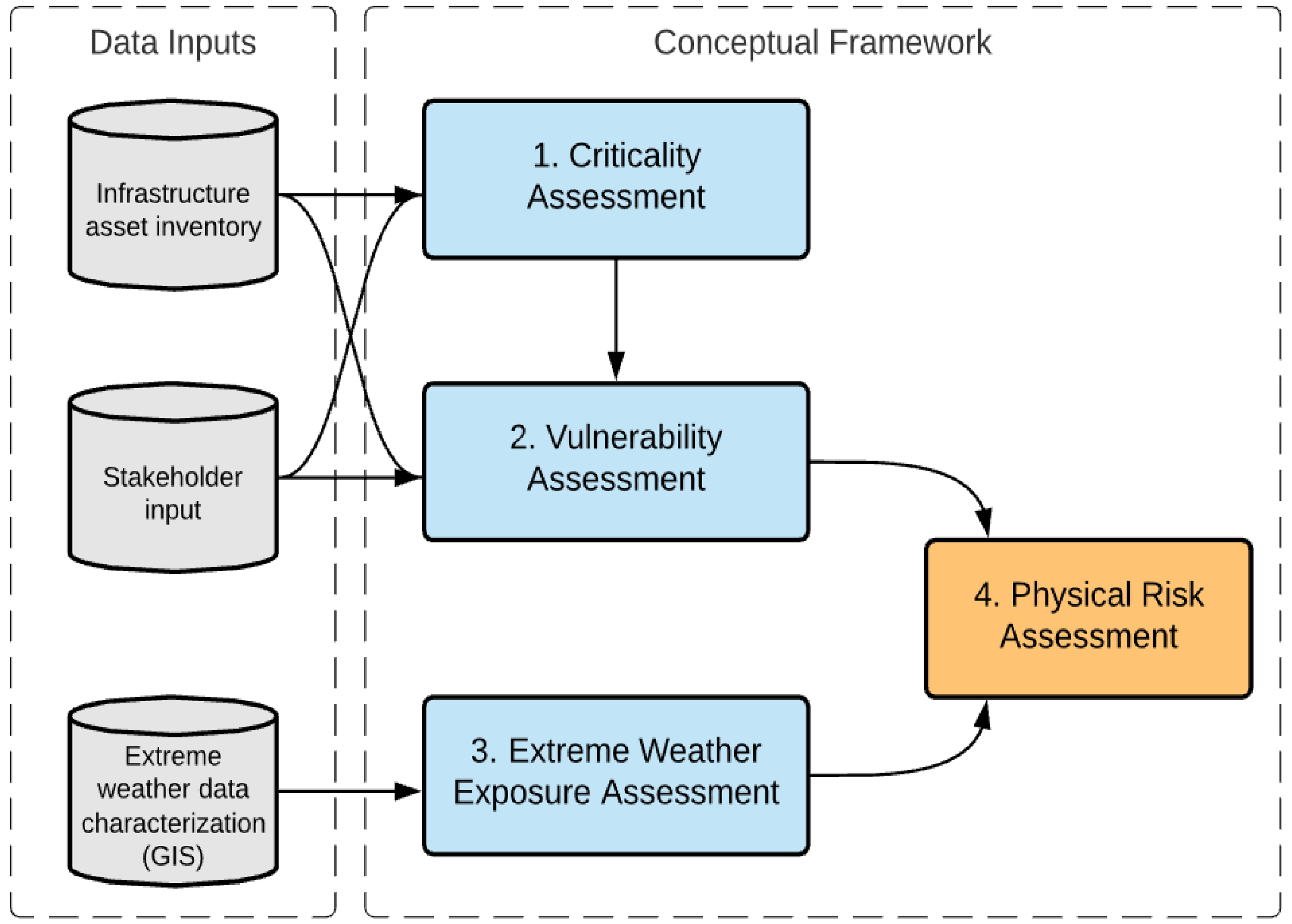
Background

- *Risk = expected losses x probability*
- Risk influenced by hazard, exposure, vulnerability
- Data on expected losses and probability of occurrence may be difficult to acquire or verify
- Risk may be estimated with a proxy indicator using readily accessible datasets
- Exists a need for port-specific framework accounting for multiple infrastructure systems, at a network level



Framework

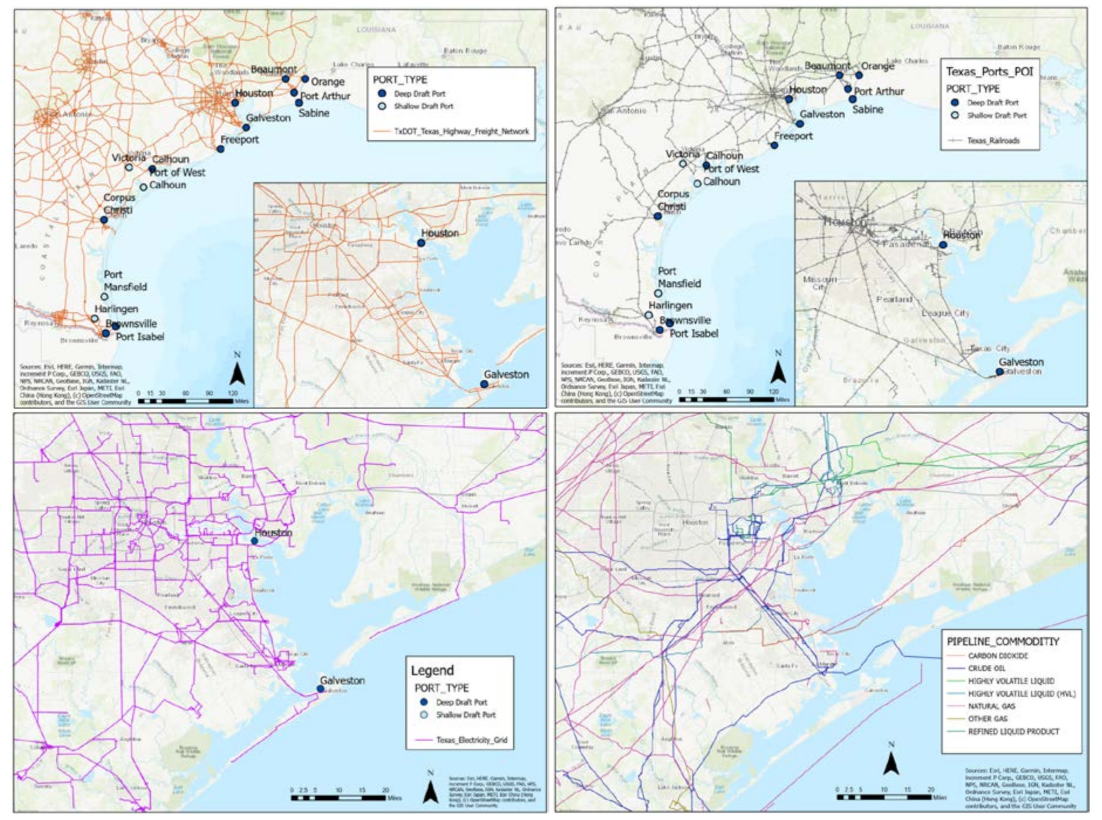


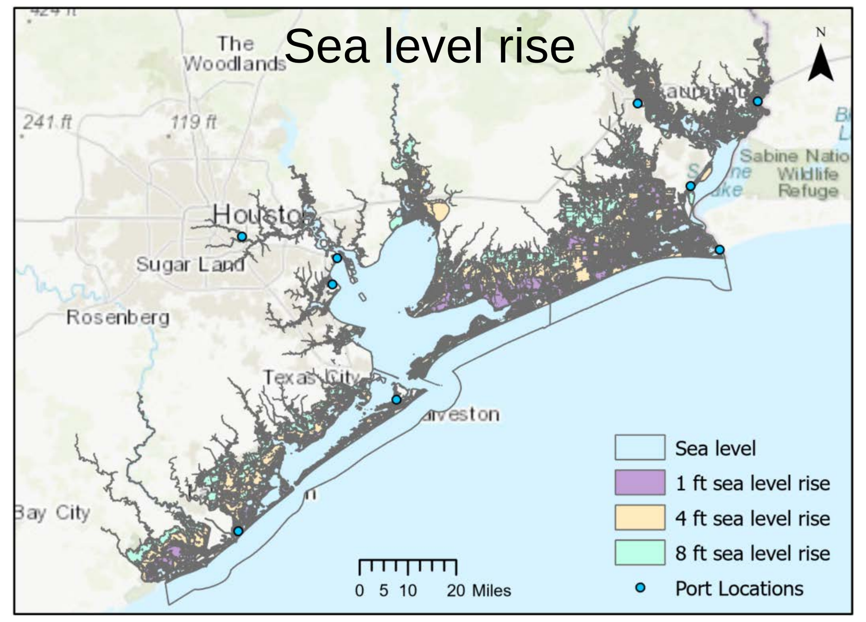
Data Requirements

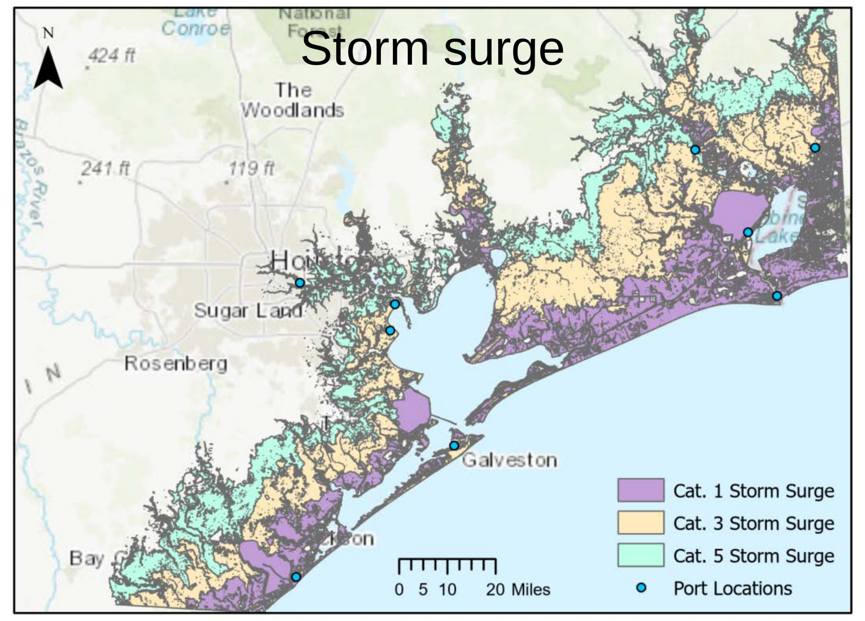
Infrastructure GIS Layers
- Port assets
- Landside assets
- Supporting utilities

Stakeholder input
- Port authorities, public agencies, private companies
- Identification of recovery bottlenecks and critical infrastructure components

Extreme weather hazards GIS layers



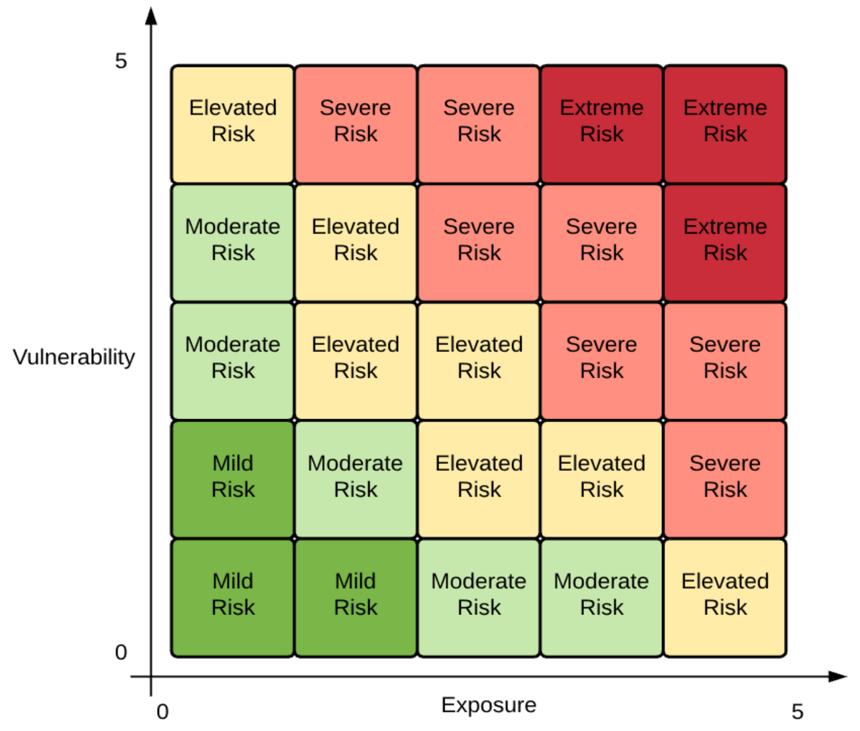




Methodology

- Scores for criticality, vulnerability, and exposure assigned from data attribute values and weights, range from 0 to 5
- Assessment performed in GIS
- Risk (R_{ij}) is product of exposure (E_{ij}) and vulnerability (V_i) scores

$$R_{ij} = V_i \cdot E_{ij}$$



Case Study

- Houston area highway, railroad, electric grid, pipeline systems
- Sea level rise and hurricane storm surge hazards
- Criticality scored with data attributes on a scale of 0 to 5

System	Criticality Attributes
Highway	Road classification, NHS designation, evacuation route status, AADT, truck traffic percentage
Railroad	Railroad owner class, line type, critical facility access
Electric Grid	Line voltage
Pipeline	Pipeline diameter

- Vulnerability taken as criticality and distance from port
  - Criticality, interdependency, replacement cost, detour length
- Exposure to hurricane storm surge and sea level rise scored by hazard severity
- Risk scores for individual hazards for each system, total risk for each system, and total network-level risk found using weighting system

System	Sea Level Rise Risk Score	Sea Level Rise Risk Level	Storm Surge Risk Score	Storm Surge Risk Level	Total Risk Score	Total Risk Level
Roadway	2.76	Moderate	4.74	Elevated	3.75	Moderate
Railway	5.90	Elevated	8.80	Elevated	7.38	Elevated
Pipeline	5.68	Elevated	8.52	Elevated	7.09	Elevated
Electric Grid	8.48	Elevated	10.66	Severe	9.57	Severe

Summary

- A framework for the assessment of port system risk is presented
- Case study for Houston region performed to demonstrate application of framework
  - Road, rail, pipeline, and electric grid systems assessed to storm surge and sea level rise hazards
- Methods may be used by TxDOT to identify roads and infrastructure assets at risk to damage from extreme weather impacts

Acknowledgements

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