Quantitative Analysis of Hurricane Harvey Impacts on Texas Maritime Facilities

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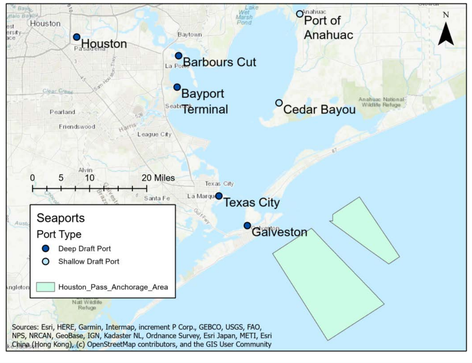
Background

- Hurricane Harvey disrupted Texas port operations in August and September 2017, resulting in significant regional and national economic impacts
- Quantifying port disruptions helps stakeholders understand the extent of past disasters and existing resilience capabilities
- **Objectives:**
  1. Quantify impact by comparing vessel arrivals during typical operations (2016) with those during Hurricane Harvey (2017) using NVC
  2. Examine Hurricane Harvey impact on vessel delay by determining changes in ship dwell time and time in port using mean dwell time and dwell time distribution

Data Sources

- Automatic Identification System (AIS) vessel tracking data
  - Location coordinates of individual vessels at ~70 sec intervals, cargo types, timestamp, other attributes
  - Publicly available from USCG
- Anchorage and container terminal GIS layers
  - Locations of ship queuing and port service areas
  - Publicly available from NOAA

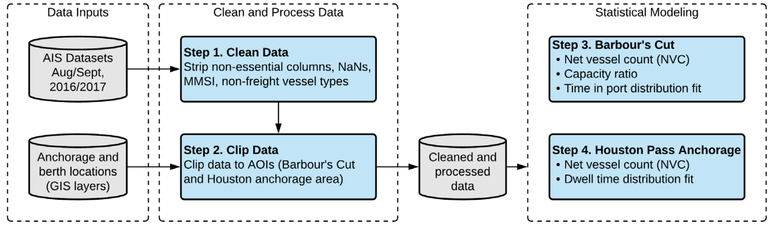
Study Area



Two levels of analysis show impacts at facility level and regional level (multiple ports)

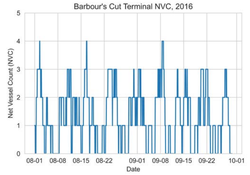
- **Houston anchorage:** waiting area for vessels seeking service at Houston port terminals located in Gulf
- **Barbour's Cut Container Terminal:** container terminal operated by Port Houston

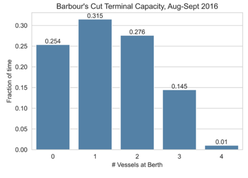
Methods

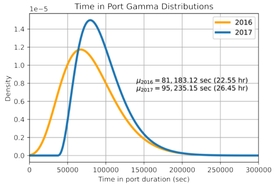


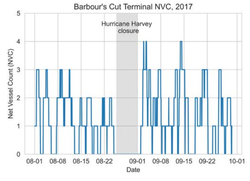
- Methods used to assess hurricane impacts:
  - Net Vessel Count (NVC): count of vessels in anchorage or at port (queue size)
  - Usage-capacity ratio: indicates berths usage and relates terminal activity
  - Dwell time distribution: statistical distribution fitting to describe wait times
- Statistical tests
  - Bayesian changepoint detection to identify length of disruption and recovery time
  - KS test to test distribution fit for dwell time datasets
  - Two-tailed KS test to verify dwell time datasets come from different distributions
  - Welch's t-test to determine if means of dwell (2016 and 2017) are different

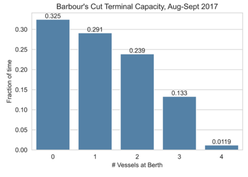
Barbour's Cut Terminal Results





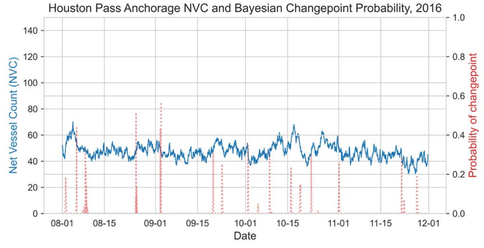


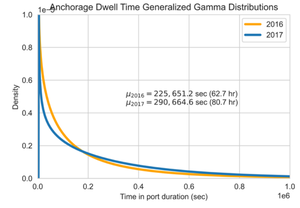


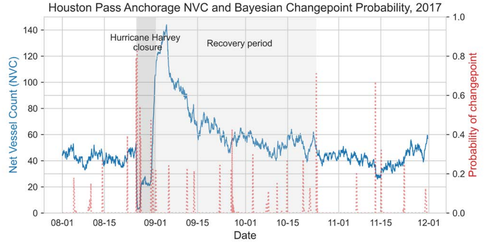


Statistic	2016	2017
Count, n	82	65
Mean, μ	22.55 hr	26.45 hrs
Std Dev, σ	9.86 hrs	8.06 hrs

Houston Anchorage Results







Statistic	2016	2017
Count, n	2,180	1,155
Mean, μ	62.7 hrs	80.7 hrs
Std Dev, σ	93.1 hrs	95.1 hrs

Findings and Discussion

- Hurricane Harvey resulted in a mean increase of **4 hours in port** and **18 hours in anchorage** for freight vessels in the Houston area
- Vessel time in port and vessel dwell time in anchorage may be fit with statistical distributions
- AIS datasets show promise as a **reliable data source** for post-disaster impact analysis
- Bayesian changepoint detection analysis is effective technique for AIS data; Hurricane Harvey disruption on Houston ports lasted **2 months**
- TxDOT may use these methods and results to examine the impacts of hurricanes on Texas ports