How Does Climate Change Contribute to the Failure of Oil & Gas Pipelines?

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Highlights

- Oil and gas industry is extremely sensitive to climate change, especially in coastal and offshore regions
- The Gulf of Mexico region is one of the most vulnerable areas as it is the primary source of offshore oil and gas production, and significant source of coastal petroleum infrastructure
- Spatial analysis of this region has shown that by 2100 (5 feet Sea Level Rise), **Hazardous Liquids, and Gas Transmission/Gathering pipelines** will be particularly at risk of failing
- Current state of project signals need to assess relocation/protection of existing pipelines that are potentially at risk
- Future work is going to be conducted to develop inference statistical learning models to identify significant predictors among large set of features from Oil & Gas pipelines data

How exactly is Climate Change affecting the petroleum infrastructure?

Temperature rise – can cause water shortages in the area; decreased availability of ice-based transportation and stability of buildings laid on permafrost

Extreme Storm Events – storm surges can flood the oil storage tanks, causing oil spills; causes the overturn and damage of petroleum platforms

Sea Level Rise – as the land becomes inundated, there is a change in the soil mechanics which causes pipelines to shift and get damaged

Types of Pipeline Systems

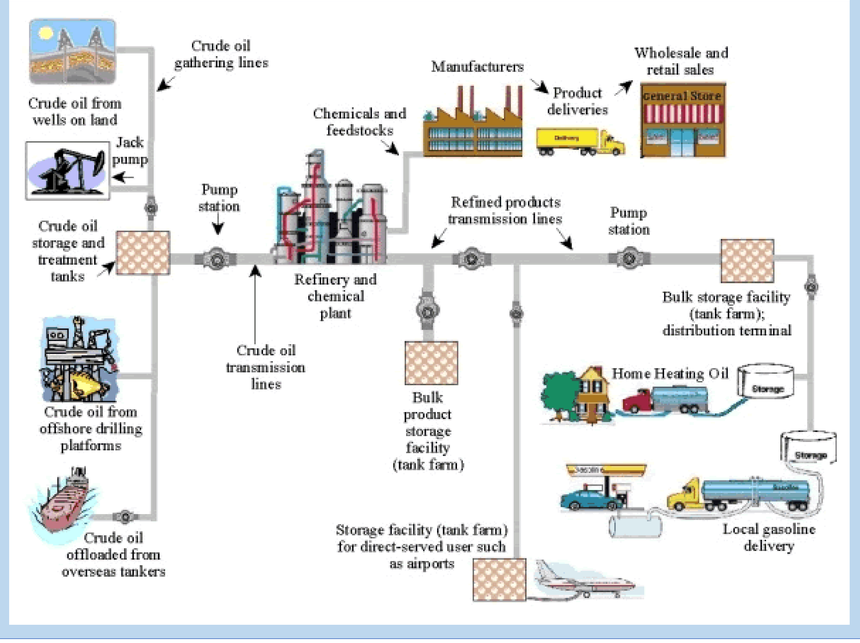
- Hazardous Liquids
- Gas Distribution
- Gas Transmission/Gathering
- Liquified Natural Gas

In this project, Liquified Natural Gas was not used

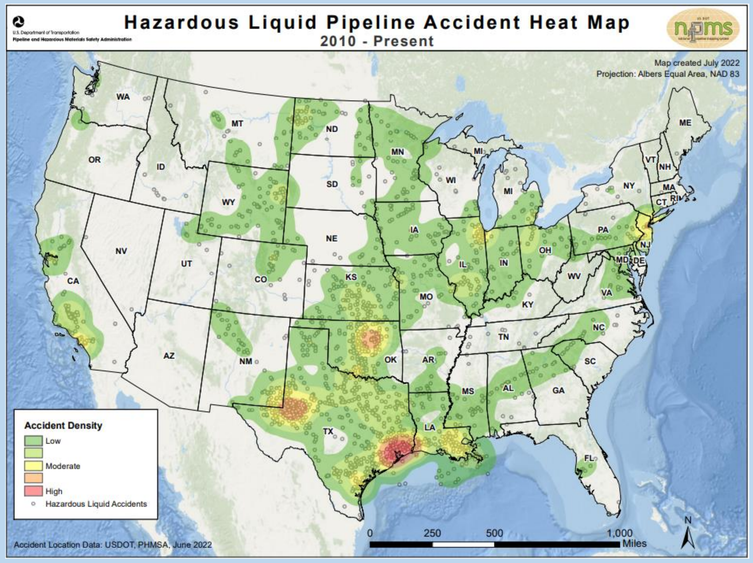
Utilized Data

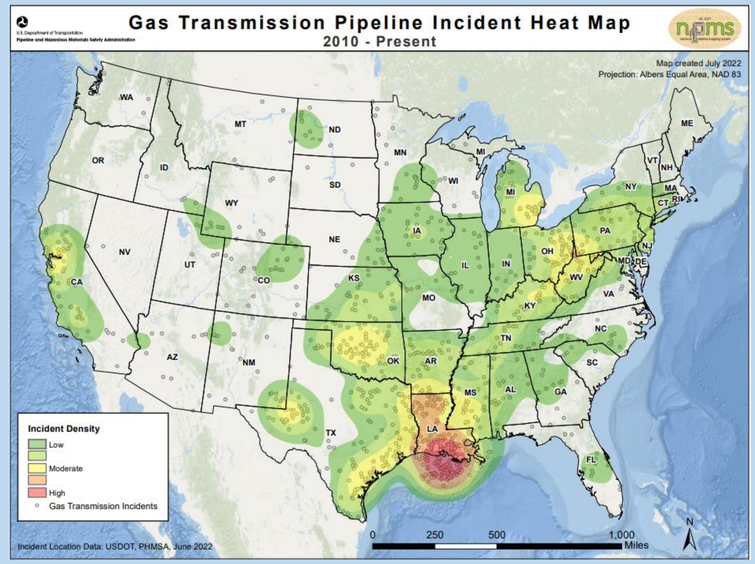
- Working Pipelines data from Pipeline and Hazardous Material Safety Administration (PHMSA), time period of 2010-2022
- Failed Pipelines data from PHMSA, time period of 2010-2022
- Sea level rise data from National Oceanic and Atmospheric Administration (NOAA)

Overview of Hazardous Liquids Pipeline System



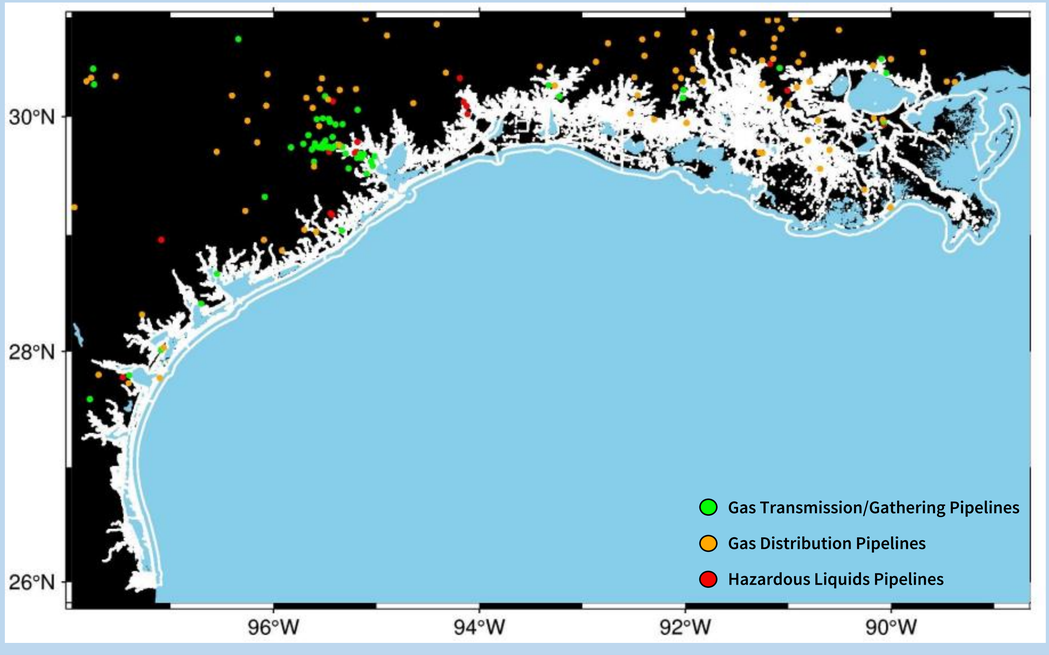
Hazardous Liquid and Gas Transmission Pipeline Incident Heat Maps





These 2 maps indicate how vulnerable the Gulf of Mexico area really is in terms of their petroleum production (onshore and offshore). Louisiana and Texas states are extremely vulnerable to pipeline failure, and them being one of the biggest petroleum infrastructure states in the US brings up huge risks not only about the dangerous liquids being spilled, but also other risks that are tied with the potential climate change worries such as migration of the nation on the shorelines due to sea level rise and many more.

Mapping 5 feet Sea Level Rise (predicted by year 2100) and its potential effects on the pipelines



Simulation of 5 feet Sea Level Rise

- Fort Pike, Louisiana

- Fort Anahuac Park, Texas

- Scholes Airport Terminal, Texas

Note: because of restricted access to National Pipeline Mapping System, pipelines are depicted via points and not usual lines. However, these points should give approximate region where they are located, and it is obvious to see the potential threats affecting these infrastructures.

Example of Damaged Offshore Infrastructures

Examples *of extreme storm impacts* on coastal and offshore petroleum infrastructure: **(A)** offshore platforms were damaged during a hurricane off of Louisiana (reproduced under CC by 4.0 license, credit to Kaiser and Chambers); **(B)** oil tanks were carried away by storm surge that caused over 1,750,000 L of oil release (reprinted with permission from"Alex Glostrum for the Louisiana Bucket Brigade", credit to Godoy); **(C,D)** before and after operating platform were destroyed during the 2005 hurricane season (reprinted with permission from Elsevier, credit to Kaiser and Kasprzak).

Future Work

- Understand which features are most significant for determining pipeline failure
- Tie external Climate data (Sea Level Rise, Extreme Storm Events – NOAA data) to add more features for the model for pipeline failure prediction modeling
- Assess infrastructural damage of the Gulf of Mexico area (Louisiana/Texas)
- Alert the need to develop pipeline-supporting material to be applied to existing pipelines for protection

References

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