Evaluating the Nation's Pipeline Infrastructure with NETL's Advanced Infrastructure Integrity Model (AIIM)

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Objective

The goal of this project is to produce a smart tool that assesses the reusability and risks associated with existing energy infrastructure, using the award-winning Advanced Infrastructure Integrity Model (AIIM). This model forecasts lifespan and potential risk using multiple factors including structural characteristics, incidents, and the surrounding environment.

Additionally, this project aims to provide scientific insights for a better understanding of carbon storage (CS) potential using existing energy resources, supporting CS stakeholder needs, national decarbonization, and mitigating climate change. An energy infrastructure database has also been developed for the model to use as input. AIIM has been utilized for assessing offshore infrastructure reuse potential for CS. In this project, it will be applied to onshore energy infrastructure.

Advanced Infrastructure Integrity Model (AIIM)

NETL's AIIM is a science-based, artificial intelligence, big data, and big data computing informed approach to assessing energy infrastructure integrity for safe future use and repurposing. Using the global to inform the local, this method integrates infrastructure stressors spanning the entire natural-engineered system to develop multiple machine learning (ML) models and spatio-temporal analytics to understand existing infrastructure integrity.

Figure 1: Graphic showing different data layer categories feeding into AIIM.

Since being recognized as a top-ranked innovation and selected as a TechConnect National Innovation Awardee for its application to offshore infrastructure, NETL is now turning to the onshore environment and applying this approach on oil and gas pipeline infrastructure.

Energy Infrastructure Database

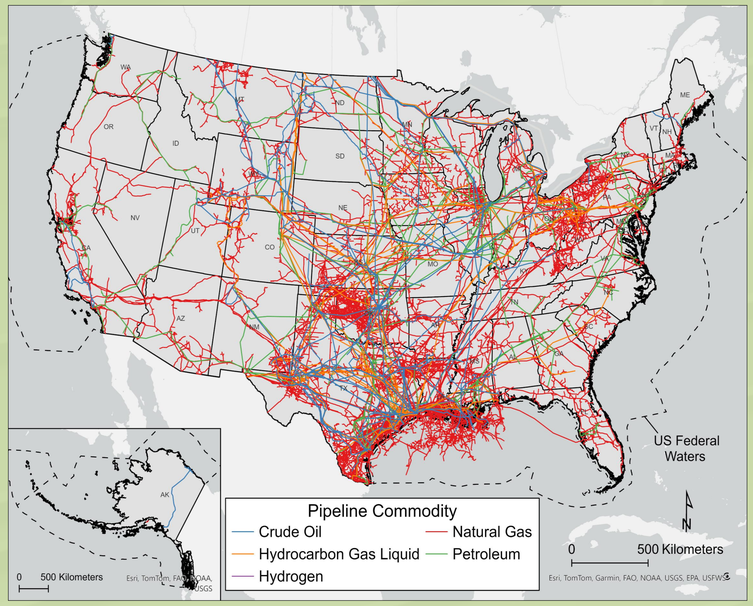

Figure 2: Map of pipelines by commodity.

AIIM will utilize an onshore energy infrastructure database that was developed by acquiring publicly available data and NETL data products. These resources include incidents, environmental variables, geohazards, and structural characteristics. Quality control has been completed for the data and subject matter experts for modeling will prime AIIM for assessing the integrity of existing onshore energy infrastructure.

Methods

1. Acquired and catalogued publicly available data and NETL derived products.
2. Soil data in the form of rasters were processed. Soil categories include carbonate content, available water supply, soil PH, etc.
3. Pipeline incident report data was processed and includes incidents for natural gas pipelines, incidents summarized by county, incidents summarized by census tract, etc.
4. A crossing count script was developed to count the number of times a particular pipeline segment was intersected by crossing features such as roads, railroads, and rivers.
   a) Pipelines were split into 1-kilometer segments.
   b) Intersection points were generated where crossing features intersected pipeline segments.
   c) The pipeline segments were converted to points. These points were generated in the middle of the segment. Crossing counts were recorded for each crossing feature.
5. Distance to oil and natural gas wells, petroleum ports, intermodal freight facilities, and geologic structures were calculated using the Distance Accumulation tool in ArcGISPro.
6. After the data preparation and quality control was complete, the data was integrated into the pipeline points layer.

Data Category	Number of Layers	Examples
Infrastructure	23	Primary Roads, Crude Oil Pipelines, Railroads
Incident Reports	7	Natural Gas Pipeline Incidents, Incidents by County
Environmental	8	Slope, Aspect, Elevation, Soils
Geohazards	5	Floodplain, Seismic Hazards, Wildfire Hazard Potential
Hydrology	4	Surface Waterbodies, Rivers, Flowlines
Climate/Weather	10	Average Surface Temperature, Precipitation
Demographic	1	Population Density by Census Tract
Geologic	3	Geologic Structures

Figure 3: Table listing data categories, number of layers for each category, and examples of data for the category.

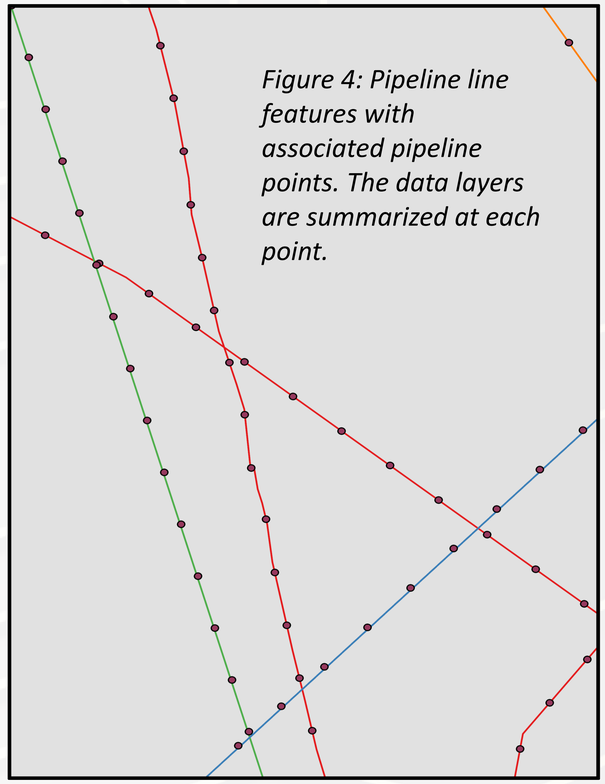

Figure 4: Pipeline line features with associated pipeline points. The data layers are summarized at each point.

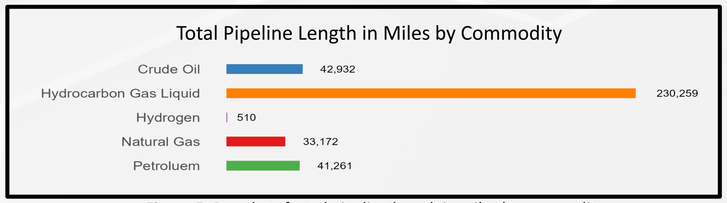

Figure 5: Bar plot of total pipeline length in miles by commodity.

Next Steps

Acquired proprietary data will be integrated into the database. The database will be used as input for AIIM and models will be generated for onshore pipelines.

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References

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