Conceptualizing Data Availability and Technical Viability Methods within the Carbon Storage Technical Viability Approach (CS TVA)

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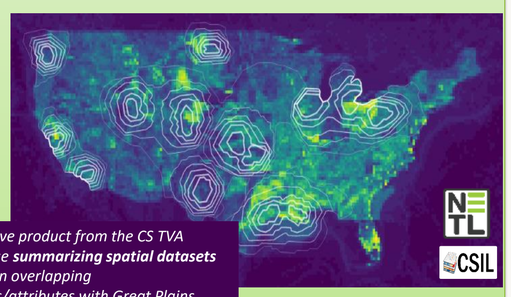
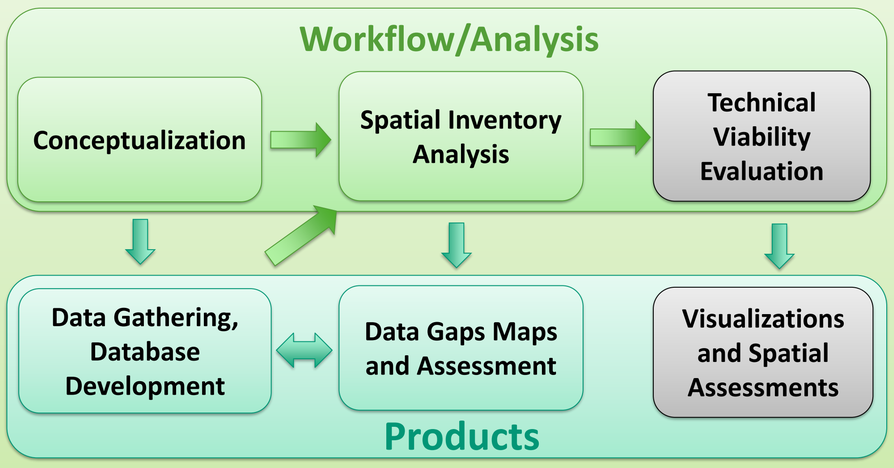
Motivation

- Need to understand more accurately the regions with evidence of high feasibility for carbon storage (CS).
- There is currently a poor understanding and lack of workflow that incorporates CO_2 storage resources, environmental and socio-economic (EJ/SJ) factors to communicate technically viable, feasible carbon storage.
- Previous assessments of data density (CSIL map below) are helpful for visualizing data spatially, however, do not address data utility or link data density to project feasibility.
- To address this gap, a new workflow, -- the Carbon Storage Technical Viability Approach (CS TVA) -- is in development.



*Derivative product from the CS TVA database **summarizing spatial datasets** based on overlapping features/attributes with Great Plains Institute carbon storage hubs*

Project Overview



Future work

- Data availability assessment and technical viability assessment are two key components of the CS TVA.
- Conceptualization is the current focus, with emphasis on linking data types required for analysis to the components of the Technical Viability Matrix (below), which can be used to qualitatively assess viability for each component.
- Developing the Technical Viability Matrix iteratively informed data requirements (left below) linked to the matrix (right below) and initial spatial inventory efforts.

Conceptualization Process

- Developed data requirements list using previous experience and existing literature on geologic carbon storage studies and aggregated the data types used into a single list.
- The Technical Viability Matrix was developed starting with the frameworks of Rodosta et al. (2011) and Callas et al. (2022). Initial CS TVA will focus on viability for sedimentary geologic CS.

Results and Outcomes

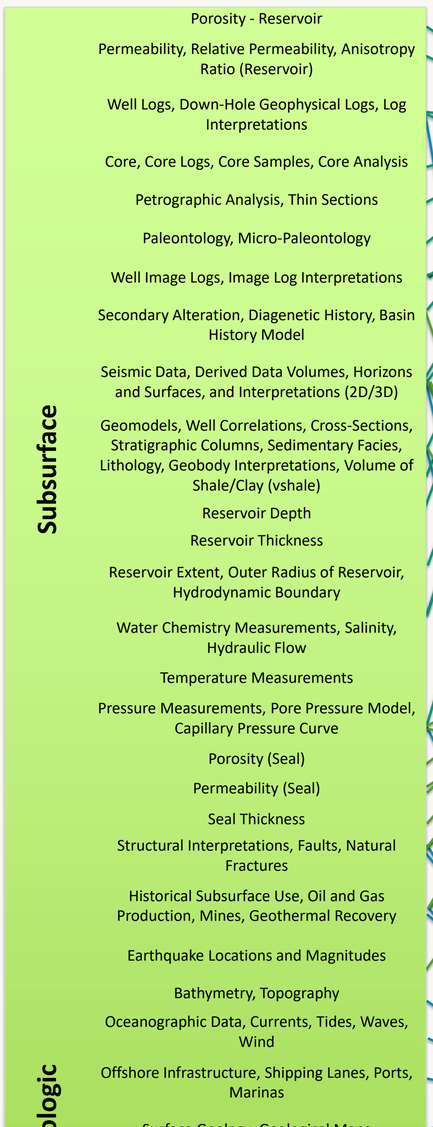
Products:

- Conceptualization linking table of data required to Technical Viability Matrix
- Demonstration of spatial data assessment tools utilized as inventorying tools (VGA, STA) workflow (CS TVA)
- Carbon Storage Technical Viability Database
- Data gaps maps and visualizations

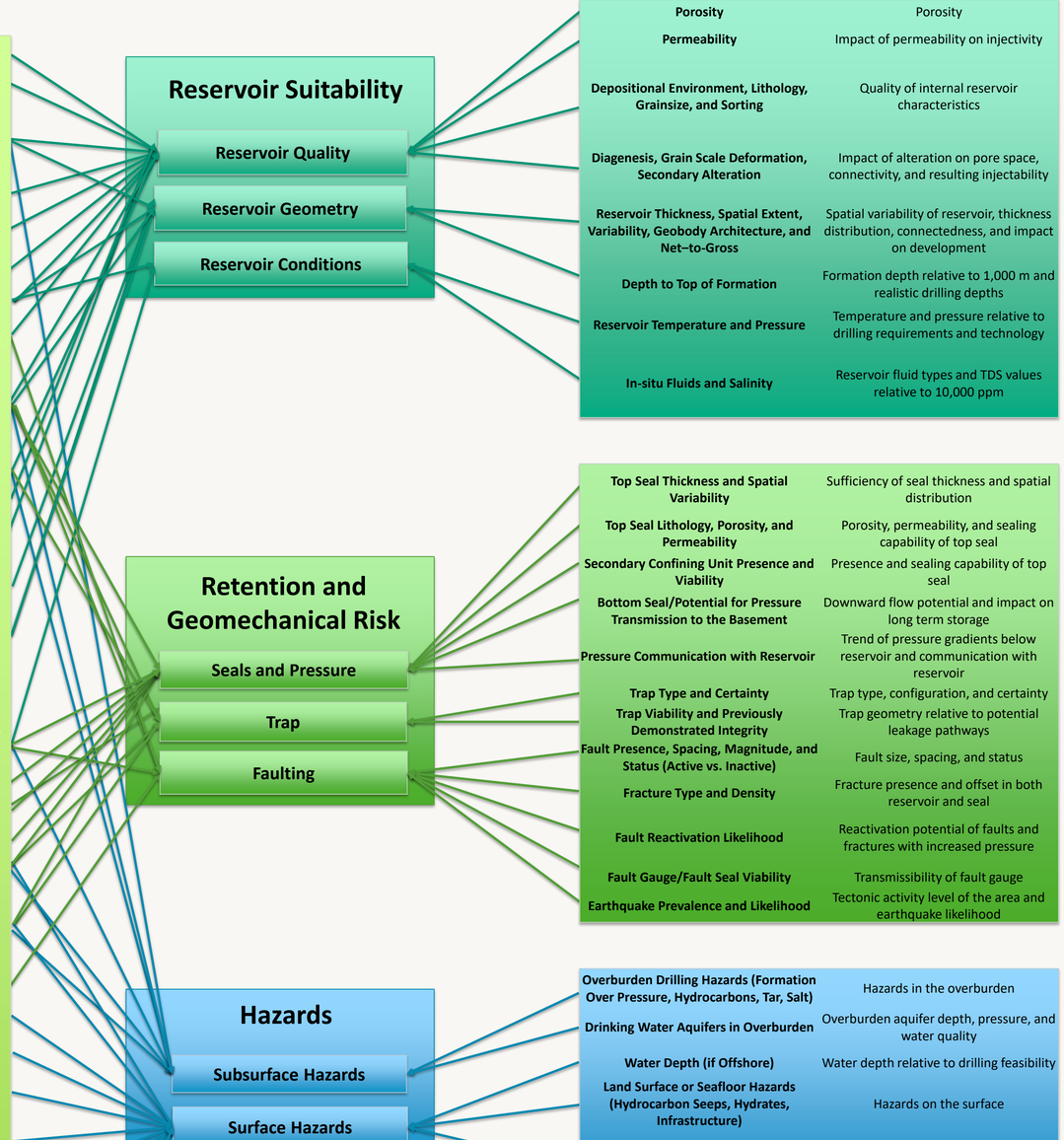
Impact:

- Tools and resources which can be leveraged by a wide variety of users, stakeholders, and audiences
- Improve communication of data resources and hurdles facing geologic CS assessments
- Focus future data gathering opportunities on most useful data types and in most effective areas

Data Required



Technical Viability Categories



Technical Viability Components

Component	Determination
Porosity	Porosity
Permeability	Impact of permeability on injectivity
Depositional Environment, Lithology, Grainsize, and Sorting	Quality of internal reservoir characteristics
Diagenesis, Grain Scale Deformation, Secondary Alteration	Impact of alteration on pore space, connectivity, and resulting injectability
Reservoir Thickness, Spatial Extent, Variability, Geobody Architecture, and Net–to-Gross	Spatial variability of reservoir, thickness distribution, connectedness, and impact on development
Depth to Top of Formation	Formation depth relative to 1,000 m and realistic drilling depths
Reservoir Temperature and Pressure	Temperature and pressure relative to drilling requirements and technology
In-situ Fluids and Salinity	Reservoir fluid types and TDS values relative to 10,000 ppm
Top Seal Thickness and Spatial Variability	Sufficiency of seal thickness and spatial distribution
Top Seal Lithology, Porosity, and Permeability	Porosity, permeability, and sealing capability of top seal
Secondary Confining Unit Presence and Viability	Presence and sealing capability of top seal
Bottom Seal/Potential for Pressure Transmission to the Basement	Downward flow potential and impact on long term storage
Pressure Communication with Reservoir	Trend of pressure gradients below reservoir and communication with reservoir
Trap Type and Certainty	Trap type, configuration, and certainty
Trap Viability and Previously Demonstrated Integrity	Trap geometry relative to potential leakage pathways
Fault Presence, Spacing, Magnitude, and Status (Active vs. Inactive)	Fault size, spacing, and status
Fracture Type and Density	Fracture presence and offset in both reservoir and seal
Fault Reactivation Likelihood	Reactivation potential of faults and fractures with increased pressure
Fault Gauge/Fault Seal Viability	Transmissibility of fault gauge
Earthquake Prevalence and Likelihood	Tectonic activity level of the area and earthquake likelihood
Overburden Drilling Hazards (Formation Over Pressure, Hydrocarbons, Tar, Salt)	Hazards in the overburden
Drinking Water Aquifers in Overburden	Overburden aquifer depth, pressure, and water quality
Water Depth (if Offshore)	Water depth relative to drilling feasibility
Land Surface or Seafloor Hazards (Hydrocarbon Seeps, Hydrates, Infrastructure)	Hazards on the surface
Topography Risks and Landslides or Turbidity Current Likelihood	Likelihood site with be impacted by landslides or turbidity
Surface-Land Ownership and Access	Land ownership, access, and rights
Subsurface Pore Space Rights	Pore space rights
Sensitive Habitats	Sensitive habitat proximity and sensitive species proximity
Population Density	Site location relative to population density and shared resources including air/water
Political Boundaries, Support, and Stability	Political climate of the area
Governmental Incentives	Level and status of governmental incentives for the project
Maturity of Regulatory Framework	Level of maturity of drilling regulatory body in the region
Maturity of Permitting Process	Maturity of regulatory body in the area, status of Class IV permitting in U.S.
Community Familiarity with Drilling Process	Community feelings towards the drilling process and likelihood to organize
Community Attitude Toward Industrial Development	Community feeling toward industrial development and likelihood to organize
Community Attitude Toward Climate Change and Net-Zero Ambitions	Community feeling on climate change mitigation efforts and net-zero ambitions
Environmental Impact of Operations on Air Quality, Noise, and Light Pollution	Impact of project on environmental conditions in the surrounding area
Infrastructure and Resource Impacts (Water Use, Materials Use, Road Traffic and Damage)	Project impact on community infrastructure and resources
Workforce Development and Job Creation	Project impact on local job creation and workforce development

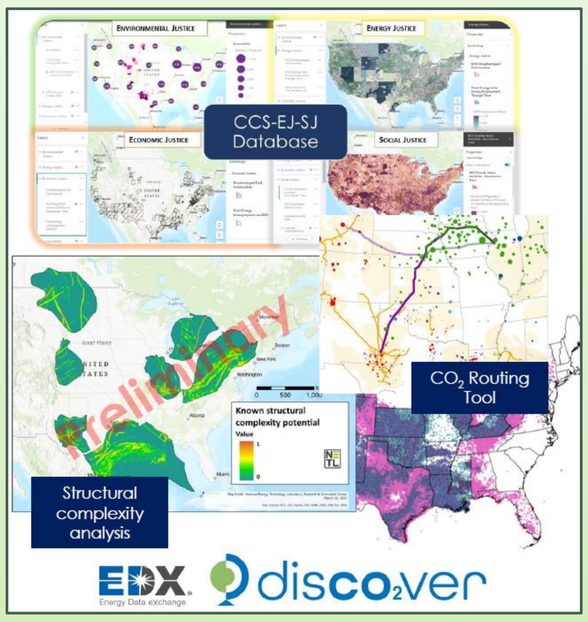
Technical Viability Assessment Method

Non-Viable	Possibly Non-Viable	Viable with Hurdles	Viable but Non-Ideal	Fair/Decent Viability	Good Viability	Excellent Viability	Unknown Viability
This component would prevent the project from moving forward or cause it to terminate early.	This component has issues that would make the project non-economic, reduce its lifespan, or reduce total injection capacity.	This component has issues that will be detrimental to the project but can be overcome with time and/or money.	This component is not well suited for sequestration but likely not prohibitive to the project moving forward.	This component is not optimized but should be sufficient.	This component is well-suited for this project.	The component is ideal, optimized, and/or desirable for this project.	There are insufficient data available to assess this component therefore viability is unknown.

- Technical viability for each component can be assessed qualitatively using the determination criteria (left) and the categories (above).
- This matrix approach integrates subsurface, physiographic, and EJ/SJ factors for a comprehensive viability assessment.

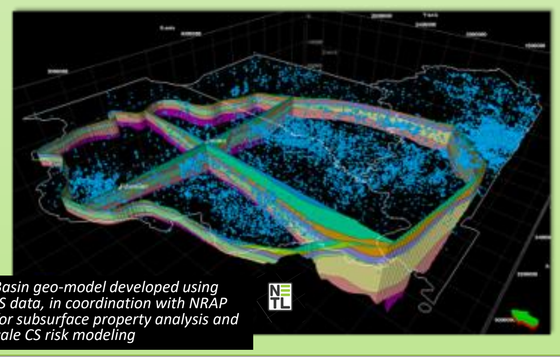
Ongoing Spatial Data Inventory and Database Development

- Initial data gathering and database development highlighted the need for an updated conceptualization of data requirements and technical viability
- A Technically Viable Carbon Storage Database is in development and will include both raw data types as well as products derived from analysis, leveraging existing NETL datasets
- Currently >1,200 shapefiles, >40 GB of data combined
- >51,000,000 features in the socioeconomic database
- Data gathering and initial spatial inventory mapping helps determine gaps and available data
- Spatial inventory tools including Subsurface Trend Analysis (Rose et al., 2020) and Variable Grid Method (Bauer and Rose, 2015) help communicate data availability, density, address data gaps, and enable comparisons between areas of interest for carbon
- Moving forward this work will also leverage data availability assessment methods and additional assessment methods such as fuzzy logic (Creason et al., 2023)



VARIABLE GRID METHOD

SUBSURFACE TREND ANALYSIS



Illinois Basin geo-model developed using EDX4CCS data, in coordination with NRAP efforts for subsurface property analysis and basin-scale CS risk modeling

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