Development of an Integrated Assessment Model for CO_2 Storage: Overview and Areas of Future Development

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RESERVOIR

PURPOSE:

Predict pressure, saturations at reservoir-seal interface at different times/ locations.

PROPERTIES:

- During and post-injection for long-term (< 1000 years).
- Allow variability in reservoir and seal properties, geologic complexity.
- Multi-phase flow, CO_2 dissolution, residual saturations.
- Different types of reservoirs: Brine reservoirs, Gas fields, Oil fields.

TYPES:

Look-up Tables, Surrogate Reservoir Models (SRM) based on artificial intelligence, Polynomial Chaos Expansion (PCE), Gaussian Regression Analysis.

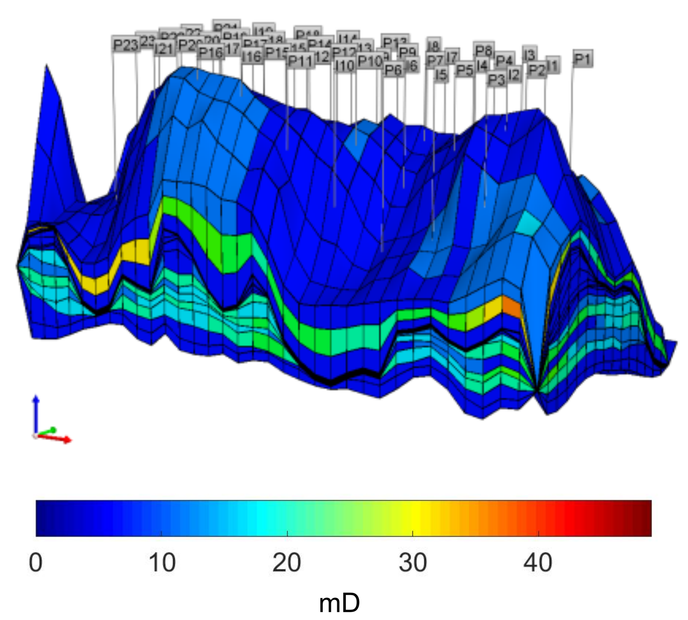


Figure 1[1]: Simulated permeability field for a reservoir.

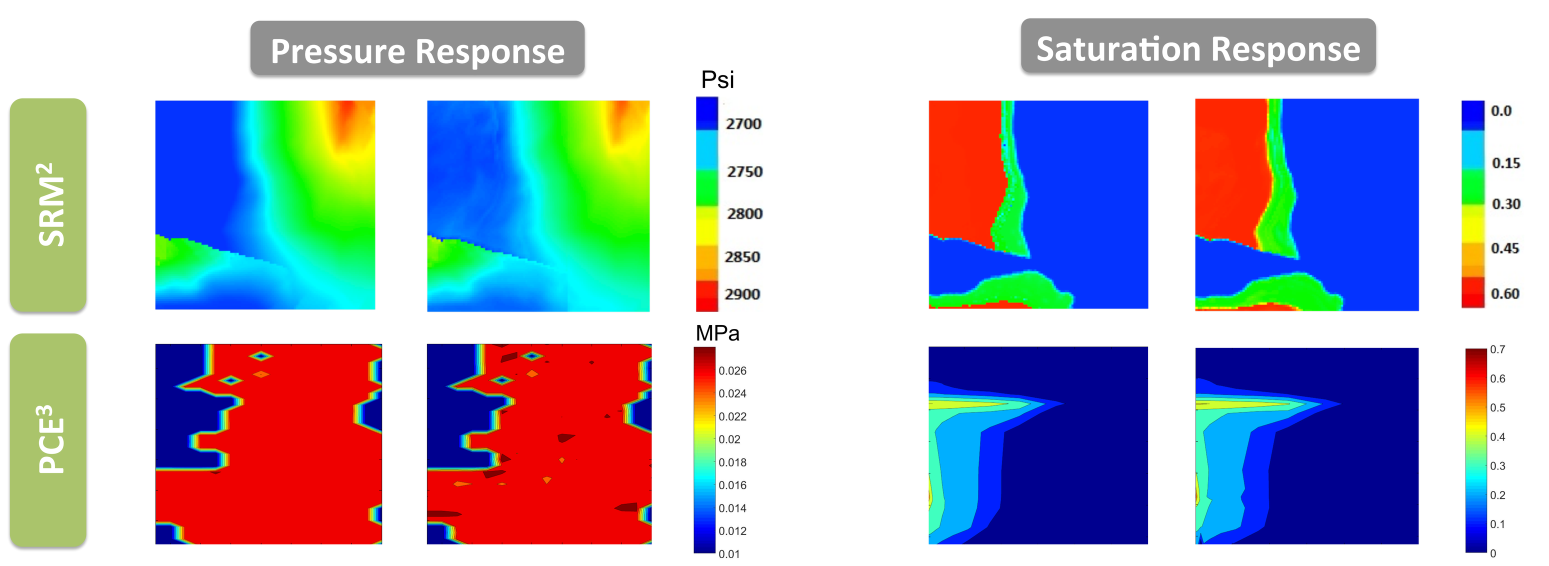


Figure 2: Comparison between the results of simulation model (left) and model results (right) for a hypothetical storage scenario.

MIGRATION PATHWAYS

PURPOSE:

Predict time-dependent leakage rates of CO_2 and brine through wellbore and seals.

PROPERTIES:

- Function of CO_2 saturation and pressure at reservoir-wellbore interface.
- Multi-phase flow, phase change, buoyancy-driven flow, capillary and residual effects.
- Allow variability in wellbore completions, wellbore effective cement permeability, wellbore depth.
- Predicts flow-rate into thief zones and shallow aquifer.

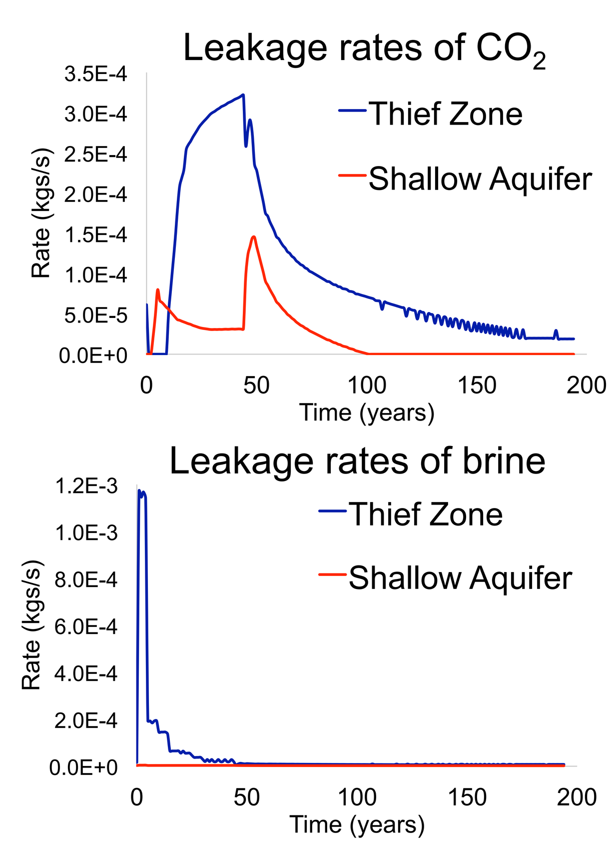


Figure 3: Fluid leakage rates predicted by Wellbore ROM[4] for hypothetical scenario.

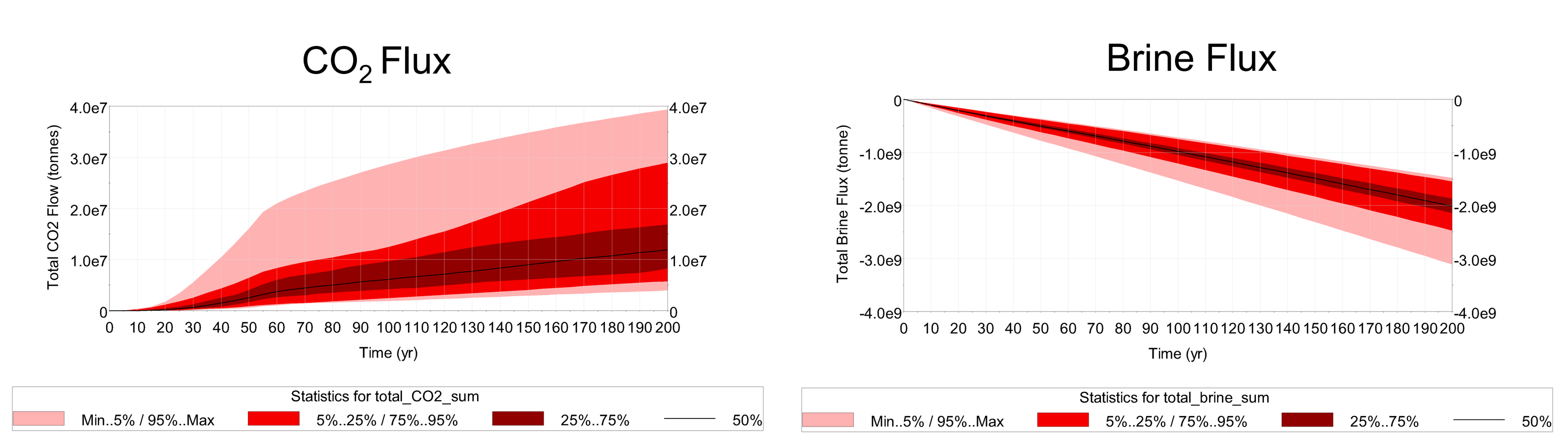
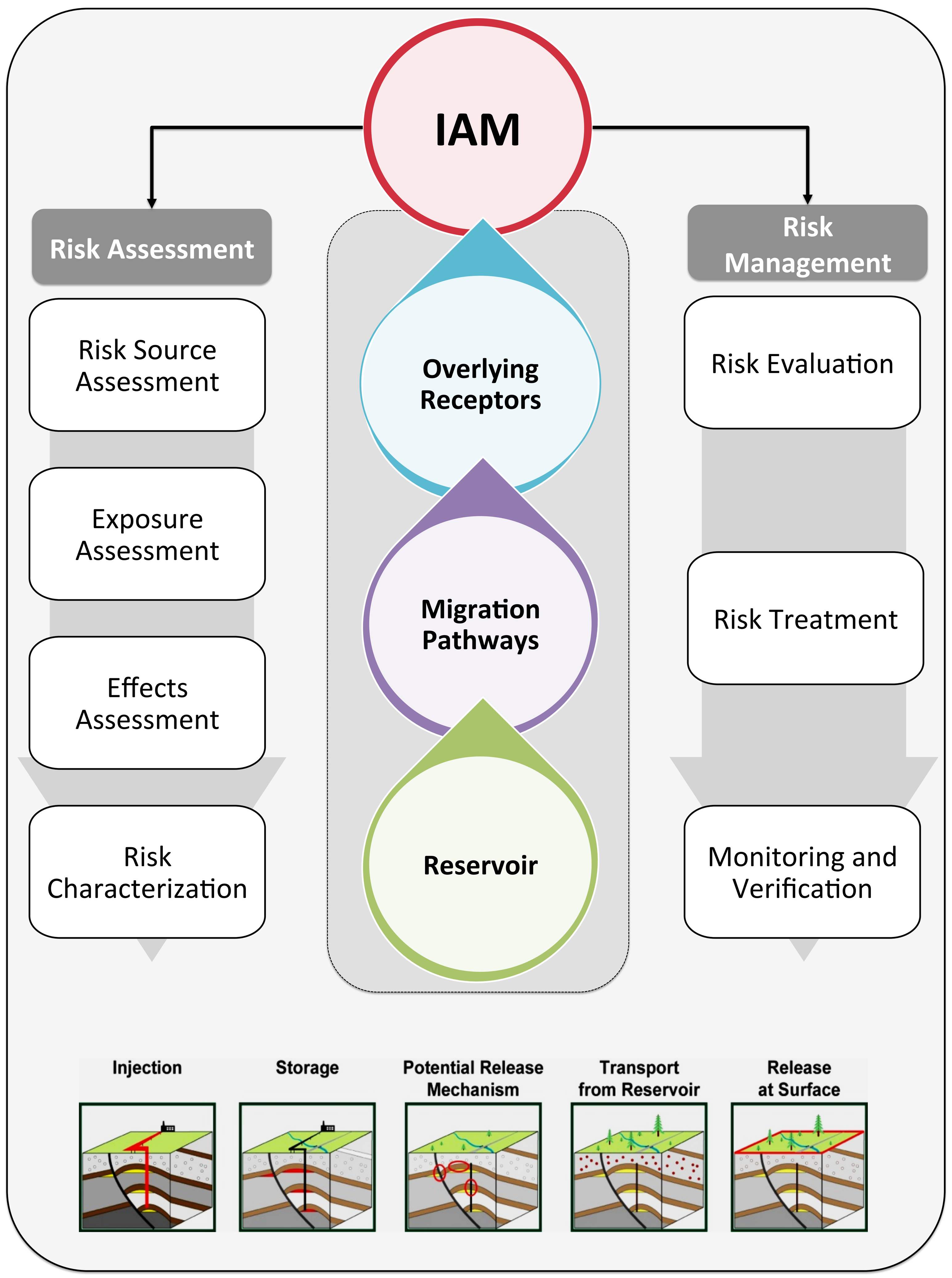


Figure 4: Fluid leakage rates predicted by seal ROM (NSealR[5]) for hypothetical scenario.

OBJECTIVES

- Analyze potential fluid migration in geologic CO_2 storage sites.
- Study of Reduced Order Models (ROMs) currently existing in the literature.
- Analyzing the sub-system level areas of development in CO_2 storage modeling.
- Development of monitoring framework to connect risk performance to engineered intervention to mitigate an observed unwanted condition.



Component	Types	Parameters
Reservoirs	Saline Formation	Pressure, Saturation, Spatial extent of perturbation, Plume thickness.
	Enhanced Oil Recovery	
	Unconventional	
Migration Pathways	Cemented Wells	Fluid flux to overlying aquifers and atmosphere.
	Open Wellbores	
	Faults/ Fractures	
Overlying Receptors	Groundwater	Changes in geochemistry.
	Atmosphere	
	Other underground resources	

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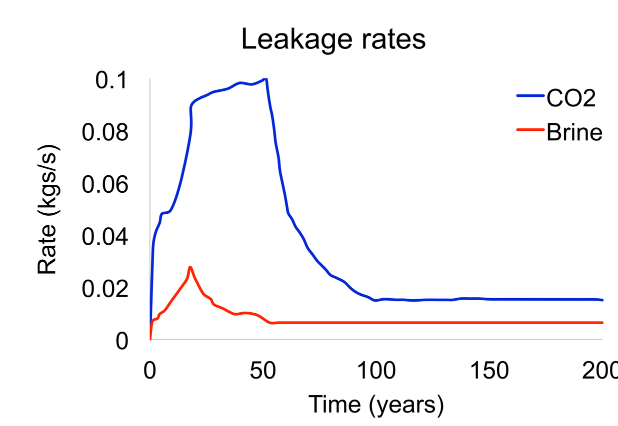
OVERLYING RECEPTORS

PURPOSE:

Predict impact of CO_2 and brine leakage in shallow aquifers:

- Changes in pH, TDS, trace metals and organic concentrations.
- Multi-phase flow, CO_2 dissolution, reactive transport.
- Unconfined carbonate aquifer (Edwards) and Confined sandstone aquifer (High Plains)[6].



PROPERTIES:

- Site-specific & geochemical data.
- Multiple uncertain hydrologic and uncertain parameters.

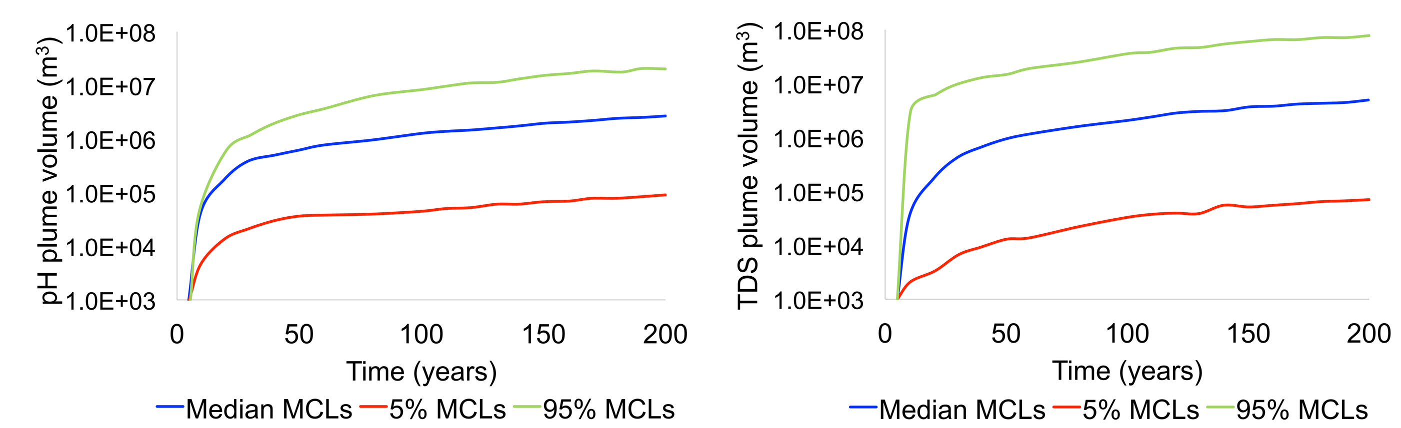


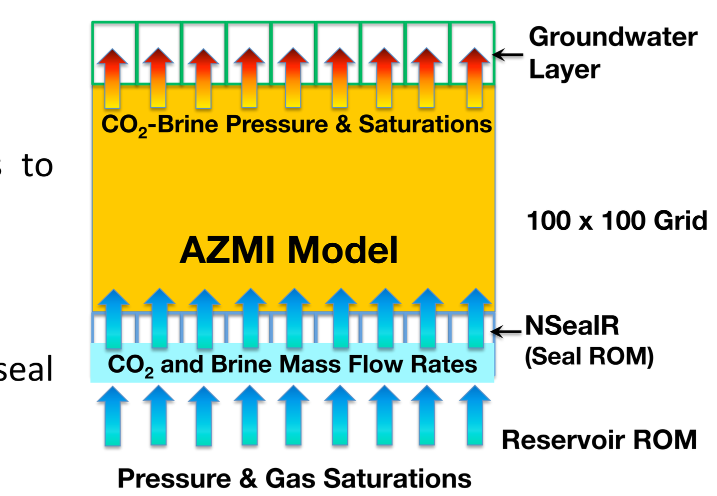
Figure 5: Statistical analysis results for two groundwater risk proxies with their 5th, 50th (median) and 95th percentiles for a hypothetical scenario.

AREAS OF FUTURE DEVELOPMENT

Characterization of fluid migration within and through the Above Zone Monitoring Interval (AZMI)

PROPERTIES:

- Stand-alone
- Fluid Property Variability, several options to describe formation features
- Computationally inexpensive.
- Model Inputs: CO_2 and brine flux from seal ROM
- Model Outputs: Pressure and gas saturations.



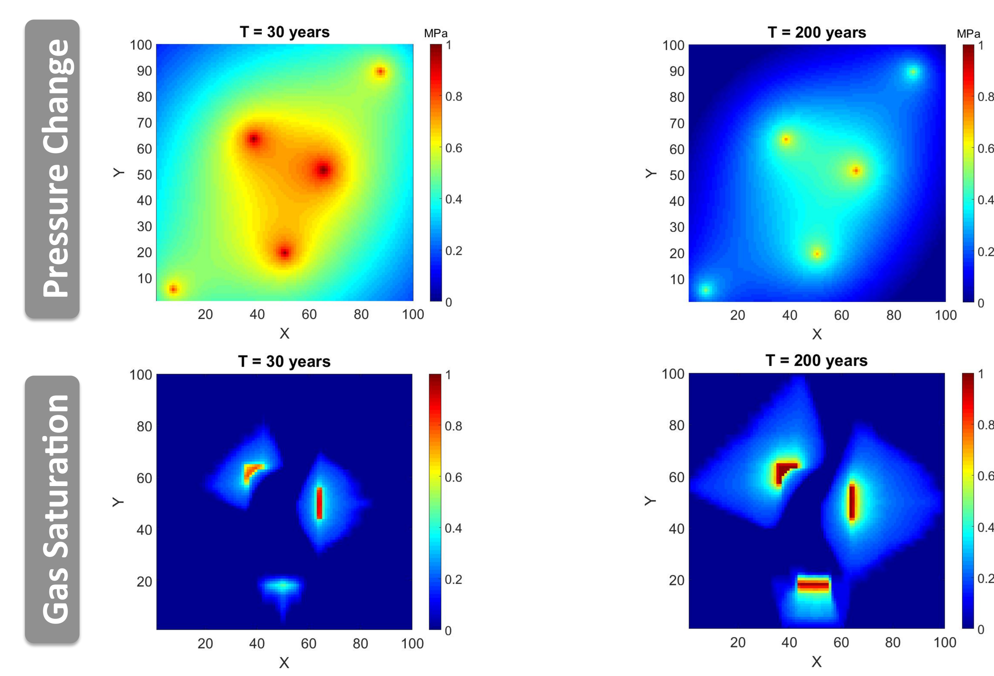


Figure 6: Simulated pressure and gas saturations from AZMI ROM for a hypothetical scenario.

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