

National Risk Assessment Partnership: Delivering Tools to Support Risk-Based Decision Making for Geologic Carbon Storage Deployment

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NRAP leverages DOE's capabilities to quantitatively assess and manage longterm environmental risks amidst geologic uncertainty and variability.



Technical Team



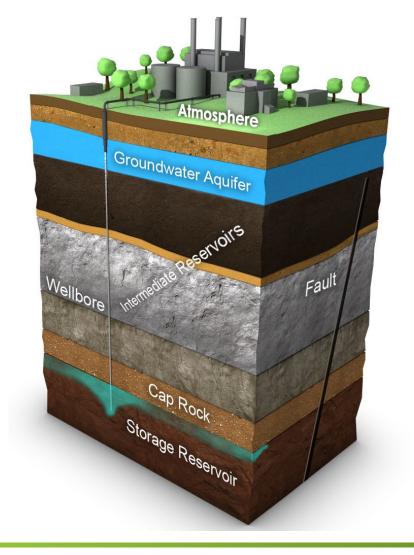








NRAP Website: https://edx.netl.doe.gov/nrap/





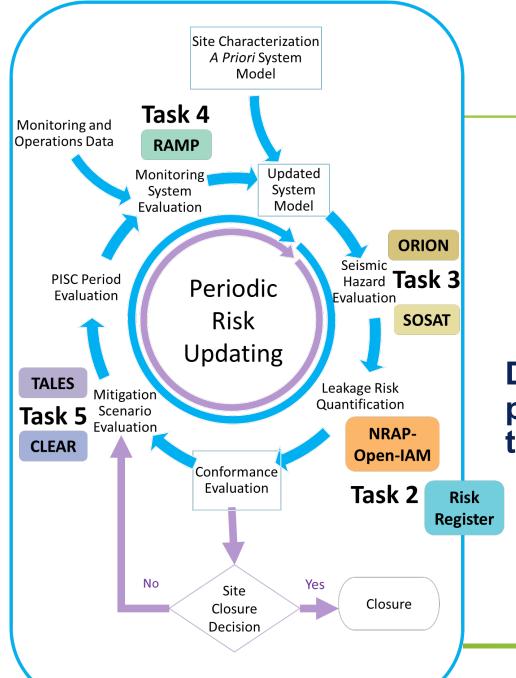














Developing numerical tools to facilitate permitting and support decision making related to multiple aspect of risk management.











Evolving Focus of NRAP

- Phase I (2010–2016) Risk Assessment and Uncertainty Quantification
- Phase II (2017–2022) Risk Management and Uncertainty Reduction
- Phase III (2022 2027) –
 Supporting CCS deployment.

NRAP Phase III Objective:

Maturing practical, useable tools and methods to quantitatively assess and manage risks and liability for geologic carbon storage at site and basin scales, and promoting their application for permitting and risk-related decision support to enable geologic carbon storage commercial deployment.













NRAP Phase III Toolset

- NRAP Open-Source Integrated Assessment Model $(NRAP-Open-IAM \beta v1.1.0; 7/2024)$
- Operational Forecasting of Induced Seismicity Tool kit (ORI ON v1. 0. 0; 3/2024)
- State of Stress Analysis Tool (wSOSAT v1.0.0; 3/2024)
- Risk-Based Adaptive Monitoring Planning (RAMP) Tool (Prototype 8/2024; α version Coming Soon!)
- Technoeconomic and Liability Evaluation (TALES) Model (α v0.5)
 - Carbon Capture, Utilization, and Storage Leakage Evaluation and Remediation (CLEAR) model (Prototype 8/2024)

Access the NRAP Toolset here:





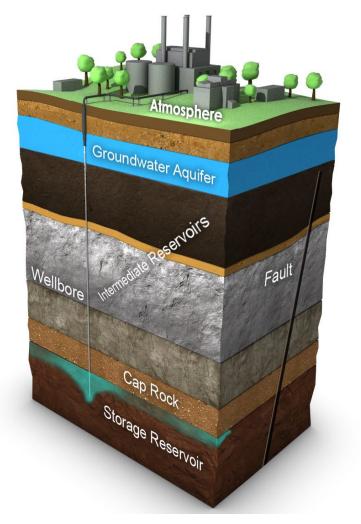






Tool for Containment Assurance and Leakage Risk Management

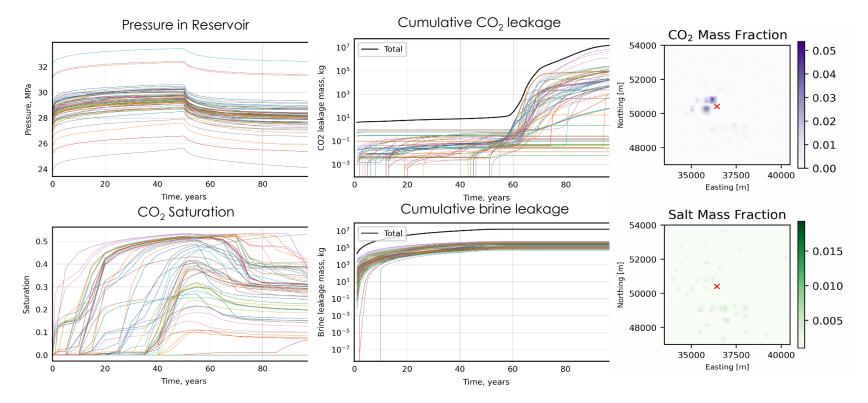
NRAP-Open-IAM Application



Reservoir LUT (Kimberlina Site)

Multisegmented Wellbore ROM

Aquifer Impact ROM









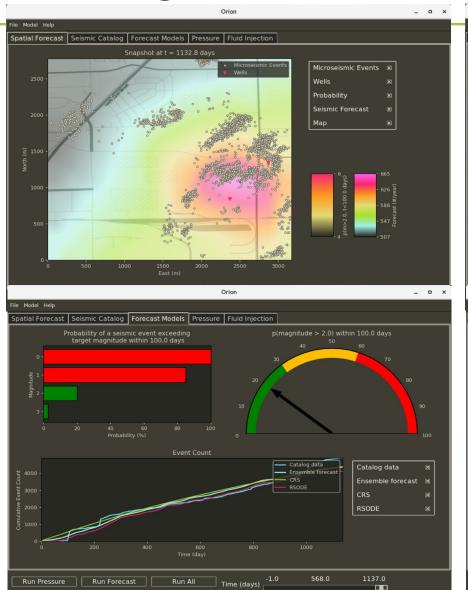


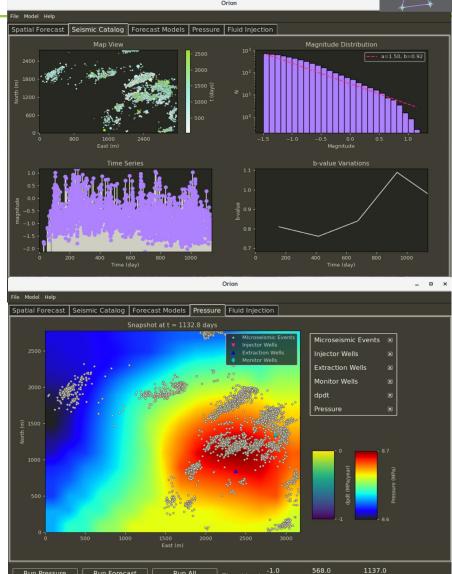




Tool to forecast and manage induced seismicity risk

- Import:
 - Well locations
 - Injection rates
 - Reservoir properties
 - Seismicity catalog
- Compute reservoir pressure and Coulomb stress changes
- Compute spatial and temporal seismicity forecast (via physics and statistical models)



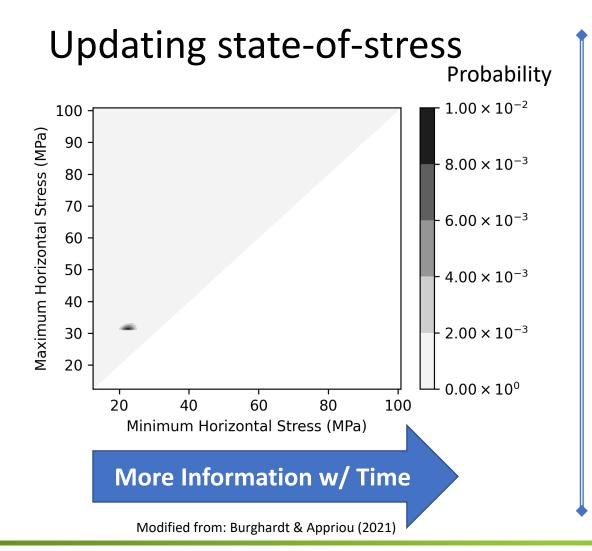


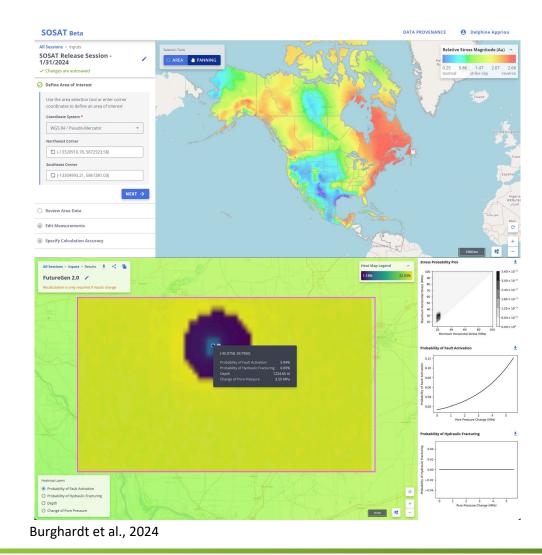






Tool to estimate probability distribution of the stress state









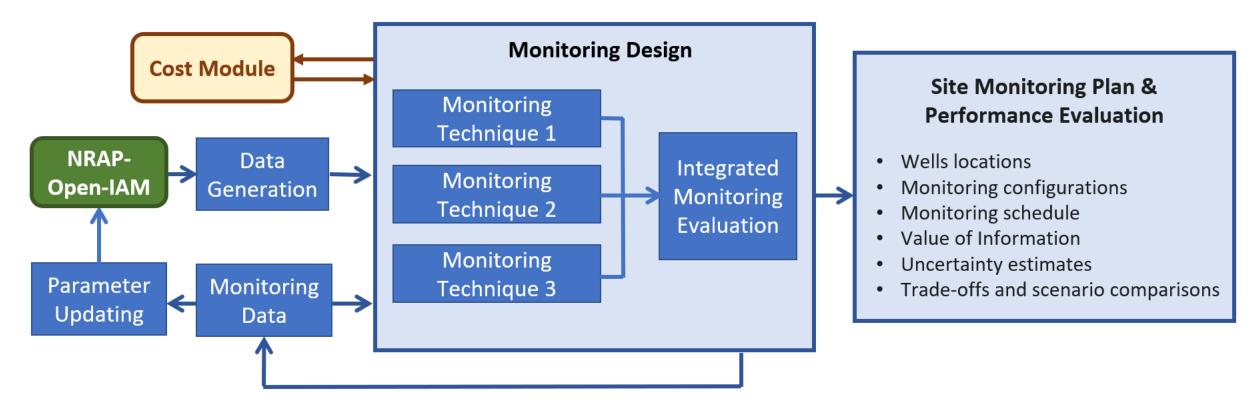








Tool to design adaptive, risk-based monitoring plans



RAMP allows the user to assess multiple monitoring technologies (downhole pressure, fluid geochemical sampling, indirect methods – seismic, gravity, electrical/electromagnetic) and their combination, sensor configurations, monitoring intervals, and select an optimal site monitoring plan based on the main project objectives.











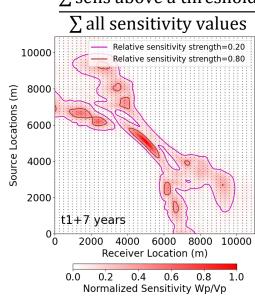


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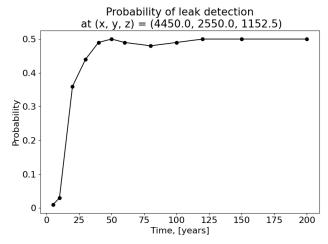
Elements of the Risk Adaptive Monitoring Planning (RAMP) Tool

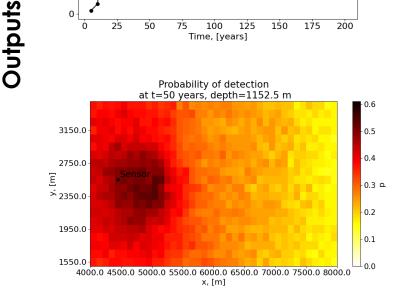
Monitoring Design/Optimization

Sensitivity Strength= \sum sens above a threshold



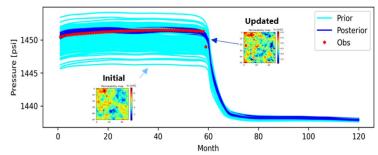
Evaluating Probability of Leak Detection



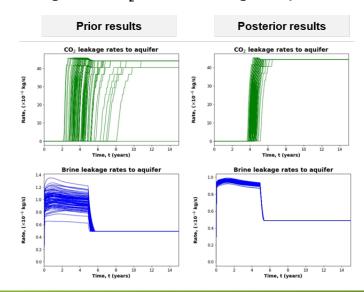


Model Updating and Dynamic Risk Assessment Using Monitoring Data

History matching reservoir pressure (initial and updated models



Assessing risk of CO₂ and brine leakage to aquifer















Technoeconomic and Liability Evaluation (TALES)
Model

Linking project technical risk to cost and liability

Scenario Definition

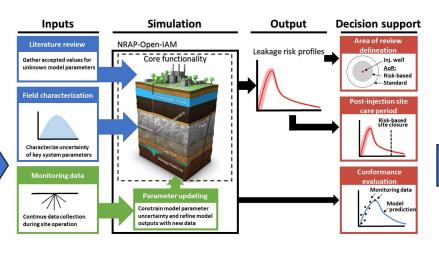
 Inputs for scenario definition, injection schedule, activity costs, etc.

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State where project is located	proj uz statul			
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Longitude for reference point for project	proj Josef	-02.077002	degrees	
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	finin piec1	TF		Options: TF for Trust feed, EA for secret account, Self for self
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General inputs applicable to all financ Project Year is which financial instruments are	al instruments			
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Insurance method 2	I TRANSPORTED TO THE PROPERTY OF THE PROPERTY	1,450	108	
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Financial Variables				
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				This value is used as the reference year for all the costs in the
Reference calendar year for cocto	ref costs worl	2023	Ī	Activity Cost Factor short Activ CF
Calcador eacr when project beging	probes worl	2025		This is the year when the project begins (first stage)
Escalation rate from reference year for costs to				This is the escalation rate from costs in the reference year to the
start of project (corretel)	cocrete ref. proibcal	3.10%	Aug.	first year of the project
Exceletion rate from start of project (excrate2)	secrets, frereibeg1	2,50%	Ann	This is the excelstion rate from the first way of the project owns
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Interest rate on debt Minimum decised internal rate of return on	debt_int_rises	6.0%	cyc	resear to be concurrent with exceletion rate during project [econ
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ogeity	IRRain1	13.0%	fat.	Needs to be consistent with esculation rate during project (esce
Income tax rate (affective federal, state and				Effective income tax that includes federal corporate tax on prof
local tax rate)	inc tax rate eff1	25.74%		(2/B/yr) and ctate and local taxes

[tem	key label	Value	Units	Notex		
Latitude of reference point for project	proi name	39.884354	decrees			
Langitude for reference point for project	proi us state	-89.077089	decrees			
Depth to top of storage formation	proj depth stor	5000				
Thickness of storage formation	proj frick stor		feet			
Thickness of caprock	proj frick cap	200	feet			
Depth to bottom of lowest aquifer classified as:						
USDW (salinity of 10,000 ppm or less)	proj_depth_USDW	4000	feet			
Depth to bottom of lowest aguifer that can be						
used as long-term source of drinking water						
(salinity typically less than about 1000 ppm)	proj. depth. Dwequif		feet			
	proj. por	0.15				
Representative permeability for storage	proj perm		mD			
Storage coefficient for storage formation	storcoeff	0.096				
Lifhostatic pressure gradient	lifth pres grad		Picq			
Hydrostatic pressure gradient	hyd pres grad	0.464	Pricq			
Temperature gradient	ifn_temp_grad	0.0137	degFR			
Process contingency, project contingens	cv and G&A factors					
Itum	key_label	Value	Units	Notex		
Process confingency factor (applied to capital						
costs for immature technologies	proc confing fact	20%				
Project confingency factor (applied to all capital						
costs)	proc confing fact	15%				
GSA factor (general and administrative						
expenses (applied to all O&M costs)	GandA_fact	2000				
Other factors						
Item	key label	Value	Units	Notes		
Number of legacy wells requiring corrective	keg_label	Value	Units	Notes		
Number of legacy wells requiring corrective action per area of AcR			Cásadahri2			
	corract wells area					

Risk & Cost Model

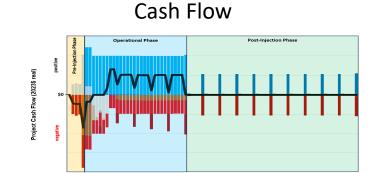
Site performance and risk quantification



Risk mitigation/remedial response activity and cost estimation

(Under Development)

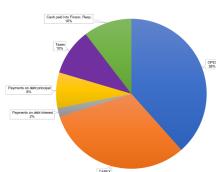
Scenario Evaluation





Taxes

OPEX
Debt Proceed



Net Present Value / Break Even

Cash paid into Financ, Resp. Trust Fund/Escrow Acct

Cash withdrawls from Trust Fund Escrow Accour















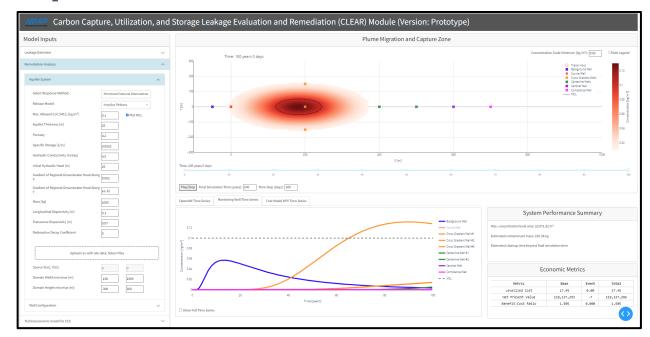
Modules to estimate remedial response.

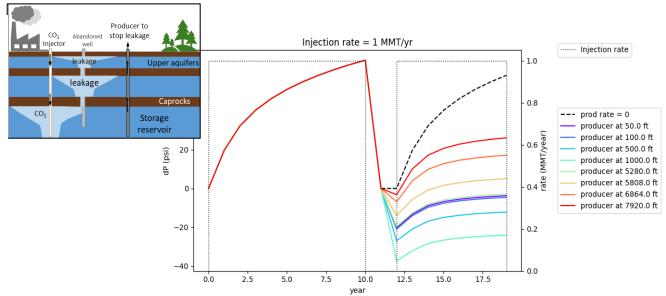
CLEAR module (USDW remedial action) (Prototype demo 8/6/2024)

- CO₂ or brine plume distribution over time in the impacted aquifer.
- Pump and Treat RR Approach
- Monitored Natural Attenuation (MNA)

Reservoir Remediation Module (Remed-Res; Prototype 8/2024)

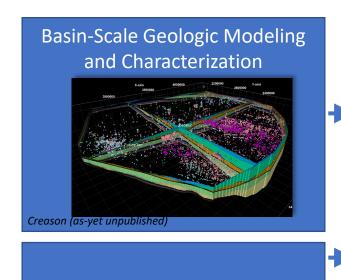
 Estimate pressure mitigation effect of brine production scenarios



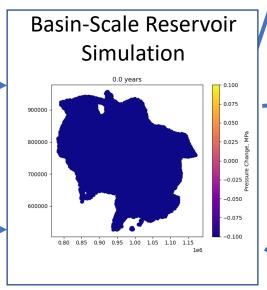


Estimating basin-scale risks of broad GCS deployment

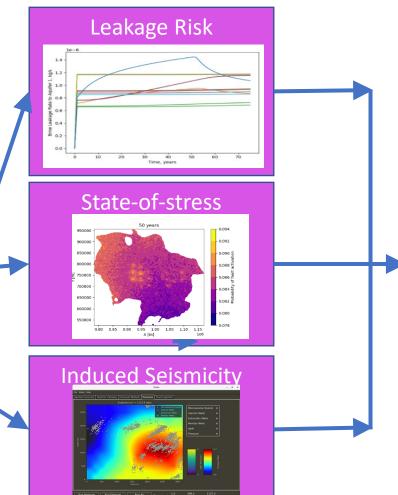
Approach: Case stud(ies) leveraging the NRAP tools to forecast basin-scale response and assess risks for credible deployment scenarios.



GCS Deployment Scenarios



Forecasts of Basin-Wide Risks



Develop
Insights on
Basin-Scale
Risks and Risk
Management

















Thank you!

Contact us at:

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NRAP Website: https://edx.netl.doe.gov/nrap/

NRAP Tools: https://edx.netl.doe.gov/group/nrap-toolset

Access the NRAP Toolset here:













