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EASiTool : An Enhanced Analytical Simulation Tool for CO_2 Storage Capacity Estimation

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TEXAS Geosciences
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Outline

- CO_2 storage capacity estimation
- What is EASiTool?
- Assumptions and technical background
- Interface
  - Input
  - output
- Case study

Static methods

- Static methods (DOE, USGS, etc)

$$G_{CO2} = A_t \times H_g \times \Phi_{tot} \times \rho \times E_{saline}$$

- Dynamic methods (Numerical simulations, analytical tools)
- EASiTool (Enhanced Analytical Simulation Tool)
  - It uses analytical models (fast)
  - It is dynamic (time, number of wells, etc)
  - It does sensitivity analysis (tornado charts)

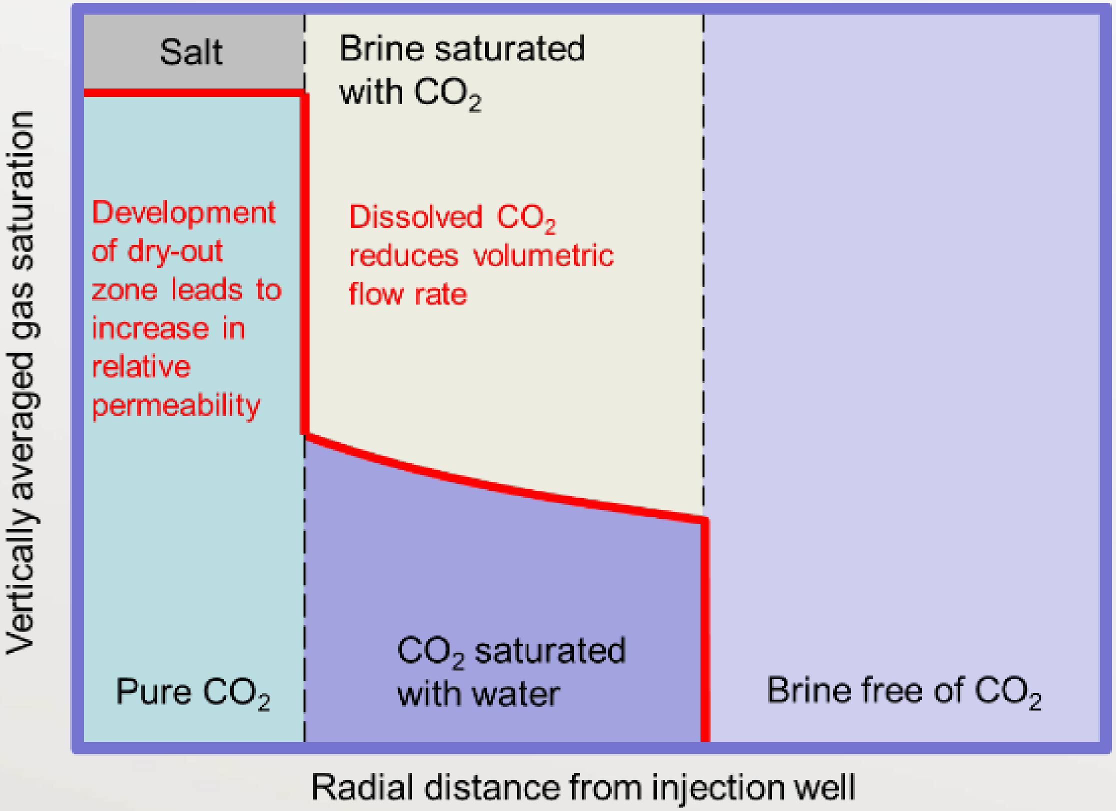
Methods Comparison

Tool/Approach Name	DOE/NETL	CSLF	USGS	EASiTool	Numerical Simulators
Reservoir scale	Yes	Yes	Yes	Yes	Yes
Accuracy	Low	Low	Low	Medium/High	High
Boundary conditions	No	No	No	Yes	Yes
Rock geomechanics	No	No	No	Yes*	Yes
Brine management	No	No	No	Yes	Yes
Required expertise	Low	Low	Low	Low	High
Cost of use	Low	Low	Low	Low	High
Computational speed	High	High	High	High	Low
Dynamic	No	No	No	Yes	Yes
Sensitivity Analysis	Simple	Simple	Simple	Yes	Yes

Assumptions

- Homogeneous/isotropic properties
- Constant rate injection
- No structure
- Two-phase flow (Brine and CO_2)
- Fluid properties are pressure dependent
- Uses superposition for multiwell scenarios

Analytical model



$$P - P_0 = \frac{M_0}{4\pi\rho_c H k} \begin{cases} \dfrac{\mu_c q_{D1}}{k_{rs}} \ln\left(\dfrac{z_T}{z}\right) + \mu_g q_{D2} F_2(z_T) + \mu_b q_{D3} F_1(z_L), & 0 \leq z < z_T \\ \mu_g q_{D2} F_2(z) + \mu_b q_{D3} F_1(z_L), & z_T \leq z \leq z_L \\ \mu_b q_{D3} F_1(z), & z > z_L, \end{cases}$$

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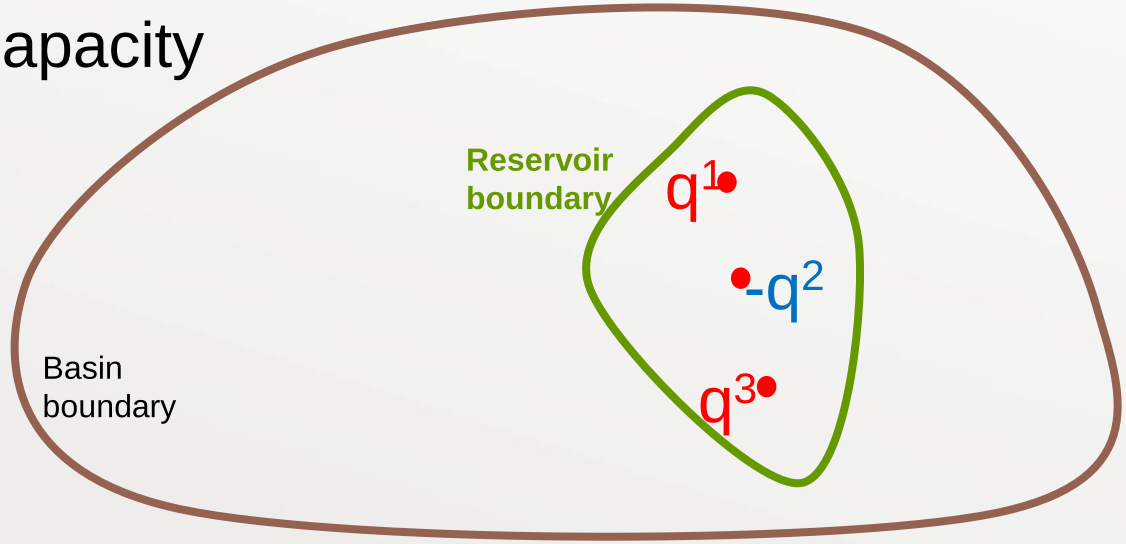
Regular Article

Role of partial miscibility on pressure buildup due to constant rate injection of CO_2 into closed and open brine aquifers

Simon A. Mathias, Jon G. Gluyas, Gerardo J. González Martínez de Miguel, Seyyed A. Hosseini

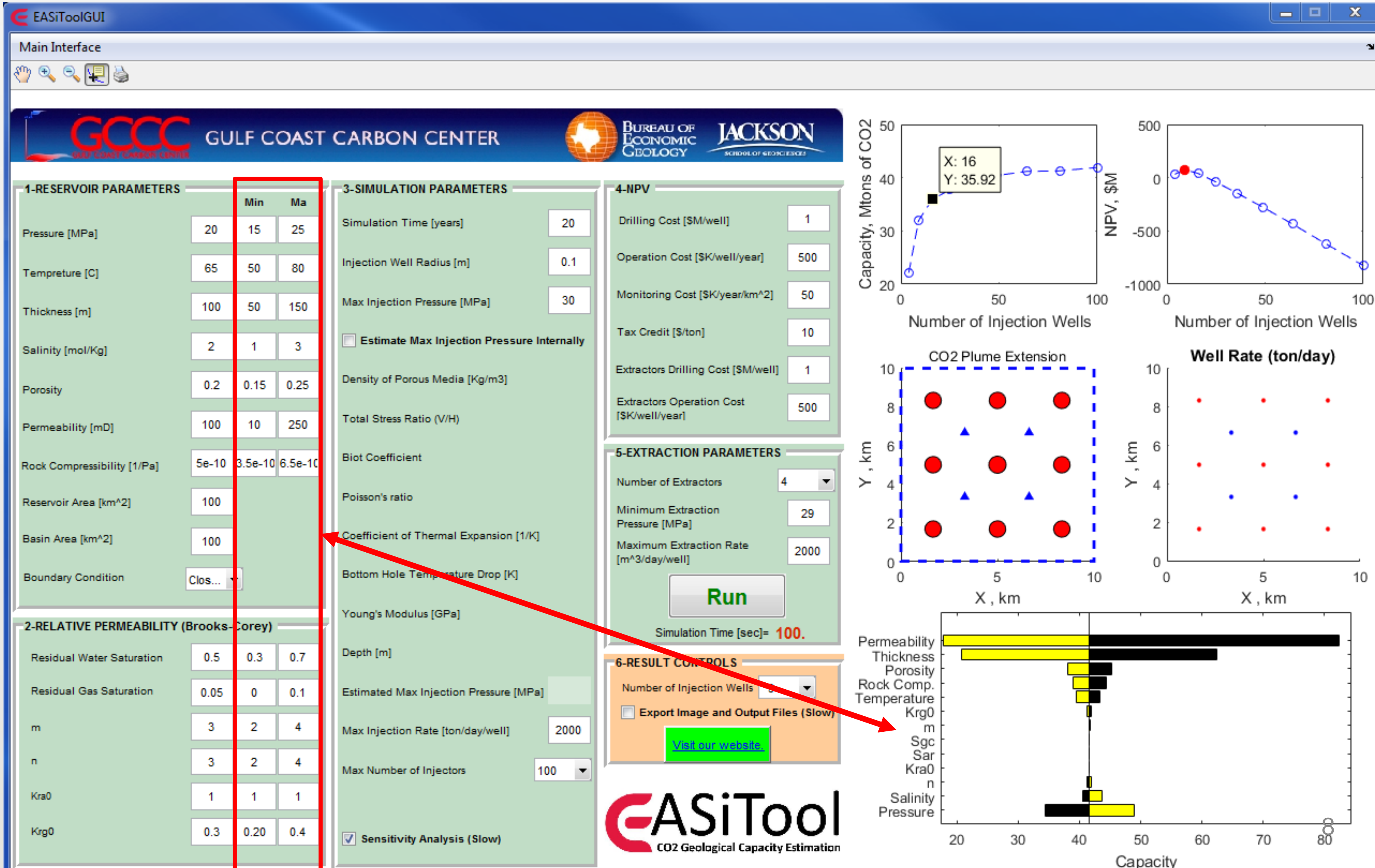
Multi-well injection & brine extraction

- Finding the maximum allowable rate to maximize storage capacity

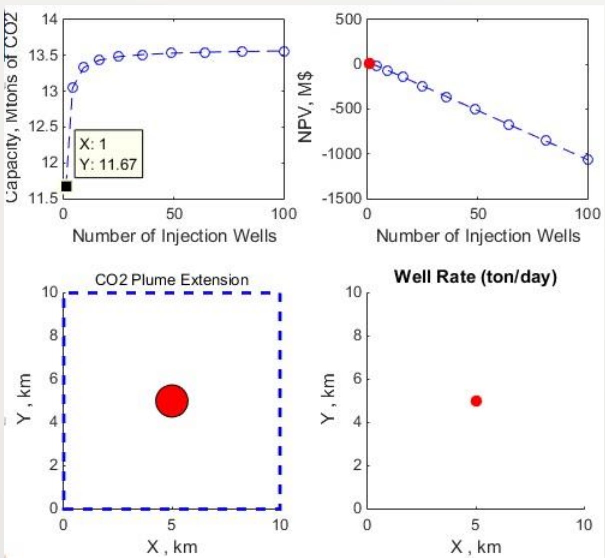


$$\begin{bmatrix} \frac{1}{2}\left(\ln(t_D)+0.80908\right)+S_a & -\frac{1}{2}\frac{\overline{\lambda_g}}{\overline{\lambda_w}}E_i\left(-\frac{r_{D1-2}^2}{4\eta_{D3}t_D}\right) & -\frac{1}{2}\frac{\overline{\lambda_g}}{\overline{\lambda_w}}E_i\left(-\frac{r_{D1-3}^2}{4\eta_{D3}t_D}\right) \\ -\frac{1}{2}\frac{\overline{\lambda_g}}{\overline{\lambda_w}}E_i\left(-\frac{r_{D2-1}^2}{4\eta_{D3}t_D}\right) & \frac{1}{2}\left(\ln(t_D)+0.80908\right)+S_a & -\frac{1}{2}\frac{\overline{\lambda_g}}{\overline{\lambda_w}}E_i\left(-\frac{r_{D2-3}^2}{4\eta_{D3}t_D}\right) \\ -\frac{1}{2}\frac{\overline{\lambda_g}}{\overline{\lambda_w}}E_i\left(-\frac{r_{D3-1}^2}{4\eta_{D3}t_D}\right) & -\frac{1}{2}\frac{\overline{\lambda_g}}{\overline{\lambda_w}}E_i\left(-\frac{r_{D3-2}^2}{4\eta_{D3}t_D}\right) & \frac{1}{2}\left(\ln(t_D)+0.80908\right)+S_a \end{bmatrix} \begin{Bmatrix} q^1 \\ -q^2 \\ q^3 \end{Bmatrix} = \begin{Bmatrix} \frac{2\pi hk\overline{k_{rg}}}{\overline{\mu_g}}\Delta P_{\max} \\ \frac{2\pi hk\overline{k_{rg}}}{\overline{\mu_g}}\Delta P_{\max} \\ \frac{2\pi hk\overline{k_{rg}}}{\mu_g}\Delta P_{\max} \end{Bmatrix}$$

Input- Output



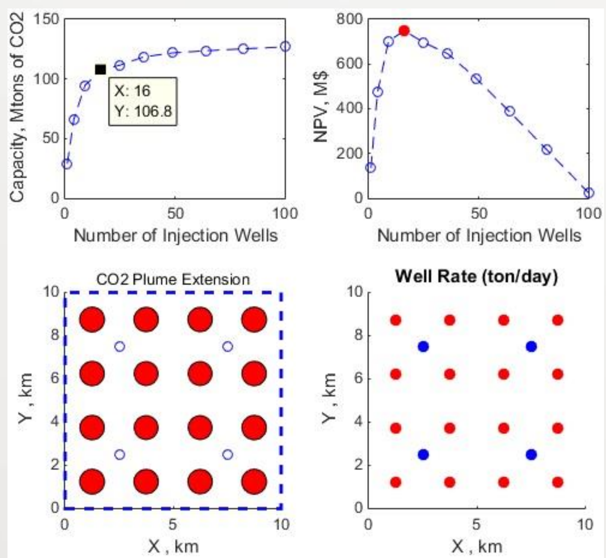
Output



0 Extractors

Capacity: 11.7 Mton

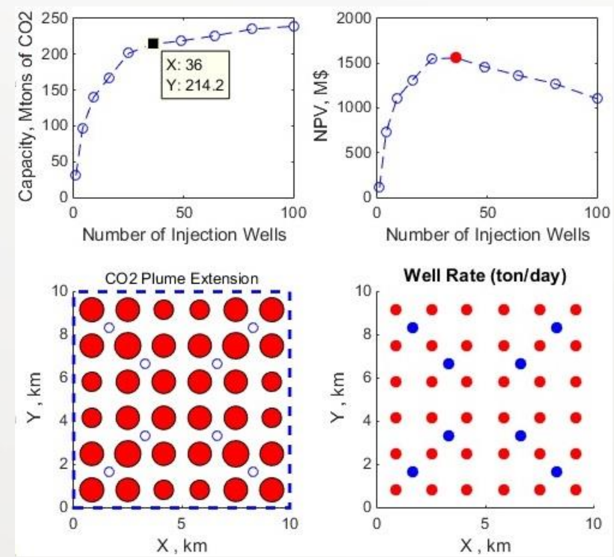
1 injector



4 Extractors

Capacity 107 Mton

16 injectors

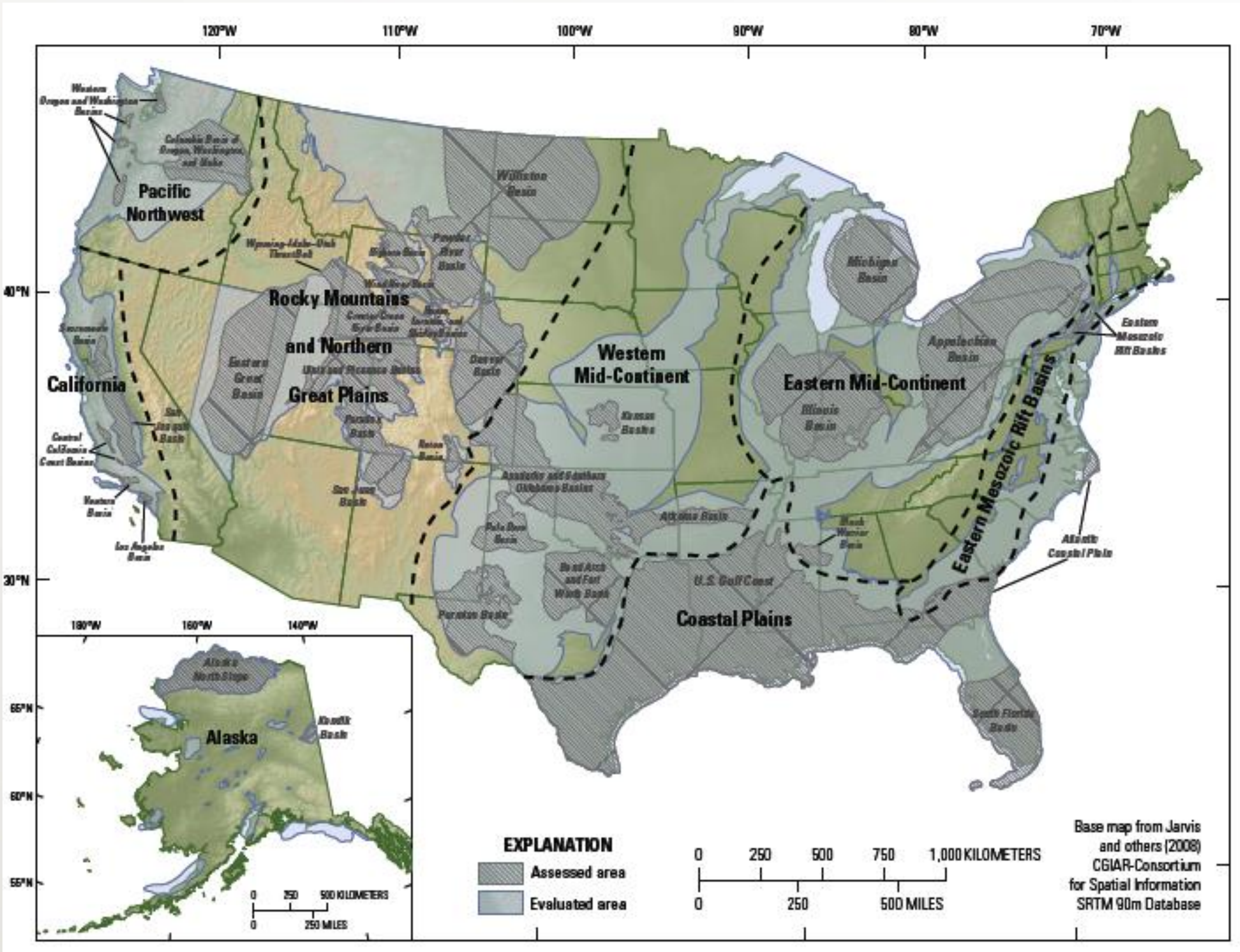


8 Extractors

Capacity: 214 Mton

36 injectors

USGS Onshore Storage Capacity Assessment



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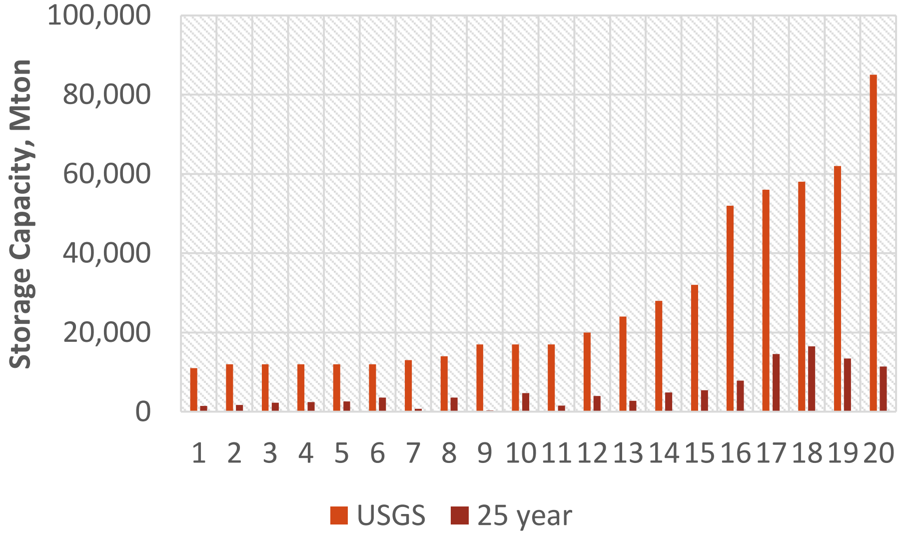
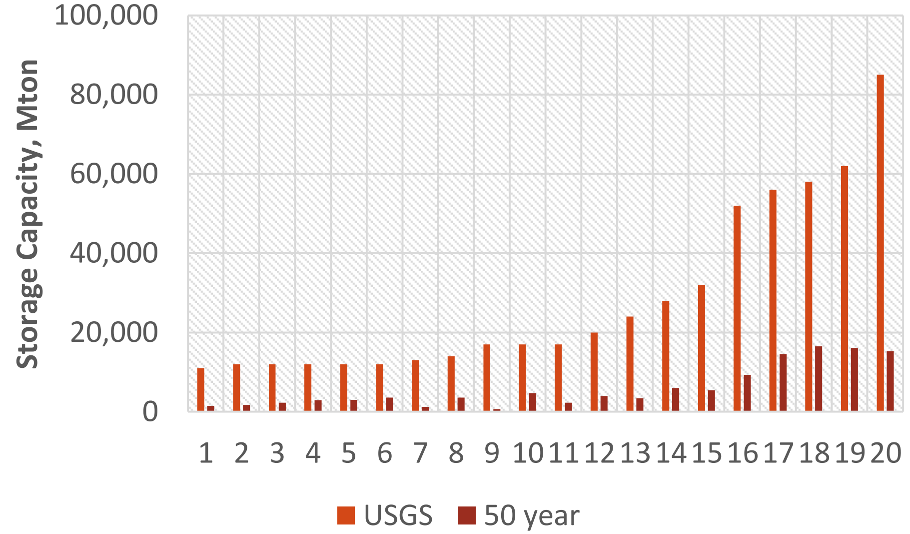
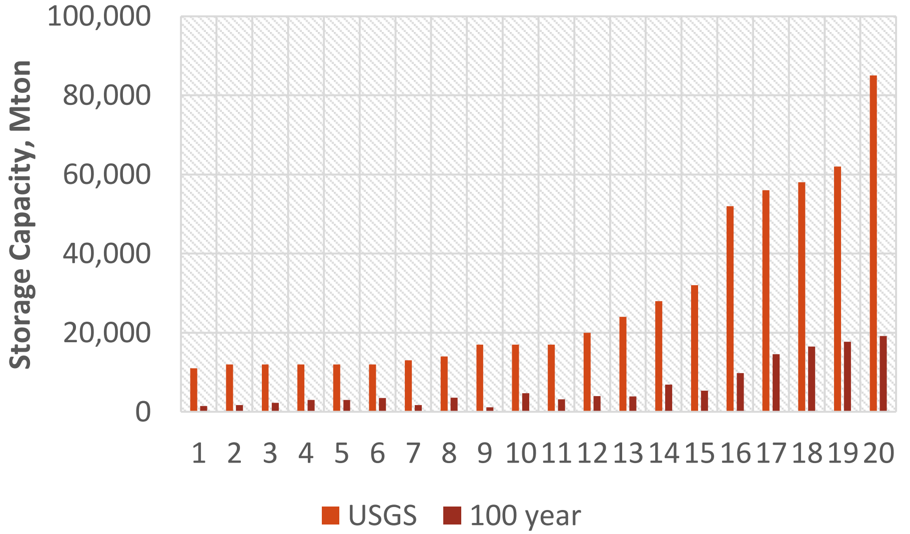
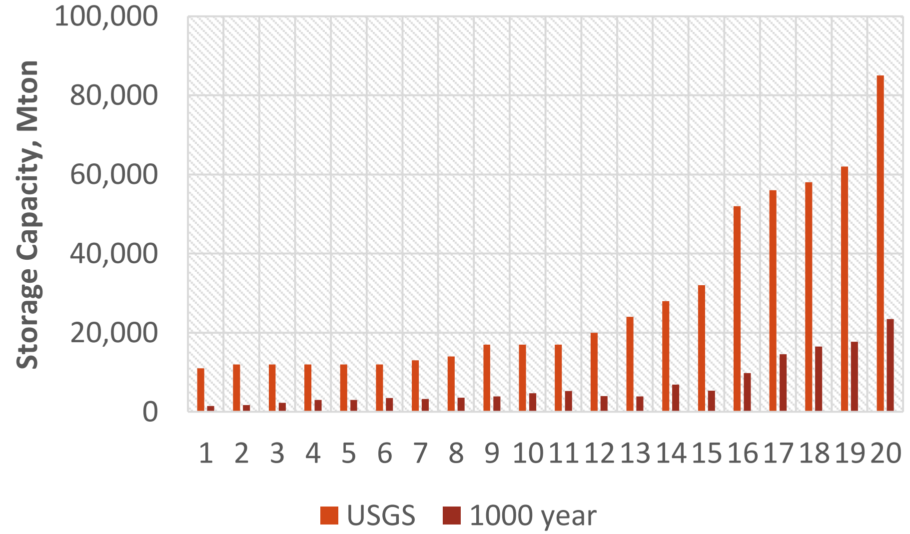
EASiTool vs USGS Static Method

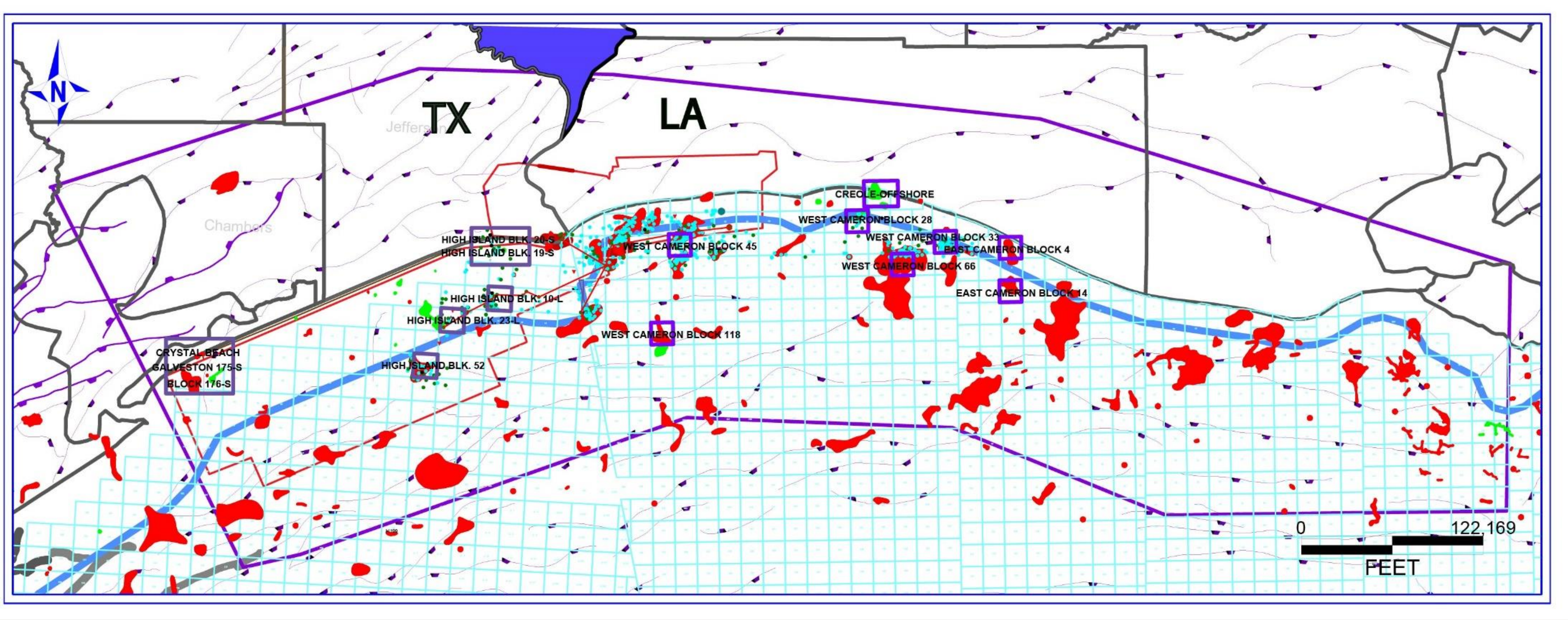








TX-LA offshore CO_2 storage



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