

Transitioning Cleanup Sites to Carbon Farms: Potential Application of Soil Carbon Sequestration Practices for Sustainable Site Remedies



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Yue (Beatrice) Li, PhD, PE

Co-authors

Kenneth Walker, PE, PG

Maile Smith, PG

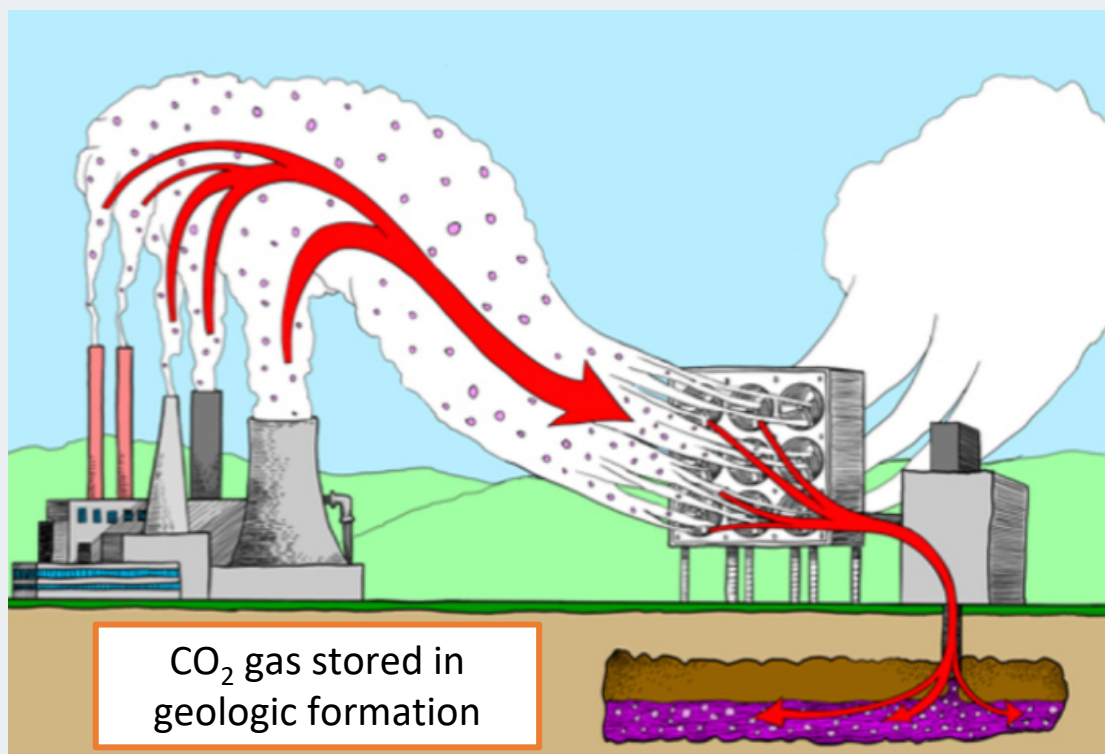
John Connor, PE, PG, BCEE

OUTLINE

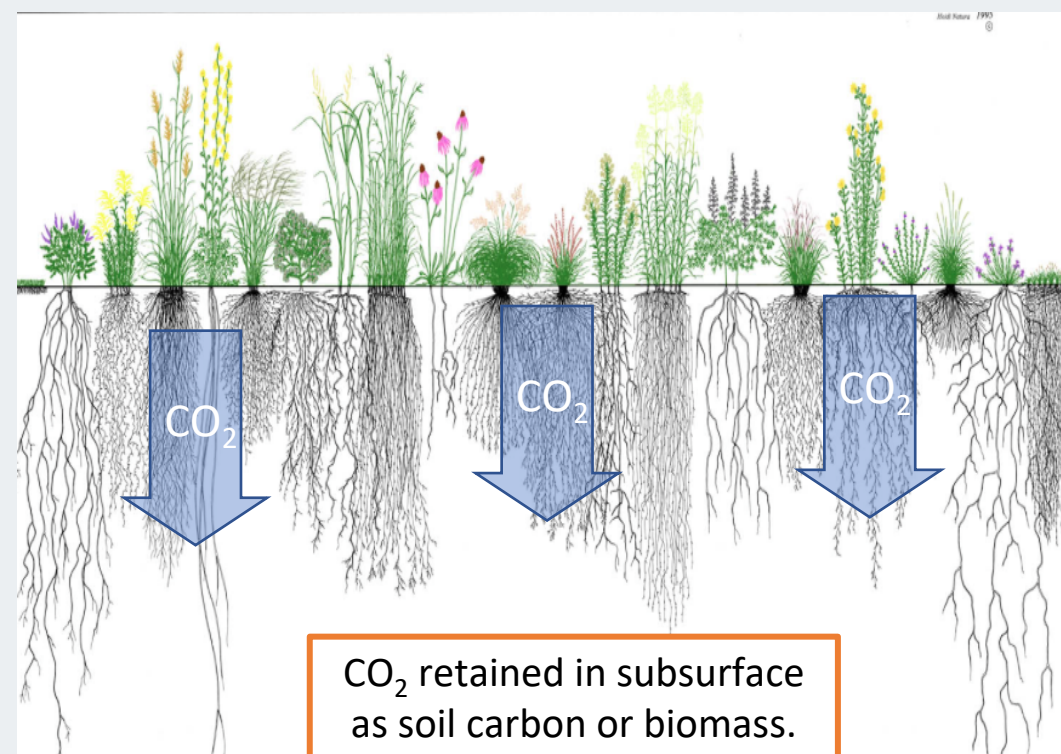
- › Nature-based Solutions on Degraded Lands
- › Potential for NbCS at Cleanup Sites
- › Cost-Benefit Considerations
- › What's Next?

Geologic vs Biological Carbon Sequestration

CO₂ Removal and Deep Storage

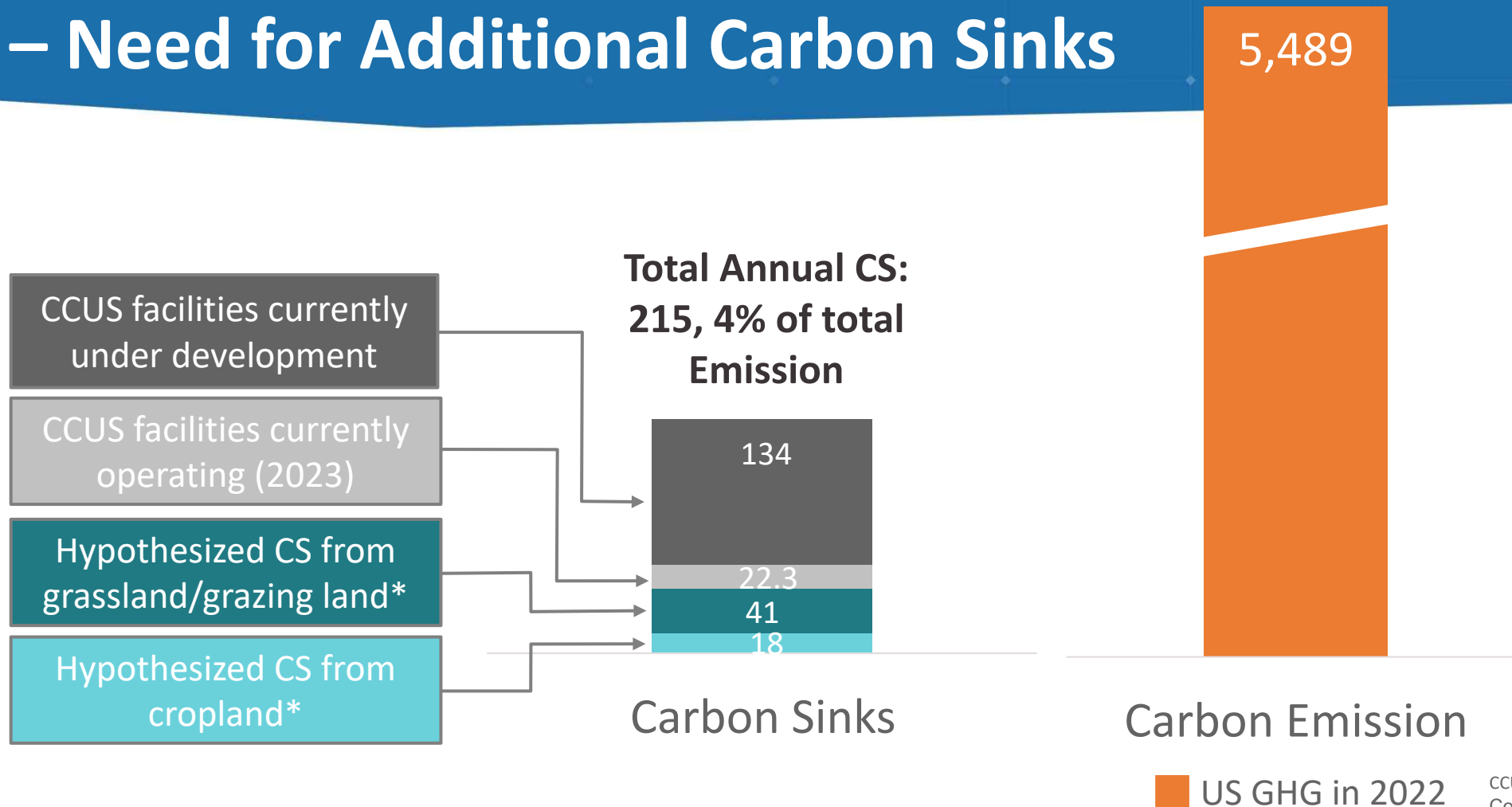


Soil Farming: Soil Carbon Storage via Photosynthesis



Hypothesized Carbon Sequestration (CS) Scenario

– Need for Additional Carbon Sinks



*Assuming carbon accrual rates of 1.11 Mg ha⁻¹ yr⁻¹ for cropland, and 1.54 Mg ha⁻¹ yr⁻¹ for grassland/grazing land, and 10% of the total land area utilized for CS.

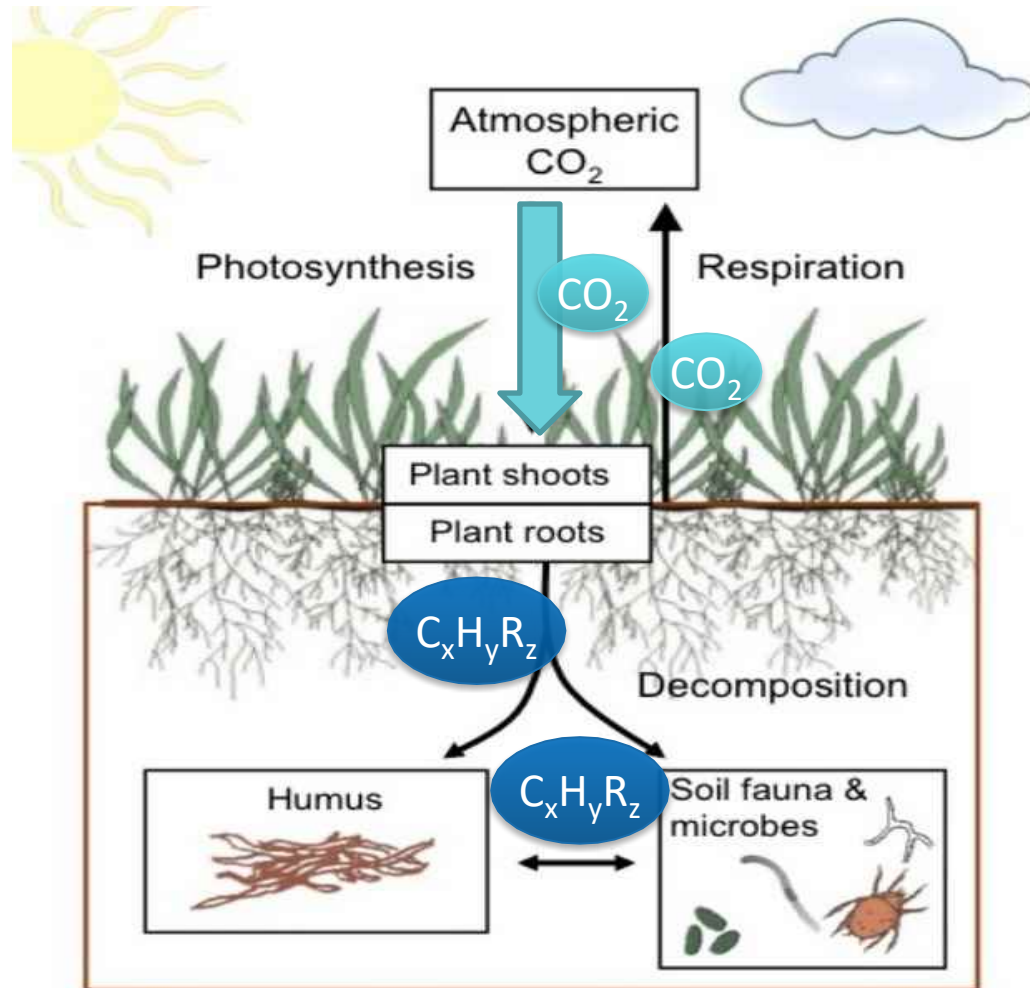
Unit: Million metrics tonnes of CO₂ per year (MTCO₂ yr⁻¹)

CCUS facilities and capture capacity from a Congressional Budget Office report (December 2023) [cbo.gov/publication/59832](https://www.cbo.gov/publication/59832); land areas for cropland and grassland/grazing land from USGS and USDA records: [USGS.gov](https://www.usgs.gov), climatehubs.usda.gov; carbon accrual rates based on literature review by the presenter and coauthors: Li, Walker, and Connor (2024). Manuscript in preparation; US emission based on USEPA inventory: [epa.gov](https://www.epa.gov)

OUTLINE

- › **Nature-based Solutions on Degraded Lands**
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Nature-based Carbon Sequestration (NbCS)

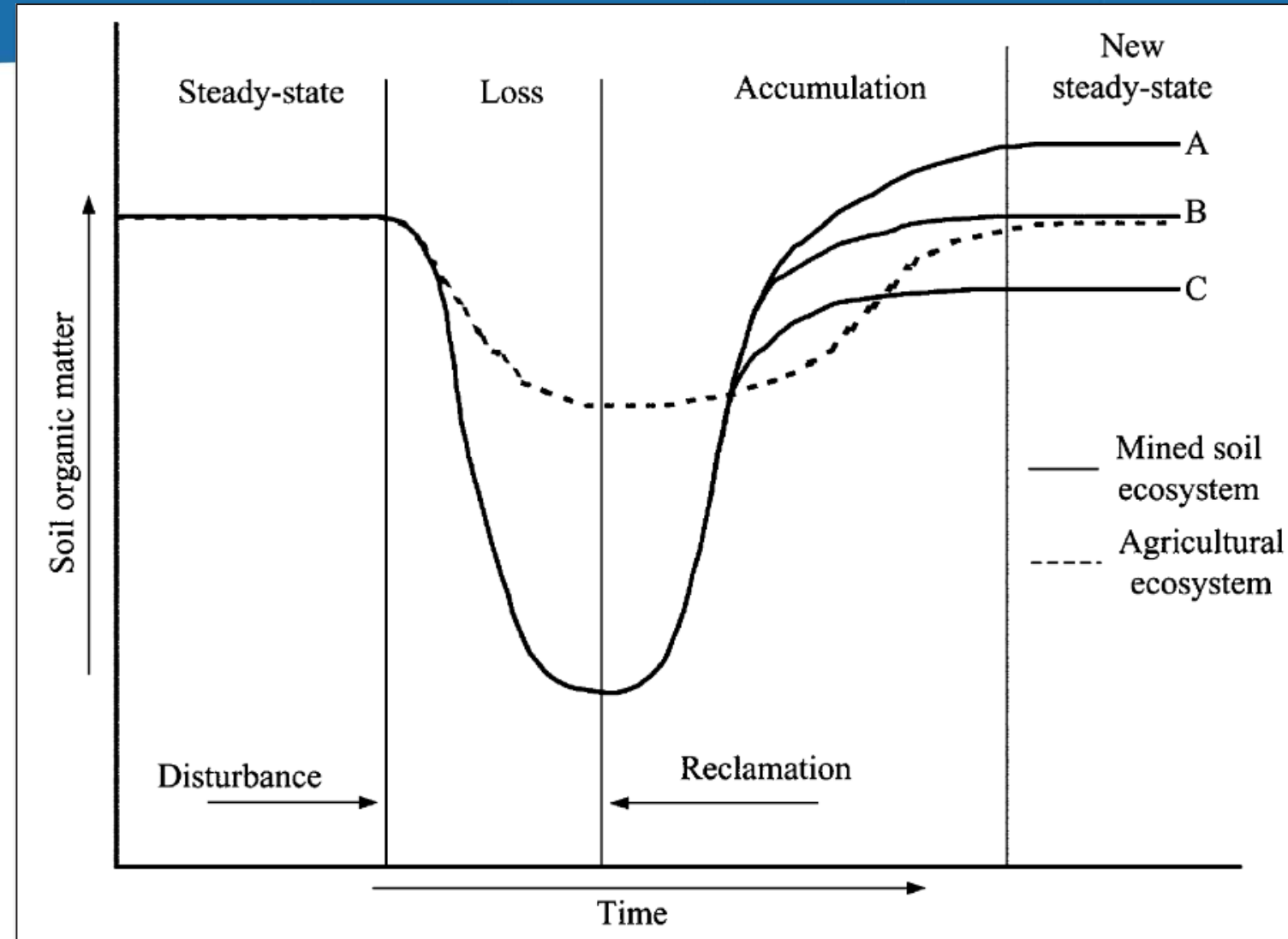


Changes in Land Management Can Enhance Soil Carbon

- Minimize disturbance
- Keep it Covered
- Grassland Restoration
- Regenerative Agriculture

Soil Degradation from Land Use

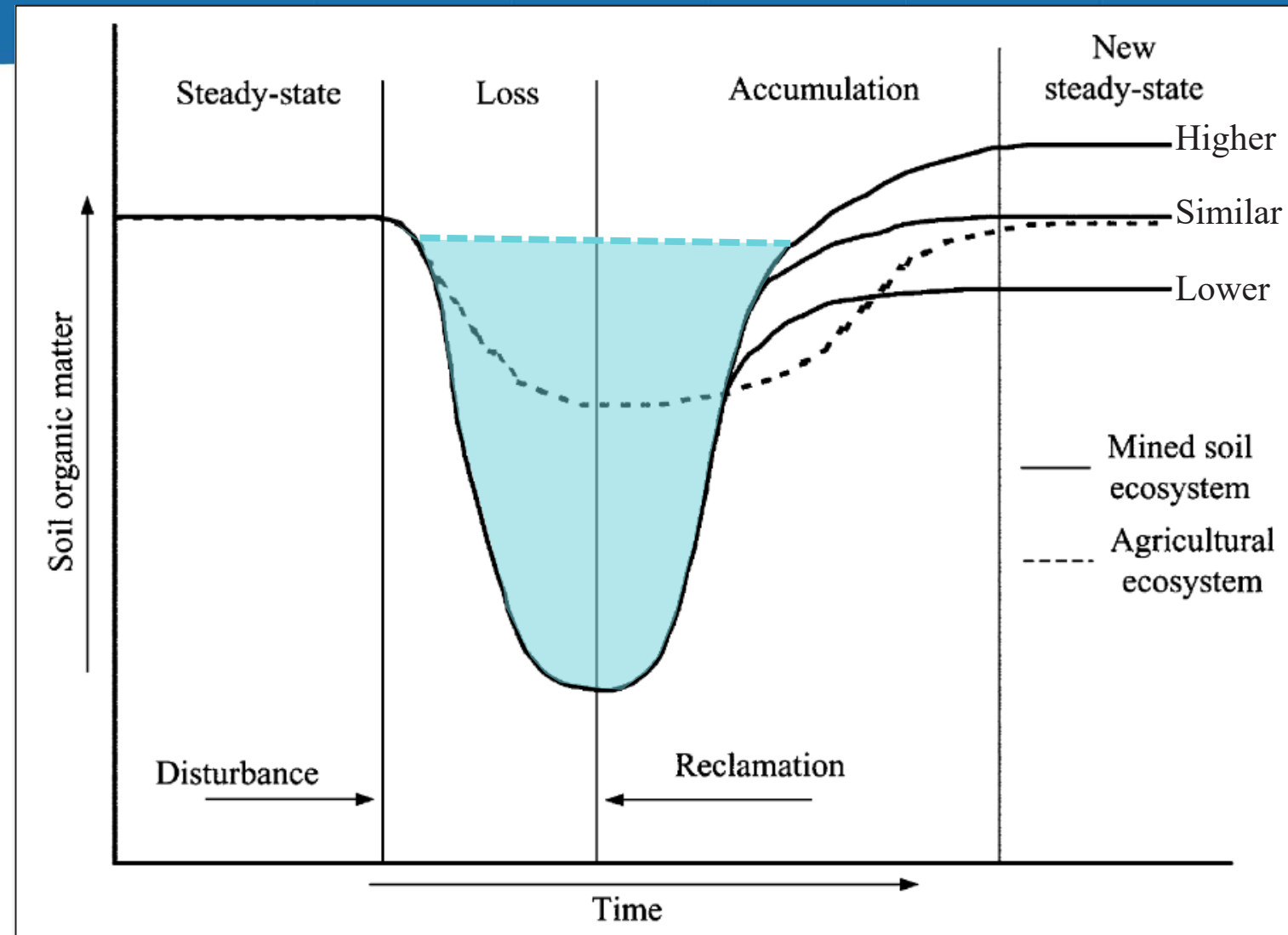
- › External drastic perturbation causes degradation in soil quality
 - › loss of soil organic matter
 - › Lack of input from plant litter



NbCS in Degraded Lands

KEY POINT

- Degraded soil has high capacity for carbon storage.
- NbCS has potential to reverse the soil degradation.

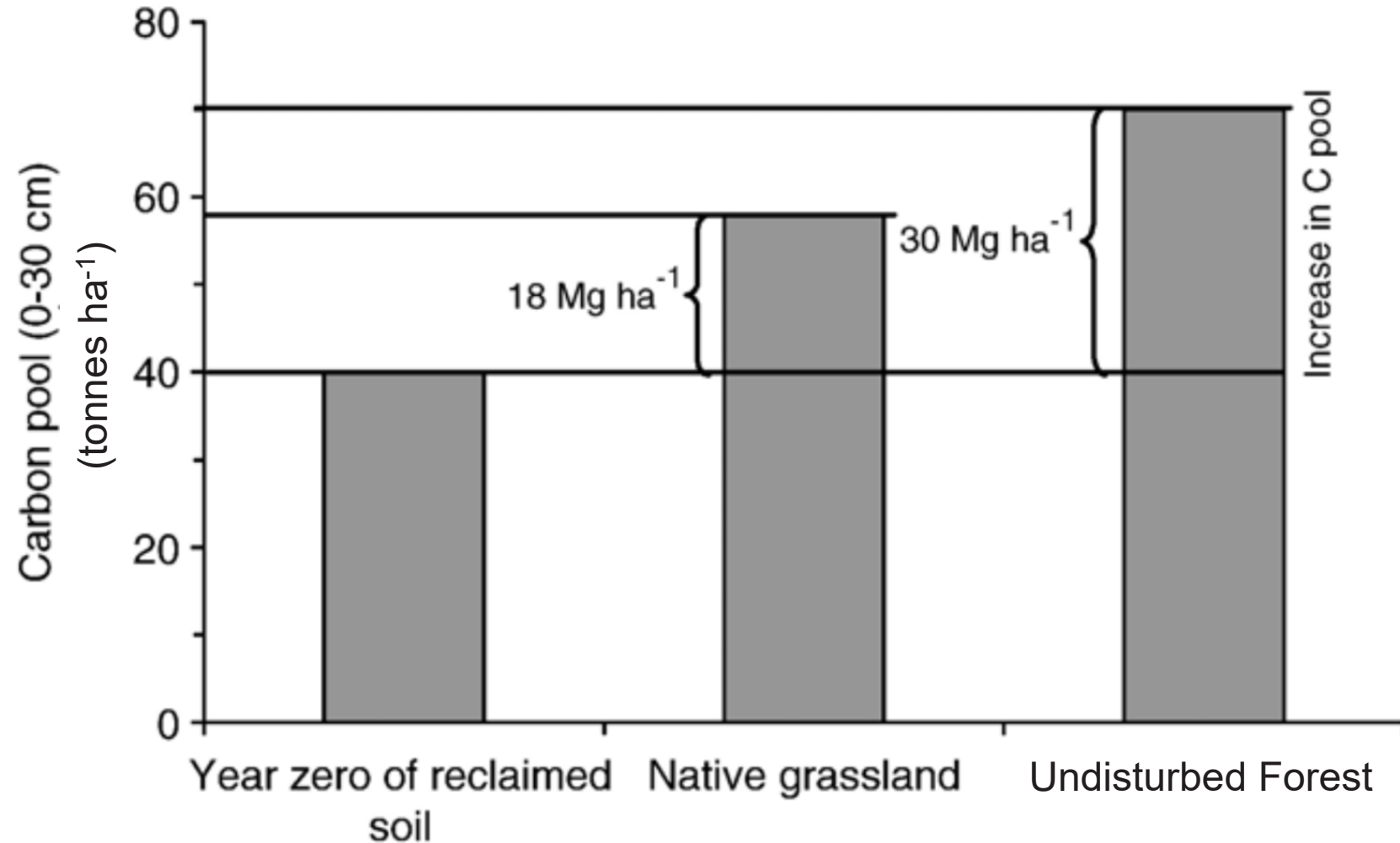


Soil Degradation and Carbon Storage

- › Comparison of carbon stock in soils under various land use in Eastern Ohio.

KEY POINT

Reclaimed soil has lower carbon storage compared to pristine soil.



OUTLINE

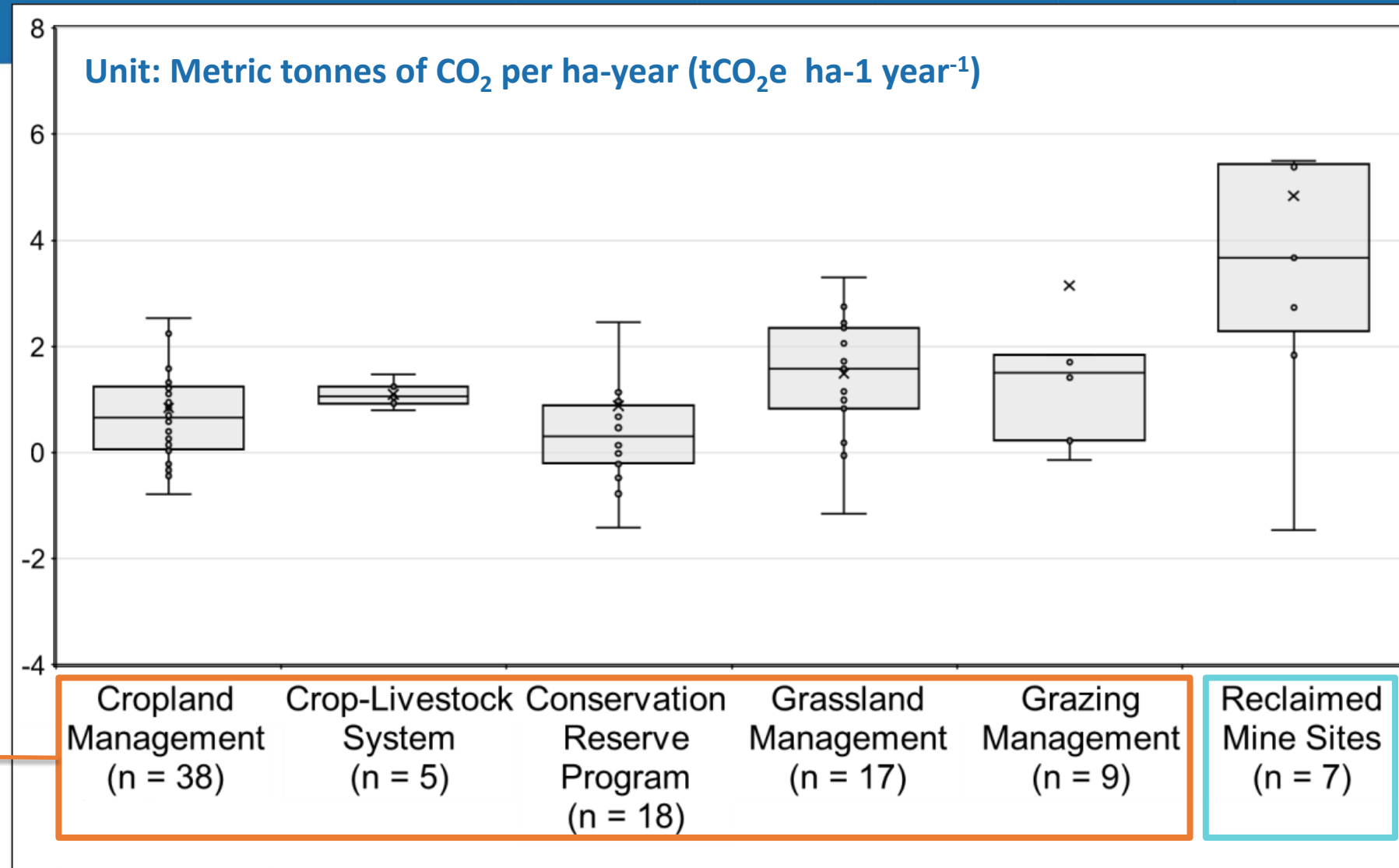
- › Nature-based Solutions on Degraded Lands
- › **Potential for NbCS at Cleanup Sites**
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Carbon Sequestration Rates

Literature Survey

- › 94 sites
- › Reported accrual rates and calculated rates from carbon stock measurements

Regenerative
Agriculture
Practices

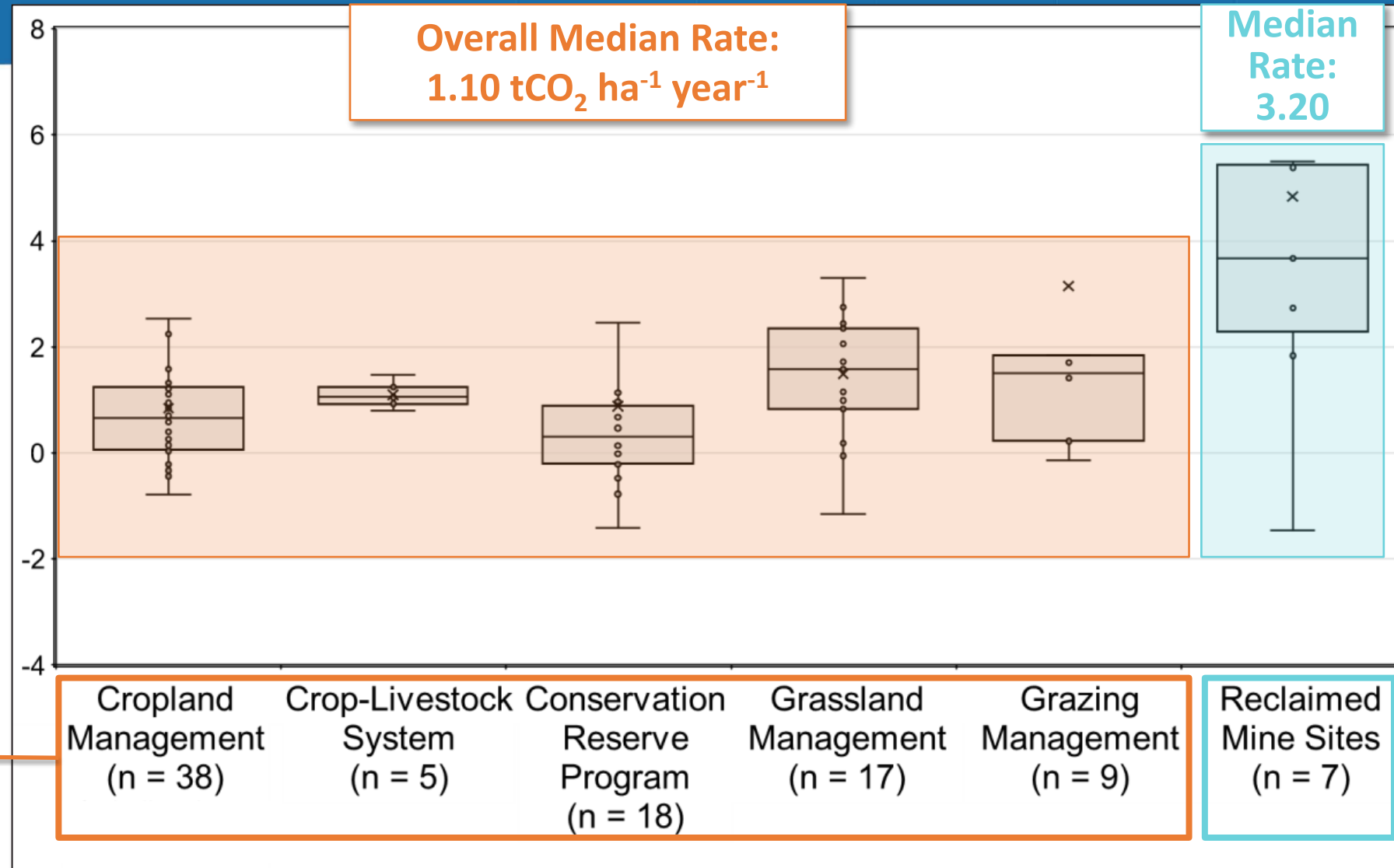


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Cost-Benefits Considerations in Site Remedy Selection

EPA Nine Criteria

from the National Contingency Plan (40CFR300.430(e)(9))

Threshold Criteria

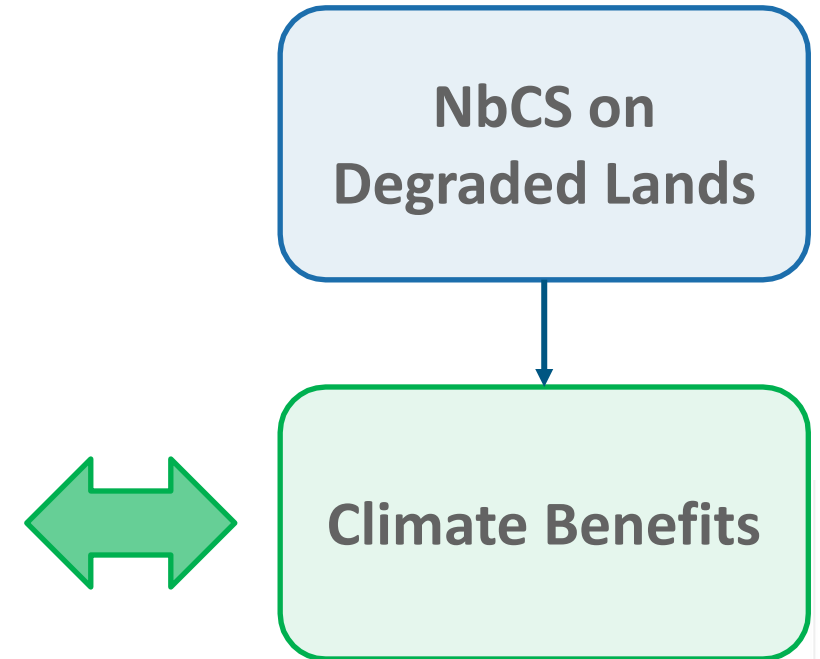
1. Overall protection of human health and the environment
2. Compliance with ARARs (applicable or relevant and appropriate standards)

Primary Balancing Criteria

3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility or volume
5. Short-term effectiveness
6. Implementability
7. Cost

Modifying Criteria

8. State acceptance
9. Community acceptance



Site Remedy Selection with Climate Consideration - Example



› Incineration



› Containment and cover

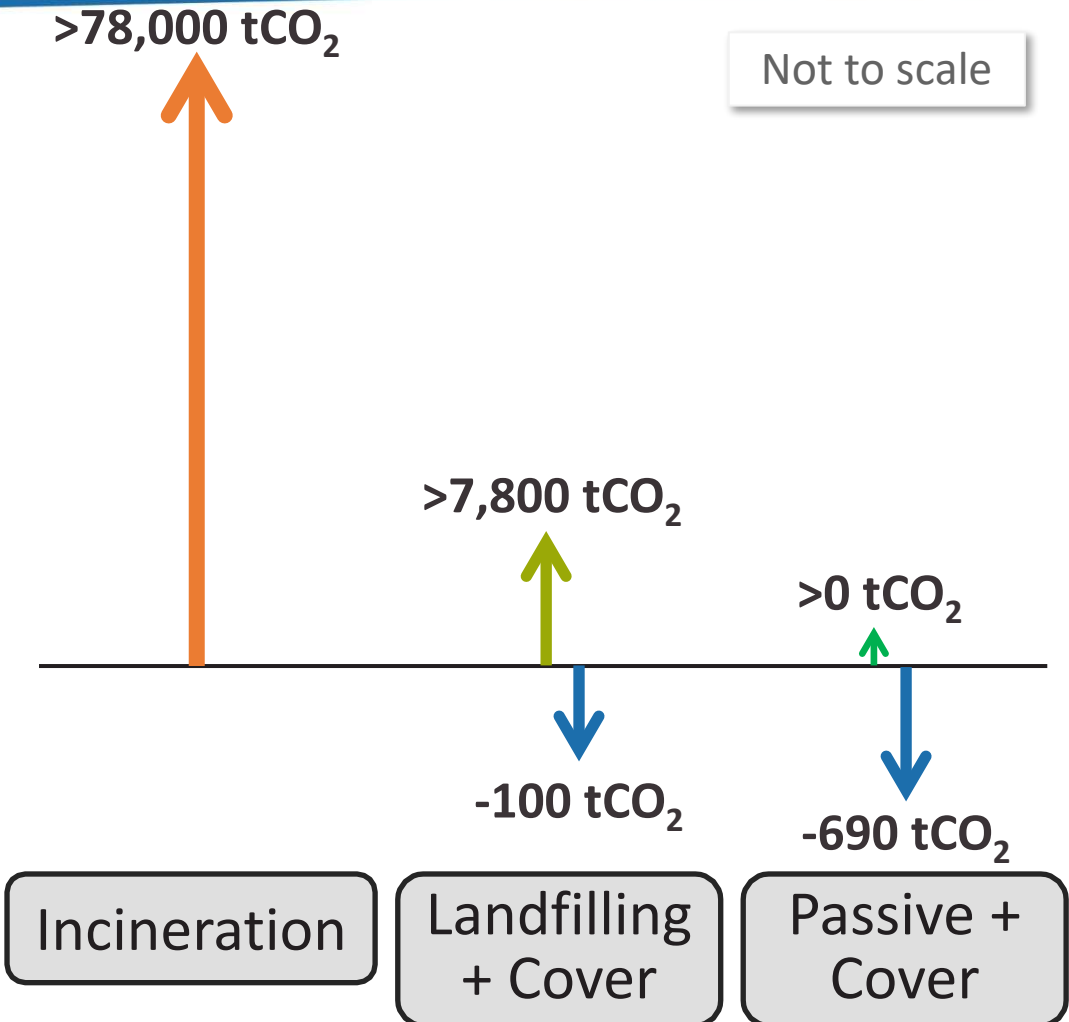
Silver Mountain Mine site in Loomis, Washington, with grazing cattle for over a decade

Site Remedy Selection with Climate Consideration – Example (continued)

Hypothetical 100,000 CY
Superfund Site Waste

- › **Alternative 1:**
Incineration
- › **Alternative 2:**
On-site landfilling
and Cover
- › **Alternative 3:**
Passive treatment
with cover

- **Carbon footprint**
- **Carbon sequestration**



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- › **What's Next?**

Transition Approach

Practical Aspect

- › Physiochemical characteristics of soil
- › Plant species
- › Amendments (and Mulching)
- › Livestock management
- › Ongoing monitoring for success

Landfill

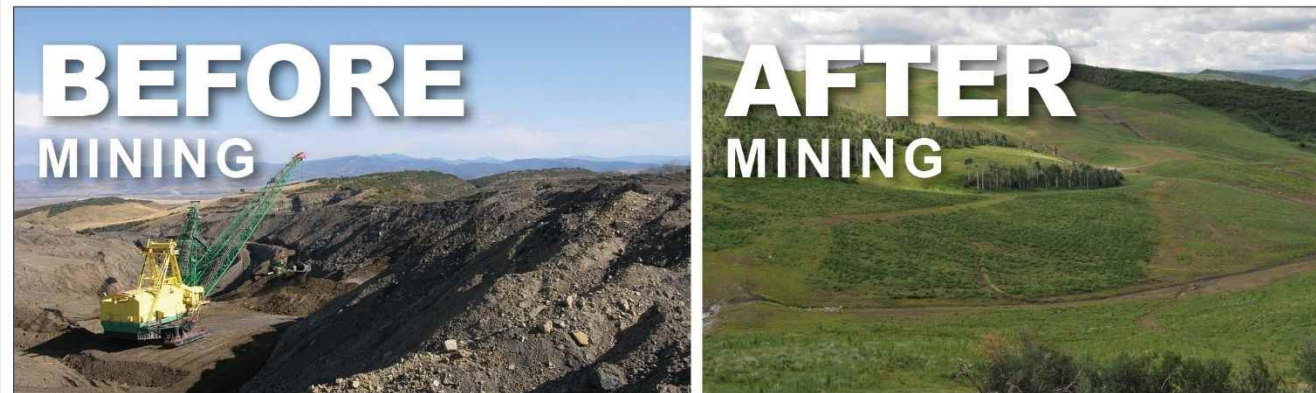
- › Phytoremediation of leachate

Remediation Sites

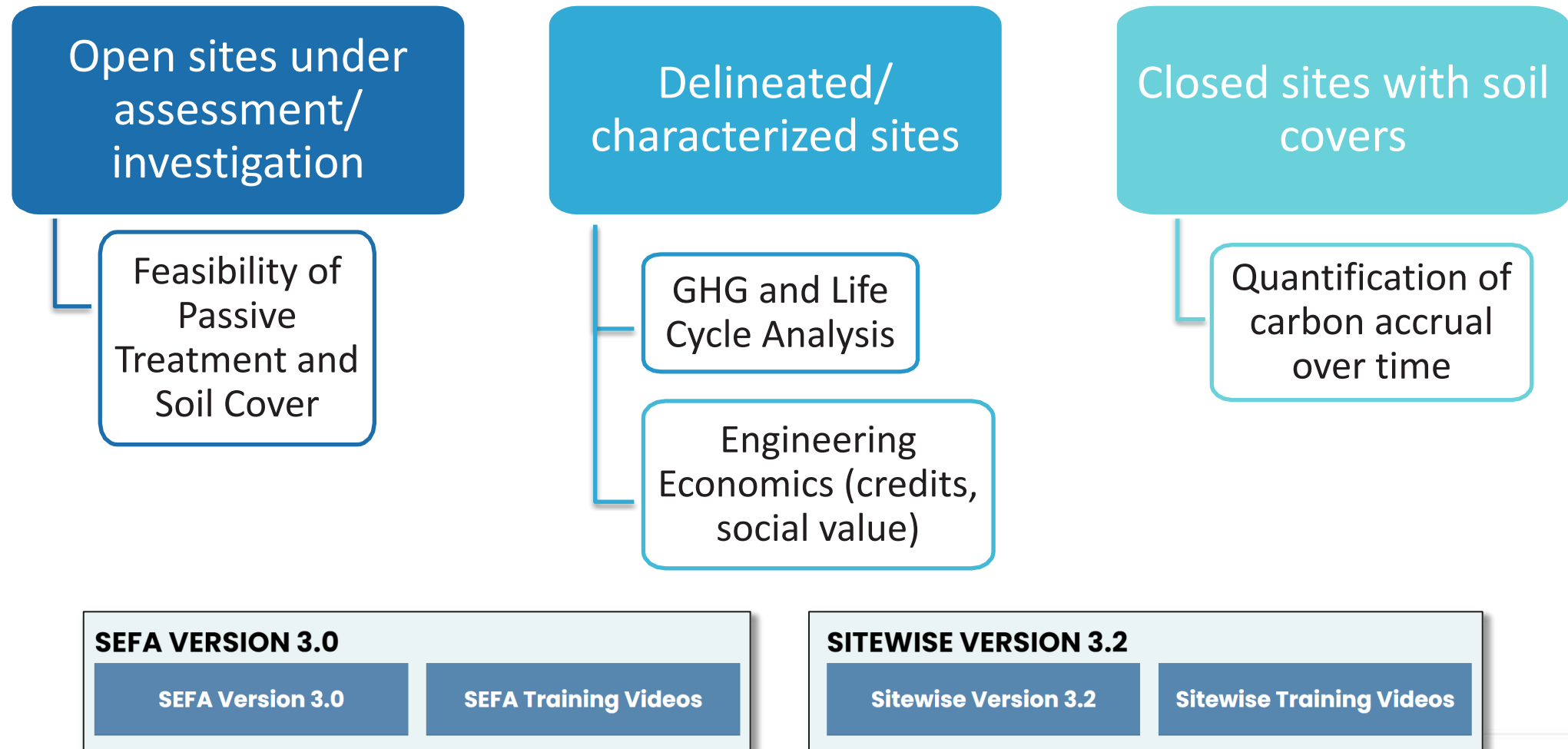
- › Level of contamination
- › Risk-based Corrective Action (RBCA)
- › Site setting
- › Phytoremediation
- › Constructed Wetland

Regulatory Aspect – mine soils

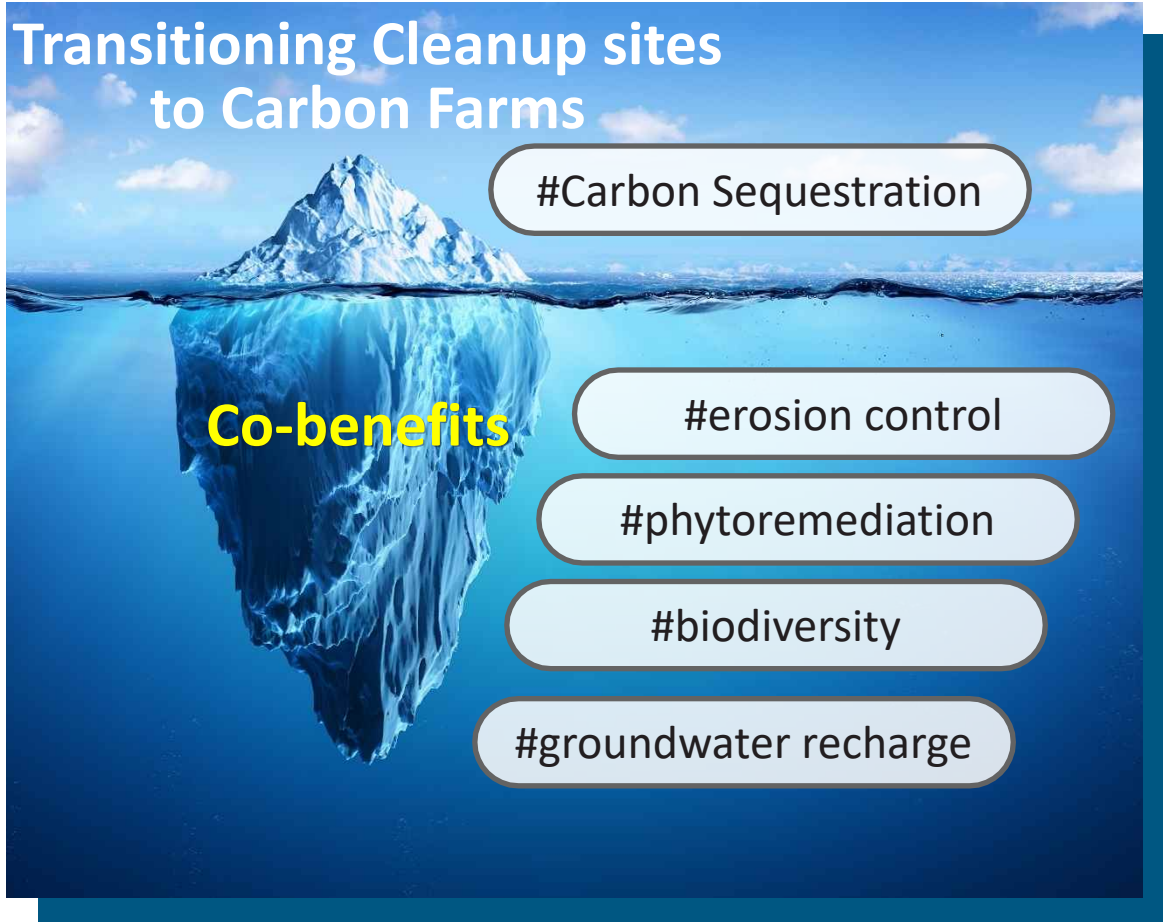
- › Surface Mining Control and Reclamation Act of 1977
 - › Permitting
 - › Bond and Eco-credits
 - › Abandoned Mine Land fund: tax on production
- › State Regulatory Agencies and Rules



Consideration of Transition Plan at Varying Stages of Remediation



Conclusions



- Degraded soils appeared to have elevated carbon accrual rate compared to agricultural soils.
- Cleanup sites transitioning to carbon farms
 - provides emission avoidance and carbon sequestration benefits.
 - has the potential to fit in existing post-closure plan for cleanup sites (permanence)
- Additional data collection necessary
 - To characterize NbCS rates and extent at cleanup sites
 - To identify suitable acreage for reclaimed sites
 - To perform engineering economics

CONTACT US

Yue (Beatrice) Li, PhD, PE
Environmental Engineer
byli@gsienv.com

