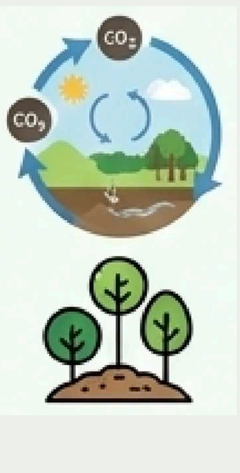
Soil organic carbon sequestration during the restoration of upland evergreen forest in Northern Thailand

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Introduction



Climate change is driven largely by rising atmospheric CO_2 from deforestation and land-use change. Forest ecosystems help mitigate climate change by storing carbon in vegetation and soils, particularly as soil organic carbon (SOC), one of the largest terrestrial carbon reservoirs. Forest restoration methods such as the Framework Species Method (FSM) can help rebuild SOC by promoting forest recovery and increasing organic inputs to the soil.

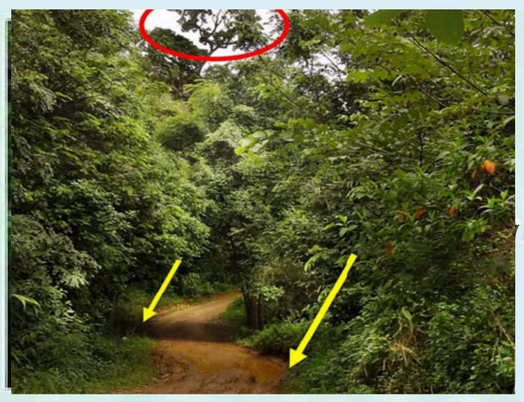
Objectives

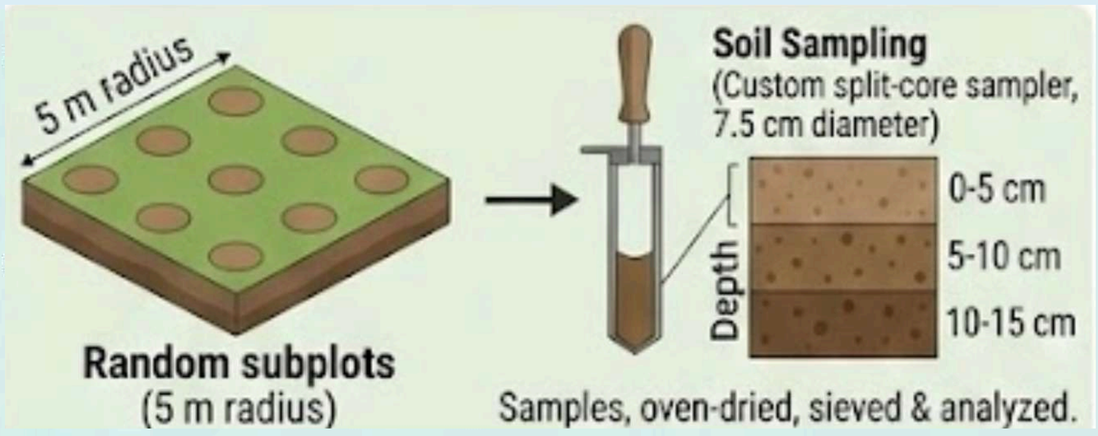
Evaluate soil organic carbon (SOC) accumulation across four forest conditions: control (abandoned agricultural land), 12-year restoration forest, 24-year restoration forest, and reference upland evergreen forest.

Assess the effects of the Framework Species Method (FSM) on soil properties, including nitrogen (N), phosphorus (P), potassium (K), and soil pH.

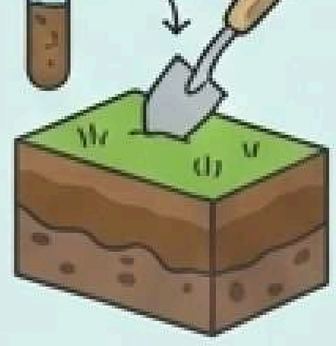
Methods





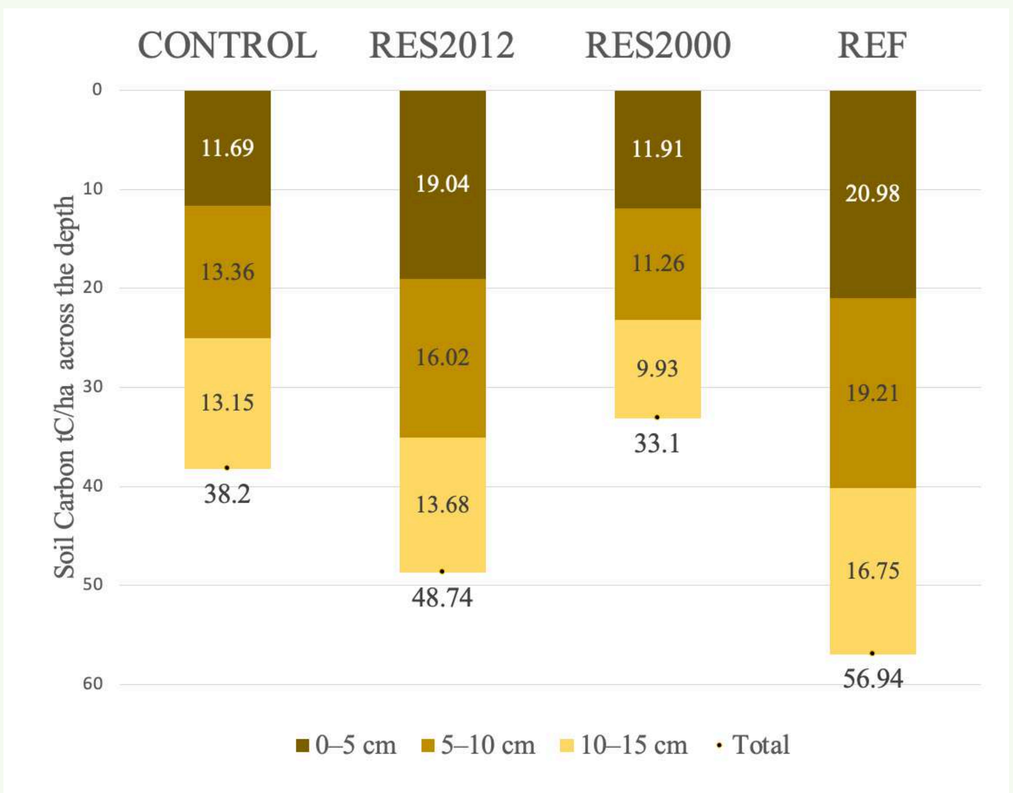


- Samples were oven-dried at 105 °C for 24 h, sieved through a 2-mm mesh, and analyzed at the CMU Agricultural Soil Laboratory.
- SOM was determined using the Walkley–Black method and converted to SOC, while N, P, K, and pH were also measured.



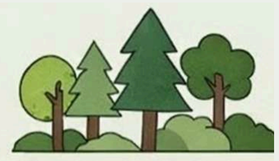
Results & Discussion

Soil organic carbon (SOC) at 0–15 cm was highest in the reference forest (56.94 tC/ha) and lowest in the 24-year restoration site (33.10 tC/ha), while the 12-year site showed relatively high SOC (48.74 tC/ha), exceeding the control (38.20 tC/ha). This suggests SOC recovery does not increase linearly with restoration age and may reflect legacy effects from past land use and differences in bulk density. Restored and reference plots showed lower pH (5.28–5.36 vs. 5.90), higher N (0.392–0.481% vs. 0.366%) and K (256–290 vs. 113 mg/kg), but lower P (0.04–0.09 vs. 2.18 mg/kg) compared with the control, indicating more active nutrient cycling under forest cover.



SOIL CHEMICAL PROPERTIES: Control vs. Restored/Reference Plots

pH	6.00 → 5.27–5.32) ↓
Nitrogen (N)	1.10% → 1.44%–1.45%) ↑
Potassium (K)	340 mg/kg → 770–870 mg/kg)
Phosphorus (P)	6.55 mg/kg → 0.11–0.26 mg/kg) ↓



More active nutrient cycling under forest cover

Conclusion

Soil organic carbon (SOC) showed recovery in restored forests, with the 12-year restoration site approaching values observed in the reference forest. Although SOC did not increase consistently with restoration age, restored sites exhibited improved soil chemical properties compared with abandoned land. These findings highlight the role of forest restoration, particularly the Framework Species Method, in supporting long-term soil ecosystem recovery.

Acknowledgements

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