

Spatiotemporal heterogeneity and nonlinear recovery trajectories of carbon budgets in restored pan-tropical peatlands

Yuhao Mo¹, Baobao Pan¹, Deli Chen¹, Shu Kee Lam¹

¹ School of Agriculture, Food and Ecosystem Sciences, Faculty of Science,

The University of Melbourne, Parkville VIC 3010, Australia

MO4@student.unimelb.edu.au

Introduction

Background:

Pan-tropical peatland degradation drives substantial carbon release, while restoration enhances sequestration capacity.

However, post-restoration carbon dynamics remain poorly quantified, with most studies limited to the initial 0–5 years.

Furthermore, while rewetting and revegetation are vital, spatial and temporal variations in effective mitigation strategies remain unclear.

Research Questions:

1. What are the spatial and temporal patterns of carbon fluxes?
2. What are the underlying environmental drivers behind carbon dynamics?

Methodology

Step 1 (Spatiotemporal Analysis): Conducts spatial and temporal analysis of carbon flux variations.

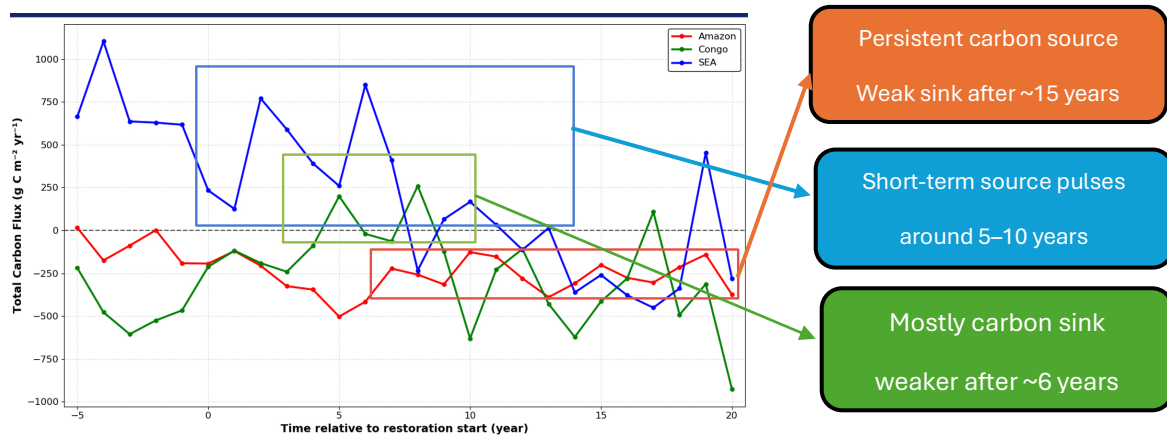
Restoration Mapping: Created by overlaying peatland distribution and protected area databases.

Carbon Flux Data: Utilizes CO₂ and CH₄ upward flux from the Copernicus Atmospheric Monitoring Service (CAMS).

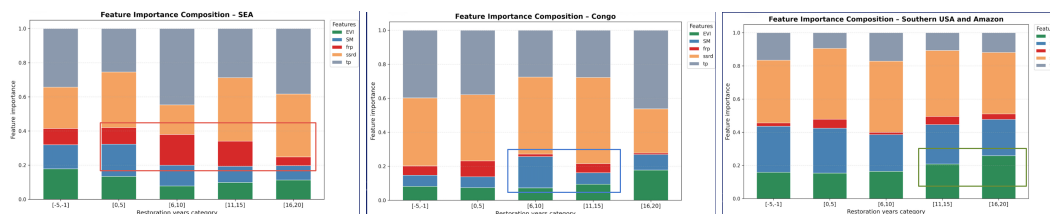
Step 2 (Driver Attribution): Employs Random Forest models to determine the feature importance of environmental drivers.

Environmental Drivers: Includes multi-source data on fire (FRP), plant growth (EVI), and hydrology from MODIS and Copernicus.

Result 1: Carbon dynamics after pan-tropical peatlands restoration



Result 2: Driving factor that affect carbon dynamics after restoration



EVI: Enhanced Vegetation Index representing vegetation productivity

FRP: Fire Radiative Power representing fire intensity and activity

SM: Soil Moisture representing hydrological status and moisture availability

ssrd: Surface Solar Radiation Downwards representing solar energy input

tp: Total Precipitation representing cumulative hydrological input

Take home message

Restored peatlands show complex and region-specific carbon dynamics.

Southeast Asian Peatlands: Fire-driven emissions remain critical.

Extreme-weather-related emissions require attention after 15 years of restoration.

Congo Basin Peatlands: Potential rebound to carbon source.

Water levels should be maintained above the ground surface.

Amazonian peatlands: Strongest carbon sequestration capacity.

Long-term protection from logging and disturbance is essential.