1. MASTER THESIS OFFER

Title: Blue carbon stabilisation processes across mangroves

Context and objective

Mangrove ecosystems absorb CO_2 from the atmosphere, and bury carbon at a rate ten times faster than terrestrial forests[1]. Therefore, mangroves are part of the "blue carbon" ecosystems. Organic matter in mangrove soils soil has accumulated for thousands of years[1], because soil organic matter (SOM) decay was slower than inputs of organic matter from net primary production[2,3]. Despite their exceptionally high carbon stocks and sink, mangroves have been relatively little studied compared to terrestrial ecosystems.

Figure 1 : One of the field site of this project: the mangrove in the Delta Mekong, Vietnam.

The mechanisms regulating SOM stabilisation in mangroves remain largely unknown[4–6]. SOM recalcitrance to microbial decomposition and anoxic conditions have been shown as major determinants of SOM decay in waterlogged mangrove soils[5,7]. Yet, SOM accessibility to soil microorganisms might also explain the long-term storage of carbon (i.e. century to millennia) in mangroves[5,8] as for terrestrial[9,10] and marine ecosystems[11,12]. SOM stabilisation may be influenced by mangrove geomorphological settings because they lead to differences in soil mineralogy, organic matter quality, and oxic/anoxic conditions, all of which influencing SOM inaccessibility to microbes.

The main objective of this master thesis will be to investigate the potential carbon stabilisation processes across two types of geomorphological mangroves settings.

Methods

The post-graduate student will use soil samples from different countries and analyse SOM protection with different state of art laboratory methods. She/he/they will use density fractionation to separate easily decomposable plant litter from stabilised SOM in interaction with the mineral phase. Moreover, she/he/they will characterise the degree of stabilisation of different SOM types by investigating the elemental and isotopic composition of the different fractions. Analyses of the quantity and composition of the lignin molecule will provide evidence about the state of degradation of the SOM present in different geomorphological settings. The post-graduate student might contribute to the writing of a scientific article if wished.

1. McLeod, E. et al. A blueprint for blue carbon: Toward an improved understanding of the role of vegetated coastal habitats in sequestering CO2. Front. Ecol. Environ. 9, 552–560 (2011).
2. Middleton, B. A. & McKee, K. L. Degradation of mangrove tissues and implications for peat formation in Belizean island forests. J. Ecol. 89, 818–828 (2001).
3. Alongi, D. M. The energetics of mangrove forests. (Springer, 2009). doi:10.1007/978-1-4020-4271-3.

4. Arnaud, M., Baird, A. J., Morris, P. J., Dang, T. H. & Nguyen, T. T. Sensitivity of mangrove soil organic matter decay to warming and sea level change. Glob. Chang. Biol. 26, 1899–1907 (2020).
5. Spivak, A. C., Sanderman, J., Bowen, J. L., Canuel, E. A. & Hopkinson, C. S. Global-change controls on soil-carbon accumulation and loss in coastal vegetated ecosystems. Nat. Geosci. 12, 685–692 (2019).
6. Macreadie, P. I. et al. The future of Blue Carbon science. Nat. Commun. 10, 3998 (2019).
7. Kristensen, E., Bouillon, S., Dittmar, T. & Marchand, C. Organic carbon dynamics in mangrove ecosystems: A review. Aquat. Bot. 89, 201–219 (2008).
8. Basile-Doelsch, I., Balesdent, J. & Pellerin, S. Reviews and syntheses: The mechanisms underlying carbon storage in soil. Biogeosciences 17, 5223–5242 (2020).
9. Schmidt, M. W. I. et al. Persistence of soil organic matter as an ecosystem property. Nature 478, 49–56 (2011).
10. Rothman, D. H. & Forney, D. C. Physical Model for the Decay and Preservation of Marine Organic Carbon. Science (80-.). 316, 1325–1328 (2007).
11. Barber, A. et al. Preservation of organic matter in marine sediments by inner-sphere interactions with reactive iron. Sci. Rep. 7, 366 (2017).
12. Kida, M. & Fujitake, N. Organic Carbon Stabilization Mechanisms in Mangrove Soils: A Review. Forests 11, 981 (2020)

2.- CONTEXT OF THE INTERNSHIP

The post-graduate student will participate in the MangC collaborative project investigating the effect of global warming on mangroves soil carbon in Malaysia, Vietnam and Australia. She/he/they will be based at the Institute of Ecology and Environment at the Paris Sorbonne University (PSU). PSU is a research-intensive and world-class university ranked 83rd in the QS world university (2020). Part of the internship will be carried out at the Ecotron of Ile de France, where an accommodation (potentially in shared room) is available. This master thesis could be a good entry to apply for a PhD with us.
Start date: January 2023 End date: June 2023 (the dates can be flexible)
Allowance of ~ 600 euros/ month (if not partner of PSU under Erasmus munduns)

3.- SUPERVISORY TEAM

Dr Marie ARNAUD (She/her); Dr. Cornelia RUMPEL (She/her), Msc Francisco Ruiz (He/him)
contact : m.arnaudd@gmail.com

4.- REQUIREMENTS

- Knowledge of coastal ecosystems and/or the soil carbon cycle
- Enthusiasm about laboratory soil analysis and repetitive tasks
- Very rigorous and persistent
- Good English or French speaking/writing skill is necessary

Person from under-represented group in STEM are highly encouraged to apply.