Master thesis internship proposal

Title: Understanding the impact of land use change on soil biodiversity and soil functioning using structural equation modelling analysis

Host organization: IRD **Research unit**: UMR Eco&Sols

Internship location: UMR Eco&Sols, 2 place Viala, 34060 Montpellier Cedex 2

Period/Date: 6 months: from January 2018

Supervisors: Dr Alain Brauman (IRD, alain.brauman@ird.fr)
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Mr Alexis Thoumazeau, PhD student (CIRAD, alexis.thoumazeau@cirad.fr)

Required profile: master student with specialization in ecology, soil science and/or agronomy. Good knowledge in uni- and multivariate statistics with R program. English writing capacities. Student with a **strong interest in data analysis.**

General context of the study:

The assessment of the soil quality and its impact on ecosystem services and goods is a scientific and societal issue that has been widely debated in the literature over the last twenty years. Broadly, soil quality can be defined as the "the capacity of the soil to function" and provide sustained biological productivity, environmental quality and plant and animal health (Karlen et al., 1997). Several indicators of soil quality have been developed (Obriot et al., 2016; Velasquez et al., 2007), but they suffer from not properly incorporating the impact of environmental and agricultural induced disturbances on the multiple ecosystem functions underpinning the soil ecosystem services. This is an important shortcoming because estimators of soil quality based on a compartmentalization of physical, chemical and biological properties, without taking into consideration their interactions, are prone to underestimate the importance of synergies and trade-offs. To address this knowledge gap, Kibblewhite et al., (2008) proposed a theoretical framework linking soil functions to major ecosystem services, and which underlines the need to consider the interactions between soil physico-chemical properties and soil biological assemblages.

Based on this framework, a CIRAD-IRD team developed a set of 9 indicators to assess three key soil functions: carbon transformation, nutrient cycling and soil structure evolution. All indicators were integrated within the "Biofunctool" package, i.e. a set of affordable, in-field and time-effective measurements of soil functioning. This approach provides integrative information that can be closely linked to soil ecosystem services.

The Biofunctool set has been applied in five experimental sites in Thailand in order to assess the impact of rubber tree plantation land use and induced land use change on soil functioning. In each experimental site, a range of 4 to 6 treatments were studied with the Biofunctool set. The study sites have also been described in terms of soil physical, chemical properties and soil biodiversity. This dataset allows us to test the impact of land use change on soil biodiversity and its consequences for ecosystem function in agricultural systems, which remains an opened question in an agricultural context.

Objective:

The objective of the internship is to acquire a mechanistic understanding of the impact of land use change on soil biodiversity and soil functioning using data from five rubber tree plantation experiments.

Methodology proposed:

1- Assemble and curate the different datasets (e.g. soil physico-chemical properties, soil biota, environmental drivers and soil functioning) in a global dataset.
2- Aggregate the Biofunctool variables to create a soil functioning variable easily linkable to soil ecosystem services.
3- Test alternative hypotheses on the relationship between soil biodiversity, physico-chemical properties and and functioning using mixed effects models and structural equation modelling[1] (ex: Poeydebat et al., 2017).

Expected output:

- Acquire a mechanistic understanding of the relationships between land use management, soil biodiversity and soil functioning in rubber tree plantations.
- Prepare a master thesis report with the structure of a scientific paper.

Fee covered: internship allowances (≈550€/month)

Karlen, D.L., Mausbach, M.J., Doran, J.W., Cline, R.G., Harris, R.F., Schuman, G.E., 1997. Soil Quality: A Concept, Definition, and Framework for Evaluation (A Guest Editorial). Soil Science Society of America Journal 61, 4–10.

Kibblewhite, M.G., Ritz, K., Swift, M.J., 2008. Soil health in agricultural systems. Philos. Trans. R. Soc. B-Biol. Sci. 363, 685–701.

Obriot, F., Stauffer, M., Goubard, Y., Cheviron, N., Peres, G., Eden, M., Revallier, A., Vieublé-Gonod, L., Houot, S., 2016. Multi-criteria indices to evaluate the effects of repeated organic amendment applications on soil and crop quality. Agriculture, Ecosystems & Environment 232, 165–178. doi:10.1016/j.agee.2016.08.004

Poeydebat, C., Tixier, P., Chabrier, C., de Bellaire, L. de L., Vargas, R., Daribo, M.-O., Carval, D., 2017. Does plant richness alter multitrophic soil food web and promote plant-parasitic nematode regulation in banana agroecosystems? Applied Soil Ecology 117, 137–146.

Velasquez, E., Lavelle, P., Andrade, M., 2007. GISQ, a multifunctional indicator of soil quality. Soil Biology and Biochemistry 39, 3066–3080.

[1] *Structural equation modeling is also called casual modeling because it tests the proposed casual relationships. This technique is the combination of factor analysis and multiple regression analysis, and it is used to analyze the structural relationship between measured variables and latent constructs.*