



Apply for a grant-funded PhD (3 years) at Cirad

Spatial and biogeochemical inference of tropical soils using AI for the assessment of the soil chemical fertility

Cirad (French Agricultural Research Centre for International Development) is the French agricultural research and cooperation organization working for the sustainable development of tropical and Mediterranean regions. Cirad works with its partners to build knowledge and solutions and invent resilient farming systems for a more sustainable, inclusive world. It mobilizes science, innovation and training in order to achieve the Sustainable Development Goals.

The research units “Recycling and Risk¹” and “AIDA²” of Cirad is likely³ to offer a grant-funded PhD (3 years) position to address the following topic: *Spatial and biogeochemical inference of tropical soils using AI for the assessment of the soil chemical fertility*.

The PhD candidate will be supervised by Dr Jean-Christophe Soulié (Cirad, Recycling and Risk), Dr Julien Demenois (Cirad, AIDA) and Dr Alexandre Wadoux (James Cook University, Australia). The PhD thesis will be connected to the African Union Soil Observatory project (AUSO) through use cases within the 14 targeted African countries of the project.

Why the topic matters?

Africa’s soils are deteriorating due to various factors, including negative nutrient balance (IPBES Global Assessment Report, 2019). Recognizing the pivotal importance of improved soil health in achieving Africa’s sustainable agricultural intensification goals, the African Union Commission prioritized improved soil health to underpin increased agricultural production. To advance the implementation of the key components outlined in the Africa Fertilizer Soil Health Action Plan, the African Union Soil Observatory (AUSO) project develops a scalable soil health dashboard. Legacy soil data will play a key role in assessing soil health in Africa due to the limited, yet growing, number of soil samples compared to other regions.

Legacy soil data are indeed an invaluable source of information for soil management, but still under-used due to several challenges. Their poor description, including their lack of precise geographical coordinates, is a key limitation. Restoring missing geographic coordinates is a prerequisite as they act as a primary key to connect legacy soil data with a wealth of auxiliary information currently available (e.g. soil type, climate, land use and land cover history), and which are essential to assess soil health. Several studies have shown that a soil could be characterized by a chemical or spectral signature of its environment, opening potential avenues

¹ <https://ur-recyclage-risque.cirad.fr/en>

² <https://ur-aida.cirad.fr/en>

³ Funding partially confirmed. If the funding is not fully confirmed in June, the PhD will be canceled.

for prediction of geolocation. However, legacy soil samples are hardly available to perform additional analysis such as vis-near or mid-infrared spectroscopy, or Ultra-High Performance Liquid Chromatography. To overcome this barrier, the supervision team of this PhD developed, as a proof of concept, a novel deep learning architecture adapting state-of-the-art techniques from other Artificial Intelligence (AI) domains to legacy soil data. The AI-based model integrates Multi-Layer Perceptron encoders, a Transformer Encoder to capture interactions among soil attributes, and conditional Feature-wise Linear Modulation layers to include geographic constraints. Implemented as a Deep Ensemble, the proof-of-concept model achieved a median prediction accuracy of 175 km.

Objectives of the PhD

Based on this proof of concept, the main objective of this PhD thesis is to develop new AI-based pipeline learning models to build an interpretative framework for assessing the chemical fertility of tropical soils in Africa, using the location of legacy soil data and their translation into available nutrients.

More specifically, the PhD thesis will address the three following scientific objectives:

- 1) Improve the geographical accuracy of predictions for legacy soil data by improving the AI-based model and integrating post-processing;
- 2) Assess the uncertainties of prediction and their propagation when using environmental data (climate, soil type, etc.) associated with predicted geographical coordinates;
- 3) Develop an AI-based predictive model of the biogeochemical behavior of tropical soils (nitrogen and phosphorus availability).

Expected profile of the PhD candidate

The grant-funded doctoral researcher must have a master's degree in applied mathematics or statistics. The grant-funded doctoral researcher is expected to have strong motivation for academic research and be willing to complete the PhD for which this position is intended. The grant-funded doctoral researcher must have an excellent command of written and spoken French and English.

The following will be considered advantages: 1) Strong interest for environmental sciences and soil sciences in particular, 2) Previous experience in a research institution, 3) Ability to work independently and in multidisciplinary research teams, and 4) Ability to work in a multi-cultural environment.

You will have the opportunity to: 1) Receive a three-year personal grant funded, 2) Integration into an internationally active research group, and 3) Collaboration with researchers working on IA, digital soil mapping and soil carbon.

Starting date: October 2026 (if funding confirmed before June 2026)

Location of the position: Montpellier, France

Questions?

For further information, please contact:

Dr Jean-Christophe Soulié

e-mail: jean-christophe.soulie@cirad.fr

Or

Dr Julien Demenois

e-mail: julien.demenois@cirad.fr

How to apply?

The following documents must be sent **no later than May 7th, 2026** to jean-christophe.soulie@cirad.fr and julien.demenois@cirad.fr and alexandre.wadoux@jcu.edu.au

- Motivation letter (max. 1 page)
- The applicant's CV (curriculum vitae)
- Copy of MSc degree diploma
- Contact details (title, full name, phone number and email address) of at least one reference
- Other documents that the applicant considers important to demonstrate their merits (*e.g.* English language proficiency, reference letter from previous supervisor, etc.).