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POST-DOCTORATE PROPOSAL

Title : Monitoring soil contamination by specific-species identification and diversity assessment based on multi-scale (from in-situ to satellite) optical remote sensing

Reference : **PDOC-DOTA-2025-01**
(to be recalled in all correspondence)

Start of contract: February 2025

Application deadline: Until fulfilled

Duration: 12 months (plus optional 12 month extension)

Keywords:

Optical remote sensing, vegetation, bio-chemical and physical traits, species-specific, biodiversity, soil contamination, phytostabilisation, machine learning, multi-(hyper-)spectral technologies

Profile and skills required:

Formation: PhD discipline related to the project's scope, such as optical remote sensing, signal / image processing, terrestrial ecosystems

Skills: strong remote sensing data processing knowledge, python programming experience, possibly GIS (Geographic Information System) skills, knowledge of the English language

Presentation of the post-doctoral project, context and objective:

The EDAPHOS R&I project, as part of the "Soil Health and Food" mission in the context of the EU Soil Strategy 2030 (Horizon Europe Call), aims to implement innovative nature-based technologies for monitoring polluted soils and remediation to accelerate their reclamation. EDAPHOS intends to demonstrate the effectiveness of phytomanagement through its deployment in seven study sites (Spain, France, Greece, Italia, Poland) using optical remote sensing for site monitoring.

TMEs (Trace Metal Element), released by various anthropic activities like agricultural, mining, smelting or other industrial activities, can lead to persistent pollution in soil even after the cessation of operations. The environment is then exposed to the transfer and dissemination of TMEs causing water and soil contamination and loss of biodiversity. Vegetation mapping and monitoring in development on polluted soils (or nearby) are of interest to provide information on the results of rehabilitation or to detect and control residual contaminants through modification of physiological activities (revealed e.g. by pigment concentrations, biomass) (Slonecker et al. 2010, Lassale et al. 2019, Malabad et al. 2022, Béraud et al. 2023), species-specific identification (Gimenez et al. 2022) or biodiversity change (Song et al. 2020). Therefore, monitoring soil TMEs on large scale for various land covers is of great interest and can be achieved by passive optical remote sensing. Hyperspectral imagery and multispectral temporal series have been widely used to assess vegetation traits and species/genus/assemblage classification. More recently, these technics are used to map variables characterizing the contamination (vegetation traits, soil composition) (Ong et al. 2019, Song et al. 2020, Lassalle et al. 2019, Lassalle et al. 2021, Fabre et al. 2020, Gimenez et al. 2022, Béraud et al. 2023). The retrieval of TME impacts on vegetation by optical remote sensing data remains challenging (species-dependent according to their sensitivity to particular TMEs, TME effects combined with other natural or environmental stressors of greater impact…) and site-specific (Wang et al. 2018).

The objective of this post-doctorate is to provide performant and robust method by means of multi-scales optical remote sensing data processed by machine learning methods to map species and diversity at local and regional scales in various polluted contexts (agricultural, mining, post-mining, industrial areas) located in Europe. Then, these maps will be correlated to foliar and soil TME contents to retrieve indicators characterizing a contamination at local scale and to monitor the phytomanaged sites (Erudel et al., 2017, Fabre et al. 2020, Gimenez et al., 2022, Béraud et al. 2023).

To reach this objective, the candidate will work on optical remote sensing images by means of a range of technologies and platforms, including hyperspectral and/or multispectral multitemporal sensor on-board satellite (PRISMA, EnMAP, Sentinel-2, PlanetScope), hyperspectral camera on-board aircraft, multispectral camera on-board drone sensors. These multi-scale data will be used in synergy at various stages: model calibration, data fusion and validation. The most suitable strategy to exploit multi-scale data to improve the quality of the provided classification and prediction maps and assess performance will be studied.

This work will contribute to set up the appropriate experiment and methodology to monitor polluted soils of the seven study sites.

Candidates should have:

- Less than 3 years after their PhD degree,
- Obtained outstanding academic results and have experience with academic publishing;
- Proven interest and experience in image processing, remote sensing, and environment.

Application materials include:

- a letter of motivation,
- an academic CV, including a publication list,
- contact details of an academic referee.

References:

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Slonecker, E.T., Fisher, G.B., Aiello, D.P., Haack, B., 2010. Visible and infrared remote imaging of hazardous waste: a review. Rem. Sens. 2, 2474–2508. https://doi:10.3390/rs2112474.

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Wang, F., Gao, J., Zha, Y., 2018. Hyperspectral sensing of heavy metals in soil and vegetation: feasibility and challenges. ISPRS J. Photogrammetry Remote Sens. 136, 73–84. https://doi.org/10.1016/j.isprsjprs.2017.12.003.

External collaborations:

University Marie et Louis Pasteur / Chrono-Environnement (FR) and CSIC (SP), CRES (GR), UNIBO (IT), GIG (PL)

Host laboratory at ONERA:

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