Hydrogeophysics-Based Forecasting of Water Resources in the Orgeval Critical Zone (Paris, France)

Workplace: Fontainebleau
Date of publication: November 2023
Type of Contract : doctoral
Contract Period : 36 months
Expected date of employment : 1 October 2024
Proportion of work : Full time
Desired level of education : master or engineering school
Experience required : Indifferent

The GWSBound Project invites applications for a PhD position in hydrogeophysics at the Geoscience laboratory of Mines Paris (PSL University) in France.

Overview of the project.

Groundwater (GW)'s strategic importance for water, energy, and food security is growing in the face of ongoing climatic changes and human uses. Precisely quantifying water resources is a critical concern, essential for ensuring sustainable yields and maintaining water quality. Components of the water balance are difficult to obtain, both in terms of accuracy and budget closure, especially at the subsurface boundaries of the GW. The GW subsurface boundaries such as the GW recharge and river- GW exchanges cannot be directly measured. Consequently, it is necessary to model these fluxes, as they are dependent on the boundary conditions and spatial description of the hydrodynamic parameters, which are largely unknown and estimated via model calibration.

The GWSBound ANR project is to provide monitoring and predictive tools of the spatiotemporal variability of the GW subsurface boundaries under the global change by the uses of innovative hydrogeophysic methodologies, such as seismic (Bodet et al., 2014; Dangeard et al., 2021; Pasquet et al., 2016; Solazzi et al., 2021) **and temperature-based approaches** (Cucchi et al., 2018; Kurylyk et al., 2019; Mouhri et al., 2013; Rivière, 2019; Tabbagh et al., 1999). In this goal, we will develop and use High-Performance numerical model and tools to process geophysical and hydrogeological data.

Team.

The GWSBound team involves partners from Mines Paris with the scientific coordinator, *A. Rivière*, whose expertise includes hydrodynamic modelling: theory, physical processes within the critical zone, design and parameterisation of numerical models, field surveys and databases; *A. Gesret*, specialist in geophysical inversion: probabilistic approaches, estimation and propagation of uncertainties; N. Desassis and D. Renard, specialists in geostatistics and spatial statistics: mostly with the SPDE approach and development of computing libraries. It benefits the expertise of geophysicists from Sorbonne Université: *L. Bodet*, expert in field seismic experiments, combined interpretation of geophysical and geotechnical data, information processing, wave propagation and mechanical properties of media; and assistance from the OSU ECCE TERRA with *S. Pasquet,* critical zone geophysicist, specialist in geophysical methods, field measurements, combined interpretation of geophysical and hydrogeological data. As for numerical modelling, the project is be supported by specialists from GET: *R. Martin* and *B. Plazolles,* seismic wave propagation and multiple data (seismic, gravity, electrical methods) imaging, inverse problems, data processing (deep learning), numerical modelling and high-performance computing.

Activities.

The doctoral candidate will be immersed in a dynamic and hands-on research environment with a comprehensive range of activities:

1. **Real Field Data Integration and survey:** Throughout the duration of the research, the candidate will actively participate in the acquisition of additional data, ensuring a continuous and rich source of information.

2. **Uncertainty Quantification in Seismic and temperature data:** The objective is to characterize how uncertainties propagate from hydrogeophysical data (field observation) to the forward models

3. **Adaptation of Geostatistical Frameworks:** The candidate will take on the crucial role of adapting geostatistical frameworks. These frameworks will be tailored specifically for the characterization of hydrofacies and water table mapping.

4. **Development of a Comprehensive Data Inversion Workflow:** The next step involves designing a data inversion workflow that integrates and jointly inverts seismic data, temperature, and groundwater water levels. This design process will be carried out in collaboration with the postdoctoral researcher on the project.

5. **Hydrogeological and Geophysical Acquisition Tool Development:** The tool will be designed to optimize the planning and execution of future hydrogeological and geophysical acquisitions.

6. **Application to Orgeval Critical Zone Observatory:** The culminating phase of this research journey involves applying the developed tool to the Orgeval Critical Zone Observatory. The student will simulate the water resources in the face of extreme events, considering the current climatic conditions.

In summary, this PhD position offers a unique opportunity for the candidate to engage in multifaceted research activities, spanning from data integration and uncertainty quantification to tool development and real-world application. Through these activities, the candidate will contribute to advancing our understanding of groundwater dynamics while also equipping the scientific community with innovative tools for sustainable hydrogeological and geophysical research.

Skills and Qualifications:

We are excited to welcome candidates who share our enthusiasm for pushing the boundaries of hydrogeology and geophysics through quantitative research. If you are passionate about this field and possess the relevant skills, we encourage you to apply and become a member of our research team. To excel in this role, candidates should possess the following qualifications:

- **Physical and Mathematical Background**: A completed or in-progress master's degree in a field related to geophysics, quantitative hydrogeology, physics, or applied mathematics. Having a background in petrophysics is advantageous. A background in statistics, probability theory, mechanics, and wave propagation are required.

- **Programming Proficiency**: Proficiency in programming languages such as Fortran 2018, C++, Julia, Python, or Rust is essential.

- **Data Analysis Skills**: Experience in data analysis, including expertise in signal processing, inverse problems, and numerical modeling, will be advantageous.

- **Teamwork and Communication**: Effective teamwork and communication skills are essential for collaboration within our research team. Proficiency in written and verbal English is required, as it will be the primary language for communication and documentation.

- **Autonomy and Quick Learning**: The duration of the Ph.D. program is relatively short, so candidates should demonstrate the ability to quickly familiarize themselves with new topics and possess strong motivation to produce meaningful results.

Application contents.

Candidates are encouraged to apply via email to agnes.riviere@minesparis.psl.eu, including a letter of motivation, a curriculum vitae, complete transcripts of Master's studies, Master's dissertation, and publications. Please also provide at least two references (with up-to-date contact information). Shortlisted candidates will be invited for interviews.

References.

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