



**Offer #2024-07382**

## **PhD Position F/M Modeling of groundwater-river exchanges for climate change predictions (IDP 2024)**

**Contract type :** Fixed-term contract

**Level of qualifications required :** Graduate degree or equivalent

**Fonction :** PhD Position

### **Context**

This project is a collaboration with the inria CARDAMOM team and the I2M fluid mechanics laboratory, and is co-financed with the CNRS IMPT program (Institut de Mathématique pour la Planète Terre). Funding already secured.

The aim is to model all hydraulic processes, both surface and subsurface, on a catchment scale and for periods of several decades. This modeling is essential to produce numerical calculation tools that can be used for regional forecasts in a context of climate change, in particular for water resource and morphodynamic issues. It is mainly based on vertically-integrated models, typically the Saint-Venant and Dupuit-Forchheimer equations. This type of model does not easily take into account infiltration processes. The problem of infiltration into the unsaturated zone, known as the vadose zone, seems to be the most critical to the relevance of predictions. This is at the heart of the thesis project. A well adapted modeling and numerical method will be proposed.

To encourage exchanges with IFPEN and BRGM, missions to Orléans and Paris will be organized on a regular basis, with remuneration in the line with the current salary scales.

### **Assignment**

#### **Assignments:**

With the help of Martin Parisot (inria Cardamom) and Mathieu Coquerelle (I2M), the person recruited will derive a vertical infiltration model and coupling with a Saint-Venant-type surface model and a Dupuit-Forchheimer-type groundwater model based on a reduction of the Richards model. An analysis of the model's properties will be carried out and a numerical strategy preserving these properties will be proposed. Particular attention will be paid to methods with no time step limitation, in order to be able to simulate several years of physical time.

#### **For a better knowledge of the proposed research subject:**

1. [1] BULTEAU, S., BADSI, M., BERTHON, C., AND BESSEMOULIN-CHATARD, M. A fully well-balanced and asymptotic preserving scheme for the shallow-water equations with a generalized manning friction source term. *Calcolo* 58, 4 (Sep 2021), 41. <hal-02479094>
2. [2] CARREAU M. AND PARISOT M. A unified modeling of underground-surface hydraulic processes: case of the saturated regions. Work in progress. <hal-03836565>
3. [3] ERSOYM, LAKKISO. AND TOWNSEND P. A Saint-Venant Model for Overland Flows with Precipitation and Recharge. *Math. and Comput. Appl.*, 2021. <DOI:10.3390/mca26010001>

#### **Collaboration:**

The person recruited will liaise with Mathieu Coquerelle of I2M to understand the physical processes involved. Discussions with Léo Agelas, Benoit Chauveau and Arnaud Pujol from IFPEN will also be organized.

### **Main activities**

#### **Main activities:**

- Derive a vertical infiltration model for the unsaturated zone
- Couple the model with the saturated zone at the bottom of the aquifer and with surface runoff
- Propose an efficient numerical scheme (without time step restrictions)
- Perform simulations at regional scales and compare with existing models write publications on the results obtained.
- Disseminate the results obtained at national and international conferences.

### **Skills**

Technical skills and level required : PhD in earth sciences or applied mathematics. Taste for

environmental problems, mathematical formalism and numerical simulations.

Language: English

## Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Possibility of teleworking and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

## Remuneration

- 2100€ / month (before taxes) during the first 2 years,
- 2190€ / month (before taxes) during the third year.

## General Information

- **Theme/Domain** : Numerical schemes and simulations  
Biologie et santé, Sciences de la vie et de la terre (BAP A)
- **Town/city** : Talence
- **Inria Center** : [Centre Inria de l'université de Bordeaux](#)
- **Starting date** : 2024-10-01
- **Duration of contract** : 3 years
- **Deadline to apply** : 2024-05-03

## Contacts

- **Inria Team** : [CARDAMOM](#)
- **PhD Supervisor** :  
Parisot Martin / [Martin.Parisot@inria.fr](mailto:Martin.Parisot@inria.fr)

## About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

## The keys to success

- A taste for environmental issues
- Solid knowledge in mathematic modeling and numerical analysis

The project lies at the interface between hydrology/hydrogeology and applied mathematics. Skills are expected in one of these domains. During the contract, the recruited person will acquire new skills and knowledge related to both domains. Strong motivation and thirst for knowledge are necessary, as well as the desire of working in a pluridisciplinary environment.

**Warning** : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

## Instruction to apply

Thank you to send:

- CV
- Cover letter
- Master marks and ranking
- Support letter(s)

### Defence Security :

This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

### Recruitment Policy :

As part of its diversity policy, all Inria positions are accessible to people with disabilities.