Postdoctoral position in

Joint simulation of runoff and water quality in intermittent river streams under climate change

Duration : 18 months
Location : Avignon, France (INRAE - BioSP)
Research topics: Machine learning, space-time statistics, hydro-meteorology
Contact : edith.gabriel@inrae.fr and lionel.benoit@inrae.fr

Job description

The main goal of this postdoctoral project is to hybridize machine learning and statistical approaches to design a multivariate space-time model for streamflow and water quality in intermittent rivers.
This model will then be used to investigate the impact of different scenarios of climate and/or anthropogenic changes on intermittent stream dynamics, and to simulate hydro-meteorological parameters to be used as inputs for impact models (e.g. hydro-geological or stream ecology model).
The above developments will build on the large and multifaceted hydro-meteorological dataset collected by the perennial environmental observatory (OPE, https://ope.andra.fr).

Work environment

This postdoctoral position is founded for 18 months by the chair Geolearning (https://chaire-geolearning.org/). The selected candidate will be mentored by Edith Gabriel and Lionel Benoit (INRAE-BioSP) and receive active support from Sylvain Gigleux, Timothée Robineau and Maxime Savatier (ANDRA-OPE). She/he will join the BioSP research team in Avignon, France (https://biosp.mathnum.inrae.fr/). The gross monthly salary ranges from 2640 to 3340 euros depending on experience.

Profile of the candidate and how to apply

Applicants must hold a PhD in statistics, machine learning, data sciences or in a related field. They must show strong interest in hydro-climatic applications and water resources management. The successful candidate is expected to have strong analytical skills, as well as good scientific programming (preferably in R or Python) and data handling skills. Good interpersonal skills, willingness to interact with other researchers and students, and ability to present at international conferences are expected. Fluency in English and strong communication skills in speaking and writing are required.

We would like to offer to the candidates the possibility to tailor the present postdoctoral project to their scientific interest and career plans. We therefore incite interested candidates to attach a 1-3 pages research project to their application. Research projects are expected to follow the general guidelines outlined in the present job description, to detail the research questions envisioned by the candidates, and to elaborate on the methodological choices they will follow to address their research questions. The candidates can build on the background information below to design their proposal.

To apply, please email your application to edith.gabriel@inrae.fr and lionel.benoit@inrae.fr. Applications must include : a CV, a cover letter, a research project, the contact information for three references, and the electronic version of one publication (preferably a paper in a peer-reviewed journal, otherwise your PhD manuscript).
Selection for position will continue until the position is filled.

Context of the project

Institutional context

The perennial environmental observatory is a long-term Earth surface monitoring network operated since 10 years by the French national agency for radioactive waste (ANDRA) in order to monitor surface and sub-surface ecosystems around the planned geologic repository for spent nuclear fuel (Cigéo). ANDRA now wants to leverage this dataset to investigate scenarios of the evolution of headwaters stream functioning under the joint influence of climate change and inception of the Cigéo industrial site. To this end, ANDRA started a collaboration with the Geolearning chair (2022-2027, INRAE - Mines Paris) which undertakes research on geostatistics, extreme events and machine learning for the climate transition.

Study area and available dataset

This research will draw on OPE data collected within three headwater catchments in the North-East of France around the village of Bure. This dataset encompasses: (i) continuous stream water samples from six automatic stations measuring a limited number of parameters (conductivity, temperature, dissolved oxygen, PAH, pH, dissolved organic carbon, nitrates and water height), (ii) intermittent stream water samples providing information on a large number of parameters (around 300) characterizing flow rate and water chemistry, (iii) integrated stream water samples measuring the long-term concentration of some pollutants, (iv) groundwater samples coming from 50 wells spread throughout the study area informing the state of the water table and its interaction with the streams, and (v) auxiliary environmental data (mostly land use, land cover and meteorological parameters) to contextualize the stream and groundwater observations.

Possible research questions that could be tackled during the postdoc

- Identify environmental proxies (and/or build composite indices) for streamflow and stream water quality.
- Design a model linking the target hydrological parameters with the environmental proxies.
- Develop a simulation method able to jointly simulate streamflow and stream water quality conditional to environmental proxies.
- Interpolate the target hydrological parameters in continuous time and on the entire hydrological network.
- Model the impact of climate and anthropogenic changes on stream water quantity and quality.

Methodological framework

We encourage applications aiming at combining space-time statistics, machine learning, and generative IA to answer the above research questions.