IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Post-doctoral position at IRSN

Times series prediction of key non legacy contaminants in French river systems using neural network modelling based on sedimentary archives and socio-historical trajectories.

Pôle Santé et Environnement

Service de recherche sur les transferts et les effets des radionucléides sur les écosystèmes

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Keywords: material flow analysis, qualitative or semi-quantitative data sets, time series prediction, auto regressive integrated moving, backpropagation neural network, predictive trajectories modelling based on societal and climatic scenarii.

1. Context and scientific proposal

The rapid evolution of environmental concerns, engineering techniques, as well as of political choices that characterized the last industrial era sometimes led to a lack of precise and exhaustive information on the environmental consequences related to industrial development. At the dawn of a new industrial revolution, when mankind converges to sustainably escape from the era of intensive exploitation of carbon and nuclear resources, the energy transition cannot exclude questions and awareness related to the potential environmental impacts from the use of new materials and new resources. This post-doctoral position is proposed in the framework of the project "TRAJECTOIRE - The memory of riverine sediments used to predict the environmental impact of new technologies" (ANR 2020 – 2023). The TRAJECTOIRE project aims to establish the socio-historical trajectories of key non legacy contaminants (radionuclides, micro-plastics and ultra-rare metals) in French river systems. The potential **environmental impacts** of the use of new materials and resources (E.g. microplastics, ultra-rare metals) can be anticipated by the feedback analysis of past environmental impacts of key **contaminants** (E.g. metals, rare earth elements, radionuclides) that were stored over time in well-preserved sedimentary deposits in river systems. Indeed, **sedimentary archives** give testimonials on previous contaminations and **anthropic pressures** because rivers are the final receptacle for many substances and sediments convey and store most of them. Sedimentary deposits at the outlet of watersheds, allow us to trace the history of these substances brought by human activities in these environments during the technological, industrial and environmental development that punctuated the 20th century. The causal links between the observed contamination levels in sedimentary archives (quantitative data sets) and the anthropic pressures determined from **documented archives** (qualitative and semi-quantitative data sets) will be assessed using **neural network analyses** for time series prediction. **Time series** models are purely dependent on the idea that past behavior and patterns can be used to predict future behavior and trends. By using these models on data sets acquired at the outlets of major French rivers, various anthropic pressures will be considered and their consequences on the concentration of contaminants over time will be identified. Socio-historical events, acquired from documented archive analyses, will be characterized as **rules of recognition** regarding their impact on concentrations, the time-lag between their occurrence and the environmental impact, and the duration of the environmental perturbation. The values of these three parameters associated to the best fittings between the data and times series models will define key pressures to be implemented in a **predictive model** based on scenario in order to forecast the levels of contaminants in river systems and estimate trajectories and resiliencies for the short, medium and long terms.

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2. Goal of the post-doctoral position

The post-doctoral position will first have to reconstruct time-series environmental data sets (radionuclides, microplastics and ultra-rare metals; quantitative data sets) from the main rivers in France based on sedimentary archives in close collaboration with the partners involved in the project Those time-series will then be combined with those from political and socio-economic drivers (anthropic pressures) to identify causal effect links. Anthropic pressures will be addressed and compiled elsewhere by the various partners as socio-historical friezes (qualitative data sets). Temporal links between the two data sets, time series from sedimentary archives and socio-historical friezes from historical documents, will be assessed by a mathematical approach using neural network modeling framework. Rules of recognition will have to be extracted from this modeling with the intention of creating a predictive model of future pollutant fate and transport in these hydro-systems based on societal and climatic pressure scenarii. This work will be supported by the work of a Master degree's internship that conducted a concept of proof of the approach by the use of neural networks with already acquired dataset (radionuclides in the Rhône River and lead in the Seine River, France).

3. Applicant Profile

The candidate should have a PhD in applied mathematics, in the field of statistics and/or probability, with a strong expertise in time series and neural network modeling. She/he should be highly motivated, with excellent oral communication and report skills

Applicants should send an application to Hugo Lepage (hugo.lepage@irsn.fr) and Valérie Nicoulaud Gouin (valerie.nicoulaudgouin@irsn.fr). The application will include a motivation letter and a short synopsis of doctoral work, a CV, a list of publications and communications.

The present project will be performed during 18 months at IRSN in Cadarache (Saint-Paul Lez Durance, 13115, France), starting in first quarter 2022.