What is the ExposUM Doctoral Nexus?

The Doctoral Nexus proposed by the ExposUM Institute are networks of 3 to 4 PhD students from different disciplines and affiliated to at least two different research units.
Compared with a traditional PhD, taking part in a Doctoral Nexus will encourage the ability to work in a team and to design projects in a transdisciplinary way while deepening one's own field of expertise.
A specific teaching programme will be offered and the doctoral students concerned will also have the opportunity to organise a seminar within the Nexus network.
Theses are funded from the outset for 4 years, including the PhD student's salary and an environmental allowance.

Summary of the overall project

Integrated approach to Persistent, Mobile and Toxic pollutants in water resources: assessment of their contribution to EXPOsome, recommendation of adaptation solutions - EXPO-PMT

Water intended for human consumption (EDCH), because of its direct contribution to the exposome, is currently causing concern for human health due to the growing number and diversification of toxic anthropogenic pollutants it contains. Among these, the 'Persistent, Mobile and Toxic Pollutants' (PMT) constitute a heterogeneous group of micropollutants recently classified by the European Union, under the REACH regulations, as 'extremely worrying'. Recent studies highlighting the presence of certain PMTs in drinking water have raised questions about their impact on human health via the aquatic exposome, and the action that needs to be taken. Adapting treatment processes therefore becomes a possible response to micropollutant pollution and in particular to PMT, the fate and impact of which are not yet fully understood. The few studies available on the ozonation or activated carbon (AC) adsorption processes currently used in drinking water treatment plants have shown that, for targeted PMTs, ozonation appears to be less effective for polar substances, and that the effectiveness of AC depends on both the specific characteristics of the substances and the type of carbon used.

The EXPO-PMT project brings together researchers from five ExposUM laboratories with complementary skills: targeted and non-targeted monitoring of organic molecules present in water at trace levels, and more specifically PMTs (HSM); fate of emerging contaminants in aquatic environments (HSM/IEM); treatment of micropollutants present in water by adsorption and ozonation processes (IEM); evaluation and spatio-temporal modelling of toxicological impacts (LBE/ITAP); management of public water services and EDCH resources and on decision support models for water services (GEAU); link between LCA and decision-making by water service managers (GEAU/ITAP).

PhD project

Title : Estimation of potential spatio-temporal toxicological and ecotoxicological impacts of ozone/activated carbon coupling for drinking water.

Objectives:

The first objective of this PhD is to utilize the results of targeted analyses of 50 PMTs to assess the potential toxicological and ecotoxicological impacts of water at various stages of treatment. The analysis of measurement points (sampled at various days and various places) will provide a reliable and robust evaluation of the spatio-temporal distribution of these impacts, assess the effectiveness of treatment processes, and identify specific stages or substances requiring further attention.

The second objective is to use temporal monitoring at different measurement points to model the concentration dynamics of the studied molecules over an extended cycle. This will allow for a precise estimation of weekly variations in potential impacts, facilitating their anticipation and improved management.

The third objective is based on untargeted mass spectrometry data analysis to investigate the overall water "fingerprint" at the distribution chain's exit. The aim is to identify spectral regions influencing impact estimations and detect previously unrecognized compounds.

Finally, the last objective is to establish a connection between this water fingerprint and confirmed risks. This will be achieved by leveraging spatial mapping of the collected measurements and developing a statistical predictive model to anticipate potential health-related events.

Methodology:

The above objectives will require specific statistical modeling approaches in alignment with Life Cycle Assessment (LCA) principles.

- For the first objective, concentrations data will be collected in other PhD of the NeXus program to support machine learning models that calculate characterization factors (CF) for PMT. Potential distributions of potential impacts will then be estimated using classical statistical methods, such as kernel density estimators.
- The second objective will be addressed using mixed-effects models, which account for temporal correlations between PMT concentrations and measurement points.
- The third and fourth objectives, based on full-spectrum mass spectrometry analysis, will be based on functional data analysis techniques, including dimensionality reduction using adapted function bases. The resulting predictive models will be built using advanced machine learning techniques.

Expected results:

The expected outcomes of this PhD include:

- A precise evaluation of the performance of different water treatment stages in terms of potential toxicological and ecotoxicological impacts, based on targeted data.
- A weekly modeling of PMT concentrations at the exit of the water distribution system.
- A comprehensive study of the water's global fingerprint using untargeted analysis (mass spectroscopy) and an assessment of potential health-related impacts.

These results will contribute to an overall performance assessment of the treatment system and help identify potential leads for treatment improvement.

Supervision:

The PhD student will be based in UR LBE, Narbonne and will be supervised by

- Rémi Servien (DR INRAE, UR LBE; supervisor), webpage,
- Dominique Patureau (DR INRAE, UR LBE; co-supervisor), webpage,
- Arnaud Hélias (DR INRAE, ITAP; co-supervisor), webpage.

Candidate profile:

The candidate (M/F) should hold a Master's or Engineering degree in Applied Mathematics (Statistics), Data Science, Life-Cycle Assessment or Environmental Science with a background in Data Science. Excellent writing and communication skills, particularly in English, are required, along with the ability to work independently. Basic knowledge of programming in either R or Python. An interest in environmental problems would be advantageous.

Application procedure

The application must include the following

- A full curriculum vitae,
- A cover letter,
- Reference letters (if any),
- Master's scores.

If you would like to apply for this position, please send an e-mail to :

- Remi.servien@inrae.fr, dominique.patureau@inrae.fr and arnaud.helias@inrae.fr (supervisors)

by copying :

- **catherine.faur@umontpellier.fr** (NeXus coordinator)

- **exposum-aap@umontpellier.fr**

Application before 16th may 2025.

The University of Montpellier

KEY FIGURES

RESEARCH CENTERS

From space exploration and robotics to ecological engineering and chronic diseases, UM researchers are inventing tomorrow's solutions for mankind and the environment. Dynamic research, conducted in close collaboration with research organizations and benefiting from high-level technological platforms to meet the needs of 21st century society.
The UM is committed to promoting its cutting-edge research by forging close links with local industry, particularly in the biomedical and new technologies sectors.
More Information: https://www.umontpellier.fr/en/recherche/unites-de-recherche

SCIENTIFIC APPEAL

Open to the world, the University of Montpellier contributes to the structuring of the European higher education area, and strengthens its international positioning and attractiveness, in close collaboration with its partners in the I-SITE Program of Excellence, through programs adapted to the major scientific challenges it faces.
More Information: https://www.umontpellier.fr/en/international/attractivite-scientifique