Thesis offer – ESR09

MSCA Cofund - MISCEA

Template EURAXESS

Note for laboratories/potential supervisors: only fill in the *green and italic parts*

Job Information

Organisation/Company: **Ecole nationale des ponts et chaussées (ENPC)**

Department: *Leesu (Water, environment and urban systems laboratory)*

Research Field: *Environmental sciences, urban hydrology, modeling*

Researcher Profile: **First Stage Researcher (R1)**

Country: **France**

Type of Contract: **Temporary**

Job Status: **Full-time**

Is the job funded through the EU Research Framework Programme?: **Horizon Europe (HE) / Marie Skłodowska-Curie Actions COFUND**

Is the Job related to staff position within a Research Infrastructure?: **No**

Additional information :

The present offer of a doctoral contract in France is for a period of three years.

Full-Time employment : estimated monthly brut salary : ~2700euros (estimated monthly net salary before income taxes: ~2100euros)

This project is co-funded by the European Union as part of the **HorizonEurope programme, Marie Sklodowska-Curie Actions, call COFUND-2022** and under grant agreement number 101126720

Offer Description

Thesis offer:

Biocides in urban runoff: modelling emissions and transfer to the receiving environment for different stormwater management scenarios

1 - Doctoral thesis project

1.1 – Context and scientific issues

While the use of pesticides in urban environments is becoming increasingly controlled, biocidal substances are being used more and more, particularly as fungicides, algaecides, demossing agent or insecticides in building materials and for pest control (ANSES, 2019; Paijens et al., 2020a). These biocides are emitted in runoff from buildings, discharged onto the ground or into the stormwater management system and reach the environment, with a potentially negative impact on aquatic and terrestrial ecosystems (Kresmann et al. 2018; Paijens et al. 2020a). However, these urban emissions of biocides and their impact on receiving environments are poorly documented. Claudia Paijens' (2019) thesis work at Leesu has shown (i) that biocides are ubiquitous in urban waters, posing a risk to the aquatic environment, (ii) that an increase in biocide flows between upstream and downstream of the Paris conurbation has been observed for several molecules, and (iii) that the presence of several biocides is related to stormwater flows, likely via leaching from building materials (Paijens et al, 2020b, 2021). Although biocide emissions from construction materials have been extensively studied in the laboratory or on the scale of test benches (Bollmann et al., 2016; Burkhardt al., 2011; Gromaire et al, 2015), few studies have quantified emissions at the scale of an urban neighbourhood and addressed the link between urban emissions of biocides, their fate in the stormwater management system and their transfer to the surface or underground aquatic environment (Burkhardt et al., 2011; Gallé et al., 2020; Paijens et al., 2020a).

The development of measures to control stormwater at source that promote on site infiltration of urban runoff raises concerns about the fate of biocides in the soil of infiltration systems and their potential transport to the groundwater. As predominantly hydrophilic molecules, biocides should not be strongly retained by the soil, unlike the micropollutants generally studied in runoff, such as metals and polycyclic aromatic hydrocarbons (Tedoldi et al., 2016). In addition, biocides can evolve into transformation products (TPs), which are poorly documented and represent an unknown risk of exposure for receiving environments. Very diffuse runoff management, in nature-based solutions (NBS) constructed with adapted/engineered soils, could allow temporary retention and biodegradation of biocides, but the real importance of these processes has not been assessed to date.

In this context, we have identified several objectives for this thesis proposal: (i) **to assess the potential for biocides to be emitted from building facades** in the urban context of the Paris region; (ii) to **evaluate soil contamination levels and the fate of biocides in the soil**; (iii) to **assess the effect of different runoff management strategies** at the scale of a building complex on the transfer of biocides into the environment (See Figure 1).

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1.2 - Scientific challenges

- Develop a methodology combining surveys, field measurements and modelling to assess the fluxes emitted over the long term (up to 20 years) and qualify the emissive potential of the existing built stock.
- Develop laboratory experiments to assess the adsorption and degradation kinetics of biocides in soils.
- Parameterize and validate a model for the reactive transfer of biocides into the soil of infiltration structures
- Construct sustainable stormwater management scenarios on the scale of a building complex.

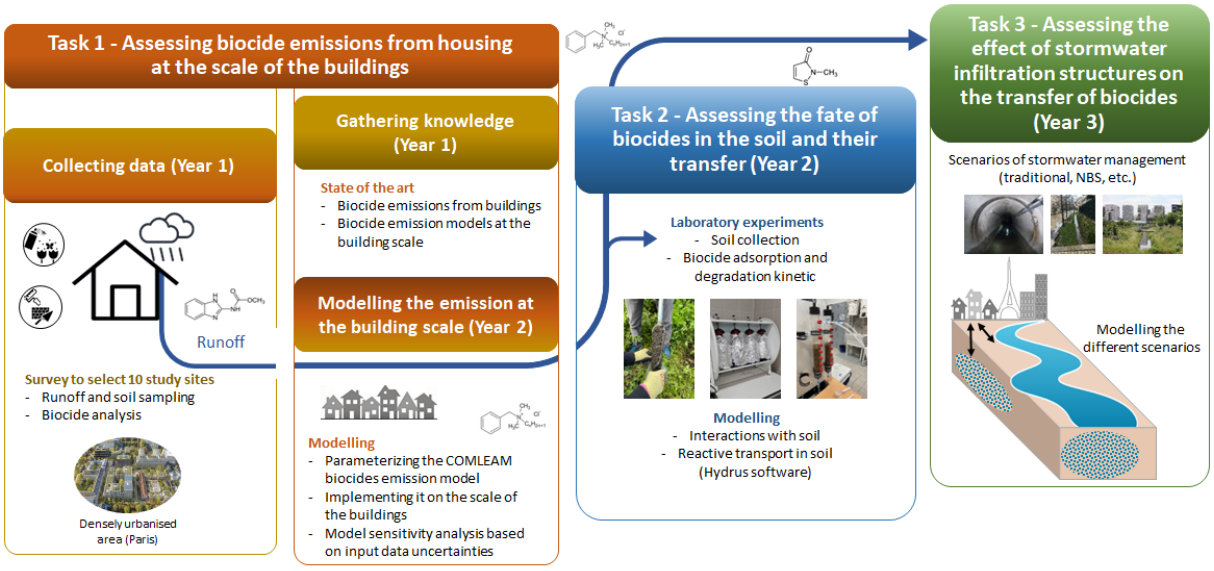

Figure 1: Different tasks of the PhD proposal

1.3 – Methodology

The thesis will be conducted as part of the Francilian Observatory in Urban Hydrology (OPUR). It has a marked interdisciplinary character (urban hydrology, soil science, chemistry) and is rich in the diversity of approaches implemented: surveys, fieldwork, laboratory experimentation, modeling of emissions and reactive transfer in soil, construction and modeling of stormwater management scenarios.

<u>Part 1 - Assessment of biocide emissions from facades (1st year)</u>

State of the art and surveys (M1 to 5). Preliminary surveys will be carried out to select a series of buildings where the presence of biocides is proven, covering facade cladding ages from one year to over 10 years. A field survey coupled with analysis of the DBNB (building database) will be carried out to pre-select the buildings, followed by surveys of owners, condominium trustees and managers to gather information on the renovation and construction of facades, and the products (coatings, paints, cleaning products) applied.

Development and application of a rain simulation protocol (M4 to 10). In order to provide a reproducible, rapid and easy-to-implement procedure, a protocol consisting of artificially watering part of the facades to simulate a rain event will be developed, then applied to selected buildings at different

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times of the year. The uncertainties associated with this approach (effect of previous weather conditions, variability according to facade exposure, temporal variability) will be assessed for one or two pilot buildings.
COMLEAN modeling (M6 to 12). The data collected in the previous two stages will be used to calibrate and validate the COMLEAN emission model at building scale. The focus will be on assessing the uncertainties associated with this modeling, in particular for the modeling of long-term emissions. This assessment will involve a sensitivity analysis of the different parameters of the emission models, the initial concentrations of biocides and the different emission functions applied.

Part 2 - Characterization of reactive transport and accumulation in soils (2nd year)
Field and laboratory (M12-20). Soils will be sampled at two or three different depths at the bottom of facades where biocide emissions have been measured, and analyzed for biocide content and TP. The levels of contamination by biocides and their TP and the mass accumulated in the soil will be compared with the total emissions simulated by the COMLEAN model.
On the basis of laboratory tests on soil columns, parameters crucial to the sorption and biodegradation processes of biocides in soil, as well as soil hydrodynamic parameters, will be evaluated. For this work, the PhD student will benefit from the support of Leesu's technical staff and a study engineer recruited for the project (biocide analysis and column tests) and M2 trainees (work on biodegradation). In collaboration with Prof. Noureddine Bousserrhine, the microbial communities present in the selected soil columns will be characterized to enable quantitative analysis of their influence on the fate of biocides in the soil. In addition to the natural soils of the experimental sites, some amended soils or technical substrates suitable for biocide treatment, such as the D-Rainclean® material developed by Funke Gruppe, will also be tested for their sorption capacity and bioavailability.
Soil reactive transfer modeling (M18-24). The Hydrus 1D model will be used to simulate the reactive transport of biocides in the unsaturated zone of the soil, with application to the case of the selected façades and receiving soil studied in Part 1. The simulation will be based on hydrodynamic soil sorption and biodegradation parameters established in the laboratory. Simulated results will be calibrated and validated by comparison with in situ data on biocide concentration and TP in the soil.

Part 3 - Modeling different runoff management scenarios at the scale of a building complex (3rd year, M24-32)
Different runoff management strategies at the scale of a building complex will be examined and their effect on biocide immissions in the different environmental compartments (soil, surface water, groundwater) will be modeled, based on the previously calibrated Comlean and Hydrus models.
Runoff management scenarios include (i) the conventional “all-pipe” scenario, in which all runoff is collected and discharged into the sewer system; (ii) diffuse infiltration of façade runoff into the soil at the bottom of façades; (iii) diffuse infiltration through an amended soil layer with improved adsorption and biodegradation properties at the bottom of the facades; (iv) more or less centralized infiltration systems, e.g. infiltration ponds or infiltration swales. In the last scenario, the runoff flowing into the stormwater infiltration system is a mixture of façade runoff, roof runoff and runoff from other impervious areas.
The biocide concentration in this mixed runoff is expected to be lower, but the hydraulic load on the infiltration system will be much higher. Different soil types and hydraulic loads will be simulated. The simulation will be carried out over a long period (at least 15 years) after façade renovation, to assess long-term impacts such as soil accumulation, biocide breakthrough and cumulative fluxes discharged to groundwater or surface water. The results obtained from this set of scenarios will be translated into recommendations and guidelines for the sustainable management of runoff from buildings.

1.4 - Expected results and exploitation

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The expected results are (i) an assessment of the importance of biocide emissions from building facades in today's urban context; (ii) an integrated model for the emission, transfer and fate of biocides from buildings to the subsoil, on the scale of a building complex; (iii) an assessment of the effectiveness of different stormwater management strategies in limiting the diffusion of biocides into the environment. The results will be published in the form of scientific articles and presentations at international conferences, as well as articles aimed at technical services and public authorities.

1.5 - Bibliography

ANSES. (2019). Étude Pesti'home (www.anses.fr/en/system/files/2019Pestihome.pdf)
Bollmann U. E. et al. (2016). Environmental Science & Technology 50:4289–4295
Burkhardt M. et al. (2011). Water Science and Technology 63:1974–1982.
Kresmann S. et al. (2018). Science of The Total Environment 625:900–908.
Paijens C. et al. (2020a). Environmental Science and Pollution Research 27:3768–3791.
Paijens C. et al. (2020b). Water, Air, & Soil Pollution 231:210.
Paijens C. et al. (2021). Journal of Hazardous Materials 402:123765.
Tedoldi D. et al. (2016). Science of The Total Environment 569–570:904–926.

2 – PhD supervisors

The PhD student will be supervised by **Pr. Marie Christine GROMAIRE and Dr. Adèle BRESSY**, tenured researchers in École nationale des ponts et chaussées (marie-christine.gromaire@enpc.fr ; adele.bressy@enpc.fr). Marie-Christine Gromaire (50% supervision) is an expert in urban hydrology and modelling, while Adèle Bressy (50% supervision) is a specialist in environmental chemistry and the fate of micropollutants in the environment. Both areas of expertise are required for the thesis.
- Pr. Marie-Christine Gromaire (https://www.researchgate.net/profile/Marie-Christine-Gromaire) is a top-grade researcher at ENPC, Leesu. Her research topic is mainly on water and contaminant fluxes associated with urban runoff, and their source control in sustainable urban drainage system (SUDS). In recent years, she focused on the study of hydrological and physico-chemical processes within nature-based solutions for stormwater management (NBSsw), as well as on the effects of a NBSsw in the city. Within the OPUR observatory of urban hydrology (https://www.leesu.fr/opur/), which she has co-managed since its creation, she is co-piloting the research topic on evaluation and improvement of SUDS performance at the facility scale, as well as the development of a long-term observatory of SUDS at the district scale, and contributing to modelling developments on the evaluation of SUDS deployment at the urban scale. She has supervised 15 PhD thesis so far, and has published 100 scientific papers.
- Dr. Adèle Bressy (https://www.researchgate.net/profile/Adele-Bressy) is a researcher at ENPC, Leesu. She works on micropollutants, in particular biocides. Her research projects focus on (i) the non-targeted quantification of emerging micropollutants in urban waters, (ii) the investigation of the emission, the transfer and the fate of biocides in urban waters and (iii) the quantification of micropollutants in domestic waters and the search for ways to reduce the emission of these biocides to the environment. She is currently involved in several research programs and projects including ANR-Biocid@Home, BiociDust, BRIQUE, and OPUR program and has supervised 8 PhD thesis (3 of which in progress), and has published 30 scientific papers

3 - Description of the working environment

The Water, Environment and Urban Systems lab (Leesu, www.leesu.fr) is a French research laboratory in environmental sciences, specialized in studying water and its management in urban and peri-urban environments.

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Leesu's main focus of research is water in the city. Facing the challenge of making the city sustainable and resilient in the context of global changes, the lab aims to gain a better understanding of water and contaminant flows in the urban environment and to develop innovative concepts for water and soil management.
Through interdisciplinary and multi-scale approaches, Leesu focuses on different aspects of global changes: climate, hydrology, urban planning and architecture, regulations, practices, uses, management methods, pollution.
Leesu's research relies on experiments and demonstrators to study the impact of global changes, the dissemination of innovations, the emergence of new sectors, the brakes and levers, the positioning of users and territorial compatibility. Leesu is committed to transferring its knowledge to local authorities, the industry and the general public.

The host laboratory will provide (i) an office with all the necessary computer equipment, as well as software to help with the transcription of interviews; and (ii) funding for missions related to the thesis (field trips) and the communication of results (conferences, publications, etc.) through the OPUR 6 program and the doctoral school.

The PhD student will have the opportunity to take part in teaching in partner establishments (Ecole nationale des ponts et chaussées, Paris-Est Créteil University, etc.).

4- Partnership

The PhD student will have the opportunity to spend time in the HSR University of Applied Sciences in Switzerland, to be trained on the COMLEAN model and to be supported for its parametrisation and use, thanks to the collaboration with Pr Michael Burkhardt. He/she will also have the opportunity to collaborate with Pr Brigitte Helmreich and spend some time at Technical University of Munich to gain knowledge on biocide adsorption within stormwater treatment systems.
Moreover, the PhD student will have the opportunity to develop European collaborations by participating in EELISA communities (for exemple, SDG 3 – Good Health & Well-Being, SDG 6 – Clean Water & Sanitation, SDG11 – Sustainable Cities & Communities, and SDG12 – Responsible Consumption & Production).

Description of the project and the candidates' eligibility criteria:

This position will be part of the EU-funded project MISCEA, which is an ambitious inter- and multidisciplinary Doctoral Training Network under the Horizon-Europe Marie Skłodowska-Curie Actions.

PhD candidates' can be of any nationality but you have to meet these eligibility criteria:

- **Not being a current employee** working at ENPC.
- Not having resided or carried out their main activity (work, studies, etc) in France **for more than 12 months** during the past 36 months immediately before the deadline of the MISCEA Programme's call. Compulsory national service, short stays such as holidays and time spent as part of a procedure for obtaining refugee status under the Geneva Convention are not taken into account.

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- **Holding a Master's degree** (or about to obtain one) or having a University degree equivalent to a European Master's degree (5-year duration) at the deadline of the MISCEA Programme's call.
- Researchers must be doctoral candidates, i.e. not already in possession of a doctoral degree at the deadline of the co-funded programme's call. Researchers who have successfully defended their doctoral thesis but who have not yet formally been awarded the doctoral degree will NOT be considered eligible.
- **Signing a declaration** of the veracity of the information provided (Declaration of honour, free of form).

If you comply with the eligibility criteria and you wish to submit your application, you must:

- Contact the thesis supervisor and explain your thesis project to her/him so that she/he validates your application.
- Submit a **5-pages thesis proposal** under the proposed research areas, with the agreement of the future supervisor + **1 page cover letter** with: *the relevance of your educational/professional background to carry out your thesis topic.* Additionally, to the submission of the 5-pages thesis proposal, the applicant will have to complete an ethics checklist based on ethics guidance from the HorizonEurope programme guide.
- **English-translated transcripts** from the master's degree or equivalent.
- **Any specific requirements of the Doctoral School** corresponding to the targeted MISCEA fellowship offer.
- English curriculum vitae, including information about the level on English language knowledge.
- One letter of reference, at least.

Templates are available on the MISCEA website (link).

Then your candidature is complete, please send inquiries to miscea-program@enpc.fr

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Requirements

Research Field: *environmental sciences, hydrology*

Education Level: **Master Degree or equivalent**

Skills/Qualifications: *urban hydrology, water quality, modeling*

Languages: **ENGLISH**

Level: **Excellent**

Where to apply

E-mail : marie-christine.gromaire@enpc.fr ; adele.bressy@enpc.fr

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