Postdoctoral position

Life Adsorb project

Paris, France - 36 month

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Research subject

Coupled analysis of hydrodynamics and micropollutant transfer in an improved reed bed filter treating road runoff water

Short description

ECOBIRD and École des Ponts ParisTech - Leesu are seeking a postdoctoral fellow to take part to a research project funded under the EU's funding instrument for the environment and climate action - LIFE program, **project Life-Adsorb LIFE17 ENV/FR/000398**. The postdoctoral fellow will be mainly in charge of the *development and operation of a modelling framework describing both the hydraulics and the pollutant fate within an innovative type of reed bed filter*.

The post-doctoral fellow will be recruited for a 36 month contract, by ECOBIRD (http://www.ecobird.fr/), which is a private engineering, research and development office in ecological engineering, belonging to SYNTEA group.

He will based at École des Ponts ParisTech (http://www.enpc.fr/en), in Paris conurbation, within Leesu research laboratory https://www.leesu.fr/. École des Ponts ParisTech is a French higher education institution that trains high-level engineers and doctors. Research at Leesu focuses primarily on urban waters and is organized around two main issues: adaptation to change and resilience of urban systems, preservation of ecosystems and natural resources.

The postdoc will be carried out in collaboration with the municipalities of Paris who is coordinating the Life-Adsorb project and several other research institutions that are partners of the project.

Start date: December 2019

Qualifications needed

- Hold a PhD in environmental science
- Thorough knowledge on water flows and pollutant transport in variably saturated porous media is needed, with strong experience in numerical modelling.
- Good knowledge of environmental physico-chemistry is also required

How to apply :

Send all the following documents in one PDF file to marie-christine.gromaire@enpc.fr and s.troesch@ecobird.fr

1. Cover letter stating your experience in relation to the subject of the postdoc
2. Curriculum vitae including a list of your scientific publications
3. Names and addresses of two referees for professional references

Detailed description of the research subject

Context

Road runoff, and in particular runoff from heavily trafficked roads such as urban outskirts, is an important vector of organic or metallic micropollutants that contributes to the degradation of aquatic environments and undermines the achievement of good ecological status under the European Water Framework Directive. In order to limit these loads to the natural environment, while contributing to the establishment of a hydrological cycle close to the natural state, solutions based on the temporary storage of runoff and its treatment in vegetated filters have been developed. They allow both the improvement of runoff water quality and the reduction of peak flow.

Among the solutions based on ecological engineering, reed bed filters, initially developed for extensive wastewater treatment, offers interesting prospects for the depollution of these stormwaters. Its effectiveness has been demonstrated for metals and nutrients, and more broadly for pollutants associated with the particulate phase. The behaviour of organic micropollutants in these structures is still relatively undocumented, and the treatment of some of these compounds seems limited by their more dissolved nature and by their possible association with colloids or dissolved organic matter.

One of the objectives of the LIFE-ADSORB project (LIFE17 ENV/FR/000398), in which this post-doctoral topic is included, is to implement and test a vertical flow reed bed filter, whose innovative design allows mechanical filtration and adsorption of dissolved micropollutants on a specific substrate, thus promoting their subsequent degradation. The focus of the project is on reducing organic and mineral micropollutants in road runoff, especially suspended solids (SS), metals, hydrocarbons and other environmentally toxic substances (phthalates, alkylphenols, perfluorinated compounds, etc.).

Objectives

The post-doctoral fellowship will focus on evaluating the performance of planted filter systems, equipped with a specific adsorbent substrate, for rainwater pollution control. By combining experimental monitoring and physics-based modelling approaches, it is necessary to understand the main processes involved in conditioning this purification performance, and in particular the interactions between the hydrodynamics of the filter and the transfer of pollutants. This knowledge will then be used to develop a simplified tool to help design and optimize the system.

Methodology

This work is focused on the reed-bed prototype developed within Life-Adsorb project for the treatment of runoff water from a 21 ha portion of the Paris ring road. The pilot, located in the Bois de Boulogne park in Paris, includes two 650 m² reed bed filters, alternately supplied by pumping. One compartment corresponds to a conventional design of a vertical flow reed bed, while the other includes a layer of adsorbent material designed to retain dissolved mineral and organic micropollutants. These filters are also subject to continuous and significant inflows of clear parasitic water, which may disrupt their operation. Their integration into the landscape of a classified natural area severely constrains their geometry, which could have an impact on the distribution of flows and residence time. Within the Life-Adsorb project, heavy experimental resources are used to monitor the hydrology (flows, water levels, substrate humidity) and the water quality (global parameters measured continuously and more punctual sampling and analysis of micropollutants) at different levels of the pilot, as well as the accumulated stocks.

The post-doctoral fellowship is organized around three main parts:

1. *Implementation of a modeling framework*

The aim here is to set up the modelling tools to describe the hydraulics and the reactive transport of micropollutants in the two compartments of the pilot system.

A physics-based modelling approach will be adopted to describe 2D or 3D flows in filters. This fine modeling aims to better understand the influence of filter geometry and water supply conditions on the hydrodynamics, and their consequences on the transfer of micropollutants. It will be coupled with a conceptual description of the reactive processes (adsorption/desorption/degradation) and a simplified description of physical filtration.

The model configuration will be based on data acquired in other parts of the Life Adsorb project: acceptance tests of planted filters, column tests for the characterization of adsorbent material, micropollutant degradation tests.

The use of the HYDRUS software is considered for the development of the model. However, a state of the art of the modelling approaches used internationally for this type of need will be carried out at the beginning of the post-doctorate period in order to specify the choice of modelling tools and implementation conditions.

A simplified 1D representation of the system, more suitable for modelling long chronicles or comparing various management scenarios, will also be proposed. The validity of this 1D modelling approach will be assessed by comparison with the reference model.

2. *Experimental evaluation of filter efficiency*

The second part of the work concerns the analysis of all the experimental data, acquired from the filter monitoring framework, in order to analyse the performance of the two filters in terms of runoff pollution control. Efficiency will be assessed in terms of concentration reductions, mass reduction and output concentration level for a wide range of macro (TSS, organic carbon, nutrients) and micro-pollutants (trace metals, hydrocarbons, PAHs, bisphenolA, alkylphenols, phthalates). The efficiency gain attributable to the adsorbent material will be evaluated by comparing the results of the two filters.

The variability of this performance will be analyzed according to the nature of the micropollutants studied on the one hand, and according to the characteristics of the in-flow events on the other hand (volume, pollutant load, initial state of the system). The resilience of the system to parasitic clear water inflows will also be studied.

Stochastic modelling of pollutant flows into and out of the facility will be developed by coupling data from continuous measurements (flow, turbidity, conductivity) with data from micropollutant sampling and analysis campaigns that cover a limited number of events, and events which differ between the two filters. It will allow a more robust comparison of the efficiency of the two filters with respect to different micropollutants.

3. *Application of the model*

The models developed in Part 1 will be used after validation on the basis of experimental data to simulate the operation of the filter under a variety of meteorological conditions. The evolution of the filter's performance over the long term will be assessed on the basis of simulations of long rainfall chronicles, and the estimated filter life, taking into account the progressive saturation of the adsorbent media. The model will also be used to test different operating scenarios and propose an optimization of the real-time management rules of the structure.

The application of the physics-based model should also make it possible to identify the key processes and the most important parameters in order to describe the pilot's functioning in a systemic way.