ROULÉPUR: Evaluating innovative solutions for the source control of micropollutants associated with road and parking lot runoff

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ROULÉPUR : Evaluation de solutions innovantes pour une maîtrise à la source de la contamination en micropolluants des eaux de ruissellement des voiries et parking

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RÉSUMÉ

Le projet ROULÉPUR, financé dans le cadre de l'appel à projets "Innovation et changements de pratiques: lutte contre les micropolluants des eaux urbaines" de l'ONEMA et des Agences de l'Eau, vise l'évaluation de solutions innovantes de maîtrise à la source des flux de micropolluants générés par les voiries urbaines, dans le cadre d'une approche pluridisciplinaire. Il s'agit de :
- mieux diagnostiquer la composition chimique et la toxicité de ces ruissellements ;
- identifier les sources primaires de contamination ;
- évaluer in-situ l'efficacité de quatre solutions innovantes de maîtrise à la source de technicités différentes ainsi que leur durabilité ;
- analyser les performances environnementales globales de ces solutions sur l'ensemble de leur cycle de vie (ACV) ;
- évaluer l'acceptabilité sociale, technique et économique de ces solutions afin d'en déduire leur potentiel de diffusion en fonction du contexte local technique et institutionnel.
Quatre solutions innovantes de traitement à la source des eaux voirie / parking sont testées en site réel: parking perméable, filtres plantés horizontaux, accotement végétalisés et fossés filtrants, dispositif compact de décantation/filtration/adsorption.

ABSTRACT

The ROULÉPUR project, funded under the French national call "Innovation and changes in practice: fighting against micropollutants in urban waters", aims at evaluating innovative solutions for the source control of micropollutants in road runoff, based on a multidisciplinary approach. It's objectives are to:
- improve knowledge on the chemical composition and toxicity of road and parking lot runoff;
- identify the primary sources of contamination, so as to guide emission reduction strategies;
- evaluate in situ the effectiveness of four innovative source control solutions of different technicalities;
- analyze the overall environmental performance of these solutions on the whole its life cycle (LCA);
- assess the social, technical and economic acceptability of these solutions and deduce their diffusion potential based on the technical and institutional local context.
Four different source control solutions are tested in situ: pervious car park, horizontal sand filters, vegetated filter strips and bioretention swales, and a compact sedimentation / filtration / adsorption device.

MOTS CLÉS

Runoff, micropollutants, source control, road, innovative solutions

1 INTRODUCTION

Roads and parking lot runoff consists of a complex matrix of micropollutants, mainly originating from car traffic related sources like various automobile consumables (fluids, brake pads, tyres), exhaust gases, automobile construction materials, but also atmospheric contributions and leaching from urban infrastructure materials. While their contamination in metals and hydrocarbons (Legret and Pagotto, 1999) has been widely documented, these waters may also convey a much wider panel of micropollutants (flame retardants, surfactants, plasticizers, antioxidants) that may be toxic for the receiving waters (Barbosa et al., 2012). The prevalence of these contaminants in the road runoff and its toxicity is insufficiently documented to this day (Tang et al., 2013).

These runoff waters often join the aquatic environment without treatment (direct or stormsewer discharges to streams, infiltration) and may thus contribute to the degradation of superficial water bodies and groundwaters.

In order to reach the good ecological state of water bodies aimed by national and European directives, source control of these micropollutant loads, or even depollution at the source of the runoff, is needed in numerous cases. Requirements this way emanate regularly from public authorities for new developments. However, the treatment solutions implemented in the past (hydrocarbons separators, settling devices) turned out expensive, little adapted to the specificities of runoff pollutants and little effective for the trapping of micropollutants.

Various technical solutions for at source runoff pollutant management have been developed over the last years (Hilliges et al., 2013; Li et al., 2014; Revitt et al., 2014). Their efficiency in terms of reduction of micropollutants but also their sustainability (maintenance, aging) and their acceptability, however, need to be better evaluated in situ. Further research is also needed in order to guide the choice between these solutions according to the nature, environment and management of the considered site.

2 THE ROULÉPUR PROJECT

2.1 Objectives

The ROULÉPUR project was funded under the French national call "Innovation and changes in practice: fighting against micropollutants in urban water". It aims at evaluating innovative solutions for the source control of micropollutants in road runoff, based on a multidisciplinary approach.

The project is lead by a consortium involving three research centers, three public services and two industrials.

This project has several objectives:

- improve knowledge on the chemical composition and toxicity of road and parking lot runoff; so as to prioritize issues related to their management;
- identify the primary sources of contamination, so as to guide emission reduction strategies;
- evaluate in situ the effectiveness (from the hydrological point of view and from the water quality point of view) of four innovative source control solutions of different technical nature;
- assess the sustainability of these solutions (maintenance, aging) and analyze their overall environmental performance over the whole life cycle (LCA);
- assess the social, technical and economic acceptability of these solutions and evaluate their diffusion potential based on the technical and institutional local context.

2.2 The studied source control solutions

Under the ROULÉPUR project, four different source control solutions are tested *in-situ*. They have been selected so as to present different levels of technicality, to be adapted to different contexts and representative of the solutions which emerged at an international level over the last years:

- a pervious and vegetated car park (Figure 1 a),
- small horizontal sand filters (Figure 1 c),
- vegetated filter strips and bioretention swales (Figure 1 b),
- a compact industrial sedimentation / filtration / adsorption device (STOPPOL 10CKF, Figure 1 d).

All of these solutions allow for settling / filtration / adsorption of micropollutants, and some allow a reduction of runoff volume by infiltration and evapotranspiration. Two out of them are based on a very diffuse management of runoff (pervious car park, filter strip) while the two others are receive the runoff

via a standard system of gutter, gully and pipe.

Figure 1 : The four studied pollutant control solutions : (a) pervious parking lot, (b) filter strips and bioretention swale, (c) vegetated sand filters, (d) compact sedimentation/filtration/adsorption device

The studied solutions address local issues faced by the local authorities partner of the project (City of Paris, CD93, CD77). The choices that were made were relatively mixed so as to reflect the diversity of urban contexts but also the diversity of cultures / technical practices.

These solutions are implemented in different urban contexts with contrasted potentials of contaminations. The pervious car park is situated in a residential district with limited traffic. The sand filters are in a dense town center in Paris suburbs, but collect runoff from a street with moderate traffic. The filter strip + bioretention system as well as the compact STOPPOL treatment device both collect runoff from roads with heavy traffic. While the first one is located in a periurban context, with lot of available space, the second one has been implemented on the riverside expressway in central Paris where no space was available for SUDS.

2.3 Methodology

The ROULÉPUR project is marked by its multidisciplinary character and by an integrated approach of the problem.

A first experimental phase, based on both targeted and non targeted screening analysis of untreated runoff collected at the 4 experimental sites, aims at the diagnosis of road and car park runoff contamination. An identification of the primary sources of this contamination will be developed based on leaching tests for different automobile materials and consumables.

The efficiency of the four source control devices will be evaluated based of the chemical analysis as well as the toxicity analysis of influent runoff and effluents (outflow, drainage, percolation, overflow) over a selection of rain events. For this task, one will focus on a selection of pollutants and micropolluants with different physico-chemical characteristics, considered as tracers of the potential behavior of micropollutants. The selected contaminants include global parameters (SS, DOC, POC), nutrients, 12 metals and three families of organic micropollutants (PAH, alkylphenols and bisphenolA, phtalates). The hydrologic efficiency of the devices is evaluated based on a continuous monitoring over a 18 month period of rain, runoff inflow and various outflows.

The process of appropriation of the 4 studied devices is analyzed based on interviews with the different local stakeholders involved in the development of a solution, in the decision making process, in the implementation and in the operation of each system. A compared evaluation of appropriation processes in the four case studies will allow the definition of the “felicity” conditions (shared support by all actors) and of the conditions of transferability to other sites and contexts.

ROULÉPUR also includes a methodological task, common to two other French projects (MICROMEGAS in Lyon and MATRIOSHKAS in Nantes), and developed within the frame of the three French observatories of urban hydrology OPUR, ONEVU and OTHU. This task aims at the definition of indicators and methods for an objective and multicriteria evaluation of the performance of SUDS.

2.4 Expected outcomes

The project is expected to enable significant advances in terms of:

- Knowledge on the nature, the level of contamination and the toxicity of runoff. It will lead to the creation of unprecedented runoff characterization database encompassing pollutants that are already regulated but which have until yet not been considered in this type of matrix, as well as data for emergent pollutants. This knowledge is essential to situate the issues linked to road runoff contamination relatively to other inputs, but also to prioritize issues based on the type of road / parking. A better understanding of the nature of the contaminants is moreover critical to guide the choice of management solutions.
- Knowledge of the primary sources of contaminants. Identification of materials and consumables causing emissions is an essential step in the development of emissions reduction strategies. Knowledge of emission factors is also needed to better estimate the pollutant potential of a site and to guide the selection of water management solutions.
- Knowledge about the fate of water and contaminants in the source control structures. The project results will identify the key processes involved, evaluate the performance of the devices in real conditions, objectify the risk of pollutant transfer to the groundwater or surface water, characterize the byproducts generated (waste, sediments contaminated soil layers).

The project is evaluating the actual performance of these solutions, integrating global environmental impacts (including production, implementation, maintenance and end of life of the devices or materials) through life cycle analyses. It allows for an operational feedback on any difficulties of implementation, operating constraints and maintenance costs.

The appropriation of these innovative solutions by the different services involved in their selection, implementation and maintenance will be analyzed under a common framework, so as to identify the conditions for their proper development.

These points are essential to guide on a nationwide scale the choice of source control systems towards the most environmentally friendly solutions, but also the best suited to the technical and social context of the project.

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