

Intitulé de la thèse/Thesis title

Impacts à court et long termes de mélange de polluants émergents (résidus de médicaments) et de métaux lourds liés aux épandages agricoles sur la flore et la faune terrestre.

Short- and long-term impacts of mixing emerging pollutants (drug residues) and heavy metals associated with agricultural land-based flora and fauna.

Encadrement/Person in charge

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Descriptif du projet de these/Thesis description

The recent work of INRA (Synthesis of the INRA-CNRS expertise of 2014 on the valorization of fertilizer materials of residual origin on agricultural or forest soils) and the technical day on the theme "sludge" organized by the AFB in December 2017, while taking stock of the essential achievements of the various past and current programs, underline the same lack of information on the links between the results of chemical analyses and the ecotoxicological effects on living organisms, as well as the lack of data on the effects of mixed contaminants.

This thesis project is in line with the work carried out within the LEHNA-IPE on the fate and ecotoxicity of these molecules, which allowed a more refined risk assessment of the direct and indirect effects of one of these substances. toxic effects notably on an aquatic ecosystem (Orias and Perrodin 2014, Perrodin et al., 2016) and work on the dynamics and mobility of pollutants, especially organic pollutants, in terrestrial ecosystems, whether towards plants and / or earthworms. by Jean-Philippe Bedell (Coehlo et al., 2018, Auccour et al., 2017, Bedell et al., 2014). In this project, we are therefore interested in the effects of mixtures, on plants and earthworms, of metallic trace elements (ETM) and emerging pollutants (drug residues) of various matrices that are sludge residues of STEP, or urban or livestock effluents. Transfers of residues of drugs and biocides for human and veterinary use to superficial and underground aquatic environments, after spreading on agricultural soils, have already been studied but are not sufficiently well known and quantified, particularly in terms of absolute and relative fluxes, to allow the determination of mass balances at catchment scale (for sludge: Gottschall et al., 2012, Giudice and Young, 2011; for livestock effluents: Amarakoon et al., 2014; al., 2004). In this general problematic of the fate and transfer of these molecules, this thesis aims to help fill these gaps, identified at the national level, particularly in terms of effects measures, by relying, on the one hand, on the achievements of the SIPIBEL observatory (www.sipibel.org) and, on the other hand, by taking advantage of the synergy with the Téléphore project.

The main objective of the thesis project is to study and provide new quantitative data on the environmental impacts of MAFOR-type solid matrices spread on agricultural soils in terms of transfer to the environment and living organisms (bioavailability and bioaccumulation). This thesis will provide ecotoxicological data that can be used for the establishment of, for

example, PNEC for soil organisms, data so far missing from the literature for most of the micropollutants involved in this project. The different stages of the thesis are therefore broken down into:

- linking the ecotoxicological profiles of the matrices studied with the chemical analyses obtained,
- the characterization of the effects of the contribution of these Mafors on populations of terrestrial organisms in real conditions of exposure (earthworm tests *in situ* and *in vitro*),
- the ecotoxicological characterization of Mafors (acute and chronic *in vitro*),
- the integration of drug residues and heavy metals, present in these matrices, in a key organism of the trophic chain (earthworms),
- the development of innovative *in situ* bioassays in order to characterize the combined effects of residues of drugs, detergents and biocides on these soil organisms (earthworms).

This thesis must make it possible to quantify the potential impacts on the environment and living organisms, in the short and long term, of the presence of mixed micropollutants in several types of solid matrices, with a view to improving knowledge at national level, points of support for the evolution of public environmental and health policies.

The knowledge acquired will mainly (i) provide ecotoxicological data that can be used for the establishment of PNECs for soil organisms, data so far missing from the literature for most micropollutants involved in this project, (ii) to inform knowledge of the impacts of drug / biocide residue mixtures related to agricultural land-based flora and fauna under realistic conditions of application; and (iii) to make recommendations of "best practices" for spreading in particular for vulnerable areas (catchment areas, etc.) in a logic of transfer of knowledge to managers in a territory.

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