Personal care products removal from greywater using nature-based solutions for water reuse in sustainable buildings: the "ReCare" project approach

Fernanda Cristina Muniz Sacco[1,], Silvia Venditti[1], Paul Wilmes[2], Joachim Hansen[1]*
[1] University of Luxembourg- Campus Kirchberg - 6, rue Coudenhove-Kalergi, L-1359 Luxembourg
[2] University of Luxembourg- LCSB, 7, Avenue des Hauts Fourneaux L-4362 Esch-sur-Alzette
* fernanda.muniz@uni.lu

Abstract
The on-site greywater treatment is an interesting alternative for the load decrease of micropollutants, such as personal care products (PCPs), due to their removal at the source. Moreover, the treated greywater, following the required quality standard, could be reused for different purposes, such as toilet flushing or irrigation of gardens and green areas. By doing so, besides contributing to the preservation of water bodies quality and aquatic ecosystem, potable water could be saved, and green spaces could be integrated in urban environment.
The use of vertical-flow constructed wetlands (VFCWs) as selected nature-based solution to remove PCPs from wastewater and greywater has been already demonstrated to be a sustainable solution for this. However, the PCPs removal mechanisms within VFCWs, such as phytoremediation, adsorption on soil and biodegradation, as well as the targeted design and dimensioning of VFCWs for this purpose need to be investigated in depth for the up-scale integration to a city's water services.
In this context, the ReCare project, funded by the FNR (Fonds National de la Recherche Luxembourg), within a 4-year PhD study aims to test the viability of VFCWs for the removal of PCPs from greywater, using different admixture substrates: conventional zeolite and activated biochar produced in a circular economy perspective I) biochar from plants, and II) biochar from cellulose-sewage. The bacterial community involved on the removal will be characterized, and finally, a VFCW treatment technology "fit for purpose" will be designed based on quality standards for water reuse in sustainable buildings.
The lab scale investigation will be carried out with 6 lysimeters (L), with a total volume of about 71 L each, filled with different substrates L1: 85% sand + 15% zeolite, L2: 95% sand + 5% zeolite, L3: 85% sand + 15% activated biochar-I, L4: 95% sand + 5% activated biochar-I, L5: 85% sand + 15% activated biochar-II, and L6: 95% sand + 5% activated biochar-II. The lysimeters will be fed simultaneously and intermittently with three types of synthetic greywater (light: only from bathrooms, medium: bathrooms + laundry, and dark: bathrooms + laundry + kitchen) in a vertical-flow mode at a frequency of three times per day. Different hydraulic loading rates will be tested.
The project will be composed of three phases: during the first phase, all lysimeters will be planted with a mix of *Phragmites australis* and *Iris pseudacorus* to then select the best substrate(s) as the main objective. With the selected substrate(s), other plants will be tested in the second phase, which will lead to the third phase, where the identified microorganisms from the two phases can be fostered, e.g., via inoculation, to enhance the PCPs removal in VFCWs. Because bioremediation is expected to be the driving mechanism in the PCPs removal, a characterization of the most abundant genera will be performed using 16S rRNA sequencing from different layers of the lysimeters, varying substrate and load rate to identify bacterial specialists contributing to the removal of PCPs. Wastewater quality and microbial biomass, as well as the pollutants removal efficiency and the residual amount in the soil/ plants will be monitored at all phases.
The knowledge gained from these lab scale studies will be then used to design and dimension a suitable greywater treatment for sustainable buildings, based on effluent quality standards for water reuse.

BIO of Presenter:
Fernanda Muniz Sacco is a Doctoral Researcher at the University of Luxembourg. She is an Agronomist Engineer with a Master in sustainable development, with more than 10 years of experience in sustainable agriculture. Since 2021, she has been developing her career in circular economy applied to the urban wastewater management.