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ABSTRACT

To reach the ambitious objectives of good chemical states for waters that have been introduced in Europe with the Water Framework Directive 2000/60/CE, it is important to control pollutant fluxes. Urban runoff being recognized as one of the major sources of pollutants in surface water and rainwater harvesting spreading in the meanwhile, upstream stormwater management seems to be necessary.

Vegetative roofs are constituted by two materials currently used in water depollution, i.e. a "soil" and plants. Therefore, this technique is often considered as a potential solution to obtain a good roof water quality. Nevertheless, vegetative roof impacts on water quality have proven to be mixed. The main reason is probably because vegetative roofs are not designed in order to purify rainwater. The objective of this presentation is to better understand plant impacts on metal storing and disposing in green roof to provide criteria for plant selection in order to improve roof water quality.

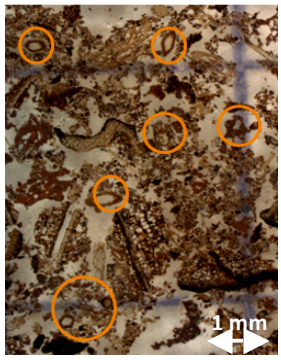

Fig. 2: Substrate section showing aggregates around S. spurium roots

This study is mainly based on two complementary steps. The first one is the monitoring of green roofs built in 2010 near Nancy (France). Three plants associations have been used on eight different structures. The first one contains six species of *sedum* (*S. album, reflexum, spurium, floriferum, hispanicum, sexangulare*). This genus is widely used for green roofing for its ability to withstand harsh climatic conditions. The two other plant associations also contain some local plants such as *potentilla erecta*, *euphorbia polychroma* and *iris sibirica*. Plant development was studied every two months. Samplings were collected twice a year and metal content was analysed in root and aerial parts. Substrates were also sampled in 2010 and 2013 for total and extractible metal contents analyses and physico-chemical characterizations. Metal content in the fertilizer used when the plants were introduced was also evaluated. Atmospheric deposits and roof water were collected monthly and analysed to measure metal contents. Along with this in situ study, complementary experiments at meso- and microscopic scale were lrealized. Thin section (20 µm thickness) of substrates containing sedums roots were made in 2013 and observed thanks to a binocular magnifier. Roots and leaves ultra-thin sections (80 nm) were observed thanks to a transmission electron microscope equipped with an Energy-Dispersive X-ray microanalysis system used to detect metals in plant tissues.

The different plants showed comparable ability to retain metal, far from hyperaccumulator capacities. The global amount of metal stored in the plant compartment was mainly influenced by the biomass of the different species. It was also superior to the amount of metals brought by the atmospheric deposit, meaning that the use of hyperaccumulator may not be necessary. It was also noticed that metal contents in plants were highly correlated to metal contents in substrates, which are bigger than atmospheric deposits ones. This indicates that a part of available metals from the substrate is stored by the plants, which contributes to reduce metal lixiviation from the substrate by rain water and consequently to reduce metal concentration in green roof water. Cr content in fertiliser proved to be significant. A strong correlation was observed between Cr amounts brought by fertiliser introduction and measured in plants. If this metal had not been retained by plants, fertilisation would have increased Cr content in roof water. Root plants seemed to foster aggregates formation (Figure 1), which can reduce small particles leaching. Organic matter content in substrate was also higher as plants were present than under bare surfaces. Both of these impacts indirectly improve water quality: the first one by reducing metal emission from the substrate and the second by improving the substrate ability to retain metals. Indeed, organic matter proved to have higher metal sorption ability than the mineral part of the substrate. However, plant roots also seemed to increase the availability of some metals in the substrate, such as Zn. This could have a negative impact on roof water quality if these elements are lixiviated by water before being absorbed by the roots. Ultrastructural observations of plant roots revealed that metals were mainly stored by cells containing condensed polyphenolic substances. Bacteria degrading these polyphenolic metabolites have also been noticed. This induces that storage of metal in green roof plants is only temporary. Consequently, if plants are introduced on green roof to improve water quality thanks to

their ability to store metals, maintenance practice should be adapted to its characteristics. Seasonal mowing and collecting of aerial parts or periodical plants substitution could be considered.