Oliver Baeder-Bederski, Centre for Environmental Research, oliver.bederski@ufz.de

Phytovolatilisation of organic chemicals

When contaminated soil and water are remediated using plants, a multitude of pathways, partly not yet quantified, are activated. ‘Phytovolatilisation’ denotes the process in which usually organic compounds are emitted from the aboveground sections of the plant into the atmosphere. This includes all the compounds which are taken up by the roots, partly transformed within the roots, and transported into the shoot.

Even though the elimination of potential environmental pollutants by plant uptake was estimated to be much lower than microbial degradation in the soil back in the 1970s, in the 1990s the phytovolatilisation of volatile pollutants became a topic of economic interest since it held out the promise of accelerating the elimination of pollutants during the remediation of contaminated sites. In the past, investigating phytovolatilisation often failed because of the analytical methods’ high detection limits. More sensitive methods such as radioactive labelling usually only detected the cumulative elimination of pollutants by evaporation and provided little information on the mechanism of these emissions. Therefore, the experimental goal of this work was to determine the dynamics of specific emission rates.

Independently of the volatilisation of the contaminants from the nutrient solution the emission rates were determinated under defined, approximated natural conditions using a dynamic gas exchange chamber. To detect traces of contaminants in air samples with high relative humidity a purge & trap technology was used.

An estimation of the specific emission rates of different materials was made with a transportation model. The model was used to ascertain what compounds are most likely to be emitted by plants due to their physical characteristics.

In experiments with 2,6-Dimethylphenol and Trichloroethylene a clear link was observed between contaminant emission and the lighting intensity likely to be due to the stomata aperture. The absolute values of the emission rates were very low and in the range of nmol/h m^2 foliar surface. The calculation of the emission rates in different scenarios shows lowly higher emission rates for materials with lower n-octanol-water partition coefficients

Phytovolatilisation is particularly suitable for eliminating volatile compounds in shallow groundwater contaminations, but the experimental proof of an increased net emission of planted areas with volatile soil contaminants near the surface compared with unplanted areas is still pending. On the basis of the model computations it is rather to be expected that the net emission of volatile lipophilic materials should be reduced into the atmosphere by a planting.