A new procedure for quantifying solute fluxes in soils
- first results of urban forest soils in the Ruhr district -

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Introduction

Object of this study was the quantification of solute fluxes with seepage water out off the organic layer of urban forests into the upper mineral soil. In this paper, we drove our attention to the anthropogenely immitted heavy metals, especially lead. In an old industrial region like the Ruhr district area-wide pollutant immission is the rule since over 100 years, caused by industry agglomeration and traffic (Dohlen & Schmitt 2003). Against the background of an up to now lasting pollution we follow the question, wether the used method allows to quantify the transport of lead and which amount of lead flux takes place at the boundary of organic layer/mineral soil at present.

Material and Method

Fig. 1:
Installation of a suction plate below the organic layer (Location: Bochum-Langendreer).

For clarification of this question newly developed suction plates made of plastics have been installed into the upper soil of two urban forests in Bochum (Fig.1). From december 2002 until november 2003 seepage water was extracted weekly from the organic layer by vacuum (constantly 250-300 hPa). The materials of the innovative suction plates with their high hydraulical conductivity and their low heavy metal adsorption should combine advantageous physical and chemical characteristics to get quantitative statements of the seepage water consistancy.

Results and Discussion

Verification of the method

The chemical and therewith qualitative skill of the suction plate's plastic materials has been tested plurally for the investigation of solved heavy metals (e.g. Grossmann et al. 1990, Wenzel et al. 1997) and since then has been proven in field studies (Koch et al. 2002, Wessel-Bothe 2002). For the verification of the seepage water *quantity* collected by suction plates in Fig.2 the weekly recovered amount of water is compared to the adequate throughfall.

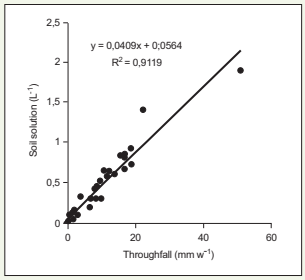

Fig. 2:
Weekly throughfall and with suction plates weekly collected amounts of soil solution in the time between December 2002 and November 2003

The close correlation (r = 0,95) between these two parameters shows that the amount of seepage water collected by suction plates has been nearly proportional to the respective throughfall. Thus, it was not influenced by the precipitation level or intensity. This result is probably facilitated by the low installation depth of the plates. Normally for a good balance using suction plates it is necessary to use a tension-controlled vacuum system (Siemens & Kaupenjohann 2004). In addition to the high correlation of rain and seepage water quantity the rate of throughfall collected by suction plates corresponds nearly to their active area, 0,04 m^2 (slope of the regression equation is 0,0409). The hereby used method could be considered as qualitatively and quantitatively nearly representative.

Lead dynamics

Fig. 3 shows the concentration curves of lead at both sites in addition to the rain at Bochum Bergen, december 2002 until november 2003. While the Pb concentration levels on both sites greatly differ, they change in a very similar way. Caused by more than 40 years of longer forestry use and hence, the stronger soil acidification and interception of air pollutants in Bochum-Langendreer, more soil degradation has taken place than in the soil under the younger forest in Bochum-Bergen. The consequences for the soil quality in BO-Langendreer were a thicker layer with lower pH value, poorer consistency of humus, and higher Pb contents.

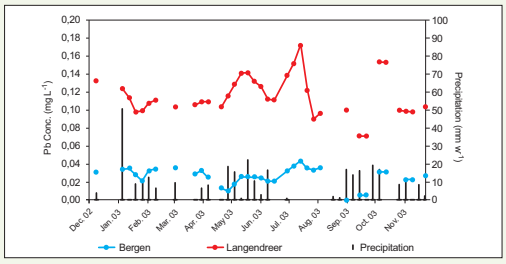

Fig. 3: Dynamic of lead concentrations (mg L^{-1}) in seepage waters from the organic layers of the sites Bochum-Bergen and Bochum-Langendreer and related weekly precipitations between December 2002 and November 2003

Lead fluxes

The result for the period from december 2002 until november 2003 is a flux of 48,39 mg Pb m^{-2} at the very strong acid site Langendreer, and 10,66 mg Pb m^{-2} at the strong acid site Bergen. A lead flux of this dimension has also been calculated by Lang & Kaupenjohann (2004) within a similar study (18,6 mg Pb m^{-2} a^{-1}).

Conclusion and perspective

The used method proved itself being suitable for quantitative studies of heavy metal fluxes in soils. Thus, a further analysis of our ample database will follow. Furthermore, the use of the described plastic suction plates could improve the quantitative monitoring of pollutant fluxes in soils, especially where the temporally analysis of the data survey is necessary.

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