Geophysical Research Abstracts
Vol. 14, EGU2012-3674-1, 2012
EGU General Assembly 2012

Characterization of polycyclic aromatic hydrocarbons and metals in ashes released from a forest fire

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ABSTRACT

Wildfires have become a permanent source of environmental and societal concerns. Whilst the impacts of wildfire on hydrological and erosion processes are well documented, the stocks and export of polycyclic aromatic hydrocarbons (PAHs) and heavy metals have received considerably less research attention. The ashes produced by wildfires, which include polluting substances such as PAHs and metals, are subject to transport processes by wind and especially by overland flow and water infiltrating into the soil and possibly reaching ground water bodies.
In the framework of the FIRECNUTS project, we are studying the stocks of PAHs and selected metals in recently burnt forest stands in north-central Portugal, and their subsequent export by overland flow. The present work, however, will focus on the stocks in the ashes, both immediately after wildfire and three months later. These ashes were collected at two burnt slopes with contrasting forest types, i.e. a eucalypt and a maritime pine stand, the two pre-dominant forest types in the study region.
The sixteen PAHs identified by US EPA as priority contaminants were analysed by gas chromatograph, after extraction and column clean up. The contents of vanadium (V), chromium (Cr), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As), cadmium (Cd) and lead (Pb) were analysed by inductively coupled plasma- mass spectrometry (ICP-MS), after an acid digestion, while mercury (Hg) was analysed by pyrolysis atomic absorption spectrometry with gold amalgamation.
The total concentration of PAHs immediately after the wildfire ranged from 314 ng/g dry weight in the maritime pine stand to 597 ng/g dry weight in the eucalypt stand. Three months later, the total concentration has decreased with 33% in the pine stand but only half (16%) in the eucalypt stand. The composition the PAHs by ring size was dominated by three-rings PAHs. This was true for all samples. The concentrations of various metals differed for the two sampling occasions but not in straightforward manners. Some metals (Co, Ni, Cu, Zn, Cd, Pb and Hg) revealed higher contents immediately after the fire, whereas others (V, Cr and As) did three months later.
The present results underline the importance of furthering the knowledge about contamination of soil and water by ashes from wildfires and the associated risks in terms of ecotoxicological effects, both in-situ and in downstream aquatic systems.

Keywords: Polycyclic aromatic hydrocarbons (PAH); heavy metals; stocks; ash; wildfires