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Impact of a trace metal contamination from mining activity on soil microbial communities and respiration activity of irrigated Kastanozems in Georgia

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The study area is located about 80 km south of Tbilisi in southeast Georgia in the Mashavera valley. Intensive agricultural land use is limited by low annual precipitation (504 mm) and hot, arid summer months. Accordingly, vegetable gardens, vineyards and orchards as well as arable land are irrigated with water of the Mashavera River. The water is heavily burdened with suspended particles, which show very high concentrations of sulfidic metals (Cu, Zn, Cd) resulting from slag heap erosion and a flotation plant of a non-ferrous metal mine. For this reason the irrigated soils in the Mashavera valley are highly contaminated with these trace metals.

Investigation of the ecological impact of the metal contamination was started in 2008 by a field experiment as well as monitoring of arable land (also see other EGU-contributions of Hanauer et al.). One aim of the study was to test the use of soil microbial parameters for the evaluation of the habitat function of soils contaminated with trace metals. Soil microorganisms play a key role in ecologically important biogeochemical processes. Under stress conditions caused by pollutants the biochemical activity and the diversity of soil microorganisms are disturbed. Therefore microbial parameters also contribute to an estimation of soil quality to prevent negative ecological effects.

Top soil samples (0-20 cm) were sampled to measure the soil microbial activity of the experimental fields (24 samples) and 35 representative areas in the Mashavera valley in March 2010. Habitat quality was evaluated by determination of pH-value, organic matter, soil texture and total as well as mobile and exchangeable (NH_4NO_3-extractable) trace metal amounts. Total contents ranged between 284 mg kg^{-1} and 1193 mg kg^{-1} for Cu, between 303 mg kg^{-1} and 975 mg kg^{-1} for Zn, and between 1.4 mg kg^{-1} and 5.9 mg kg^{-1} for Cd. Basal respiration and substrate induced respiration of the microorganisms were measured by a portable infrared gas analyzer, which determined the CO_2 production. First results indicate a reduced microbial activity in soils irrigated with contaminated Mashavera water. Lowest respiration rate (basal respiration: 3.8 μg g^{-1} TM h^{-1}, substrate induced respiration: 52.8 μg g^{-1} TM h^{-1}) was measured in a sample with one of the highest trace metal contamination (Cu: 1193 mg kg^{-1}, Zn: 975 mg kg^{-1}, Cd: 5.9 mg kg^{-1}). Analysis of microbial community structure by polymerase chain reaction – single strand conformation polymorphism (PCR-SSCP) to examine differences in the structural diversity of soil bacteria between contaminated and uncontaminated soils are still in progress. For the analysis 24 samples of the total sample number were chosen. Upon exposure to metal stress a shift of the native microbial community structure is expected possibly causing a decrease in microbial diversity and the development of metal-resistant microorganisms. The results will be presented.