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Soil Microbial Indicators for Different Land-Use Types in River Oasis of the Altay Mountains

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Abstract

Agricultural intensification and rising grazing pressure in the river oases of the Sino-Mongolian Altay Mountains question the long-term productivity of the local agro-pastoral land use systems. Biological and bio-chemical parameters are reliable indicators for monitoring environmental impacts on soil as they respond more sensitive to modifications in land-use than physico-chemical ones. In view of this, this study aimed at the quantification and assessment of soil biological and bio-chemical parameters exemplarily across typical land-use types of the Mongolian river oasis Bulgan Soum. To this end, the topsoil of six different land-use types (carrot fields, hayfields, seabuckthorn fields, rangeland sites of the pediments, rangeland sites in the floodplain, saline sites) was analysed for soil biological (microbial biomass carbon (C) and nitrogen (N), basal respiration, ergosterol) and soil physico-chemical properties (texture, bulk density, pH, electrical conductivity, inorganic C, total C and N). Based on this, ratios of microbial biomass C/N, microbial biomass C/soil organic C, ergosterol/microbial biomass C and the metabolic quotient were calculated. Microbial biomass C showed minima of 212.8 μg g^{-1} soil for rangeland sites of the pediments and maxima of 816.0 μg g^{-1} soil for rangeland sites in the floodplain. For the latter sites the metabolic quotient qCO_2 was relatively low with 17.1 mg CO_2-C g^{-1} biomass C d^{-1} while highest values of qCO_2 were measured for seabuckthorn and hay fields (51.8 and 43.3 mg CO_2-C g^{-1} biomass C d^{-1}, respectively). For both irrigated agricultural sites also the portion of saprotrophic fungi to total microbial community was highest (ratio of ergosterol to microbial biomass C: 4.9 and 4.6 ‰, respectively) and the availability of organic matter to soil microorganism was lowest (ratio of microbial biomass C to soil organic C: 1.8 and 2.3 %, respectively) across all land-use types. In summary, an intensification of agriculture in the river oasis was reflected by a rise of qCO_2, an increase of the ergosterol to microbial biomass C ratio and a decline of availability of organic matter to microorganism. Therefore, results confirm the potential use of soil biological and bio-chemical parameters as indicators and allow the identification of sustainable land use systems.

Keywords: Arid steppe ecosystem, Central Asia, land-use change, soil organic carbon, soil respiration, soil salinity

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