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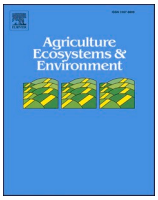

Effects of cultivation and agricultural abandonment on soil carbon, nitrogen and phosphorus in a meadow steppe in eastern Inner Mongolia

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ABSTRACT

Grassland conversion into cropland and further into abandoned land may result in substantial changes when such conversion neglects the historical context of the land use pattern in question in most cases. The objectives of this study were to examine the effects of land use shifts on soil organic carbon (OC), total nitrogen (TN) and total phosphorus (TP) in a meadow steppe in eastern Inner Mongolia. Four sites within 50 km were selected as replicates, and within each of the four sites, the plant and soil properties were investigated separately for three land use types, grassland, cropland and abandoned land from cropland, to reveal the effect of land use changes on soil nutrient contents and stocks. We found that cropland had the highest canopy biomass, whereas grassland maintained the highest root biomass. Significant decreases in OC and TN contents occurred mainly in the 0−20 cm soil layer with the conversion of grassland into cropland, whereas TP contents significantly increased in the 10−30 cm soil profile. Abandonment obviously increased the soil OC and TN contents in the 0−20 cm soil layer compared with cropland, although the levels of native grassland were not reached. The C:N, C:P and N:P ratios were highest in the entire soil profile for the grassland followed by the abandoned land and then the cropland. Changes in nutrient stocks with land use shifts showed similar trends as those in the relevant nutrient contents, but the change ratios of stocks among different land use types could be significantly underestimated due to the cultivation-compaction effect. Thus, we concluded that the abandonment and maintenance of native grasslands should be adopted to protect and maintain the soil organic matter and nitrogen in the meadow steppe of Inner Mongolia.

1. Introduction

Vegetation and soil are the major nutrient reservoirs of terrestrial ecosystems and are key components of the nutrient cycles of the ecosphere (Schlesinger, 1997; Chadwick et al., 1999). Whereas vegetation determines to a great extent the fixation and input rates of carbon into an ecosystem, the soil is the major source of and reservoir for various nutrient elements, and both are significantly subjected to land use changes (Guo and Gifford, 2002; Hooke et al., 2012). With the land use type being a major factor regulating ecosystem nutrient pools, any land use change may lead to significant reallocations of ecosystem biomass and nutrients within the vegetation-soil system, which has implications for the relevant biogeochemical processes of carbon and nutrients at a regional scale (Schimel, 1986; Post and Kwon, 2000; Lozano-García et al., 2016; Peichl et al., 2012).

Grasslands are among the largest carbon and nutrient pools of the global terrestrial biome, and they contain the vast majority of their carbon and nutrient stocks in the belowground compartment (Scurlock and Hall, 1998; White et al., 2000). For native, normally utilized grasslands, their biomass and soil carbon and nutrient stocks maintain a balanced state at the decadal or longer-term scale. Whereas the plant species composition may change to varying degrees, the soil nature and properties of long-term undisturbed grassland are usually much less variable compared with other types of terrestrial ecosystems (Tilman et al., 1996).

However, the conversion of natural grasslands into croplands is usually accompanied by significant changes in vegetal biomass, soil physical characteristics, and carbon and nutrient contents, leading to corresponding changes in carbon and nutrient stocks and their stoichiometric ratios. On the one hand, derived croplands are characterized

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