Geophysical Research Abstracts
Vol. 17, EGU2015-10414, 2015
EGU General Assembly 2015

Impact of cattle grazing on soil and vegetation – a case study in a mountainous region of Austria

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In mountainous regions of Austria and of many other European countries, climate change may cause a further intensification of grassland management. Therefore, the effects of intensive cattle grazing on selected soil chemical and physical properties, above- and below-ground phytomass, forage quality, plant species composition and plant species richness at the scale of a representative paddock in a mountainous region of Austria were investigated.
At the study site (Styrian Enns valley; 675 m a.s.l.), climate is relatively cool and humid, with a mean annual air temperature of 6.7°C and a mean annual precipitation of 970 mm, of which 66% falls during the vegetation period (April-October). The soil is a deep, base-rich Cambisol with a loamy sand texture. The paddock investigated has a total area of about 2 ha and had been grazed by dairy cows (Brown Swiss) five times per grazing season. The stocking density was 4 cows ha-1 during 180 days from early May to the end of October with a grazing time of about 8 hours per day. The strip grazed permanent pasture was manured annually for a long time, mostly with cattle slurry.
Vegetation surveys were carried out using the method of Braun-Blanquet. Above- and below-ground phytomass, forage quality and mineral element concentration in the harvestable above-ground plant biomass were determined by using standard methods. During the grazing season surface soil samples (0-10 cm depth) for chemical analyses were collected before each grazing period (5 analyses of composite samples per site). At the beginning and the end of the grazing season also soil samples for physical analyses were taken from the topsoil (0-15 cm depth).
Heavy cattle treading led to a substantial soil compaction especially in the 5-10 cm layer and to a deterioration of topsoil structure. The porous crumb structure was replaced by a compact platy structure. The topsoil was enriched with nutrients (mainly nitrogen, potassium, phosphorus and boron). The degree of phosphorus saturation was very high. Consequently, the risk of elevated nutrient losses via leaching and surface runoff is increased. This, in turn, may pose a threat to ground water, surface water and adjacent ecosystems. In the intensively grazed cattle pasture we observed considerable changes in plant species composition and species cover. Vegetation cover, plant species richness, pasture yield, forage quality and below-ground phytomass declined due to overgrazing. In contrast, the untrampled and unmanured habitat below the fence of the paddock can be regarded as a retreat area for many plant species which do not tolerate heavy trampling and manuring. Thus, in assessing biodiversity, this corridor should be taken into consideration.
Within the paddock, we found a permanent transfer of soil nutrients and organic matter by grazing cattle, leading to a high spatial heterogeneity in some soil properties. Consequently, within intensively grazed paddocks differential manure-application rates and variations in grazing intensity are necessary.