

Anthropic changes to the biotic factor of soil formation from forests to managed grasslands along summits of the western Pyrenees Mountains, France

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Mounting evidence indicates that highland pastures of the humid-temperate western Pyrenees were converted from mixed forests to managed grasslands thousands of years ago, as early as during the late Neolithic and Bronze age by human actions including use of fire. We observe pronounced differences between soil profiles of ancient pastures and old-growth forests in otherwise similar landscape positions. In order to test physical and chemical differences, we collected paired samples of forest versus grassland soils at four separate hillslope sites where there was a clear boundary between the two vegetation types. Animal trails were excluded from sampling. Factors of climate, topography, parent material, and time of soil formation were essentially identical in the forests and pastures of each site, but the time of soil under grassland vegetation may have varied. Each paired hillslope site included five core samples (7.6 cm diameter) from the upper 7.6 cm of the mineral soil within each vegetation type, and the A horizon thickness was recorded at each core hole site. In addition, one complete soil profile was sampled in each vegetation type at each site, making a total of 20 core samples and 4 complete profiles from each respective vegetation type. In addition, we measured the magnetic susceptibility of the mineral soil surface on two transects crossing the vegetation boundary. Core samples have been measured for bulk density, pH, plant-available nutrients, and organic matter; and tests for total carbon and nitrogen, amorphous silica, charcoal, and other forms of black carbon are ongoing. Preliminary results indicate pastured A horizons are about three times as thick as forested soils, contain more organic matter, have lower soil bulk densities, have much finer and stronger structural development of soil aggregates. These traits favor much greater infiltration and water holding capacities of the pastured soils, which we have validated with saturated hydraulic conductivity tests. Pedogenically, the pastured soils indicate that melanization processes have been much more pronounced than in the forested soils. Distinct changes in soil materials result from conversion to pasture. Significantly more black carbon (including macro-charcoal) appears to be present in the pastured soils, indicating that it plays an important role in melanization, in addition to long-term sequestration of carbon. Pastured soils contain greater contents of amorphous silica due to more rapid phytolith production from grasses as opposed to trees. Pastures register significantly higher soil magnetic susceptibility than forests, presumably from past use of fire. In essence, anthropic manipulation of the biotic factor of pedogenesis has created new soil materials, processes, and functions. Our current research involves radiocarbon and chronostratigraphy to establish rates of this anthropisation of the biotic factor.