Submitted Abstract

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Abstract

Thousands of years ago mountainsides of the humid-temperate western Pyrenees (Basque region of southern France) were converted from native forests to managed grasslands involving intentional use of fire. The timing of this landscape conversion is evidenced by paleoecological proxies of charcoal, soil magnetic susceptibility, and acrolein/PAHs (geochemical indicators of fire) within stratified slopewash deposits sampled from zero-order watersheds. Radiocarbon chronologies indicate that forest to pasture conversion occurred at 5,000-6,000 years ago in some watersheds and pastures have persisted until the present-day with varying degrees of episodic soil erosion. Our study focused on four hillsides where a well-defined boundary exists between ancient pastures and ancient forests, allowing paired comparisons of soil properties between the different vegetation types. Soil forming factors of climate, topography, parent material, and time were essentially identical in the forests and pastures at each site, isolating variability of the vegetation factor, but the time of soil under grassland vegetation may have varied from site to site. We sampled one complete soil profile and five widely separated core samples of the A horizon from each vegetation type at each site (totaling four soil profiles and 20 A horizon cores from each vegetation type). Analyses included bulk density, pH, plant-available nutrients, organic matter, fulvic versus humic acids, total carbon and nitrogen, amorphous silica, and charcoal content. Results indicate pastured A horizons are about three times as thick as forested soils, contain more organic matter, and have lower bulk densities. These traits favor much greater infiltration and water holding capacities of the pastured soils, which we demonstrated at some of the sites with a compact constant head permeameter (Amoozeemeter). Pastures contain significantly more humic acids than forests, indicating melanization prevails in managed pastures, and pastures sequester significantly more black carbon (charcoal) than forests, resulting from persistent use of fire as a management tool. Pastures also contain greater amounts of amorphous silica, attributable to rapid phytolith production from grasses versus trees. Comparative analysis indicates that the pastures generally have better "soil quality" than the forests, which contradicts the stereotypical paradigm that pastoral land use degrades soil. Thus, long-held land use practices and management decisions in the western Pyrenees facilitate soil sustainability and indeed soil improvement. Ongoing anthropological studies seek to understand how past decisions and methods have shaped this sustainable land use, which promises to inform best land use practices and soil sustainability in other alpine agropastoral regions.