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1100 years of human impact on woodland and soils in Kjarardalur, West Iceland

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Prior to the Norse settlement of Iceland around AD 874 climate was the principal control of ecosystem variability. Since then, drastic changes have been imposed on the island's ecosystem through human activities. Unsustainable land use has reduced vegetation coverage, altered floral composition and accelerated soil erosion, especially in conjunction with harsh climate. Healthy ecosystem, soil and vegetation, is not only an important resource to meet human demands but also a prominent sink of atmospheric CO_2. In contrast, soil erosion and land degradation are major sources of atmospheric CO_2.

This study discusses the impact of human activities and climate change on vegetation, soil erosion, and soil organic carbon (SOC) in West Iceland. Analyses conducted include pollen in Histosols, soil properties, soil accumulation rates and SOC in Histosols and Andosols.

Our data demonstrate a pre-settlement landscape that was not entirely stable, where relatively small differences in climate may have caused subtle changes to the terrestrial environment. However, the early colonists and subsequent occupants altered the environment significantly. The magnitude of alteration was spatially variable depending on land management. The vegetation and soil data demonstrate a swift transformation of environmental conditions across AD 874. The most profound impacts include reduction in birch woodland and concurrent decline of important habitat for fragile understory, which facilitated soil exposure and reduced soil quality.

After about 300 years, land degradation-anticipated management towards enhanced sustainability was probably adopted at one of the farming properties in the study area, allowing for soil recovery after a period of drastic decline. At other properties unsustainable land use continued to degrade the terrestrial ecosystem. The late-Medieval climatic change and introduction of the Little-Ice age exerted added strain on the environments over the entire area, resulting in further soil degradation. The property where sustainable land use had been adopted preserved woodland cover and maintained greater soil quality than elsewhere in the valley, where thresholds of ecosystem resilience were crossed.

Unsustainable land use over 1100 years caused vegetation denudation that accelerated soil erosion, with attendant redistribution of soil over the landscape, and decline in its quality. Vegetated areas became important sinks for wind-transported soils, as evidenced by increase in deposition rate and higher bulk density. This led to an increase in susceptibility to soil erosion, and decline in SOC content. Despite decrease in SOC content, the high sedimentation rate and elevated bulk weight resulted in higher SOC sequestration at these sites, even though soil quality declined. The potential soil C sequestration in adjacent sparsely or devegetated soils were highly impaired and along with soil mass losses these areas became sources of anthropogenic CO_2.