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Dust emission from grazed grasslands on Colorado Plateau (USA) drylands: Modern events and long-term effects

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Surficial deposits of semi-arid grasslands on the Colorado Plateau (USA) commonly contain eolian dust. Dust abundance in these upland deposits resulted from redistribution by geomorphic processes, periodic accumulation on stable surfaces, and changes in dust flux related to late Pleistocene and Holocene climate change. Instrumental monitoring since 1998 illustrates controls of contemporary climate and land use on wind erosion and dust emission from these grasslands. Least particle saltation is observed at a never-grazed site, intermediate saltation at a site grazed until 1974, and most saltation at a currently grazed site, at which dust emission spiked during a recent drought (2002). These instrumental records, along with biogeochemical studies, provide a basis for assessing the effects of disturbance at previously grazed sites.

At the undisturbed site, eolian dust, much of which accumulated over centuries to millennia, composes as much as 20 % of the sandy soil (at 0-10 cm depth) and contributes about 40-80 % of rock-derived nutrient stocks (P, K, Na, Mg, Mn, Zn, and Fe). Two sites, which were grazed from the late 1800s to 1974 and which are otherwise similar to the undisturbed site in geologic and geomorphic characteristics, have 38-43% less silt and 14-51% less Mg, Na, P, and Mn content relative to soils at the ungrazed site. Measurement of magnetite content (a proxy for far-traveled eolian dust in these settings) and assessment of type and cover of biologic soil crusts imply that the differences in Mg, Na, P, and Mn are related to grazing-induced wind erosion of soil fine particles. Historic grazing also diminished rates of soil respiration and soil organic matter (60-70% decrease in surface soil C and N relative to the never-grazed

site). The losses of soil C and N and the evidence for substantial rock-derived nutrient loss by wind erosion suggest that livestock grazing in arid regions causes long-lasting deficits in the soil fertility of native grasslands. The ecologic importance of eolian dust in these landscapes underscores their vulnerability to wind erosion. The loss of nutrient-rich eolian dust in these soils may quickly and severely change soil characteristics that developed over centuries.