Wind Erosion and Dust Emission in Western Deserts—More or Less in the Future?

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How will climate change affect future wind erosion and dust emission in the West? Will human activities accelerate or suppress wind erosion and dust emission? These questions bear on issues of land management, water management, air quality, ecosystem dynamics (losses and gains of nutrients), and human health over large areas of American drylands.

Changes in dust emission and deposition may be one of the first large-scale, obvious impacts of future climatic change, manifested perhaps by new dust sources or the cessation of existing sources, along with respective increases or decreases in regional dust flux. We still lack fundamental understanding about dust sources—their locations, time periods of activity, relations to climatic variability and land uses, and their dust compositions. Some improved understanding, nevertheless, has been gained over the past ca. 20 years through sporadic monitoring and other approaches (e.g., analyses of visibility records and dust-trap samples). As a result, a clearer picture is emerging regarding the effects of relatively short-term droughts and wet periods (including ENSO cycles) on dust emission in western deserts.

Recent investigations demonstrate that the intensity of modern dust generation from sparsely vegetated drylands depends greatly on interannual variability in vegetation density (especially for annual plants), which is strongly influenced by the amount and timing of antecedent precipitation. In contrast, the potential for dust generation from undisturbed dry lakes, generally lacking vegetation, is controlled primarily by hydrologic factors. Critical hydrologic factors include depth to water table, response of near-surface sediment to rainfall, groundwater chemistry, and presence or absence of subsurface impermeable beds. Dust production from dry lakes can be prolific where vapor discharge commonly produces soft, salt-rich sediments at and near the surface.

Older records of dust flux and composition are found in dust components of certain soils and lake sediments that can be dated by radionuclide and luminescence methods. The best settings for such records are isolated, undisturbed, high-elevation lakes that have received atmospheric dust for centuries and even millennia. Recent results from a few lakes in the Rocky Mountains (Utah and Colorado) reveal that human activity over the past 150 years has had a major effect on regional dust composition and probably on dust flux, compared with dust deposited during multi-decadal droughts within the past millennium.

Three related long-term goals for future dust studies are (1) to identify areas vulnerable to wind erosion and dust emission; (2) to recognize the wide range of potentially adverse effects on ecosystems, water availability, and people; and (3) to develop the capability to predict future dust emissions under variable and changing climate, in conjunction with a variety of climate and soil-moisture models. Reaching these goals will require linked understanding of geologic surfaces and their sediment availability, vegetation dynamics, soil hydrology, climate variability, meteorological conditions, dust-transport pathways, and various human activities that produce mineral aerosols.

In a broad sense, a warmer West with higher rates of evapotranspiration, coupled with continued or increased human disturbance of desert landscapes, would result in more dust emission relative to recent decades.

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