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Editorial: Understanding soil wind erosion and control practices in arid and semiarid environments

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Editorial on the Research Topic
Understanding soil wind erosion and control practices in arid and semiarid environments

Soil wind erosion is a serious problem in arid and semiarid regions globally because of removal of nutrients and finer soil particles from the soil surface, reduction of soil productivity, suppression of crop growth by sandblasting seedlings, damage to infrastructure, and impacts on air quality, human health, and visibility from dust emission, among other negative consequences. In this Research Topic, wind erosion is studied by various approaches such as field observations, wind tunnel testing, and laboratory measurements. Here, we present a brief review and summary of these articles.

Dong et al., Tan et al., Tian et al., and Chen et al. conducted field experiments to test how land management practices influence wind erosion parameters or reduce erosion in the field. Dong et al. present long-term observations that indicate both rotational grazing and long-term grazing exclusion can significantly enhance soil aggregate stability and analyze and discuss the relative effectiveness of these management practices. Tian et al. present results from a field experiment to explore effective slope management practices to control soil erosion from large mine dumps, which is a serious environmental problem for their study region and others. They found that microtopography modifications and vegetation treatments provided sufficient protection to prevent erosion of soils with added benefits of increasing soil organic matter content and biodiversity. Similarly, Chen et al. conducted a field experiment to test how different tillage practices reduce wind erosion in the corn belt, northern China. Similar to previous studies such as Sharratt and Feng (2009, https://doi.org/10.1002/esp.1812), they found wind erosion from no-tillage (NT) treatment significantly lower than that from conventional tillage (CT) treatments. However, their observations suggested direct creep was a dominant process for the corn belt landscape rather than suspension or saltation. Xu et al. present a laboratory experiment to test how salt crust character was influenced by salt type and content. Soil crust is an important limiting factor for wind erosion, and salt crusts can be prevalent in dry areas because of strong evaporation and high salt concentrations of irrigation water. They found that $CaCl_2$ produced crusts with greater compressive strength than did other salts, whereas Na_2SO_4 appeared to reach the maximum strength earlier than other salts with a smaller increase of salt content. They concluded that, because of their compressive strength and toughness,

crusts of KCl, $CaCl_2$, NaCl, and Na_2SO_4 could be useful to control wind erosion as long as their content was around 3%.

Like other geomorphologic processes, wind erosion is also characterized by high spatiotemporal variability among regions. Tan et al., Zhang et al., and Funk et al. report on observations of wind erosion and dust emissions in different regions and found differing results from previous studies. Tan et al. measured wind-blown sand over a Gobi surface. Transport below 0.6 m accounted for >99 per cent of the total amount, suggesting direct saltation may be a much more important process for Gobi surfaces than suspension or creep. Zhang et al. monitored airborne dust concentrations in the Mogao Grottoes, Northwest China, and indicated that particulate matter less than 10 μm (PM10) dominated total suspended particle (TSP) concentrations with a mean ratio (PM10/TSP) of 0.82. Maximum TSP real-time concentrations (16,000–21,000 μg m^{-3}) observed from the Mogao Grottoes were greater than the concentrations observed from Kennewick, WA (600 μg m^{-3}) and most hotspot dust source areas of China (10,000 μg m^{-3}), comparable to the concentrations observed from Israel, and Inland Delta region of Mali, but smaller than from Sahara, North Africa, or Tel Aviv, Israel (Ganor and Foner, 2001, https://doi.org/10.1029/2000JD900535). Generally, the composition in PM observed in the air is different from that in soil, but few studies have identified phytoliths in the PM. Funk et al. used Scanning Electron Microscopy and Energy Dispersive X-Ray analysis (SEM-EDX) to investigate the existence of phytoliths in the observed dust. They found that the fraction of phytoliths in the PM was up to 8.3%, and the fraction of organic origin was up to 25%. In contrast, the fraction of phytoliths in the soil varied from 0.01% to 3%. As an important plant nutrient and source of Silicon (Si), a sink for organic carbon (Schaller et al., 2021, https://doi.org/10.3390/plants10020295), and a reliable indicator in palaeovegetation and palaeoenvironment reconstruction (An et al., 2015, https://doi.org/10.1038/srep15523), loss of phytoliths should be highlighted in land management practices.

Wind tunnels are a useful tool in wind erosion studies because they allow researchers to control conditions. Wang et al. evaluate a Concrete Plate-Insert Sand Fence in decreasing sediment transport from a Gobi surface along the Lanzhou-Xinjiang High-Speed Railway under various wind conditions. Although the fences adequately reduced wind velocity, considerable sand may be deposited gradually on both leeward and windward sides of the sand fence because of the two wide row spacing between the double-row fences and porosity of the sand fences. As a result, the sand fences along Railway may lose their transport-limiting capacity as more sand is deposited. Risks in potential sand deposition on the Railway should be considered alongside fence effectiveness by managers to avoid losses due to sand transport in the future. Plant-based sand prevention is another popular mitigating practice. Zhang et al. test the performance of windbreak forest belts in controlling sand transport from the Gobi Desert surface along the Lan-Xin Railway, Northwest China. While sand was also deposited on both leeward and windward sides of the windbreak forest belts, the three shelterbelt rows appeared to perform better than the concrete sand fence, with an efficiency up to 90% compared to <72% efficiency of the sand fence.

This Research Topic aimed to advance our understanding of soil wind erosion and control practices in arid and semiarid environments. As a research community, we have made significant progress in understanding wind erosion processes and impacts over the last few decades. Despite this progress, wind erosion continues to be a national, regional, and international problem, especially in the context of uncertainty associated with global climate change. Future research employing a variety of approaches—including field observations, wind tunnel and laboratory experiments, remote sensing, and modeling—will continue to be needed to meet the challenges of mitigating negative impacts of soil wind erosion into an uncertain future.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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