Acceleration of Wind Erosion on the Tibetan Plateau Due to Future Climate Change

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The Tibetan Plateau (TP), the highest and most extensive highland on Earth, is undergoing rapid atmospheric warming and desertification (Feng et al., 2006). Wind erosion, which is the driving process of desertification and related dust events, has not been studied under changing climate scenarios for the TP. It is not clear whether desertification will be accelerated by future warming or restrained by increasing precipitation.

Here we use process-based wind erosion simulations to elucidate the relationship between wind erosion and climate change under historical and the fifth phase of the Coupled Model Intercomparison Project (CMIP5) projected climate conditions considering the intra-annual variation in climatic factors. The Wind Erosion Prediction System (WEPS) was adopted to account for the effect of climate change on wind erosion (Wagner, 2013). We determined the future temperature and precipitation trends based on historical data from 1966 to 2013, which were later added as positive/negative tolerances to account for most of the CMIP5 global model outputs.

Focused on the sandy land near Cuona Lake, Anduo County, Tibet, where serious desertification and wind-blown sand activities could bury the Qinghai-Tibetan Railway (QTR) and other facilities (Figure 1), the results show that the future precipitation increases, even with the maximum value from the CMIP5 predictions, will not be able to offset a moderate warming-induced increase in wind erosion. The projected increase in spring precipitation by 10-30% could potentially reduce the yearly wind erosion by 7-26%. However, the increase in temperature results in a significant increase in the yearly erosion, i.e., from 28% for the +0.8°C scenario to 86% for the +2.8°C scenario, with a moderate increase of 62% for the +1.8°C condition. A wind erosion increase of more than 27% is projected by 2065 (1.8°C temperature and 20% precipitation increases, i.e., the lower half temperature and the highest precipitation increases according to the 42 CMIP5 predictions), and desertification is very likely to be accelerated as a consequence of climate change (Figure 2).

The significant warming, particularly in winter, will result in a large increase in the wind erosion because of the looser and drier surface, while the rare rainfall only slightly increases in this period. The precipitation increase in spring has a limited erosion-control effect due to the short effective duration, whereas in summer wind-blown sand activity is initially weak and additional rainfall does not make a sufficient contribution. More attention should be paid to the intra-annual variance in changing climatic factors when evaluating land-surface processes.

References

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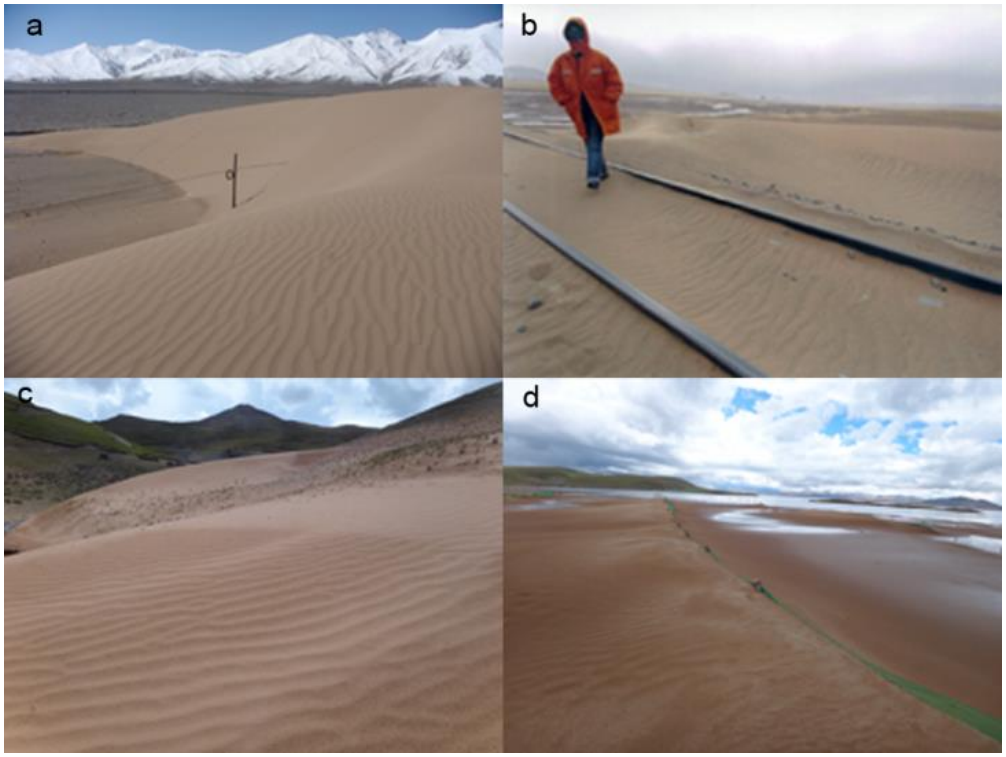

Figure 1. Problems caused by wind-blown sand and dune mobility in Anduo County, Tibet: (a) Newly accumulated crescent sand dune burying telegraph poles, (b) Blown sands deposited on the QTR rails, (c) Degraded land becoming bare sand surface, and (d) Sand fence buried by shifting sand along Cuona Lake.

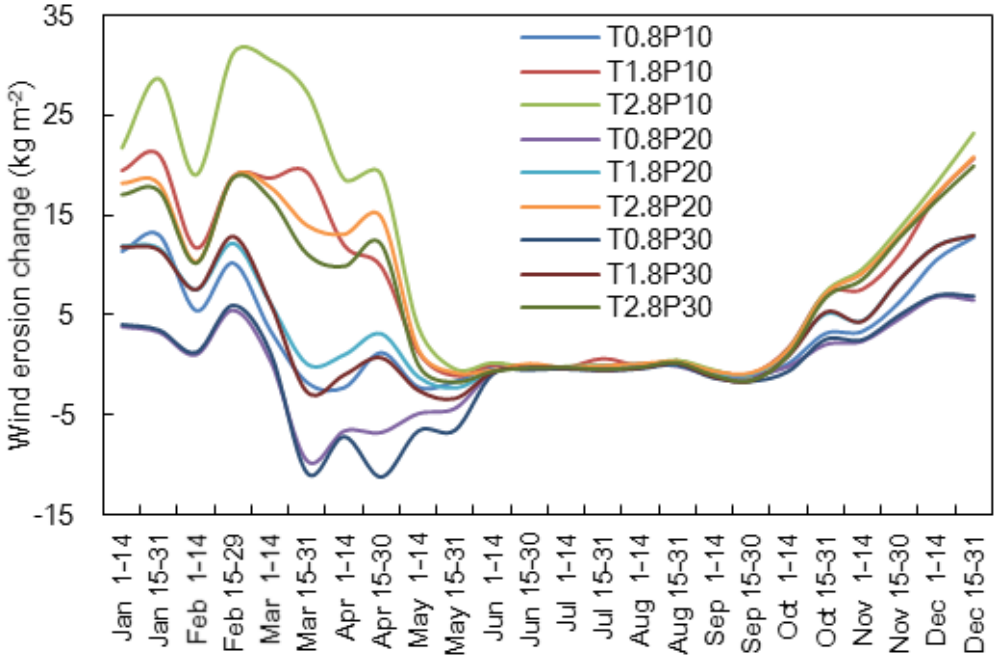

Figure 2. Changes in the inter-annual wind erosion compared with the present conditions in various increasing temperature (T in °C) and precipitation (P in %) scenarios.