Effectiveness of sand fences on preventing wind-blown sand at Tottori Sand Dune

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The Tottori Sand Dune is the largest area of natural sand dunes in Japan. A sand fence has been emplaced to prevent blowing dune sand from damaging the environment and interfering with human activities; however, there has been no quantitative evaluation of its effectiveness.To evaluate the effectiveness of the sand fence in reventing wind-blown sand, it is necessary to monitor sand movements, deposition, and erosion of the dunes.
In this study, we set up piezoelectric blown sand meter to observe wind-blown sand flux inside and outside the sand fence to evaluate the effectiveness of sand fences for preventing wind-blown sand. We estimated the total sand flux in the near-surface layer (0 to 10 cm) inside and outside the sand fences during the late January to May 2021. The reduction efficiency of sand flux was calculated at each measured wind speed. We found that the sand fence reduced more than 80% of the sand transport at wind speeds lower than 17 m s^{-1} . We also calculated the threshold wind speed, which is the minimum wind speed to initiate blowing sand, inside and outside the sand fences during two strong wind-blown sand events. The threshold wind speeds outside the sand fence were greater than that inside, indicating effective sand trapping.
We explored the use of UAV photogrammetry to detect topographic changes of sand dunes. We conducted five separate field surveys in the Tottori Sand Dunes from March to May 2021. Based on the generated topographic models with high accuracy (RMSEs: around 0.018 m), we evaluated topographic changes due to sand movement to and from the areas of sand fences. Strong winds produced obvious changes of elevation between March and April in which sand was transported from the fenced area to the sand dunes. Between April and early May, sand was deposited in the fenced area, demonstrating the effectiveness of sand fences to intercept moving sand. During May, a distinct rise in topography due to vegetation growth may have partially masked the effects of the sand fences. Our results provide a basis for planning mitigation measures such as wind-blown sand prevention and improve landscape conservation of the Tottori Sand Dunes.

Keywords: blown sand flux, piezoelectric blown sand meter, threshold wind speed, UAV photogrammetry

