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ABSTRACT OF DOCTORAL THESIS

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Title: Factors affecting sand transport flux in the Gobi Desert, Mongolia
(モンゴル・ゴビ砂漠における飛砂フラックスに影響する要因)

Sand transport is the most important process of emission of dust, which is globally transported and affects the Earth system, the marine ecosystem, etc. The amount of sand transport can be quantified by sand transport flux (Q), which is defined as the vertical integral of a horizontally transporting particle mass flux. Prediction of Q is a challenge because it depends on many factors. The Q is a function of the friction velocity, u_*, a measure of wind shear velocity at the near surface, the threshold friction velocity, u_{*t}, which defines the minimum wind friction velocity required for sand transport, and soil particle size. However, the ratio of predicted to observed Q has had high variation in previous studies. Those studies assumed that sand transport takes place under the full sand availability conditions. In reality, the sand availability is often limited. The main objective of this thesis is to understand the factors affecting the sand transport flux on dry surfaces in the Gobi Desert, Mongolia. This study explored the factors affecting sand transport flux by a combination of field experiments, Sentinel-1 (Synthetic Aperture Radar) SAR remote sensing data analyses, and numerical simulations using a 0-dimensional sand transport model in Tsogt-Ovoo, located in the northern part of the Gobi Desert, Mongolia under dry conditions in spring from 2017 to 2021. The observed threshold friction velocity (u_{*t}-observed) was low (0.23 m s^{-1}) at the smooth sandy surface. The u_{*t} noticeably increased (from 0.41 to 0.71 m s^{-1}) with the roughness density of stones (from 0.05 to 0.32). We found a linear relationship between the SAR data and the u_{*t}-observed at stony and vegetated surfaces, except for different characteristics of crusted surfaces. The estimated threshold friction velocity from SAR (u_{*t}-estimated) using the linear relation varied greatly both spatially and temporally over the study area during the dry periods of spring from 2017 to 2021. The observed and simulated Q using the u_{*t}-estimated suggest that sand availability is an important factor affecting sand transport flux. We found an exponential relationship between the SAR data and the sand availability. Finally, a spatial distribution of Q was quantified using u_{*t} and sand availability from SAR under spatially constant wind speeds. The simulated horizontal sand flux by the SAR-based model varied spatially and temporary. Stone, dead vegetation, and soil surface crust are important factors affecting the u_{*t}, which determines the starting and ending of sand transport through their roughness and coverage effects and, thus affects its flux. However, we also clarified that the Q cannot be predicted by the u_{*t} alone, and sand availability is the key factor affecting Q. The spatial distribution of Q can be quantified by our developed SAR-based model at a dry heterogeneous surface. Further research is required on the measurement and prediction of the Q at not only dry but also wet surfaces because SAR data is also sensitive to soil moisture, which is another important factor affecting the Q.