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学 位 論 文 要 旨

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題目: Relationship between Sand Transport and Surface Conditions
(地表面状態と砂移動の関係に関する研究)

Severe dust events mainly occur in arid and semi-arid regions of East Asia, particularly in the Taklimakan Desert, Gobi Desert, and Loess Plateau regions in China and Mongolia. They cause serious environmental consequences and have negative effects for human society in China and other parts of Asia, such as in Japan and Korea. It is important to develop an early warning system and monitoring system for damage by dust storm. However, the protective role of natural vegetative roughness and soil moisture under vegetated surface do not fully explain in present regional wind erosion models.

In this thesis, we examine the effect of vegetation and soil moisture on the sand transport using field observations (1) on the grassland of Mongolia in 2008 and 2009, a source region of Asian dust, (2) Hexi Corridor in Northwest of China from March through May 2011, and (3) intensive field observations in Tottori sand dune of Japan April through May 2011, and 2012.

We examined the effect of vegetation on the transport of sand of various particle sizes and investigated the relationship between vegetation cover and saltation flux by using field observations of a grassland Mongolia. We used a sand particle counter to measure the number of saltation particles of various sizes, and also measured the particle size distribution in two soil samples in the study area, one from a site effectively sheltered by vegetation, and the other from a nearby exposed site. The threshold wind speed, saltation flux and particle size data showed that threshold wind speed increased as the vegetation cover increased. Particle size differences between the soil samples from the sheltered site and the exposed site show that particles from 124 to 645 μm were effectively trapped by the vegetation.

We conducted field observations to examine the frequency of dust and

saltation events, and to determine the effect of surface conditions on them using a vegetation surface (shrub land). The observations were conducted in the center of the Hexi Corridor, which is a dust source area and the main pathway of transportable dust to downwind regions of East Asia. Results indicate that the high frequency of cyclone activity is the main reason for dust events during springtime. Dust concentrations were dominated by high winds from the NW–N direction. Dust and saltation events occurred mainly in April, due to low precipitation and high wind speed; however, most dust events were dominated by transportable dust, not local dust. The low frequency of local dust events was due to the following reasons. (1) The soil contained few particles larger than 70 μm , which can cause saltation bombardment. 2) Vegetation covered 17% of the surface and effectively trapped particles of 104 to 500 μm . 3) The soil at our observation site was very hard.

Intensive field observations were conducted at Tottori sand dune to examine the effect of soil moisture and flexible and non-flexible roughness on saltation. Results indicate that the incidence of saltation increased as the wind energy increased. Threshold wind speed is significantly correlated with soil water content and increased sharply from 4%. Sediment discharge decreased with increased height, and 96% of sediment discharge occurred at 13 cm. Approximately 60% of the wind causing saltation was from the south, however, the southerly wind energy was almost 2.9 times less than that from the north. Saltation occurrence from the south was related to the combination of wind speed from 4 to 10 m s^{-1} and surface moisture conditions below 4%. The sand trap ratio of solid wire roughness was higher than that of flexible vegetative roughness under multiple conditions.

To summarize the main results obtained in this study based on the field observations in China and Mongolia, the source region of Asian dust, and Tottori sand dune of Japan, (1) the restraint effect of vegetation on saltation was from 7% to 20% vegetation cover condition, (2) dust emission is hardly occur when saltation particle which cause dust emission was few, even in the major source of Asian dust, (3) in the basic experiment in Tottori sand dune, the sand trap ratio of solid roughness with porosity was higher than that of flexible roughness. These results have possibilities that can be applied to the countermeasures in the source region of Asian dust.