日本沙漠学会奨励賞報告

- 題目：　土質材料の多孔質性を活かした覆土システムの効率化と半乾燥地への適用に関する研究
  「Optimizing the efficiency of a soil cover system based on the pore structure characteristics and its applicability in arid regions」

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ABSTRACT:

Global warming ramifications are being felt through changing precipitation patterns and water availability, augmenting the likelihood of intense droughts. The extended periods of droughts have been exacerbating the deserts and drylands, reaching up to 45% of the earth's land and comprising a home to more than 4 billion people (UNCCD, 2017). The soil-atmosphere fluxes, including evaporation and infiltration, vary considerably with time and space and are difficult to predict. Those fluxes represent the interaction of the atmosphere, ground, and vegetation cover. The evaporation rate is extremely high in arid regions and dramatically exceeds precipitation.

Combating such environmental disasters requires a thorough understanding of the dominant evaporation flux that can be deployed to develop affordable, easy-to-implement, and environmentally friendly technologies to curb the ramifications. Through this study, a simple yet promising soil cover system to suppress the actual evaporation rate and maximize water conservation is proposed. The developed technology considers that during evaporation from a bare soil surface, the ground controls the water supply, while the atmosphere represents the demand. Therefore, from a geotechnical point of view, the water supply follows the prevailing head gradients normally oriented upwards, ejecting more water to the ground surface that gets lost to evaporation. The proposed technology considers installing a cover layer that forces the head gradients downward, thus suppressing the supply potential and, finally, less water to get lost to evaporation. A simple design framework for the cover layer based on the relative micro-pore structure of the cover and the original ground materials is proposed. The framework allows for determining the suitable cover granular material with the optimum thickness to maximize the water storage within the original ground. The validity of the proposed cover mechanism and its efficiency were confirmed in the laboratory, while its applicability is being tested in a research field located in an arid region.

Furthermore, an accurate prediction model of the actual evaporation rate from bare soil profiles was proposed. The model estimates the water supply from a bare soil profile considering the spatial and temporal development of the film region (unsaturated layer), which was correlated to a newly proposed pore structure index (I_{PSD}). Moreover, a novel visualization technique utilizing a simple image analysis algorithm to trace the unsaturated layer formation and dynamics was developed and deployed to construct the model.

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