EGU24-4974, updated on 14 Aug 2024
https://doi.org/10.5194/egusphere-egu24-4974
EGU General Assembly 2024

Integrative Analysis of Electrical Conductivity and Hydraulic Properties in Assessing Shallow Slope Stability

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This study integrated hydrological surveys with geophysical monitoring methods to obtain the geotechnical insights related to shallow landslides. The varied and complex conditions in subsurface pose difficulties in linking geophysical monitoring data to soil engineering properties. Therefore, we investigated the relationship between hydrological response and slope movement using real-time soil water and electrical conductivity data and displacement monitoring records. By integrating the relationship with the soil water characteristic curve (SWCC) and soil stress characteristic curves (SSCC) established from laboratory tests, we established specific curves that correlate electrical conductivity with soil water and stress. We also extended unsaturated soil shear strength model to relate the matric suction and electrical conductivity. We adopted finite element hydrodynamical model HYDRUS 2D and Slope Cube Module to assess the slope stability of shallow landslides triggered by rainfall. The local factor of safety obtained from numerical simulations were compared with the estimated shear strength values. The results showed that the changes in the shear strength estimated from the electrical conductivity is consistent with that of the local safety factor obtained from numerical simulations. This revealed that the shear strength model with electrical conductivity as a variable can reasonably evaluate slope stability, and is also suitable for analysis related to the hydraulic properties of unsaturated soils. This study can provide guidance for future field monitoring works and serve as a basis for shallow landslide early warning and slope stability assessment.