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Capability of Sentinel-2 MSI data for monitoring and mapping of soil salinity in dry and wet seasons in the Ebinur Lake region, Xinjiang, China

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Soil salinization is one of the biggest challenges for food production worldwide and an important threat to farming activities, water quality, land degradation and sustainable development in arid and semi-arid areas. Soil salinization is mainly characterized by significant spatiotemporal dynamics. The salt-affected soils are predominant in the Ebinur Lake region in Northwestern China. However, detailed soil salinity information at local scale is ambiguous due to limited monitoring techniques. Nowadays, the availability of Multi-Spectral Instrument (MSI) onboard Sentinel-2, offers unprecedented perspectives for the monitoring and mapping soil salinity. The use of MSI data is an innovative attempt for salinity detection in arid land. We hypothesize that field observations, MSI data and MSI data-derived spectral indices using the partial least square regression (PLSR) approach will lead to an accurate regional salinity map. For this novel approach, a new assessment is required. Based on electrical conductivity (EC) of 74 ground-truth measurements and according to various spectral parameters, such as satellite band reflectance, published satellite salinity index, red-edge index, newly constructed two-band index, and three-band index from MSI data, we constructed inversion models. Different algorithms including Pearson correlation coefficient method (PCC), variable importance in projection (VIP), Gray relational analysis (GRA), and random forest (RF) were applied for variable selection. The results showed that both, the newly proposed normalized difference index (NDI) [(B12−B7)/(B12+B7)] and three-band index (TBI4) [(B12−B3)/(B3−B11)] show a better correlation with validation data and could be applied to estimate the soil salinity in the Ebinur Lake region. The established models were validated using the remaining 44 independent ground-based measurements and were then used to map the soil salinity over the study area. The RF-PLSR model performed the best across the five models with R2V, RMSEV, and RPD of 0.92, 7.58 dS [U+202F]m^{-1} and 2.36, respectively. The results suggest that soil salinization changes are significantly different for each season. Specifically, the soil salinity in the dry season was higher than in the wet season, mostly in the lake area and nearby shores. The results from this research attempt to create a more reliable soil salinity map for arid environments and could be useful to environmental planners for more precise land degradation monitoring and future land reclamation in arid or semi-arid regions.