Predicting and mapping of soil salinity using machine learning algorithms in central arid regions of Iran

Ruhollah Taghizadeh-Mehrjardi¹, Norair Toomanian², Shahab Shamshirband³, Amir Mosavi⁴, Thorsten Behrens¹, Karsten Schmidt¹, and Thomas Scholten¹

¹Eberhard Karls University Tübingen, Institute of Geography, Soil Science and Geomorphology, Tübingen, Germany (ruhollah.taghizadeh-mehrjardi@mnf.uni-tuebingen.de)
²Soil and Water Research Department, Isfahan Agricultural and Natural Resources Research and Education Center, AREEO, Isfahan, Iran
³Department for Management of Science and Technology Development, Ton Duc Thang University, Ho Chi Minh City, Vietnam
⁴Kando Kalman Faculty of Electrical Engineering, 1034 Budapest, Hungary

In this study, we predicted and mapped soil salinity using machine learning (ML) and digital soil mapping (DSM) approaches. Support vector regression (SVR) and the hybrid of SVR with wavelet transformation (W-SVR) where applied to correlate soil salinity of the upper 200 cm of soil to a wide range of environmental covariates derived from a digital elevation model (DEM), remote sensing (RS) and climatic data. Results indicate that W-SVR performed better in predicting soil salinity at all depth intervals with scattered index ranging from 1.45 to 1.68 compared to the standalone SVR. This is particularly true at the lowest soil depth when W-SVR indicated ~1.5 times higher accuracy compared to the SVR. At this soil depth topographic features are the main covariates in the models. For topsoil salinity, land use represented by RS features controls the spatial distribution of the salinity widely. Independent from soil depth, climatic features are the most important predictors for soil salinity in all ML models. The predicted salinity maps show the highest salinity for soils in the eastern parts of central Iran. Furthermore, the importance of topographic features for all ML algorithms coincides with most landform characteristics in central Iran and confirms a close relation of soil salinity not only to land use practices like irrigation but also to soil-landscape relationships in this dry region.

Keywords: Soil salinity, machine learning, spatial variation, central Iran, support vector regression, wavelet transformation

Acknowledgments

Ruhollah Taghizadeh-Mehrjardi has been supported by the Alexander von Humboldt Foundation under the grant number: Ref 3.4 - 1164573 - IRN - GFHERMES-P.