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Comparison of random forests and multiple linear regression models to forecasting ion concentrations in surface waters under global environmental change

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Salinisation of surface waters is a global environmental issue that can regionally pose a risk to organisms in freshwater ecosystems, potentially leading to high environmental and economic costs. Global environmental change including climate and land use change can increase the transport of ions into surface water systems. Therefore, models are required to forecast dissolved ion concentrations in water bodies. In this study, we forecasted the change in dissolved ion concentrations in running waters of Germany including electrical conductivity (EC), Ca2+, Mg2+, and SO42-. We used the major factors controlling water salinity such as geologic and soil properties, climate, vegetation, and topography as predictors in statistical modelling and compared the predictive power of Random Forest (RF) and multiple linear regression (LR) models. The predictive power of RF models was slightly higher than LR, where 65% to 71% of the variance in the respective response (ion concentrations and EC) was explained. Moreover, the mean square prediction errors were all smaller than 7% for both LR and RF models. The relative importance of different environmental variables in forecasting EC differed among LR and RF models, but generally relative variable importance was as follows: geology > climate > soil properties > vegetation. We present forecasts of future EC and discuss its ecological implications.