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The potential of gamma-ray spectrometry as supplementary information for mapping central European soils

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Permanently updated soil maps are needed inter alia for the prediction of landslide hazards, flooding and drought effects, land degradation monitoring, and precision farming. Since comprehensive and intensive field mapping is not affordable, alternative mapping approaches are required. A promising tool, with quite unrecognised potential for modern soil science is gamma-ray spectrometry. As the radioelements potassium, thorium and uranium respond differently to soil forming processes, it should be possible to infer from their concentration on weathering status, and after calibration on soil properties and types. This paper aims to investigate the potential of airborne gamma spectrometry for mapping of central European soils and soil properties. The study was conducted for a test site in Southern Saxony, Germany, 140*85 km wide, representing diverse soil landscapes. Seven different petrographic training and validation areas were chosen each. To assess the potential of gamma-ray spectrometry as additional data layer, predictions were carried out (i) with and (ii) without radiometric data. The outputs were compared with independent soil information of the validation areas. Both prediction runs used the following predictors: elevation, slope, curvature, planform curvature, profile curvature, terrain ruggedness index, relative altitude, vertical distance above drainage network, wetness index, and convergence index. As additional predictor parent material derived from a reclassification of the official geological map (1:1M scale) was used. As radiometric properties potassium, thorium and uranium were used. The radiometric raster datasets were generated by universal kriging using relative altitude as covariate. Training and validation datasets were selected from a comprehensive dataset representing more than 14.000 point data. Point data include soil types and substrates, and for more than 800 sites soil profiles with analysed texture, pH, exchangeable cations, nutrients, and efficient cation exchange capacity. The study shows that gamma spectrometry is suitable to enhance the prediction of soil types and properties such as texture significantly.