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Using the diffuse reflectance spectrometry technique to predict nutrient and heavy metal concentration and fluxes of suspended sediment in the Attert River basin (Luxembourg)

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Quantitative estimation of soil and sediment properties with diffuse reflectance spectrometry has been used increasingly in recent years. In this study, nutrient and heavy metal concentrations of suspended sediment were predicted from VIS/NIR spectra (ASD FieldSpec-II spectrometer, 0.4–2.5 μm) through partial least-square regression models (PLSR). Suspended sediment samples were collected regularly during storm runoff events and more intermittently during low flows by means of automatic water samplers. Reflectance measurements were undertaken on sediment retained on glass fibre filters after sample filtration when they were completely covered by sediment. This technique is seen as a simple and less costly alternative to conventional sediment sampling and laboratory analysis. Sediment loads and corresponding fluxes of particle-bound substances were then calculated by interpolation of suspended sediment concentration measurements.
The investigations were undertaken in seven nested catchments of the Attert River basin (NW Luxembourg) ranging from 0.4 to 247 km2. The catchments were selected for the contrast and spatial variability of the bedrock (sandstone, marls and schist) and land use (forest, cropland and grassland). Chemical property values measured on time-integrated suspended sediment, bed sediment and potential sediment sources samples (topsoil and channel banks) collected in the catchments were used to calibrate the PLSR models. For each sediment property, a PLSR calibration model was developed, which was subsequently used to predict the chemical properties of the sediment retained on the glass fibre filter from the spectra. Then, calibrated models were used to study the variation of nutrient and heavy metal concentrations not only during storm runoff events but also during a 3-year period.
The methodology proved to be a useful, fast and easy to apply approach for studying the variation of suspended sediment properties during storm runoff events from spectra. Furthermore, predicted nutrient and heavy metal concentrations could be combined with the sediment fingerprinting approach for documenting the intra-storm variations of suspended sediment sources. In addition, for single flood events relevant fluxes of particle bound materials could be estimated.