Comparison between UAV airborne and proximal measurements of a gammaspectrometer for soil texture mapping

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A gammaspectrometer is a proven geophysical tool or soil sensor for mapping soil textural properties at high resolution at field level. It measures the concentration of radionuclides in the (top)soil (0-30 cm) which is a proxy for soil texture in areas with similar provenance. However, the use of this technique depends on the accessibility of fields for the vehicles carrying the sensors. Being able to apply soil sensors by using a UAV ("drone") instead of a quad, tractor, airplane or helicopter increases their applicability. It is more flexible, suited to small(er) areas and can fly when crops or natural vegetation are present or when difficult driving conditions prohibit the use of a vehicle. To evaluate the usability of a gammaspectrometer for UAV application we designed a comparison study for the prediction of physical soil properties measured by a gammaspectrometer under an UAV and on a tractor in a 40 ha (8 fields) area in Flevoland, the Netherlands. The study area is situated in a 60 year old polder made on top of Pleistocene sands. The tillage layer and gammaspectrometer depth range of 30 cm has 0 - 20 % clay. Land use is arable land and pasture. The area is measured with a MS2000 gammaspectrometer by tractor and a MS1000 gammaspectrometer on a DJI S1000+ Spreading wings UAV. For calibration, 14 samples are taken and analysed in the lab on % clay, % silt, grain size, organic matter content and on the concentration of radionuclides. Both spectral datasets are analysed using full spectrum analysis and translated to soil parameters using regression analysis. An independent set of 44 validation samples was taken and analysed in the lab. Sample locations were allocated using stratified random sampling. Using these data we compared the two gamma-ray measurements on their ability to predict physical soil properties, their footprint and accuracy. The difference in spatial and spectral resolution is assessed and a comparative cost analysis is performed. Results indicate lower uncertainties (4 % median absolute error) with the ground based gammaspectrometer measurements, but comparable costs to UAV sensing. We also compared the local calibration of the gamma ray data to calibration with a national dataset. We found that ground based measurements perform better with local calibration while UAV based measurements perform better with national calibration. We conclude that applying UAV gammaspectrometer sensing is possible, leads to reasonable accuracies (6 %) and is advantageous in less accessible terrain with variation in soil physical properties.

! 90 % of this abstract was also published and presented at BonaRes conference in Berlin 26-28 February 2018 by the same authors!

Keywords: gammaspectrometer, UAV, proximal, soil sensing, soil texture, comparison, validation