Can portable X-ray fluorescence measurements replace standard soil assays in soil protection regulations? A case study in Wallonia (Belgium).

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In Wallonia (South of Belgium), as in most regions of Europe, soil protection regulations require using the aqua regia method as the standard soil assay to determine the soil metal content. However, this destructive analytical method requires time, expensive reagents and laboratory conditions. Portable X-ray fluorescence (pXRF) could be a suitable alternative as it is a fast, low-cost and non-destructive analytical method which can, moreover, be performed directly in the field. In order to assess the feasibility of replacing aqua regia assay results by pXRF measurements, we analyzed trace metal contents in more than 500 soil samples using both methods. Samples were selected to represent the wide range of soil types, parent materials, land uses, horizons and contrasting concentrations (background values, soils in urban or industrial areas, soils from polluted sites) occurring in Wallonia. This study presents the scope of applications, limitations and detailed practical recommendations for the use of pXRF devices to meet the requirements of the regulations on soil protection for the Walloon region case study.

We observed a strong linear relationship between the measurement values obtained by aqua regia and those obtained by the pXRF. The mean absolute percentage error of the aqua regia content prediction by linear regression ranges from 6% (Cd) to 24% (Cr) when the pXRF measurements were performed on dried and sieved soils. In general, pXRF proved to be capable of predicting the metal aqua regia content for the whole range of soil regulatory threshold values for the Walloon region. However, for Cd and Hg, pXRF quantification limits were far above the regulatory threshold values for the case of the regulations concerning sewage sludge application and the reuse of excavated material. Our analysis of the accuracy of the prediction of the standard soil assay values using pXRF allows us to put forward some practical recommendations for the use of pXRF in place of standard soil assays for soil protection regulations.