Geophysical Research Abstracts
Vol. 16, EGU2014-9001-1, 2014
EGU General Assembly 2014

Application of laboratory reflectance spectroscopy to target and map expansive soils: example of the western Loiret, France

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Swelling soils contain clay minerals that change volume with water content and cause extensive and expensive damage on infrastructures. Based on spatial distribution of infrastructure damages and existing geological maps, the Bureau de Recherches Géologiques et Minières (BRGM, i.e. the French Geological Survey) published in 2010 a 1:50 000 swelling hazard map of France, indexing the territory to low, moderate, or high swelling risk. This study aims to use SWIR (1100-2500 nm) reflectance spectra of soils acquired under laboratory controlled conditions to estimate the swelling potential of soils and improve the swelling risk map of France. 332 samples were collected at the W of Orléans (France) in various geological formations and swelling risk areas. Comparisons of swelling potential of soil samples and swelling risk areas of the map show several inconsistent associations that confirm the necessity to redraw the actual swelling risk map of France. New swelling risk maps of the sampling area were produce from soil samples using three interpolation methods. Maps produce using kriging and Natural neighbour interpolation methods did not permit to show discrete lithological units, introduced unsupported swelling risk zones, and did not appear useful to refine swelling risk map of France. Voronoi polygon was also used to produce map where swelling potential estimated from each samples were extrapolated to a polygon and all polygons were thus supported by field information. From methods tested here, Voronoi polygon appears thus the most adapted method to produce expansive soils maps. However, size of polygon is highly dependent of the samples spacing and samples may not be representative of the entire polygon. More samples are thus needed to provide reliable map at the scale of the sampling area. Soils were also sampled along two sections with a sampling interval of ca. 260 m and ca. 50 m. Sample interval of 50 m appears more adapted for mapping of smallest lithological units. The presence of several samples close to themselves indicating the same swelling potential is a good indication of the presence of a zone with constant swelling potential. Combination of Voronoi method and sampling interval of ca. 50 m appear adapted to produce local swelling potential maps in areas where doubt remain or where infrastructure damages attributed to expansive soils are knew.