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Soil magnetism and soil processes in the spatial domain: Applications for landmine clearance

J.A. Hannam

National Soil Resources Institute, School of Applied Sciences, Building 37, Cranfield University, Cranfield, Bedfordshire, MK43 0AL, U.K. (j.a.hannam@cranfield.ac.uk / Phone: +44 1234 750111)

Magnetic minerals in soils are derived from a number of sources ranging from formation in situ to inputs from anthropogenic activities. Magnetic minerals formed in situ in soil systems are a product of, and hence reflect soil processes linked to the soil forming factors climate, parent material, organisms, relief, time and man. The magnetic minerals formed during pedogenesis have particular magnetic characteristics that impact on the efficacy of metal detectors during landmine clearance, where highly magnetic soils effectively act in a similar manner to metallic targets found in land mines. As magnetic properties of soils are not part of standard soil analyses alternative attempts to model soil magnetic properties is achieved by capitalizing on the links between diagnostic soil forming factors used in soil type classification and soil processes integral to the development of magnetic minerals in situ. Soil type and magnetic property associations were investigated using a soil survey archive dataset from Bosnia-Herzegovina producing analogous mapping of soil magnetic characteristics linked to nationally mapped soil types. Several areas were highlighted as problematic for metal detectors but improved spatial soil differentiation within these areas would significantly aid strategic planning of mine clearance operations. As the processes linked to the development of minerals in situ are spatially dependent, regional derivation of soil-landscapes were modeled using digital terrain analysis techniques. Soil associations were produced from fuzzy k-means classification of primary and secondary terrain attributes for a pilot area in Herzegovina. Soil associations were validated in the field and field sampling enabled the characterization of magnetic soil associations linked to likely effects on detector performance, improving the spatial resolution of the initial national map. Determining soil magnetic properties is also applicable to

other disciplines that utilize magnetic properties for environmental purposes such as determining background from anthropogenic signals in soils, paleoclimatic proxies and sediment source tracing.