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Quantifying the heterogeneity of soil compaction, physical soil properties and soil moisture across multiple spatial scales

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England's rural landscape is dominated by pastoral agriculture, with 40% of land cover classified as either improved or semi-natural grassland according to the Land Cover Map 2007. Since the Second World War the intensification of agriculture has resulted in greater levels of soil compaction, associated with higher stocking densities in fields. Locally compaction has led to loss of soil storage and an increased in levels of ponding in fields. At the catchment scale soil compaction has been hypothesised to contribute to increased flood risk. Previous research (Pattison, 2011) on a 40km2 catchment (Dacre Beck, Lake District, UK) has shown that when soil characteristics are homogeneously parameterised in a hydrological model, downstream peak discharges can be 65% higher for a heavy compacted soil than for a lightly compacted soil.

However, at the catchment scale there is likely to be a significant amount of variability in compaction levels within and between fields, due to multiple controlling factors. This research focusses in on one specific type of land use (permanent pasture with cattle grazing) and areas of activity within the field (feeding area, field gate, tree shelter, open field area). The aim was to determine if the soil characteristics and soil compaction levels are homogeneous in the four areas of the field. Also, to determine if these levels stayed the same over the course of the year, or if there were differences at the end of the dry (October) and wet (April) periods.

Field experiments were conducted in the River Skell catchment, in Yorkshire, UK, which has an area of 120km2. The dynamic cone penetrometer was used to determine the structural properties of the soil, soil samples were collected to assess the bulk density, organic matter content and permeability in the laboratory and the Hydrosense II was used to determine the soil moisture content in the topsoil. Penetration results show that the tree shelter is the most compacted and the open field area is least compacted in both periods. The falling head test showed that soil permeability was lowest around the feeding area and highest in the open field area in both periods. Laboratory tests showed that the tree shelter had the lowest bulk density values, due to the higher levels of organic matter content and the field gate had the highest levels of bulk density in both periods. There was also a significant difference in bulk density at the field gate and open field areas between the two periods. These results highlight statistically significant differences between heavily compacted areas where animals congregate and less-trampled areas of the field.