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COMPACT: The role of soil management in mitigating catchment flood risk

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This paper reports a new NERC funded research project which addresses the impact of agricultural soil compaction on surface runoff and catchment scale flood risk. The intensification of agriculture, through increasing the number of animals in pasture, and the use of larger, heavier machinery for arable farming, over the past 50 years or so is hypothesised to have had an impact on the severity and frequency of flooding. These land management practices cause soil compaction, which reduces the rate of rainfall infiltration and the volume of water that can be stored within the sub-surface. This results in more rainfall being partitioned into the faster surface runoff pathway into rivers and potentially causing flooding downstream. However, the level of soil compaction is highly heterogeneous over space and time. This is because different animals i.e. cattle, sheep and horses, exert different loads on the soil and are kept at different densities. Furthermore, farm animals are known to exhibit behaviour whereby certain parts of the field are moved over more frequently than others. The same is the case in arable farming practices, whereby ploughing forms tramlines or wheelings, which are more compacted. Different forms of management practice ranging from zero-tillage to conventional cultivation exert different pressures on the soil at different times of year. However, very little is known about this variability of soil compaction levels at the sub-field level and land under different management practices.

This research aims to quantify this sub-field variation in compaction severity and depths through using novel Ground Penetrating Radar (GPR) and Animal tracking GPS technology. Combining these with more conventional soil property tests, including bulk density, saturated hydraulic conductivity and using a penetrometer will allow relationships with frequency of load to be developed over different spatial and temporal scales. Furthermore, X-Ray CT scanning will reveal the fine scale impacts of compaction on soil structure. This data will form the input to a physically based, reduced complexity, spatially distributed hydrological model to test feasible "what if?" scenarios. This will upscale local changes in land management and soil characteristics to catchment scale flooding.

Results from research focussing on a priori compacted areas, such as feeding areas, field gates, shelter zones and tractor wheelings show that these are statistically different to areas assumed to be less compacted in the open field.