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

Flood risk is an increasing challenge in the UK, with 2.4 million properties being susceptible to fluvial flooding. This type of flooding is caused by the quantity of runoff being discharged by a river exceeding the capacity of the river channel. This results in water being transferred to the floodplain, which can have severe economic and social impacts. The quantity and speed of runoff from the landscape into rivers is a major factor in generating flooding. The way in which the landscape is managed therefore can have a significant impact on this process. 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) technology, and assess the impact on the physical soil properties, how water interacts with the soil and ultimately how important this effect is on catchment scale flood risk. This will be achieved through using a multi-methods approach combining field experiments, laboratory tests on soil samples and numerical hydrological modelling. First areas of high and low compaction will be identified using GPR and validated using traditional field based approaches. These will be related to loadings through GPS spatial data on where animals and machinery have moved over. A wide range of field and laboratory tests will then be carried out to quantify properties such as bulk density, porosity, saturated hydraulic conductivity, and particle size. 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, CRUM3. Feasible "what if?" scenarios will be co-produced with the project partners, including the Environment Agency, Trent Rivers Trust, Sustainable Land Trust, Natural England, and National Farmers Union through the Soar Catchment Partnership. This will upscale local changes in land management and soil characteristics to catchment scale flooding. This research will be undertaken with a group of catchment managers, land owners and local residents. This will both benefit the research scope and impacts of the findings. Recommendations and dissemination for industry, regulators, governmental bodies, charities and local land owners and residents will inform evidence based policy on Natural Flood Management. This will be achieved through steering group meetings, a British Hydrological Society national meeting, Project Away day, end of project riverside picnic, and the use of social media. Dissemination will also occur through more traditional academic routes.