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Heterogeneity and topsoil depletion due to tillage erosion and soil co-extraction with root vegetables: a serious threat to sustainable agricultural land use in the UK

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The term soil erosion has become almost synonymous with water erosion and yet tillage erosion and soil loss with root crop harvest, although less visible, may be responsible for the majority of the on-site costs of soil erosion in many arable areas of the UK. The study reported here is a first attempt to model soil erosion associated with these processes in England and Wales, at the National scale. A GIS-based modelling approach in the Arc/Info environment is employed in order to meet the requirement for large-scale evaluation of erosion severity. Existing models that have been subject to independent test are used or adapted and widely available data is employed in model parameterisation. Tillage erosion is simulated using a diffusion-type model and a slope curvature index derived from coarse-scale topographic data. The curvature index is calibrated by statistical comparison to curvature values derived from a high resolution digital terrain model. Soil loss with root crop harvest is simulated using information concerning patterns of sugar beet and potato cultivation and estimation of soil moisture during the crop harvest season. Soil loss associated with root crop harvest may be as high as 1 t ha-1 year-1 if land is permanently used for root crops in a 3 year rotation. However, when the arable area of the UK is considered as a whole root crop harvest is responsible for a mean rate of soil loss of approximately 0.1 t ha-1 year-1. Tillage erosion is found to be the dominant process of soil redistribution and onsite erosion on arable land, in comparison with both soil loss through root crop harvest and with long-term water erosion rates. Mean gross rates of tillage erosion were found to be 3.7 t ha-1 year-1, representing approximately 7.4 t ha-1 year-1 erosion and the same rate of deposition. Soil redistribution at these rates is generating an heterogeneous soilscape in which continued functioning for food and fibre production may be jeopardized. These problems may be exacerbated by increased water stress in eroded soils if climate change does, as predicted, result in hotter and drier summers.