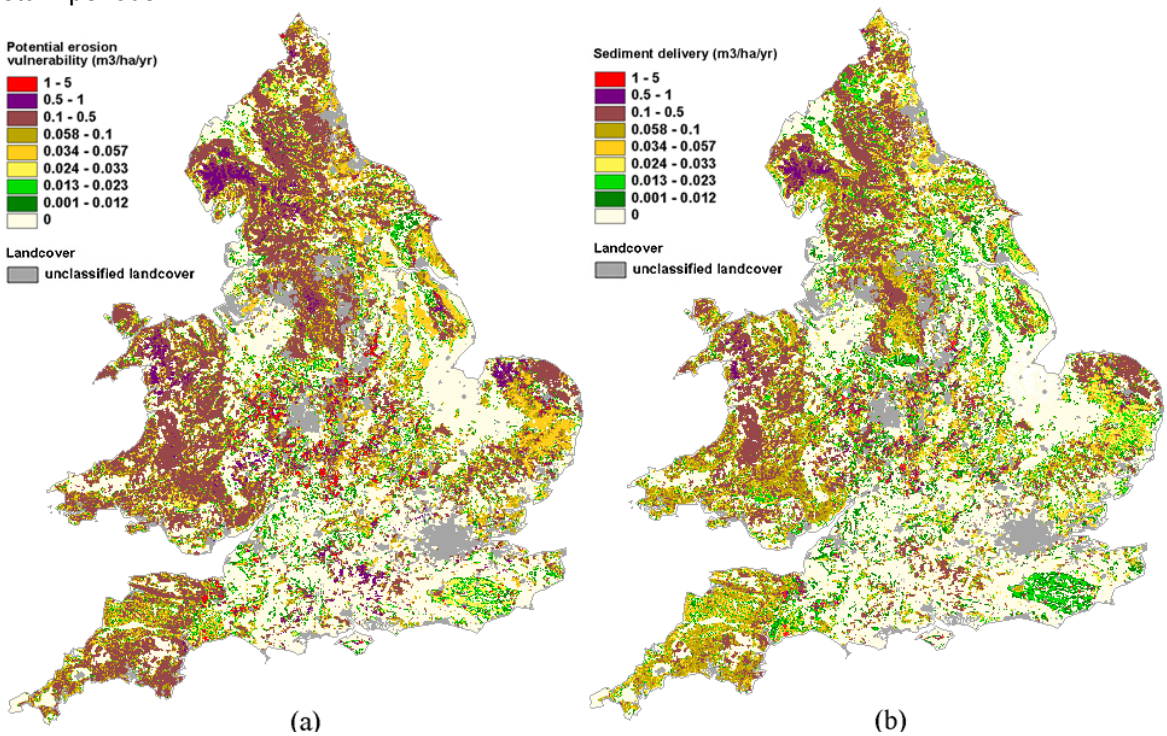
Prediction of Sediment Delivery to Watercourses from Land

R&D Technical Summary P2-209/TS

This project used existing field research and spatial datasets to produce an assessment of erosion vulnerability of land and of delivery of eroded sediment to watercourses. Data from a series of objective and nationally-representative erosion monitoring studies on upland, lowland grassland and arable soils were used to calculate the probability of erosion of a given magnitude occurring for different soil-slope combinations. Such probability analysis allowed erosion rates for arable, upland and lowland grassland soils to be compared. The efficiency of sediment delivery from land to watercourses, which in turn directly reflects the connectivity between the land surface and the river system, was characterised. Two measures of connectivity were developed: the connectivity index, which represents the relative efficiency of sediment transfer, and the connectivity ratio, which is based directly on the connectivity index and represents a scaling of that index to provide a quantitative measure of the efficiency of sediment transfer. Using GIS, the probabilities of erosion for different soil-slope combinations were combined with the connectivity ratio to illustrate graphically the distribution of estimated annual sediment delivery to watercourses in England and Wales for different return periods.



The distribution of (a) of erosion vulnerability estimates and (b) estimated sediment delivery to watercourses expected to occur annually in England and Wales under 1-in-10 year events.

The final product comprises maps illustrating the annual erosion vulnerability and sediment delivery to watercourses for different probabilities or return periods. Although the detailed methodology and the maps are unvalidated, the results for the 1-in-10-year return period broadly confirm the findings of other researchers. The maps may be used to identify potentially high risk areas of England and Wales for sediment delivery to watercourses. The greatest risk of erosion and diffuse pollution associated with sediment is shown to occur under arable agriculture in parts of Somerset, the Isle of Wight, Norfolk, the West Midlands and Nottinghamshire. The soils at risk are largely brown earths, brown sands and brown rendzinas with sandy loam, loamy sand and silty textures. Compared to previously published data, the erosion rates shown on the maps are rather low, reflecting the fact that individual events >10 m^3 ha^{-1} have higher return periods than 1-in-10 years and that such events usually relate to field sizes of 1-3 ha, whereas the data presented here represent averages over 1 km^2.

The research output demonstrates the validity of the techniques used for the identification of areas at risk of erosion and sediment delivery to watercourses in England and Wales. Uncertainties remain, however. Although the dataset used is the most comprehensive available, it is not sufficient to quantify the risk of erosion from different soils at a more detailed level using, for example, soil series. Further calibration and validation of the connectivity ratio provided are needed: again, the collection of specific data is necessary for this to be possible. Finally, extrapolation of the erosion data across land use types nationally, using GIS, ideally requires more accurate maps of vegetation cover and specific land uses than those currently available. The distinction between lowland grassland and grass leys in a rotational arable system particularly needs to be improved.

The possibilities for validation and improvement extends to the estimates of connectivity, where additional work could inform the calibration of the connectivity index used to produce estimates of the connectivity ratio and to validate the resulting values. In the longer-term, however, further field-based work and experimental investigations to improve existing understanding of sediment delivery and the factors controlling slope-channel connectivity could be carried out. This improved understanding is likely to lead to the incorporation of further controlling factors into the procedure used to estimate the connectivity index, particularly factors related to adventitious effects on slope-channel connectivity, such as field boundaries, the position of gateways and the role of tracks and roads in routing water and sediment.

Despite these reservations and the need for further work, the maps of vulnerability to erosion and sediment delivery to watercourses produced by the project can be used to identify broad regions at risk where more detailed local investigations can be targeted. The maps represent the first consolidated assessment at a national level, allowing comparisons of the situation across the range of slope, soil and land use combinations.

This R&D Technical Summary relates to information from R&D Project P2-209 reported in detail in the following outputs:

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Electronic Data (Internal Agency use only) on shared GIS drive.

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