Healthy soils are an essential element of a sustainable environment. **Andy Tye, Barry Rawlins** and **Russell Lawley** describe how soil mapping is helping to protect this most fundamental resource.

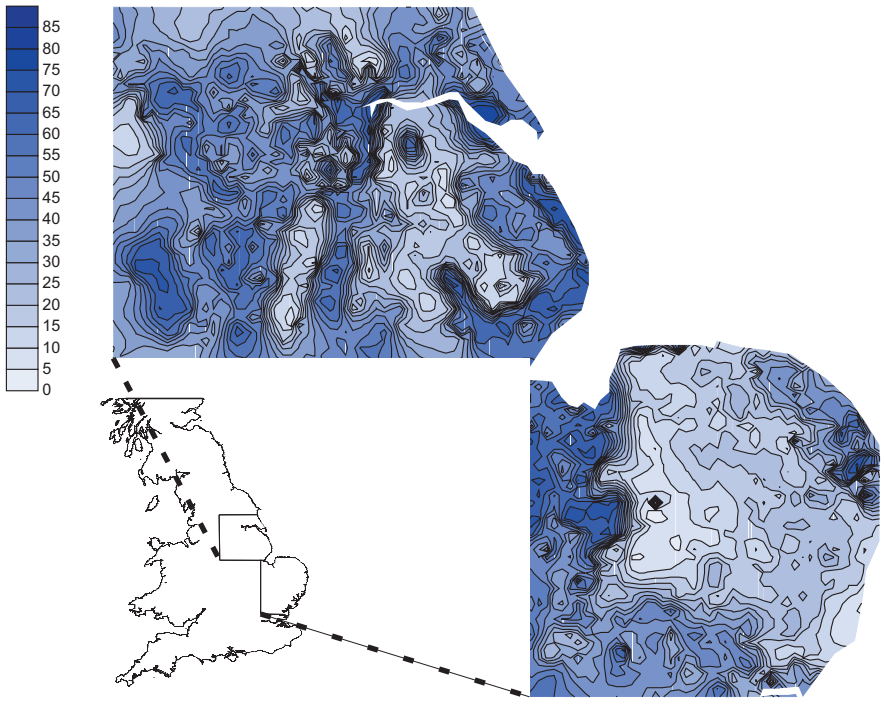
Mapping soil erosion risks

We rely on soils to provide much of the food we eat and to filter the water we drink. Yet in the UK we largely take these functions for granted. As weather patterns shift in response to global warming, we can expect the properties of our soils to change. So we need to know with confidence how these properties vary in space to determine the likely impacts of any future changes. Rather than collecting new samples, which is costly, we can analyse archived soil samples to predict how soil functions are likely to change.

The BGS has an extensive soil archive totalling 67 000 samples, one of the legacies of the ongoing geochemical baseline survey of Great Britain (G-BASE, *see article on page 28*). A recent use of this resource has been to produce a dataset of soil particle-size distribution throughout the East of England, a project undertaken in collaboration with the Department of Geography at the University of Nottingham. Over 9000 soil samples were collected, at a density of one sample for every two square kilometres, across the Eastern England study area (see diagram, *right*). From this, 2550 samples were selected on a statistical basis to be analysed using a Malvern™ laser particle-size analyser. The texture of soils is a key parameter in determining many soil characteristics. It affects soil drainage properties, such as the soil's ability to hold water and nutrients and ease of cultivation.

At present, there are two main areas where the new database is being used. Within our Sustainable Soils programme there is a strong interest in developing techniques to improve the mapping of soils by combining geostatistical and geophysical techniques. For example, airborne surveys detecting natural radiation emitted from the ground can be used to improve maps of soil texture because these properties are correlated. Possessing information on the distribution and variation in soil texture at such a high resolution is an invaluable resource. One important reason for understanding the variation in soil textures through mapping is to increase our understanding of soil erosion.

In Eastern England, soil is used intensively as many of the soils types are considered to be the most agriculturally productive in the country. However, many of these soils are prone to wind erosion as they

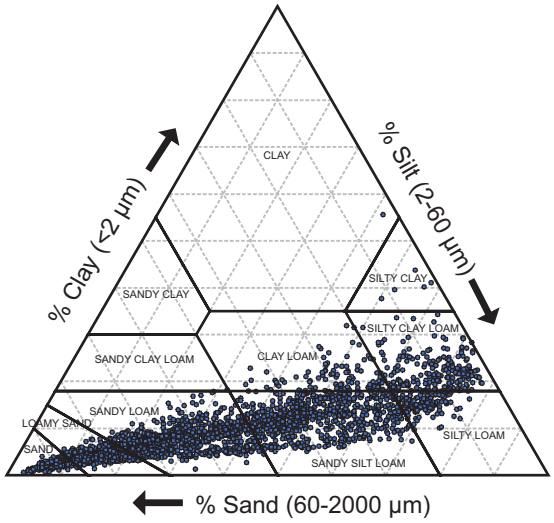


Proportion, as a percentage, of silt (particles between 2 and 60 micrometres in size) in topsoil across Eastern England.

have a high proportion of silt-sized particles (see photograph, *right*). This is despite considerable research into ways of reducing erosion by improving cultivation techniques and timing. The soils at most risk include those derived from marine alluvium and fen peat that are found extensively around the Wash as well as the drained fen peats from the Cambridgeshire and Lincolnshire Fens. In the coastal areas of Suffolk there are extensive areas of deep, well-drained sandy soils, derived from glacio-fluvial drift that are at risk from both wind and water erosion. In Nottinghamshire, the sandy soils derived from the Permo-Triassic sandstones are also at risk of erosion. Soil texture is conveniently expressed in the form of a triangular diagram representing the proportions of clay, silt, and sand sized particles (see figure, *below*).

Wind erosion on soils derived from late Devensian (15 000–11 000 years BP) fluvial–aeolian cover sands near Pocklington, Yorkshire.

Many aspects of wind erosion are poorly understood but its effects are numerous. It can cause serious deterioration to the soil including the loss of fine material and organic matter, the degradation of soil structure, and the loss of nutrients. The erosion of topsoil is a major problem throughout Europe. It has been estimated that losses of 40 tonnes per hectare can occur every year without visible signs of erosion. The extent of these problems demonstrate the importance of high-resolution data for mapping and research. In addition, we need to consider the potential effects of climate change. Current forecasts, reported by the UK Climate Impacts Programme, suggest that summer precipitation in Eastern England may decline by up to 50 per cent by 2080 leading to a 40 per cent reduction in soil moisture. This will increase the risk of wind erosion during the summer months. The degree of wind erosion at a site is strongly related to the soil texture, and the high-resolution data provided by our analyses will help us to identify the areas facing the greatest threats. Soil in these areas will need more careful management to avoid large losses.



Soil texture across the study area.

The database is also being exploited in collaborative research with the University of Nottingham. At present, the research is providing background data about the geochemistry and properties of the particle sizes that are susceptible to erosion and transport by wind. These data could be used to examine the possible health effects and nutrient losses associated with wind erosion. The effects of increased quantities of airborne soil particles on human health are increasingly being recognised. The penetration of soil dust into the lungs has been found to exacerbate asthma as well as other lung problems. This can lead to sizeable financial costs both to employers and medical services. For example, a study by scientists at the Australian Commonwealth Scientific and Industrial Research Organisation in 2000, suggested that lung problems caused by wind borne dusts could cost the state of South Australia around A$20 million (about £8.7 million at the current rate of exchange) a year. The cause of the problems could be related to the presence of particles in the lung but also to the particles' inherent geochemical properties, or to contaminants associated with the particles such as heavy metals or agricultural chemicals. Another important feature is the loss of nutrients from soil carried in dusts. These could typically result in the contamination of ground and surface waters. In particular, the concentrations of phosphorus associated with soil fractions lost through wind erosion could lead to the eutrophication of surface waters.

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