

Connecting soil-erosion risk from source to sink: an upscaling approach

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Durham University, Department of Geography In partnership with British Geological Survey

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Key Words

Modelling; Soil erosion; Water quality; Risk; Upscaling

Overview

Soil-erosion risk is increasingly considered to be a significant problem in the UK. It has direct impacts in the areas where the initial loss of soil occurs on agricultural land both in terms of loss of productivity and in the increased work required to rectify problems. However, major impacts also occur as the mobilized sediment subsequently moves through the landscape. For example, drainage ditches can become blocked by fine sediment increasing the possibility of flooding; water courses and reservoirs can become turbid preventing their use as water supplies; and siltation of gravel beds prevents their use by species such as salmon for spawning and pearl mussels for habitat. In landscapes that are extensively and/or intensively cultivated such as throughout the UK, the use of pesticides and fertilizers that are transported either in solution or adsorbed onto the transported particles means that the effects are accentuated, both as direct pollution of water supplies and indirect effects such as eutrophication of watercourses. Thus, erosion has clear economic effects, with significant implications for food security, as well as a range of ecosystem service and health implications.

Up to present, the main methods for estimating erosion risk concentrate on identifying the sources of potential erosion, using models that have rarely if ever been developed or fully tested in a UK context. They

have also been poorly developed in terms of addressing the pathways of sediment moving across the landscape, relying on discredited models of sediment-delivery ratios. The Mahleran model of Wainwright *et al.* (2008a-c) was explicitly designed to work across a range of scales and to build in an explicit appreciation of the pathways that sediment moves. The subsequent development of a Marker-in-Cell version (Mahleran-MiC: Cooper *et al.*, 2012) provides an explicit means of estimating the source, transport path and deposition of sediment on a particle-by-particle basis, and is thus ideally suited for the estimation of the full set of erosion risks. However, it does require a significant amount of local information that contrasts with the need to evaluate risk at the landscape, regional and national scales. This project aims to develop and test an upscaling methodology that will overcome these limitations and thus for the first time provide a fully integrated assessment of erosion risk.

Methodology

The project will have three objectives in order to achieve this aim:

O1 To develop ways of upscaling soils information based on UK databases of soil, bedrock and land-use characteristics so that it can be used to parameterize key elements of the model including infiltration, surface roughness and particle size. A second strand

of this work will relate to the upscaling of information relating to agricultural practice. This objective will build on previous work by Wainwright on upscaling topography, vegetation and roughness data (Zhang *et al.*, 2002; Müller *et al.*, 2007) and ongoing work at BGS in upscaling of soil properties (e.g. Kerry *et al.*, 2011; Lark and Lapworth, 2013).

O2 Application of MAHLERAN and MAHLERAN-MiC to example study areas in the UK with contrasting land uses. A limited amount of field experimentation will be carried out to test the parameterizations developed in O1, but for the most part the datasets used for testing will be derived from existing sources, for example in the defra Demonstration Test Catchments or from existing erosion-plot data.

O3 The tested methods and model applications in O1 and O2 will be generalized and upscaled to be applied across larger areas. In the first instance, these applications will focus on multiple catchment scales for practical purposes, and will be evaluated on the ground using information from existing schemes, such as catchment-sensitive farming and the related network of officers.

Timeline

Year 1: Developing an understanding of the literatures on risk, soil erosion, modelling and upscaling. Training in statistical and numerical modelling techniques. Starting to develop databases necessary for O1, using information initially derived from the BGS Soil Portal. Paper 1

Year 2: Statistical analyses to complete O1 and development of methods to relate the results of O1 to the model applications in O2. Start to test model in field catchments. Paper 2

Year 3: Complete model testing in catchments to complete O2, and develop applications for upscaling to achieve O3. Paper 3

Year 4: Complete upscaling work for O3 and take results to appropriate end-users for appropriate testing. Write up final version of thesis and remaining papers

Training & Skills

This project will be a CASE partnership with BGS, enabling the student to gain experience of applied as well as academic settings of research into soils and erosion. The Soils research team at BGS will provide the PhD student with access to any skills and facilities that are necessary to achieve the project objectives, including a wide-ranging set of scientist skills in soil science, statistics and numerical modelling, as well as

various laboratory facilities related to the investigation of soils. This training will be complemented by related training at Durham University. The project will also involve training in the development of research with clear impacts and with communication of scientific results with end-users and non-scientific communities.

References & Further Reading

Soils Portal at the BGS:

<https://www.bgs.ac.uk/nercsoilportal/>

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Further Information

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