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# The new assessment of soil loss by water erosion in Europe. Panagos P. et al., 2015 Environmental Science & Policy 54, 438–447—A response

Robert Evans[a,*], John Boardman[b,c]

[a] Global Sustainability Institute, Anglia Ruskin University, East Road, Cambridge CB1 1PT, UK
[b] Environmental Change Institute, Oxford University Centre for the Environment, South Parks Road, Oxford OX1 3QY, UK
[c] Department of Environmental and Geographical Science, University of Cape Town, Rondebosch, South Africa

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ABSTRACT

We respond to an article by Panagos et al.—'The new assessment of soil loss by water erosion in Europe' in Environ. Sci. Policy, 2015, 54, 438–447. It is aimed at helping policy makers make better decisions. The assessment uses a Geographical Information Systems approach based on the Revised Universal Soil Loss Equation. RUSLE is based on data gained from plot experiments. The authors assume RUSLE is the only way to assess erosion and ignore critiques of erosion models and other ways of assessing erosion. A different way of assessing water erosion, based on collecting information on extent, frequency and rates, mainly from farmers' fields but also grazed uplands, has been carried out over recent decades in Britain. The two ways of assessing erosion, one largely theoretical, the other based on reality, evolved in response to particular situations. However, they should relate well to each other. We show that the model is inappropriate to assess soil loss by water erosion in Britain, not only for agricultural land but also for uncultivated land. Predicted high rates of erosion do not relate well to where erosion actually occurs and are too high, and the model takes no account of the spatial extent of erosion on the ground. In other words, the model does not reflect reality. Policy decisions should not be taken based on such a model. Erosion must be assessed in a better way with a large field-based element.



## 1. Introduction

A new assessment of soil loss by water erosion in Europe has recently been published (Panagos et al., 2015a), aimed at policy makers. The assessment is based on a model, the Revised Universal Soil Loss Equation (Laflen and Moldenhauer, 2003). Here, we respond to this assessment. Our response, based on fieldwork to assess if erosion was a problem in Britain reflects a difference in attitude as to how water erosion should be assessed. We think it should be based on assessments made in the field, by locating eroded fields (Evans and Boardman, 1994; Evans, 2002a) or eroding upland landscapes (Evans, 1996) and estimating how much soil has been eroded. The paper by Panagos et al. (2015a) considers it should be done using a model based on plot experiments to estimate the rate of soil erosion. As Panagos et al. (2015b,c) note this is the most frequently used way to assess erosion and has been used in many countries. Because this is the most used method to assess erosion, there is a multitudinous literature on it, as a corollary there are many fewer references to field assessment as most of the research has been carried out in Europe, especially Britain (Evans, 2002a) and Switzerland (Prasuhn, 2011, 2012).

However, that a particular technique is most frequently used does not necessarily mean it is the best, or indeed, the only way. The RUSLE based model assumes estimated rates of erosion apply across the landscape. In our research we have found that rill erosion, which accounts for much of the erosion (Evans, 1990a), often occurs in isolated fields, does not happen in that field every year and that the severity of erosion can vary greatly from field to field and year to year (Evans et al., 2015). Here, we will not argue whether the value of the factors which comprise RUSLE are correct, we are sure others more qualified to make those criticisms will do that, what we are concerned with is how the RUSLE based model predicting soil erosion by water compares with results of field-based assessment in Britain. The policy makers whom Panagos et al. (2015a) are hoping to influence would hope that the two ways of assessing water erosion would relate to each other, the field assessment verifying and validating the model assessment, or at the least the two should compare well, for example, where erosion occurs and the relative magnitudes of rates of erosion.

As Sterman (2010, pp. 846) notes "no model can ever be verified or validated. Why? Because all models are wrong . . . . . . . . . . .all models, mental or formal, are limited, simplified representations of

* Corresponding author.
*E-mail address:* Robert.Evans@anglia.ac.uk (R. Evans).

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the real world. They differ from reality in ways large and small, infinite in number." Further, he goes on to note (Sterman, 2010, pp. 850), "Experienced modellers likewise recognise that the goal is to help their clients (*or policy makers, our italics*) make better decisions, decisions informed by the best available model. Instead of seeking a single test of validity models either pass or fail, good modellers seek multiple points of contact between the model and reality by drawing on many sources of data and a wide range of tests. Instead of viewing validation as a testing step after a model is completed, they recognise that theory building and theory testing are intimately intertwined in an iterative loop. Instead of presenting evidence that the model is valid, good modellers focus the client (*policy maker*) on the limitations of the model so it can be improved and so clients will not misuse it." We argue here that for Britain this new assessment of water erosion does not reflect reality as seen in the field, and should not be used by policy makers as the only source of information regarding soil erosion.

## 2. Differences in approach to assessing soil erosion by water

The differences in approach to assess soil loss by water erosion probably arise from the different circumstances pertaining at the time. Thus in the 1930s soil erosion was high on the agenda in the USA and was widespread (Bennet, 1939), and an understanding of processes driving erosion was needed. Plot experiments were set up at experimental stations to measure water erosion on different soil types, under different crop types, with differing plot lengths and with both natural and simulated rainfall. It was assumed that erosion risk based on the factors derived from plot experiments, **R**ainfall erosivity, **K** soil erodibility, **LS** slope factors, **C** crop cover and **P** practices to inhibit erosion, could be modelled using the Universal Soil Loss Equation to predict erosion risk (Laflen and Moldenhauer, 2003) and identify localities where erosion should be tackled. In Britain, on the other hand, where it was considered water erosion was not a problem, primarily because rainfall intensities were low (Hudson, 1967), when erosion in arable fields first started to be reported (Evans, 1971) information was sought on the extent of erosion (where and how many eroding fields) to see if it was a problem (Evans, 1996). It was quickly realised that erosion was most extensive in particular soil landscapes and needed to be assessed in a more methodical way. Measurements of severity of erosion could be made easily and quickly in arable fields of rill and gully erosion by measuring length of channels and their cross sectional areas at points down the channels and estimating volumes of soil deposited by measuring area and depth of deposits. Erosion in the uplands was less easily assessed (McHugh et al., 2002; McHugh, 2007). Evans (1996, 2002a, 2010) outlines the evolution of the assessment of water erosion in Britain and how erosion and runoff could be mitigated. In other words, one method of assessing erosion was to model erosion risk, the other was to find out where erosion occurred, its extent, frequency and severity. One way was largely experimental and theoretical, the other pragmatic and based on what was actually happening on the ground, i.e. reality. The modelled approach takes a more long-term view of risk, field-based the shorter term.

Estimates of rill and gully erosion in England were found to be within a range of one-half to twice the average value estimated by a number of researchers (Evans and Boardman, 1994) and compared well when estimated both on the ground and from photographs of the field (Watson and Evans, 1991). At that time, and still, that was considered a reasonable estimate of error, as it was obvious, for example, that an estimate 10 times the average would appear excessive, i.e. would need 10 times the length of rills estimated or deeper rills than measured, or enormous areas of fields covered by deposits or much deeper deposits than measured. Evidence for interrill erosion, better defined as wash or sheet erosion as wash can occur without rilling, was/is rare except on silty soils or the reworking of already deposited material from rills and gullies. It may occur widely across landscapes, but rates of erosion are low (Evans et al., 2015).

Because of the differing approaches to assessment, rarely have either set of researchers referred to each other's work. Criticism of field-based assessments are related to whether rates of erosion can be related to topographical factors and rainfall. Clear cut relationships do not emerge between slope angle, slope length and relief within the field and erosion (Evans, 1990a). Maps of rainfall erosivity of England and Wales (Morgan, 1980; Davison et al., 2005) do not relate well to where from field-based assessment land is most at risk, especially in lowland England (Evans et al., 2015; Fig. 1, pp.3). However, within the modelling fraternity there is debate too as to what the importance or weighting of the factors should be, e.g. in the European context, for erosivity (R), (Panagos et al., 2015b), topography (LS) (Desmet and Govers, 1997; Panagos et al., 2015c), crop cover factor (C) (Panagos et al., 2015d) and mitigating factors (P) (Panagos et al., 2015e). Data from plot experiments show that topographical factors may correlate significantly with erosion rates, but not always especially for slope gradient, but the correlations are weak (Cerdan et al., 2010). Hence, with regard to topographical factors similar criticisms can be made of both types of assessment, i.e. they do not relate well to plot or field data. Also it can be envisaged that other modellers could be critical of Panagos et al. (2015a) in that with different RUSLE factors the erosion risk map would be different and more like the results expected, i.e. reality, what is seen on the ground.

Using Geographical Information Systems models can predict erosion risk, based on severity (rates) of erosion at a variety of scales, but field-based assessments can also bring out the different rates of erosion occurring within fields (=plot scale) (Evans, 1992), fields and soil landscapes (Evans, 2002a) and has been done nationally for lowland soil landscapes in England and Wales (Evans, unpublished). A number of models used to predict soil erosion and sediment at regional scales use plot-based data, and after comparing the results from these and other models, 14 in all, de Vente et al. note (2013, pp. 26) "..understanding and predicting the sediment delivery process at the catchment scale, under present and future land use and climate conditions, is still a major challenge in soil erosion and sediment yield research." Field assessment could be a useful tool to aid in this challenge (Evans, 2006a).

However, regardless of how erosion is assessed whether by modelling or using information gained in the field, the two ways of assessment should relate well to each other, as they do for example in showing that plots or fields planted to maize erode much more than plots or fields planted to cereals (Evans, 1995a).

## 3. A critique of the RUSLE assessment of soil loss, with especial reference to Britain

This new assessment of soil loss by water erosion in Europe (Panagos et al., 2015a) is based, as noted above, on a prediction of erosion rates using a modified version of the Revised Universal Soil Loss Erosion Equation. RUSLE predicts long-term average erosion rate for a parcel of land. The equation was originally devised to predict average erosion rates only for cultivated land and is based on plot experiments and rainfall simulation studies (Laflen and Moldenhauer, 2003). RUSLE applies to rangeland where mechanical practises can be used to mitigate erosion (Renard et al., 1997). It is noteworthy that a high-resolution erosion risk map of Switzerland based on a USLE approach only applies the model to agricultural land (Prasuhn et al., 2013). There were sound reasons for restricting the USLE to cultivated land. Thus, cultivating the land to expose soil is a very different process to animals or fire