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Interactive Comment

Interactive comment on "Modelling soil erosion at European scale: towards harmonization and reproducibility" *by* C. Bosco et al.

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The paper is one of the many papers that have tried to describe soil erosion on a complex landscape, for the whole of Europe, at a scale much less detailed than the one at which erosion processes occur or at which the model chosen to describe erosion was originally developed. The goal is achieved using a powerful software, applied to RUSLE (slightly modified), with data extracted by public data bases, which are summarily described. Finally the prediction (maps) is validated. Usually local to national evaluation of soil erosion are made using USLE-derived models, because it is often needed to have an idea of where erosion may be more intense and where in can be neglected. This paper addresses the problem of dealing with the chosen model in a mathematical

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correct way (i.e. flow chart and definition of objects, computational algorithms), which is often overlooked. Hence, as a referee I found this paper worth publishing, a possible step forward.

The main difference with respect to previous attempts is the programming approach which is based on freely available software and a “semantic array programming paradigm”. Judging from the frequent links to explanatory web pages, the software system looks powerful but I never used it. I feel that an extra paragraph explaining what this system does that others don’t would improve readability: this paradigm is certainly unknown to most of the potential readers.

The model used in this exercise is the RUSLE to which an effect of rock fragments is added. My main objections to this paper are based on the choice of the model and its use (or misuse). It seems to me is that you did no efforts to represent a field scale model at a scale where cells may contains several fields: you did not mention cadastral maps among your data bases; it seems that you have not attributed a range of possible field sizes among which to choose the more correct one for any particular place using some criteria (e.g., fields nearby towns are smaller than far away fields). Maybe you calculated sediment accumulation flow. In this latter case, how? From divide to permanent drainage lines? Which were the effects on the L factor? More or less the same comments, linked to the scale issue, can be done for the other RUSLE factors.

Another important part is the definition of what we want to achieve: are you interested in present export of sediments? Or do you only want to know to the present rate of erosion/sedimentation on site? Or do you want an index of soil erosion (which is not to the real value)? The third one can be successfully approached by using some product of the USLE-family of models (once re-scaled). But is an erosion index the only goal? Or are you also interested in predicting what erosion will become in 10-20 or 50 years from now? Then USLE-derived models are useless unless they are re-written because USLE-like models do not isolate climatic factors (see further comments below) apart rain intensities and totals.

Let's now get into the paper:

The modelling architecture: Is the USLE/RUSLE model applicable at 1x1km resolution? Personally I don't think so, especially when the lower pixel size is 90x90 m. It seems to me that we are playing at producing colored maps unless the model has been changed enough to "average" the behaviour of the processes (already simplified and lumped inside the RUSLE), i.e. I believe that we need a rewriting of the RUSLE for the purpose/scale of application. This implies changing both the model and its input parameters. Have you retained anything of the approximation made by Mitasova and co-workers? And what about their modelling of the sediment fluxes which were both divergent and convergent, following the topography? What about DTM artifacts such as local minima where sediment can be trapped (but should not)? And what when the local minima are dams or karst or pseudo-karst sinks? Procedures for dealing with these two cases can be found in the GRASS software. Did you retain them? When along a slope you have a cascade of land uses, soils, slopes and slope length how do you operate? Do you use an average soil erodibility, S and C ? do you use the total slope length or there is some sort of max admitted length (or max contributing area)? What when your unit cell is cut by roads? (asphalt or dirty, roads divert fluxes, and Europe is hyper-dissected by roads). What about property subdivisions, which call for canals, cumulated tillage erosion effects, and large differences in the timing of the agricultural operations?

Line 2649-23: Runoff is taken into account by R (rainfall energy and peak runoff as I30) and L (runoff accumulation), S (factor belonging to overland flow shear stresses and flow velocity), partly by C (raindrop interception and part of hydraulic friction) and K (soil profile permeability class). In other world, the whole structure of the RUSLE contributes in implicitly defining runoff, its shear stresses and transport capacity. It is not a limitation of R alone, it is a limitation of the whole model. RUSLE is an example of a model built following a purpose, that of evaluating soil loss at the field scale, (originally only East of the Rocky Mountains): I feel that using it at other scales means rewriting it. Furthermore: if climatic conditions change, also runoff changes and then all the mentioned parameters are to be tuned to the new situation.

Soil erodibility: there are strong evidences pointing at a climatic effect differentiating erodibility values in at least 2 classes, (Borselli et al., 2012, Catena. 97, 85-94 – which already includes a rock fragment effect). Substantially semiarid or arid climate, or climates with hot dry periods have lower K values than temperate, cool climates.

Topographic factor: the effect of climate on it is shown by differences in the length effect on soil erosion. The majority of studies shows an increase in soil loss per unit surface with increasing slope length. Nevertheless, Borselli et al. (2008. Catena 75, 268–277) put an upper value to the max extent of the upslope contributing area in order to bring RUSLE predicted erosion into acceptable levels (in agreement with local observation). In central Sicily, where there is one of the best soil loss experimental stations presently active in Europe, the empirically determined L factor decreases with the plot length (Bagarello and Ferro, 2010, Biosyst. Eng., 105, 411–422). Yair and Raz-Yassif (2004, Geomorphology, 61, 155-169) published similar findings. The quoted authors interpreted their data as an effect of how runoff is built and on how effective is runoff to transport sediments.

Validation: Using Google Earth (GE) is a good idea but with some problems. Your model depicts an ideal situation with no interaction with anthropic features such as roads and other infrastructures that instead tend to densely cover large part of the European landscape so your predictions cannot predict what is caused by these interactions. GE has a resolution, which is at the limit to see erosion features unless you simply look for bare soil as more eroded than vegetated spots. Using panchromatic you can see lines corresponding to rills (not always). Hence you actually need a validation of the erosion maps made using GE versus known (measured) averaged annual soil erosion totals. Moreover, you can count on several (not many) images. Every image is a single photogram that you compare with a mean annual value (i.e. an annual total averaged over many years). All this casts serious shadows over the validation, even if this validation is very much better than nothing.

As a final comments: one of the reason why it is substantially impossible to prove or disprove USLE-family models is that the time to collect data to average over 10-20 years totals is 10-20 years long!

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 2639, 2014.