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Discussions

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

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Interactive comment on "Modelling soil erosion at European scale: towards harmonization and reproducibility" *by* Bosco et al: reply to Anonymous Referee #3

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We would like here to provide our reply to the observations reported by the Anonymous referee #3 on our manuscript.

[Comment] – "The study is quite interesting, but it is not in the main scope of NHESS and should not be included in the journal. Soil erosion is not a natural hazard".
[Reply] – Soil erosion is widely recognised as a natural hazard (Rawat et al., 2011; Gares et al., 1994; Mather, 1982). Several papers on this topic have already been published in NHESS (e.g. Chang and Zhang (2010), Diodato et al. (2009), Anton et al. (2012)). This is also the opinion of Anonymous referee #1 and #2 who considered this paper to be 'a substantial contribution to the understanding of natural hazards and their consequences'. Hence our paper falls within the main scope of NHESS.

[Comment] – " 'soil erosion is linked to several natural hazards...' This is important for an acceptance in this journal. What is the link? Who can soil erosion modelling help to understand NH".

[Comment] – " 'impractical to measure soil loss across landscapes...' Why? Here a short abstract of the complexity of erosion measurement and the problem of remote sensing and erosion is needed".

[Reply] – Additional information on the link of soil erosion by water with natural hazards (e.g. with wildfires, Vafeidis et al., 2007, Terranova et al., 2009, Di Leo et al., 2013) will be integrated in the introductory part of the manuscript jointly with a short description of the main difficulties and limits of measuring soil erosion rates by water across whole landscapes. This will complement the introductory discussion on the current approaches (physically based vs. empirical models) and their relationship with the availability of data for large regions or subcontinents, so as to better justify the selected approach.

[Comment] – "Why an introduction to physical based models. There is no need to. No physical models are mentioned in the text"

[Reply] – The limits of physically-based model to be applied at small scale have been introduced in the manuscript to strengthen our decision to apply an empirical model for modelling soil erosion by water in large areas. Unfortunately, a too small fraction of the literature discusses at least the essential aspects of the extent with which data-scarcity driven "simplifications" and *de-facto* empirical assumptions are widespread, even in physically-based models. Furthermore, disciplinary barriers might prevent some interested readers from easily orienting themselves towards this literature. In the rationale of our manuscript, the potential propagation of the associated uncertainty (due to lack of data for an appropriate parameterisation) of the otherwise very promising physically-based methods should be considered aside from published results within controlled and data-rich environments. We found this discussion convenient for interested readers (even from other disciplinary fields) for a better understanding of these aspects when considering our proposed approach. This is why a very brief summary of essential literature dealing with this problem has been given.

[Comment] – " 'USLE ... has been applied all over the world...'. The model is used everywhere, but is it valid? Is there any regional validation for Europe? Is it valid on the scale used on? A wide spread model usage is no validation. ".

[Reply] – The RUSLE model (Renard et al., 1997), which predicts the average annual soil loss resulting from raindrop splash and runoff from field slopes, is still the most frequently used erosion model for large regions (Renschler and Harbor, 2002). Moreover, the EIONET data collection exercise indicated that the RUSLE is widely used also at national level. During the EIONET data collection (Panagos et al., 2014) the official point of view of the Member states was asked. Although this is not a validation it can be concluded that the RUSLE is successfully used at these scales. Some attempts have been made to validate the RUSLE model at regional scale (Van Rompaey et al., 2003; Vieillefont et al., 2003). Besides erosion measurements and surveys, interpretation of high-resolution remote sensing imagery and aerial imagery can also be used for validating erosion maps (Vrieling, 2006) obtaining a qualitative or semi-quantitative estimation of soil erosion rates. Similar techniques have been applied in Bosco et al. (2014) for validating the soil erosion map presented in the paper. We clearly stated in the manuscript the limits of the approximations needed for modelling soil erosion by water at the continental scale. We also hope that future progresses in the field will eventually enable more accurate estimations to become available with a reduction of the overall amount of uncertainty (the comparison we offer with two other recent estimates of soil erosion by water in Europe might be useful in this respect). Nevertheless, we believe that updating this kind of modelling exercises – even from a methodological/architectural perspective – is essential for providing a better support to risk assessors and policy-makers when they must deal *right now* with large-scale integrated assessments of multiple environmental aspects. On the usage of USLE/RUSLE family of models in the context of our manuscript, it might be of interest even our comments in Bosco et al. (2014b).

[Comment] – "Why does a 1,000,000 scale soil map lead to a 1km raster resolution.

In my opinion there is no direct link between map scale and raster resolution. ".

[Reply] – At a scale of 1:1,000,000 – for vector products based on georeferenced shapes – we considered that it is not possible to distinguish any information reported with a dimension less than $1\,mm$, consequently we decided to use the same dimension ($1\,mm$ on the map corresponds to $1\,km$ in the field) for the resolution of our map.

[Comment] – "Which factor is used? L- S- or LS? If slope is the only input than you use just the S-Factor, or not? Please clarify"

[Reply] – Both slope lenght (L) and slope steepness (S) have been calculated starting from a digital elevation model (DEM). As mentioned in the paper: "L and S factors have been determined using the same approach and equations applied by Bosco et al. (2008)".

[Comment] – " 'dimensionless proportion [0, 100 %]' C-factors range from 0,001 and 1"

[Reply] – C factor is a dimensionless quantity which in theory may range from 0 to 1 (Renard et al., 1997) and which represents the ratio of actual conditions to reference conditions (i.e. the proportion of actual effects with respect to reference ones). Renard et al. (1997) state "[a]s with most other factors within the RUSLE, the C factor is based on the concept of deviation from a standard [...] The soil loss ratio (SLR) is then an estimate of the ratio of soil loss under actual conditions to losses experienced under the reference conditions". Our usage of the symbol % follows standards such as ISO 31-0 (ISO, 1992) and the NIST guide for the use of the International System of Units (Thompson and Taylor, 2008) which clearly define the symbol % as equivalent to the number 0.01, and the quantity to which the symbol is attached as a dimensionless ratio. Therefore, the range [0, 100 %] is exactly equivalent to the range [0, 1]. Since the quantities concerned are all dimensionless (i.e. of dimension one), % plays a similar role to the SI prefix *centi-* (for 10^{-2}) attached to other units (Quinn, and Mills, 1998). Unfortunately, misuses – especially in some empirical equations – of percentages are not infrequent. A recurring misuse in erosion related empirical equations is to silently omit the percentage symbol, so as for e.g. the dimensionless ratio 50 % to be confused with the number 50 instead of the number 0.5. The Semantic Array Programming paradigm (de Rigo et al, 2012) follows the aforementioned standards and thus does not distinguish between **::proportion::**[1] quantities and ratios with upper limit 1 (ratios without upper limit would be annotated as **::nonnegative::**[2] quantities) or equivalently percentages in [0, 100 %]. This helps to avoid ambiguities among disciplines and domain-specific customary habits in the mathematical notation.

[Comment] – "reference not available. Calculation of the C-factor is unclear".
[Reply] – This reference is published and available online at http://files.figshare.com/1293888/Bosco_de_Rigo_STF_MRI_11b13_2013.pdf. The report by Bosco and de Rigo (2014) contains the calculation procedure of the C factor values. A table reporting the C factor values for every land cover class is present within the report.

[Comment] – " 'we assumed the rock fragments cover equals the volumetric rock fragment content...' One sentence is needed to show connection and the difference between those two parameters".
[Reply] – The volumetric content percentage of rock fragments in the top soil and the cover percentage of rock fragments at the soil surface are indeed two different parameters (Poesen and Lavee, 1994). However, as a first approximation and due to the limited amount of available data on soil stoniness at the European scale, we assumed these parameters to have the same value as suggested in Govers et al. (2006).

[Comment] – "How is it possible to see erosion/deposition on a satellite image? Are there any gullies visible? The erosion/deposition categories of Warren et al 2005 are made for field surveys and not for satellite image. Is a 'stonier surface' really visible on

[1] http://mastrave.org/doc/mtv_m/check_is#SAP_proportion
[2] http://mastrave.org/doc/mtv_m/check_is#SAP_nonnegative

a google image? Is a satellite image of one day representative for a long-term process like water erosion? "

[Reply] – As reported in the validation report (Bosco et al., 2014), associated to the present manuscript, satellite images and Google Earth pictures (mainly from Street View) have been used jointly with different techniques (EIONET data) for a qualitative/semi-quantitative validation of the presented soil erosion map. It was often possible to recognise the categories for field validation of Warren et al. (2005) (e.g. rills, litter dams, etc.) within the high resolution pictures available in Google Earth. In some cases, when high resolution satellite images were also available, it was possible to easily recognise the presence of gullies or deep rills and of dense rill patterns.

A revised version of the manuscript will be submitted at the end of the open discussion by integrating the changes, additional explanations and literature to meet the requirements of the reviewers.

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