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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Temporal and spatial scale and positional effects on rain erosivity derived from contiguous rain data" *by* F. K. Fischer et al.

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We thank S. Mylevaganam for his interest in our work and his rapid comments. In our reply we refer to his numbering of comments.

Reply 1) We did not define the thresholds but they were defined by Wischmeier (1959, but see also Wischmeier and Smith 1958, 1978). According to Wischmeier, a rainfall is regarded erosive if at least one of both criteria meets the requirements. A rain with 6.4 mm in 30 min is thus regarded erosive but its erosivity will be very low (about 1 permil of our highest erosivity).

Reply 2) Mylevaganam (2018) is correct that it is conceivable that these thresholds may vary locally (soils will vary even within one slope) and even temporally (e.g. depending on antecedent soil moisture). Indeed, different thresholds have been proposed for Germany (10 mm or 10 mm/hr; Rogler and Schwertmann 1981) but these thresholds have never been tested and confirmed. We are aware of two studies, one in Germany (Martin 1991) and one in Nigeria (Sabel-Koschella 1988), which tried to verify the thresholds and the duration over which the maximum intensity has to be determined but without any improvement. The simple reason is that erosivity close to the threshold is very low and does not exceed uncertainty of the erosion measurement, which is large. Also uncertainty of rain (gauge) measurement is in the range of 1 to 2 mm (wind drift, adhesion, mechanical resistance etc.).

The SWAT model does not use rain erosivity because it is a landscape model that includes the change in transport capacity along the flow path into the calculation. It thus depends on the so-called initial abstraction, which acts similarly as the thresholds of rain erosivity although the initial abstraction basically applies to runoff and not to erosion. Many attempts have been made to regionalize initial abstraction.

Reply 3) 121% result from squaring 110%. At this part of the manuscript the equations have not been introduced and hence the reader cannot know that the calculation of erosivity is more complicated. Exactly 121% would only result for conditions leading to eqn 2.3 throughout the entire rain event while other values would be obtained for condition requiring eqn 2.1 or eqn 2.2. The squaring results from the fact that eqn 2.1 to 2.3 only calculate the kinetic energy per mm of rain and hence the result of these equations have to be multiplied with the amount of rain per time increment and summed up . This sum has then to be multiplied with the maximum 30-min intensity, which causes the squaring (Wischmeier 1959; Wischmeier and Smith 1958, 1978). Hence with all three equations intensity has to be squared and our sentence and the simple example to illustrate the problem of non-linearity in the introduction is still correct.

Reply 4) This is true and well known. For individual events especially wind speed and drop size distribution my deviate considerably from the average conditions (e.g. see Brandt 1990, Iserloh et al. 2013). However, the necessary data are usually not available because drop size is usually not measured and wind speed during thunderstorms varies locally. Furthermore, to the best of our knowledge, no algorithm exists that would incorporate this information in erosivity calculation. Other influences like land use and soil structure/texture have no impact on rain erosivity but they influence the resistance against erosivity. These influences are considered in other factors of the Universal Soil Loss Equation.

A sequence of rains as proposed Mylevaganam (2018) would meet the definition of an erosive event if both rains would be separated by not more than 6 hr. For a longer separation we can expect that the soil stabilizes and gains its resistance against raindrops again (e.g. due to drying and the attractive forces of water menisci).

Reply 5) It may be that a lower threshold would apply for the following rain but also the opposite could be true and thresholds could increase for a subsequent rain because of the solid seal developed during the preceding rain. These influences are beyond the concept of rain erosivity as an entirely rain dependent property without consideration of soil or crop management that are entered at a later point of erosion calculation (Wischmeier and Smith 1978). This concept of rain erosivity explained from 72 to 97% of the variation in individual-storm erosion from tilled continuous fallow (Wischmeier 1959) and it is in use since then. In particular this concept was able to explain soil loss of more than 10'000 plot yr sufficiently accurate to serve as sound basis for conservation farm planning (Wischmeier and Smith 1978).

Reply 6) The simple reason is that rain intensity is never constant during a rain and periods with an intensity of 0.05 mm/hr or lower can also occur during a rain that exceeds the criteria of an erosive event. A detailed justification of the equations can be taken from the original publications (Wischmeier 1959, Wischmeier and Smith 1958).

References: Brandt, J.: Simulation of the size distribution and erosivity of raindrops

and throughfall drops, Earth Surface Processes and Landforms 15, 687-698, 1990.

Iserloh, T., Fister, W., Marzen, M., Seeger, M., Kuhn, N. J. and Ries J. B.: The role of wind-driven rain for soil erosion - An experimental approach. Zeitschrift fur Geomorphologie 57(1 SUPPL. 1), 193-201, 2013.

Fischer, F.K., Winterrath, T. and Auerswald, K.: Temporal and spatial scale and positional effects on rain erosivity derived from contiguous rain data, Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2018-305, 2018

Martin, W.: Die Erodierbarkeit von Böden unter simulierten und natürlichen Regen und ihre Abhängigkeit von Bodeneigenschaften, Diss., TU München. 1988.

Mylevaganam S.: Interactive comment on “Temporal and spatial scale and positional effects on rain erosivity derived from contiguous rain data” by F. K. Fischer et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2018-305-SC1, 2018.

Rogler, H., and Schwertmann, U.: Erosivität der Niederschläge und Isoerodentkarte Bayerns, Journal of Rural Engineering and Development, 22, 99–112, ISSN 0044-2984, 1981.

Sabel-Koschella, U.: Field studies on soil erosion in the southern guinea savanna of western Nigeria Diss., TU München, 1988.

Wischmeier, W. H.: A rainfall erosion index for a universal soil-loss equation, Soil Sci. Soc. Am. Pro., 23, 246–249, 1959.

Wischmeier, W. H., and Smith, D. D.: Rainfall energy and its relationship to soil loss, T. Am. Geophys. Un., 39, 285-291, 1958.

Wischmeier, W. H., and Smith, D. D.: Predicting rainfall erosion losses – a guide to conservation planning, U.S. Department of Agriculture, Agriculture Handbook No. 537, Washington, DC, 1978.

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