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Problems and solutions in the meta-analysis of rainfall simulation data

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Rainfall experiments are laborious which restricts the number of experiments and especially the range of landscapes, soils, soil uses etc. within one data set. A meta analysis of data from several researchers allows overcoming such restrictions but also shows more clearly the methodological shortcomings of rainfall simulation experiments. We finally combined the results (experimental conditions, hydrographs, sedigraphs) of more than 300 rainfall simulation experiments conducted by six researchers. Lessons learned from the aggregation of data were:

• Results of several other researchers had to be discarded due to a lacking accuracy and/or insufficient data
• Some researchers try to smooth their data (either by the type of measurement or mathematically) which causes statistical problems in the comparison of different data sets if the original data are destroyed.
• Time to ponding, which is essential for deriving infiltration rates from the runoff and rainfall data, was measured by a minority of researchers.
• Rock fragments are rarely measured, but results show that missing data cannot be replaced by zero.
• Soil texture including rock fragments is measured with inconsistent size classes. Data can only be combined (e.g. by calculating the geometric mean diameter) if sufficient classes (» 3) have been measured. This means that especially rock fragments have to be classified and the upper limit of the largest class has to be reported because otherwise a geometric mean diameter cannot be calculated.
• Time since tillage appeared to be an important parameter for the sealing process during the rain experiments but was rarely measured. Time since tillage entered the prediction equations as logarithm, which allows it to be estimated with sufficient accuracy from crop data when it was long but information was clearly insufficient and could not be estimated with sufficient accuracy where time since tillage was short (< 4 d) although many experiments covered this temporal range.
• Cover is not always measured and noted in sufficient detail (distinguishing between plants, residues and rock fragments) although its dominant influence on runoff and erosion is well known.
• We found no way to include soil moisture data in our meta-analysis due to the inconsistencies between measurements (surface soil moisture, topsoil moisture, subsoil moisture) and between units (gravimetric vs. volumetric).

The meta-analysis clearly showed that many data sets cannot be combined, which restricts their further evaluation. However, the inconsistencies in data also imply that the published results, equations and conclusions are not generally valid and thus of limited value. Basic rules for data collection in rainfall simulation experiments should be set up and their application should be controlled.