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Effect of antecedent soil-water content on aggregate stability and erodibility of a loess soil

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Soil erosion processes are affected by the erodibility of the soil and by the erosivity of the rain. Aggregate stability is commonly considered as the most significant soil physical property that determines soil erodibility. Both aggregate stability and soil erodibility are commonly considered to be constant properties, without taking into account the influence of time-dependent parameters, such as antecedent soil-water content (θa), being the soil-water content prior to the rainfall. The effects of rain characteristics and invariant soil properties such as texture and organic matter content on soil erosion processes are well documented. However, the effect of antecedent soil-water content on aggregate breakdown, seal formation and subsequent soil erosion is much more disputable as opposing effects have been reported. The objectives were to determine the effect of θ_a on aggregate stability, seal formation, runoff and soil loss. Lab experiments were conducted on a Belgian silt loam soil. Air-dried soil aggregates were subjected to antecedent soil-water contents of 0.04 (air-dry aggregates), 0.12 and 0.19 m^3 m^{-3}. Aggregate stability was determined according to the 'dry and wet sieving' method of De Leenheer and De Boodt (1959). The method starts from fixed aggregate fractions obtained from dry sieving which subsequently are prewetted and undergo a wet sieving. Runoff and soil loss was determined by means of a laboratory rainfall simulator, consisting of a rotating circular water tank, which is located at 3.20 m height and which is supplied with 90 glass capillaries serving as drop formers. A positive relationship between antecedent soil-water content and aggregate stability was found. This can be attributed to a decrease in slaking forces. On the soils with highest antecedent soil-water content an increase in aggregate stability due to prewetting prevented aggregate breakdown. As such, no seal was formed and no runoff occurred. The highest total runoff values were observed for the intermediate θ_a, while intermediate amounts of total runoff were noticed for the air-dry aggregates. Soil loss, however, showed a different trend: highest values were found for the lowest θ_a, intermediate values for the intermediate θ_a and no soil loss for the highest θ_a. We further observed that θ_a had no influence on the final runoff rates and on the final infiltration rate through the soil surface. In using a water discharge and stream power equation to predict sediment transport, we found a decreasing erodibility with increasing θ_a. We therefore suggest including θ_a as an additional variable to assess soil erodibility in deterministic event-based water erosion models.