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Rainfall Threshold For Slope-Channel Connectivity In Agricultural Catchment

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Many rainfall events lead to the transfer of soil material from one slope section to another, which does not notably alter slope relief (first transfer threshold). Some events lead to the transfer of soil from the water divide to the footslope (second transfer threshold). In a few exceptional cases, soil material is transferred directly into river channels due to severe erosion moving large quantities of soil over long distances. Extreme events lead to the transfer of soil material down the entire slope length, its deposition at the footslope and even further across the valley floor. Sediment is transferred directly from slopes to river channels (third transfer threshold or slope-channel connectivity threshold). This work presents rainfall threshold values and probability of slope-to-river sediment transfer in a foothill agricultural catchment in Poland.

The study is based on research performed in the Dworski Potok Catchment (227–275 m a.s.l.), which is a small agricultural foothill catchment (0.29 km2), situated in a moderate climate zone, with slopes covered with loess-like formations. The paper uses precipitation data for the period 1987–2009 obtained at the Łazy Field Research Station near Bochnia (Poland) and long-term field data on splash (2007–2009), slope wash (2007–2009) and linear erosion (1998–2009) on slopes.

In Dworski Potok Catchment change in the slope relief was brought about by short transformation periods, during which soil erosion by water took place, especially if it was caused by events of high magnitude and low frequency. Those periods which, depending on the criterion adopted, lasted from 0.3 to 4% of the time of study were the most interesting and effective episodes in the development of slopes. It was determined that in the researched multi-year period, the transfer of soil material was possible to occur after certain parameters had exceeded the following threshold values: EI30 = 40.5 MJmmha-1h-1 or I30 = 9.8 mmh-1 for the first transfer threshold, EI30 = 106 MJmmha-1h-1 or I30 = 30 mmh-1 for the second transfer threshold, and EI30 = 226.8 MJmmha-1h-1 or I30 = 35 mmh-1 for the third transfer threshold (slope-channel connectivity threshold).

The probability of the occurrence of several events (3–7) of exceeding the first transfer threshold during the course of a year is quite large, ranging from 10.4% (7 events) to 17.5% (4–5 events). The probability that at least one event will cross the first threshold is very large at 96% (occurs every year). The probability that one or two soil erosion events will occur per year that will cross the second transfer threshold is 26.5 and 27.1%, respectively. The probability that the second threshold will not be crossed at all is relatively large at 12.9%. The probability that the third threshold will be crossed only once per year is 36.2%. The probability that the third threshold will not be crossed at all is very large at 43.8%. Finally, the probability that the third threshold will be crossed at least once per year is 20.0%.

In the foothill Dworski Potok catchment slope and channel are weakly linked. The connecivity between the two is local and episodic. Footslope areas and flat valley bottoms covered with grass function as a barrier separating the slopes and the stream channel. Only during the most erosive rainfalls does sediment flux directly to the stream channel take place. Even then most of the material is deposited at the footslope and in flat valley botooms.