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Differentiating causes for erosion at the catchment scale: do soil conservation measures mitigate weather dynamics?

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Abstract

The efficacy of most measures to control soil loss is well established at the field or plot scale. Less well documented are the changes in hydrological behaviour and sediment production at the scale of the (small) catchment. In Norway, incentives to reduce tillage have been in place for over decades. However, even long time (20 years) discharge monitoring of a series of small catchments does not show a clear effect of the application of conservation measures. This research hypothesizes that the effect of weather conditions for a 4.2 km^2 catchment in southeastern Norway outweighs the effect of conservation measures in the time series on runoff and sediment load. To test this, it was assumed that trends and changes in soil loss E over time are the product of an agromic index C, precipitation P and rainfall erosivity R. The values of C were calculated based on extensive farm records, covering every tillage operation for every field in the catchment for the period of investigation. Runoff and sediment load records were used to parameterise and test different correlative models. In order to quantify the effect of topography on the degree to which conservations measures reduce soil loss at catchment level, a spatially distributed connectivity index was calculated and multiplied with C. Calculations were carried out for a 10 year period, in monthly time steps. The following statistical models proved the most promising to correlate sediment load to precipitation and agronomic practice.

$E_t = a \cdot P_t^b \cdot P_{t-1}^c \cdot C_t^d$

$E_t = a \cdot R_t^b \cdot P_{t-1}^c \cdot C_t^d$

where P_{t-1}^c, the precipition in the prior month, is a proxy indicator for antecedent moisture conditions.

The results show that precipitation dynamics outweigh the effect of soil conservation measures for this typical agricultural catchment. It also shows that the inclusion of a hydrological connectivity index improves the quantification of the effect of soil conservation measures on the catchment scale.