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Why is there no simple relationship between soil loss and slope length?

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The probability of sediment deposition per unit distance travelled, or its reciprocal, the mean travel distance, are concepts that help to introduce some rationality into discussions of the relationship between slope length and soil loss. Here we illustrate the complexity of this topic using two very simple sediment transport relationships under spatially uniform rainfall. The assumed relationship is that the rate of detachment for a grain size class is proportional to the flow power (q.s) and to the abundance of the class, and inversely to the mean grain size on the surface. The mean travel distance is assumed to be proportional to the flow discharge per unit width and to the ratio of mean grain size to the size of the deposited grain. These relationships are comparable to a dimensionless shear stress criterion with equal mobility, and to a frictional sled model.

These relationships allow us to quantify the relationships of runoff and sediment transport with travel distance, for different infiltration models associated with semi-arid to humid climates, for slope morphology, for the patchiness of infiltration rates and for the duration and intensity of significant bursts of rainfall, illustrating the range of realistically possible relationships and providing some indications on how to model erosion in greater or less detail, replacing the over-simplified expressions in widespread current use.