**Assessing Path Tortuosity On Rill Flow Resistance**

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**Abstract.** The structure of the flow of meandering channels is surprisingly more complex compared to that of straight ones. The channel tortuosity is defined as the ratio between the actual channel length and the straight length measured between the upstream and downstream boundary sections. Currently, the effect of tortuosity has been little investigated for rill flows. In this study, a theoretical flow resistance law, initially developed for open channel flows, has been applied to investigate the effect of rill tortuosity on flow resistance using experimental measurements. This flow resistance law is obtained by integrating the power velocity profile and depends on its scale parameter 

The experiments were carried out on a plot, 2 m wide, 7 m long, located at the experimental area of the Department of Agriculture, Food and Forest Sciences of the University of Palermo. The plot was filled with soil having a clay percentage of 32.7%, silt of 30.9%, and sand of 36.4%, and slope equal to 18%. Mobile bed rills were manually incised to obtain four different values of tortuosity, approximately equal to 1 (straight rill), 1.08, 1.16, and 1.30. The rills were initially shaped by a low clear flow discharge. Then, the experimental runs were carried out using a constant inflow clear discharge equal to 0.32 L s-1. Each rill channel was divided into nine longitudinal segments. Each segment was bounded by two cross-sections having a linear distance of 0.624 m. A rill reach is defined as the distance from a given cross-section to the rill end. For establishing the rill channel geometry, the three-dimensional Digital Terrain Model (3D-DTM) was created by the Structure from Motion technique using a set of about 70 photographs taken from the plot area by a digital camera.

In each experimental run, the mean hydraulic radius R in the reach was determined using a method, recently developed, which couples the ground survey of the rill channel from the SfM technique with the survey of the water tracks inside the channel marked by a dye solution. The slope steepness s of each rill reach was obtained by the rill thalweg extracted by 3D-DTM. The mean rill flow velocity V was measured by the dye-tracing technique using a Methylene blue solution as a tracer. The abovementioned measurements allowed to calculate the Darcy-Weisbach friction factor

$f=\frac{8gRs}{V^{2}}$

in which g is the acceleration due to gravity. The measurements were used to calibrate the relationship between  and the rill slope, the Froude number, and the rill tortuosity. Finally, the reliability of the theoretical flow resistance law was tested by comparing the measured and estimated f values.