

# Soil Erosion Measurement Techniques and Field Experiments

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Soil erosion is a process in which soil particles are first detached from the soil surface and then transported by erosive agents such as rainfall, overland flow and channelized flows in rills, ephemeral gullies and gullies [1–3]. Accelerated soil erosion affects both natural and anthropogenic environments. It is also responsible for land productivity decrease due to the removal of soil organic matter and plant nutrients [4,5]. The negative effects of soil erosion include in-site effects, such as degradation of soil structure, loss of organic matter and nutrient content, and reduction in the cultivable soil layer [6]. Erosion also determines off-site damages due to soil particles entering the water system, such as sedimentation into channels, loss of reservoir storage, eutrophication of waterways, and contamination due to fertilizer and chemical pesticides [7].

Accurate and repeatable measurements of erosion processes are required both for understanding and realizing correct modeling. Experiments provide an opportunity to investigate to what extent the concepts used in models are a truly valid descriptions of the erosion processes occurring.

The main aim of this Special Issue was to collect papers dealing with (1) experimental sites for measuring soil erosion at different spatial (plot, hillslope, basin) scales, (2) field experiments that aim to study the soil erosion processes (interrill, rill, and gully erosion), and (3) new methods and procedures for measuring soil erosion processes (e.g., three-dimensional photo-reconstruction techniques, measurement of erosion features using aerial and terrestrial acquisition platforms, and tracers).

Eleven articles (ten research articles and one review) are published in this Special Issue. They cover different aspects of erosion processes, investigate cause–effect relationships, and develop new models for predicting soil erosion. The effects of rainfall, cropping system, etc., on soil erosion have been discussed, and different types of erosion (i.e., rills, gullies) have been studied.

Among the research articles, the papers by de Oliveira et al. [8] and Nicosia et al. [9] deal with rill erosion. In particular, the first [8] presents the development and verification of an improved and cost-effective flume apparatus and corresponding testing methodology. The authors tested both the apparatus and methodology using statically compacted specimens of a latosol from the central region of Brazil. They produced erosion curves with repeatability that were superior with respect to their initial linear and transition portions. The second [9], instead, assessed the influence of the rill profile shape on flow resistance law. The analysis demonstrated that the component of the Darcy–Weisbach friction factor due to the profile shape varies in the range 0.68–14.6% of the overall friction factor for the concave profile, and from 3.4 to 26.9% for the convex profile. The authors also proved that the concave profile leads to an eroded rill volume lower than those detected for the uniform and convex profiles (reduction of 57.9% compared to the uniform profile).

Only the paper by Nkonge et al. [10] deals with gully erosion. They studied the susceptibility of the Kakia–Esamburmbur catchment in Narok, Kenya, to this kind of erosion. The authors obtained that land use/cover, distance to road, sediment transport index, and topographic wetness index significantly influence gully occurrence in the catchment.



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Many papers investigated new solutions for preventing soil erosion phenomena or proposed their relationship with the examined variables. Merlo et al. [11], in turn, evaluated the relationship between soil properties (microbial biomass carbon, basal soil respiration, and metabolic quotient) and erosion in areas managed with different cropping system practices under no-tillage in the Brazilian Cerrado. They demonstrated that not only physical and chemical, but also biological properties are deeply affected by erosion. Regarding the application of agricultural practices, Vianney Nsabiyumva et al. [12] evaluated, in three provinces of Morocco, their effects, combined with olive tree plantations, on the hydrological response (final infiltration, imbibition of rainwater, runoff coefficient, and soil detachment). The authors demonstrated that vegetation has an important role in moisture conservation in surficial depths in all sites and reduces runoff. Banu and Atom [13] proposed the use of quicklime to stabilize cohesionless soils, demonstrating its efficiency for both poorly graded and well-graded soils. Its use significantly improves the strength, critical shear stress, and erosion rate index of the soil. Bombino et al. [14] presented an interesting case study, developed in Calabria, using burned felled logs for controlling soil erosion and favoring forest self-regeneration in post-fire conditions, obtaining encouraging results.

Todisco et al. [15] developed a runoff correction factor for the USLE using rainfall and satellite antecedent soil moisture data. They also validated the obtained estimates of runoff and soil loss using plot-scale measurements obtained at SERLAB (Soil Erosion Laboratory) of the University of Perugia. The authors found that the event rainfall depth added to the antecedent soil moisture is a suitable predictor of the runoff.

The article by De Girolamo et al. [16] deals with the measurements of the suspended sediment load in two mountainous river basins in Apulia. The authors developed sediment rating curves to address gaps in the suspended sediment concentration time series. They also obtained that the majority of the suspended sediment load was transported during high-flow conditions, accounting for over 80% of the total load, while, for low-flow conditions, it constituted less than 1% of the total load.

Vergni and Todisco [17] used the datasets comprising many years of soil loss observations at the plot-scale experimental site SERLAB, and applied the random forest machine learning model. This model achieved a global accuracy of 84.8% in recognizing erosive and non-erosive events, demonstrating slightly better performances than non-machine learning methodologies.

Finally, the review paper by Pampalone et al. [18] provides an insight into the scientific activity conducted from the 2000s using the data collected in the plots installed at the Sparacia experimental area for soil erosion measurement in Sicily (South Italy). The authors also described methods and procedures for quantify soil erosion processes (sediment sampling and water level reading in the storage tanks for total erosion measurements; profilometer, and structure from motion technique for rill erosion measurements).

The research's new and relevant findings will help to study soil erosion and understand the dynamics of some processes regarding this topic. The chosen articles advance our knowledge on how water soil erosion can be controlled and reduced, and could give further ideas about what can be investigated in future and what the main challenges are in this field of study.

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