5th INTERNATIONAL CONGRESS of the European Society for Soil Conservation

Palermo - June, 25-30 2007

5th INTERNATIONAL CONGRESS OF ESSC

EUROPEAN SOCIETY FOR SOIL CONSERVATION

Changing Soils in a Changing World: the Soils of Tomorrow

BOOK of ABSTRACTS

Editor: Carmelo Dazzi

Palermo, University campus
June 25-30, 2007

ISBN 978-88-9572-09-2

Delay times for saturation overland flow in forest soils

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Delay time to runoff generation, defined as the time that it takes from the start of the rainfall because runoff occurs, is strongly related to the mechanism of runoff production. In arid and semi-arid regions, characterised by high rainfall intensities on soil exhibiting low permeability and poor vegetation cover, the runoff generation mechanism is the *Hortonian overland flow* and the associated delay time is commonly called *time to ponding*; reaching of time to ponding requires that rainfall intensity exceeds infiltration capacity, so that wetting front moves from the upper to the lower horizon (soil saturation from above).

Differently, in humid regions, characterised by high groundwater table, high vegetation cover with very structured soils, because of the very high content in organic matter, such as forest soils, infiltration capacity exceeds rainfall intensity. Runoff production is linked to occurrence of i) a not very deep upper horizon with permeability much higher then the lower horizon or ii) a perched water table. In both cases, soil starts to saturate at the bottom of the permeable layer and, contrary to *Hortonian overland flow*, wetting front moves from the lower to the upper horizon (soil saturation from below). Once the soil is saturated (i.e. delay time is reached) its infiltration capacity is zero, so any additional rain will not infiltrate, it be will stored on the surface or become overland flow. This mechanism of runoff production is called *saturation overland flow* and the associated delay time can be approximated to the time that it takes for the wetting front to reach the bottom of the high permeable upper horizon (or the perched water table). Particularly for forest area, delay time to runoff generation includes the additional delay due to the interception loss. Net rainfall intensity growths attaining to gross rainfall intensity, when interception storage capacity is achieved.

In this work, for *saturation overland flow* conditions, by modelling the flow in the unsaturated zone by a simple piston displacement model, firstly a delay time relationship is derived and helpfully compared to that of time to ponding (Green and Ampt, 1933) valid for *Hortonian overland flow*. An analytical solution of the maximum delay time, i.e. the delay time associated to zero antecedent soil moisture condition, accounting for the additional delay due to interception, for constant rainfall intensity, is presented. An application of the model is carried out for a forest Sicilian basin (10 km^2), Eleuterio at Lupo. A lot of characteristics of the basin (pedology, soil use, etc.) are known by previous studies (Dazzi et al., 1983; Gianguzzi, 2004). NDVI, widely recognised as a good estimator of middle and high vegetation cover, is used to evaluate vegetation parameters figuring in the interception model. Soil hydrological characteristics will be provided by deriving water-retention curves and by using the SFH method (simplified falling-head technique) recently introduced (Bagarello et al., 2004) to determine saturated hydraulic conductivity. The probability of the antecedent soil moisture condition is determined by using the eco-hydrological approach introduced by Rodriguez-Iturbe et al. (1999, 2000), which results are supported by dendrochronological records. Delay times to runoff production measured at the outlet for 30 rainfall events are compared to those obtained by the application of the model.

Key-words: infiltration; interception; delay time.