Geophysical Research Abstracts
Vol. 14, EGU2012-2764, 2012
EGU General Assembly 2012

Generalizing a complex model for gully threshold identification in the Mediterranean environment

D. Torri (1), L. Borselli (2), P. Iaquinta (3), G. Iovine (3), J. Poesen (4), and O. Terranova (3)

(1) National Research Council, Research Institute for Geo-hydrologic Protection, Perugia, Italy (torri@cnr.it, +39 75 5014421), (2) Instituto de Geologia / Fac. De Ingegneria, Universitad Autonoma de San Luis Potosì (UASLP), Av. Dr. Manuel Nava 5, 78240 San Luis Potosí, S.L.P. – MEXICO, (3) National Research Council, Research Institute for Geo-Hydrologic Protection, Via Cavour 6, 87036 Rende(CS), Italy, E-mail: iaquinta@irpi.cnr.it, iovine@irpi.cnr.it, terranova@irpi.cnr.it, (4) Physical and Regional Geography Research Group, K.U. Leuven, GEO-INSTITUTE, Celestijnenlaan 200 E, B-3001 Heverlee, Belgium, Email: Jean.poesen@geo.kuleuven.ac.be

Among the physical processes leading to land degradation, soil erosion by water is the most important and gully erosion may contribute, at places, to 70% of the total soil loss. Nevertheless, gully erosion has often been neglected in water soil erosion modeling, whilst more prominence has been given to rill and interrill erosion.
Both to facilitate the processing by agricultural machinery and to take advantage of all the arable land, gullies are commonly removed at each crop cycle, with significant soil losses due to the repeated excavation of the channel by the successive rainstorm.
When the erosive forces of overland flow exceed the strength of the soil particles to detachment and displacement, water erosion occurs and usually a channel is formed. As runoff is proportional to the local catchment area, a relationship between local slope, S, and contributing area, A, is supposed to exists. A “geomorphologic threshold” scheme is therefore suitable to interpret the physical process of gully initiation: accordingly, a gully is formed when a hydraulic threshold for incision exceeds the resistance of the soil particles to detachment and transport. Similarly, it appears reasonable that a gully ends when there is a reduction of slope, or the concentrated flow meets more resistant soil-vegetation complexes.
This study aims to predict the location of the beginning of gullies in the Mediterranean environment, based on an evaluation of S and A by means of a mathematical model. For the identification of the areas prone to gully erosion, the model employs two empirical thresholds relevant to the head (Thead) and to the end (Tend) of the gullies (of the type SAˆb>Thead, SAˆb<Tend). Such thresholds represent the resistance of the environment to gully erosion, depending on: stoniness, vegetation cover, propensity to tunneling erosion due to soil dispersibility in water, and the intrinsic characteristics of the eroded material and of the erosivity of the rainfall event. Such thresholds must be weighed with the local steepness S and applied to all the points of the spatial domain. The mathematical model works in steps as follows: (i) the territory is partitioned into elementary cells, (ii) a pre-processing allows for the identification and removal of sinks in the DTM, (iii) through analyses of hydraulic connectivity, the hierarchical relationships between the various cells are determined.
A collection of literature data on the problem of topological threshold Thead has been made. In particular, databases relevant to both a) rangeland and b) renaturation situations (usually after abandonment), and c) databases for cropland have been merged. Selected data have been examined and interpreted mathematically to assess a value to be taken as a constant for the exponent “b” of the above equation. Literature data on the problem of topological thresholds Tend are quite few. The basin area loses its relevance in the considered relationship between A and S; therefore, a constant value of S can be chosen as a threshold, as the trend with the basin area can present a very small exponent.
The basin considered in the present study is the “Esaro of Crotone” in Calabria (Southern Italy). To calibrate the model, the following layers have been employed: (i) a 5-m DTM, (ii) a soil map at 1:25000 scale, (iii) a land use map (CORINE-level IV). A sample check of the data has been conducted with some direct surveys. Validation of the model and evaluation of its performances have been performed through photo-interpretation of low-altitude flights. As a result, a susceptibility map to gully erosion is presented, related to the different combination among A, S, land use and soil characteristics that characterize the examined basin. Finally, an analysis is proposed, based on the comparison between the current land use and a scenario with insertion of sown grass strips for certain land uses and slope classes.