Geophysical Research Abstracts,
Vol. 10, EGU2008-A-00662, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-00662
EGU General Assembly 2008

Critical dependence of surface runoff on generating and intercepting covers relative areas

D. Nezlobin (1), G. Sinai (1), H. Rubin (1), H. Lavee (2), S. Pariente (2), E. Sachs (2)
(nezlobin@techunix.technion.ac.il / phone: 972 4 8292343)

Mixed land cover (LC) often consists of runoff generating (e.g. rock outcrops) and intercepting (e.g. dense vegetation) cover types. The relative areas and spatial arrangement of covers affect the abundance of the flow pathways avoiding interception, and, therefore, surface runoff connectivity and delivery to the slope base. To investigate these effects quantitatively, rain simulator laboratory experiment has been conducted and its results explained in terms of percolation theory modifications. (Percolation theory describes transport properties of statistically large, partly connected systems, especially their critical dependence on macroscopic connectivity).

In the rain simulator experiment the generating cover has been represented by impervious patches and the intercepting one by sand. Relative cover areas, their spatial arrangement and slope steepness have been altered and meaningful surface runoff characteristics, such as initiation times on different length scales and the total cumulative runoff, have been measured.

The total observed surface runoff and the probability of obtaining surface runoff of a certain length have been found to depend critically on the generating and intercepting covers relative areas. (For the same values of relative areas results have been obtained for various spatial arrangements and then averaged). The mathematical explanation of the observed critical dependence is as follows: average size of generating cover clusters increases sharply when the generating cover relative area reaches the finite axial percolation threshold. The character of this increase and its dependence on scale of observation are well known from the percolation theory. As a result, the number of continuous pathways throughout the generating cover increases sharply, however these pathways can still be too tortuous for surface runoff. Finally, for even higher values of the generating cover's relative area (around the straight percolation threshold), the number of straight pathways throughout this cover increases sharply. This leads, in turn, to much greater surface runoff connectivity and effective discharge. To check this explanation we have introduced the SCGA (Straightly Connected Generating Area) which is the area of generating cover connected by straight pathways to the system outlet (slope base). Almost perfect linear dependence has been found between critical growth of SCGA and that of cumulative surface runoff. The predictability of surface runoff characteristics is minimal for generating relative areas taking values near the straight percolation threshold, since in this range various spatial arrangements of the same generating area may have notably different SCGA.

For systems with a complex topography the generating area connected by the limited tortuosity pathways (LTCGA) can be considered instead of the SCGA.

It seems, therefore, that the straight or limited percolation approach provides reasonably good geometric estimators (SCGA or LCGA) of the maximal contributing area and allows quantitative description of changes in the surface runoff connectivity, when the latter is affected by land cover. In particular, this approach explains mathematically the critical dependence of surface runoff on covers relative areas, observed in many land use and land cover change (LCC) studies, and supported by the conducted experiment.