Geophysical Research Abstracts
Vol. 18, EGU2016-289, 2016
EGU General Assembly 2016

Comparing a simple methodology to evaluate hydrodynamic parameters with rainfall simulation experiments

Simone Di Prima (1), Vincenzo Bagarello (2), Inmaculada Bautista (3), Maria Burguet (1), Artemi Cerdà (1), Massimo Iovino (2), and Massimo Prosdocimi (4)

(1) Department of Geography, University of Valencia, València, Spain (sidipri@alumni.uv.es), (2) Department of Agricultural and Forest Sciences, University of Palermo, Palermo, Italy, (3) Universidad Politécnica de Valencia, Hydraulic and Environmental Engineering, Valencia, Spain, (4) Department of Land, Environment, Agriculture and Forestry, University of Padova, Legnaro PD, Italy

Studying soil hydraulic properties is necessary for interpreting and simulating many hydrological processes having environmental and economic importance, such as rainfall partition into infiltration and runoff. The saturated hydraulic conductivity, K_s, exerts a dominating influence on the partitioning of rainfall in vertical and lateral flow paths. Therefore, estimates of K_s are essential for describing and modeling hydrological processes (Zimmermann et al., 2013). According to several investigations, K_s data collected by ponded infiltration tests could be expected to be unusable for interpreting field hydrological processes, and particularly infiltration. In fact, infiltration measured by ponding give us information about the soil maximum or potential infiltration rate (Cerdà, 1996).

Moreover, especially for the hydrodynamic parameters, many replicated measurements have to be carried out to characterize an area of interest since they are known to vary widely both in space and time (Logsdon and Jaynes, 1996; Prieksat et al., 1994). Therefore, the technique to be applied at the near point scale should be simple and rapid.

Bagarello et al. (2014) and Alagna et al. (2015) suggested that the K_s values determined by an infiltration experiment carried applying water at a relatively large distance from the soil surface could be more appropriate than those obtained with a low height of water pouring to explain surface runoff generation phenomena during intense rainfall events. These authors used the Beerkan Estimation of Soil Transfer parameters (BEST) procedure for complete soil hydraulic characterization (Lassabatère et al., 2006) to analyze the field infiltration experiment. This methodology, combining low and high height of water pouring, seems appropriate to test the effect of intense and prolonged rainfall events on the hydraulic characteristics of the surface soil layer. In fact, an intense and prolonged rainfall event has a perturbing effect on the soil surface and, reasonably, it can better be represented by the high runs than the low runs (Alagna et al., 2015). Obviously, this methodology is also simpler than an approach involving soil characterization both before and after natural or simulated rainfall since it needs less equipment and field work.

On the other hand, rainfall simulation experiments are more realistic and accurate, but also more sophisticated and costly (Cerdà, 1997). Rainfall simulation is often used to measure the infiltration process (e.g., Bhardwaj and Singh, 1992; Cerdà, 1999, 1997, 1996; Cerdà and Doerr, 2007; Iserloh et al., 2013; Liu et al., 2011; Tricker, 1979), and it has become an important method for assessing the subjects of soil erosion and soil hydrological processes (Iserloh et al., 2013). Its application allows a quick, specific and reproducible assessment of the meaning and impact of several factors, such as slope, soil type (infiltration, permeability), soil moisture, splash effect of raindrops (aggregate stability), surface structure, vegetation cover and vegetation structure (Bowyer-Bower and Burt, 1989).

The objectives of this investigation are: (i) to compare infiltration rates measured by applying water at a relatively large distance from the soil surface with those obtained by rainfall simulation experiments and (ii) to verify if the K_s values determined with the BEST procedure are in line with the occurrence of runoff measured with a more robust methodology.

Acknowledgements

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 603498 (RECARE project).

References

Alagna, V., Bagarello, V., Di Prima, S., Giordano, G., Iovino, M., 2015. Testing infiltration run effects on the estimated hydrodynamic parameters of a sandy-loam soil. Submitted to Geoderma.

Bagarello, V., Castellini, M., Di Prima, S., Iovino, M., 2014. Soil hydraulic properties determined by infiltration experiments and different heights of water pouring. Geoderma 213, 492–501. doi:10.1016/j.geoderma.2013.08.032

Bhardwaj, A., Singh, R., 1992. Development of a portable rainfall simulator infiltrometer for infiltration, runoff and erosion studies. Agricultural Water Management 22, 235–248. doi:10.1016/0378-3774(92)90028-U

Bouwer, H., 1966. Rapid field measurement of air entry value and hydraulic conductivity of soil as significant parameters in flow system analysis. Water Resour. Res. 2, 729–738. doi:10.1029/WR002i004p00729

Bowyer-Bower, T.A.S., Burt, T.P., 1989. Rainfall simulators for investigating soil response to rainfall. Soil Technology 2, 1–16. doi:10.1016/S0933-3630(89)80002-9

Cerdà, A., 1999. Simuladores de lluvia y su aplicación a la Geomorfologia: estado de la cuestión. Cuadernos de investigación geográfica 45–84.

Cerdà, A., 1997. Seasonal changes of the infiltration rates in a Mediterranean scrubland on limestone. Journal of Hydrology 198, 209–225. doi:10.1016/S0022-1694(96)03295-7

Cerdà, A., 1996. Seasonal variability of infiltration rates under contrasting slope conditions in southeast Spain. Geoderma 69, 217–232. doi:10.1016/0016-7061(95)00062-3

Cerdà, A., Doerr, S.H., 2007. Soil wettability, runoff and erodibility of major dry-Mediterranean land use types on calcareous soils. Hydrol. Process. 21, 2325–2336. doi:10.1002/hyp.6755

Iserloh, T., Ries, J.B., Arnáez, J., Boix-Fayos, C., Butzen, V., Cerdà, A., Echeverría, M.T., Fernández-Gálvez, J., Fister, W., Geißler, C., Gómez, J.A., Gómez-Macpherson, H., Kuhn, N.J., Lázaro, R., León, F.J., Martínez-Mena, M., Martínez-Murillo, J.F., Marzen, M., Mingorance, M.D., Ortigosa, L., Peters, P., Regüés, D., Ruiz-Sinoga, J.D., Scholten, T., Seeger, M., Solé-Benet, A., Wengel, R., Wirtz, S., 2013. European small portable rainfall simulators: A comparison of rainfall characteristics. CATENA 110, 100–112. doi:10.1016/j.catena.2013.05.013

Lassabatère, L., Angulo-Jaramillo, R., Soria Ugalde, J.M., Cuenca, R., Braud, I., Haverkamp, R., 2006. Beerkan Estimation of Soil Transfer Parameters through Infiltration Experiments—BEST. Soil Science Society of America Journal 70, 521. doi:10.2136/sssaj2005.0026

Liu, H., Lei, T.W., Zhao, J., Yuan, C.P., Fan, Y.T., Qu, L.Q., 2011. Effects of rainfall intensity and antecedent soil water content on soil infiltrability under rainfall conditions using the run off-on-out method. Journal of Hydrology 396, 24–32. doi:10.1016/j.jhydrol.2010.10.028

Logsdon, S.D., Jaynes, D.B., 1996. Spatial Variability of Hydraulic Conductivity in a Cultivated Field at Different Times. Soil Science Society of America Journal 60, 703. doi:10.2136/sssaj1996.03615995006000030003x

Prieksat, M.A., Kaspar, T.C., Ankeny, M.D., 1994. Positional and Temporal Changes in Ponded Infiltration in a Corn Field. Soil Science Society of America Journal 58, 181. doi:10.2136/sssaj1994.03615995005800010026x

Tricker, A.S., 1979. The design of a portable rainfall simulator infiltrometer. Journal of Hydrology 41, 143–147. doi:10.1016/0022-1694(79)90111-2

van De Giesen, N.C., Stomph, T.J., de Ridder, N., 2000. Scale effects of Hortonian overland flow and rainfall–runoff dynamics in a West African catena landscape. Hydrol. Process. 14, 165–175. doi:10.1002/(SICI)1099-1085(200001)14:1<165::AID-HYP920>3.0.CO;2-1

Zimmermann, A., Schinn, D.S., Francke, T., Elsenbeer, H., Zimmermann, B., 2013. Uncovering patterns of near-surface saturated hydraulic conductivity in an overland flow-controlled landscape. Geoderma 195-196, 1–11. doi:10.1016/j.geoderma.2012.11.002