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Modelling spatial distribution of soil steady state infiltration rate in an urban park (Vingis Parkas, Vilnius, Lithuania)

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Within the hydrological process, infiltration is a key component as control the partitioning of the rainfall into runoff or soil water (Cerdà, 1997). And the infiltration process is determining the fate of the soil development and the human impact in the soil system (Brevik et al., 2015). On forest soils, the infiltration use to be high due to the macropore flow, which drainages the surface runoff usually generated by the hydrophobic response of soil reach in organic matter (Hewelke et al., 2015) or as a consequence of forest fires (Jordán et al., 2010; Pereira et al., 2014) due to the development of water repellent substances (Mao et al., 2015), which are mainly associated to the ash (Pereira et al., 2014; Pereira et al., 2015). To understand the role the infiltration plays in the soil development and the runoff generation is important, and also is necessary to understand how some factors such as vegetation, crust, stones, litter, mulches… play in the hydrological, erosional and pedological system (Cerdà, 2001; Keesstra, 2007; Liu et al., 2014; Bisantino et al., 2015; Cassinari et al., 2015, Cerdà et al., 2015; Mohawesh et al., 2015; Terribile et al., 2015). The well-know importance of the infiltration process did not resulted in the research on the infiltration on urban areas, although there is where the infiltration is more altered.

Water infiltration is extremely important in urbanized areas, since the majority of the surfaces are sealed by concrete, asphalt and other materials. Soil sealing increases exponentially the impacts of flash floods and reduces soil infiltration capacity. This decreases importantly one of the most important services provided by soil: water storage and infiltration. In this context, the existence of green areas and urban parks are of major importance to mitigate the impact of human settlements in soil water infiltration. The aim of this work is to assess the spatial distribution of steady-state soil water infiltration in the larger urban park in Vilnius, Vinguis Parkas. The studied area is located near the Neris River and occupies an area of approximately 162 hectares. Inside the park a total of 95 randomly points were selected to measure soil steady infiltration, between April and September of 2016. At each sampling point, 4 infiltration measurements were carried out using a cylinder infiltrometer with 15 cm higher and a diameter of 7 cm (Cerda, 1996). Each experiment has the duration of 1 hour and the measurements of the infiltrated water were carried out 1, 2, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55 and 60 minutes (Cerda, 1996). The steady state infiltration value of each sampling point corresponds to the average value of the 4 measurements. In each point, the 4 measurements were separated by 5 meters to take in account the spatial variability (Neris et al., 2013). In total 380 infiltration tests were carried out (95x4). Previous to data modelling, data normality was assessed using the shapiro wilk-test and homogeneity of the variances, using Levene test, respectively. The original data was not normally distributed and, only respected the Gaussian distribution and heteroscedasticity after a logarithmic transformation. Data modelling was carried out using transformed data. The accuracy of steady-state soil infiltration spatial distribution was carried out testing several interpolation methods, as Inverse Distance to a Weight (IDW) with the power of 1,2,3,4 and 5, Local Polynomial methods, with the power of 1 and 2 Radial Basis Functions – Spline With Tension (SPT), Completely Regularized Spline (CRS), Multiquadratic (MTQ), Inverse Multiquadratic (IMTQ) and Thin Plate Spline (TPS) – and Geostatistical methods as, Ordinary Kriging (OK), Simple Kriging (SK) and Universal Kriging (UK) (Pereira et al., 2015). Methods performance was assessed calculating the Root Square Mean Error (RMSE) from the errors obtained from cross-validation. The results showed that on average steady state infiltration rate was 69 mm h-1, with a minimum of 12.72 mm h-1 and a maximum of 692.31 mm h-1. The spatial variability was extremely high (coefficient of variation of 153.71). Among the methods tested the most accurate was SK (RMSE=0.542) and the least precise TPS (RMSE=0.695). With the exception of the IDW5, all the correlations between observed and estimated values were significant at a $p<0.05$. All the residuals followed the normal distribution. Steady state infiltration was high in the southern and central part of the plot (where the human impact is high) and low in the northern part of the park, where forests

are denser.

References

Bisantino, T., Bingner, R., Chouaib, W., Gentile, F., Trisorio Liuzzi, G. (2015) Estimation of runoff, peak discharge and sediment load at the event scale in a medium-size mediterranean watershed using the annagnps model Land Degradation and Development, 26, 340-355.

Brevik, E. C., Cerdà, A., Mataix-Solera, J., Pereg, L., Quinton, J. N., Six, J., Van Oost, K. (2015) The interdisciplinary nature of SOIL. SOIL, 1, 117-129.

Cassinari, C., Manfredi, P., Giupponi, L., Trevisan, M., Piccini, C. (2015). Relationship between hydraulic properties and plant coverage of the closed-landfill soils in Piacenza (Po Valley, Italy). Solid Earth, 6, 929-943.

Cerdà, A. (1996) Seasonal variability of infiltration rates under contrasting slope conditions in southeast Spain. Geoderma, 69, 217-232.

Cerdà, A., González-Pelayo, O., Giménez-Morera, A., Jordán, A., Pereira, P., Novara, A., Brevik, E.C., Prosdocimi, M., Mahmoodabadi, M., Keesstra, S., García Orenes, F., Ritsema, C. (2015) The use of barley straw residues to avoid high erosion and runoff rates on persimmon plantations in Eastern Spain under low frequency – high magnitude simulated rainfall events. Soil Research (In press)

Cerdà, A. (2001) Effects of rock fragment cover on soil infiltration, interrill runoff and erosion. European Journal of Soil Science, 52, 59-68.

Cerdà, A. (1997) Seasonal changes of the infiltration rates in a mediterranean scrubland on limestone. Journal of Hydrology, 198, 209-225.

Hewelke, E., Szatyłowicz, J., Gnatowski, T., Oleszczuk, R. (2015) Effects of soil water repellency on moisture patterns in a degraded sapric histosol, Land Degradation and Development, DOI: 10.1002/ldr.2305

Jordán, A., González, F.A., Zavala, L.M. (2010) Re-establishment of soil water repellency after destruction by intense burning in a Mediterranean heathland (SW Spain). Hydrological Processes, 24, 736-748.

Keesstra, S.D. (2007) Impact of natural reforestation on floodplain sedimentation in the Dragonja basin, SW Slovenia. Earth Surface Processes and Landforms, 32, 49-65.

Liu, Z., Yao, Z., Huang, H., Wu, S., Liu, G. (2014) Land use and climate changes and their impacts on runoff in the Yarlung Zangbo river basin, China. Land Degradation and Development, 25, 203-215.

Mao, J., Nierop, K.G.J., Rietkerk, M., Dekker, S.C. (2015) Predicting soil water repellency using hydrophobic organic compounds and their vegetation origin. SOIL, 1, 411-425.

Mohawesh, Y., Taimeh, A., Ziadat, F. (2015) Effects of land use changes and soil conservation intervention on soil properties as indicators for land degradation under a Mediterranean climate Solid Earth, 6, 857-868.

Neris, J., Jimenez, C., Fuentes, J., Morillas, G., Tejedor, M. (2012) Vegetation and land-use effects on soil properties and water infiltration of Andisols in Tenerife (Canary Islands, Spain). Catena, 98, 55-62.

Pereira, P., Cerda, A., Ubeda, X., Mataix-Solera, J., Arcenegui, V., Zavala, L. (2015) Modelling the impacts of wildfire on ash thickness in short-term period. Land Degradation and Development, 26, 180-192.

Pereira, P., Úbeda, X., Martin, D., Mataix-Solera, J., Cerdà, A., Burguet, M. Wildfire effects on extractable elements in ash from a Pinus pinaster forest in Portugal (2014) Hydrological Processes, 28, 3681-3690.

Pereira, P., Úbeda, X., Mataix-Solera, J., Oliva, M., Novara, A. (2014) Short-term changes in soil Munsell colour value, organic matter content and soil water repellency after a spring grassland fire in Lithuania. Solid Earth, 5, 209-225.

Terribile, F., Agrillo, A., Bonfante, A., Buscemi, G., Colandrea, M., D'Antonio, A., De Mascellis, R., De Michele, C., Langella, G., Manna, P., Marotta, L., Mileti, F.A., Minieri, L., Orefice, N., Valentini, S., Vingiani, S., Basile, A. A (2015) Web-based spatial decision supporting system for land management and soil conservation. Solid Earth, 6, 903-928.