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Effect of the method of estimation of soil saturated hydraulic conductivity with regards to the design of stormwater infiltration trenches

Artur Paiva coutinho (1), Dieuseul Predelus (1), Laurent Lassabatere (1), Erij Ben Slimene (1), Antonio Celso Dantas Antonino (2), Thierry Winiarski (1), Jaime Joaquim da Silva Pereira Cabral (2), and Rafael Angulo-Jaramillo (1)

(1) Université de Lyon, Laboratoire d'Ecologie des Hydrosystèmes Naturels et Anthropisés, LEHNA, UMR 5023 CNRS, ENTPE, UCB-Lyon-1, Rue Maurice Audin, 69518 Vaulx-en-Velin, FranceFrance (artur.coutinho@entpe.fr), (2) Universidade Federal de Pernambuco, Centro de Tecnologia e Geociências,. Av. Prof. Luiz Freire, 1000, Cidade Universitária,50740540 - Recife, PE - Brasil, acda@ufpe.br

Best management practices are based on the infiltration of stormwater (e.g. infiltration into basins or trenches) to reduce the risk of flooding of urban areas. Proper estimations of saturated hydraulic conductivity of the vadose zone are required to avoid inappropriate design of infiltration devices. This article aims at assessing (i) the method-dependency of the estimation of soils saturated hydraulic conductivity and (ii) the consequences of such dependency on the design of infiltration trenches. This is illustrated for the specific case of an infiltration trench to be constructed to receive stormwater from a specific parking surface, 250 m2 in area, in Recife (Brazil). Water infiltration experiments were conducted according to the Beerkan Method, i.e. application of a zero water pressure head through a disc source (D=15 cm) and measures of the amount of infiltrated water with time. Saturated hydraulic conductivity estimates are derived from the analysis of these infiltration tests using several different conceptual approaches: one-dimensional models of Horton(1933) and Philip(1957), three-dimensional methods recently developed (Lassabatere et al., 2006, Wu et al., 1999, and Bagarello et al., 2013) and direct 3-dimensional numerical inversion. The estimations for saturated hydraulic conductivity ranged between 65.5 mm/h and 94 mm/h for one-dimensional methods, whereas using three-dimensional methods saturated hydraulic conductivity ranged between 15.6 mm/h and 50 mm/h. These results shows the need for accounting for 3D geometry, and more generally, the physics of water infiltration in soils, if a proper characterization of soil saturated hydraulic conductivity is targeted. In a second step, each estimate of the saturated hydraulic conductivity was used to calculate the stormwater to be stored in the studied trench for several rainfall events of recurrence intervals of 2 to 25 years. The calculation of these volumes showed a great sensitivity with regards to the estimated values of saturated hydraulic conductivity. The designed volumes of the trench vary from 8.3 m3 to 15.9 m3 for one-dimensional methods and 11.9 m3 to 24.5 m3 for three-dimensional methods, respectively. The results show that any miss-estimation of the saturated hydraulic conductivity of soils may drastically impact the design of infiltration devices and the related extra-costs.

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