CHANGES IN HYDRAULIC CONDUCTIVITY OF FOREST SOIL.

Mgr. Anton Zvala, PhD.
Institute of Hydrology SAS, Dúbravská cesta 9, 841 04 Bratislava Author, zvala@uh.savba.sk

ABSTRACT

Most infiltration methods measure the saturated hydraulic conductivity only one depth at or near the surface. Measurement results extend the theory of hydraulic conductivity of the soil at various depths. An organic horizon is created on the forest floor surface, which causes an increase in saturated hydraulic conductivity. Hydraulic conductivity with soil depth decreases, this claim applies to research sites 3, 4, 5 and 6. Research sites 1 and 2 differ in hydraulic conductivity. The impact of relief on saturated hydraulic conductivity at soil sampling point 1 in the dead arm of river, where saturated hydraulic conductivity increases at a soil depth 0.5 m. The increase in saturated hydraulic conductivity may be caused by soil erosion from the dead arm of river slope, which covered the organic horizon of the forest soil.

Keywords: saturated hydraulic conductivity, texture a structure of soil, relief, fluvisol, soil erosion

METHODS AND DATA

Measurement of hydraulic conductivity on a device with variable hydraulic head (standard method according to the norm).
Research site The research site is located in the Bratislava cadastre Podunajské Biskupice, south of Lieskovec (Nature reserve Topoľové hony a Biskupické luhy). It is part of the Danube Lowland and the Danube Plain. Six soil sampling points were selected at the research site (Table 2). We collected 11 soil samples at 0-1 m depth at each sampling point. Soil sampling point 1 is in the dead arm of the river 2.5 m below ground level and soil sampling point 2 is 20 m away from soil sampling point 1 at ground level. Soil sampling points 3 and 4 are 50 m away from soil sampling points 1 and 2. Soil sampling point 3 is in the dead arm of the river, 3 m below ground level and the soil sampling point 4 is 20 m away from the soil sampling point 3 at ground level. The next soil sampling points 5 and 6 are 1200 m away from soil sampling points 3 and 4. Soil sampling point 5 is in a dead arm of the river, 3 m below ground and soil sampling point 6 is 20 m away from soil sampling point 1 at ground level. We collected one soil sample into a roller, from each sampling site and soil depth. Hydraulic conductivity was measured repeatedly three times on each soil sample.

RESULTS AND DISCUSSION

A graphical representation of saturated hydraulic conductivity towards the depth of the soil is shown in the Figure 1. An organic horizon forms on the surface of forest soil, which has specific properties and causes increase in saturated hydraulic conductivity. We measured the values of saturated hydraulic conductivity for the soil sampling points 1, 2, 3 and 4, soil depth 0 m in the range from $(4.3\pm0.6)\times10^{-6}$ m·s $^{-1}$ to $(2.2\pm0.3)\times10^{-5}$ m·s^{-1}. We measured similar values for organic horizons of forest soil (Zvala et al., 2017, Orfánus et al., 2021). At the soil sampling points 5 and 6 is a layer of soil at soil depth 0 cm with lower saturated hydraulic conductivity. At soil depth 0.1 cm is higher saturated hydraulic conductivity. The organic horizon is probably covered by an erosion layer of soil. Hydraulic conductivity with soil depth decreases (Southard and Buol, 1998, Chen and Hsu, 2012, Awedat et al., 2021). This claim applies to research sites 3, 4, 5 and 6. For comparison, we had three pairs of measuring points, with one of the pairs of measuring points located between 2.5 m and 3 m below ground level in the dead arm of the river. From the graphical representation (Fig. 1.) it was found that the measuring points at greater depth had lower hydraulic conductivity. This claim does not apply to the pair of measuring points 1 and 2 where the hydraulic conductivity values were influenced by organic matter at a soil depth of 0.5 m (Fig.2). The impact of relief on saturated hydraulic conductivity at soil sampling point 1 in the dead arm of river, where saturated hydraulic conductivity increases at a soil depth 0.5 m (Fig. 2.). We measured an increase in saturated hydraulic conductivity $(4.5\pm0.3)\times10^{-5}$ m·s^{-1} in soil depth 0.5 m, soil sampling point 1. The increase in saturated hydraulic conductivity may be caused by soil erosion from the dead arm of river slope, which covered the organic horizon of the forest soil. Fig. 3 shows a mixed layer of organic matter with mineral matter and undecomposed vegetation roots, which confirm the covering of the organic horizon of the forest soil by an eroded soil layer.

CONCLUSIONS

Differences in saturated hydraulic conductivity in natural conditions are caused texture and structure of soil, relief, spatial variability of soil, fluvial and erosional activity. An organic horizon forms on the surface of forest soil, which has specific properties and causes an increase in saturated hydraulic conductivity (Zvala et al., 2017). Most infiltration methods measure the saturated hydraulic conductivity of the unsaturated zone at only one depth at or near the surface. Measurement results extend the theory of hydraulic conductivity of the soil at various depths in a one-dimensional saturated vertical flow domain. The hydraulic conductivity towards the soil depth decreases (Southard and Buol, 1998, Chen and Hsu, 2012, Awedat et al., 2021). For comparison, we had three pairs of measuring points, with one of the pairs of measuring points located between 2.5 m and 3 m below ground level in the dead arm of the river. From the graphical representation (Fig. 1) it was found that the measuring points at greater depth had lower hydraulic conductivity. The hydraulic conductivity towards the soil depth decreases does not apply to the pair of measuring points 1 and 2 where the hydraulic conductivity values were influenced by organic matter at a soil depth of 0.5 m (Fig. 2). The increase in saturated hydraulic conductivity may be caused by soil erosion from the dead arm of river slope (with inclination 5 - 20°), which covered the organic horizon of the forest soil in the dead arm of the river (Minár et al., 2001). Similar land cover due to soil erosion was identified by the authors (Calitri et al., 2020, Ni et al., 2024). Small soil particles (e.g. gley layer in fluvisol, soil sampling points 3, soil depth 0.9 m) cause less space for water movement in soil and decrease saturated hydraulic conductivity.

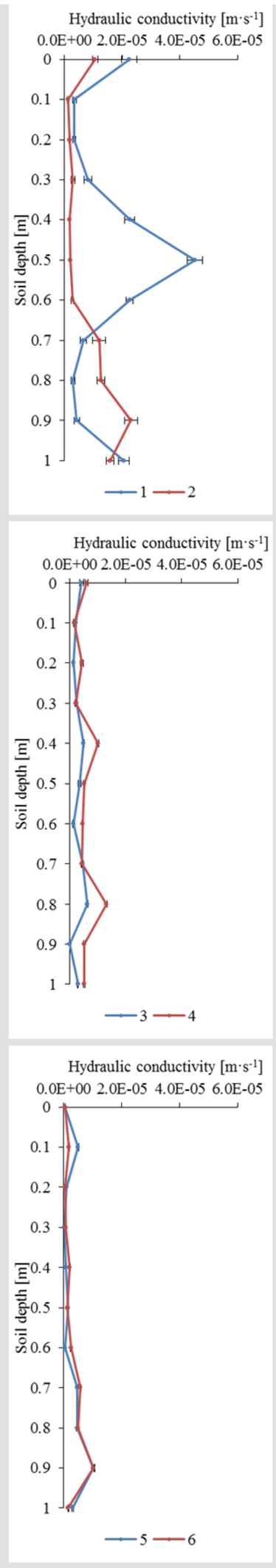

Fig. 1. Graphs of average saturated hydraulic conductivity and standard deviation for measurement points 1-6

Fig. 2. Overlaid organic horizon of forest soil at research site 1. White circles indicate visible vegetation roots and darker organic matter.

Acknowledgement
The poster is the result of the implementation of the VEGA Grant Agency project 2/0035/23 Influence of heating on hydrophysical and chemical properties of forest soil.