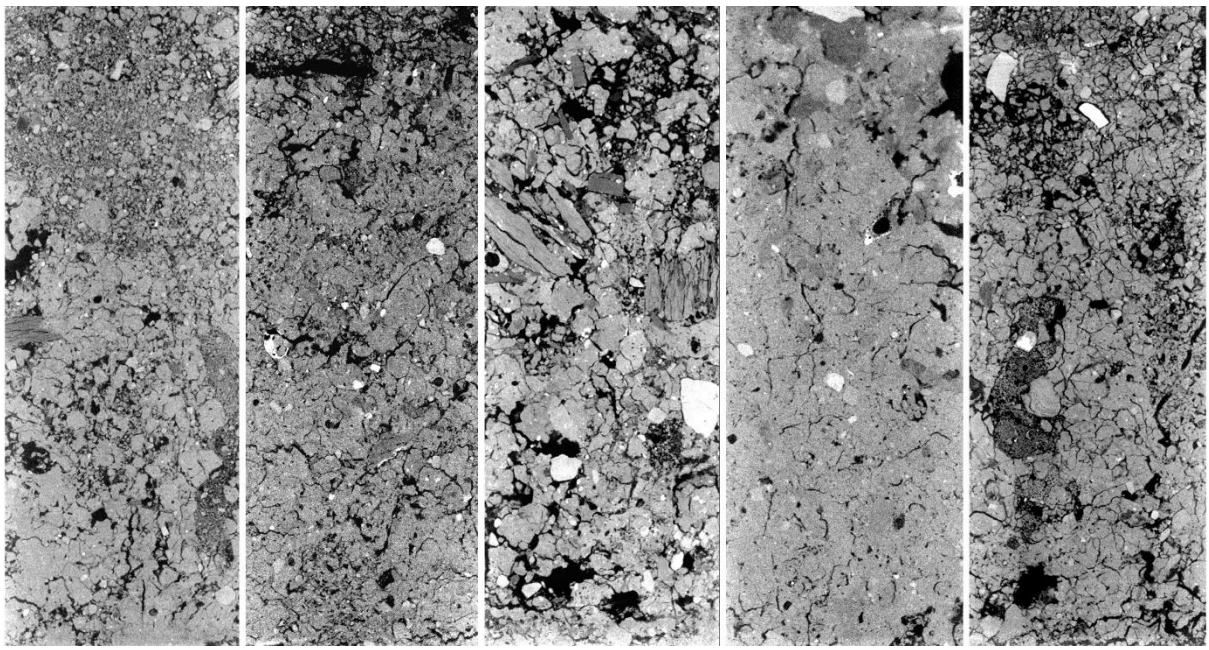
Czech University of Life Sciences Prague
and
Czech Society of Soil Science

6th International Symposium of Soil Physics

February 6-7, 2024

Prague, Czech Republic



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Program

Tuesday, February 6

Time	Authors and Title
9:00 - 9:30	Arrival, registration
9:30 - 9:40	Radka Kodešová: Opening remarks
9:40 - 10:00	Beczek Michał: High-speed imaging technique in soil splash phenomenon
10:00 - 10:20	Barna Gyöngyi: Investigation of the cation exchange capacity and macroaggregate stability in representative Hungarian soil types and their correlation with other soil properties
10:20 - 10:40	Matula Svatopluk: Soil treatment effect on measured hydraulic properties
10:40 - 11:00	Nikodem Antonín: Using scaling factor for describing soil hydraulic properties of colluvic soils
11:00 - 11:20	**Coffee Break**
11:20 - 11:40	Szatyłowicz Jan: Effect of vegetation cover on water repellency persistence of drained peat soils
11:40 - 12:00	Katona Máté: Impact of forest organic matter on soil water holding capacity
12:00 - 12:20	Thet Bunthorn: The impact of different soil cover on soil structure and hydraulic properties
12:20 - 12:40	Fér Miroslav: How sewage sludge and composted sewage sludge affect soil hydrarulic properties
12:40 - 14:00	**Lunch**
14:00 - 14:20	Toková Lucia: Secondary succession on abandoned fields affects soil properties
14:20 - 14:40	Miháliková Markéta: Unlocking field capacity: A reliable, simple, and budget-friendly indirect approach
14:40 - 15:00	Rajkai Kálmán: Soil water retention estimation by the fractal dimension of water retention power function determined from the clay content
15:00 - 15:20	Gnatowski Tomasz: Calibration of TDR for monitoring the soil moisture content in the polder scale
15:20 - 15:40	**Coffee Break**
15:40 - 17:00	**Lightning Session** (3-5 min presentations of the posters)
17:00 - 18:00	**Poster Session**
18:00 -	**Mixer, Beer Session**

Wednesday, February 7

Time	Authors and Title
9:40 - 10:00	Erdberga Ieva: Abrupt textural differences in difficult to drain sandy soil
10:00 - 10:20	Botyanszká Lenka: Impact of microplastics on sandy soil properties and plant performance
10:20 - 10:40	Petreje Marek: Biodiverse rooftop system that combines recycled substrates and a dual-purpose wetland-green roof design
10:40 - 11:00	Makó András: Comparison of water and NAPL retention of soils of the Hungarian Soil Structural Database (HunSSD)
11:00 - 11:20	**Coffee Break**
11:20 - 11:40	Ray Richard: Performing SWCC inversions using soil descriptions and field moisture measurements
11:40 - 12:00	Kuželková Marta: Soil moisture regime under the canopy of beech, spruce, and larch trees
12:00 - 12:20	Jeřábek Jakub: Assessment of soil water content spatial-temporal variability at multiple scales at an agricultural site
12:20 - 12:40	Šanda Martin: Isotopic composition of soil water in irrigated and non-irrigated vineyards
12:40 - 14:00	**Lunch**
14:00 - ….	**Excursion**

List of Abstracts

Investigation of the cation exchange capacity and macroaggregate stability in representative Hungarian soil types and their correlation with other soil properties

Gy. Barna[1*], A. Makó[1], K. Rajkai[1], H. Hernádi[1], T.J. Novák[2], Zs. Bakacsi[1], V. Labancz[3], M. Kocsis[1], P. Sipos[4], M. Karlik[4], T. Tóth[1]

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In 2016, we started to develop a nationally representative database of typical Hungarian soils, focusing mainly on the soil physical, structural and physico-chemical properties, HunSSD. In this presentation, we investigated the macroaggregate stability, cation exchange capacity (CEC) and their relationship with other soil properties, and we tested the effects of land use, as well.
We explored 60 soil profiles, and from each soil horizon we collected altogether 257disturbed and undisturbed soil samples. The land-uses were grassland, arable land, forest, orchard/vineyard.
Comparison of the macroaggregate stability (MaAS, %) was carried out between the top soil horizons of these profiles. We defined the most important soil properties determining macroaggregate stability. In case of the salt-affected soils the *CEC–base cations (~sum of exchangeable H^+),* the *Q humus quality index* and *clay content* play key role. On the contrary, in case of the not salt-affected soils *organic matter (SOM)* and *calcium carbonate* content are the most dominant parameters. Grasslands and forests have significantly different MaAS values in not salt-affected soils.
The correlation analysis for the whole database revealed that the soil properties most closely related to CEC were (in decreasing order of importance): *clay content, soil organic matter content, specific surface area*. When the effect of soil properties was examined for each main soil type separately, different orders of importance were observed. Chernozem soils do not differ significantly from Meadow soils and from Salt-affected soils, while Lithomorphous and Bog soils differ from all other main soil types; Skeletal soils and Brown forest soil have similar CEC values.

Acknowledgment
This research is supported by the Hungarian National Research, Development and Innovation Office Foundation (Grant No. OTKA K134563), by a common grant from the Hungarian and Polish Academy of Sciences (Grant No. NKM 2019-17), and by Eötvös Lóránd Research Network (SA-26/2021).

References

Molnár S., Gy. Barna, E. Draskovits, R. Földényi, H. Hernádi, Zs. Bakacsi and A. Makó (2019) A BET-fajlagos felület, a humuszanyagok és további talajtulajdonságok összefüggéseinek vizsgálata jellemző hazai talajtípusokon. *Agrokémia és Talajtan, 68*, 57–77.

Soil treatment effect on measured hydraulic properties

Kamila Báťková, Svatopluk Matula*, Markéta Miháliková, David Kwesi Abebrese, Recep Serdar Kara, Cansu Almaz

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Recent limitations of plant available water on farmlands in the Czech Republic increased the need for more sustainable approaches leading to improvements in water infiltration and retention within the soil. The ability of soils to infiltrate and transport water through the soil profile is characterized by soil hydraulic conductivity. This study explores the changes in saturated and near-saturated hydraulic conductivity induced by applied tillage system on agricultural field over a 25-year-long period. The experimental field is located in Praha Ruzyně and it is managed by the Crop Research Institute (Výzkumný ústav rostlinné výroby, v.v.i.). The investigations are carried out for Haplic Luvisol, on which the following treatments are repeatedly applied: conventional tillage (CT), reduced tillage (RT), and no-tillage (NT). Over the years, different types of infiltrometers have been used to determine hydraulic conductivity at saturation (Ks) and at near saturation K(h). Additional supporting information such as particle size distribution, dry bulk density, particle density, organic matter content, aggregate stability, resistance to vertical penetration, pH, and electrical conductivity were occasionally measured. Generally, significant variability in the measured characteristics has been observed. The results showed lower values of Ks and K(h) for soil under NT in comparison to RT and CT. As the time was passing, the NT plot did not tend to improve its soil hydrophysical characteristics due to increased macropore connectivity as published in some other studies (Strudley et al., 2008; Rasmussen 1999). The actual values of Ks and K(h) could be affected by the infiltrometer type, but the conclusions comparing the values for NT, RT, and CT plots remained the same. Crucial importance of macropores in water infiltration and transport have been confirmed in this study. Even though they represent a small proportion of the total porosity, the water flow is mainly regulated by macropores.

Acknowledgment
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References

Strudley, M.W., T.R. Green and J.C. Ascough II. 2008. Tillage effects on soil hydraulic properties in space and time: State of the science. *Soil and Tillage Research*, 99, 4-48.

Rasmussen KJ. 1999. Impact of ploughless soil tillage on yield and soil quality: A Scandinavian review. *Soil and Tillage Research*, 53, 3-14.

High-speed imaging technique in soil splash phenomenon

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High-speed imaging is a technique for recording and observing rapidly changing phenomena in many fields, such as ballistics, industrial manufacturing processes, agriculture, automotive, spray nozzles, air conditioning systems, streamflow. It is based on the use of high-speed cameras, which allow capturing images at a speed of several thousand frames per second. One of the applications is also to use this technique to study the soil splash phenomenon which is one of the water erosion processes. The soil splash is caused by water drops hitting the soil surface during rainfall, which results in detachment and ejection of splashed material and transport thereof over different distances. The aim of this study was to present the use of the high-speed camera technique for investigation of soil splash phenomenon influenced by the impact of a single drop of water.

The measurements were performed in Institute of Agrophysics PAS based on the set of three calibrated Phantom Miro M310 high-speed cameras used for the characterization of soil splash phenomenon aspects e.g. detachment and ejection of particles, deformation of soil surface (micro-crater formation). Water drops with a diameter of 4.2 mm fell on soil samples with various kinetic energy values depending on the height of the drop fall (up to 7m). The experiments included different soil properties such as soil texture, initial moisture content, hydrophobicity. The interaction of falling drop with soil surface and the subsequent aspects were registered by a cameras with a speed of 3260 fps (frames per second) at the highest available resolution (1280x800 pixels) and then analyzed in Dantec DynamicStudio software.

Acknowledgment
This work was partly financed from the National Science Centre, Poland; project no. 2022/45/B/NZ9/00605.

References

Beczek M., Mazur R., Ryżak M., Sochan A., Polakowski C., Beczek T., Bieganowski A.: How much raindrop energy is used for transportation of the two-phase splashed material? GEODERMA 425, 2022

Beczek M., Ryżak M., Sochan A., Mazur R., Polakowski C., Hess D., Bieganowski A.: Methodological aspects of using high-speed cameras to quantify soil splash phenomenon. GEODERMA 378, 2020

Mazur R., Ryżak M., Sochan A., Marciszuk K., Beczek M., Lamorski K., Bieganowski A.: Surface deformation and displacement of bed elements during splash - model tests. CATENA 185, 2020

Impact of microplastics on sandy soil properties and plant performance

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The escalating influx of microplastics into the environment profoundly impacts soil properties, necessitating an exploration of the variable interactions between microplastics and soil across diverse types. The study aimed to investigate the impact of microplastic (HDPE, PVC, and PS at a 5% concentration) present in sandy soil on both soil properties and crop characteristics, providing insights into the consequences of microplastic contamination in agricultural systems. The study found that microplastic contamination increased the persistence and severity of SWR and decreased soil bulk density, water sorptivity, and hydraulic conductivity. Surprisingly, radish plant biomass remained unaffected, likely due to sandy soil's hydrophysical properties and adaptive plant responses. Although microplastics had no significant impact on the maximum photochemical efficiency of PSII, variations in photosynthetic efficiency values stabilized over time across all treatments. Microplastic contamination had no significant impact on the nitrogen, phosphorus, potassium, or zinc contents of crops, nevertheless, minimal changes were observed, including reduced copper in all treatments and decreased magnesium and iron in PVC and PS treatments compared to the control. Even if microplastics-induced subcritical water repellency was present in our experiment, it may not have hindered water movement enough to prevent plants from accessing water, and thus could not have caused significant changes in biomass. Nevertheless, the increasing concentration of microplastics, especially HDPE and PVC, in sandy soils may represent a future problem.

Acknowledgment
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Behaviour of six pharmaceuticals in soil columns with green pea plants observed and simulated with HYDRUS

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Green pea plants (*Pisum sativum* L.) were planted in 26 soil columns (height of 20 cm, diameter of 17 cm) under greenhouse conditions. Plants in 16 soil columns were irrigated with a solution of 6 pharmaceuticals (carbamazepine, clindamycin, fexofenadine, irbesartan, and sulfamethoxazole) and 8 with fresh water. The columns were analyzed as follows. One column was dissembled 16th day to examine masses of stems, leaves, and roots (depths of 0-5, 5-10, 10-15, and 15-20 cm). Next, sampling was carried out 23rd, 30th, 41st, and 48th day. Four columns were always analyzed to obtain information about a plant growth (i.e., the mass of stems, leaves, blossoms, pea pods, and roots in different soil layers), concentrations of all compounds and their metabolites (carbamazepine-10,11-epoxide, and clindamycin sulfoxide) in plant tissues and concentrations of compounds in soils. One column irrigated with fresh water was similarly analyzed as a control. Plant leaves were scanned, and their area was evaluated using the ImageJ program. One column was also always used to analyze soil hydraulic properties on undisturbed 100-cm^3 soil samples taken from the soil columns using the multistep outflow experiment. Soil water contents (at depths of 2.5 and 15 cm) and pressure heads (at depths of 5 and 15 cm) were measured in 4 columns during the entire experiment. In addition, air temperature and humidity, and potential evaporation were monitored. The sorption and degradation of all compounds were evaluated using batch sorption and degradation experiments. The HYDRUS-1D model and a recently developed dynamic plant uptake module (DPU) for HYDRUS (Brunetti et al., 2021b) were used to interpret an observed hydraulic regime in soil and a compounds translocation and transformation in the soil-plant continuum (Brunetti et al., 2021a, 2022). The DPU-HYDRUS model successfully interpreted observed data and estimated metabolization rates in plant tissues.

Acknowledgment
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References

Brunetti, G., R. Kodešová, H. Švecová, M. Fér, A. Nikodem, A. Klement, R. Grabic, and J. Šimůnek, 2021a. On the use of mechanistic soil–plant uptake models: a comprehensive experimental and numerical analysis on the translocation of carbamazepine in green pea plants, *Environmental Science & Technology, 55*, 2991–3000.

Brunetti, G., R. Kodešová, H. Švecová, M. Fér, A. Nikodem, A. Klement, R. Grabic, and J. Šimůnek, 2022. A novel multiscale biophysical model to predict the fate of ionizable compounds in the soil-plant continuum, *Journal of Hazardous Materials*, 423, 127008.

Brunetti, G., J. Šimůnek, R. Kodešová, and M. Šejna, 2021b. The Dynamic Plant Uptake Module for HYDRUS (2D/3D). https://www.pc-progress.com/en/Default.aspx?hydrus-module-DPU.

The effects of soil moisture and temperature on VIS-NIR soil spectra

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VIS-NIR spectroscopy emerges as a rapid, cost-effective, and user-friendly approach for assessing soil properties. With promising applicability in field settings, its use through proximal sensing enables direct soil analyses, significantly minimizing sample requirements (Debaene et al., 2014). This research delves into the ProbeField project, an internal initiative of the EJP SOIL consortium, which aims to address challenges associated with field measurements, such as uncontrolled factors like soil moisture, surface roughness, and environmental variables (Lorenzetti et al., 2023). The ProbeField project systematically examines these uncontrollable parameters and evaluates various protocols for in situ sample scanning.
This paper focuses on the investigation of soil moisture and temperature effects on mineral soil spectra, conducted under controlled laboratory conditions. The results underscore the substantial impact of these two parameters, particularly soil moisture, on the shapes and intensity of the spectra. Consequently, these variations influence the method's efficacy in predicting key soil attributes such as carbon (C), nitrogen (N) content, and soil texture. Despite these challenges, the paper provides valuable insights and proposed procedures to mitigate and correct these issues, enhancing the reliability and robustness of VIS-NIR spectroscopy in soil analysis applications.

Acknowledgment
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References

Debaene, G., J. Niedźwiecki, A. Pecio, and A. Żurek, 2014. Effect of the number of calibration samples on the prediction of several soil properties at the farm-scale, *Geoderma*, *214-215*, 114-125.

Lorenzetti R., F. Castaldi, F. Fondón, C.L. Borůvka, L. Metzger, K. Ben-Dor, F. F. van Egmond, F. Barbetti, R. Fantappiè, M. Debaene, G. Klumpp, K. Liebisch, F. A. Gholizadeh, and M. Knadel, 2023. The contribution of the European Project ProbeField to in-field use of proximal soil sensors, *Proceedings of the 2023 IEEE International Workshop on Metrology for Agriculture and Forestry*, 727-731.

Abrupt textural differences in difficult to drain sandy soil

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The aim of the study was to find out the reason why a field with a coarse sand texture, well-organized drainage system and lowered groundwater table constantly has surface water, especially after heavy rains and snowmelt. Soil profile was created at 57°49′267′′N and 24°33′482′′E, 35 m above sea level. According to geological data, soils in this area have formed on glaciolimnic sediments with sandy texture. The main data on soil properties are summarized in table 1, a photo of the soil profile can be seen in figure 1.

Table 1 Values characterizing the soil profile

Horizon	Horizon dimensions	Texture (in field)	pH_{H2O}	pH_{KCl}	Organic matter, %	Organic C, %
Ap	0-15 cm	LS	6,63	6,41	19,21	4,99
2Brα	15-53 cm	FS	8,50	7,78	1,18	0,31
3Brα	53-69 cm	Si	8,23	7,52	1.46	0,38
4Cα	69-120 cm	US	8,38	7,82	1,21	0,32
5Cα	120-180 cm	Si	8,46	7,67	1,72	0,45
Horizon	$CaCO_3$ equivalent, %	Color, wet; dry	Course fragments ≥2mm, %	Form of course fragments	>2mm fine earth ≤0,2mm, %	Fine earth, <0,2mm, %
Ap	1,30	2,5Y2,5/1; 2,5Y 3/1	4,09	Angular	48,96	46,94
2Brα	8,61	6/10Y; 7/10Y	0,19	Subrounded	13,71	86,10
3Brα	9,06	4/10Y; 10YR 6/1	0,05	Subrounded	3,06	96,89
4Cα	9,94	2,5Y 6/2; 10YR 7/2	48,20	Subrounded	43,08	8,72
5Cα	12,04	5YR 4/2; 7,5YR6/3	9,16	Rounded	9,71	81,13

Fig 1

Due to WRB 2022 version this soil classifies as Eutric Katocalcaric Reductigleyic Gleysol (Polyarenic, Polysiltic, Aric, Drainic, Endosceletic, Humic, Uterquic, Geoabruptic)

The textural features of this soil indicate the reason for accumulation of surface water. A layer with low water permeability is already 15 cm deep. The constant change in texture and the shape of the coarse fragments show a different origin of bedrock and allows reject the previously made conclusions that the soil was formed on solely glaciolimnic sediments. The statement is true only referring to layers from 15 - 69 cm.

How sewage sludge and composted sewage sludge affect soil hydraulic properties

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The contribution is focused on the effect of sewage sludge and composted sewage sludge on soil hydraulic properties, plant quality and their transpiration, and on greenhouse gases emissions from soil. The research was carried out on two different soil types (Haplic Luvisol in Hněvčevs and Haplic Cambsol in Humpolec). Both biosolids were applied to both soils before sowing corn. Undisturbed soil samples were taken several times during the vegetation period to measure soil pH, organic carbon content, etc. Stability of soil aggregates were assessed using the WSA index. Intact 100-cm^3 soil samples were used to measure the hydraulic properties using the multistep outflow method, and also using the pressure plate apparatus. Another set of undisturbed soil samples was used to study soil structure using the X-ray computed tomography. The plant photosynthesis and transpiration, and the net CO_2 and net H_2O effluxes were measured using the LCi-SD portable photosynthesis system. Other plant parameters as chlorophyl content and biomass were also assessed. The mini disk tension infiltrometer with a disk radius of 2.22 cm was used to measure unsaturated hydraulic conductivities for pressure head of –2 cm ($K_{h=-2}$) before harvesting. The results confirmed that the application of sludge and compost on agricultural soils can significantly affect soil properties and related processes. For example, retention ability of enriched soils was larger than that of unenriched soils (control). The greater effect was observed in the Haplic Cambisol than in the Haplic Luvisol. Similarly, while the influence of sludge and compost on unsaturated hydraulic conductivity ($K_{h=-2}$) for different variants in Hněvčeves was not significant, in Humpolec much higher unsaturated hydraulic conductivities were found for the variant with compost than for the variant with sludge or the control variant. The largest CO_2 effluxes were measured from soils with compost followed by those from soils with sewage sludge and control. Which is consistent with our previous observations (Fér et al., 2022, 2024). Similarly, the largest chlorophyl content in leaves and biomass was found for plants grown in soil with compost followed by soil with sewage sludge and control. The effect of both biosolids in the Haplic Cambisol seemed to be greater than in the Haplic Luvisol. It follows that the influence of the studied additives is probably more pronounced in lower quality soils, such as Cambisols, than in higher quality soils, such as Luvisols.

Acknowledgment
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References

Fér, M., R. Kodešová, A. Klement, and A. Nikodem, 2022. The impact of treated wastewater and biosolids from the municipal wastewater treatment plant on water and carbon dioxide effluxes from soils. *Journal of Hydrology and Hydromechanics*, *70(3)*, 276–283.

Fér, M., R. Kodešová, A. Klement, A. Nikodem, and L. Pavlů, 2024. Carbon dioxide and water effluxes from soils affected by reclaimed wastewater and sludge from the wastewater treatment plant during the three-year period. *Biologia*, https://doi.org/10.1007/s11756-023-01588-z.

Calibration of TDR for monitoring the soil moisture content in the polder scale

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The proper soil moisture monitoring presently is the global issue regarding controls and management of limited resources of water in terrestrial ecosystems (Vereecken et al., 2016). Over the last four decades, the main alternative of the volumetric soil moisture content measurements is the TDR method, which applicability in field studies depends on the proper selection of calibration curve converting the dielectric constant into the soil moisture content (Malicki et al., 1996). The importance of calibration issues appears in the area with complex geological history and spatial and vertical variation of soils. These characteristics are attributable to polder which can be areas that are devoted to intensive agricultural use worldwide (Yan et al., 2016). The profiles of those soils contain layers of diverse or even contrasting properties, including mineral soils with the humus amendment, humus and peat soils. In heterogeneous soils dielectric constant often expresses different forms of the dielectric mixing model, which includes relative permittivity of water, solid phase, and air fraction (Jacobsen et al., 1995). The main issue in this approach is the determination of α index summarizing soil geometry concerning the applied electric field. The literature data indicate that the singular α value index range from 0.4 to 0.8 for different variety of dielectric mixing models and soil types (Jacobsen et al., 1995). However, Capparelli et al. (2018) indicate that this index nonlinearly varies over the soil moisture content range in Andic soils developed from pyroclastic ashes, which improves the prediction of this soil property.
The main objective of this study was to evaluate the three-phase dielectric mixing model for the soil moisture content determination in field conditions depending on soil type variation at the polder scale. The study results showed that the parameter varies linearly over the whole soil moisture content range depending on soil types differentiated by mineral and organic particle amendments.

References

Vereecken, H.; Schnepf, A.; Hopmans, J.W.; Javaux, M.; Or, D.; Roose, T.; Vanderborght, J.; Young, M.H.; Amelung, W.; Aitkenhead, M.; et al., 2016. Modeling Soil Processes: Review, Key Challenges, and New Perspectives. *Vadose Zone Journal 15*, doi:10.2136/vzj2015.09.0131.

Malicki, M.; Plagge, R.; Roth, C., 1996. Improving the calibration of dielectric TDR soil moisture determination taking into account the solid soil. European Journal of Soil Science, 47, 357–366.

Yan, R.; Gao, J.; Huang, J., 2016 WALRUS-paddy model for simulating the hydrological processes of lowland polders with paddy fields and pumping stations. *Agricultural Water Management, 169*, 148–161.

Jacobsen, O.H.; Schjonning, P., 1995. Comparison of TDR calibration functions for soil water determination. In: Proceedings of the Symposium: Time-Domain Reflectometry Applications in Soil Science; pp. 25–33.

Capparelli, G.; Spolverino, G.; Greco, R., 2018. Experimental Determination of TDR Calibration Relationship for Pyroclastic Ashes of Campania (Italy). *Sensors* 18, 3727,1-14, doi:10.3390/s18113727.

X-ray analysis of soil structure changes in Constructed Technosol used in a layered bioretention cell system

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Constructed Technosols play an important role in urban hydrology e.g. in the functioning of stormwater bioretention cells. Water infiltration, colloid transport, and heat transport are affected by changes in pore system geometry particularly due to the development of macropores and clogging by particles. The aim of the study is to relate changes in bioretention cell performance to the structural changes of soils at the microscale by invasive and noninvasive methods. Noninvasive visualization method of X-ray microtomography was used to investigate soil of the biofilter in terms of structure development, pore-clogging and pore geometry deformations (Jarvis et al., 2017).

Two experimental identical bioretention cells were established in December 2017. Subsurface of the bioretention cells is formed by biofilter (Constructed Technosol), sand filter and a drainage layer. The 30 cm thick biofilter soil mixture is composed of 50% sand, 30% compost, and 20% topsoil. The regular soil sampling program was initiated in 2018 in order to visualize and quantify the soil structure and internal pore geometry of samples. Five batches of undistributed samples were taken for three years. Over three years, three batches of 24 undisturbed samples each were collected in June 2018, November 2018, May 2019, November 2019, and June 2020. Those collected samples were scanned by CT imaging. Analyses of pore network morphology were performed on the segmented 3D images of samples.

During the first year, the macroporosity decreased in both BCs due to soil consolidation. Results of the study show that short term consolidation was followed by gradual development of macropore system in biofilter. A significant correlation was found between macroporosity and connection probability, as well as between macroporosity and critical diameter. Pore thickness analysis revealed that the most represented pore fraction during the three years was 80-310 μm in size. The biofilter exhibited optimal conditions for plant growth.

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References

Brenner, D.J., E.J. Hall, 2007. Computed tomography - an increasing source of radiation exposure, *New England Journal of Medicine*, 357, 2277–2284. https://doi.org/10.1056/NEJMra072149

Jarvis, N., M. Larsbo, J. Koestel, 2017. Connectivity and percolation of structural pore networks in a cultivated silt loam soil quantified by X-ray tomography, *Geoderma*, 287, 71–79. https://doi.org/10.1016/j.geoderma.2016.06.026

Assessment of soil water content spatial-temporal variability at multiple scales at an agricultural site

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The soil water content is vital for plant growth, and its value is a key variable in hydrological modeling. The initial soil water content has been identified as a controlling factor in rainfall-runoff periods (e.g., Zehe et al., 2007). Its spatial variability is affected by factors such as topography, soil properties, and the type and quality of vegetation or crops (Li et al., 2023). Despite its importance, the spatially distributed monitoring of soil water content is complicated, especially at agricultural sites with frequent soil disruptions. Cosmic ray neutron sensing (CRNS) and a network of soil water content nests (Zreda et al., 2008; Bogena et al., 2010) are often used to study water movement in the shallow part of the soil profile. In this contribution, we present the dynamic soil water content at a small agricultural site located 30 kilometers east of Prague, monitored using both CRNS and a network of soil water content nests. The results show differences in the seasonal development of soil water content among the monitored years. CRNS provided spatially aggregated information that corresponded to the point-based measurements to some extent.

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References

Bogena, H.R., Herbst, M., Huisman, J.A., Rosenbaum, U., Weuthen, A., Vereecken, H., 2010. Potential of Wireless Sensor Networks for Measuring Soil Water Content Variability. Vadose Zo. J. 9, 1002–1013. https://doi.org/10.2136/vzj2009.0173

Zehe, E., Elsenbeer, H., Lindenmaier, F., Schulz, K., Blöschl, G., 2007. Patterns of predictability in hydrological threshold systems. Water Resour. Res. 43. https://doi.org/10.1029/2006WR005589

Li, T., Schiavo, M., Zumr, D., 2023. Seasonal variations of vegetative indices and their correlation with evapotranspiration and soil water storage in a small agricultural catchment. Soil Water Res. 18, 246–268. https://doi.org/10.17221/60/2023-SWR

Zreda, M., Desilets, D., Ferré, T.P.A., Scott, R.L., 2008. Measuring soil moisture content non-invasively at intermediate spatial scale using cosmic-ray neutrons. Geophys. Res. Lett. 35, 1–5. https://doi.org/10.1029/2008GL035655

Impact of forest organic matter on soil water holding capacity

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The changing climate increases the adverse effects of droughts, which are also felt by forest vegetation (Führer, 2018). Soil water capacity is often modelled on arable crops, but a forest environment is different in many ways, of which we have focused on the increased organic matter in topsoil. In Hungary, we started to map the soil conditions of older natural forest stands, sampled them and investigated the available water resources provided by the topsoil. In addition to the values derived from the matrix potential, it was also reasonable to use pedotransfer functions (Brooks & Corey, 1964; Campbell, 1978; Szabó et al., 2019), and therefore several methods were used for the evaluation. A further aim of the research is to apply these models effectively under forest conditions. Although the majority of the luvisol soil types found are typical of forests, the research is not limited to a single soil type. Soil samples were taken up to the limit of the occurrence of soil-forming processes, but at least up to 100 cm. The texture, bulk density, organic matter content, carbonate content and pH of the soils determined the available water resources. The properties were measures in 10 cm layers. The available water resources were also analysed together with the weather conditions over the last 70 years to get an accurate picture of drought periods and to make a forecast for the coming periods (Thornthwaite, 1955; Granier, 1999).

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References

Brooks R.H., Corey A.T., 1964. Hydraulic Properties of Porous Media. *Hydrology Paper*, Vol. 3, Colorado State University, Fort Collins. 37 p.

Campbell G. S., 1974. A simple method for determining unsaturated conductivity from moisture retention data. *Soil Science, 117*, 311–314.

Führer E., 2018. A klímaértékelés erdészeti vonatkozásai. *Erdészettudományi Közlemények, 8,* 27–42. doi: 10.17164/EK.2018.002

Granier A., Bréda N., Biron P., Villette S., 1999. A lumped water balance model to evaluate duration and intensity of drought constraints in forest stands. *Ecological Modelling, 116*, 269–283. doi: 10.1016/S0304-3800(98)00205-1

Szabó, B., Gyurkó, D., Weynants, M., Weber, T. K. D. (2019): Web interface for European hydraulic pedotransfer functions (euptfv2). Institute for Soil Sciences and Agricultural Chemistry, Centre for Agricultural Research. doi: 10.34977/euptfv2.01

Thornthwaite C. W., Mather JR., 1955. The water budget and its use in irrigation. In Water, *The Yearbook of Agriculture*. US Department of Agriculture: Washington DC, pp. 346–358.

Using VIS-NIR reflectance spectroscopy and magnetic susceptibility for describing properties of colluvic soils

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Soil degradation due to water erosion is one of the greatest problems of agricultural soils worldwide. To be able to map the extent of soil degradation and consequently propose actions for soil improvement, an effective approach is needed. Soil organic carbon (SOC) content and its time fluctuations is one of the key features characterizing the given site and occurring processes. It is widely accepted as the main soil quality indicator and therefore can be used for soil degradation assessment. Traditional laboratory techniques (dry combustion, wet oxidization) of soil organic carbon determination are usually labor intensive and time consuming, which means they are not suitable for large sample collections (e.g., large areas or continual monitoring). Therefore, there is a need for fast, reliable, and cost-effective techniques. Our previous study documented that the VIS-NIR reflectance spectroscopy and magnetic susceptibility can be a very efficient tool for SOC mapping with the Chernozem (a loess region of South Moravia, Czech Republic) areas heavily affected by water erosion. Within this area colluvial soils with up to an about 4 m deep humus enriched horizon were developed. Distribution of soil properties within the colluvial soil profiles at several positions were evaluated using standard and novel methods to distinguishing the different sedimentation phases and understanding colluvial soil formation. The same study was also performed in another two locations (Cambisol and Luvisol areas). Results showed that while both methods could be used for estimation of SOC distribution within the soil profiles in the Chernozem area, in the other two areas the VIS-NIR reflectance spectroscopy method was less accurate, and magnetic susceptibility approach was even inaccurate because there was no correlation between SOC and content of ferrimagnetic particles.

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The effect of total N and SOC on soil CO_2 efflux under different tillage on Cambisol (Central Lithuania)

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The goal of the work was to quantify the relationship among soil chemical properties (SOC – soil organic carbon and N – total nitrogen) and soil carbon dioxide (CO_2) efflux from 0–10 cm top-soil layer under contrasting tillage (NT – no-tillage, RT – reduced tillage and CT – conventional tillage) on Cambisol (Sandy loam and Loam).

Soil CO_2 effluxes from top-soil depth in different treatments were investigated using a closed chamber method (Kochiieru et al., 2023). The CO_2 efflux was measured five times per growing season from April to August in 2021. Soil samples were collected for the measurements of SOC and total N within 0–10 cm soil layer in April 2021.

Soil CO_2 effluxes increased gradually by reaching the maximum between end of May till the beginnings of July in different tillage in sandy loam and loam. Soil carbon dioxide efflux in sandy loam was 20.1% lower than in loam. The CO_2 efflux varied from 0.69 μmol CO_2 m^{-2} s^{-1} to 2.07 μmol CO_2 m^{-2} s^{-1} in sandy loam, and from 1.05 μmol CO_2 m^{-2} s^{-1} to 2.48 μmol CO_2 m^{-2} s^{-1} in loam. Soil CO_2 efflux, average across data, tended to decrease in following orders: NT > RT > CT in sandy loam and RT > CT > NT in loam.

The content of SOC from 0–10 cm depth soil averaged from 8.3 to 9.2 g kg^{-1} in sandy loam and from 10.4 to 12.2 g kg^{-1} in loam. The content of SOC in loam was 26.9% higher than in sandy loam. Average SOC, tended to decrease in following orders: NT (9.2 g kg^{-1} and 13.0 g kg^{-1}) > RT (8.5 g kg^{-1} and 12.2 g kg^{-1}) > CT (8.3 g kg^{-1} and 10.4 g kg^{-1}) in sandy loam and loam, respectively.

Total nitrogen (N) content under 0–10 cm depth soil amounted to 0.97 – 1.13 g kg^{-1} in sandy loam and 1.13 – 1.54 g kg^{-1} in loam. Soil N content in sandy loam was 24.8% lower than in loam under different tillage systems. Average total N, tended to decrease in following orders: NT (1.13 g kg^{-1}) > CT (1.00 g kg^{-1}) > RT (0.97 g kg^{-1}) in sandy loam and NT (1.54 g kg^{-1}) > RT (1.45 g kg^{-1}) > CT (1.13 g kg^{-1}) in loam.

The soil CO_2 efflux had a linear regression models: with soil organic carbon ($y = 0.089x + 0.561$; $R^2 = 0.681$) and with total nitrogen ($y = 0.722x + 0.607$; $R^2 = 0.639$). The measurements of soil indicate that the amount of soil organic carbon and total nitrogen significantly to the soil-atmosphere exchange of CO_2 efflux. This result may be explained by a more favorable soil environment conditions for soil biota activity and root development, which in turn is an indicator of good soil health.

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References

Kochiieru M., Veršulienė A., Feiza V., Feizienė D. 2023.Trend for soil CO_2 efflux in grassland and forest land in relation with meteorological conditions and root parameters. Sustainability, 15 (9): 7193.

Comparison of particle size analysis using the standard hydrometer method and the improved integral suspension pressure method

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Soil texture is a key soil characteristic, and its knowledge can be used to estimate other important soil properties such as hydraulic conductivity, retention curve parameters, or available water for plants. Particle size analyses are performed using standard methods such as the pipette or hydrometer method. Currently, standard methods are being replaced by innovative automated methods, which may include automatic measurement of pressure changes in the suspension or laser analysis. This paper compares the standard hydrometer method with the improved integral suspension pressure method (ISP+).

The measurements were performed on four types of soil samples, namely two samples of sandy soil, one sample of silty soil, and one experimental mixture prepared by mixing foundry sand (d50 = 0.14 mm) and micro-milled sand (d50 = 0.027 mm) in a 1:1 ratio. Each sample type was measured 8 times (4x density method, 4x ISP+). Therefore, overall, 32 particle size analysis was performed. The same pretreatment of soil samples was used. The control reference density was calculated using the constant density based on the mass of the dissolved dispersant and the variable density of water as a function of temperature.

The results indicate that the sand fraction reached almost identical values in all four soil sample types. The differences in sand fraction for both methods reached a maximum of 1.95%, with higher values measured by the ISP+ method in all samples. For the silt fraction, the most significant difference was measured in the sample with the experimental mixture, where an average of 4.05 % more silt particles were measured by the hydrometer method compared to the ISP+ method. For the clay fraction, a statistically significant difference was measured only for the one sample type (experimental mixture), where the hydrometer method completely ignored the low amount of clay fraction (the difference was 2 %).

Overall, the results from both methods are very similar, and in most cases, the differences in the clay, silt, and sand fractions are not statistically significant. According to the results, it can be expected that the highest deviations will be measured in soils with a high proportion of the fine-grained fraction (clay or silt). However, to verify this statement, soil samples with a high proportion of clay particles should be measured using both methods. The measurements must be verified by another standard method (e.g., pipette method).

Automated calibration methodology to avoid convergence issues during inverse identification of soil hydraulic properties

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Inverse modeling of in-situ experiments is a well-established method for determining various material parameters. This study focuses on the single ring (SR) infiltration experiment, a standard and reliable dynamic field test. Traditionally, the steady-state phase of this experiment is utilized for determining saturated hydraulic conductivity. Here, we investigate the potential extension of this experiment to assess hydraulic parameters for unsaturated conditions, specifically for the top-soil layer, by analyzing the unsteady phase using inverse analyses of the governing flow motion equation, which is described by the quasilinear Richards equation.
To address convergence issues associated with the nonlinear operator, stemming from challenging combinations of input parameters, a novel scanning methodology is introduced. This approach helps mitigate problems that may arise when automatically analyzing a wide parameter space. The validity of the methodology is confirmed through virtual infiltration scenarios involving clay and sand, and subsequently applied to actual SR infiltration data. To assess non-uniqueness, we employed a modified genetic algorithm with niching to identify and map local optima.
Our findings reveal the existence of multimodality in both benchmark problems and real-world scenarios. This discovery is crucial as it highlights the presence of local optima that may not necessarily be physically meaningful, even in systems without multimodal grain size distributions. The identified local optima exhibit distinct retention and hydraulic conductivity curves. Ultimately, with knowledge of the saturated water content, the most physically realistic set of soil hydraulic properties (SHP) can be determined.

Soil moisture regime under the canopy of beech, spruce, and larch trees

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Forest soil is an amazingly diverse environment. The vast vegetation cover produces a high amount of plant litter, which enriches the mineral substrate through the decomposition of organic matter. Root systems further shape the soil environment by creating preferential pathways that significantly increase the infiltration process (Jarvis et al., 2012). While the vegetation impact on soil hydraulic properties is mostly pronounced in the organic horizon, the soil water regime is deeply impacted by precipitation partitioning through vegetation. Structural tree traits, e.g., branch inclination, root system architecture, bark roughness, and stem shape, have a major effect on the rainwater input into the soil (Crockford & Richardson, 2000). Since the close connection of vegetation and soil water, the seasonality of deciduous forests is significantly affecting the forest hydrological balance (Staelens et al., 2008). With different traits and strategies among tree species, the very same mineral soil properties may result in completely different soil moisture conditions during the annual seasons (Kuželková et al., 2023). As climate change brings rising temperatures and uneven precipitation patterns, Central Europe should expect a concerning increase in drought periods (Markonis et al., 2021). In order to improve efficient water management within the landscape, the insights on vegetation effect on soil moisture regime are becoming highly relevant for future actions.

This study aims to gain an understanding of the vegetation effect on soil moisture across different tree species and to assess its hydrological impact on the landscape under changing climate. With more than 50 soil moisture and temperature autonomous stations (TMS 4, TOMST), a monitoring network under three common Central-European tree species was built in a drought-prone area of central Bohemia. During the nearly three years of monitoring, strong patterns in soil moisture regimes between different tree species were observed. While the seasonality of deciduous beech and larch trees promoted efficient winter and early spring soil water recharge, with the mean VWC in the spring of 2022 being 0.30±0.04 for beech and 0.22±0.04 for larch, the soil conditions under evergreen spruce trees remained significantly drier 0.14±0.04. Moreover, even though the mean bulk density of silty loam mineral substrate remained consistent across all sites, the organic soil layer exhibited a distinct variation between different tree species, suggesting the ability of vegetation to re-form the soil environment and its hydro-physical properties.

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References

Crockford, R. H., & Richardson, D. P. (2000). Partitioning of rainfall into throughfall, stemflow and interception: effect of forest type, ground cover and climate. Hydrological Processes, 14(16–17), 2903–2920.

Jarvis, N. J., Moeys, J., Koestel, J., & Hollis, J. M. (2012). Preferential Flow in a Pedological Perspective. In Hydropedology (pp. 75–120). Elsevier.

Kuželková, M., Jačka, L., Kovář, M., Hradilek, V., & Máca, P. (2023). Tree trait-mediated differences in soil moisture regimes: a comparative study of beech, spruce, and larch in a drought-prone area of Central Europe. European Journal of Forest Research.

Markonis, Y., Kumar, R., Hanel, M., Rakovec, O., Máca, P., & Agha, Kouchak, A. (2021). The rise of compound warm-season droughts in Europe. Science Advances, 7(6).

Staelens, J., De Schrijver, A., Verheyen, K., & Verhoest, N. E. C. (2008). Rainfall partitioning into throughfall, stemflow, and interception within a single beech (Fagus sylvatica L.) canopy: influence of foliation, rain event characteristics, and meteorology. Hydrological Processes, 22(1), 33–45.

Trends of soil darkness as a new index of soil health - analysis of Landsat collection for EU

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Monitoring the health of soil requires indicators - the most frequently used for this purpose include the content of soil organic matter and soil moisture. The development of a soil condition indicator map usually requires collecting soil samples, their laboratory analyses, and then spatial interpolation of the results. This process is time-consuming and expensive. In our work, we present an alternative indicator integrating indicators of organic matter content and relative soil humidity, which is soil darkness. Soil darkness decreases when the health of the soil in terms of organic matter balance or soil water balance is poor. Remote sensing of soil darkness changes therefore allows for quick identification of risk areas of soil health. To examine the behavior of the proposed indicator at the EU scale, a script was developed on the Google Earth Engine platform that selected Sentinel2 and Landsat 4-8 data from 1983-2023, pre-filtered pixels without clouds and snow, and among them pixels with bare soil (selected by thresholds values of NDVI and NBR2). Soil darkness was calculated in 10-year intervals and trend lines were plotted. The slope values of the trend lines have been visualized as a map for the EU.

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References

Wang, J., Zhen, J., Hu, W., Chen, S., Lizaga, I., Zeraatpisheh, M., Yang X., 2023. Remote sensing of soil degradation: Progress and perspective, *International Soil and Water Conservation, 11, 429-454.*

Obalum, S.E., Chibuike, G.U., Peth, S., Ouyang, Y., 2017. *Environmental monitoring and assessment, 189: 176.*

Zhang, M.W., Wang, X.Q., Ding, X.G., Yang, H.L., Guo, Q., Zeng, L.T., Cui, Y.P., Sun, X.L., 2023. Monitoring regional soil organic matter content using a spatiotemporal model with time-series synthetic Landsat images, *Geoderma Regional, 34*

Effect of agricultural management on soil structure

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The aim of this contribution is to introduce the SoilX project. The SoilX Project as a part of EJP SOIL addresses 3 main research questions: 1. How exactly did soil management alter soil hydraulic properties in long-term field experiments across Europe? 2. To what extent can soil structural improvements enhance the resilience of cropping systems to future precipitation extremes? 3. Which socio-economic factors enable soil management improvements? Contrasting soil management treatments in 12 long-term agricultural field experiments (LTE) across Europe are investigated. The project focuses on the impact of different organic amendments, residue management, tillage, and cover cropping. In the Czech Republic, field measurements and sampling were carried out in the spring of 2023 at two locations, Čáslav (Luvisol) and Lukavec (Cambisol). Two variants were investigated at both sites: control (no fertilizers and other enrichments), and manure and H+N3PK fertilized soil. In the field, a penetration resistance, soil CO_2 efflux, field soil water content (SWC), and unsaturated hydraulic conductivity were measured. Grab soil samples were taken in the depth of 5, 30 and 50 cm to evaluate basic soil properties, and stability of soil aggregates (WSA index). Intact 100-cm^3 soil samples were taken in the same depth to measure the hydraulic properties using the multistep outflow method, and also using the pressure plate apparatus. Another set of undisturbed soil samples was used to study soil structure using the X-ray computed tomography (CT). In laboratory the mini disk tension infiltrometers were used to measure unsaturated and near-saturated hydraulic conductivities for pressure head of –5 and –0.3 cm, respectively. Preliminary results indicate apparent differences in most of the parameters measured for the different variants. For example, the higher WSA index, near-saturated hydraulic conductivity, or field SWC, and the better soil structure assessed using CT were found for fertilized variant than for control. On the other hand, the field soil CO_2 effluxes, penetration resistances, and unsaturated hydraulic conductivities for different variants do not significantly differ. Data obtained within this project and data gained before during LTE will be used as inputs into selected biophysical models to estimate the benefits of soil structural improvements for mitigating the impacts of increasing precipitation extremes (i.e. drought and heavy precipitation) under climate change. Synthesized project results will improve the basis of knowledge and evidence to provide better soil and crop management advice for both farmers and policy makers at European and regional levels.

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Comparison of water and NAPL retention of soils of the Hungarian Soil Structural Database (HunSSD)

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The pore size distribution of soils and its temporal and spatial variation strongly influences the movement and storage of water and organic contaminants in subsurface. Determination of the retention of non-aqueous phase liquids (NAPLs) based on commonly used prediction methods using soil water retention curves and physicochemical properties of liquids is rather questionable, as different phase interactions may occur in air/water/soil systems compared to air/NAPL/soil systems. These interactions (e.g. swelling-shrinkage, disaggregation, wettability) depending on the properties of solid and liquid soil phases and leading to different pore size changes, which can cause huge variations of transport parameters.
In our research we used soil samples and test results from the Hungarian Soil Structure Database (HunSSD) compiled by us. 45 soil profiles typical for Hungary were selected for this study. Different genetic horizons (160) of the soil profiles were sampled and the important soil properties were determined. NAPL retention from saturation to 1500 hPa and water retention from saturation to 15540 hPa were determined on undisturbed soil samples. NAPL retention measurements were performed with modified pressure plate extractors using a model fluid, namely Dunasol 180/220. The five-parameter van Genuchten (vG) function was fitted to the measured data. Pore size distributions of the soils with non-polar and polar liquids were calculated using the fitted vG-function - according to the SSSA classification system - taking into account different properties of the used liquids. In this presentation, we will show how the retention curves of the two liquids relate to each other on soils with different textures, and the accuracy/inaccuracy of the NAPL retention curves estimated from the soil water retention curves using the classical Leverett function. We are going to present the relationship between the pore size distributions determined by the two liquids. We have also calculated the average geometric diameters of the pore size distributions and investigated their possible estimation from other (easily measurable) soil properties.

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Testing different approximations of soil heat flux under mountain meadow conditions

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The soil heat flux, the transfer of energy between the soil and the atmosphere, is part of the surface energy balance and plays an essential role in evapotranspiration. However, soil heat flux is often neglected or ignored in energy balance calculations and estimates of evapotranspiration. Less often, soil heat flux is approximated or estimated using models or relationships derived from limited observations. Much less frequently, this flux is directly measured. This is primarily due to the difficulty of accurately measuring the heat flux to soil, as it is affected by complex interactions at the soil-atmosphere interface and is fundamentally influenced by vegetation cover. The absence of measurements of soil heat flux or its crude approximation can lead to inaccuracies in the quantification of energy balance and estimation of evapotranspiration, which can affect climate change studies, soil biology and soil biochemistry, and ecosystem ecology.

To measure heat flux into the soil, a pair of HFP01 sensors (Hukseflux Thermal Sensors B.V) has been available in the Liz catchment (average altitude 941 a. s .l., precipitation average 861 mm, average air temperature 6.3 °C) since 2012. The sensors allow passive low-energy detection of heat flux by means of several thermocouples that register the temperature change along their height. The use of a pair of sensors is desirable due to the expected considerable spatial variability of the thermal characteristics of the soil. Installation in the soil was made from the side of a shallow trench near the weather station on its south side about 5 cm below the surface. The sensors are approximately 1 m apart. After installation in the soil, the sensors were not disturbed. The ground cover above the sensors was originally mainly grasses but is now dominated by mosses.

Soil heat flux approximation methods were tested on three hydrologically distinct vegetation seasons - average, below average and above average. The assumption of zero heat flux to the soil at the diurnal step is not correct under our geographic conditions for most of the vegetation season. On the other hand, the error due to this approach is not very large in the calculation of evapotranspiration. The hourly soil heat flux approximated as part of net radiation proposed by Burridge and Gadd (1977) approximates the daily soil heat flux reasonably well, but the absolute errors are quite large and the method fails at sunset and sunrise when the direction of flux changes. Surface temperature calculated from pyrgeometr measurements has been shown to correlate with measured soil heat flux.

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References

Burridge, D.M., A.J. Gadd, 1977. The Meteorological Office operational 10-level numerical weather prediction model, Scientific paper – Meteorological Office. *British Meteorological Office, Bracknell, England*.

Hukseflux Thermal Sensors B.V. User manual HFP01 & HFP03: Heat flux plate/heat flux sensor. V2123. Delft: *Hukseflux Thermal Sensors B.V.*, 2015.

Unlocking field capacity: A reliable, simple, and budget-friendly indirect approach

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Field capacity (FC) or field water capacity is defined as the maximum amount of water soil can hold against the force of gravity after excess water has drained away (Cassel and Nielsen, 1986). This study presents a cheap, fast and uncomplicated technique for indirectly determining the field capacity (FC) in soil, which is a crucial parameter for hydropedology, environmental modeling and irrigation applications, despite its often unclear definition. Relationships between FC (determined as water content at certain set matric potentials) and soil moisture constants, specifically maximum capillary water capacity (MCWC) and retention water capacity (RWC), were established using undisturbed soil core samples analyzed by pressure plate method and by "filter paper draining method" (Spasić et al., 2023). This method involves determining the gravimetric soil water content of core samples. The samples were saturated and then allowed to drain naturally on the filter paper for a specified time interval (max. 24 hours). This method has long history of use in the Czech Republic as an approximate of FC, but it has never been correlated with a soil water content determined at a specific matric potential.

The objective was to lower the time and expenses linked to conventional FC measurement techniques, and to enable the utilization of legacy databases comprising MCWC and RWC figures. The outcomes exposed the significant possibility of the "filter paper draining method" as an encouraging strategy for indirect FC determination, tested on more than 700 samples.

FC as soil water content at -33 kPa can be well approximated by the equation FC33 = 1.0802 RWC - 0.0688 (with RMSE = 0.045 cm^3/cm^3 and R = 0.953). For FC as soil water content at -5 or -10 kPa, either of the following equations can be used: FC5 = 1.0146 MCWC - 0.0163 (with RMSE = 0.027 cm^3/cm^3 and R = 0.961) or FC10 = 1.0152 MCWC - 0.0275 (with RMSE = 0.033 cm^3/cm^3 and R = 0.958), respectively.

Historical pedotransfer functions by Brežný and Váša (Drbal, 1971) relating FC to fine particle size fraction were also evaluated for practical application, and according to the results, they cannot be recommended for general use.

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Ministry of Agriculture of the Czech Republic, National Agency for Agricultural Research, project No. QK1910299, and CZU FAFNR, project No. SV22-15-21380.

References

Cassel, D.K.; Nielsen, D.R. 1986. Field Capacity and Available Water Capacity. In *Methods of Soil Analysis: Part 1. Physical and Mineralogical Methods*, 2nd ed.; Klute, A., Ed.; American Society of Agronomy - Soil Science Society of America: Madison, Wisconsin, USA, pp. 901-926. ISBN 0-89118-088-5.

Drbal, J. 1971. Practicum in Soil Amelioration Pedology, 1st ed.; State Pedagogical Publishing House: Prague, CZ. (in Czech).

Spasić, M.; Vacek, O.; Vejvodová, K.; Tejnecký, V.; Polák, F.; Borůvka, L.; Drábek, O. 2023. Determination of physical properties of undisturbed soil samples according to V. Novák. *Methodsx* 10, 102133. doi:10.1016/j.mex.2023.102133.

Using the scaling factors for describing the spatial and temporal variability of soil hydraulic properties along the hillslope transects strongly affected by soil erosion

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Extensive agricultural use of land coupled with intensive water erosion at geomorphologically diverse areas with uniform soil substrate and originally similar soils can lead to high diversity in soil types and, correspondingly, to a high spatial and temporal variability of soil properties (including soil hydraulic properties). Therefore, this study aimed to propose a procedure to characterize the variability of soil hydraulic properties and the soil–water regime. The study was performed on five morphologically diverse study sites. Conventional tillage has long been applied at all locations. The original soil units (Haplic Chernozem, Haplic Luvisol, two Haplic Cambisols, and Rendzic Leptosol), because of soil erosion, changed to Regosols, Ranker or Sceletic Leptosol (steep parts), and accumulated Chernozem, accumulated Luvisol, colluvial soils, or Haplic Phaeozem (colluvic) (base slope and the tributary valley), respectively. One representative transect with the most diverse terrain attributes (elevation, slope, curvature, exposition, etc.), which caused the most variable soil properties, was delineated at each location. Five sampling points were selected at each transect, assuming that the soil at different points would be modified by the different stages of the erosion-accumulation processes: 1. summit, 2. shoulder, 3. backslope, 4. footslope, and 5. toeslope. Soil hydraulic properties, $\theta(h)$ and $K(h)$, were measured on 100-cm3 undisturbed soil samples (taken before and after the vegetation period) using the multistep outflow experiment and numerical inversion with HYDRUS-1D. Next, the reference soil hydraulic properties, $\theta^*(h^*)$ and $K^*(h^*)$, and scaling factors (αh, αK, and $\alpha\theta$) were evaluated to describe spatial and temporal variability of the soil hydraulic properties. The sampling day significantly affected αh, αK, and $\alpha\theta$ in the Chernozem area; αh and αK in the Cambisol (developed on shale) area; and αh and $\alpha\theta$ in the Leptosol area. While values for the Chernozem area indicated an improvement in soil hydrological conditions during the vegetation period, the values for the Luvisol, Leptosol, and Cambisol (developed on shale) areas indicated aggravation. No considerable changes were observed for the Cambisol (developed on granodiorite and shale) areas. The sampling position significantly affected $\alpha\theta$ in both Cambisol areas. At some locations (e.g., Chernozem area), the spatial variability reflected different erosion-accumulation processes within the transect.

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References

Nikodem, A., R. Kodešová, M. Fér, and A. Klement, 2021. Using scaling factors for characterizing spatial and temporal variability of soil hydraulic properties of topsoils in areas heavily affected by soil erosion, *Journal of Hydrology*, 593, 125897,.

Nikodem, A., R. Kodešová, M. Fér, and A. Klement, 2021. Variability of topsoil hydraulic conductivity along the hillslope transects delineated in four areas strongly affected by soil erosion. Journal of Hydrology and Hydromechanics, 69(2), 220–231.

Using scaling factor for describing soil hydraulic properties of colluvic soils

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The soil structure and, consequently, soil hydraulic properties of tilled soil vary in space and time. The spatial variability of soil properties within the sloping area may be enhanced by water erosion processes (i.e., soil material loss at steep parts and its accumulation at concave and bottom parts), which may even lead to soil type diversification. In addition, colluvial soils and deposits, occupying concave slope elements, are formed by many layers of different ages and characteristics. When interpreting the water regime using the HYDRUS programs, it is then necessary to enter a number of materials with different properties. However, the variability of the soil properties can also be entered using the reference soil hydraulic properties and scaling factor. Therefore, this study aimed to test this alternative method to characterize the variability of soil hydraulic properties and the soil–water regime. The study was performed on the morphologically diverse study site in a loess region of Southern Moravia, Czech Republic. The original soil type Haplic Chernozem, resulting from erosion, was changed to regosol (steep parts) and colluvial soils (base slope and the tributary valley). At this location, the spatial and temporal variability of topsoil hydraulic properties within a representative transect was previously evaluated using the scaling factor and HYDRUS-2D (Nikodem et al., 2021). In 2021, new research focused mainly on colluvium took place on the site (Zádorová et al., 2023). Two colluvial profiles in two representative terrain positions (toe-slope and side valley) were excavated down to the expected in-situ material not affected by the colluvial process. Two reference soil profiles representing the main parts of the catena were examined – a fully developed soil in the upper flat part and a truncated profile in the highly exposed steep part. Soil hydraulic properties, $\theta(h)$ and $K(h)$, were measured on 100-cm3 undisturbed soil samples using the multistep outflow experiment and numerical inversion with HYDRUS-1D. Next, the reference soil hydraulic properties, $\theta^*(h^*)$ and $K^*(h^*)$, and scaling factors (αh, αK, and $\alpha\theta$) were evaluated to describe spatial and temporal variability of the soil hydraulic properties. Finally, the HYDRUS-1D program was used to simulate water flow within the soil profiles, in which spatial variability of soil properties was interpreted in the usual way (i.e., specified by different soil hydraulic properties) or using the hydraulic properties and scaling factors that were either defined for each layer or linearly interpolated.

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Project No. 21-11879S and CZ.02.1.01/0.0/0.0/16_019/0000845.

References

Nikodem, A., R. Kodešová, M. Fér, and A. Klement, 2021. Using scaling factors for characterizing spatial and temporal variability of soil hydraulic properties of topsoils in areas heavily affected by soil erosion, *Journal of Hydrology*, 593, 125897.

Zádorová, T., V. Penížek, L. Lisá, M. Koubová, D. Žížala, V. Tejnecký, O. Drábek, R. Kodešová, M. Fér, A. Klement, A. Nikodem, J.R. Rojas, P. Vokurková, A. Vaněk, and P. Moska, 2023. Formation of Colluvisols in different soil regions and slope positions (Czechia): Stratification and upbuilding of colluvial profiles, *Catena*, 221, 106755.

What is the influence of varied tree species on physical properties of reclaimed soil after sand excavation?

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Soil structure, defined by particle arrangement and pores, crucially influences water infiltration, storage, and root space. Aggregate formation, integral to soil structure, is biologically influenced, with trees playing a vital role in this dynamic process (Eynard i in., 2004). The aim of this research was to investigate the influence of varied tree species on soil physical properties on post-mining soils, characterized by the initial stage of pedogenesis.

The research was conducted on reclaimed areas after sand extraction - Szczakowa quarry. The study focused on plots that had been afforested with four varied trees species: Scots pine (*Pinus sylvestris* L.), European larch (*Larix decidua* Mill.), Silver birch (*Betula pendula* Roth) and European oak (*Quercus robus* L.). Within each plot, a soil profile was created and two types of samples were collected from distinct morphological soil horizons. In the first group of samples was analysed basic soil properties, including texture, organic carbon content, pH and particle density. The second type of samples were collected to 100cm3 cylinders, from which soil physical properties, such as bulk density and porosity structure, were analysed.

Investigated soils were classified as Arenosols, based on the World Reference Base for Soil Resources classification criteria. The studied soils were typically characterized by acidic pH, subangular structure in the upper layers and granular structure in the subsoil. The tested soils were characterized by porosity in the range of 24-54%, decreasing with increasing depth. The highest porosity was characterized by soil in topsoil especially in pine, which is related to texture, and soil organic matter. Also in topsoil was noted the highest percentage of macropores compared to subsoil. The preliminary research suggests that pine had a beneficial impact on soil density and porosity.

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References

Eynard, A., Schumacher, T. E., Lindstrom, M. J., & Malo, D. D. (2004). Porosity and Pore-Size Distribution in Cultivated Ustolls and Usterts. *Soil Science Society of America Journal*, 68(6), 1927. doi:10.2136/sssaj2004.1927

Biodiverse rooftop system that combines recycled substrates and a dual-purpose wetland-green roof design

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A circular economy-based hybrid green roof system and green roof substrate was developed and tested to reduce the environmental impact of using natural resources such as water and components of substrates based on common primary materials. Two case studies and laboratory analysis were conducted to assess the performance of green roof substrate consisting of recycled crushed brick-based demolition waste and biochar from pyrolyzed sewage sludge. Substrates were tested for their hydro-physical properties such as maximum water capacity, retention curves, bulk density, grain size and pH and suitability for vegetation growth.

The purpose of first case study, which involved a green roof of 7×5 m^2, was to test two newly developed circular substrates in conditions of real green roof and to compare it with standard, commercially available, substrate. The new substrates differed in the amount of pyrolyzed sewage sludge biochar they contained (9.5 vol. % for one and none for the other), but both contained large proportion of crushed brick (37.5 vol. %). The impact of the pyrolyzed sewage sludge was the main focus of the evaluation. At the same time, the changes in hydrophysical characteristics (retention curves, hydraulic conductivity, grain size) over time were evaluated.

Second case study was conducted on two raised beds to test the newly developed substrates in the context of the novel solution combining an extensive green roof and rooftop constructed wetland that uses pre-treated grey water. This system is called Hybrid green roof (HGR). The viability of a hybrid green roof system that uses greywater for irrigation was evaluated by measuring water balance, testing water samples from different sections of the experimental beds, and monitoring temperature and water content along the height of the bed layers. The hybrid green roof system has a constructed wetland section that treats the greywater before it reaches the green roof.

Extensive green roof areas of experimental beds in both studies were planted with Sedum spp. Vegetation in both case studies is thriving. The biochar apparently provides nutrients for the plants, which results in more vigorous growth on the substrates containing biochar. In case of HGR, the nutrient (phosphorus and nitrogen) levels in the leachate from the test beds were relatively low, because the irrigation water goes directly to the drainage layer and does not wash out the nutrient rich substrate with biochar. The nutrient levels have only increased when there is rainfall. The recycled materials used to amend the substrates in this study had similar properties (maximum water capacity, bulk density, pH) to the commercial ones.

The results of the experiment show that hybrid green roof system can effectively reduce the nutrients concentrations in greywater and provide enough water for vegetation to grow, which can effectively reduce the urban heat island effect, cool the building underneath and even provide a source of good quality domestic water.

References

M. Petreje, et.al, Performance study of an innovative concept of hybrid constructed wetland extensive green roof with growing media amended with recycled materials, J. Environ. Manag. vol, 331 (2023), 10.1016/j.jenvman.2022.117151

Effect of amending soil by exogenous materials on soil aggregate stability and humic substances content and quality

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The resistance of soil aggregates against water is an important indicator of soil quality. The stability of soil aggregates depends on soil type, agrotechnical measures, climatic conditions, and organic material application. Due to the lack of organic fertilizers and their high prices different exogenous materials (e.g. digestate, compost etc.) are applied as a fertilizer. The study aims to evaluate the effect of amending soil by mineral fertilizers /NPK/, livestock manure /FYM/, cattle slurry /Slurry/, and digestate /Digestate/ on aggregates stability and humic substances content and quality. The long-term field experiment was carried out at the locality Jevíčko, region of Boskovice Furrow Malá Haná (the Czech Republic). The soil type was classified as Haplic Fluvisol (Němeček et al., 2011) and it is used as permanent grassland. Basic soil properties were determined by standard analytical methods during the summer and autumn of 2023. Active and exchangeable soil reaction was determined by the potentiometric method. Soil aggregate stability was determined by aggregate crumbling after the placement to water. Soil organic carbon was determined using the oxidimetric titration method (Nelson, Sommers 1996). Humic substances were extracted by the mixture of 0.1 M NaOH and 0.1 M Na_4P2O_7 (1:1, w/w). The quality of humic substances was evaluated by HA/FA ratio and using UV-VIS spectroscopy. Results were statistically evaluated (ANOVA, Tuckey test). The following significant correlations were found in the studied period. In the summer there was a significant difference in soil aggregate stability between the NPK (70%) and Control (62%) variants. In autumn there was a significant difference in soil aggregate stability between the Control (65%), FYM (75%), Digestate (74%) and Slurry (73%) variants. HK/FK ratio showed a statistically significant difference between the Control (0.99) and FYM (1.21) and Slurry (1.14) and Digestate (1.14). Furthermore, a significant difference was observed between the FYM and NPK (1.07) variants. Oxidizable carbon content recorded significant statistical differences in summer and autumn in the Slurry, Digestate, and NPK variants. The FYM and Slurry variants significantly differed from all other variants. It can be concluded that the greatest influence on the stability of soil aggregates had the FYM application.

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Green infrastructure as an example of nature-based solution to improve urban soil and environmental quality

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Urbanisation is a major threat to the environment and soil cover. Today, urban areas are growing on average twice as fast as the urban population. By 2050, it is estimated that the global population lived in cities will reach 70%. Continued urban growth is therefore an unavoidable problem. Urban soils are an important part of the urban ecosystem, so it is very important to manage them properly, meaning ensuring soil quality is adequate to maintain plant and animal productivity, keep or improve water and air quality and support human health and habitat (Li et al. 2018). Urban soils provide a range of ecosystem services relevant to cities. The most important for the urban environment are regulating and cultural services (Sudra 2015). Regulating services mitigate flooding, buffer the urban heat island effect, capture pollutants and are responsible for nutrient cycling and carbon storage. Unsealed urban soils host many soil organisms (Setälä et al. 2014). An unsustainable urban landscape results in air, water and soil degradation as well as the fragmentation of natural habitats and a decline in biodiversity. A sustainable urban landscape can be achieved through the use of nature-based solutions that support natural ecological functions by protecting ecosystems and recovering ecological capacity where it has been lost (Tayefli Nasrabadi 2022). Nature-based solutions can also improve soil properties and quality in the city. One of the nature-based solutions particularly relevant in the city is green infrastructure. A study carried out in Lublin and Pulawy (Poland) in 2022 showed that vegetation plays an important role in the urban ecosystem. Contamination levels were determined in the soil samples and then correlated with vegetation intensity. It was found that there is a very strong relationship between these factors. The more intensive the vegetation, the less contaminated the soils are. Green infrastructure also has a positive effect on improving thermal conditions in the city by mitigating the urban heat island which improve the quality of residents' life.

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References

Li G., Sun G-X., Ren Y., Luo X-S, Zhu Y-G., 2018, Urban soil and human health: a review, *European Journal of Soil Science* (69), 196-215

Setälä H., Bardgett R.D., Birkhofer K., Brady M., Byrne L., de Ruiter P.C., de Vries F.T., Gardi C., Hedlund K., Hemerik L., Hotes S., Liiri M., Mortimer S.R., Pavao-Zuckerman M., Pouyat R., Tsiafouli M., van der Putten W.H., 2014, Urban and agricultural soils: conflicts and trade-offs in the optimization of ecosystem services, *Urban Ecosystems* (17), 239-253

Sudra P., 2015, Usługi ekosystemowe na tle wybranych koncepcji ekologii miasta, *Człowiek i Środowisko* (39), 61-73

Tayefi Nasrabadi, M., 2022, How do nature-based solutions contribute to urban landscape sustainability?. *Environ Dev Sustain* 24, 576–591

Soil water retention estimation by the fractal dimension of water retention power function determined from the clay content

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In the increasingly frequent dry weather periods, the water retention capacity of soil (SWRC) is of increasing importance. Thus, quick and simple determination of the water retention capacity of their soils is becoming more and more important for farmers. The fractal dimension in the Hungarian water retention capacity estimation is not yet used. We developed a method of fractal dimensional estimation of water retention capacity on a recently collected representative soil physics database and applied it to a previously built database in order to establish its more general usability. First we established a log-linear relationship between SWRC and the soil clay content. Then we considered this fractal dimension as the Brooks and Corey (1964) like power function exponent defined by Tyler and Wheatcraft (1990) and converted it to *m* and *n* exponents of the van Genuchten (vG) function. The *alfa* parameter of vG function was determined as reciprocal of the bubbling pressure of soil. The results of estimated water retention data are presented on both the test and an independent database together with the statistical evaluation of the prediction errors.

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References

Brooks, R.H. and A.T. Corey, 1964. Hydraulic Properties of Porous Media, *Hydrological Paper No. 27.* Colorado State University. Fort Collins.

Tyler, S.W. and S.W. Wheatcraft (1992): Fractal scaling and soil particle size distribution: analysis and limitations. *Soil Science Society of America Journal, 56,* 653–668.

Van Genuchten, M. Th. 1980. Closed-form equation for predicting the hydraulic conductivity of unsaturated soils. *Soil Science Society of America Journal, 44,* 892–898.

Performing SWCC inversions using soil descriptions and field moisture measurements

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With the recent introduction of low-cost soil moisture sensors, soil scientists and engineers are faced with inverting field moisture data to infer the unsaturated behavior of a profile. While matric suction measurements in the field would be desirable, they are not always available. A typical scenario occurs when a modeler has only filed moisture data at several depths and a general soil profile description. The goal then becomes developing a plausible soil-water characteristic curve (SWCC) profile that adequately captures its hydrological behavior.
This study describes efforts to develop such profiles at several locations in Eastern Hungary where colleagues have collected several years of soil moisture data along a two or three-meter vertical profile. Soil properties at each location are similar and share meteorological conditions due to their proximity. The study outlines the process of estimating unsaturated parameters, focusing on data validation, soil profile correlations to SWCC estimates, and confidence levels in estimating local groundwater recharge.

Determination of physical properties of undisturbed soil samples according to V. Novák

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The methodology described here presents the procedures for determining physical soil properties of undisturbed soil samples. Besides describing the methods for determining bulk and particle density, moisture content and porosity of the soil in detail, it also offers a way of determining soil's water holding properties when there is no pressure membrane apparatus available. This method is based on a capillary water saturation experiment and gravimetric measurements performed in different time intervals after the saturation (30 minutes, 2 hours, and 24 hours). With a few, simple to follow steps, and not using complicated and space-consuming equipment, it can be replicated in almost any laboratory, and the results are easily interpreted. The method was, and still is, widely used in the Czech Republic, and some parts of it are used as standard soil testing methods. To a lesser or greater detail, this method is described in Rejšek (1999), Valla et al. (2011), Pospíšilová et al. (2016) and ÚKZÚZ (2016), and this methodology is compiled from those publications, mainly focusing (and using the same abbreviations) on the procedures described by Valla et al. (2011). The methodology described does not essentially differ from the original, but the steps here have been described to a greater detail, based on the practical experiences obtained over the years, in order to make some common mistakes less likely to happen. The methodology is further complemented with graphical illustrations for each step described in the process, making it clearer, more easily understood, and easier to replicate. Since this methodology has not been available in English so far, this guide offers a great opportunity of its replication on an international level.

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References

Spasić, M., Vacek, O., Vejvodová, K., Tejnecký, V., Polák, F., Borůvka, L., Drábek, O. 2023. Determination of physical properties of undisturbed soil samples according to V. Novák, *MethodsX, 10*, 102133.

Long term effects of soil tillage system and straw retention on soil properties in winter rape

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In the Experimental station of Vytautas Magnus University, Kaunas district, Lithuania, a long-term field experiment has been established since 1999. The soil of the experimental site is classified as Epieutric Endocalcaric Planosol (Endoclayic, Episiltic, Aric, Drainic, Endoraptic, Uterquic), according to the World Reference Base (WRB, 2022). The texture of the topsoil is sandy loam, and the agrochemical properties are the following: pH_{KCl} – 7.6 (slightly alkaline), organic carbon (OC) – 1.65 %, plant-available potassium (K_2O) – 134 mg kg^{-1} and phosphorus (P_2O_5) – 266 mg kg^{-1}.

The study aimed to explore the impact of different soil tillage systems and straw retention on soil properties in the context of winter rape. It sought to provide insights into the potential benefits of these practices and evaluate their effects on various soil characteristics.

Multiple soil tillage systems, including conventional tillage and reduced tillage, were compared, taking into account the influence of straw retention. The focus of the study was on winter rape, a widely cultivated crop with significant importance in agricultural systems.

The analysis encompassed several soil properties, soil structure, stability of the soil. By examining these properties, the researchers aimed to gain a better understanding of how different soil management practices can impact soil health and fertility. The findings of the study suggest that adopting reduced tillage systems and retaining straw can have positive effects on soil properties in winter rape cultivation. These practices appear to enhance organic matter content and improve soil structure. Additionally, they have the potential to promote nutrient availability and microbial activity, which are crucial for maintaining soil fertility.

However, it is important to note that further research is necessary to fully explore the long-term effects and practical implications of these practices in diverse agricultural settings. By considering factors such as soil type, climate conditions, and crop rotation, future studies can provide more comprehensive insights into the effectiveness of different soil tillage systems and straw retention strategies in optimizing soil properties for winter rape cultivation.

Key words: sustainable tillage, soil properties, crop rotation.

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Effect of vegetation cover on water repellency persistence of drained peat soils

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Soil water repellency is a naturally occurring phenomenon observed in soils across various land use types and climatic conditions. It is widely acknowledged that soil water repellency is primarily caused by organic compounds originating from living or decomposing plants or microorganisms. Peat is the surface organic layer of soil that consists of partially decomposed organic matter, derived mainly from plant material, which has accumulated under close to water-saturated conditions. Peatlands play an essential role in the environment, and their conservation requires knowledge of water-related processes. An important factor influencing the flow of water in soils is their hydrophobicity. Drainage of fens and adapting them for agricultural production have contributed to the degradation of peat soils. The main goal of this study was to evaluate the effect of the use of drained peat soils on the persistence of their water repellency as a function of their moisture content. Additional objectives were to determine the critical soil moisture content at which soil water repellency starts and examine the effect of soil drying temperature on the persistence of soil water repellency. Soil samples (Rheic Fibric Histosol and Rheic Murshic Hemic Histosol) were collected from four sites in the Biebrza Wetlands (Poland). The sites are used as extensive meadows, intensive meadows, alder swamp forest, and nettle birch forest. The Water Drop Penetration Time (WDPT) test was used to assess the persistence of soil water repellency during the drying of soil samples in laboratory conditions. The three-straight lines model was proposed to describe the relationship between WDPT and soil moisture content. Performed research showed that the persistence of soil water repellency in the studied soils measured using the WDPT test was found to be closely related to the soil moisture content. The suggested three-straight lines model enables describing of the actual repellency persistence to the moisture decrease in drying hydrophobic peat and mursh soils. In addition to soil moisture, soil type (peat, mursh) plays an important role in controlling water repellency persistence. The type of soil vegetation cover influences soil water repellency persistence to a much lesser extent than the influence of soil type.

Isotopic composition of soil water in irrigated and non-irrigated vineyards

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Isotope methods in forensic practice have spread in recent decades to a number of sectors, including forensics or product inspection, including food. Naturally, wine production is also subjected to these methods, where the correctness attributable to a given region is checked by the national authorities of all EU countries. In wine, among others, the ^{18}O of the wine water and the ^{2}H (D/H1, D/H2) in the alcohol groups and the ^{13}C. The national authorities are obliged to take grapes from a given number of sites in designated wine-growing sub-regions, from which a database is compiled after certified winemaking to assess production in a given region and year (Hermann and Voerkelius, 2008). A number of factors influence the isotopic composition of grapes, such as rainfall, the immediate and long-term temperature, solar radiation, air humidity or the characteristics of each variety, including the harvesting period (Gómez-Alonso and García-Romero, 2010). As global climate change progresses, with hot, dry summers becoming more frequent, many wine growers are resorting to supplementary irrigation of their vineyards. With the increasing unavailability of water in the landscape, the long-distance transfer of water and thus the different isotopic inputs of the irrigation carried out can have an impact on the isotopic composition of the soil water and can affect the final isotopic composition of the product (Tardaguila et al., 2008). This study focused on monitoring the ^{18}O content of soil water in irrigated and non-irrigated vineyards in Sedlec u Mikulova for two growing seasons (2020, 2021) in the context of observed climatic and hydrological variables. Rainfall at the vineyard site and surface water in the wider area were also sampled to map the isotopic variability of possible inputs. The South Moravia region is very isotopically diverse in terms of surface water sources. In the locality of this warm region, local streams meet with waters from cooler more distant areas. A specific input is the evaporated water from the Dukovany nuclear power plant, partly composing waters in the Jihlava river, a tributary of the Dyje river used as irrigation in this case. In terms of the occurrence and isotopic composition of water in the soil, the irrigated soil profile is visibly different in terms of both soil moisture and isotopic composition from the non-irrigated profile. Long-term irrigation also has an effect on the different distribution of vine roots, resulting in different water extraction dynamics during the growing season as found in non-irrigated vineyard. These factors can affect final composition of the grapes and it is therefore necessary to take them into account when controlling the resulting production.

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References

Gómez-Alonso, S., García-Romero, E. 2010. Effect of irrigation and variety on oxygen (d18O) and carbon (d13C) stable isotope composition of grapes cultivated in a warm climate. Australian Journal of Grape and Wine Research. Vol.16, 2. 283-289. doi: 10.1111/j.1755-0238.2009.00089.x

Tardaguila J., Bertamini M., Reniero F., Versini, G. (2008) Oxygen isotope composition of must-water in grapevine: Effects of water deficit and rootstock. Australian Journal of Grape and Wine Research 3(2):84 – 89 DOI: 10.1111/j.1755-0238.1997.tb00119.x

Hermann, A., Voerkelius, S. (2008). Meteorological impact on oxygen isotope ratios of German wines Am. J. Enol. Vitic. 59, 194-199

Relation of erosion to stabilization of soil aggregates via glomalin-related soil protein in luvisols

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Glomalin is a part of soil organic matter, linked to the presence of arbuscular mycorrhizal fungi (Wright 1996), conventionally quantified as a protein compound by Bradford assay (Bradford, 1976), therefore called glomalin-related soil protein (hereinafter GRSP) (Nichols, 2003). The potential for physical stabilization of soil aggregates and improvement of soil structure by water repellency and adhesion of soil particles may be partially influenced by the content of GRSP (Rillig, 2006; Young 2012). The positive correlation between the content of GRSP and the stability of soil aggregates against the disintegration by water was supported in several articles (Niu, 2017; Sharifi, 2018; Welemariam, 2018; García-González, 2018). The question is to what extent may this relationship be valid in different soil physical conditions such as soil texture, state of weathering, mineralogy, and others.

The research about the mentioned influence of GRSP was conducted in 2021. The location of interest was arable land in the surroundings of the city of Brno. The originally selected soil dataset was searched in the national database of BPEJ (bonified soil-ecological units) of agricultural land of the Czech Republic, and the emphasis was placed on soils mapped as luvisols. The resulting dataset was divided according to the actual situation of the soil into two groups, soils classifiable as luvisols according to the WRB classification, and soils classifiable as regosols or cambisol originating from eroded and degraded luvisols. GRSP was measured in the form of easily extractable GRSP ($GRSP_{EE}$) and total GRSP ($GRSP_T$). The stability of soil aggregates was measured as the content of water-stable aggregates (hereinafter WSA) together with other conventionally measured soil parameters.

Results show that the only significant correlation between GRSP and WSA was found in the case of $GRSP_{EE}$ on luvisol ($r = 0{,}6642$; $p = 0{,}0362$; $\alpha = 0{,}05$). The content of clay, silt, sand, and soil organic carbon played no significant role in the percentage of WSA in any group of soils. In contrast, the pH negatively correlated with significance in every group of soil and the whole dataset of luvisols and regosols ($r = -0{,}6697$; $p = 0{,}0012$; $\alpha = 0{,}05$). In comparison to other studies with similar soil texture (Sun & al., 2021) the correlation of $GRSP_{EE}$ with WSA was lower but still higher than in the case of $GRSP_T$, indicating that $GRSP_{EE}$ might be more closely related to the stabilization of soil aggregates. Regosols in eroded locations showed no such relationship, which reflects the usual property of soils with lower soil organic matter. The negative correlation of pH with WSA in the case of the study can be linked to the fact that water erosion usually uncovered parent material with high pH (loess) or that cambisol with lower pH than luvisols shows different mechanisms of aggregate stabilization.

The impact of different soil cover on soil structure and hydraulic properties

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Land use significantly affects the soil-water and temperature regimes. Very different soil surface treatments are found especially in urban environments, where different materials are used to cover the soil surface, which are used in horticulture and construction (Kodešová et al., 2014). Alternations of these regimes due to modifications of soil covers may lead to changes in soil properties. Therefore, the goal of this study was to find out how soil properties, particularly soil structure and soil hydraulic properties changed during our experiment, which has been mainly focused on the monitoring of soil water and thermal regimes under five different surface covers: bare soil (BS), bark chips (BC), concrete paving (CP), mown grass (MG), and unmown grass (UG). The surface of a Haplic Chernozem (which was originally covered by grass) was modified in autumn 2012. Since then, climatic conditions are monitored, and soil-water contents and temperatures are measured at various depths. In the summer 2020, after removal of the surface cover, intact soil samples were taken, on which the hydraulic properties were measured using the multistep outflow method. Another set of undisturbed soil samples was used to study soil structure using the X-ray computed tomography. In addition, these samples were next used to prepare thin soil slides for micromorphological analyses. Undisturbed soil samples were also taken to measure soil pH, organic carbon content, etc. Stability of soil aggregates were assessed using the WSA index. Along with soil sampling, the measurement of some characteristics took place directly in the field. The mini disk tension infiltrometer with a disk radius of 2.22 cm was used to measure unsaturated hydraulic conductivities for pressure head of –2 cm ($K_{h=-2}$). The net CO_2 and net H_2O efflux were measured using the LCi-SD portable photosynthesis system with a Soil Respiration Chamber. The CT and micromorphological analyzes showed that character of pores in soils with grass (MG, UG), which are mainly influenced by roots and organisms living in soils, differs from pore character in soils covers by BC or CP that are impacted mainly by living organisms. Both groups differ from BS, which is mainly affected by regular treatment, i.e. weeding etc. Measured soil properties reflected soil-pore character. For example, the highest aggregate stability was for UG, followed by MG, BC, CP, and BS. The highest porosity was found for UG, followed by BS, MG, BC, and CP. However, the highest retention ability was observed for BC followed by UG, MG, CP and BS. The $K_{h=-2}$ values for UG, MG and BS were much higher than those for CP and BC. Finally, the highest net CO_2 was measured for BC and MG followed by UG, CP and BS.

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References

Kodešová, R., M. Fér, A. Klement, A. Nikodem, D. Teplá, P. Neuberger, and P. Bureš, 2014. Impact of various surface covers on water and thermal regime of Technosol. *Journal of Hydrology, 519,* 2272–2288.

Secondary succession on abandoned fields affects soil properties

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Abandonment of agricultural lands is occurring mainly in Europe, North America and Oceania, and changing the fate of landscapes as the ecosystem recovers during fallow stage. The objective of this study was to find the impact of secondary succession in abandoned fields in Borský Mikuláš, Sekule, and Studienka (Borská nížina Lowland, southwestern Slovakia) on some parameters of soils with different texture. Soil chemical (pH and soil organic carbon (SOC) content), hydro-physical (hydraulic conductivity, water and ethanol sorptivity), and water repellency (water drop penetration time, repellency index and contact angle) parameters in sandy, loamy sand and sandy loam soils were estimated. Clay content decreased in loamy sand and sandy loam soils, while negligible changes of clay content in sandy soils were registered. At the start of land abandonment, the SOC content was greater in sandy loam and loamy sand soils than in sandy soil due to the better fertilization. Therefore, the SOC content increased in sandy soil and decreased in sandy loam and loamy sand soils during 12-years-lasting field abandonment. The water repellency parameters increased and pH decreased during abandonment. The hydraulic conductivity decreased in sandy soil and varied in sandy loam and loamy sand soils during abandonment. The water sorptivity varied in the course of succession. The ethanol sorptivity did not change significantly during abandonment. As the ethanol sorptivity depends mainly on soil pore size, the last finding could mean that the pore size of studied soils did not change in the course of succession (Lichner et al., 2020, 2023; Toková et al., 2022).

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References

Lichner, Ľ., M. Iovino, P. Šurda, V. Nagy, A. Zvala, J. Kollár, J. Pecho, V. Píš, N. Selehrnia, and R. Sándor, 2020. Impact of secondary succession in abandoned fields on some properties of acidic sandy soils, *Journal of Hydrology and Hydromechanics, 68*, 12–18.

Lichner, Ľ., P. Šurda, L. Toková, S. Hološ, J. Kollár, and D. Igaz, 2023. Impact of duration of land abandonment on soil properties, *Journal of Hydrology and Hydromechanics, 71*, 148–155.

Toková, L., S. Hološ, P. Šurda, J. Kollár, and Ľ. Lichner, 2022. Impact of duration of land abandonment on infiltration and surface runoff in acidic sandy soil, *Agriculture, 12*, 168.

Inter-instrument comparison of diffraction analysers for the determination of soil grain size fractions

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The granulometric composition of soil, or soil texture as it's also known, is one of the basic characteristics ascertained when determining particle size distribution (PSD). Over recent decades, there has been an increasing effort to replace traditional methods for determining granular composition, such as sedimentation or pre-sieving, with the laser diffraction method (LDF), primarily due to their time-consuming nature. When using LDF equipment, however, PSD results often vary, depending on the type of device used, its manufacturer and development and the software applied. Our goal was to assess soil grain size composition at two windbreaks with adjacent arable land using the two most commonly used LDF analysers, the Mastersizer 3000 and Analysette 22 (Bieganowski 2018), and to compare the results. In each case, we used the same protocol and device set up. Soil samples were taken at a depth of 0–10 and 10–20 cm along transects running perpendicular to the axis of the windbreak, with an overlap into the adjacent agricultural land, during spring 2022, when the arable land was unprotected by crop cover. While the trend in grain size curves remained very similar, we recorded significant differences in PSD between the analysers, with grain size fractions mainly classified as "sandy loam" with the Mastersizer 3000 and mainly as "silt loam" with the Analysette 22. Consequently, future studies should ensure that they provide detailed information on the LDF device used and its settings, allowing clarification of any under- or overestimation of individual fractions (e.g. clay, silt, sand), and thus get as close to true values as possible.

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References

Bieganowski, A., M. Ryżak, A. Sochan, G. Barna, H. Hernádi, M. Beczek, C. Polakowski, A. Makó, 2018. Laser Diffractometry in the Measurements of Soil and Sediment Particle Size Distribution, *Advances in Agronomy*, https://doi.org/10.1016/bs.agron.2018.04.003.

Impact of post-fire soil management on physical properties: A comparative study of various tree species and charcoal influence

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Wildfires represent a significant ecological disturbance, often leaving lasting impacts on soil properties. Understanding the long-term impact of fire on soil physical properties is crucial for successful reclamation efforts. This study aims to investigate the soil physical properties, including bulk density, particle density and porosity, in a forest recovery, 30 years after a fire, with a particular focus on the influence of tree species and the presence of charcoal. Four different tree species, namely pine (*Pinus sylvestris* L.), larch (*Larix decidua* Mill.), birch (*Betula pendula* Roth), and oak (*Quercus robus* L.), were selected as representative species for the study. The forest revealed two distinct zones: one with the presence of charcoal following the fire and another where charcoal had been removed from the surface after fire. Soil samples were collected from each horizon of the soil profile in the experimental plots. All soil profiles according to WRB classification belongs to Podzol groups. The preliminary findings reveal nuanced variations in soil physical properties of topsoil horizons among the selected tree species and charcoal presence. In the absence of charcoal, distinctions in bulk density among these four plant species are minimal. In the presence of charcoal, bulk density increases in coniferous trees (pine and larch), implying a more compacted soil profile, while it decreases in deciduous trees (birch and oak), signifying a relatively loose soil structure. The interaction between charcoal and tree species exhibits intricacies in relation to particle density. Oak soil consistently displayed the lowest particle density among the tested tree species, irrespective of charcoal presence. Charcoal presence influenced particle density differently across species, resulting in an increase in pine soil, a decrease in larch and oak soils, and minimal changes in birch soil compared to areas where charcoal was removed. Due to its low particle density, oak soil exhibits the lowest porosity among the various tree species. The introduction of charcoal resulted in a substantial increase in porosity of birch and pine soil. Conversely, the porosity of larch soil experiences a marked reduction when the presence of charcoal leads to a decrease in particle density and an increase in bulk density. In the other horizons, there were no clearly different about bulk density, particle density and porosity among the experiment plots. These observations underscore the potential influence of tree species and the presence of charcoal remnants on soil physical properties in forest reclamation.

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References

Roces-Díaz, J. V., C. Santín, J. Martínez-Vilalta and S. H. Doer, 2022. A global synthesis of fire effects on ecosystem services of forests and woodlands, Front Ecol Environ 2022, 20(3), 170–178.

Estimation of soil organic carbon diversity with visible–near-infrared (VIS-NIR) spectroscopy

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Soil organic matter (SOM) and black carbon (BC) is an important factor determining the soil quality, however, the diversity of its fractional composition indicates the effectiveness of soil productivity as an attribute of the ecological and economic value of soil. No single analytical method can adequately account for SOC fractions in soil. Diffuse reflectance spectroscopy provides a good alternative that may be used to enhance or replace conventional methods of soil analysis, as it overcomes some of their limitations. VIS/NIR spectroscopy has great potential for simultaneously estimating a variety of soil properties, known as a rapid, cost-effective, quantitative and eco-friendly technique, can provide hyperspectral data with narrow and numerous wavebands.

Thus, the objective of the study was to develop the model of soil organic carbon content and their fractional composition based on laboratory measurements of reflectance within the visible and near-infrared spectral ranges for agricultural usage region. Forty top soils (0-30 cm) of different properties e.g. pH H_2O= 3.8-7.8, content of clay= 0-60g/kg and silt= 90-45 g/kg were collected from agricultural area. Total soil carbon content (TC) was determined by TC/TN analyzer Vario Macro Tube and soil organic carbon (SOC) by Turin method. Different SOC fractions were selected: humic substances as regard the content of humic acids-HA + fulvic acids-FA + humins-HY (modified ISO 12782-4 Method) and black carbon (thermal oxidation at 375^{o}C/ 24h). Spectral analysis was performed using the Veris VIS-NIR spectrophotometer in bench top mode (Veris Technologies, Salina, KS, USA) in the 350-2220 nm spectral range using Veris spectrophotometer software V1.74. The spectrum from each sample was matched with laboratory analysis data to create a database for calibrations. A multivariate calibration model is required to obtain some practical information from the VIS-NIRS spectra. The Partial Least Square Regression (PLS), a popular multivariate calibration technique for quantitative analysis of NIR spectral data and Support Vector Machine (SVM), was used to determine the best correlation between the chemical data and spectra data.

Soils differed substantially in SOC content (7.9-187.2 $g \cdot kg^{-1}$) and individual SOM fractions. BC accounted for 1.6 to 27.9% of TC. Fractionation of soil organic matter indicated on FA as the smallest portion (1-11.7%) of total HS while HA and HY ranged from 14.3 to 65.2% and 32.2 to 84.7%, respectively.

The soil spectrum was dominated by strong interfering signals due to vibration of the aromatic rings in region of 400nm and broad bands at 1900 nm and 2200 nm. These bands were attributed to stretching of C=O in conjugated carboxyls, quinones, amide I, and to symmetrical and antisymetrical stretching in carboxylates, responsible for formation of linkages with other organic molecules constituting readily available compounds for plants.

Laboratory apparatus for simultaneous measurement of saturated hydraulic conductivity on undisturbed soil samples

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In times of global warming, recurrent droughts and torrential rainfall, the measurement of saturated hydraulic conductivity (Ksat) is increasingly relevant to provide input data for calculations in landscape water management. However, the variability of measurement results for K_{sat} is one of the highest among all hydropedological characteristics. Not only heterogeneous soils often show different K_{sat} values when measured , and therefore it is preferable to measure the same soil in multiple replicates to obtain representative data. In addition, the measurements are relatively time consuming and automating the actual measurements can be an additional advantage.The Laboratory of Experimental Hydropedology (LEH) of VÚMOP, v.v.i. has so far carried out measurements of K_{sat} for its projects and orders on its own equipment adapted for one soil sample. The equipment is fully compliant with EN ISO 17892-11 Geotechnical investigation and testing - Laboratory testing of soils - Part 11: Determination of permeability. To ensure simultaneous K_{sat} measurements on multiple samples at the same time, a completely new instrument was developed at our site in 2023, which improves, simplifies and accelerates K_{sat} measurements at a relatively low cost. Initial start-up measurements were made on representative soil samples that had high K_{sat} values, so there was a noticeable simplification of the physical work, with the instrument itself providing water supply relatively quickly for multiple samples at once. Subsequent measurements were made on homogeneous samples of laboratory sand ST2 from Sklopísek Střeleč, a.s., where the results of the new instrument were compared with those of the previously used equipment. The results of measurements on the new device were comparable. The above-mentioned „Laboratory apparatus for simultaneous measurement of saturated hydraulic conductivity on undisturbed soil samples“ is registered as a Functional sample and the relevant documentation is available in the library of VÚMOP. The use of this apparatus should increase the number of analyses performed several times, which is beneficial for many hydropedology-related topics such as e.g. predictive analytical modelling describing water movement in soil, solving problems related to drainage structures, shallow wells...

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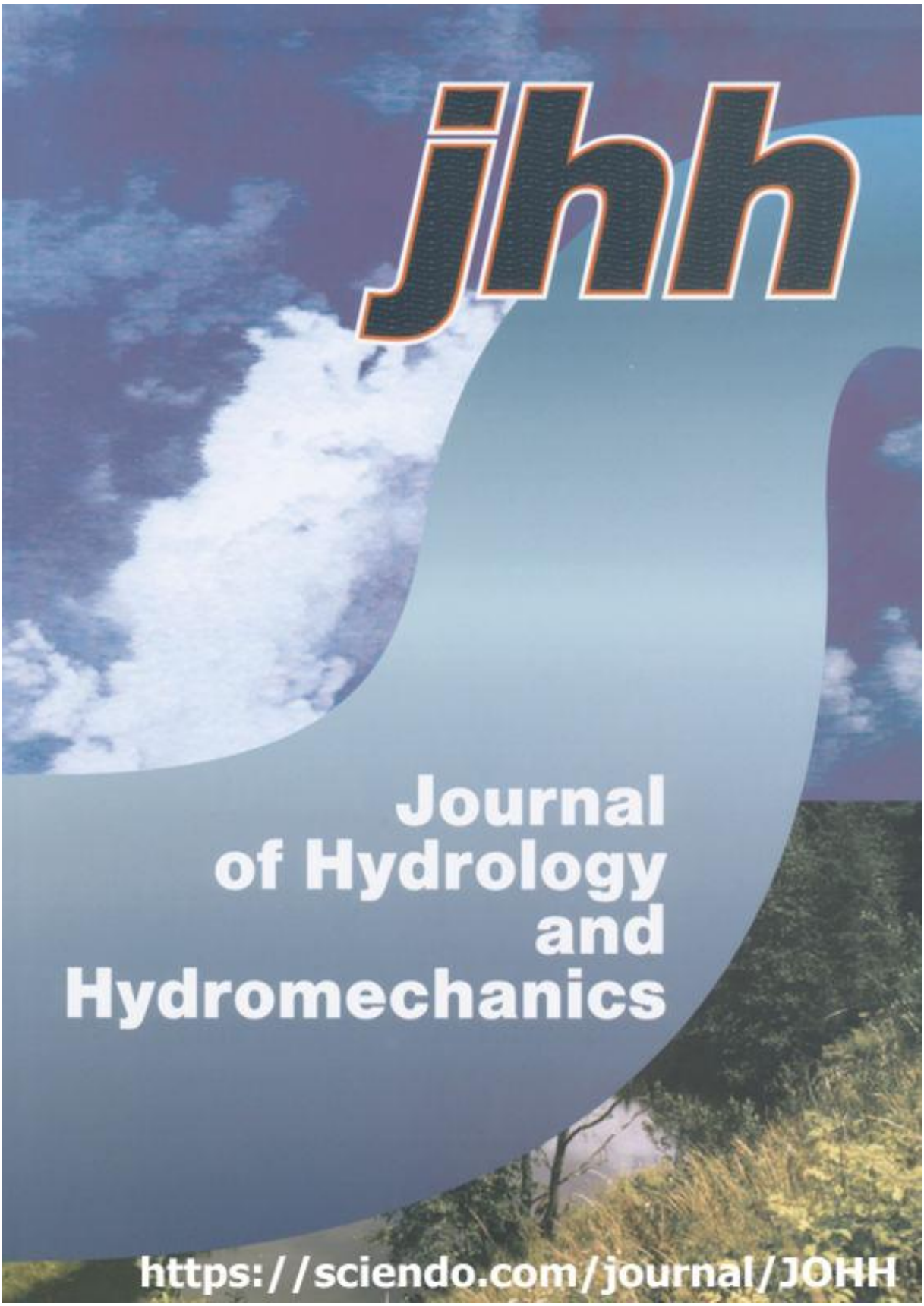
Project No. MZE RO0223.

References

Kulhavý, Z., M. Čmelík, I. Pelíšek, 2014: Souprava infiltrometru a permeametru s dávkovacím čerpadlem. Granted patent CZ 305517 Permeametr s dávkovacím čerpadlem (2015)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