2^{nd} INTERNATIONAL SYMPOSIUM OF SOIL PHYSICS

Institute of Environmental Engineering
Polish Academy of Sciences

Organizers:

Commission of Soil Physics, Polish Society of Soil Science

Lithuanian Soil Science Society

Katowice Branch of Polish Geophysical Society

Aleksandras Stulginskis University, Lithuania

08 February, 2017

Symposium program

08 February, 2017

Institute of Environmental Engineering, Polish Academy of Sciences

34 M. Skłodowskiej-Curie str., 41-819 Zabrze, POLAND

9.00 – 09.15 Opening of the Symposium

09.15 – 11.00 Presentations (1 session)

09.15 Beata HOUŠKOVÁ, Jarmila MAKOVNÍKOVÁ, Ján ŠLINSKÝ. **How ecological farming influences soil properties.**

09.30 Cezary KAŹMIEROWSKI. **Indirect estimation of hydraulic properties of soils in the Polish Lowlands.**

09.45 Juratė ALEINIKOVIENĖ, Tomasz ZALESKI, Rimantas VAISVALAVIČIUS, Romutė MIKUČIONIENĖ. **Testing and evaluation of various organic and mineral substrates seeking for sufficient productivity**.

10.00 Ewa PAPIEROWSKA, Sylwia NOWAK, Jan SZATYŁOWICZ, Tomasz GNATOWSKI. **Hydrophobicity of soils contaminated by petroleum products.**

10.15 Hana GRISON, Eduard PETROVSKY, Ales KAPICKA, Sarka STEJSKALOVA. **Magnetic and chemical parameters of andic soils and their relation to selected pedogenesis factors.**

10.30 Marcin SZUSZKIEWICZ, Adam ŁUKASIK, Tadeusz MAGIERA, Maria SZUSZKIEWICZ. **Diversificationof geo- pedo- and technogenic magnetic and geochemical signals in soil profiles: A case study of Poland.**

10.45 Virmantas POVILAITIS, Sigitas LAZAUSKAS, Šarūnas ANTANAITIS, Renaldas ŽYDELIS. **Water, soil and cereals crops productivity under different management**.

11.00 – 11.30 Coffee break (tea drinkers will be not discriminated)

11.30 – 13.45 Presentations (2 session)

11.30 Michał BECZEK, Magdalena RYŻAK, Tomasz KORBIEL, Agata SOCHAN, Rafał MAZUR, Andrzej BIEGANOWSKI. **Single raindrop impact on soil surface as a sound wave source**.

11.45 Rafał MAZUR, Magdalena RYŻAK, Michał BECZEK, Agata SOCHAN, Tomasz KORBIEL, Józef HORABIK, Andrzej BIEGANOWSKI. **A system for recording of the mechanical impulse of the water drop's impact on a soil surface**.

12.00 Tomasz ZALESKI, Mariusz KLIMEK, Bartłomiej KAJDAS, Joanna KOWALSKA. **Soil water dynamics and water regime in genetic horizons of Retisol**.

12.15 Edyta HEWELKE, Jan SZATYŁOWICZ, Piotr HEWELKE, Rufat AGHALAROV, Tomasz GNATOWSKI. The effect of diesel oil pollution of forest soils on their CO_2 efflux and hydrophobicity.

12.30 Ryszard MAZUREK, Tomasz ZALESKI. **Shelterbelt as factor affecting physical properties of adjacent farmland soils.**

12.45 Guillaume DEBAENE, Jacek NIEDŹWIECKI, Alicja PECIO. **VIS-NIR „on-the-go" platform for the determination of several soil physical properties**.

13.00 Agnieszka JÓZEFOWSKA, Bartłomiej KAJDAS. **Earthworms vs. substrates, do they change soil biological activity - laboratory experiment**.

13.15 Tomasz STAŃCZYK, Anna BARYŁA. **Use of optical 3D scanner to analyze changes in soil microtopography under simulated rainfall**.

13.30 Andrzej BIEGANOWSKI, Małgorzata Bzowska-Bakalarz. **Elaboration of innovative method for monitoring the state of agrocenosis with the use of remote-sensing gyro system in terms of precision farming.**

13.45 Summary and closing

14.00 A common move to the restaurant for lunch

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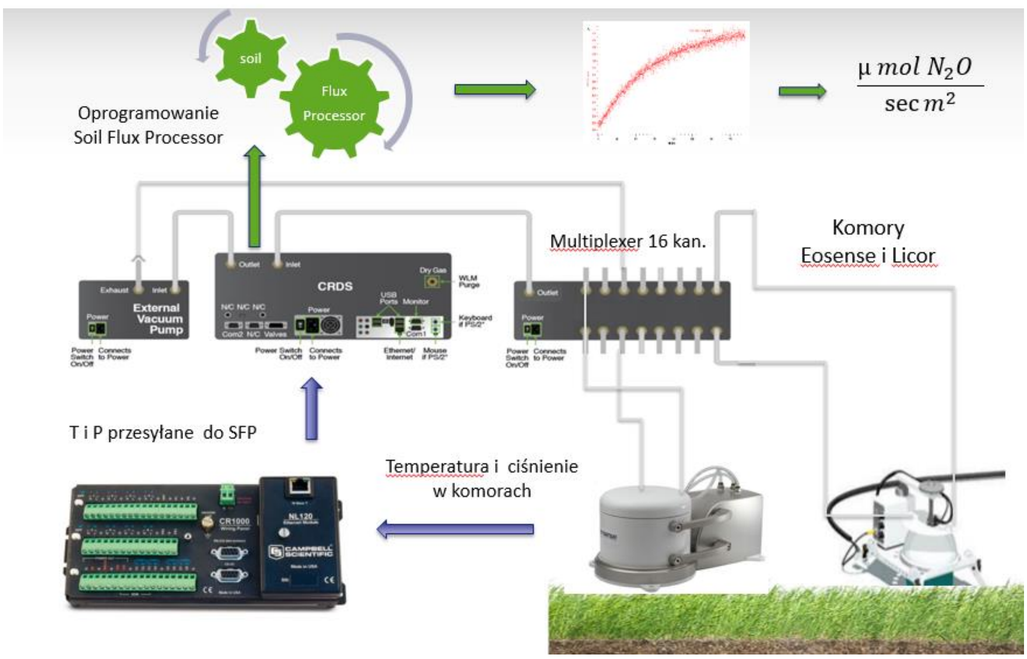

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Dostarczając najnowsze rozwiązania znajdujące się obecnie na rynku pomagamy uruchamiać nawet najbardziej zaawansowane stanowiska badawczo-rozwojowe.

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Abstracts

How ecological farming influences soil properties

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Keywords: ecological farming, soil cultivation practices, soil structure, soil physical properties

Soil subjects to a number of degradation impacts. The cause of soil degradation processes directly lies in the way of its use, which affects ecological functions of soil and consequently the stability of the land. Ecological farming using soil cultivation in circles, so called Agrokruh system is the way to grow healthy crops without heavy machinery and chemicals, how to live healthily in harmony with nature. It is better to invest in long-term into sustainable use of land growing healthy crops and producing tasty food. The Agrokruh system is environmentally friendly methods of cultivation, where the individual fields have the shape of a circle and are operated by a rotating arm fixed in the middle of the field. Single rows are cultivated in a spiral. Soil cultivating tool is mounted on a chain and is guided along the arm. The chain by the turn of the arm is wound on the sprocket fixed in the point of circle rotation. The circumference determines the width of cultivation line. It is possible to fix interchangeable tool that can serve as a spade, rotary tiller, and seeder or for drip irrigation. The circular fields are located side by side and so one working arm can be easily moved to a adjacent field when disconnected from the center of the first field. By a simple turn it will get in the center of the adjacent circular field. Thus it may be one arm for a number of cultivated fields. This method allows cultivation of soil without using heavy machinery, even without direct access to the land. Such cultivation has positive impact on soil properties. When comparing with traditional cultivation the differences are mainly visible in soil structure quality. Amount of agronomically valuable structure is higher in the soil from Agrokruh in the whole profile in comparison with soil with traditional cultivation. Amount of microaggregates (<0.25mm) shows that soil with traditional cultivation has the highest portion of such aggregates in the depth from 20 to 40 cm. This is due to lower aggregates stability in water and can be result of soil cultivation by ploughing.

Preliminary results of the nutrient regime assessment show that ecological type of cultivation in comparison with traditional one has sufficient nutrients level, despite the non-use of fertilizers. This amount can ensure the requirements of cultivated crops.

The main pros of this ecological farming are sustainable use of soil, protection of soil properties and soil biodiversity, as well as low energy consumption and low emissions production.

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Indirect estimation of hydraulic properties of soils in the Polish Lowlands

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In order to describe soils quantitatively, and to model processes taking place in it, quantitative data on various soil characteristics are required. In absence of measurements of particular characteristic, its value is usually estimated or taken from established soil science knowledge. However, in order for such "filler data" to produce reliable values of unmeasured parameters, proper way of estimation ought to be found. Optimal estimator together with mathematically described relationship between estimated characteristics and its estimators, as well as the estimation error are required.

During the presentation, results of research on indirect assessment hydraulic properties of soils from Polish Lowland region, water retention curve (WRC), available water capacity (AWC), saturated hydraulic conductivity (K_s) will be presented. A database of the hydraulic properties of soils in the Polish Lowlands was developed for the purpose of modeling these properties. The database holds verified and standardized (in terms of units) analytical data, and provides insight into the scale of variation of soil characteristics, as well as its mutual relationship. Subsequent analysis of interdependence of soil properties resulted in equations used in following tasks: 1) parameters of van Genuchten-Mualem model of WRC, 2) field capacity (FC), 3) permanent wilting point (PWP), 4) available water capacity(AWC) and 5) saturated hydraulic conductivity (K_s) using only routinely determined soil properties (texture, soil organic carbon, bulk density and porosity). Accuracy of estimation of soil hydraulic parameters by developed models was compared with results obtained by using models previously described in literature on independent datasets (ESBN – EC 2004, Unsoda - Nemes i in. 2001). Many statistical measures of accuracy and efficiency of modeling were used evaluate the accuracy of estimation.

Testing and Evaluation of Various Organic and Mineral Substrates Seeking for Sufficient Productivity

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Keywords: organic and mineral artificial substrates, microbial abundance and biomass density, substrate qualitative parameters and plant growth

Nowadays markets are supplying organic and mineral substrates mainly of an artificial origin. Due to the heterogeneity of the substrate compositions, not all the substrates are offered of high quality ones. Highly stabilized products, which results from composting of different materials, should have a prolonged period not only of mineralization but also of humification beyond to the stage of substrate maturity. In this abstract, we describe the possibilities to analyze productivity of substrates consider on microbiological, biochemical and biological measurements highlighting some of the key findings for sufficient substrate productivity.

Laboratory and greenhouse experiment studies with three substrates (*substrate I*, *substrate II and substrate III* corresponding to manufactured substrates as *soil probiotic*, *plant probiotic* and *agro probiotic*) were conducted at Aleksandras Stulginskis University, Kaunas, Lithuania in 2016. The substrates and control mineral soil have been laboratory incubated for microbial abundance and microbial biomass density evaluation. However, substrates have been evaluated according the organic matter content (%), pH_{KCl} value and availability of NH_4-N (mg·l^{-1}), NO_3-N (mg·l^{-1}), P_2O_5 (mg·l^{-1}), K_2O (mg·l^{-1}), mobile calcium (Ca, mg·l^{-1}) and mobile magnesium (Mg, mg·l^{-1}). Two substrates (referred as *plant probiotic* and *soil probiotic*) and control mineral soil (improved with *agro probiotic*) were used for greenhouse experiment with lettuce (*Lactuca sativa*, L.) establishment. The aboveground and belowground biomass of the 10-day-old lettuce plants was collected and dry mass have been estimated.

To predict the approach of organic composition in substrates (for declare about the substrate humification-mineralization equilibrium), the microbiological biomass density in water saturated substrates was estimated (Fig. 1). It was found, that microbiological biomass density has been changing during the substrates incubation time (up to 36 hours). However, in water extracts with mineral soil microbial biomass density was the lowest 7.0 ± 10^{-4} mg ml^{-1}. Even though the density had tendency to increase (by 9 times) but it was lower (3.4 ± 10^{-3} mg ml^{-1}) in comparison with microbial biomass density in organic substrates. In *substrate I* (SI) microbial biomass density have been changing at least extent from 7.4 ± 10^{-3} mg ml^{-1} in the beginning of incubation to 6.1 ± 10^{-3} mg ml^{-1} up to 36 incubation hours. However, the more variable changes in microbial biomass density have been estimated in *substrate II* (SII) and *substrate III* (SIII) water extractions.

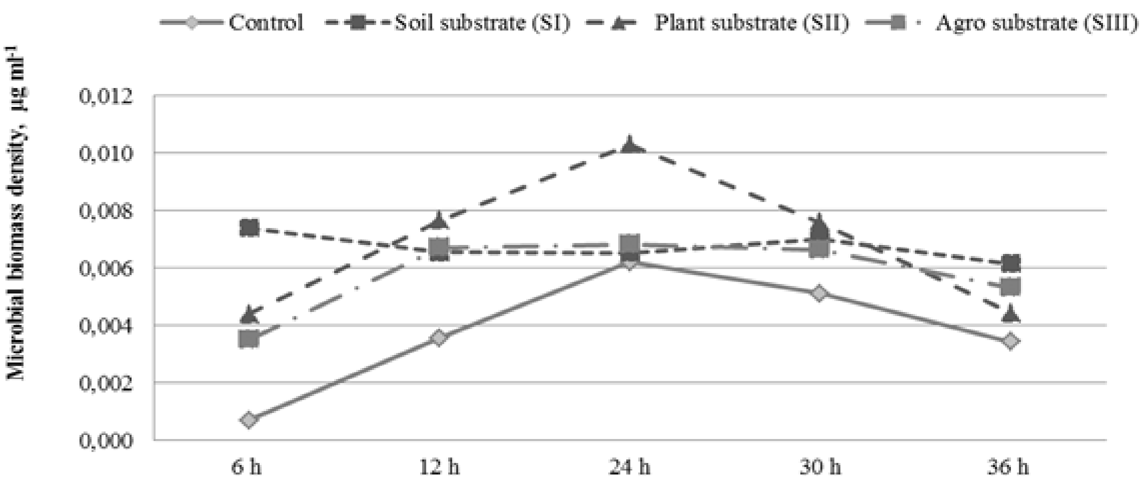

Figure 1. Microbial biomass density (μg ml^{-1}) in water extractions of organic substrates and mineral soil

The results on microbial abundance indicated that the predominance of microorganisms have been depending on the composition of organic matter in substrates. Even though, the exact biochemical composition of organic compounds in substrates was not estimated, it was indirectly predicted that decomposed organic material and nutrient availability for microorganisms was differently expressed. It was estimated, that the highest abundance in microorganisms is of *substrate II* plate counts. The *substrate II* could correspond as with the most multifunctional consistent in organic compounds. However, the predominance of *Cellulomonas*, *Clostridium*, *Nitrosomonas* and *Pseudomonas* cultures in *substrate III* plate counts shows that organic compounds in substrate are easy decomposable organic and amino acids or carbohydrates.

The estimation on the lettuce (*Lactuca sativa* L.) plant productivity (plant leave biomass) has shown that substrates had no extremely expressed effect. Even though, lettuce plants had higher leave productivity in *substrate I*, the leaf area did not differ due to the substrates. Though, the mineral soil has been improved with *agro probiotic*, the lettuce leaf area was not significantly increasing. However, the 10-day-old lettuce plants have had different development intensity. In *substrate I* lettuce plants have formed in average 6-7 true leaf, meanwhile, in *substrate II* and in mineral soil lettuce plants had in average 4-5 true leaf, thus, in some cases lettuce leaf pigmentation have been changing.

Microbiological and biochemical aspects should be taken into consideration when designing an artificial substrate, to assure the quality of the chosen materials and sufficient productivity.

Hydrophobicity of soils contaminated by petroleum products

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Keywords: soil hydrophobicity, pollutants, petrol, diesel fuel, contact angle, water drop penetration time

Soil hydrophobicity is a natural phenomenon encountered in mineral as well as in organic soils. One of the main reason causing hydrophobicity of mineral soil is the presence of hydrophobic organic material coating grains and soil particles. It is commonly accepted that an increase in soil organic matter content is correlated to hydrophobicity growth. However, this phenomenon can also be caused by anthropogenic factors such as soil contamination with petroleum hydrocarbons (PH). Petroleum products introduced into the soil affect both biotic components (plants and animals) and abiotic components. PH will modify physical, chemical and biological soil properties mainly changing the amount and the chemical composition of organic matter. PH also reduce soils water capacity, degrade colloids physical and chemical properties, destroy the fauna and damage soil microflora. Finally, petroleum hydrocarbons may change environmental pH (increasing acidity). The correct recognition of soil hydrophobicity and its spatial distribution is necessary to predict and prevent from its negative effects such as changes in ecosystems leading to their degradation. The aim of this research was to determine the influence of petroleum pollutants on hydrophobicity of selected mineral soils.

The investigated soil samples were collected from pine forest roads from Ruda Milicka in Western Poland near Wrocław. As part of laboratory investigations the soil hydrophobicity was assessed using the water drop penetration time test and the wetting contact angle method. Contact angles were measured using the sessile drop method with a goniometer CAM 100 (KSV Instruments) and the Wilhelmy plate method with DCAT 11 measuring set-up (Dynamic Contact Angle Meter and Tensiometer). The soil analysis were done at room temperature (20°C) within maximally 5 min after sample preparation using standard procedure. The measurements were conducted on seven soil samples, one control sample and six soil samples mixed with petrol and diesel fuel at different concentration levels: 1%, 5% and 10% and left under cover. The research were conducted at the Soil Physic Laboratory of the Water Centre at Warsaw University of Life Sciences -SGGW.

From the examination of the results it was found that hydrophobicity of the mineral soil increases with the increase of pollutant concentration in the soils. The diesel pollution of soil results present an higher soil hydrophobicity as compared to petrol pollution. This study has shown that samples contaminated by petrol pollution were classified as moderate or strong hydrophobic soils and the samples contaminated by diesel pollution were extremely hydrophobic.

Magnetic and chemical parameters of andic soils and their relation to selected pedogenesis factors

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Keywords:: Iron oxides, magnetic susceptibility, frequency-dependent susceptibility

Abstract: Although volcanic rocks are usually rich in highly magnetic Iron oxides, knowledge about these minerals in andic soils with respect to the soil development is missing. The aim of this contribution is to investigate the relationship between magnetic and basic chemical properties of andic soils developed on volcanic basement and parameters related to the pedogenesis factors. The studied sites are located on basaltic lava flows in the eastern part of the French Massif Central. Investigated pedons with alu-andic, sil-andic and vitric properties were analysed by a set of magnetic and soil-chemical methods. Magnetic parameters include low-field volume-specific and mass-specific magnetic susceptibility, frequency-dependent magnetic susceptibility, remanent properties (including S-ratio) and coercivities. Chemical parameters include the pH_{H2O}, soil organic matter, total cation exchange capacity, base saturation, and content of Fe and Al extracted in dithionite-citrate, acid-ammonium oxalate, and pyrophosphate solutions. Micro-morphology of Andosols and parent material was observed by scanning electron microscope with energy dispersive spectrometer. The pedogenesis factors are represented by parent-rock age, annual precipitation and soil thickness.

Our findings suggest that (1) precipitation is the most important pedogenesis factor with a strong relationship to the relative magnetic grain-size, concentration of ferrimagnetic minerals, aluminium dissolved in pyrophosphate and acid-ammonium oxalate, and content of organic matter; (2) parent-material age shows a well-pronounced relationship with magnetic grain-size parameters represented by the frequency-dependent susceptibility and ratio of saturation remanent to saturation induced magnetisation (Mrs/Ms), selective dissolution parameters, and pH_{H2O}; (3) thickness of soil profile shows a link to Mrs/Ms, pH_{H2O}, and content of organic matter.

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Diversificationof geo- pedo- and technogenic magnetic and geochemical signals in soil profiles:A case study of Poland

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Keywords: environmental magnetism; magneto-geochemical signals; soil pollution; genetic soil horizons; heavy metals

The primary goal of this work was to distinguish the most reliable methods for identifying the origin and nature of magnetic and geochemical enhancement in different genetic soil horizons. Depending on local conditions (geology, pedogenesis and anthropopression) effect of magnetic and geochemical signals in soils varies. We investigated four type of soils developed on different bedrock (*Entic Podzol* – the Tumlin Sandstone,Eutric Cambisol – basaltoid, *Humic Cambisol* – amphibolite and *Dystric Cambisol* – serpentinite). We measured magnetic (magnetic susceptibility, frequency-dependent magnetic susceptibility and thermomagnetic curves), geochemical (heavy metal contents: Co, Cr, Cu, Fe, Mn, Ni, Pb, Zn) and basic soil parameters (soil reaction, total nitrogen, organic carbon, cation exchange capacity and base saturation). Additionally, the enrichment factor and index of geoaccumulation were calculated. Our results suggest that the mass magnetic susceptibility measurements of profiles of investigated *Entic Podzol* and *Humic Cambisol* are both good proxies of techno- and pedogenic developments because of the presence of lithogenic weakly magnetic minerals in bedrocks (the Tumlin Sandstone and amphibolite). In *Eutric Cambisol* and *Dystric Cambisol*, weathering and redistribution of lithogenic and strong magnetic minerals such as magnetite or titanomagnetite, which occur in bedrocks (serpentinite and the basaltoid), take place. Therefore, the magnetic susceptibility values in the topsoil and subsoil horizons are more dependent on geology than anthropopression or pedogenesis. However, the presence of the other magnetic signal sources can be detected, if aspects of geological, geochemical and pedogenic processes and technogenic influence are taken into consideration*.

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Water, soil and cereals crops productivity under different management

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Key words: drainage water, ground water, cereals crops, biomass, modelling.

Valinava long-term experiment (55.22° N, 23.51° E) established in 1991 at the Institute of Agriculture, Lithuanian Research Centre for Agriculture and Forestry and is managed by the staff of the Department of Plant Nutrition and Agroecology. The experiment is situated on the terrace of the Dotnuvele River and occupies 4.4 ha. Prevailing soil is sandy loam and light loam *Endocalcari – Endohypogleyic Cambisol* (*CMg-p-w-can*). Carbonates depth is 40–60 cm. Soil pH_{KCl} – 7.2, content of total N – 0.18 %; available phosphorus (P_{AL}) – 66 mg kg^{-1}, available potassium (K_{AL}) – 99 mg kg^{-1}. Crops are grown in 4-course crop rotation: spring barley (*Hordeum vulgare* L.), red clover (*Trifolium pratense, L.)*, winter wheat (*Triticum aestivum, L.*) and spring oilseed rape (*Brassica napus, L.*). Crops are grown under three levels of management intensity: a) conventional, b) integrated and c) organic, each replicated twice in space, occupies approximately 786 m^2 (32.2 m long, and 24.4 wide) and contains 6 sub-plots (44 m^2 – 20 m long, 2.2 m wide).

Winter wheat and spring barley in conventional and integrated agroecosystems were applied with herbicides, fungicides and insecticides and in organic system were grown without application of industrial fertilisers and plant protection measures. In conventional system, winter wheat grown for a target yield of 6 – 7 t ha^{-1}, and spring barley for 5 t ha^{-1}. The

In this experiment measuring of drainage water runoff amount, ground water table levels, and crop yield and biomass production are performed. For indication of nitrogen and water deficit in cereal crops simulation with model DSSAT v4.0.2.0 is performed.

These studies showed that water stress simulated by the DSSAT v4.0.2.0 model correlated relatively well with actual readings of soil moisture sensors. The growing period of crops during the experimental years was warmer than the climate normal, with contrasting rainfall. Drainage water runoff measurements show that substantial part of precipitation was lost during the non-growth period resulting in lower levels of ground water table and temporary moisture deficiency in crops. Although soil moisture measurements and simulation indicated water stress in late spring or early summer in all experimental years, significant yield losses occurred only in a few cases. On average, the yield of winter wheat grown without fertilizers and pesticides was 67%, spring barley 70%, spring rape 47% and red clover 124% of that under conventional management.

Single raindrop impact on soil surface as a sound wave source

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Keywords: sound wave, splash phenomenon, raindrop impact

Soil, being one of the most important components of terrestrial ecosystem, undergoes continuous degradation as a result of various physical and chemical factors, where one of the most important is water. Soil splash phenomenon is the first stage of water erosion process initiated when a water drops hitting soil surface during rain can cause the transport of the mass of splashed soil particles detached from the surface, breakdown of soil aggregates, create sediment for transport or cause the crusted surface. This work focus on new aspect of splash phenomenon characterization which is related with sound wave resulted from drop impact.

The aim of this study was to define the sound pressure level propagating in the air during raindrop impacts on soil surface.

The measurements were conducted on three types of soil with different textures and initial moisture content. Soil samples were dried, sieved through a 2mm mesh and placed in aluminium rings (40mm diameter). In order to ensure different initial water content, samples were humidified to four moisture levels related with specific pressure head (pF 0, pF 1, pF 1.5, pF 2.2). Ten consecutive water drops have been falling on soil surface of the sample and sound pressure changes were registered after each drop. The measuring system consisted of: a) formation part dosing water drops with 4.3mm in diameter and releasing from capillary on height of 1.5m, b) recording system containing eight microphones of type 40PH (G.R.A.S. Sound & Vibration Company, Denmark) and two NI-9234 (National Instruments) acquisition cards. The microphones were arranged in one plane, at a distance of 1m from the place of drop impact. LabView (National Instruments) dedicated application was used for registering and analysing sound pressure. The mentioned system was installed in the anechoic chamber (AGH University of Science and Technology, Kraków) in order to minimalize the level of sound waves reflected from walls and reduce the noise from the outside. All measurements for different types of soil were done in 15 repetitions.

The choose of the adopted method and results from the measurements allowed to determine few general statements: 1) the sound wave of the instantaneous value of the sound pressure generated by water drops impact on soil surface constitutes a non-stationary course of a polyharmonic and fading sound signal character; 2) the sound pressure level values for three types of soil ranged from ca. 30dB to 40 dB; 3) the highest sound level value 42 dB were observed for sandy soil; 4) the sound pressure level depends mostly on the particle size distribution of the soil and less on the initial moisture content.

Ryżak M., Bieganowski A., Korbiel T. Sound wave energy resulting from the impact of water drops on the soil surface. PloS ONE 2016, 11(7): e0158472. doi:10.1371/journal.pone.0158472

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A system for recording of the mechanical impulse of the water drop's impact on a soil surface

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The splash phenomenon is the first stage of water erosion, i.e. a process associated with degradation of the soil surface. Its short duration, small scale, and high dynamics greatly hinder investigation of the phenomenon. The nature of splash has created the need to use a series of multiple drops or rainfall simulators in research, which influenced the course of the studies and the number of acquired data.

Technological progress has facilitated the use of modern methods for investigations of the splash phenomenon. The adoption of high-speed cameras for this purpose should be mentioned. Photos taken using high-speed cameras allow accurate analysis of the splash phenomenon occurring after the impact of a single drop and ensure a better understanding of this process. Another innovative measuring technique is based on the use of dynamic pressure sensors. The measuring system of this type was used in this study.

The aim of the study was to determine to the applicability of the dynamic pressure sensor for the measurement of the impulses of force propagated through a soil sample, which is caused by the impact of water drops on the sample surface.

The presented measuring system includes a 106B50 sensor from PCB Piezotronics, a National Instruments NI USB-6363 card sampling at a frequency of 2 MS/s, and software developed in LabView. The evaluation of the applicability of the system to study the splash phenomenon was based on measurements of impacts of 10 consecutive drops of water on air-dry soil samples. Soil samples were prepared in aluminum rings with a diameter of 40 mm and a height of 10 mm; the samples were placed on the sensor, which registered the pressure change. Water drops with a diameter of 4.2 mm were falling from a height of 1.5 m. The measurements were performed in 10 repetitions.

The use of the presented system allowed observation of pressure changes recorded on the sensor after each impact of water drops. The preliminary results obtained provide a possibility to use systems based on dynamic pressure sensors to study the splash phenomenon. The use of this system requires further test measurements and improvement of the methodology of measurement.

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Soil water dynamics and water regime in genetic horizons of Retisol

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Keywords: water retention, water regime, silt deposite, Carpathian Foothils

Retisols derived from silty deposits dominate in the soil cover of the Carpathian Foothills. The hydrophysical properties of these are determined by the grain-size distribution of the parent material and the soil's "primary" properties shaped in the deposition process. The other contributing factors are the soil-forming processes, such as lessivage (leaching of clay particles), and the morphogenetic processes that presently shape the relief. These factors are responsible for the "secondary" differentiation of hydrophysical properties within the soil profile. Both the primary and secondary hydrophysical properties of soils (the rates of water retention, filtration and infiltration, and the moisture distribution over the soil profile) determine their ability to take in rainfall, the amount of rainwater taken in, and the ways of its redistribution.

The aim of the study, carried out during last three years (2014-2016), was to investigate the dynamics of soil moisture in genetic horizons of Retisol derived from silty deposits.

Data of soil moisture were measured using 5TM moisture and temperature sensor and collected by logger Em50 (Decagon Devices USA). Data were captured every 10 minutes from 6 sensors at depths: - 10 cm, 20 cm, 40 cm, 60 cm and 80 cm. Precipitation data come from meteorological station situated 50 m away from the soil profile.

The humic (ochric) horizon and the eluvial (luvic) horizon of Retisols have higher total porosity, drainage porosity, available water retention, and saturated hydraulic conductivity (Ks) than the illuvial (argic and fragic) or parent material horizons. On the other hand, bulk density, clay fraction content, and retention of water unavailable for plants are lower in the eluvial horizons than the illuvial ones.

While the humic and eluvial horizons show greater potential for water filtration, it is the illuvial and parent material horizons that determine the filtration capacity of the entire soil. The latter horizons both have a very low saturated hydraulic conductivity (Ks), which makes it nearly impossible for groundwater to supply these layers. Tongues – glossic forms found in Retisols – exhibit a higher filtration capacity and thus help supply deeper soil horizons.

Due to these reasons two zones differing in the type of water regime were distinguished in Retisols: an upper zone comprising humic and eluvial horizons, and a lower zone consisting of illuvial and parent material horizons. The upper zone shows lower retention of water available for plants, and relatively wide fluctuations in moisture content, compared to the lower zone. The lower zone has stable moisture content during the vegetation season, with values around the water field capacity. Large changes in soil moisture were observed while rainfall. These changes depend on the volume of the precipitation and soil moisture before the precipitation.

The effect of diesel oil pollution of forest soils on their CO_2 efflux and hydrophobicity.

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Key words: soil physical properties, diesel contamination, soil water repellency, CO_2 efflux.

Contamination of soil with petroleum products is a major environmental problem. Petroleum products are common contaminants in soils due to human activities and they are causing substantial changes in the biological (particularly microbiological) processes, chemical composition, structure and physical properties of soil. The main objective of this study was impact assessment of soil moisture on CO_2 efflux from diesel contaminated Albic Podzols soils. Two diesel treatments (3000 and 9000 mg·kg−1 of soil) were prepared for four layers from two different forest study sites. CO_2 emissions were measured using a portable infra-red gas analyser (LC Pro Plus, ADC Bioscientific, UK) during the drying of soil samples in the laboratory conditions (from saturation to air-dry). Also assessment of soil water repellency was performed using the water drop penetration time. Analysis of variance (ANVOA) was conducted for CO_2 efflux data. The obtained results show that CO_2 efflux from diesel contaminated soils is higher than the efflux from uncontaminated soils. The non-linear relationship between soil moisture content and the CO_2 efflux exist only for upper soil layers. while in the deeper soil layer the efflux is practically not observed on soil moisture content changes. Contamination of soil by diesel leads to increase of soil water repellency. The water repellent soils found to have bigger CO_2 emission.

Shelterbelt as factor affecting physical properties of adjacent farmland soils

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Keywords: shelterbelts, soil water, sustainable agriculture

Shelterbelts, included in agricultural practices planning, can be treated as sustainable agriculture type. Due to lack of full-size agroforestry systems model in Poland, shelterbelts can be established as basis to build structures of seminatural type of sustainable agricultural management.

Primarily, shelterbelts are important factors of phytomelioration and erosion impedance. Moreover, trees not only protect soil against the erosion, but create microclimatic condition in adjacent farmland areas. Shelterbelt composed of trees and bushes can take a part in water transport and evapotranspiration.

This study was conducted to analyze shelterbelts impact on some physical farmland soil properties. Distance from the trees effect was studied in frames of impact on chosen physical soil properties: solid phase density, bulk density, air-water properties and soil moisture.

Solid phase density is strictly correlated with distance from the trees. Solid phase density and soil bulk density were characterized by lower values in arable soils adjacent to trees compared with more distant areas. Moreover, solid phase density values were significantly correlated with organic carbon content in soil, that was affected by plant debris decomposition entered soil from aboveground part of trees and decomposed from dead root system parts.

Water-air properties of farmland soils are highly equaled due to agricultural practices that are the main factor shaping physical state of agricultural used soils. No clear dependences can be observed between distance from shelterbelt and these soil properties. However, values of water-air properties farmland soil adjacent directly to shelterbelt were distinct varied from soil located in farer distance from trees.

Soil moisture was spatially and temporal varied. Generally, soil moisture was following precipitation and thermic air properties. Very important in soil moisture data set was farmland and shelterbelt position. When the trees are located in northern margin of field, their influence on soil water content is smaller compared to situation were shelterbelts are located on eastern or western field margins. It was found higher soil moisture values in arable soil located closer to trees, especially in the spring time. This set was changed with growing season progress and reverse situation can be observed in the autumn. Thus, soil moisture values were affected not only by distance from the trees, but by position and crop phase as well. It was found out that arable soils moisture variation was growing with the distance from shelterbelt.

The spatial arrangement of the examined parameters indicates the direct and indirect effects of trees on the development of better physical conditions of adjacent located farmland soils. Simultaneously, this set creates better and more stable conditions for biological life in arable soils located closer to the shelterbelts.

VIS-NIR „on-the-go" platform for the determination of several soil physical properties

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Keywords: near-infrared spectroscopy, "on-the-go", soil texture, readily-dispersible-clay, electrical conductivity

Chemical and physical soil properties are strongly affected by particle size fractions. Readily dispersible clay (RDC) is the part of the clay fraction in soils that is easily or potentially dispersible in water when small amounts of mechanical energy are applied to the soil. The amount of RDC in the soil is of significant importance for agriculture and environment because clay dispersion is a cause of poor soil stability in water which in turn contributes to soil erodibility, mud flows, and cementation. Soil electrical conductivity (EC) is a function of soil salinity, clay content and water content. Therefore, soil conductivity measurements have the potential for providing estimates of within-field variations of these properties. Visible and near-infrared (VIS-NIR) spectroscopy is a rapid and non-destructive analytical technique that correlates diffusely-reflected near-infrared radiation with the chemical and physical properties of materials and has the potential to define fine scale spatial variability of soils. The method can be used to analyse several constituents simultaneously. The fusion of VIS-NIR measurements with electrical conductivity and soil temperature data has thus the ability to improve the prediction of soil properties (i.e. soil texture and RDC) of VIS-NIR models.

Ten representatives samples selected by a fuzzy logic algorithm were used to develop calibration models using partial least-square regression (PLSR). Calibration samples were analysed for soil texture (clay, silt and sand – WRB 2014), soil organic carbon (SOC) and RDC content using conventional methods and wet chemistry. The Veris mobile sensor platform is collecting VIS-NIR spectra as well as soil EC (shallow and deep) and temperature. Each point is referenced by GPS and allow for the production of very precise maps.

The best PLSR model were obtained using the fusion of VIS-NIR data (standard normal variate pretreatment) with deep EC for RDC and clay prediction. The maps obtained from predicted values are in accordance with our knowledge of the field. The spatial variability of RDC is in accordance with the field orthophotography. Areas of high RDC content corresponding to areas of bad plat development.

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Earthworms vs. substrates, do they change soil biological activity - laboratory experiment

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Keywords: soil texture, earthworms, microbial carbon biomass, dehydrogenase activity

Earthworms are known as soil engineers, they have impact on soil structure, porosity and soil carbon turnover. In 100 cm3 boxes soil with different texture, thin layer of black horticultural soil and three different earthworm species were placed for three months. In addition, boxes without earthworms were included in the experiment as control. Adult Lumbricide from an epigeic group – Lumbricus castaneus (L.cas.) and endogeic group – Aporeectodea caliginosa (A.cal.) and Aporectodea rosea (A.ros.) were placed separately in individual boxes. Four type of soil texture were taken into experiment: sand (S), loam (L), silt loam (Si) and clay (C). After experiment pH, soil microbial carbon content (MBC) and labile carbon (LC), dehydrogenase activity (DHA) and area of earthworm traces (ET) were investigated. Univariate ANOVA for soil texture and earthworm species and they interaction effect on soil parameters, linear correlation and RDA ordination was done.

Earthworm species (E) and soil texture (T) and E × T interaction had effect on ET. The mean amount of ET was higher in soil with endogeic species than epigeic species and control. The highest ET in variant with A.ros. was in sandy and loamy and it was significantly higher than in control and L.cas. variant for this soil texture. Earthworm species, soil texture and they interaction had effect on LC. The highest LC content was in variants with silt soil the lowest in variants with loamy soil. LC was closely correlated with soil parameters such as texture or pH than with biological one. Microbial activity, such as MBC and DHA were significantly affected by soil texture. Sandy soil had higher DHA than clayed one. DHA was positively correlated with sand and negatively with clay content. MBC was positively correlated with clay and negatively with silt content.

After three months experiment we can concluded that earthworms did not change significantly microbiological properties such as DHA and MBC. A. rosea and A. caliginosa are more active and had higher ET than L. castaneus. Soil texture had significant effect on all investigated parameters, such as pH, LC, ET, MBC and DHA. Taken into consideration all investigated parameters we can noticed that loamy and silt soils are similar.

Use of optical 3D scanner to analyze changes in soil microtopography under simulated rainfall

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Keywords: soil microrelief, soil erosion, rain simulation, roughness, DEM, 3D scanner

Spatial differentiation of soil surface of microtopography has a significant impact on the course of various processes underlying water erosion, for example surface runoff and sediment transport. In the study we evaluated spatial and quantitative changes in soil surface microtopography to describe water erosion process under simulated rain with use of a non-contact, non-laser, optical 3D scanner. The experiment was conducted in two variants: with and without drainage layer. Two clay soils collected from farmlands from the catchment of Lake Zgorzała (Warsaw) were investigated. Six subsequent tests of simulated rain were applied, with intensity equal to 55 mm h^{-1}. The surface microrelief was scanned after every 10 minutes of rainfall simulation. The surface points coordinates were interpolated using natural neighbour method and GIS software to generate Digital Elevation Models (DEM) with a 0.5 mm resolution. Additionally the volume of surface and underground runoff as well as soil moisture were measured.

The key indicator used to describe the diversity of the soil microtopography is surface roughness. Two DEM-derived surface roughness indices: Random Roughness and Terrain Ruggedness Index were used for microrelief description. Calculated values of both roughness factors have been decreasing with time under the influence of rainfall in all analyzed variants. During the sprinkling the moisture of all samples had been growing rapidly from air-dry state to the maximum water capacity in 20-30 minutes. Simultaneously the intensity of surface runoff was increasing and cumulative runoff value was: 17 - 35% for variants with drainage and 72-83% for the variants without drainage, relative to cumulative rainfall. The observed soil surface elevation changes were associated with aggregates decomposition, erosion and sedimentation, and above all, with a compaction of the soil, which was considered to be a dominant factor, hindering the assessment of the erosion intensity of the of the scanned surface.

The accuracy of used scanner seemed to be sufficient in detecting soil surface elevation changes in the below millimetre range, as long as congruence of the subsequent scans can be achieved with high precision.

Phytoremediation of Heavy Metals Contaminated Soils Combined with Energy Production Using *Sida hermaphrodita*

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Keywords: Phytoremediation, Heavy metals, Gasification, Residues management

Combining site phytoremediation with energy production gives opportunity to manage heavy metals contaminated soil. Nowadays, the majority of biofuels originate from food crops whereas the most of the wooden biomass used for energy production are forestry originated. Alternative appears in second generation energy crops. There is a number of energy crop species which have been tested with success for phytoremediation purposes. *Sida hermaphrodita* has a potential of phytoextraction of HMs with comparison to other energy crop species. One of the most promise biomass conversion technology for contaminated biomass is gasification. This process gives opportunity to control the fate of inorganic pollutants after combustion. The aim of the study was to assess phytoextraction efficiency, amount of produced energy and ash composition after gasification process of *S. hermaphrodita* biomass cultivated on HMs contaminated arable land in Bytom, Poland and on HMs contaminated sewage sludge dewatering site in Leipzig, Germany. It was found, that *S. hermaphrodita* is a species that accumulates HMs, mainly due to its soil bioavailability. Lower heating value was significantly higher for biomass obtained on HMs contaminated arable land when compare to sewage sludge dewatering site. There is possibility to recirculate ashes after gasification to the presented contaminated sites. All ashes obtained after gasification process are suitable for application as forest fertilizers according to Finish and Swedish regulation. Additionally, ashes obtained from biomass cultivated on German site are suitable for application in agriculture application as fertilizer, according to Polish Government regulations.

Low intensity tillage and cover crop combination in order to minimize soil compaction and weed pressure

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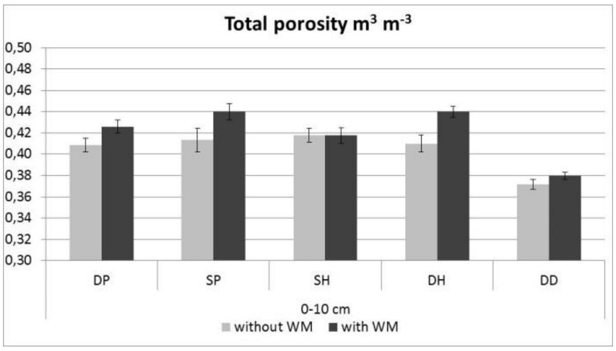
Keywords: low intensity tillage, cover crop, bulk density, soil porosity, alternative weed control

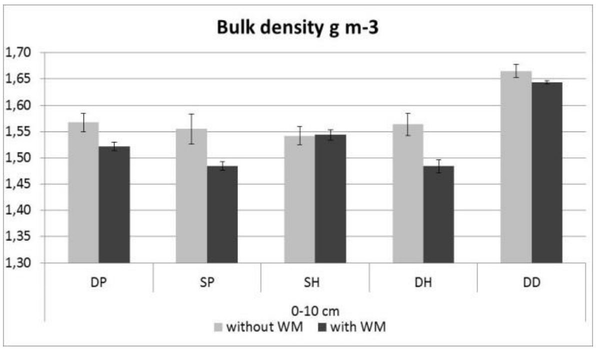
Low intensity tillage is economically beneficial and minimizes soil erosion, but it often accompanied by problems, such us soil compaction and higher weed and pest infestation. A cereal-based crop rotation, which is common practice in Lithuania, increases the occurrence of the specific weeds and pest, especially when low intensity tillage technologies are applied.

A number of studies were performed on different crop between crop, also known as catch crop or cover crop, for grain manure, in order to reduce nitrogen leaching. Nevertheless, not so much studies of its impact on soil physical properties and weed density under various tillage conditions are available.

The aim of our study was to measure the effect of white mustard *Sinapis alba* L., as a cover crop, on soil compaction and weed pressure in different tillage systems. Five tillage practices, namely DP - deep ploughing (20-22 cm), SP - shallow ploughing (16-18 cm), SH - harrowing (8-10 cm), DH - harrowing (14-16 cm) and DD - direct drilling, were investigated in combination with and without white mustard, in a loamy soil in a long-term experiment in Dotnuva. White mustard was established before harvest of the main crop, using a fertilizer spreader, in 2013 and 2014. White mustard had a positive effect on soil bulk density, total porosity and other physical properties in 0-10 cm soil layer (Fig. 1). It also clearly reduced the number and mass of weeds in all tillage treatments.

Our results suggest that white mustard as cover crop might be an option not only to prevent nitrogen leaching but also to reduce soil compaction and weed pressure.





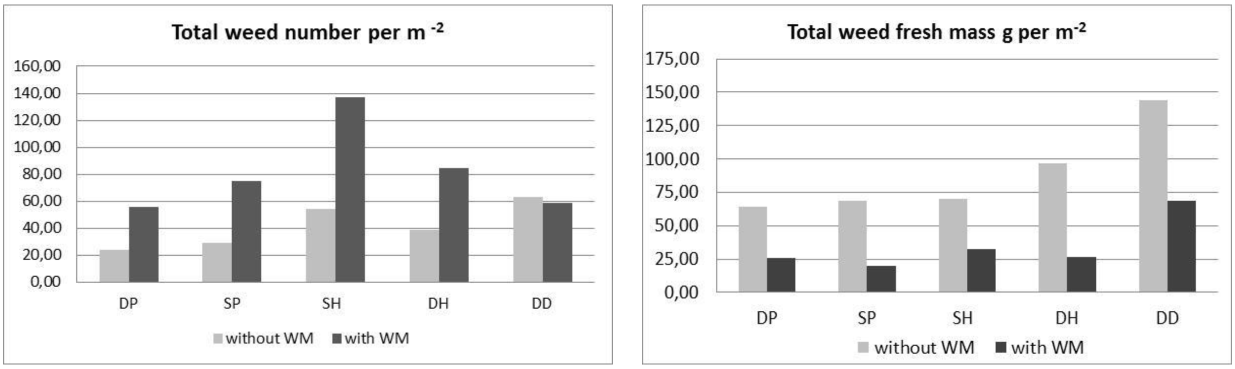


Figure1. Tillage and White mustard influence on soil physical properties and weed infestation

Transformation of Retisols properties in the Lithuania due to agrogenization

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Keywords: Retisols, agroecosystem, soil tillage, organic matter transformation, chemical and physical properties, bulk density, total porosity, field capacity, plant available water.

Soil is a multicomponent and multifunctional system, with definable operating limits and a characteristic spatial configuration. Thus, the major challenge within sustainable soil management is to preserve soil multifunctionality for other ecosystem services while optimizing agricultural yields. The aim of the work is to determine the changes of morphological and chemical properties in Western Lithuania agroecosystems Retisols caused by their agrogenic transformation. Several methods used to study above mentioned transformations: a) particle size distribution of the soil particles in the liquid dispersion was determined using the light-scattering technique, b) soil pH was determined in 1M KCl (soil–solution ratio 1:2.5) using potentiometric method, c) soil organic carbon (SOC) content was determined by the Tyurin method modified by Nikitin (1999) with spectrophotometric measure procedure, d) mobile humic substances were extracted using 0.1M NaOH solution and determined according Ponomariova and Plotnikova (1980), e) water extractable organic carbon (WEOC) was determined in water extract (soil–water ratio 1:5) and measured by IR-detection method after UV-catalysed persulphate oxidation. Undisturbed core samples were collected using stainless steel rings (100 cm 3 volume) for soil water potential (hPa) determination in four replicates. Water release characteristics (water retention, total porosity, field capacity, plant available water content and soil density) were determined at -4, -10, -30, -100 hPa matric potentials (ψm) in a sand-box, at -300 hPa ψm (in a sand-kaolin box). Loose soil samples were used for determination of water content at -15500 hPa ψm retention by implementing a high pressure membrane apparatus.

Our study revealed a clear evidence of soil profile morphological and chemical changes to a depth of 40-50 cm, however, the most distinct transformations take place in the upper 30 cm layer of agrogenically changed Retisols (Fig. 1.). Thus, here it needs to be highlighted: when Ah horizon is deepening (by ploughing) from 10-15 cm up to 25-30 cm thick the El horizon becomes disturbed and partially incorporated/mixed into Ah horizon; the features of Ahp horizon changes Ah horizon and AhEl horizon develops (caused by soil deep loosening) at a later. Afterwards, due to the long-term deep plough practice and soil erosion (where it takes place), El horizon becomes completely destroyed and a sequence of Retisols layers in the upper profile part changes from Ah–El–ElBt to the Ahp–ElBt. Likewise, significant transformation patterns were observed in the total and organic carbon content of the agrogenically transformed Retisols: the values of both total and organic C decreased twice in comparison to corresponding forest soils.

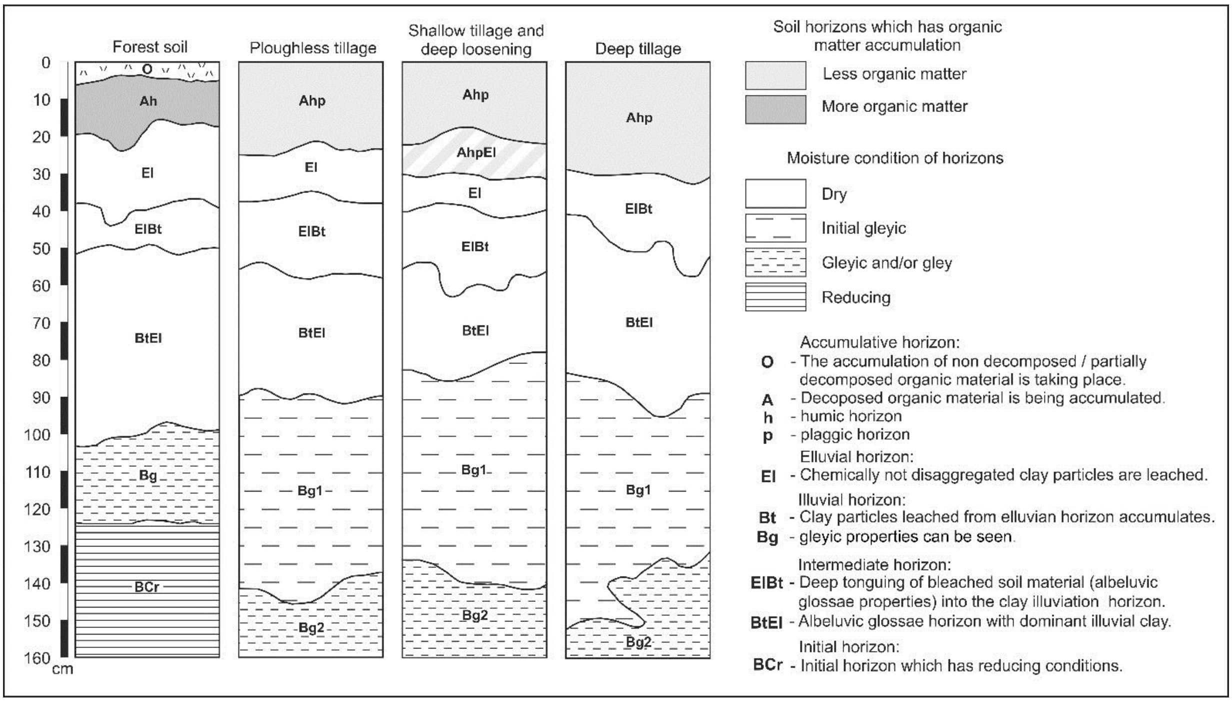

Figure 1. Morphology of Retisols profiles due to the different agrogenic influence

In general, the presence of organic matter in the surface Ah(p) horizon contributes to decrease of soil bulk density, however, the decline of organic matter due to intensive soil tillage practice causes the increase of soil bulk density in the upper accumulative horizons. The changes in total soil porosity are directly related to soil bulk density. Thus, the lower soil bulk density is an indicator of higher soil total porosity and in opposite, the higher soil bulk density is an indicator of lower soil total porosity and soil compaction. This is the case in 0-30 cm depth soil layer whereas the total soil porosity is determined to be higher under the forest and much lower under no-tillage agriculture.

Soil water capacity decreases when soil bulk density increases, however, soil water capacity also decreases when structure of deposits is weak. The Ah horizon of forest soil is friable and non-structured therefore its water capacity is lower in comparison with the deeper well-structured Ahg horizon. Despite that the higher number of pores and humus content results in better water holding capacity and its smoother release over time. The highest variation of plant available moisture content is visible in 0-70 cm depth soil layer. The differences in soil moisture content at 0-30 cm soil depth are determined by land-use features and by soil forming processes at the depth 30-70 cm.

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The regulating ecosystem services supplied by soil in relation to land use

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The concept of ecosystem services has become an important tool for modelling interactions between ecosystems and their external environment in terms of global bio-climatic changes. The provision of ecosystem services depends on biophysical conditions and changes over space and time due to human induced land cover and land use. Traditionally, agroecosystems have been considered primarily as sources of provisioning services, but more recently their contributions to other types of ecosystem services have been recognized. According to several authors agroecosystems can provide a range of other regulating and cultural services to human communities, in addition to provisioning services and services in support of provisioning. Traditionally, agroecosystems have been considered primarily as sources of provisioning services, but more recently their contributions to other types of ecosystem services have been recognized. One of the regulating services is water regulation, which was evaluated through the accumulation of water in the soil. The potential of water accumulation in the soil, was modeled and evaluated through water retention capacity, which is the fundamental hydrophysical soil characteristics. Accumulation of water in the soil was evaluated in 5 categories on the basis of the water holding capacity calculated to the soil water in mm in the context of the depth of the soil. Six agricultural study areas, each of them with two different land use categories (arable land and permanent grasslands) located in various natural conditions of Slovakia, were evaluated. Study sites were selected on the basis of the following criteria: 1/polluted area (texturally medium heavy Fluvisol; inorganic contamination), 2/ non polluted area (without the inorganic contamination; texturally heavy Fluvisol), 3/ area threatened by erosion (texturally medium heavy Cambisol), 4/ abandoned land (texturally medium heavy Rendzic Leptosol), 5/ low productive land (texturally light Regosol), 6/ medium productive land (texturally medium heavy Cambisol) and 7/ productive land (texturally medium heavy Chernozem). The ability of the soil to accumulate water depends on soil parameters (soil texture, soil structure, sceleton content, soil compaction) as well as on the biophysical parametres (relief, the slope, climate, rainfall, groundwater level The lowest acumulation of water on soils used as arable land was determined on texturally light Regosol (151 mm) and the highest on texturally heavy Fluvisol (414 mm). Water supply in soil under Grassland ranged from 191 mm to 369 mm. The greatest differences can be seen in the relation to site land use and diversity of soil type (humus content, gravel content and soil texture).

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Elaboration of innovative method for monitoring the state of agrocenosis with the use of remote-sensing gyro system in terms of precision farming

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The aim of the project is development of the Decision Support System based on the remote sensing method for precision farming (for determination of needs for agricultural practices). This method will be also applied for assessment of the degree of degradation of meadows (the method will refer to biodiversity of examined meadows) and for the carbon dioxide balance between the soil – vegetation and the atmosphere. The analysis will be performed for most important crop: wheat and maize, in 2 regions. Meadows will be examined for the Wieprz river valley. The advantages: 1) substantial limitation of data derivation costs, 2) air-borne data are more representative and more costand time-efficient than soil and plant analyses and give spatial data what is more precise for precision farming than insitu point measurements, 3) ensuring all benefits of precision farming, which results in substantial reduction of cost and environmental benefits, 4) development of remote sensing method for evaluation of CO_2 exchange will ensure faster, cheaper, and easier derivation of data required for greenhouse gas balance. The project will be implemented the stages of research and development of the remote sensing monitoring system, ground and air-born investigations, and design of a decision support system for precision farming.

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