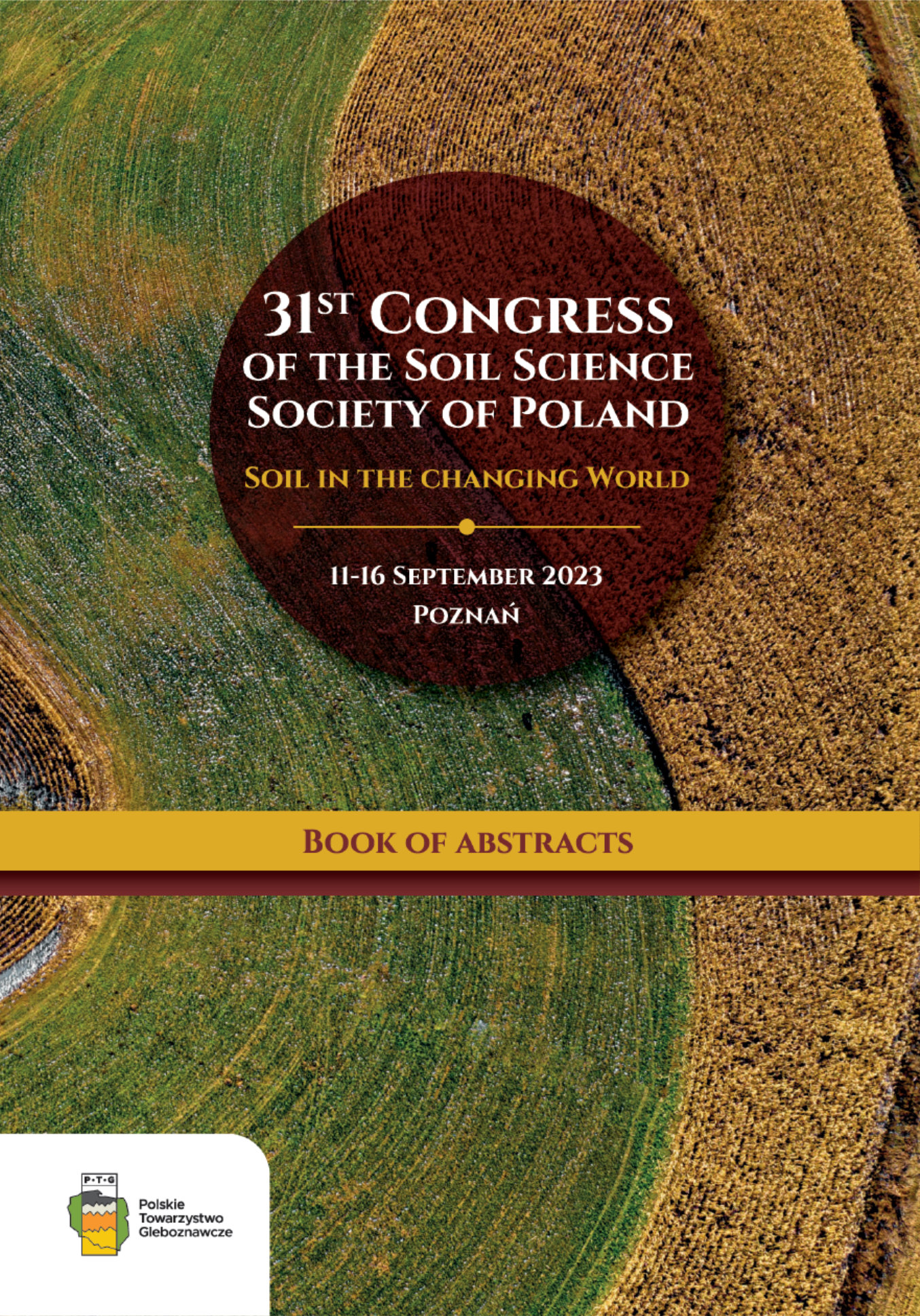

31ST CONGRESS OF THE SOIL SCIENCE SOCIETY OF POLAND

SOIL IN THE CHANGING WORLD

11-16 SEPTEMBER 2023

POZNAŃ

BOOK OF ABSTRACTS

Polskie Towarzystwo Gleboznawcze

31ST CONGRESS
OF THE
SOIL SCIENCE SOCIETY OF POLAND
“Soil in the changing World”

11 – 16.09.2023

Poznań

Poznań University of Life Sciences

Department of Soil Science and Microbiology

60-656 Poznań, Szydłowska 50 St.

Printed on the basis of submitted materials.

Included abstracts were not peer-reviewed; the responsibility for scientific value lies with their authors.

Cover design:

Marcin Sykuła

Printed by:

Drukarnia J&S Studio Reklamy i Promocji

62-010 Pobiedziska, Jesiotrowa 2 St.

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Dr inż. Tomasz Kaczmarek

Mgr Paweł Kaczmarek

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19^{00} – 22^{00} **Meeting (Get together)**
Bistro "Ogród Smaku"

Tuesday, September 12, 2023.

7^{00} – 8^{30} **Breakfast**
Bistro "Ogród Smaku"

8^{00} – 9^{00} **Registration of Participants**
Biocentrum building – ground floor looby

9^{00} – 10^{00} **Opening of the Congress**
Biocentrum building – auditorium

10^{00} – 11^{00} **Plenary session (1)**
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10^{30} – 11^{00}
Andrzej Kędziora
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12^{00} – 12^{15}	**Jankowski M.**: Systematic position and genesis of the 'Kuiavian black earths' in the light of pedoarchaeological research.
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ABSTRACTS OF THE ORAL PRESENTATIONS

Patterns and driving factors of ecological stoichiometry insystem of deadwood and soil in mountains forest ecosystem

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Keywords: altitude, decay classes, exposure, spruce, woody debris

The aim of our research was to identify the factors that most strongly determine the C, N and P cycles in the deadwood - soil system in mountains forest ecosystems. We assumed that the climatic conditions resulting from the location in the altitude gradient and rate of deadwood decomposition most strongly determine the C/N/P stoichiometry. A climosequence approach comprising north (N) and south (S) exposure along the altitudinal gradient (600, 800, 1000 and 1200 m a.s.l.) was set up. Spruce logs at different decomposition stages (III, IV and V) were selected for the analysis in Babiogórski National Park (southern Poland). We calculated the C/N/P stoichiometry for deadwood and soil samples to reflect the nutrient availability. Our research indicates a very strong influence of the location conditions in the altitude gradient on the C/N/P stoichiometry. The GLM analysis confirmed the importance of high a.s.l. in shaping the C, N and P content. A strong correlation was confirmed between P content, N content and C/N ratio. A higher C/N/P ratio was found in deadwood compared to soil, regardless of location. Decaying wood is an important source of N and P and the degree of decomposition made a significant contribution to explaining the variability of C, N and P content. The obtained results indicate the need to leave deadwood in forest ecosystems in order to improve biogeochemical cycles. Deadwood, by having a beneficial effect on many components of the forest ecosystem, will improve its biodiversity and, consequently, its stability.

Morphology and some properties of Folisols in selected areas of Sudetes

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Keywords: Folisols, morphology, plant communities, properties

This paper presents selected aspects related to the properties and morphology of selected 19 profiles of Folic Histosols formed on sandstone and granite. The soils represented two mountain ranges of the Sudetes (Karkonosze and Stołowe Mountains), from 684 m to 1408 m a.s.l. A total of 78 soil samples were collected. In the organic horizons, the following remains were found: leaves, twigs, shoots, bark, wood and the presence of charcoal. The organic horizons were classified on the basis of the criteria of the Polish Soil Classification 6th edition (2019) based on the Klasyfikacja Gleb Leśnych Polski concerning forest humus, as Ol, Of and Oh sub horizons. The thickness of the organic soils ranged from 11 to 67 cm. The morphology of the Folisols was varied and indicated that they could be formed both on flat surfaces, with varying degrees of slope, concave, convex, as well as in rock crevices and from accumulated organic material at the base of rocks. The research has shown that fallen tree trunks, branches and the specific morphology of the bedrock can be elements that favour the accumulation of litter material. The organic materials of Folic Histosols show lower rainwater retention capacities than peat in terms of moisture at water field capacity. The low pH values of the organic horizons, the high proportion of exchangeable acidity in the sorption complex and the low nutrient abundance limit the development of plants. Folisols were classified according to the Polish Soil Classification 6th edition mostly as rocky folisols with a smaller amount of typical folisols and debris folisols.

Soil as a part of geographical education – Generation Z perspective

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Keywords: soil education, gamification, edutainment, 'digital natives'

One of the challenges of the modern world is to increase social awareness of the environment and geography lessons create an opportunity for transferring the skills of conscious management of the Earth's resources. The research clearly shows that students lack an awareness of threats related to the environment (Urbańska et al., 2022). The awareness of threats related to various Earth spheres is considerably differentiated. Research shows that the soil issues are the least known in this aspect. Soil education is deficient in many countries. In schools, soil topics are usually taught briefly and with little detail. This may result in students' perceiving the pedosphere as less important than the other spheres– "just" 'dirt' we walk on! A proper approach to the issues of sustainable development without an full knowledge of the environmental threats is impossible.

How to encourage a "digital native" to understand the soil - something so "down-to-earth"? The best option is to change the way of knowledge transferring to make this process much more attractive for modern generations. There are a lot of possibilities: mobile games related to soil (free game-based learning platforms) or on-line and off-line mobile applications for the soil profile description. Presented digital platform SYStem consists of: database, WebService, web portal, mobile/web application (https://sites.google.com/site/shareyoursoils/home) and combines soil education with ecological issues and exciting social networking service. This motivational, challenging, and rewarding digital environment helps learners work toward a goal while choosing actions, and experience the competition and consequences of those actions (experience level/ranks/digital rewards/skills badges/points). This kind of interactive competitive game-based techniques in learning process can be a perfect way to increase public awareness of soils. "Learning by doing" or even "learning by playing" is a key aspect of multitasking nature of digital natives as well as the ability to apply the knowledge in practice.

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Assessment of compatibility of forest biocoenoses with biotopes on the Soil Model Area in the Puszcza Biała Forest

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Keywords: soil model areas, soil trophic index

The aim of the study was to assess the compatibility of forest biocoenoses with biotopes on the Soil Model Area (SMA) in the Puszcza Biała Forest, based on the diagnosis of forest site and examining the compatibility of the properties and trophism of soils determined by the soil trophic index (STI) with the undergrowth and stand vegetation. Investigated SMA with an area of 325.74 ha is located in the central part of Puszcza Biała Forest (52°68′78″N, 21°57′51″E) in the Wyszków Forest District. In the 1970s, the Polish State Forests and the Soil Science Society of Poland established 139 SMAs with an average area of 405.5 ha in order to preserve typical (model) soils for a given region (district), constituting a permanent comparative base for conducting scientific research and practical training of foresters.

There were 5 soil subtypes on the examined SMA which belonged to the following trophic groups with an average value and range of STI: mixed coniferous forest (MCF) -22.0 (20-23), mixed broadleaved forest (MBF) - 27.1 (24-33) and eutrophic organic soils – 30.5 (29-32). The largest area was occupied by very well-formed Brunic Arenosols, which according to the average and range of STI values belong to the MCF - 22 (20-23) and MBF - 25.5 (24-28) trophic groups. On the surfaces of 4 profiles of Brunic Arenosols in the MBF trophic group, non-compliance of one trophic unit of the partial soil diagnoses according to STI with the undergrowth and stand diagnoses was found. Also, on the surface of one soil profile with the value of STI -25, the presence of regraded forest was found. The existing incompatibility of biocoenoses with biotopes can be described as a low degree, because STI in most of these soils showed values at the transition between the MCF and MBF trophic groups.

Possible policies and actions to protect the soil cultural and natural heritage

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Keywords: Soil health, World heritage sites, Soil literacy, Soil strategy, Landscape

Soils are considered healthy when they can continuously provide a variety of ecosystem services, including cultural services for humans and the preservation of geological, geomorphological, and archaeological heritage. However, strategies and policies aimed at preserving and enhancing the cultural and natural heritage of soil are rare and incomplete.

This lecture presents the current state of the art and a framework to provide inspirational ideas for designing policies and actions to promote soil cultural and natural heritage protection. Through online and documental analysis, the arguments presented in published papers dealing with soil as natural or cultural heritage are summarized. The main policies and actions to preserve natural and cultural heritage at global and European levels are analyzed, along with examples at the national level to exemplify policies and actions aimed at protecting natural and cultural heritage, including reference to soil features.

The analysis indicates that there is significant scientific production, and eight main criteria can be used to include a soil site, either a profile or a soilscape, in an inventory of cultural and natural heritage. However, most current soil policies and actions do not provide examples of cultural heritage sites where the primary object of preservation is the soil itself, not just its functional characteristics. The only acknowledgement at the global level is the area of typical Chernozems of Moldova, which is among the tentative sites on the World Heritage List of UNESCO.

Some of the main values that characterize cultural and natural heritage are excluded by soil policies, including scientific and didactic interest, recreational, scenic, and aesthetic values, as well as the inspirational, religious, identity, ethnic, and ethical relevance, which are acknowledged for other natural bodies such as geological and geomorphological sites.

Among the possible European strategies that could be implemented to valorize soil natural and cultural values, the two most suitable instruments are the research and innovation programs of Horizon Europe to support the implementation of the Soil Health and Food mission, and the Natura 2000 program. Soil cultural and natural values may be instrumental in increasing soil literacy, which is one of the goals of the Soil mission. In the Natura 2000 program, the inclusion of descriptions of the presence of pedosites could be an immediate action, increasing both the cultural and naturalistic values of the areas and promoting

collaboration between soil scientists and professionals from other disciplines, thus enhancing a transdisciplinary approach to soil health and its societal connectivity.

At the global level, a common goal of the community of soil scientists is to increase soil awareness. The International Union of Soil Sciences promotes the celebration of World Soil Day every year and the decade of soil. Another common goal could be the proposition of soil sites to be included as part of the natural and cultural heritage by regional, national, and international authorities.

The effect of dissolved organic matter derived from agricultural waste materials on phosphorus sorption in sandy soils

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Keywords: agricultural organic waste, dissolved organic matter, phosphorus sorption, sorption parameters

Considering the discrepancies on the effect of organic matter on phosphorus (P) sorption in the literature and the scarcity of studies on the effect of dissolved organic matter (DOM) derived from agricultural waste materials on P sorption in natural soils, as well as the growing need to search for renewable sources of available P and organic matter in agricultural soils, there is still an urgent need for a deeper understanding of the interaction between P and DOM in different natural soils. The results of a study on the effect of DOM on P sorption in sandy soils rich in Al and Fe but with different properties and land use will be presented.

The aim of the research was to examine the effect of DOM derived from various types of agricultural organic materials on the P sorption process in sandy, strongly P-fixing soils. P sorption process was carried out in soils not saturated and saturated with DOM derived from: compost (CPT), biogas digestate (BD), cattle manure (CM), horse manure (HM). The Freundlich and Langmuir isotherm equations were applied to describe P adsorption in the soils. The introduction of DOM derived from CPT, BD and CM increased the P sorption (*Q*) in cultivated and forest soils. DOM-HM caused a significant decrease of *Q* in the soils studied. A significant increase in the Freundlich *nf* exponent was observed after the introduction of all DOM types, indicating a significant increase in the energy heterogeneity of P sorption sites in soils. Changes of K_L parameter indicate a lowering of P binding energy in soils after the introduction of all DOM types, which may have an effect on the easier P availability in the studied soils. The greatest effect on the decrease of P binding energy was observed after the introduction of HM, followed by BD, CM.

Diversity and dynamics of soils in the forest zone of the Tatra National Park

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Keywords: mountain soils, soil organic matter, soil biological activity

Scientific research on soils in the Tatra Mts. began 100 years ago. However, the subject of the genesis of soils and their dynamics in this high-mountain area is still interesting, especially since in recent years an increase in the number of catastrophic events have been observed. The aim of the presentation is to show the diversity of the soil cover in the forest zone of the Tatra National Park and the dynamics of soil properties in response to some environmental disturbances in the medium- and short term.

Based on more than 650 analysed soil profiles, it was found that these soils are very diverse, due to the complexity of their development (the impact of both natural and anthropogenic factors), which researchers have empasized in the past. Soils morphology and their properties very often show features typical of high-mountain areas, the most important of which are: shallow soil profile, high content of rock fragments, high or very high content of poorly transformed organic matter.

In order to assess medium-term changes, a case study on soil renaturalization was carried in the Jaworzynka Valley. Fifty years after the conversion of pastures to mostly uncultivated grasslands, the development of genetic soil horizons and the sequestration of SOC in the soils have occurred despite significant slope inclination. SOC pools and the form of SOC sequestration strongly depend on vegetation. In order to assess the short-term dynamics, a case study on changes in soil biological activity in the Lejowa Valley was carried out. Two years after the windfalls the overall soil microbial activity have decreased due to the collapse of fungal activity, with
only minor changes in soil properties.

Assessment of heavy metals pollution of urban soils in two cities representing different regions of the world

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Keywords: anthropogenic pollution, heavy metals, pollution indices, urban area

The content of heavy metals in urban soils of Villavicencio in Colombia and Krakow in Poland was determined, including cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb) and zinc (Zn). The first city was founded in 1840 and is located in a typical tropical climate, while Krakow is a much older city with more than a thousand years of history in a temperate warm climate. However, both cities currently have similar populations, areas and traffic volumes. In each city, a main road was selected, running from the suburbs to the city center. Along this road, surface soil samples were collected, and total heavy metals content, pH, organic carbon and texture were determined. To evaluate and compare pollution between both cities, the following indices were used: Enrichment Factor (*EF*), Geoaccumulation Index (I_{geo}), Nemerow Pollution Index ($PI_{Nemerow}$), Potential Ecological Risk (*RI*) and Contamination Security Index (*CSI*). Pollution indices were calculated based on reference and local geochemical backgrounds. The results indicate that most of the soils in Krakow were characterized by a higher content of the analyzed heavy metals and the pollution indices showed significantly higher contamination than in Villavicencio, especially in the case of Cd, Pb and Zn. This data reveals the influence and importance of anthropogenic and natural factors, contributing to understand the influence of history, industrial development, car traffic, environment, soil properties, land use and public policies on soil pollution by heavy metals.

Transformation of peat soils in the changing world

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Keywords: peat soil, decomposition, oxidation, sustainable management

Peat soils cover just 3% of the worlds's land area but receive disproportionately more attention. This is justified: Peat soils have a range of particular properties and potentials. They store ca. 644 Pg of carbon (C). In most peatlands, this C store has accumulating since the onset of the Holocene, storing ca 25 g C yr^{-1}. Currently, this C store is rapidly depleted due to oxidation following drainage, releasing 5% of the global greenhouse gas emissions.

Peat consists of different plant remnants, forming out leaves, fine and coarse roots, rhizomes, and woody tissue. Depending on climatic and hydrologic conditions and trophic status, peat forms accompanied by a process called "primary" decomposition. Many peat soils have experienced "secondary" decomposition following drainage for centuries, but not on a large scale.

The world is currently experiencing a "Great acceleration" that also affects peat soils, exposing them to drainage, cultivation of forest trees and agricultural crops, coverage and mixing with sand, fertilization, erosion, and extraction at unprecedented speed. Nowadays, as climate change is also man made, it can be considered a part of the "great acceleration" as well. The resulting transformations of peat soils concern its chemical composition, the residual accumulation of recalcitrant materials and the formation of new substances. This changes the stochiometric composition of the peat, its ability to hold water and even changing its hydrophilic behavior -for which Polish Soil Scientists coined the term "grainy moorsh". Due to the extremely low bulk density of pristine peat soils and the strong oxidation rates, drained peat soils rapidly shrink in volume, changing the topography of the landscape, sometimes putting land area at risk of being lost to the sea. Often, these transformations have deteriorated the suitability of affected soils for agriculture and forestry.Therefore, recent activities have focused on reconciling the cultivation of peat soils for wet production (Paludicultures) for revitalizing peat soils. In this rapidly changing world, it is imperative to develop solutions for a more sustainable management of peat soils.

Environmental factors forming the soil cover of a part of the Łowicko-Błońska Plain

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Keywords: soil cover, Łowicko-Błońska Plain, sand thickness, drainage, land use change

The soil cover is explained by the analysis of soil-forming factors. On a global scale, the climate, vegetation, and water conditions that determine the zonal arrangement of soils are of decisive importance. At local scale, the same factors, (changing in single profile and in chronostructure). During this research an attempt was made to categorize the impact of soil-forming factors.

The Łowicko-Błońska Plain (part of Central Masovian Lowland) looks flat and monotonous, but in the microscale the variability of the natural environment is quite significant. The substratum is made up of heavy loam, silt and clay formations, within shallow network of drainage. Occasionally the rocks are covered with sand of various thickness. For this reason, the soil cover is very diverse, from acidic Brunic Arenosols or Podzols to alkaline Mollisols.

The research was carried out on a transect located in the central part of the region, from Gongolina (S) to Pawłowice (N). The research included a query of materials regarding the natural environment features and landscape transformations caused by human activity over the years. The analysis of anthropogenic changes was observed on a topographic map (as for before 1914), a modern orthophotomap and a lidar image.

It was found that the soils of the Łowicko-Błońska Plain are primarily determined by lithological features of substratum, mainly a thickness of aeolian sand, and by its moisture. The variable sand admixture affects reduction of a trophy and deterioration of water conditions. In addition, anthropogenic factors, mostly agriculture use, had a significant impact. Drainage was an equally important factor (at least twice), which led to the lowering of a groundwater level, and transformation of Histosols and Mollisols. Spatial range of leading soil-forming factors was varying in time and led to relic or/and adaptive features in the soil profile.

Microbial abundance and activity in the technogenic saline soil environment

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Keywords: soil microbiota, soil salinity, halophytes, SUITMAs, N-cycle

Human activities can dramatically alter landscapes, such as industrialized zones at high risk of soil salinization. The microbiome plays a crucial role in the biological functioning of degraded lands. However, the abundance of microorganisms in technogenic salt-affected soils, and in particular, the presence of specific guilds of microorganisms involved in the N cycle, has not been thoroughly studied. This research aims to address this knowledge gap by assessing the microbiota in relation to soil properties and plant species composition across two transects reflecting different land use types (saline wasteland and arable fields). The studied soils were alkaline (pH-H_2O 7.4-8.0), ranging from non-saline to strongly saline (EC_e 1.0-58.1 $dS \cdot m^{-1}$), and rich in organic carbon (1.5-10.5%), total nitrogen (0.15-0.97%), and calcium carbonate (2.6-25.1%). Our findings reveal that pH and salinity, as well as plant species composition, the most influenced soil microbiota. High soil salinity reduced the abundance of Bacteria and Fungi, as well as the abundance of nitrifying microorganisms, while denitrifying bacteria and N_2-fixers were more resistant. Their presence was related to the obligatory halophyte *Triglochin maritima*. Moreover, high soil pH negatively influenced the hydrolytic activity of soil microbiota and the abundance of Archaea. However, a positive correlation was detected for Bacteria and bacterial amoA gene copy numbers. Furthermore, we found that calcium carbonate could mitigate the adverse effects of high salinity on soil microbiota. Our results can be valuable for land reclamation projects.

Systematic position and genesis of the ‘Kuiavian black earths’ in the light of pedoarchaeological research

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Keywords: Kuiavia, Black earths, Chernozems, Soil genesis, Pedoarchaeology

Black earths are commonly regarded as soils of hydrogenic origin, occurring in depressions and flat areas with difficult water outflow. In Kuiavia, soils defined in this way occupy vast spaces, however, they are distributed in various topographical locations, often covering landforms with height differences of up to 15 m with a continuous mantle. Research conducted as part of the project of the National Science Center No. 2016/23/B/ST10/01067 allowed to verify the systematic position of these soils and draw conclusions about their origin and age.

The genesis of the real, hydromorphous black earths should be associated with changes in the hydrographic network of this area, and mainly the disappearance of vast shallow lakes, between the Neolithic period (about 4500 years BP) and the Roman period (about 2000 years BP). However, the soils located in higher terrain positions have the character of typical and illuvial Chernozems. Radiocarbon dating of the organic matter of these soils and the stratigraphy of archaeological findings allow us to conclude that they were fully formed already in the middle Holocene (Northgrippian), at the beginning of the Neolithic (about 6500 years BP). Illuviation of carbonates and clay fraction occurred not earlier than 3500 years BP, i.e. already in the Neo-Holocene (Megalayan).

Distribution and geographical regularities of the occurrence of ochre soils (Rubic Arenosols) in Poland in the light of the BDL data analysis and own research

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Keywords: Ochre soils, Rubic Arenosols, Soil Geography, Poland

Ochre soils (Chromic/Rubic Arenosols) are one of the least known elements of the soil cover of Poland and Europe. They are characterized by an allochthonous accumulation of iron oxy-hydroxides giving an exotic red colour to their diagnostic rubik (Bo) horizon. So far, mostly single profiles and locations of ochre soils have been studied. The aim of this work is to determine the geographical regularities of the occurrence of ochre soils based on data from mapping forest habitats and the results of own research. 400 cartographic contours of ochre soils were analysed: 330 objects registered in the Forest Data Bank (BDL) and over 70 other objects found in the field.

The ochre soils are formed mainly from Quaternary sandy deposits (99.5%) with the texture of loose sand and slightly loamy sand (95.6%). Their ranges are usually smaller than 3 ha (62%), however, individual contours may reach area of up to 80 ha.

Nine characteristic situations of occurrence of ochre soils in relation to relief and nine in relation to water conditions were determined. It was found that ochre soils most often occur in the bottoms of depressions with a shallow groundwater level and in connection with slopes and valley forms. The location of many contours of ochre soils near actually not active spring niches or above various hydrographic objects indicates their relic nature associated with changes in water conditions.

Effect of charcoal production in historical times on soil phosphorus in aeolian landscape

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Keywords: phosphorus, nutrient cycling, human impact, charcoal, forest ecosystems

Application of the light detection and ranging (LIDAR) technique for relief modeling allowed the identification of a large number of small, circular landforms in European forests. Further studies have shown that these are remains of charcoal production in historical times. Large density of such forms in some areas suggests a strong impact of that process on terrestrial ecosystems, in particular soils. Considering large ecological and utilitarian importance of the issue, we undertook an interdisciplinary study focused on environmental effects of charcoal production in northern Poland. Pedological studies, conducted in three landscapes (moraine, fluvioglacial, and aeolian), covered many aspects. Here, we focused on the impact on soil phosphorus is aeolian landscape. The studies covered three stands, and three soil profiles were done at each of them, including the relict charcoal hearth (RCH) center, surrounding ditch, and control. The soils were sampled and analyzed using standard procedures. The soils were poor in P, which is typical for dune locations. Its contents fluctuated from 55.6 to 495.1 mg kg^{-1}, excluding litter horizons, whereas stocks from 282.0 to 620.9 g in a soil pedon (1 x 1 x 1.5 m). The effect of charcoal production on element stocks, forms, and profile distribution was clear, however, the observed tendencies depended on soil type. Residual and bound to sesquioxides forms of P usually predominated in the studied soils.

Acknowledgements: The study was supported by National Science Centre, Poland, project no. 2018/31/B/ST10/02498

Restoration of soil biology in transformed soils

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Keywords: enchytraeids, earthworms, tree species, post-fire soil, post-mining soil

The restoration of degraded areas after human activities such as mining or catastrophes like fires is necessary. Therefore, we have investigated various strategies for regenerating and reconstructing forest ecosystems in such locations. In the case of newly formed or regenerated soils, organisms play a crucial role in the reclamation process. By ensuring the influx of organic matter, such as through afforestation, we can promote the development of microorganisms and, subsequently, facilitate the emergence of soil fauna and the soil formation process. The primary research question we addressed was: How does soil fauna, including earthworms and enchytraeids, contribute to the soil forming process in post-mining soil and soil regeneration after a wildfire, while considering the tree species and the presence of pyrogenic carbon?

For our research, we selected sandy soil in sandpit excavations (SM) and post-fire areas (PF). Both areas were afforested with a variety of tree species, including Scots pine (*Pinus sylvestris* L.), European larch (*Larix decidua* Mill.), Silver birch (*Betula pendula* Roth), and European oak (*Quercus robur*). Soil profiles were created and described in these locations, and soil samples were collected for basic soil analysis, including pH, soil organic carbon and nitrogen content, and soil porosity. Furthermore, soil oligochaetes, earthworms, and enchytraeids were collected from all plots to assess the density and species diversity of soil fauna.

Based on the WRB classification, the tested soils were classified as Arenosols (SM) and Podsols (PF). The density of the studied soil fauna was not high, but their presence and diversity may indicate a positive trajectory of changes occurring in these soils.

This research was funded by The National Science Centre, Poland, grant No. 2021/42/E/ST10/00248.

Polygenetic texturally bi-partial Luvisols/Planosols in SW Poland

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Keywords: albeluvic tonguing, textural discontinuity, stagnic properties, soil origin, soil classification

Texturally bipartite and stagno-gleyed Planosols and Luvisols are commonly reported from the temperate climate zone. A unique combination of lithogenic, periglacial and pedological features has raised questions about the classification and genesis of these soils. In particular, an Eemian age for the illuvial clay (argic) horizon in loamy subsoils developed from pre-Vistulian ice-sheets has been hypothesised. Eight texturally bipartite soil profiles (sandy over loamy), located within the range of the Odra glaciation were investigated from the Lower Silesia region (SW Poland). Abrupt changes in the relative contributions of particle size fractions, heavy minerals, rare-earth elements, rounded and semi-rounded sand grains, and clay minerals, as well as the presence of wind-polished periglacial pavements, accompanied by Late Pleistocene–Holocene optically stimulated luminescence ages for the cover sands, have confirmed the different lithogeneses of the topsoil and subsoil layers as the reason for the abrupt textural difference in the soil profiles. Macro- and micromorphological observations support the following model of soil development in SW Poland: (a) formation of illuvial soil (Luvisol type), including its argic horizon, during the Eemian; (b) truncation of profile (erosion of eluvial horizons) during the cold stages of the Last Glacial Maximum, followed by the formation of a periglacial pavement, soil cracking and the cryogenic reworking of the illuvial structures in the argic horizon; and (c) soil burial with wind-transported sands (during MIS 2, remodelling in the Holocene), which formed a lithological discontinuity at the top of argic horizon. During the Holocene, the upper argic horizon has been transformed by extending the albeluvic tonguing under a humid temperate climate. Observations from SW Poland support the hypothesis that Planosols/Luvisols in the older (post)glacial landscapes are polygenetic soils, in terms of their litho- and pedogeneses, the formation of which started in the Eemian and is still active.

The risk associated with soil contamination as assessed with various indices

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Keywords: pollution, contaminants, assessment, geochemical background, human health

Considerable soil contamination occurs in Poland, and in other countries with similar economic structure, on a local scale, in particular in the sites of contemporary or historical industry, mining, waste disposal or accidental release of hazardous substances. For such sites, appropriate tools should be used to assess the state of contamination and remediation efficiency. The first part of the talk will provide an overview of methods commonly used for such an assessment. Some methods are based on total concentrations of substances in soils, which are compared with soil screening values SSV, established as either intervention or target values, sometimes related to land use categories. In the literature, the methods based on comparison of total concentrations with geochemical background are commonly used, and often misused. They involve calculation of single or complex indices, such as geoaccumulation index Igeo, enrichment factor EF, Hakanson risk index RI, Nemerow pollution index PI, and many others. The proper selection of a background level is crucial in those methods. In fact, total concentrations of contaminants in soils do not reflect a real hazard, therefore risk-based assessment has recently gained increasing importance. The procedures of environmental risk assessment (ERA) take into account human health risk and ecological risk. Their bases and legislation status in Poland and EU countries will be briefly presented. In the case of human health risk, attention will be put to various scenarios and exposure pathways. The principles of ecological risk assessment will be discussed including the context of ecotoxicity, disruption of ecosystem services and soil health indices, that are currently gaining popularity. In the second part of the talk, several examples will be presented to compare the results of contamination assessment using various approaches. The cases of contaminated sites will be chosen from the author's own experience and from the literature.

Equation for determining cumulative particle size distribution using the pressure of a sedimenting suspension

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Keywords: particle size distribution, sedimentation methods, suspension preassure

One of the basic properties of soil—its particle size distribution (PSD)—can be measured using several techniques, among which methods based on sedimentation have a prominent place. Many of these sedimentation methods use changes in the density of a suspension to produce a PSD curve. A certain group of these measure changes in suspension pressure during the ongoing sedimentation process. To date, conversion of the measured changes in suspension pressure to cumulative PSD (CPSD) has been performed using statistical methods and not a physical model of the phenomenon. Here, this gap is filled. Based on the Stokes equation, an equation was derived linking the CPSD function with the function $P_L(D)$ describing the suspension pressure and its derivative $P'_L(D)$ in the depth L under surface. The solution of the equation, using the finite-difference method, is also provided. Solutions were obtained that enabled both the determination of the CPSD function based on changes in the pressure of the suspension at a specific depth and, conversely, the determination of changes in the suspension pressure depending on the shape of the CPSD function. Several applications of the obtained calculation model are presented, including the possibility of calculating the dependence of the suspension pressure on the depth and buoyancy force acting on the cylinder immersed in the sedimenting suspension. The use of the derived equation to interpret test results is shown through examples of six selected soils with different PSDs.

Estimation of phosphorus forms in soil based on VIS-NIR-SWIR spectral reflectance

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Keywords: phosphorus fractions, VIS-NIR-SWIR spectral reflectance, estimation, PLS

The purpose of the presented research was to evaluate the feasibility of estimating the content of various phosphorus fractions in soil based on spectral reflectance measurements in the VIS-NIR-SWIR range. The analysis included a set of 170 soil samples from three different environments, from a reclamation experiment on a post-mining heap in Pątnów (48), from a study of soil profiles in the western Ukraine (110), and an analogous study in Mongolia (28). Total phosphorus content was determined in soil samples and phosphorus fractionation was carried out using the method of Hedley et al. (1982) as modified by Spychalski et al. (2015), based on which the content of five phosphorus fractions was determined: I (P-H_2O) - labile, most readily available to plants, II (P-$NaHCO_3$) - exchangeable phosphates and loosely absorbed organic and mineral phosphorus compounds, III (P-NaOH) - forms bound to iron and aluminum hydroxides and fulvic and humic acids, IV (P-HCl) - hardly soluble phosphorus compounds bound to calcium, V (P-residue). Spectral reflectance measurements in the range from 350 to 2,500 nm were made with an ASD FieldSpec 3 spectroradiometer with a Mug-Lite adapter, and a Spectralon® white standard was used to calibrate the radiometer. Predictive model development was performed using The Uscrambler® software, using the partial least squares (PLS) method with cross-validation. Modeling was performed for various forms of spectral curve transformations, i.e. linearization, normalization and filtering. The root mean square error (RMSEcv), its normalized value relative to the mean value, i.e. the relative root mean square error (rRMSEcv), and the coefficient of determination (R^2) were used to evaluate the accuracy of the modeling.
The study showed that on the basis of spectral reflectance in the range of 350-2500 nm and after applying MaxN normalization, it is possible to estimate the content of phosphorus fractions IV and V, the sum of the fractions I-V and total phosphorus with rRMSEcv < 34% and R^2 > 0.70. Fractions I-III, extracted with H_2O, $NaHCO_3$ and NaOH, respectively, were estimated with high error. RMSEcv increased as their content increased, with smaller values of RMSEcv achieved at lower contents of each fraction (I-III), but with large values of relative error (rRMSEcv) and low coefficient of determination (R^2).

A threats to the existence of human civilization

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Keywords: climate change, land degradation, water cycle, warming

As a result of the evolution of the earth system, a world was created in which all biotic and abiotic elements were subject to the laws of nature. The basic processes taking place in this world are energy flow and matter circulation, primarily the water cycle. The stream of solar energy is the only source of energy for these processes that guarantees their stability, and thus the existence of this world. That was until to the appearance of man. A characteristic feature of the development of human civilization is the failure to respect the laws of nature. Initially, human errors were easily corrected by the laws of nature. This was due to the small human population and very poor technical capabilities. However, the exponential growth of the human population and continuous civilizational development, in which the development of technical knowledge was far ahead of the development of knowledge of nature created new threats. The main threat is a strong, negative transformation of the structure of the earth's surface, which has led to a change in the structure of the earth's heat balance and global climate change. The most dangeur changes of the earth's surface character are deforestation and degradation of forest ecosystems. Forest ecosystems use around 85% of the sun's energy for evaporation. The water vapor transports huge amounts of heat to the upper layers of the atmosphere and condenses there, warming them. This causes more heat to be radiated from the earth system, reducing the greenhouse effect of that system. Cutting down forests reduces the flow of water vapor and stronger heating of the near-surface layers of the atmosphere. The chances of reversing trend of deforestation is extremely small.

Soil transformations in the Silesian loess zone (SW Poland) – evidence of environmental change and human activity in the Holocene

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Keywords: Buried soils, Barrows/kurgans, Central European loess zone, Chernozem-Luvisol transformation, Prehistoric agriculture

In Central Europe prehistoric soils are occasionally preserved beneath anthropogenic mounds. Features such as barrows (kurgans) had been constructed during several periods in the Late Holocene, allowing to study differently aged buried soils. By comparing their properties with the traits of material building the mounds and present-day reference profiles, it is possible to characterize past human activity and environmental change in timescales spanning thousands of years. When the dating of the barrows is known (e.g. Neolithic, Bronze Age, early medieval), then the local soil evolution can be placed in a specified chronological framework, especially if a number of sites are investigated throughout a region.

Ongoing, multi-proxy pedo-archaeological research on prehistoric buried soils conducted in the loess zone in Silesia indicates:

1) a widespread presence of chernozemic soils which dominated in the open, forest-steppe landscape at the onset of the Neolithic (late 6th millennium BC) and persisted well into the Late Holocene.

2) that human activity maintained the "openness" of the prehistoric landscape: indicators of agriculture (crop cultivation) were discovered *in situ*, in the soils buried by the barrow mounds.

3) a transformation of chernozemic soils into Luvisols/Retisols, that occurred in vast areas of the Silesian loess zone sometime during the Subboreal or Subatlantic. This major alteration was driven by more humid climatic conditions and the spread of close-canopy, beech-dominant forests, the expansion of which was especially likely in times of settlement decline and land abandonment (e.g. the Migration Period – late 5th-7th c. AD). However, patches of chernozemic soils have persisted until the present-day in those places, where deforestation has been sustained by continuous human activity (e.g. due to agricultural needs).

Analogous soil transformations were also identified in other areas of the Central European loess zone (in Saxony and Moravia), suggesting a supra-regional significance of the described phenomenon.

Selected properties of post-fire forest soils in the Bohemian Switzerland National Park (Národní Park České Švýcarsko)

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Keywords: post-fire area, forest soils, physical and chemical properties

One of the contemporary human challenges is dynamic climate change, which increases global average air temperatures. This contributes to the reduced annual amount of precipitation, and thus the occurrence of droughts. Consequently, there is an increase in the fire risk, which is particularly visible in coniferous stands. In July 2022, the largest fire in the history of the Czech Republic broke out, which affected over 1,000 hectares of forest complexes in the Bohemian Switzerland National Park. The paper presents the results of research on selected physicochemical and chemical parameters of post-fire soils collected in September 2022 from the area of the Bohemian Switzerland National Park. The study plots were selected based on the species composition of trees that grew before the fire. Fifteen areas of former *Picea abies* Karst., *Fagus sylvatica* L. and *Pinus sylvestris* L. stands were selected for the study, where open pits were established. At the same time, soil pits were established in areas not affected by the fire, with similar stands of trees (reference plots). The basic physicochemical and chemical soil properties were analyzed, including the content of cations and anions in the water extract, and the content of cations in the assimilable and total forms. The study showed a significant effect of burnt ectohumus - forest litter on the properties of the humus horizon. In soils exposed to fire, an increase in the content of cations of total forms was noted, e.g. potassium, compared to reference ones. Research on the properties of soils formed after the fire will be continued in the following years as part of the project which concerns the determination of changes in the newly created forest ecosystem, considering processes of plant succession.

Properties and evaluation of the total content and share of mobile fraction of selected trace elements in technogenic soils at the mine tailings disposal site in Bytom, Silesian Upland

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Keywords: Technosols, mineral composition, potentially toxic trace elements, element mobility

The aim of the study was to determine soil properties and mineral composition, as well as to evaluate total content and mobility of As, Cr, Zn, Cd, Cu, Pb, Mn, and Fe in technogenic soils (Technosols) developed on mine tailings disposal site in Bytom. Four soil profiles, which differed in the advancement of soil-forming processes and plant cover, were investigated. Soil reaction was alkaline due to high content of carbonates. The pH_{H2O} of the studied soils was in range 7.3–8.1. The highest content of total organic carbon (TOC) and total nitrogen (TN) was found in organic horizon (42.3–44.4% of TOC and 1.2–1.4% of TN). Mineral composition of all studies soil profiles was similar. Predominating minerals occurring throughout the profiles were ankerite and/or dolomite (most likely Fe dolomite). Common mineral in all profiles was also quartz and gypsum. The investigated Technosols were contaminated with As, Zn, Cd and Pb in accordance with the Regulation of the Minister of the Environment. The share of mobile forms of the tested trace elements in their total content was strongly differentiated. The largest share of mobile forms was recorded for Cd, on average 30.9% of the total content, a smaller share of mobile forms was found for: Cu (16.6%), Pb (13.7%), Zn (10.3%) and Mn (7.6%). Chromium, As, and Fe occurred mostly in immobile forms. All tested trace elements, except for Cd, Pb and Cu, occurred in hardly mobile and immobile forms.

The effect of shrub roots in the formation of fertile islands in soils of temperate pine stands

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Keywords: enzyme activity, exudation rate, microbial biomass, root morphology

The aim of our research was to determine the role of shrub root systems in shaping the biochemical properties of soils in pine stands. The activity of extracellular and intracellular enzymes as well as microbial biomass were used to reflect the impact of the root systems of shrubs. The present study was conducted with the objective to assess root exudation and its response to the share of shrubs in the composition of the stand. The research was carried out in the Olkusz Forest District, southern Poland. The research will cover pine monocultures and pine stands with rowan, alder buckthorn and European hazelnut in shrubs layers. Exudates were collected using a culture-based cuvette system. Additionally, we determined the morphology, and production of fine roots. Our research indicates the great importance of shrub root systems in shaping the biochemical activity of forest soils. Soils of stands with an admixture of shrubs, especially European hazelnut, were characterized by significantly higher enzymatic activity. A strong correlation of enzymatic activity with selected morphological features of roots was noted. Our research indicates the possibility of using shrub admixtures in pine stands to create fertile islands, which will result in improved properties and greater stability of stands.

Arsenic solubility in soils of lower course of Trująca River valley

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Keywords: arsenic, historical mining sites, mobility, soil, Trująca valley

Arsenic (As) is one of the most toxic elements on Earth. In Poland, arsenic ores occur in the Sudetes, where they were mined from several smaller and larger deposits. Among them, the mine in Złoty Stok was of the greatest economic importance. Its history reached 13th century. Hundreds of years of ore mining and processing have resulted in significant contamination of water and soils with arsenic. Previous studies were focused only in the upper part of the Trująca river valley. In this study, we collected 14 soil samples along the Trująca river within the distance of 1500 m (in a straight line). The samples were collected from the depth 0-15 cm. After drying, they were crushed and passed through a 2-mm stainless steel sieve, and the basic soil properties were determined. Additionally, pseudototal concentrations of As were determined by ICP-MS after microwave digestion in aqua regia, according to US EPA 3051 (2007) procedure. Potentially available forms of As were extracted from soil with 0.05 M EDTA, and actually soluble As species – with 1 M NH_4NO_3 (ISO 19730). The maximum As concentrations, that exceeded 8400 mg As kg^{-1}, were found in the closest vicinity of tailings impoundment, in the upper part of the area. Those concentrations tended to decrease towards the mouth of the river, where they dropped to 1240 mg As kg^{-1}. This value should be still considered very high. The percentage of easily soluble forms of As was generally low, i.e. below 1%, but in two soil samples it reached 3% of total As concentrations. However, analysis of potentially soluble forms of arsenic showed that up to 80% of the total As can be mobilized. This fact indicates that As present in the soils under study can pose a high risk to living organisms and to the environment.

This research was supported by the National Science Centre of Poland (project number 2021/05/X/ST10/00680).

Soil organic matter under traditional Andean mountain land uses

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Keywords: andisols, volcanic ashes, soil disturbance, soil quality, paramo ecosystem

Soil genesis and functions are conditioned by the composition of mineral and organic materials, whose interaction determines the efficiency of physical, chemical, and biological processes. The organic matter is direct and indirect link between properties due to its relationship with the soil quality. The study site was La Cocha Ramsar wetland - North Andean Amazon Corridor, located in El Encano corregimiento, Pasto municipality, Nariño Region (Colombia). The average annual temperature is 10.8 °C and rainfall between 1,000 and 4,000 mm per year; the soils are derived from volcanic ash (Andisols), with lacustrine influence, with acidic pH, slow drainage, low fertility, steep slopes and sandy loam texture. To determine the dynamics of organic matter in a Pachic Hydric Melanudand (USDA, 2022) under grassland, potato and Andean paramo; the physical, chemical, biological soil properties for the nine sampling points (three repetitions per use) were performed. The Bulk Density (BD), Total Porosity (TP), Aggregate Stability (AS), Soil Organic Matter (SOM), pH, Available Phosphorus (AP), Total Nitrogen (TN), Cation Exchange Capacity (CEC), Microbial Biomass (MB) and basal respiration (BR), were measured at three sampling depths (0-5 cm, 5-15 cm, and 15-30 cm) with three repetitions by land use. The results shown significant influence ($p \leq 0.01$) of non-organic amendments and fertilizers on the content of AP, TN, CEC, TP, BM, and RB. The SOM was linked to the availability of nutrients ($p<0.01$) as well as to the functioning of the pore space (TP $p<0.01$), with a direct impact of land use on the dynamics of SOM. These results allow planning the anthropic activities will be maintained in paramo ecosystems, revaluing those that modify the physical properties of the soil (degrading). Making possible to implement management or remediation processes in the future to conserve the provision of ecosystem services associated with the soil quality and land degradation.

Improved soil quality in Andean mountains through implementation of restoration program

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Keywords: soil quality indicators, soil degradation, land use, forest restoration, private nature reserve

The soils provide essential ecosystem services, generating support for the existence of ecosystems and biodiversity, its crucial understand his quality through ecological processes assess. Few studies in tropical mountain environments estimate the effectiveness of ecosystem restoration from soil quality (SQ) indicators evaluation. This study evaluates soil quality as an indicator of natural recovery and restoration processes in the civil society nature reserve named “La Montaña Mágica-El Poleo" (MM) eastern Andes mountains in Zapatoca Municipality, Santander Region (Colombia). The five most common land uses scenarios in the Andean ecosystems were evaluated, such as: natural forest, active restoration, coffee plantation, badlands and passive restauration. The main objective was to analyze the physical, chemical and biological characteristics in the soil in relation to soil uses; stablish soil base line for SQ indicators in the different land uses and determine the state of restoration systems in relation to other evaluated land uses for the study site. The SQ parameters were evaluated using Anova and Dunnett test. Passive and active restoration improved soil bulk density, porosity, and biological parameters than number of individuals and families of soil macroinvertebrates. Active restoration showed low pH values, low aluminium concentration and increase in potassium concentration respect the other evaluated soil uses. The changes in the SQ indicators were product of organic matter contribution, root system developed and nutrients recirculation in the soil which were favored by restoration systems. This study made possibly understand SQ changes in relation to land uses than practical tool to evaluate ecological restoration methods in natural areas in the Colombian eastern Andes.

Applicability of a portable XRF spectrometer in combination with soil magnetometry to identify the sources of metals in topsoil

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Keywords: portable XRF spectrometer, heavy metals, soil pollution, soil magnetometry

The main aim of the research was assessment the applicability of portable XRF spectrometer (pXRF) to soil pollution study in combination with soil magnetometry, following the ISO21226-2019 standard. The analyzes were carried out in 2021-2022 on the two sites in forested areas of Natura 2000, located in the Cieszyn county. The measurements were conducted using the pXRF - Explorer 7000 and BARTINGTON MS2B and MS2C magnetic sensors. The results of the metal content obtained using the pXRF method were verified in a chemical laboratory (ICP OES after aqua regia extraction). The results of the study exhibits, that the most reliable values are obtained during laboratory measurements for air-dry and homogenized soil samples. Measurements carried out directly in the field were characterized by low measurement stability, resulting from the heterogeneity of the measured soil surface (high porosity, variable granulation, high content of organic matter) and high litter moisture. In the case of such elements as Co, Mn, Pb, V, Zn, the concentration values measured by pXRF were comparable to the results obtained by ICP OES method. In the case of As, the average values obtained by ICP OES were 50% lower, whereas for Cr and Ni by ICP OES values were respectively 140 and 200% of the values measured with pXRF. Spatial correlations between the values of magnetic susceptibility (κ) and the content of seven elements (As, Co, Cr, Mn, Ni, Pb, Zn), and also the PLI Index, were sufficient to apply the soil magnetometry method according to the ISO-21226-2019 procedure on both tested sites. However it should be noted, that in the site affected by pollution from one dominant pollution source (Třinec ironworks), the correlation values were much higher than in the case of site where two different emission sources overlapped (urban and industrial).

Contemporary problems of Polish soil classification and quality assessment of agricultural lands

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Keywords: soil classification, land quality assessment

The currently valid polish soil classification and quality assessment of agricultural lands has been operating in a slightly changed state since 1956. Within 12 years, the classification covered almost 22 million hectares of land. The classification is used to calculate tax liabilities on account of the land owned, or decides on the intended use of the land, paying particular attention to the protection of agricultural land against its exclusion from agricultural production. Inspections carried out in poviat starosties carried out by the Supreme Audit Office in 2020 and 2022 regarding the implementation of soil classification of the land in Poland clearly indicated numerous irregularities. They concerned both the administrative and legal sphere as well as the soil classification sphere. The most important problems include the method of selecting a classifier and exercising control over the soil classification of lands.

The main focus of the presentation was on the problems arising from the progress of soil science knowledge. The lack of correlation between the content of classification, soil and agricultural maps with the current state of soil science knowledge is also discussed.

Possible adverse effects of microplastic occurrence in arable soil on food production safety

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Keywords: microplastic, soil, pollution, potentially toxic elements, plant growth

Due to increasing use and unintended disposal of plastic wastes, microplastic (MP) have been assigned to the list of micropollutants possessing threaten to human health and environment. Microplastic in soil can be introduced from different sources including air deposition, water runoffs or soil mulching and fertilization. In Poland the scale of the problem of MPs pollution is soil is not well recognized, however based on estimates from neighboring countries, microplastic is present in most of the arable soils in UE and the content of MPs is increasing rapidly having still unknown risk to human health and food production safety. The effects of MPs on soil physicochemical properties and nutrient cycling is still discussed, however there are evidence that MPs alter important biogeochemical processes by changing their characteristics and microbial activity. Moreover a lot of attention should be paid to coexistence of MPs and other pollutants (organic and inorganic) as microplastic particles may act as vectors of these substances in soil, increasing the risk of pollutant transfer in the food chain. In our study we are focusing on the changes of soil properties that are important for regulation nutrient and contaminant bioavailability to plants. Results of our preliminary studies showed that some soil properties e.g. porosity, water holding capacity, pH or carbon content can be positively affected by presence of MPs and in many cases plant growth can be improved, especially on heavy clay soils. While some negative effects can be observed e.g. increase of potentially toxic elements availability to plants and higher transfer of pollutants in plant tissues, what causes potential risk of food contamination or pollutant leaching to ground waters.

Project funding was supported from project “MISTRZ” no. N090/0002/21 and from Doctoral Student Grant, no. N020/0007/22 at the Wroclaw University of Environmental and Life Sciences

Application of Munsell CAPSURE Color Matching Tool Portable Spectrocolorimeter in description of color as a diagnostic property of soil materials

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Keywords: soil color, soil erosion, soil spectrocolorimeter, UAV photogrammetry

One of the basic indicators of topsoil properties is the color of the surface horizon. Anthropogenic denudation in moraine plateaus of Northern Poland leads to strong transformation of the soil cover of agricultural areas, which affects strong differences in the color of plowing horizons. The original diversity of the soil cover, conditioned by lithology, relief and water conditions, undergoes even a stronger differentiation and leads to formation of soils truncated in the upper parts of the slopes and accumulative at the foot of them.

The development of remote sensing technologies started a new stage of research on the diversity of soil cover on a local scale. Low-altitude photogrammetry carried out with unmanned aerial vehicles (UAV) is a modern attempt to determine the extent and degree of erosional alteration of soil cover. Studying the color of surface soil horizons may also require a more specialized approach and the use of advanced color determination techniques, which may be distorted depending on personal perception. The study aims to compare the classical manual soil color tests in the laboratory (printed Munsell color charts), the results obtained from orthophotomaps and the tests of soil samples in the laboratory conditions using the Munsell CAPSURE Color Matching Tool Portable Spectrocolorimeter which automatically determines the color of a given surface. Comparing the results of soil color from three different sources: classic manual determination based on Munsell soil color charts, pixel color on an orthophotomap and data from CAPSURE device is an innovative approach to research on soil color and soil properties. The use of such a device is an innovation in soil research and possibly an acceleration of determining of soil properties and their systematic position.

Possibilities and barriers to use of soil liming to improve the economic efficiency of agricultural production and reduce the eutrophication of surface waters

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Keywords: soil liming, soil acidification, agriculture

The current level of liming of agriculturally used soils in Poland is from a few to more than 38 times lower than recommended by the Institute of Soil Science and Plant Cultivation (IUNG). The pH of soils can be easily regulated through soil liming treatment. However, as the results of the National Agricultural Census 2020 showed, only about 21% of farms were carrying out soil liming in 2019-2021.

In 2022-23, research was conducted as part of the project: *Possibilities and Barriers to the Use of Soil Liming to Improve Economic Efficiency of Agricultural Production and Reduce Eutrophication of Surface Waters* (KSOW/6/2022/079), co-financed by the European Union under Scheme II of the Technical Assistance "National Rural Network" of the Rural Development Program 2014-2020.

The main aim of the project was to determine the factors that influence the insufficient use of calcium fertilizers by farmers in agricultural crops.

The research was conducted in 4 voivodeships: małopolskie, podkarpackie, opolskie and zachodniopomorskie. These regions are characterized by decidedly different environmental, structural and historical conditions, which significantly enriched the spectrum of the conducted research and broadened the possibility of analysis and conclusions.

During the field surveys research conducted among farmers and employees of agriculture-related institutions, the most important natural, economic and environmental factors that influence the inclusion of liming in a series of agrotechnical treatments were identified and described.

The results of the study showed that the reasons for low levels of liming are complex and can be divided into: social, technological, logistical-technical and economic. The occurrence of individual barriers limiting liming depends on many characteristics of the farm and its user. These barriers are more likely to manifest themselves on smaller, economically weaker farms, where agricultural production is an additional, rather than the main, source of income.

Soil properties under stands of different age in the Lasy Janowskie reserve

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Keywords: Lasy Janowskie reserve, soil properties, organic carbon, pine, pine-fir stands

The research is a part of the project entitled: "The impact of care and protection treatments on the stability of stands and the diversity of flora and fauna on the example of the Lasy Janowskie reserve". The main goal of the project is development of detailed guidelines for the planning and implementation of care and protection treatments in stands under active protection on the example of the Lasy Janowskie reserve. It is a valuable object mainly due to its historical values. It covers one of the largest partisan battlefields from World War II. This area is under active protection. Permanent training and research areas with an area of about 0.25 ha (50 × 50 m) were established in pine stands: 21-year-old, 31-year-old, 49-year-old and 60-year-old, and mature pine-fir stands (74 and 84 years old and 120 and 135 years old). The first stage of the work consisted in the characteristics of the studied plots before performing the treatments. The soil research was additionally used to analyze the influence of the age of stands on soil properties under active protection conditions.

Soils analysis were carried out on 14 research plots. On each plot, samples were taken in five repetitions (organic horizons Ol, Ofh and mineral layers 0-10cm, 10-20cm, 20-30cm). The samples were examined for pH (1MKCl and H_2O), organic carbon (Corg) and total nitrogen (Nt), basic cations (BC), hydrolytic and exchangeable acidity. Differences in the content of Corg, Nt, BC and acidity between the plots concerned mainly the top layer of the soil.

The research was supported by State Forests National Forest Holding (Umowa nr EZ.271.3.21.2021)

As we are seen, so we are perceived! The role of soil scientists in promoting soils

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Keywords: education, promotion, soils, soil science

An important element in educating the public is to reach the widest possible audience. On the one hand we have formal education which most of us soil scientists do. but how do we approach informal education and promotion of soils? Are we as soil scientists showing up and reaching out effectively to a wide audience? How are we using the current opportunities that current technology has created for us? What are we doing well and what do we need to improve in order for soil scientists to become "soil influencers"?

Effect of combustion wastes on selected properties of soils in Southern Wielkopolska (Poland)

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Keywords: calcite, ash, contamination, sandy soils

Coal and wood combustion in households generates by-products that are represented by ashes and soot. Ashes and soot are classified as municipal wastes and there are picked up by waste management companies. Nevertheless, very common practice is scattering of ashes on soil surface around houses. Therefore, the aim of the study was to determine the effect of ashes from low emission sources on selected properties of soils. The study was executed based on analysis of soil profiles that were affected by combustion wastes. The soils were collected in Dębicze village (Southern Wielkopolska) and soil profiles were classified according to the SGP6 (2019) and the WRB 2022. Selected properties were analyzed in soil samples (i.e. pH, $CaCO_3$ content, soil texture). Furthermore, chemical composition (aqua regia digestion followed by ICP-OES analysis) as well as phase composition (SEM analysis) of soils were determined. The soil profiles were characterized by the presence of: (a) ashes after bituminous coal and wood combustion in households (DAS1, DAS2), (b) ashes after bituminous coal combustion in horticultural sector (DAS 3), and (c) ashes after wood combustion in household (DAS 4). According to the SGP6 (2019), soils were classified to the following subtypes: aggerosol (DAS1), gleba rdzawa typowa (DAS2), industriosol (DAS3), and urbisol (DAS4). In turn, according to the WRB 2022, soils were classified to Arenosols (DAS1, DAS2) and Technosols (DAS3, DAS4) RSGs. The study revealed that: (a) horizons containing combustion wastes are enriched in Zn and Cu, (b) deposition of household ashes on the soil surface increases the pH of soil from deeper horizons in contrast to the deposition of ashes from horticulture sector, (c) increase of pH in deeper soil horizons results from K leaching from ashes and calcite dissolution, and (d) iron coatings on the quartz grains bind leached K and Ca.

A new approach for the spatial assessment of agricultural soil quality

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Keywords: digital soil mapping, machine learning, maintenance of soil fertility, soil quality index

Soil quality is defined as capacity to function within natural or agriculturally transformed ecosystems: to maintain plant productivity, to ensure the health of plants and animals, to correct soil functioning, and providing wide range of ecosystem services. The evaluation of soil quality is necessary for the sustainable agriculture and soil protection, what may be crucial for further plans of agricultural soil management in EU Member States due to the problem of soil degradation, climate change and implementation of European Green Deal. Delineation of areas threaten with degrading processes and these with high ecological value will need application of the set of indexes characterizing soil physical, chemical and biological properties. We aimed to develop the methodology using selected soil indicators for the assessment of agricultural soils quality. The proposed original quantitative-qualitative procedure includes four steps: (i) calculation of selected statistics to delete redundant and highly correlated indicators: two-way ANOVA, Spearman's rank correlation, cluster analysis using Ward's method, and PCA; (ii) creating maps at the country scale of selected soil indicators using digital soil mapping approach (QRF); (iii) dividing values of all selected indicators into ranges; (iv) calculating Soil Quality Index based on the geometric mean of the soil indicator ranks. The preliminary evaluations indicate the applicability of the developed approach for the assessment of agricultural soil quality at a national scale. We are convinced that proposed procedure will be a valuable and effective tool significantly contributing the evaluation of agricultural soils ecosystem services.

The work was supported by EJP SOIL project under grant agreement No. 862695.

Assessment of the contamination of selected heavy metals in urban soils of different land uses of Lublin and Krakow (Poland)

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Keywords: urban soils, land use, pollution, heavy metals

The assessment of the ecological risk is an extremely important research problem due to the progressive process of urbanisation worldwide and the quality of life of city dwellers. The research carried out aims to indicate the influence of anthropogenic transformation of soils, typical of urban areas, on the content of heavy metal elements (Cd, Cr, Cu, Ni, Pb, Zn). The following urban functions have been identified: residential (HA), industrial (IA), transport (TA), cemetery (CM), recreational (RA), allotments (GA), agricultural (AA), forests (FA), wastelands (naturally and artificially undeveloped areas) (WA), soil sealing (EA). Zones with different functions were selected within the administrative boundaries of 2 cities (Lublin and Krakow), from where soil material was collected (representative 0-20 cm surface samples, 5 from each zone). The content of total elements (Cd, Cr, Cu, Ni, Pb, Zn) was determined using the F-AAS method after extraction with aqua regia, based on the ISO 11466:2002 method. Based on the Regulation of the Minister of the Environment on the manner of conducting the assessment of pollution of the earth surface, exceedances of the permissible levels of chromium were found in 40 % of the surface samples in the industrial zone and in the urban wasteland zone of Krakow, and 20 % of the samples taken in the urban wasteland zone for zinc. At the same time, slight exceedances of permissible cadmium contents were found for 20 % of samples in the residential, allotment gardens, agricultural use and urban waste zones. In the area of Lublin, in the zone of urban wasteland, 20 % of surface samples were characterised by elevated cadmium concentration. The content of the other heavy metals (Pb, Cu, Ni) did not exceed the concentration levels allowed by the 2016 Ordinance in all mixed-use zones of the analysed cities.

An attempt to update the agricultural soil map in terms of typology to the Polish Soil Classification, 6th edition in the West Pomerania Region

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Keywords: soil maps, Systematics of Polish Soils, update of soil maps

Each successive soil taxonomy introduces new criteria for distinguishing soil units and often new nomenclature. However, soil maps are usually not updated in Poland with new taxonomies.

In 2021, after the publication of the Polish Soil Classification, 6th edition, an article was published showing the possibility of correlating soils separated on agricultural soil maps with the latest Systematics of soils based on divisions from the agricultural soil map in the scale of 1:25,000. In turn, in 2022 an article was published discussing the compatibility units of the legend of selected maps of Polish soils with the types of Systematics of Polish soils (2019) based on the analysis of soil profiles.

The summary presents an attempt to update the agricultural soil map for the Zachodniopomorskie Voivodeship, which can be considered as a representation of the young glacial areas of Northern Poland. The update was made on the basis of a digital version of the agricultural soil map in the scale of 1:5000. Almost 190,000 polygons were taken into account, from which those that did not contain information about the type of soil (i.e. soil polygons of state forests, built-up areas (Tz) and wasteland (N)) were rejected. The update was made only in the field of soil typology.

On the updated map of the West Pomeranian Voivodeship, you can find 8 out of 9 orders of soils distinguished in the latest Systematics. There were no anthropogenic soils, which were not distinguished on earlier maps. However, it can be assumed that a large part of them is hidden in the rejected cases of soils of built-up areas (Tz). Out of 30 soil types, 9 soil types were missing from the updated map. In addition to the already mentioned anthropogenic soils, these types are marked with the symbols: BH, BR, CC, CS, OE, SQ, SI. Some of them are not found in Pomerania region (e.g. SQ, BR, CC), some soil types are found only in forests (OE, BH), and the remaining ones probably occupy too small areas to be separated on the agricultural soil map within Western Pomerania. The largest area is occupied by soils in orders: P (50.4%), B (23.2%, including BV 22.1%), O (14.2%) and C (9.3%).

Nutrient bioaccumulation and distribution in silver birch (*Betula pendula* Roth) biomass growing on post-arable soils

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Keywords: silver birch, bioaccumulation, biogeochemical cycling, nutrients, agricultural land

The aim of this study was to evaluate the bioaccumulation rates of chosen macro- and micronutrients and their distribution in biomass of silver birch growing on post-arable soils. The study covered two stands located in the complex of Dystric Cambisols (15 and 35 years old) developed from glacial tills and two in the complex of Brunic Arenosols (10 and 35 years old) developed from fluvioglacial sands. Soil and birch biomass were sampled at 10 replicates per stand. Biomass samples included fine roots, coarse roots, stem wood, bark, coarse branches, fine branches, and leaves. Soil samples were taken from depths of 0-10, 10-20, 20-40, and 40-80 cm. Contents of total organic carbon (TOC), N, and S were determined by dry combustion (Vario MacroCube, Elementar), whereas contents of P, K, Ca, Mg, Fe, Mn, Cu, and Zn using the inductively coupled plasma atomic emission spectrometry (ICP-OES, Avio 200, Perkin Elmer) after microwave digestion in aqua regia (soil samples) and nitric acid (biomass samples). Soil analysis included also pH and particle-size distribution. The studied soils were acidic and moderately abundant in TOC and N, but generally poor in the remaining elements. Contents of elements strongly varied among birch organs. The highest contents were usually found in leaves followed by roots (N, P, K, Mg, S), bark (Mn, Cu), or branches (Ca). Fe occurred at the highest amounts in fine roots, whereas Zn in the bark. Large variability showed also bioaccumulation factors. Among macronutrients, silver birch showed the highest bioaccumulation intensity with regard to N, followed by Ca, K, or S, while among micronutrients with regard to Zn. Comparing the same fractions of birch biomass in terms of elemental content as well as bioaccumulation factor between the studied stands, statistically significant differences were observed in many cases for all elements.

Protecting soil and increasing biodiversity in the Czech Republic: An approach based on landscape connectivity and erosion modelling

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Keywords: water erosion, soil protection, landscape connectivity, biodiversity, GIS

Water erosion is the most significant degradation factor affecting soil quality in the Czech Republic, as well as in other countries. More than half of the agricultural land in the country is threatened by water erosion. Anthropogenic influences affecting both soil management and landscape structure are one of the significant factors accelerating water erosion. This was particularly evident in the post-war period during the collectivization of agriculture, when the average size of agricultural land increased. These landscape changes led to the loss of approximately two-thirds of landscape elements and a significant decline in biodiversity. In this presentation, we describe these historical trends and present an approach to soil protection that simultaneously increases biodiversity in the agricultural landscape.

Based on raster modelling of erosion processes, landscape connectivity in GIS, and statistics, we propose measures which can reduce the overall erosion risk and related degradation processes while increasing the functional connectivity of existing or newly created landscape elements, leading to an increase in biodiversity. This approach is based on our certified methodology for calculating raster functional connectivity, which allows us to identify areas where corrective measures would contribute to an increase in biodiversity. The resulting raster layer can be combined with erosion modelling techniques to precisely locate areas where corrective action would have a synergistic effect, reducing soil vulnerability and increasing biodiversity. This approach to soil protection and biodiversity enhancement will be presented in a specific, intensively cultivated agricultural area of the Czech Republic, predominantly consisting of chernozem soils.

Acknowledgements: This research was carried out with the support of the Technology Agency of the Czech Republic (projects: Center for Landscape and Biodiversity - SS02030018, Implementation of new methodological procedures in soil protection against erosion - SS05010161).

Pedological dynamics after forest fire involved by a management method used after the disturbance

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Keywords: soil organic carbon, nutrients, soil preparation, post-fire restoration, forest management

Due to the ongoing climate changes, temperate forests are increasingly exposed to fires. However, until now the functioning of post-fire temperate forest ecosystems with regard to used forest management method has been weakly recognized. We examined three variants of forest restoration after fire (two variants of natural regeneration with no soil preparation - NR, and artificial restoration by planting following soil preparation - AR) regarding their pedological dynamics in post-fire Scots pine (*Pinus sylvestris*) ecosystems. The study was conducted using a 15-year timespan in a long-term research site located in the Cierpiszewo area (N Poland) being one of the biggest post-fire grounds in European temperate forests in last decades.
We found that the restoration rates of soil organic matter, carbon and most studied nutritional elements stocks were higher in NR plots than in AR. This could be primarily linked to the higher ($p<0.05$) density of pines in naturally regenerated plots, and the subsequent faster organic horizon reconstruction after fire. The difference in tree density also involved regular differences in air and soil temperature between among plots: consistently higher in AR than in both NR plots. In turn, lower water uptake by trees in AR implied that soil moisture was constantly the highest in this plot. Our study delivers strong arguments to pay more attention to restore post-fire forest areas with the use of natural regeneration with no soil preparation.

Analysis of granulometric indices of the colluvial material in the young glacial landscape

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Keywords: particle-size distribution, agricultural use, slope, young glacial landscape

Soils in young glacial, agricultural landscapes are characterized by high dynamics of soil processes. Glacial landforms may form a mosaic in the landscape thus the variety of soil processes is considerably high, resulting in, among others, assorted soil texture. Analysis and comparison of particle-size distribution (PSD) in moraine (ML) and ice-dammed lakes (ID-LL) landscapes were not studied. Since the landscape of ice-dammed lakes origin has diversified relief and is under intensive agricultural use, the aspects of erosion are of great importance. The changes in PSD were studied in 14 soil catenas representing young glacial landscape in northern-central Europe (north-eastern Poland), of eroding soils at upper slope (US) as well as colluvial soils at middle (MS) and lower (LS) slope and in the depressions (D). The PSD of the fine fractions (<2 mm) was analysed according to hydrometer method. In order to describe the effect of agricultural use on the variability of PSD in soil surface horizons, sedimentological and granulometric indices were calculated. In the studied moraine landscape, the content of coarse silt fraction was increasing in the catenal sequence, from 9.7% in US to 17.7% in D. Similar relationships were revealed for the fine silt content. Significant differences were found between the average contents of coarse and fine silt fractions at US as well as LS and D. However, such relation was not found in the in soil catena in the ice-dammed lake landscape. Eroded and colluvial soil material were very poorly sorted with standard deviation index 2.65-3.69. Humus horizons of analysed soils had very fine, fine skewed PSD, mesokurtic and platykurtic distribution (ML), symmetrical, fine skewed and platykurtic distribution (I-DLL). The cluster analysis enabled to separate 2 groups of soils: one group in moraine landscape and the other in ice-dammed lakes landscape. The PSD in studied soils was similar only among the soils within one type of landscape.

Degree and paths of transformation of ombrogenic peat soils due to drainage on the example of the Western Bieszczady Mountains

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Keywords: organic soils, soil organic matter, long-term drainage, dissolved organic matter

Specific examples among ombrogenic peatlands are those located in mountainous areas which are highly sensitive to changes in the natural environment. They undergo transformations, among others, due to the influence of anthropogenic factors, primarily the lowering of the water table level resulting from drainage. One of the most important research issues addressed in the functioning of peatland ecosystems and organic soils related to peatland drainage is the phenomenon of releasing water-soluble organic matter and biogenic compounds into surface waters. Ombrogenic peat soils occurring in mountainous areas are often overlooked in global analyses concerning carbon sequestration and the storage of biogenic compounds. Therefore, the aim of the presented research was to determine the potential release of dissolved organic matter and nitrogen and phosphorus compounds from organic soils characterized by varying degrees of transformation.

The organic soils selected for the study were located in three ombrogenic peatlands in the Upper San River Valley. The main characteristic distinguishing these sites and consequently, the soils, is the impact of human activity. The drainage of peatlands have led to noticeable contemporary changes in the morphology and properties, mainly of the surface horizons. Differences between the studied soils resulting from the degree of transformation are clearly evident in the composition of the sorption complex, soil pH, and the degree of organic matter decomposition. Among the studied biogenic compounds, the differentiation of organic matter properties in relation to the degree of transformation is more evident in mineral nitrogen transformations compared to phosphorus. However, the higher advancement of organic matter transformations caused by progressing mineralization with increasing peatland transformation degree, which is primarily demonstrated by the narrowing of the C/N ratio and the decrease in organic carbon concentration, does not result in an increase in dissolved organic matter towards more drained soils.

Diversity of organic carbon stocks in humus horizons of selected subtypes of truncated clay-illuvial soils, north-central Poland

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Keywords: soil erosion, arable horizons, Luvisols, Retisols

Clay-illuvial soils (Luvisols or Retisols in WRB) are the most common type of soil found in Poland. These soils are characterized by high diversity which is reflected in the wide range of subtypes in last, 6th edition of Polish Soil Classification (2019). Regardless of that, due to relatively high productivity most of them are "base" of agricultural production in Poland. Northern Poland is dominated by areas with significant local denivelations which, combined with agricultural use, leads to truncation of clay-illuvial soils. Slope processes lead to changes in the general morphology of soil profiles (e.g. truncation) and generally affect the quality of humus horizons and soil organic carbon (SOC) content.
The aim of the presented study is to assess the organic carbon resources in arable horizons of clay-illuvial soils - mainly in the context of their differentiation into various subtypes resulting from erosional transformations. Organic carbon stocks were calculated for 72 soil profiles. The average organic carbon stocks were comparatively low - 3.28 $kg \cdot m^{-2}$. The largest SOC stocks (4.12 $kg \cdot m^{-2}$) were recorded in the "non-eroded" humic stagnogleyic clay-illuvial soils. Eroded pedons (34 profiles - with Bt directly below Ap horizons) were divided into three subtypes – (I) eroded, (II) eroded humic and (III) eroded stagnogleyic clay-illuvial soils. Eroded humic subtype had quite high average stocks od SOC – 3.61 $kg \cdot m^{-2}$, the other two truncated subtypes had significantly below 2 $kg \cdot m^{-2}$. Some truncated soils show a significant depletion of humus - while in many of them the present SOC stocks are close to those classified as non-eroded. The reason may be both different rates of erosion and regeneration techniques (e.g. strip till) leading to the rebuilding of SOC stocks in eroded pedons. Thanks to the possibility of creating complex subtypes (PSC 2019) - individual subtype taxa well reflect the diversity of the described feature.

EcoLab flex – a new and modern tool for whole ecosystem observation

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Keywords: ecotron, global change, isotopes, water cycle, lysimeter

UGT EcoLab flex is a new generation of ecotrons where the optimal technical support to answer every research questions. The EcoLab flex can be designed e.g. as a single ecotron with one lysimeter, as a single ecotron with several stackable lysimeters or as a double station. Examples can be found in the literature. No matter what climate scenarios are in the research focus, from dry to humid, hot to cold, whether a weak breeze or a hurricane, lots of sunlight or high humidity, groundwater levels high or low, everything can be simulated with the integrated systems in EcoLab flex. When it comes to soil, the choice of either using Ready-To-Go lysimeter sampling technology and getting the undisturbed soil body from the field into the lab, or creating an artificial soil as needed. The EcoLab flex offers a well thought-out concept from the idea, through the implementation to the result. Easy operation, uncomplicated monitoring and quick changes of scenarios from anywhere via the innovative PLC control system for all actuators (e.g. lighting, irrigation, air conditioning). Insights on the development of the project or the growth of the plants are possible with the integrated camera in the atmosphere unit anytime and anywhere with a smart device. The EcoLab 500 consists of two main components that build vertically on each other: Atmosphere Unit and Floor Unit. With the WIP (Water Isotope Probe) setup for EcoLabs the extend to the mini-ecosystems with a system can be done for the determination of stable isotopes in the soil and atmospheric unit.

Impact of waste from CHP plant on distribution of pollutants in anthropogenic soil

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Keywords: urban soil, slag, contamination, Pb isotopes

The level of contamination in urban soils varies worldwide depending on the environmental factors and the soil properties. Atmospheric pollution is an important, but not the only source of metals, as urban soils often contain admixtures of anthropogenic materials (e.g. building rubble, wastes, and slags). This makes urban soils difficult to generalize and site-specific studies show that, among others, soil mineralogy and mineralogy of admixtures control PTE mobility.

An interesting soil was found in Wrocław (Poland) that contains up to 10 cm thick layer of slag-coke mixture occurring at depths of 20-30 cm. It is unclear if the layer was deposited intentionally as a reinforcement of the embankment or if it was a waste. Regardless of its history, now it offers a possibility to study the relative contributions of metals from air or within-soil deposition in a complex urban site. Based on elemental ratios such as Ni/Pb or V/Zn we showed that the urban soils analyzed in this study were contaminated predominately by two sources: atmospheric and a buried slag-coke layer. With Pb isotope being similar between the two sources, ratios of two metallic elements were the best indicator of contributions from each source. Nevertheless, Pb isotopes backed with EDTA leaching analyses were essential to estimate the proportion of anthropogenic Pb (and probably other elements) within the soil profiles. In this study the proportion was affected by the thickness of the solid layer that may have protected underlying soils from contaminants moving downward. Vanadium behaved differently compared to other analyzed elements, which can be linked to its predominance in V-rich sulfides that were prone to weathering. Altogether, we showed the importance of buried solids as a source of contamination. The implication is that such solid may be an important soil component acting as both the main contaminant and an insulator.

Radioactivity of Technosols in Poland: lessons learned and challenges for the future

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Keywords: Technosols; Radionuclides; TENORM; Annual effective dose

The aim of the study was to analyse the radioactivity of Spolic Technosols developed on disposal sites of three different industrial wastes: (1) thermal power station (TPS) ash, (2) phosphogypsum and (3) mining wastes from historical metal mines. Total concentration of U, Th, and Cs, as well as the activity of select radionuclides in Technosols were determined to recognize the level of radioactivity, and to assess the potential radiological health risk. Total U, Th, and Cs concentrations in ash were higher than in native soils of Poland. Total U, Th, and Cs concentrations in Technosols were in ranges, respectively: 1.5–11.3, 4–22.9, and 0.2–21.3 $mg \cdot kg^{-1}$ (soils developed from TPS ash), 0.3–3.1, 5.6–12.3, and up to 0.2 $mg \cdot kg^{-1}$ (soils developed from phosphogypsum), as well as 1.5–47.2, 0.8–15.9, and 1.9–20.5 $mg \cdot kg^{-1}$ (soils developed from mining wastes from historical metal mines), The activities of radioisotopes in all Technosols (in $Bq \cdot kg^{-1}$) were in ranges: 0.26–140 (^{137}Cs); 5.2–1265 (^{40}K); 3.2–99.9 (^{228}Th); 3.2–100.0 (^{228}Ra); 3.0–5228 (^{226}Ra); 10–2933 (^{210}Pb); 2.0–552 (^{238}U); 0.1–38.8 (^{235}U). Isotope activities vary strongly between study sites and throughout soil profiles. Technosols developed from bituminous coal ash had higher radioactivity of ^{40}K, ^{228}Th, and ^{228}Ra than soils developed from lignite ash. Artificial ^{137}Cs occurred in surface horizons of Technosols which is an effect of air dust deposition in the topsoil. Annual effective dose (AED) values in Technosols developed from TPS ash amounted 0.07–0.16 $mSv \cdot a^{-1}$, and were higher than the global and Polish average AED (0.06 and 0.07 $mSv \cdot a^{-1}$, respectively) for outdoor external terrestrial radiation.

Research was funded by the Polish National Science Centre (decision no. DEC-2011/03/D/ST10/04599) and the AGH University of Science and Technology grant no. 16.16.210.476.

Soil formation and deposition rates in sandy cones in the Stołowe Mountains tableland (SW Poland)

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Keywords: sandstone cliffs, radiocarbon dating, OSL, Arenosols

Active disintegration and chemical weathering in tableland areas with sandstone capping provide substantial amounts of sand, mechanically removed through the fractured caprock and accumulated below cliff walls. Sandy cones emerging from fissures provide 1-3 meter-thick bodies allowing us to track the past sand removal processes and the contemporary pedogenesis in such landforms.
For this study, in the Stołowe Mts. tableland, two sandy accumulations were chosen – within Szczeliniec Wielki (SzW) and Białe Skały (BS), both formed along continuous rock walls with weak signs of disintegration. We combined two independent dating techniques, AMS radiocarbon dating and single-grain optically stimulated luminescence, to reconstruct the cones' chronology and calculate sedimentation rates. Finally, we correlated the achieved data with paleoclimatic proxies available for the region. The ^{14}C dating of charcoals confirms the Late Pleistocene (12810–12620 cal BP) as the beginning of sandy cone accumulation. Until the mid-Atlantic, the sedimentation rates were relatively low, below 0.02 cm yr^{-1}, while later (especially during the early and high Middle Ages) increased up to 0.06 cm yr^{-1}. The obtained OSL ages are significantly younger than the ^{14}C dates, setting the formation of the cone from ca. 7.12 ka. The deposited material reveals very weak to weak imprints from pedogenic processes (podzolisation) which led to the classification of the sandy cones as Arenosols.

This study was financed by the National Science Center, Q-MESA project nr 2020/39/D/ST10/00861 (awarded to dr Filip Duszyński).

Soil organic matter properties and carbon sequestration

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Keywords: soil management, soil organic matter fractionation, humin, spectroscopic properties, carbon sequestration

Soil organic matter properties and carbon sequestration (SOMPACS) is an acronym of the project entitled “Soil management effects on soil organic matter properties and carbon sequestration”, coordinated by the Wroclaw University of Environmental and Life Sciences in result of EJP SOIL 1st External Call. The goal of this project is to assess management practices that enrich the most resistant SOM pools. The project is realized by a consortium of 12 research institutions from Poland, Germany, Ireland, Lithuania, UK, Italy and USA.

Soil samples and plant productivity from eight long-term experiments (including 100-year experiment in Skierniewice and 180-year long Broadbalk experiment in Rothamsted) that differ in soil management practices (i.e. conventional vs. no-tillage; mineral vs. organic fertilization; with and without catch crop; and arable land vs. undisturbed grassland) are investigated.

In addition to the determination of basic soil properties, the following state-of-the-art analyses are conducted: (1) SOM composition and stability by Py-GC-MS; (2) fractionation of aggregate size classes and C pools of increasing physicochemical protection; (3) isotopic analysis of δ13C and δ15N performed on different SOM pools; (4) microbiological properties (community-level physiological profiling, selected functional genes involved in C and N cycles, microbiome and mycobiome analyses by next-generation sequencing, genetic diversity using terminal restriction fragment length polymorphism); (5)

enzymatic activity; (6) soil water retention and soil water repellency; (7) mineral composition of clay fraction; (8) soil structure stability.
The most resistant SOM pool (humin) is isolated by different methods (isolation vs. extraction) and examined for structure, using spectroscopic techniques (Py-GC-MS, NMR, FTIR, EPR, UV-Vis-NIR, fluorescence). The C stocks in the 1 m depth soil profile will be evaluated and DOC is determined to assess the potential leaching and microbial availability of C. Additionally, in-field CO2 emission from selected experiments is monitored.

The research is financed by NCBR (EJPSOIL/I/78/SOMPACS/2022).

The effect of tree species on labile fraction of soil organic carbon and nitrogen in varied categories of reforested degraded ecosystem – on post-fire and reclaimed post-mine sites

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Keywords: reforestation, reclamation, sandy soils, DOC, C:N

This study compared soil organic matter (SOC) and associated total nitrogen (TN) pool regeneration in different scenario of SOC and nitrogen pool regeneration by labile C and N fractions, including microbial biomass C (MBC), cold-water-soluble C (WSC), water-soluble N (WSN), hot-water-extractable C (HWC), hot-water-extractable N (HWN), particulate organic carbon (POC), and particulate organic nitrogen (PON) in post-mining, post-fire, and undisturbed soils under different tree cover (Scots pine, common birch, and black alder). Our results suggest longer process of SOC and TN regeneration and their labile fractions pool in sandy soils during primary succession after mining than during secondary succession after fire disturbance. A higher proportion of WSC in SOC in the post-mining compared to the post-fire site suggests higher SOC turnover and potential for leaching during primary than secondary succession. The post-fire soils had similar SOC stocks to undisturbed soils but differed in the stocks of C and N labile fractions. Post-fire soils were characterized by lower POC:SOC and less stable organic matter than the undisturbed soils because of charcoal admixture. In contrast, the lowest WSN:TN ratio indicated higher recalcitrant N pools in post-fire soils. The studied tree species differently affected the recovery of SOM properties after disturbances. Compared to soils under pine and birch, only post-mining soils under alder had higher SOC, TN, and labile fraction (except MBC) stocks. Common birch stimulated the development of large MBC across all sites. Soils under Scots pine showed less stable SOM than those under birch and alder, which may accelerate the podzolization processes. The results indicate longer recovery of C and N pools during primary succession than in secondary succession. Finally, alder has limited usefulness as a phytomelioration species that increases the C and N pools in post-fire sites.

Identification of the influence of the parent material factor on the properties and genesis of soils based on mineralogical, micromorphological and submicromorphological features of the soil substrate

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Keywords: soil parent material, soil forming processes, micromorphology, mineralogy, SEM

The research concerned the identification of soil substrate features that would adequately describe its lithogenic origin or soil transformations. Soils formed from various source rocks in several regions of Poland were studied. Field observations, laboratory analyzes of physicochemical properties as well as micromorphological (SM), submicromorphological (SEM, EDS) and mineralogical (XRD) studies were carried out.
In field studies, it was found that the lithological types of the host rock largely determine the macroscopic characteristics of soil profiles. Great emphasis has been placed on the use of computer image analysis (CIA) techniques in MS research. With the help of the CIA, it was proved that the distribution of the RGB spectrum of the color of the soil substrate is a very important indicator for assessing the advancement of soil-forming processes in soils with *chromic* features. The joint application of SM and EDS enabled comprehensive development of issues concerning: i) transformations of gleic processes in soil substrates containing hematite; ii) Iron enrichment of relict terra fusca soils by decomposition of glauconite or iii) source of iron, manganese and organic carbon in flysch shale soils. The conducted SEM studies allowed to show differences in the origin of some soil components (e.g. carbonates, iron compounds or organic matter) depending on the source rock. Observations and analysis of some structures built of various mineral components allowed to demonstrate the degree of advancement of transformations that the rock material undergoes during the formation of the soil substrate. Many of the original features of the rocks have been preserved, and their presence proves the progress of pedogenic changes. The research confirmed the significant role of cryogenic interactions on the soil substrate in soils located in the periglacial zone of the last glaciation (central Poland). XRD studies played a special role in the identification of minerals, the presence of which is an important clue to the genesis of the soil.

The role of mofets in the formation of morphological and chemical properties of soils

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Keywords: Gleysols, volcanic exhalation, mountain soils, electric conductivity

The study aimed to investigate the morphological and chemical properties of soils near natural surface mineral water springs – named in the Polish language "mofeta". Mofeta is a type of volcanic exhalation, a cool discharge that mainly emits carbon dioxide. Along with the release of carbon dioxide, other compounds, including soluble carbonates, oxalates and sulphates, bicarbonates and others, also escape from the mofet. Their occurrence in the natural environment is mainly in some places of the Beskid Sądecki Mts. region and is related to the geological and tectonic configuration of this region. Soil samples were taken in the area of Muszyna and Krynica-Zdrój. The samples were tested for organic matter, total nitrogen, particle size distribution, pH, sorption properties and electrical conductivity. Soils are usually located in the source zone of streams or the immediate stream valley. The soil around the mofets was classified as a Gleysols. Due to their iron enrichment, these soils near mofets have a strong red colouration. The soils are mainly neutral or alkaline reactions (pH in KCl from 6.21 to 7.22), and generally loamy texture. In the surface horizons, the content of organic matter in different stages of decomposition was in the range of 1.57 – 7.62%. The humus horizons were also characterised by a high variation in base saturation, particularly in calcium and magnesium cations. The electrical conductivity (346.3 – 1873.3 μS) of these soils was highly variable. It is the main impact of the mineralization of the water supplied by the entire soil profile.

POSTER ABSTRACTS

Accumulation of selected heavy metals in soils and dandelion (Taraxacum officinale) near a heavily trafficked road in Bydgoszcz

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Keywords: heavy metals, urban soils, road transport

Densely built-up urban agglomerations with a dense street network, dense industry and a diversity of human activities affect the natural environment, including the soil. Urban soils, often present increased heavy-metal contents. This is the result of long-term accumulation in the soil, which is ensured by the continuous emission of pollutants, including traffic. The aim of the study was to estimate the impact of traffic pollution on the soil environment using a phytoindicator. The phytoindicator was a dandelion (Taraxacum officinale), characterized by a high rate of accumulation of certain chemical pollutants. The plant showed variability of metal accumulation in the above-ground parts and in the roots.

The subject of the study was soil derived from Szubińska Street. The samples were collected from mineral horizon directly at the edge of the roadway, from the median strip between the roadways. Dandelion (Taraxacum officinale) plants were collected from the same locations from which soil samples were taken. All collected plants were at the same stage of development (during flowering). Selected physicochemical properties were determined using commonly used procedures in soil science laboratories. The concentration of heavy metals (Zn, Cu, Ni, Pb, Cd, Cr) in soil and plant was determined by atomic absorption spectrometry, using Solaar S4 spectrometer. The results of the amount of heavy metals in soil and plant were statistically analyzed.

In the study area, the concentration of heavy metals in the soil does not exceed the standards adopted in the Regulation of the Minister of Environmental Protection (2016), therefore, the analyzed soil samples can be classified as uncontaminated. The total content of the analyzed metals in soil and plant material was as follows Zn > Cu > Pb > Ni > Cr > Cd. The above-ground parts of the plants contained more heavy metals than the roots.

Military erosion as a factor of soil cover formation on the example of a bombing ground from the Roztocze National Park area

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Keywords: military erosion, bombturbation

Soil erosion is a process of movement and transport of the upper layer of soil by different agents. We distinguish glacial erosion, water erosion, aeolian (wind) erosion and mass movements. Deformation of the soil surface can also be induced by various aspects of military activity. A specific form of military erosion is bombturbation, where soil is drastically transformed by bomb explosion; a crater is formed, which is a place of increased accumulation of organic material, around the crater there is an accumulation of material rejected for some distance as a result of the explosion.

In the Roztocze National Park there is an area of more than 100 hectares, where during World War II Soviet aircraft dropped excess bomb loads that were not dropped on the front line. In the post-war years, the area became spontaneously forested, and is now protected. There are more than 500 bomb craters in the area, which have not been transformed in any way by man, since their creation. The craters have a varied surface area, ranging from 6 to 137 m^2, with an average of 33 m^2. The maximum diameters range from 3 to 24 m (average 7 m), the circumference is from 9 to 55 m (average 21). The depths of the craters also vary strongly, with an average depth of about 1.5 m, with the maximum reaching nearly 3 m.

The pilot study included an investigation of two craters, formed on different substrates, limestone and sand. Chemically, elevated heavy metal content and high iron content were found in the soil both in the crater and in its immediate vicinity. Nevertheless, the contents were generally within the acceptable range.

Typologically, the soils developed in craters were classified as Turbisols, nevertheless, the profile structure indicates advanced soil-forming processes of a natural nature.

Effect of Soil Moisture and Temperature on VIS-NIR soil spectra

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Keywords: VIS-NIR spectroscopy, soil moisture, temperature

VIS-NIR spectroscopy is a rapid, low-cost, and easy-to-use method for analysing soil properties. It has the potential to be used in the field and through proximal sensing allows direct soil analyses and therefore substantially reduce the number of samples. This is the focus of the ProbeField – an EJP SOIL project. Unfortunately, field measurements are not without problems e.g. soil moisture, surface roughness and any non-controlled environmental parameters. Those uncontrolled parameters are tested within the ProbeField project as are several protocols to scan samples *in situ*. In this paper, we present some of the results obtained by studying the effect of soil moisture and temperature on mineral soils spectra (but under laboratory conditions). Those two parameters strongly affected the shapes and intensity of the spectra (especially soil moisture) and therefore the suitability of the method for predicting e.g. C, N content or soil texture. However, some clues/procedures to correct these problems are presented.

Project financed by the EJP SOIL project – ProbeField.

Analysis of Soil Processes and Sorption Properties of Arenosols and Podzols by Radionuclides Distribution in Profiles

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Keywords: distribution, ^{137}Cs, ^{210}Pb, ^{214}Pb, ^{40}K

To assess the radioecological situation in the area of the Belarusian NPP (BelNPP), moss and soil material from soil profiles in the forest ecosystem was collected in the Lithuanian part of the 30-km zone edge. Terrestrial mosses, forest soil horizons samples (organic and mineral) collected from the pine forest ecosystem in the summer of 2022 were studied by gamma spectrometric method. As shown by our previous publication on the analysis of samples collected in 2017, anthropogenic radionuclides (^{137}Cs, ^{239}Pu and ^{240}Pu) in the 30-km zone of the BelNPP were mainly due to global fallout after nuclear tests. At some sampling points, radionuclides from the Chernobyl accident were present in a small proportion. Samples taken in 2022, with a more detailed resolution compared to 2017, made possible more accurately assess the vertical distribution of not only the anthropogenic radionuclide (^{137}Cs), but also some natural radionuclides (^{40}K, ^{210}Pb and ^{214}Pb).
Features on vertical distribution of anthropogenic and natural radionuclides in soil is presented in this study. The distribution makes difference on soil type and can be related with soil development stage and forest ecosystem age. The results can be used for prediction of pollutants retention by forest ecosystem.

Modification of the Bremner method for nitrogen fractionation in organic soils

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Keywords: soil nitrogen, murshic process, peat degradation, Bremner method

The aim of the work was to assess the transformation of nitrogen compounds in drained organic soils, based on the modified Bremner method of analyzing organic nitrogen forms. Soil research was carried out in the low peatlands of Eastern Polesie, in the area of the upper course of the Wieprz-Krzna Canal. The object of the research were muck peat soils, made of rush peat and sedge peat. Basic physical and chemical properties of soils were determined. For the analysis of nitrogen forms, the Bremner method was used, consisting of one-stage hot acid hydrolysis (in 6 M HCl) and qualitative analysis of the separated nitrogen compounds. Compared to the classical method, mineral nitrogen and dissolved organic nitrogen (DON) were separated from soil samples before the acid hydrolysis stage. Performing two-stage sequential fractionation allowed to determine the following fractions of soil nitrogen:

1. N mineral and DON (1M KCl extraction);
2. N - hydrolysing (in 6M HCl), including: N - amino acid; N - ammonium; N - amino sugar; N - serines and threonines;
3. N - non-hydrolysing (calculated by difference).

The research confirmed the typical effect of the murshic process on the modification of soil properties: increase in soil compaction and ash content, decrease in porosity, decrease in carbon content and C/N ratio, increase in the degree of humification of organic matter. The research showed the usefulness of the modified Bremner method for studying the dynamics of nitrogen transformations in drained organic soils. Significant correlations were found for the properties of the tested soils and most of the defined forms of nitrogen. Compared to peat horizons, muck horizons were characterized by a significantly higher amount of mineral forms of nitrogen, DON, hydrolyzing nitrogen and significantly lower amounts of non-hydrolyzing nitrogen. In the pool of hydrolyzing nitrogen, muck horizons were characterized by a significantly higher share of N-ammonium and a lower share of N-aminosugar.

Electrochemical properties of humic acids

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Keywords: zeta potential, electrolytic conductivity, humic substances

The aim of study was to determine the changes in the electrochemical properties of humic acids (HA) and their two molecular weight fractions (HA>30kDA and HA<30kDa) at different pH conditions (5.59, 7.17 and 8.20) during their time of storage. Soil material used for the study were sampled from the surface layer (0–50 cm) of mountain fen soils. HA were isolated by IHSS procedure. The electrolytic conductivity (conductometric method) and electrokinetic (zeta) potential (Laser Doppler Electrophoresis method) of HA samples after 0, 24, 72, 192, 360, 504 and 672 hours from preparation, were determined simultaneously by means of the ZetaSizer Nano ZS apparatus. The Henry's equation and Smoluchowski approximation were used by the software for the zeta potential calculation.

The electrokinetic potential depended on HA fractions, pH values and the time of storage. The zeta potential was at the similar level for both separated fractions of HA. The most negative values of zeta potential were obtained for unfractionated samples. With the increasing pH, the zeta potential received more negative values. During the time of storage, the value of zeta potential was almost stable for about 72 hours. Next, it changed rapidly (increased and decreased at the time ranged from 72 to 360 hours) to increase linearly at the time from 360 to 672 hours.

The values of electrolytic conductivity did not depend on the HA fractions. However, they were modified by the pH conditions and the time of storage. During the time of storage, the electrolytic conductivity decreased to obtain the minimum value after 192 hours from samples preparation. Then, it increased linearly in time from 192 to 504 hours and next it stabilized.

The observed changes in the electrochemical properties of humic acids and their two molecular weight fractions were the result of many coexisting processes.

This work was supported by Polish National Science Centre, project NN 310 162338.

Qualitative and quantitative properties of organic matter in the selected urban soils of Wrocław, SW of Poland

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Keywords: humic substances, technosols, humic acids, fulvic acids, elemental composition

One of the main goal of caring for the quality of urban soils should be stabilisation, limiting C losses and facilitating the transformation of soil organic matter (SOM) into more stable substances. Large variations in organic carbon properties is mainly determined by the direction and intensity of the degree of anthropogenic influence, land use and possible organic fertilization. Moreover, organic matter in anthropogenic soils may contain both natural humic substances and organic components of an anthropogenic origin. Thus, SOM in urban soils is characterised by different intensities of susceptibility to transformation, decomposition and humification processes. Object of this study was to determine the quantity and quality of SOM originating in the top soil horizons of the central part of Wroclaw (SW of Poland). Total organic carbon (TOC), total nitrogen (TN), pH_{KCl} and soil texture were determined. A comprehensive SOM and humic substances (HS) analysis were performed: contents of fulvic (CFA) and humic acid (CHA) carbon, the CHA/CFA ratio and residual carbon (CR). Elemental composition and CP MAS ^{13}C NMR spectra for the humic acids (HA) were determined and α (aromaticity) and ω (oxidation) ratios were calculated. The pH_{KCl} of investigated horizons ranged from 6.48 to 6.52. TOC content varied from 22.39 to 66.1 g kg^{-1}, while TN ranged from 2.09 to 4.6 g kg^{-1}. In the most analysed urban soils the highest share in SOM was found for CR, while HA was the predominant group over FA. CP MAS ^{13}C NMR spectroscopy of HA molecules indicated the structure of the samples were dominated by compounds with low aromaticity cores and considerable contents of aliphatic components. Moreover, the analyses of the share of particular types of carbon bonds and α showed the key factor differentiating the studied HA molecules was the share of aliphatic structures.

Evaluation of the impact of long-term reclamation on the enzymatic properties of degraded soils in Jeziórko

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Keywords: soil degradation, soil reclamation, sewage sludge, mineral wool, soil enzymes

For many years, both in Poland and in the world, there has been a problem of degraded land and land. An example of strongly acidified and degraded soils is the area of the Sulfur Mine in Jeziórko. The environmental damage in these areas has outlined the need for soil reclamation and reconstruction on degraded land and devastated. Enzymes are characterized by high susceptibility to the influence of unfavorable environmental factors. The negative impact of anthropopressure on the enzymatic activity of soils is confirmed, among others, by the results of Baran et al. [2009], Bielińska, Żukowska [2002], Januszek [1999]. Therefore, the aim of this study was to assess the impact of long-term soil reclamation with waste (mineral wool, sewage sludge and flotation lime) on the enzymatic properties of soils degraded by the sulfur industry in Jeziórko. The research shows that Grodan mineral wool from horticultural crops under cover had beneficial properties. This waste was characterized by a particularly high content of assimilable phosphorus and potassium. Mineral wool had a high water retention capacity. Municipal sewage sludge was characterized by a reaction close to neutral. This precipitate also had other beneficial properties. The content of assimilable forms of phosphorus and potassium was assessed as high. Post-flotation lime was also characterized by favorable properties. The pH value measured in 1 mole of KCl was 6.8. This waste was characterized by a low content of assimilable phosphorus, while the content of assimilable potassium was high. Reclaimed land with the use of waste shaped the enzymatic activity of soils. The addition of mineral wool and sewage sludge to degraded soils increased the content of enzymes: dehydrogenase, phosphatase and urease.

Suitability of publicly available data from the Polish Soil Chemistry Monitoring Programme for the years 1995–2020 to assess temporal trends in the condition of soils of the Lublin Voivodship

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Keywords: soil classification, soil chemical properties, PCA, geostatistics, temporal variability

The study evaluated the suitability of publicly available data from the Polish Soil Chemistry Monitoring Programme (PSCMP) for the years 1995–2020 to assess temporal trends in the condition of soils of the Lublin Voivodship. Selected parameters (texture, total organic carbon, $CaCO_3$, pH, hydrolytic acidity, exchangeable acidity, exchangeable Al, total nitrogen, saturation degree with exchangeable bases) for all 20 measurement points in the Lublin Voivodeship were analysed using statistical and geostatistical methods. According to the typology used in PSCMP, the soils studied were: Podzols, Luvisols, Brunic Arenosols, Cambisols, Gleyic Phaeozems, Fluvisols, Fluvic Phaeozems, Calcaric Cambisols. The comprehensive analysis of the data allowed for several general conclusions. Firstly, the soil types given should be referred to with caution. Secondly, mapping spatial distributions of the studied parameters may be difficult due to the mosaic of land use and land cover forms occurring within the Lublin Voivodeship and the scarcity of the measurement points. A characteristic feature of the measured parameters is also their undirected temporal variability, so analogous parameters measured at different measurement points showed different temporal trends. For this reason, creating forecasts for the parameters at a local scale could be difficult. Principal component analysis carried out for each year identified characteristic patterns in the data and revealed that the relationships among parameters changed after 2015. It could be partly related to the different contractor responsible for the 2020 measurement cycle. Nevertheless, the data gathered in PSCMP are very valuable. They cover a rather long period of time (1995–2020) and allow to recognise general trends in soil's properties at the country scale. The data should be, however, thoroughly analysed by soil scientists from all over Poland. If PSCMP is to continue within the current survey network, it would be also advisable to redo soil classification basing on the field works.

Differences in the content of available potassium in technogenic soils formed on the internal heaps of the Górażdże Limestone Mine

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Keywords: technogenic soils, available potassium, reclamation of degraded lands, limestone mine

Mining carbonate raw materials are among the industries that cause one of the greatest changes in the soil cover. Open-pit mining contributes to the formation of soilless grounds, which are restored to use as part of technical and then biological reclamation. The paper presents the results of research on selected properties of technogenic soils formed in the area of the Górażdże Limestone Mine. Technogenic soils formed in the area of the internal heap of the mine are diversified, e.g. due to the granulometric composition: (1) formed from brown rendzina soils with a high content of limestone rubble, (2) sandy fractions from rusty soils. These soils were removed from the previously forested area intended for mining. The study aimed to determine the impact of both soil conditions and vegetation, i.e. trees planted as part of the biological reclamation of heaps, on the content of available potassium. Plots with Scots pine aged up to 5, 10 and 15 years were selected for the study. In the collected soil samples, analyses of basic physicochemical parameters were performed, and the content of available potassium was determined according to the Egner-Riehm method using a BWB-XP flame photometer by BWB Technologies UK LTD.

Significant differences in the available potassium content in the profile of technogenic soils formed from forest soils - brown rendzinas were found. In the upper layer of 0-20 cm, the potassium content was over ten times higher (10.8 $mg \cdot 100g^{-1}$) than in the layers at a depth of 70-90 cm (1.1 $mg \cdot 100g^{-1}$). In the case of technogenic soils formed from sandy formations, no such significant differences were found in the entire analyzed profile, and the values ranged from 1.2 to 1.8 $mg \cdot 100g^{-1}$. At the same time, the influence of growing trees on the pedogenic processes of the newly formed technogenic soils was observed.

Molecular characteristics of humin fraction from soils of temperate climate: a study on Chernozems and Phaeozems in Poland

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Keywords: SOM, humin molecular structure, humic substances, spectroscopic methods

The main aim of the research was to assess the molecular character of humin fraction (HM) obtained from various arable soils in the temperate climate zone of Poland. This fraction represents the most resistant pool of the SOM, which plays a key role in carbon sequestration in the soil environment.

The HM was isolated from the mollic horizons of Phaeozem and Chernozem soils derived from different parent materials, by exhaustive extraction of humic and fulvic acids with NaOH and then removing the mineral fraction with HF/HCl treatment. The assessment of the structural properties of the HM was carried out using the ^{13}C CP MAS NMR, FTIR, EPR, HPLC, SEM-EDX, and elemental composition analyses. The content of elements in the studied HM varied in the range of 42.02–58.86% for C, 3.88–4.77% for H and 2.52–3.68% for N, while the low H/C ratio indicated the dominance of aromatic structures. The ash content ranged from 22.89 to 54.50%, highlighting the inevitable and strong association of the constituents of the HM with mineral colloids. The ^{13}C CP MAS NMR and FTIR spectra of the HM showed the advantage of aromatic structures over the aliphatic ones, ranging from 7.05 to 10.32%. The EPR study indicated evidence of an unpaired electron situated on the condensed aromatic moieties. The HPLC investigation revealed the dominance of hydrophobic fractions, ranging from 77.41 to 80.83%. All of the research techniques applied suggest that the HM comprises of a condensed structure with a predominance of aromatic components of a stable, rigid core. The HM isolated by the adopted method is not a pure organic fraction but constitutes of strongly bound organo-mineral compounds, resistant to further treatment with an alkali and HF/HCl mixture.

The research was financed by the National Science Centre, Poland (project 2018/31/B/ST10/00677).

Effect of a wheat straw biochar deashing on the biosorbent properties and retention of different pesticides classes

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Keywords: biochar, pesticides, sorption, deashing

Biochar activation methods have recently attracted extensive attention due to their pronounced role in improving sorptive properties of carbon-based materials. As a result, engineered biochars gained application potential in the purification of soil and water. In the presented study, changes in the physiochemical properties of a high-temperature wheat-straw biochar (BC) upon its deashing in HF/HCl were investigated. On the pristine and chemically activated biochar (BCd) retention of five pesticides (carbaryl, carbofuran, 2,4-D, MCPA and metolachlor) was studied. Deashed biochar exhibited high stability and was more aromatic than its pristine counterpart. Investigated functional group distribution of biosorbent changed with deashing process, revealing a substantial decrease of silicates, input biomass components and increase in abundance of surface hydroxyl groups. BCd revealed weaker antioxidant properties than BC, more developed both meso- and microporosity and nearly three times higher surface area. Hydrophobic pesticides (metolachlor and carbamates) displayed comparably high (88-98%) adsorption on both BCs. Whereas, the most hydrophilic and ionic pesticides studied – phenoxyacetic acids, were weakly and reversibly retained on pristine biochar with sorption magnitude achieving 7.3 and 39 % of 2,4-D and MCPA dose introduced. Meanwhile, their retention on the BCd was nearly total, due to its increased surface area and chemical interactions of the agrochemicals with unclogged surface OH groups. It is postulated that the irreversible and strong retention of the pesticides on deashed biochar undergoes mainly via the pore-filling mechanism, with both the porous structure of the adsorbent and its surface chemistry playing a vital role. The engineered biochar has a potential to serve as a filtering material (superadsorbent), immobilizing organic compounds of diverse hydrophobicity.

This research was co-funded by Wroclaw University of Environmental and Life Sciences (“MISTRZ” funding number N090/0004/21).
* Materials 2023, 16(6), 2185; https://doi.org/10.3390/ma16062185

The impact of long-term application of manure and nitrogen fertilizers on selected properties of sandy soil

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Keywords: organic matter, fractional composition, soil enzymes

OM is an important indicator of soil fertility, and it plays an essential role in the efficiency of agriculture, the quality of the environment and global climate changes. The aim of this study was to determine the effect that the long-term application of manure and nitrogen on organic matter properties, including the activity of soil enzymes.

The soil was sampled from a long-time field experiment, in the Kujawsko-Pomorskie province, Poland. The experiment is carried on in the three-course crop rotation, potato, rye, rye in randomized split-plot design. The first factor of the experiment was the dose of manure (0, 30 t/ha), the second dose of nitrogen (0, 40, 60, 120 kg/ha). The experiment was established in 1979. The samples were taken after 40 years of experimentation. There was investigated the activity of soil enzymes: dehydrogenases (DEH), catalase (CAT), proteases (PRO), alkaline (AlP) and acid (AcP) phosphatases; the content available: phosphorus (AP), potassium (AK) and magnessium (AMg); the content total organic carbon (TOC), total nitrogen (Nt), dissolved organic matter (DOM) and its fractional composition (content and share of carbon and nitrogen of humic (CHAs, NHAs), fulvic (CFAs, NFAs) acids and humin fractions).

The content of TOC in manure-treated soil samples was 21% higher compared to the control. For soils fertilized only with nitrogen (without the addition of manure), this increase was only about 4%. The share of the DOC fraction ranged from 0.95 to 1.30% TOC and increased with the increase of the nitrogen dose. The values of the ratio of carbon content in humic acids to carbon content in fulvic acids (CHAs/CFAs) were significantly higher on manure-treated sites compared to soil non manure treated. Among the presented biochemical indicators: geometric mean of enzyme activities (GMea), total enzyme activity index (TEI), metabolic activity index (MAI), MAI is correlated with the quality parameters of organic matter.

The effect of multi-component conditioner with zeolite and potassium humate on soil properties

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Keywords: organic-mineral conditioner, soil, physico-chemical properties, enzymes

The application of various conditioners in agriculture is one of the management practices used to improve soil quality and plant growth and development. The aim of the study was to assess the effect of a multi-component conditioner (Solactiv) on the selected soil properties in one-year experiments carried out at three study sites, which were under a conventional tillage system. The study sites were located on farms in three geographic mezoregions in the Kuyavian-Pomeranian Region (Midwestern Poland). The studied soils were Haplic Luvisol that were composed of sandy loam. At each site the experimental area was divided into two equal parts (fields). One field was treated with Solactiv at a dose of 300 kg ha^{-1} in accordance with the manufacturer's recommendation, while the second field was a control. The following laboratory analysis were performed: basic physico-chemical properties (e. g. different forms of soil C and N, exchangeable and hydrolytic acidity, bulk density, exchangeable forms of P, K and Mg, cation exchange capacity – CEC), soil water properties and microbial and enzymatic variables (microbial biomass C and N, activity of cellulase and dehydrogenases, the fluorescein sodium salt hydrolysis). A one-way analysis of variance (ANOVA) was used to determine the effect of Solactiv on the soil properties. As compared to the control soils, the application of conditioner significantly increased the enzymatic activity and the microbial biomass C and N as well as available water capacity, while decreased soil bulk density and soil acidity. The application of Solactiv enhanced CEC, exchangeable P, K and Mg but differences were not statistically significant. The lack of significant effect of conditioner was found in the case of the total and dissolved C and N forms. The application of Solactiv is considered to be a promising approach for developing sustainable agriculture by improving the soil's biological activity and water-related properties.

The research was financially supported by The Polish Agency for Enterprise Development, grant number ID POIR.02.03.02-06-0002/17 as well as by NaturalCrop Poland Ltd.

Accumulation of organic carbon in the surface horizon of post-arable soils in Central Poland

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Keywords: soil organic carbon, carbon sequestration, Brunic Arenosols, coniferous forests, forest stand age

Forest soils are a very important element of the habitat, and therefore should also be monitored for the possibility of carbon dioxide sequestration. In Australia, China and many European countries, currently running programs to increase forest area, both to meet the provisions of the Kyoto Protocol, as well as those resulting from the regional management of soil resources. Afforestation leads to changes in the physicochemical, chemical and microbiological properties of soils. However the published reports about changes in the abundance of soil organic carbon after the afforestation process are not clear. The change in soil organic carbon content depends among others to climate conditions and previous land use. In this study the attempts were made to determine the changes in the organic carbon content in soils in post-agricultural forest soils in coniferous forests with the age of stand. The research area was located in the Skrzynka Wielka test site, where 6 research plots with similar soil type, geological structure and trees covered (*Pinus silvestris*) were selected. The introduction of the coniferous trees caused, first of all, the gradual disappearance of the plow layer, the development of the organic horizon on the soil surface and a decrease in the pH value in the upper soil horizons. The change in the soil reaction was the more pronounced the older the stand was. In this research, it was hypothesized that the different age of the stand would have an impact on the accumulation of organic carbon in the soil. It was assumed that the oldest forest stands would more favorable conditions for the accumulation of organic carbon in the soil profile, especially in the surface horizons, due to the increased inflow of organic matter compared to younger stands.

The effects of ageing process on the release of arsenic from soil into water and its related ecotoxicity

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Keywords: arsenic, solubility, pH, seed germination, Phytotox

Adverse environmental effects caused by the presence of toxic elements in soils depend not only on their total concentrations, but also on the forms in which they occur. Water-extractable species of toxic elements, that can be easily released into pore water and underground water, are of particular importance. The contaminants, that have been delivered to soil in the forms of aqueous solutions, will undergo various transformations, such as the processes of specific and non-specific sorption, binding by soil components and occludation in hydroxides, which altogether are referred to as "ageing". Consequently, the solubility and ecotoxicity of contaminants, will decrease. In this study, we examined the dynamics of such changes under controlled conditions in an incubation experiment. Four soils, differing in texture and organic carbon content, were brought to three pH ranges and spiked with water solution of sodium arsenate to obtain various soil As concentrations, up to 1000 $mg \cdot kg^{-1}$. The soils were incubated at constant moisture (80% of water holding capacity) for three months. The changes in water extractability of As over time were examined. Arsenic ecotoxicity in soils was assessed based on two indices: 1) the reduction of seed germination, examined with two different plant species, and 2) the results of Phytotox bioassay. The process of As immobilization turned out to proceed quickly, and water-extractability of As in all soils dropped significantly within the first week of incubation. The dynamics of those changes depended on soil properties and pH. Arsenic immobilization was particularly efficient under acidic conditions. The results of both bioassays were strongly correlated with the concentrations of water soluble As. The results of this study provide a good reference base for further experiments with As-spiked soils.

Influence of microplastic on enzymatic activity of arable soils

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Keywords: dehydrogenases, urease, microplastics, agricultural soils

Microplastics (MPs) are commonly defined as plastic particles of various shapes and sizes from 100 nm to 5 mm. The sources of MPs in agricultural soils are mainly plastic mulch, biowaste, composts, digestates, sewage sludge and wet and dry atmospheric deposition. Once in the soil, MPs can be incorporated into soil aggregates, thus affecting the soil ecosystem. Soil enzyme activity is a potential sensitive indicator of soil quality and an important indicator for evaluating soil fertility. It is also an important indicator for early warnings of changes in soil ecosystems. The influence of MPs on the activity of soil enzymes is widely analyzed. However, the research results are not clear.

The objectives of this study were to investigate the effects of three MPs (high density polyethylene (HDPE) from plastic bags, polypropylene fibers (PP) from disposable masks and polyethylene terephthalate (PET) from water bottles) on enzyme activities of sandy and loamy soils. The soil for the tests was collected after 28, 56 and 84 days of incubation. The activity of dehydrogenases (ADh) and urease (AU) was determined in the soil material.

The influence of microplastics on enzymatic activity varied depending on the type of enzyme, grain size, type of MPs and incubation time. The addition of MPS significantly stimulated the ADh of sandy soil. On the other hand, in loamy soil, the ADh reaction depended on type of MPs. The addition of microplastic stimulated urease activity independent of soil texture. The inhibition of ADh and AU in sandy soils was observed with the incubation time. In loamy soil, no such relationship was observed.

Changes in the content of phosphorus, magnesium and potassium in the soil under the influence of struvite fertilization in soybean cultivation determined by 3 analytical methods

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Keywords: extraction methods, macroelements, soil chemistry, soybean

The purpose of this study was to compare soil element extraction by three different methods under conditions of struvite fertilization and its use in soybean cultivation. The use of Egner-Rhiem, Mehlih 3 and Yanai methods showed an unequivocal increase in soil Mg content after struvite application. The results of the study presented that different extraction methods showed different P content from the soil. The content of available phosphorus was about 122-156 mg kg^{-1} dm, 35.4-67.5 mg kg^{-1} dm and 100-159 mg kg^{-1} dm according to Mehlich, Yanai and Egner-Riehm methods, respectively. A positive correlation was found between soil Mg and K contents determined by Mehlich and Yanai methods, which may suggest that the Yanai method can be introduced into standard soil chemical analysis in Poland. No such correlation was found for phosphorus, which is a difficult element to determine due to the large number of factors affecting its availability. If the Yanai method were to be introduced into analysis at chemical-agricultural stations in Poland, it would be necessary to develop limit values based on long-term field experiments.

Effect of struvite (Crystal Green) fertilization on soil P, Mg and K content in soybean cultivation

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Keywords: macroelements, soil chemistry, soybean, struvite fertilization

The prospect of depleting phosphate indicates that phosphorus recovery will be necessary in the coming years. Agriculture accounts for nearly 90% of global phosphorus consumption, but its current consumption is unsustainable and incompatible with the natural cycle. The preliminary research conducted fits into the strategy of developing a circular economy based on a closed cycle of phosphorus extraction from sewage sludge as fertilizer and its reuse in agriculture. Struvite is considered a promising phosphorus fertilizer as an alternative to traditional phosphorus fertilizers. A pot experiment with struvite was conducted in May 2022 at the Wroclaw University of Environmental and Life Sciences (Pawłowice). The two-factor experiment was conducted in six replicates. The first factor was the differential placement of phosphate fertilizers (band and broadcast). The second factor was the various of phosphorus fertilizers relative to the control. Two phosphorus fertilizers were used in the experiment: traditional triple superphosphate (SUP), commonly used in soybean cultivation, and Crystal Green (CG). The particle size distribution of the mineral parts corresponded to sandy loam. The purpose of the study was to determine the effect of struvite fertilization on P, Mg and K soil abundance. Soil chemical analysis included total and bioavailable forms of potassium, magnesium and phosphorus determined by microwave mineralization and Egner-Riehm methods. Both the placement method and phosphorus fertilizer significantly affected the macroelements content. Phosphorus fertilizer caused differences in the content of all macroelements. Potassium content increased by 2% under struvite fertilization compared to the control and by 14% compared to triple superphosphate. Magnesium content also increased after struvite fertilization: by 17% compared to the control. Phosphorus content decreased after struvite fertilization, but this may have been due to the slightly acidic soil pH. Polish soils are characterized by a very acidic or acidic pH, which affects phosphorus availability.

The secondary transformation effect on dissolved organic carbon content in drained fen peatland soils

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Keywords: agriculture use, drainage, grasslands, mursh, soil organic matter

Peatland soils are the most carbon-rich soils in the world, storing ca. 600-1000 Gt of carbon. However, human activity and observed climate change have transformed these ecosystems from long-term carbon sinks into carbon sources, thus altering global carbon cycling. In temperate climates, drainage for agricultural use (mainly grasslands and arable lands) is the most common cause of peatland degradation. The grassland fens in the Grójec Valley (Central Poland) are dominated by organic soils, with well-developed mursh material in the surface layers as a consequence of long-term agricultural use. Here, we assessed the dependency between the state of secondary soil transformation (based on index W_1) on dissolved organic carbon (DOC) content in the uppermost (0-30 cm) soil layers. The study was conducted during the growing season (1 March to 31 October) in 2017–2019. The soil samples (in total 1296 samples) were collected from three small soil pits (at each of the 6 study site) separately from 0-10, 10-20 and 20-30 cm layers. We determined the DOC and total organic carbon (TOC) by using an elemental analyser, while the secondary transformation of soils was determined by the water holding capacity index W_1. The DOC content ranged from 1.00 to 4.99 g kg^{-1}, while the overall values of index W_1 were 0,420-0,897. Based on the obtained results it can be stated that the tested dependency between study parameters was very weak. Expected significant negative correlation between DOC and W_1 index was found only in the uppermost soil layers (0-10 cm) in the year 2018 (the driest and the hottest year among study period). Thus, we conclude that increase DOC production in strongly transformed mursh horizons, occurs only in extremely unfavourable soil-weather conditions.

Effect of carboniferous rock and post-fermentation sludge addition on soil physical condition

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Keywords: Podzol, carboniferous rock, post-fermentation sludge, soil physical condition, durability of soil properties changes

The study shows the results of a soil analyses in the fourth year after the application of two kinds of environmentally burdensome wastes. One of the wastes was mineral – carboniferous rock from a coal mine, and the other one was organic – post-fermentation sludge from an agricultural biogas plant. The experiment was an example of an action in which the natural utilisation of wastes was associated with their potentially amending effect on the soil. The wastes were applied once to a soil of poor quality - a Podzol with the particle size distribution of loamy sand. The hypothesis to be verified was that one-time application of waste carboniferous rock and/or post-fermentation sludge to a soil has a beneficial effect on the physical status of the soil, and the effect of the changes of the soil properties has a permanent character. For that purpose determinations of the following soil properties were performed: soil texture (PSD), total organic carbon content (TOC), particle density (PD), bulk density (BD), total porosity (TP), air capacity (FAC), air permeability (FAP), water content at sampling (SM), field water capacity (FC), available water content (AWC), unavailable water content (UWC), saturated hydraulic conductivity (Ks) and water-stable aggregates content. The ratio FC/TP and mean weight diameters of water stable aggregates (MWD) were calculated. Some soil properties have been improved by the use of post-fermentation sludge and the combined application of the two wastes. These were the following soil properties: PSD, TOC, BD, TP, SM, soil water-stable aggregates content and MWD. However, changes to the soil air-water properties (FAC, FAP, FC, AWC, UWC, Ks and FC/TP) were unfavourable. The effect of the application of the wastes to soil was permanent, as differences resulting from the soil treatments were still visible in the fourth year after the start of the experiment.

Contamination of garden soils in selected allotment gardens in Wrocław

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Keywords: urban soil, gardens, trace elements

Small, family gardens, in Poland, usually called allotment gardens, are a popular recreation place for town residents. Their additional function is cultivating vegetables and fruit. In the situation of growing vegetables on garden-polluted soils, there may be a problem of the uptake of potentially toxic elements from garden soils by vegetables which poses a risk to the health of consumers. Contamination of garden soils is also dangerous for soil organisms living in such soils, which reduces their abundance and biodiversity. The toxicity of trace elements depends on the forms of their occurrence in soils and soil properties, as well as factors affecting the solubility of trace elements and their concentration in soil solutions. The aim of this study was to examined concentrations of selected trace elements: Cu, Pb, Cd and Zn in garden soils located in 9 complexes of allotment gardens in Wrocław. Soil samples were collected for analysis from the depth of 0-30 cm from 108 different places in different parts of Wrocław. The results showed that the occurrence of heavily polluted garden soils with elements such as cadmium, lead, copper and zinc, exceeded permissible values according to Polish legal regulations, was found in the area of Hutmen - a non-ferrous metalwork plant, producing in the past considerable amounts of metal-bearing dust. In this area, the following total concentretion of trace element were found in the soils : Zn: 701 - 3465 [mg/kg], Cu: 156-322 [mg/kg], Cd: 4-6 [mg/kg].

This work was supported by the Wrocław University of Environmental and Life Sciences (Poland) as the Ph.D. reserch program „Bon doktoranta SD UPWr” no. N020/0004/22.

LUCAS soil databases as a tool for estimating changes in organic carbon content in European mountain forest soils

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Keywords: Soil organic carbon, LULC change, mountains, forests

Forest are huge reservoirs of organic carbon which is stored both in above and belowground biomass. Furthermore, dead organic matter from these two sources is sequestered in soils. Soil organic carbon (SOC) is particularly important in climate change mitigation by stabilizing organic compounds and its long-term retention in the soil environment.

A large part of European forests are located in mountainous areas, where the harsh climatic conditions hamper fast decomposition of dead organic matter. Furthermore, due to land abandonment area of forest in European mountains is rapidly increasing. Land use/land cover (LULC) change and tree species conversion are the main determinants of changes in SOC content. Thus, the aim of this study was to estimate the SOC content change due to the impact of LULC change in European mountain forests.

LUCAS (Land Use and Coverage Area Frame Survey) databases from 2009, 2015 and 2018 provides data on land cover and SOC content in European mountains (areas above 500 m above sea level). The greatest increase in the SOC content was noted in locations where conversion from meadow to deciduous forest occurred (on average 3.46 g C kg^{-1} $year^{-1}$). Under continuous (between 2009 and 2018) mix forests the content of SOC content decreased on average -0.87 g C kg^{-1} $year^{-1}$, while and under coniferous forests decreased on average -0.21 g C kg^{-1} $year^{-1}$. On the other hand, at sites located under deciduous forests SOC content increased on average 1.08 g C kg^{-1} y^{-1}. The obtained results suggest that forest succession and conversion to deciduous forests can have a great impact on SOC sequestration in European mountains.

This project received funding from the EU's Horizon 2020 Research and Innovation Program under Grant Agreement No. 952327 (HES-GEO).

Changes in the structure of alluvial soil in situ contaminated with petroleum hydrocarbons

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Keywords: alluvial soil, hydrocarbon contamination, mercury porosimetry, pore-size distribution, soil texture

Defined as a spatial system of solid phase elements and pores, soil structure determines its physico-chemical properties and biological functions. This study presents modification of soil structure induced by human activity.

Samples of clayey alluvial sediments were collected from the area that had been exposed to a long-term contamination with petroleum fuels. Total hydrocarbon content in the soil ranged from 272.8 to 930.9 mg/kg d.w.

Mercury intrusion porosimetry (analysed pore size 0.003 to 360 μm) and particle-size distribution analyses were performed in terms of comparison between contaminated and clean soil.

Thermal analysis showed a similar composition of the tested soils, as follows: beidellite>> kaolinite, quartz, organic matter (2-3%). Both clean and contaminated soil represent silty clay, but in the contaminated soil diameter d_{50} shifted from 0.002 to 0.0036 μm and the clay content decreased from 50 to 44%.

Mercury porosimetry revealed that in the contaminated soil total porosity decreased from 52.0 to 40.6% and the bimodal pore-size distribution (maxima at 2 and 0.2 μm) changed to a unimodal distribution (maximum at 0.5 μm). The major structural changes were found in the interparticle pore space, with the highest reduction of ultramicropores ($0.1<d<5$ μm) – from 0.34 to 0.21 cm^3/g (classification by Brewer, 1964) and storage pores ($0.5<d<50$ μm) – from 0.20 to 0.10 cm^3/g (classification by Greenland, 1977) in the clean and contaminated sample, respectively.

The reduction and redistribution of the pore space in contaminated soil might be attributed to the effect of clogging the pores with hydrocarbons as well as flocculation of clay particles and rearrangement of soil structure induced by changes in interparticle forces.

These studies provide valuable insight in transformation of soil structure and its high sensitivity to long-term hydrocarbon contamination in natural conditions.

Processes of transforming organic soils in Poland

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Keywords: soil-agricultural map, shortage of surface waters, organic soils, mursh processes, drought

The process of transformation and degradation of organic soils depends primarily on the intensity of their drying. The main reason for drying is the lowering of the groundwater level as a result of melioration, periodically low precipitation and an increase in air temperature, which significantly accelerates the rate of evapotranspiration. Spatial analysis of the information contained in the soil - agricultural map at a scale of 1:25 000 showed that organic soils and soils of organic origin, which include peat soils (T), peat-muck soils (Etm) and muck-peat soils (Emt) and mursh soils and mursh-mineral soils (M) in the 1970s in Poland accounted for 13.3% of agricultural land. A significant part (46.0%) of all soils of organic origin is occupied by mursh and mursh-mineral soils (M), which are a sign of mursh processes. The most intensive of mursh processes on a national scale are recorded in the area of natural shortage of surface waters (Kleczkowski, 2001), which extends in the belt of the Polish Lowlands from Wielkopolska through Kujawy, Mazowsze to Zachodniopomorskie regions, where almost one-third (29.5%) of increased share of mursh soils. The current pilot studies of reference profiles presented on the soil-agricultural map at a scale of 1:25 000, carried out at IUNG-PIB in Puławy, showed in most cases a decrease in the content of organic matter in soils of organic soils. In all pilot areas, shallowing of organic layers, local variations in the groundwater level and the intensity of their drainage were found. In some of the analyzed objects, changes in the quality of the soil cover were also found, which lead to irreversible changes and degradation of this type of soil habitats. In the zone of natural shortage of surface waters and the highest occurrence of mursh soils, the highest frequency of agricultural droughts has been recorded in recent years.

Humic substances of horticultural media derived from willow (*Salix viminalis* L.) biomass compost

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Keywords: humic acids, humus fractions, compost maturity, horticulture media

Exploitation of peat from very sensitive ecosystems, which regenerate very slowly, contributes to the degradation of natural habitats and adversely affects biodiversity and the functionality of peatlands. In accordance with the principles of sustainable horticulture, it is advisable to replace these substrates with other organic materials obtained locally. One proposal may be the production of compost based on readily available plant materials, e.g., *Salix viminalis* L.
The research evaluated the usefulness of horticultural substrates prepared on the basis of compost from chipped willow without additives and with the addition of nitrogen and mycelium decomposing the cellulose-lignin fraction of wood. The produced composts were mixed with different components (peat, vermicompost) and additives (basaltmeal, biochar from deciduous wood). A total of 29 different substrates were subsequently tested in the study. The contents of pH, total organic carbon, and total nitrogen were determined. Quantitative determinations of humic (HA) and fulvic acids were performed after extraction of the substrates with 0.1 M HCl and 0.1 M NaOH, according to the method described by Swift (1996). Humic acids were extracted, purified, and freeze-dried. Elemental analysis of HA molecules was performed for *C, H, N*. *O* was calculated with the mass balance. UV-VIS absorbances were recorded at 465 and 665 nm. Among all analysed substrates, the highest content of HA was found for the compost-peat mixture. This type of substrate was characterized by the lowest content of humin, which suggests that compost provides access to the best humified organic matter. On the basis of the HA atomic ratio and E4/E6 ratio, it has been found that substrates based on willow compost contained HA with a lower degree of aliphaticity compared to other substrates. The addition of biochar to the substrates resulted in a higher content of the humin fraction and a higher degree of HA's aliphaticity.

Evaluation of filtration properties of anthropogenic soils after revitalization in the Saski Park and the Ludowy Park in Lublin

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Keywords: filtration properties, anthropogenic soils, urban park

The condition of the proper functioning of the ecosystem of urban parks is the good condition of the soil environment and a stabilized system of water and air conditions. It has often turned out that disturbances in this system cause a deterioration of the condition of the vegetation, especially the tree stand. The two city parks in Lublin were selected to study the filtration properties of soils: the Ogród Saski and the Park Ludowy. The geological base of the Ogród Saski consists of marls, the top layer consists of loess formations. The soil cover of the Park Ludowy was created as a result of mixing natural peat and silt material with materials introduced by man.

In each of the characterized objects, five research points were selected. Samples were taken from each point in five repetitions to standard cylinders with a volume of 100 cm3 to determine the filtration properties. The filtration coefficient in meters per day was determined using the Wit apparatus, using the constant water level method. Taking into account the obtained values, the soil material was included in the appropriate classes of water permeability. An apparatus for testing the permeability of molding sands of the LPiR-1 type was used to measure air permeability. The results are given in $m^2 \cdot Pa^{-1} \cdot s^{-1}$.

In most points in the soil from the studied objects, the highest values of air permeability were found in the surface layers, with the increase in depth there was a clear decrease in the value of the analyzed feature. This is undoubtedly due to the meliorative effect of the grass root system. The examined soils indicated significant human interference in the soil environment. This was particularly visible in the Park Ludowy, where the natural genetic levels were blurred as a result of mineral fertilization and drainage fertilization with organic material.

Disappearance of shallow histosols within the agricultural areas of the Lower Silesian voivodeship

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Keywords: histosols, mineralization, soils disappearance

The aim of the pilot project entitled "Analysis of the impact of changes in land use and climate change on the process of mineralization of histosols in the area of Lower Silesia for the Polkowice county" was an inventory of shallow histosols on arable land under current law protection. Due to the nature of the pilot studies, the number of research areas was limited to 500 locations. In order to ensure optimal representativeness when selecting the research plots, the areas where the mineralization of histosols could occur the fastest were taken into account, e.g. areas with shallow organic horizons according to soil-agricultural maps (up to 50 cm thick), located within arable land, drained. Fieldwork was carried out in 2021 and included uncovering the topsoil horizon on each plot, preparing a description of the soil, preparing photographic documentation and collecting a soil sample from the accumulation horizon using a slotted probe. In the laboratory, the Tiurin method was used to determine the content of organic matter in the collected soil samples. As a result of the research, it was found that only 2.5% of the examined area is characterized by the presence of organic soils according to the criteria specified for these soils in SGP6. In addition, it is highly probable that this process also affected deeper organic soils, and the direction and rate of mineralization in these soils requires additional research. The consequence of the mineralization of organic soils is their transition to the group of mineral or mineral-organic soils, which translates into their exclusion from legal protection. There is also a need to update the content of soil maps.

Research commissioned and financed by the Lower Silesian Office of Geodesy and Agricultural Areas in Wroclaw.

The content of macro and microelements in organic soils of the Middle Noteć River Valley

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Keywords: agricultural use, drainage, fen peatlands, macroelements, microelements

The study was conducted on agriculturally used fen peatlands in the Middle Noteć River Valley, located ca. 15 km from the Chodzież town, in Poland. The aim of the study was to determine the content of macro- and microelements in organic soils used for agriculture ca. 40 years after the application of the last drainage works. Field works were carried out in the period 2016-2019 within two study areas (deep and shallow drainage ditches). Two research transects were designated in each of the study areas. In total, 24 soil profiles were done and described, and 133 soil samples were collected from each of the distinguished genetic soil horizons. Study soils represents the following soil types according to Polish Soil Classification (6th edition): peat soils, murshic soils, gyttja soils and earth-covered peat soils. The soil types diversity in the study area was the effect of the ongoing process of soil transformation (mursh-forming process) and the variability of parent materials. The total content of macro- and microelements in organic soils depends primarily on type of soil organic matter, as well as the degree of its transformation. In the case of drained organic soils, the organic matter undergoes a mineralization process, as a result of which nutrients are released. Based on obtained results it ws found that calcium (Ca) was the dominant macroelement, followed by iron (Fe) and then magnesium (Mg), phosphorus (P), sodium (Na) and potassium (K). On the other hand manganese (Mn) was the dominant microelement, followed by zinc (Zn), lead (Pb), chromium (Cr), copper (Cu), nickel (Ni) and cadmium (Cd). The observed higher content of microelements (especially Pb and Zn) in the upper soil horizons may indicate their anthropogenic origin.

Is a sustainable SOC increase in arable soils possible? Ameliorative Fractional Deep Tillage (aFDT) as one option

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Keywords: C sequestration, arable soils, ameliorative Fractional Deep Tillage

The need to mitigate climate change also calls for innovation in agriculture. There is no doubt that arable soils are and can be huge reservoirs of carbon. Currently, the focus of scientific interest is on how to store additional carbon in the soil, and, thereby, remove CO_2 from the atmosphere.

Ameliorative fractional deep tillage (aFDT), an almost forgotten land reclamation technique from the earlier 1960s, is now once again the focus of scientific interest. It used to be aimed at increasing yields by increasing the depth of the topsoil ("Krumenvertiefung") and breaking up soil compaction zones and thereby increasing rooting space.

Ameliorative fractional deep tillage (aFDT) is the shaftwise translocation of topsoil material into the subsoil and subsoil material into the topsoil by special plough shares. After appling the plough the soil organic carbon content increases based on two principles: firstly, the degree of C saturation and microbial activity decrease with increasing soil depth; secondly: soils which are undersaturated with C strives to reach a soil-specific degree of saturation.

How large is the long-term effect of C sequestration depending on soils (horizons) and climate? To what extent does the CO_2 sequestration effect depend on soil properties (C saturation deficit, clays, iron oxides, etc.)? Can the aFDT method be applied to polish soils? Answers to these questions may be provided by re-examination of soils where the method of deep ploughing was applied in the 1960s.

Accumulation of potentially toxic metal(loid)s in soils of the Odra river floodplain

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Keywords: alluvial soils, inter-embankment zone, farmlands, heavy metals, risk assessment

Floodplain soils are often contaminated with potentially toxic elements of geogenic and anthropogenic origin. This also applies to a valley of the Odra river, which in its upper reach flows through areas of historical and contemporary mining and heavy industry. This study examined the distribution of typically anthropogenic metal(loid)s, i.e., Pb, Zn, Cu, As and Cd, and geogenic metals, i.e., Mn and Fe, in soil profiles of the middle Odra valley, and analyzed factors that determine their concentrations. Thirteen soil profiles, located inter the embankment area and outside the embankments, were examined. Most of profiles indicated stratification typical for alluvial soils. The surface horizons of inter-embankment soils are built of silty–loam layers of various depths, considerably enriched in metals of anthropogenic origin, in particular Pb, Zn and Cd, and to a lesser extent also in Cu and the metalloid As. Low soil pH is an important factor of environmental risk. Those soils that proved to have acidic reactions will require liming to reduce the risk associated with their potential use for agricultural purposes. The soils located out of embankments did not show any considerable enrichment in the elements examined. The concentrations of all the elements in deeper soil layers (>60 cm) in both zones showed a strong, statistically proven, linear dependence on the parameters related to soils' sorption properties, i.e., cation exchange capacity, clay content and the sum of clay + silt, with the latter relationship being statistically most significant. Based on this, the typical concentrations of elements related to soil texture were assessed, which can be used as the values of geochemical background for soils of the Odra valley. Outliers, particularly in the case of As, were explained by possible redistribution under reducing conditions.

Selected properties of drained floodplain soils in Odra valley

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Keywords: alluvial sediments, floodplain terrace, river regulation, groundwater level

The elimination of flooding and lowering of the groundwater table after large-scale river regulation allow deep penetration of soils by plant roots, soil fauna, and microorganisms, thus creating favorable conditions for advanced pedogenesis. The aim of the research carried out in the middle Odra valley, SW Poland, was to demonstrate the directions and intensity of the transformation of morphological features and selected properties of alluvial soils and to assess their changes in the conditions of river regulation. Soil pits were located in 6 transects on the Holocene river terrace of the Odra River (former floodplain). The soils were used as forests, grasslands and arable lands. An analysis of 25 soil profiles confirmed a noticeable pedogenic transformation of the soil morphology and their properties. Gleyic properties, identified in the bottom section of a few profiles only, were in most of the other profiles replaced with stagnic properties testifying to a substantial alteration of the moisture regime, related to the transition from dominant ground-water supply to precipitation-water supply. In the agricultural soils the effects of terrain microrelief former meandering of the river are clearly visible, which is manifested by the heavier texture of the soils situated presently close to the river and lighter texture of soils located further away. The transformation of alluvial soils used as permanent grassland into arable soils causes not only a decrease in the soil organic carbon content in the soil, but also a decrease in the unit sorption capacity of humus compounds. The development of a diagnostic mollic, and in particular of cambic horizons, correlated with the shift from Fluvisols to Phaeozems, and in the majority, to Cambisols. The transformation of forest alluvial soils connected with the absence of flooding, elucidate the inevitable change of forest management in the river valley, including a quantitative alteration in the forest species composition that may lead to a disappearance of the native riparian forests.

Does the release of pollutants from intensive poultry rearing pose a threat to the soil environment?

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Keywords: intensive agricultural production, soil contamination, soil health, biological indicators, ecotoxicity

Continuous pressure from industrial activities, urbanization development and the intensification of agricultural production has a significant impact on the soil conditions, both on their functions and on the range of ecosystem services provided. The last few years have seen a significant increase in the number of livestock farms (including poultry farms), which can result in the release of divers pollutants that pose a threat to human health and the environment. The impact on soils is mostly related to improper management or storage of organic waste (manure or litter) which may contain pesticide residues, hormones, antibiotics, antibiotic resistance genes, trace elements and pathogens. In view of the scarcity of literature data, a study was undertaken to assess the impact of intensive poultry farming on soil health (biological activity and functional diversity) and on soil ecotoxicity.

The study was carried out on an arable field where a manure heap was located. Soil samples, collected in autumn at different distances from the manure pile, were analysed in detail for Corg, pH, mineral N, available P and K, trace elements and selected anions. Biological indicators included: enzymatic activity, respiration and microbial biomass, nitrification potential and soil metabolic profile. Soil ecotoxicity was assessed using a battery of bioassays. The trace elements content was low and did not exceed the limits from the Polish Regulation, but Cu, As and Zn (used as nutritional additives to increase the efficiency of poultry feeding) predominated. A significant decrease in biological activity (up to 52%) was observed at the closest distance to the manure pile. Soil ecotoxicity was also highest at this location and the response of organisms was as follows: Heterocypris incongruens>Thamnocephalus platyurus>Aliivibrio fischeri>Sinapis alba, confirming that intensive poultry rearing can be a risk to the soil environment.

This study was supported by the National Science Centre, Poland, under research project No. 2019/35/B/NZ7/04394.

Assessment of soil organic matter quality and composition of clay minerals in arable Vertisols

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Keywords: humus substances, clay minerals, Vertisols

Soil organic matter (SOM) affects the chemical and physical properties of soils. Arable soils are the major reservoir of carbon in terrestrial ecosystems, and Vertisols are an important local reservoir of SOM. The purpose of the study was to evaluate the properties of SOM and the composition of clay minerals in the topsoil of Gleyic Vertisol (Gniew, north Poland). Vertisols are specific soils with high shrink-swell properties, wedge-shaped aggregates, and deep, wide cracks. The texture, bulk density (BD), pH, and cation exchange capacity of soil samples were determined. The content of total organic carbon (TOC) and carbon in humins, humic acids (C_{HAs}), fulvic acids (C_{FAs}), and dissolved organic carbon (DOC) were also assayed. The absorbance of humic acids was measured at 465 nm and 665 nm and used to calculate the value of the ratio $E_{4/6}$. The X-ray diffraction method was applied to assess the mineralogical composition of the clay fraction. The texture was represented by clay, silty clay, and clay loam. The values of BD ranged from 1.59 to 1.90 Mg m^{-3}. Smectite has been considered a major component of the clay fraction, with illite, kaolinite, and hydroxy interlayered minerals of secondary importance. The content of TOC ranged from 18.2 to 22.2 g kg^{-1} in the Ap horizon and from 9.43 to 15.3 g kg^{-1} in the A2 horizon. The value of the humic-to-fulvic acid ratio (C_{HAs}/C_{FAs}) was significantly higher in the A2 horizon in comparison to the Ap horizon. In the plough horizon, the values of the $E_{4/6}$ ratio were significantly higher, indicating more favorable conditions for SOM mineralization. The spectrometric characteristics of HAs separated from the A2 horizon suggest a higher degree of maturity and a larger molecular weight than those from the Ap horizon.

Phosphorous content of mountains soils subjected to long-term tourist pressure and extensive grazing

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Keywords: mountain soils, tourism influence, phosphorous

The research was carried out in the Karkonosze Mts in the vicinity of the „Na Hali Szrenickiej", „Pod Łabskim Szczytem", „Dom Śląski", „Strzecha Akademicka" and „Kamieńczyk" mountain hostels. Since the 16th century animals have been grazed here, from the 17th to the 19th century, in some objects more intensively. From the 18th century tourist exploration has been developed. From the second half of the 19th century until today touristic exploration began to develop intensively. Now these areas are subjected to very intense tourist pressure. The aim of the work was to analyze the content of phosphorus in soils to determine the intensity of anthropogenic pressure. Phosphorus was determined using the calcium lactate extraction (available phosphorus, Eghner-Rhiem method) due to the existing database of analyses of the study area and in 1% citric acid that is commonly used to analyze phosphorous in connection with human activity. Soil samples were collected from meadow soils at a distance of 20 to 400 m from the objects. Samples from topsoil horizons and for selected points from all soil horizons were tested. The values determined in citric acid were higher than the available phosphorous and statistically correlated. The greatest differences in phosphorus content in soils between places of different tourism and agriculture influences were observed especially in surface horizons. High contents have been determined in objects where artifacts were found. The highest content of phosphorous was recorded in the close vicinity of the hostels as the influence of tourism, however co-location with agricultural activity is possible. Available phosphorus content of control samples was 4.1 $mg \cdot kg^{-1}$ and citrate extract 24.3 $mg \cdot kg^{-1}$; of soil profiles located close to hostels phosphorus content was respectively 8.1 and 37.2 $mg \cdot kg^{-1}$; in profiles located far from hostels (but in the grazing areas) 4.4 and 29.9 $mg \cdot kg^{-1}$. The differences were statistically significant.

Assessment of rusty soil fertility in various forest habitats

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Keywords: SIG, rusty soil, Albic Brunic Arenosols, habitat diagnosis

The aim of the study was to determine the fertility of rusty soils in different forest habitats using the Habitat Soil Index, SIG, method. This method also made possible to diagnose the habitat type on the basis of soil characteristics, using the SIG values, and then to establish a synthetic diagnosis of the forest habitat type. The study was carried out in the Zwoleń Forest District which is located in south-eastern Poland in the Równina Radomska mesoregion (318.86). Taking into account natural and forestry regionalization, the district is located in the Kraina Małopolska region (VI) and in the mesoregion of the Równina Radomsko-Kozienicka (VI.3). The coniferous and mixed coniferous forest habitats were selected for the study (according to Forest Data Bank) with the dominance of pine and an admixture of birch. The studied soils were classified as rusty podzolic soil (Albic Brunic Arenosols (Protospodic)). The sequence of horizons was as follows: O, AEes, BhfeBv, Bv, C. In the coniferous forest a humus of the moder form was found, and in the mixed one the moder-mor. It was stated that the studied soils in had sand texture, very low pH in the humus-eluvial horizons and a low pH in the deeper horizons of the profile, a wider C/N ratio in the upper horizons, and a decreasing with depth content of total nitrogen and organic carbon. The SIG of 21 indicated that both habitats had oligotrophic soils. Furthermore, based on the SIG and diagnoses by undergrowth and stand, the habitat type of coniferous forest was reclassified as degraded mixed coniferous forest.

The ecological and forest significance of rusty soils undergoing processes of brunification and podzolization

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Keywords: forestry, forest typology, rusty soils

Brunification and podzolization are considered opposing processes in forestry. Brunification is associated with deciduous forests (mainly oak), while podzolization is linked to coniferous forests (mainly pine and spruce). Therefore, a change in the species composition of the forest stand from deciduous to coniferous, or vice versa, can alter the direction of soil formation processes. In the case of rusty soils, this leads to the development of rusty brown soils or rusty podzols. However, it is possible to find rusty soils where both of these processes are evident. In the years 1992-1994, this was reflected in the identification of a sub-type of rusty brown podzolized soils in forest habitat studies. According to the current "Classification of Forest Soils" in forestry, a soil exhibiting characteristics of both processes can only be classified into one of two sub-types – either rusty brown soil or rusty podzolized soil. This has significant implications for forest management, which relies on the results of habitat assessments and the determination of the forest habitat type based on them. In the case of rusty soils exhibiting both brunification and podzolization, classifying the soil as rusty brown directs the habitat type towards mesotrophic mixed mesic forests and fertile mesic forests, while choosing rusty podzolized soil allows for a wide range of options – from poor mesic pine forests to mesotrophic mixed mesic forests. Therefore, it is considered justified to differentiate rusty soils undergoing both brunification and podzolization in habitat studies. Apart from impact of such differentiation on forest management, it would enable the distinction of this sub-type of soils among other rusty soils, thereby facilitating a better understanding of their properties and the factors influencing their formation. The abstract of the study described such soils from the area of the Murowana Goślina Forest Experimental Station.

Holocene vegetation succession and environmental shifts recorded in peatlands of south-eastern Iceland

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Keywords: vegetation history, palaeoenvironment, radiocarbon dating, south-eastern Iceland

Peatlands are important terrestrial sediments storing information on landscape changes, climatic and vegetation dynamism as well as human activity. To reconstruct Holocene vegetation succession and environmental shifts in a fragile subpolar environment of south-eastern Iceland we used an over 4-meter-thick peat profile located to the south of Vatnajökull ice cap, near Lómagnúpur (N 63°57'21,2'' W 17°40'13,8''; 99 m a.s.l.).

High-resolution (1 cm intervals) plant macrofossil analyses helped to separate 5 zones in the studied core, while seven radiocarbon ages allowed to place them in a timeframe. In the 1st section mainly *Equisetum sp.* and wood pieces were present (however, up to layer dated to 8589-8417 cal yr BP) no wood pieces were found). In the 2nd section, *Carex sp.* and *Carex cf. rostrata* as well as *Brown moss* occurred. In the 3rd section, a decline of the *Carex* species and emerging of fungal sclerotia can be observed. In the 4th section renewed increase of *Carex* species appeared again. Also, the entering of *Sphagnum cf. teres* and a slow decrease in *Equisetum sp.* abundance can be seen. In the 5th section, *Sphagnum, Carex, Equisetum* species, and wood pieces declined almost completely. *Selaginella selaginoides* is multiple in this section. *Juncus sp., Caryophyllaceae,* and *Poaceae* occurred at the top of the analyzed peat profile.

Humans settled in Iceland in the 9th century and a vast deforestation and intensive grazing had started. The clearing of trees and shrubs reached up to 25%. It is clearly visible in the analyzed peat, as wood pieces were present up to layer dated to 937-796 cal yr BP and almost completely absent in the higher part of the profile (excluding one part slightly before a layer dated to 467-308 cal yr BP – beginning of the Little Ice Age).

Meteoric ^{10}Be as a tracer of soil erosion rates of loess–mantled soils (SW, Poland)

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Keywords: long-term erosion rates, loess mantles, cosmogenic nuclides, polygenesis

Loess deposits are considered as terrestrial archives that allow tracking changes in the soil ecosystem related to progressive deposition and erosion events of varying intensities. Providing data on long-term erosion rates is crucial for determining the stability of a loess mantle and reconstructing the evolution of loess-enriched soils. We use the meteoric ^{10}Be to i) define the factors responsible for its distribution along the profile, ii) determine long-term erosion rates in loess-enriched polygenetic soils characterised by illuviation processes, and iii) evaluate initial soil thickness and stability over time. The pattern of meteoric ^{10}Be throughout the soil profiles was mainly connected with clay translocation and accumulation in the illuvial horizons. Nonetheless, in the soil where loess has been deposited over serpentinite the highest ^{10}Be content was reported in the lowest – C horizon, what was the effect of the more prolonged deposition of serpentine to ^{10}Be deposition before the loess accumulation. The assumed erosion rates ranged from 0.1 to 3 t ha^{-1} yr and strongly depended of environmental conditions. The calculated erosion rated allowed to conclude the thickness of the removed loess cover, which reached from a few dm to even 3 m. Based on the results of long-term erosion rated we indicated four phases of soil evolution: a) pre-exposure of sediments to meteoric ^{10}Be accumulation; b) formation of thick loess mantles during the Last Glacial Maximum; c) erosion events between 21 and 11.6 ka that significantly shallowed the initial loess mantles; d) pedogenesis (with subsoil clay accumulation) in the Holocene within the thinner relicts of the former Late Pleistocene loess mantle followed by a recent and strong erosional phase due to human impact.

Evolution of Technosols' physical and water retention properties under 43-year wheat-rapeseed rotation in lignite post-mining land

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Keywords: Technosols, agricultural reclamation physical and water retention properties

During open-pit lignite mining, the natural landscape is degraded including soils and new anthropogenic landforms are generated, which require reclamation. This study analyzed the impact of long-term agricultural reclamation on the physical and retention properties of Technosols. The experiment involved cultivation of winter wheat and winter oilseed rape under 3 fertilization variants (0NPK, 1NPK, 2NPK). After 43 years of restoration, an Ap horizon (dividing to Ap1 and Ap2) developed in fertilized Technosols but was not clearly formed in unfertilized minesoil. In the surface subhorizon (Ap1), there was improvement in the physical quality (*S*) by decreasing densities (bulk density *BD*, particle density *PD*), increasing the structural stability index (*SI*), soil porosity (*SP*), air-filled porosity (*AFP*, a statistically insignificant), and water retention properties (field capacity *FC* and plant available water capacity *PAWC*). Generally, in the Ap2, properties are comparable to those in the surface horizon AC of unfertilized Technosols and to those observed in 1978. Regardless of fertilization, there was deterioration in physical quality (*S*) in parent materials, which was associated with an increase in compaction (*BD*) and reduction in porosities (*SP, AFP*), whereas particle density (*PD*) and water retention capacities (*FC* and *PAWC*) remained unchanged over time. These changes over 43 years have led to distinct profile variations in physical and water retention properties. The surface horizons of 43-year-old post-mining soils fertilized, are characterized by lower densities (*BD* and *PD*) and higher porosities (*SP, DP, AFP*), water capacities (*FC, PAWC*) and better physical quality (*S*) compared to unfertilized minesoils. In the subsurface horizons, properties were similar regardless of fertilization. The effect of mineral fertilization on improving properties in surface horizons is indirect, through stimulation of plant development and biomass production. Increasing fertilization above plant requirements does not lead to further improvements of properties in surface horizon.

Assessment of the spatial variability soluble forms of macronutrients in soil

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Keywords: spatial variability, soluble forms, macronutrients

Insufficient availability of macronutrients in the soil can lead to decreased plant productivity. The use of fertilisers at variable rates requires knowledge of their spatial distribution in the field. The purpose of this study was to determine the spatial variability of soil-soluble macronutrient forms K, P, and Mg on 33 ha of arable land in Lower Silesia (Poland) and to compare their occurrence with selected soil properties (granulometric composition, pH, Corg, and soil water content). Soil samples were collected in a regular grid with a resolution of 80 m. Distribution maps of macronutrients were obtained with spatial interpolation methods, and the evaluation of spatial variability was calculated with the semivariance estimator. Based on the distribution of the silt and clay fractions in the field, it was found that 78% of the area was covered with very light soils. A large spatial variation in the content of soil-soluble forms of macronutrients was found. Most of the field area in terms of phosphorus content in the soil was evaluated as a high and very high level, while for potassium and magnesium it was low and very low.

Acknowledgements
The research was supported by the WATERAGRI project ‘Water retention and nutrient recycling in soils and steams for improved agricultural production’ which received funding from the European Union’s Horizon 2020 Research and Innovation Programme under grant agreement No 858375 (https://wateragri.eu).

Influence of anthropogenic factors on the content of selected macroelements and enzymatic activity of the soil

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Keywords: biochar, soil, enzymes, carbon, macroelements

One of the directions of using biochar is application biochar (BC) in agriculture as an exogenous source of carbon as well as for potentially increasing soil fertility. The aim of the study was to define the influence of BC produced from various organic waste materials: one-month-old compost (OMOC), pine bark (PB), pine needle mulch (NM), pine cones (PC) and maple leaves (ML), mellow compost (MC), stabilized municipal sewage sludge (MSS), pine sawdust (PS), sycamore sawdust (SS) and oak leaves (OL) on the activity of alkaline (AlP) and acid (AcP) phosphatases and the content of available: phosphorus (P), potassium (K) and magnesium (Mg). The obtained results indicate that the response of alkaline and acid phosphatase activity to biochar depends on the biochar feedstock its usefulness for environmental purposes may be different. Alkaline and acid phosphatase activity increased after adding MSS biochar to the soil (1.310 mM pNP $kg^{-1}h^{-1}$ for AlP and 2.406 mM pNP $kg^{-1}h^{-1}$ for AcP). The lowest phosphatase activity in the soil was obtained after adding NM biochar (0.788 mM pNP $kg^{-1}h^{-1}$ for AcP) and PC biochar (0.234 mM pNP $kg^{-1}h^{-1}$ for AlP). Statistical analysis indicated a significant effect of various types of biochar on the content of available P, K and Mg in the soil. The soil with pre-composted material (OMOC) and with maple leaves (MSS) contained significantly more P than soils amended with other biochars. Among the tested variants of soils with the addition of biochars, the variant OMOC contained significantly lowest content of K. Application of biochar obtained from NM, PC and ML resulted in a significant reduction of Mg content in the soil. The decrease was 63%, 52% and 58%, respectively. The research results might be implemented to "design" biochars suitable for improving soil fertility.

Impact of climate change on acidity of alluvial soils

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Keywords: floodplain, climate change, drought, pH

Recent climatic changes have led to a massive drying out of the Vistula valley lakes. As a result, sediments are being transformed into soils. The material accumulated on the bottom of the floodplain water bodies is usually characterised by a near-neutral reaction. When the water disappears, the material is subjected to different processes. In temperate humid climates, where precipitation predominates over evaporation, this is primarily a leaching process. The study consisted of an analysis of 10 small floodplain lakes that dried up in 2019. In 2017, sediments were collected from their bottoms. In 2021, newly formed soils were sampled once a month. The aim was to compare pH changes (pH in H_2O and KCl) over 4 years and dynamics during the growing season. The pH of the bottom material of all studied reservoirs decreased slightly. In 2017, the pH value was mostly greater than 7, while in 2021 it oscillated in the range of 6.5-6.9, not exceeding 7. The pH value was highest in spring, with a slight decrease in the summer and autumn seasons. Based on the results, it can be concluded that the pH of soils formed from the sediments of dried lakes decreased and it can be assumed that it will decrease further with time. The sediments of floodplain lakes usually contain high levels of trace elements, which are more active in acidic environment. For this reason, a decreasing pH poses a risk of increasing trace element activity and contamination of the food chain.

Hydrological dynamic in Andean andisols, Las Palmas basin

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Keywords: andisols, hydropedology, mountain soils, climatic change, water balance

Soil is important factor in water regulation at catchment scale in high mountain; wetland systems, land uses, temperature and precipitation have high variability, unfortunately, these factors had been poorly understood and studied in the Andean region. The main objective of this research is evaluated water fluxes associated to land uses dynamics in andisols in the Las Palmas microcatchment, Andean Colombian zone. This basin is located in Envigado Municipality, Antioquia Region, Colombia. Six instrumented sites were installed in three experimental plots with 2 sites per use for forest "Oak secondary forest", grassland and potato tillage. In each plot runoff was measured with Gerlach's box, percolation with lysimeters at 20 and 50 cm deep, soil moisture sensors (20 and 50 cm deep), automatic rain gauge (one per plot), four pluviometers inside forest; the information was storage in automatic datalogger. Two complete weather stations and four piezometers inside the catchment. The results showed high soil moisture retention under Tillage > Grasslands > Forest (had better hydrological regulation). The soils have good recharge capacity between 15 hours to 3 days in humid periods, and 1 to 4 days in dry periods, the soils were never wilting point conditions. The runoff was low than 1%, the lowest valued was register under forest, infiltration were high between 83 to 99% of total rainfall for forest, tillage and grasslands. The lysimeters register 50% more percolation at 20 cm in comparison to 50 cm deep. The interception was 17 % of total rainfall. Soil moisture regime in study soils was udic with high soil moisture storage, low surface runoff, high subsurface runoff, high infiltration and percolation. Results underling the importance of andisols in the basin and wetland systems hydrological regulation. In future studies its necessary to monitoring water behavior in relation to wet land regulation by andisols.

Long-term and short-term soil erosion rates in loess landscape of Trzebnica Hills reflected in ^{10}Be in-situ and $^{239+240}$Pu analyses

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Keywords: loess landscape, soil erosion, ^{10}Be in-situ, $^{234+240}$Pu

Loess landscapes are highly susceptible to soil erosion which affects the stability, productivity and transformation of soils. ^{10}Be in-situ enables to determine long-term erosion rates (occurring since the surface was formed), whereas $^{234+240}$Pu give a possibility to calculate short-term erosion rates (the last 60 years). Therefore, in this study long- and short-term erosion rates were determined as well as how much erosive processes have intensified in recent decades.
The research was conducted in the area of Trzebnica Hills. Long-term erosion rates ranged between 0.44 and 0.85 t/ha/yr, whereas short-term erosion rates varied from 1.2 to 10.9 t/ha/yr. These values lie within the range of data presented for other loess areas in Europe. Short-term erosion rates are significantly higher than long-term due to the intensification and mechanisation of agriculture in the XX century, but also climate change may be an additional factor intensifying erosion processes. Moreover, short-term erosion rates considerably exceed tolerable erosion rates which range from 0.5 to 1.0 t/ha/yr, thus soils in the study area are subjected to degradation. It is reflected in the shallowing of productive soil horizon and exhumation of fluvioglacial materials or glacial till that are older than loess deposits and less productive. Based on short-term erosion rates it is calculated that Luvisols occurring in the study area will disappear within 80-300 years and soil unit will change on Regosols.

This research was financed by the National Science Center (Poland) project number 2018/29/B/ST10/01282 (Opus 15).

Persistence of arable Chernozems and Chernic Rendzic Phaeozems in the eroded undulating loess plateau in Central Europe

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Keywords: Chernozems, Rendzic Phaeozems, soil catena, soil erosion, colluvial soils

Chernozems are considered to degrade under the temperate humid climate of Central Europe, particularly in the arable and undulating areas and, thus, exposed to erosion. The present study was carried out in the loess-covered Proszowice Plateau (southern Poland), which was found to have a continuous cover of chernozemic soils in the past. Ten soil profiles located in two neighbouring slope catenas have documented the sequence of chernozemic and non-chernozemic soils (Chernozems, Phaeozems, and Calcisols), impacted by water erosion under intense arable land use and spatially dependent on the relief intensity. Soils in elevated, strongly inclined (and, thus, intensely eroded) slope positions lost their *mollic* horizons and gained the features of Calcisols. However, soils in elevated, slightly inclined positions preserved the morphological and physicochemical features of Chernozems, even if their *chernic* horizons were thinned to a ploughing depth. Also, the colluvial soils located on the short slopes, in close proximity to eroded hilltops, are saturated with secondary carbonates throughout the profile and retain their chernozemic features (Calcic Chernozems). Whereas, the colluvial soils located on the long, slightly inclined slopes, at a large distance to eroded hilltops, are deeply leached from carbonates and meet the criteria of Haplic Phaeozems (in well drained sites) or Gleyic Phaeozems (in poorly drained foothills and depressions). Moreover, the Chernic Rendzic Phaeozems with thick *mollic/chernic* horizons are present in elevated (thus expectedly eroded) parts of hills with thin loess overlying the limestone bedrock. The presence of chernic horizons in soils threatened by erosion indicates that the persistence of Chernozems and Chernic Rendzic Phaeozems is possible in undulating arable lands threatened by erosion in temperate humid climate of Central Europe if supported by sustainable agriculture, preventing soil erosion and organic matter loss from humus horizons.

Soils rich in calcium carbonate int he Masurian Lake Biosphere Reserve (NE Poland)

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Keywords: soil properties, soil classification, pararendzinas, post-glacial areas, calcium carbonate leaching

The Masurian Lake Biosphere Reserve was created in 2017 by way of renomination of the previous Lake Łuknajno Biosphere Reserve, existing since 1977. The research was carried out in the soils of the eastern part of the Łuknajno lake catchment. Eleven soil profiles were described, and the following analyses were carried out: soil texture, $CaCO_3$ content, soil reaction, total content of C, N, P, Fe and the content of pedogenic forms of iron and aluminium. According to the Polish Soil Classification (2019), the soils were classified as ordinary pararendzinas (9 profiles), humic rusty soil (calcareous) (1 profile) and humic rusty arenosol (1 profile). According to the WRB classification (2022), 9 profiles were classified as Calcaric Regosols (Arenic, Ochric), and two profiles as Eutric Brunic Arenosols (Ochric) and Eutric Arenosols (Humic). The studied soils occupy convex landforms associated with the marginal zone of the Vistulian glaciation and contain various amounts of calcium carbonate in the topsoil, with higher content in the parent material (up to 20-30%). Apart from the intensive leaching of calcium carbonate, the process of releasing pedogenic forms of iron and aluminum takes place but the presence of calcium ions makes it slow. These soils are characterized by high porosity, high content of stable humus with high biological activity, high sorption and buffer capacities. The calcium carbonate leached from the soils of the catchment area had accumulated in the basin of Lake Łuknajno in the form of thick layers of calcareous gyttja.

The influence of organic substrates on the reduction of salinity of soils near the streets of Opole

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Keywords: rendzinas, easily soluble salts, coconut fibres, poplar shavings, salinity reduction

The paper presents the results of the research which involved the use of coconut fibres, poplar shavings as well as fine sand and medium gravel to reduce the amount of easily soluble salts entering the soil environment as a result of winter road maintenance. For the study purpose, rendzinas were selected, i.e. soils formed on Cretaceous marls characterized by a shallow humus level with a high content of skeletal parts, as well as the lack of homogeneity of the material within the soil profile. All study plots have been selected within the road lane of the main streets of Opole.

The reduction of the salinity in the investigated soils may result from the sorption of readily soluble salts by the organic material, which was particularly evident in the plots with the top layer of coconut fibres.

In the experiment, an attempt was made to determine the optimal method of application of the analyzed material on the soil surface. The use of organic materials mixed with the soil (mix) has a positive effect on the properties of rendzinas but only in a layer of 10-30 cm depth. This is revealed by lower values of electrical conductivity or a reduced amount of Na^+ and Cl^- ions in the deeper layer of the soil profile.

The research is experimental with the focus on the possibility of coconut fibre application in roadside zones as well as in other areas exposed to soluble salts.

The subject discussed in the research should inspire to search for other new methods of neutralising the salinity of roadside areas, contributing to the improvement of the quality of the natural environment.

Impact of trampling on selected soil properties on the example of nature-didactic trails

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Keywords: soil, tourist trails, compaction, organic carbon, human impact

The aim of the research was to determine changes in selected soil properties on the educational and tourist trails of Bór and Zabłocie as a result of the pressure of trampling. The research was carried out in spring and autumn in the Bór and Zabłocie reserves. In each of the areas, sites were marked out along trails, where tourist pressure has the most significant impact on the ground: there were 9 sites in the Bór reserve, and 6 sites in the Zabłocie reserve. Compaction measurements were carried out with a pocket penetrometer, and samples were taken at a depth of 0-5 cm directly from the trail, as well as control 1 m from the trail. Basic analyzes of physicochemical properties of soils were carried out: granulometric composition according to the PTG standard of 2008, soil pH potentiometrically in 1M KCl solution and distilled water, organic carbon by the Tiurin method. The Kruskal-Wallis test was used to determine statistically significant differences in Statistica 13.0 with the UR license in order to compare the properties of soils from sites under the pressure of trampling compared to control sites away from trails. Based on the obtained results, it was determined that the average compaction had higher values directly on the tourist trails than outside it. However, there were no differences in compaction between the tested trails. It was found that the pH of the soil in the Bór reserve decreased in autumn. Meanwhile, in the Zabłocie reserve, pH variability was not observed. Significant changes were noted for the content of organic carbon. The content of organic carbon in autumn decreased by about 5-6%. This may indicate an intense tourist season that caused these changes and a significant impact of trampling on the condition of the soil environment.

Distribution of metals in organic matter fractions of spent mushroom substrate

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Keywords: spent mushroom substarte, sequential extraction, carbon fractions, metals fractions

The presence of various forms of organic matter and metals in the mushroom substrate inspired research to determine the quantity and quality of organic matter and its interaction with metals in spent mushroom substrate. The research was carried out in the context of the rational use of this waste in fertilization and soil reclamation, as well as the assessment of the potential threat to the environment during its storage.

The research material consisted of spent mushrooms substrate samples after the cultivation of *Agaricus bisporus* from 5 cultivation plants located in central-eastern Poland (a region known for the centralization of mushroom production). Sequential extraction of elements (organic carbon and metals) was used to distinguish the following fractions of metals: soluble in water (deionized H_2O), exchangeable, bound with colloids (1M KCl), complexly bound with humic substances (0.1M $Na_4P_2O_7$), more tightly bound with humic substances (0.1M NaOH), strongly bound with the organic and mineral solid phase of the waste (4M HNO_3), residual (*aqua regia*).

The obtained results made it possible to determine the quality of organic matter and to determine the amount of metals in bioavailable, potentially labile forms and to varying degrees related to the organic matter of the waste. It was proven that the tested organic material, regardless of the place of origin, is characterized by a similar quality of organic matter. In general, it is characterized by a high potential for soil enrichment with biogenic elements and organic matter, including to a large extent (about 1/4) in labile forms and susceptible to decomposition processes. Metals constituting plant nutrients were bound mainly by humic substances. Heavy metals were present mainly in the residual fraction. A significant content of labile forms of organic matter suggests that there is a potential risk of migration of organic compounds and metals outside the place of storage of the spent mushroom substrate, and in the case of fertilizer use, also migration outside the soil environment.

Glebory'23 – results of the field camp of scientific societies of geography students from Nicolaus Copernicus University in Toruń and Jagiellonian University in Kraków in the Wdecki Landscape Park

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Key words: Wdecki Landscape Park, Soil maps, Soil Classification, Catena, Soil Geography.

On July 10-15, 2023, a joint field camp of the scientific societies of geography students from Nicolaus Copernicus University in Toruń (SKNG UMK) and Jagiellonian University in Kraków (KGUJ) took place in the Wdecki Landscape Park. 18 students and 7 supervisors participated in the camp.

The aim of the camp was to recognize the soil cover of the Park, and in particular: 1. preliminary verification of the soil map made on the basis of the re-edition of soil-agricultural and soil-habitat maps, 2. recognition of the representative spatial sequences of soils (catenas) in various landscapes, 3. testing in the field the key of the Polish Soil Classification (SGP 6; PTG, 2019). 18 soil pits organized into catenas were made in the field: 1. in the area of the Wda outwash plain, at its contact with the river valley, 2. in the area of the Wda outwash plain, at its contact with the ice-melting depressions, 3. on the moraine plateau and 4. on the inland dune.

The dominant soils on the Wda outwash plain are Rusty soils representing various stages of podzolization. Peat, Murshic, Ochre and Mucky soils were found in the depressions. The moraine plateau is occupied by various subtypes of Clay-illuvial soils. In the Wda valley there are Alluvial soils interbedded with organic formations.

The following persons participated in the camp:
SKNG UMK: Patryk Grzywaczewski, Joanna Martewicz, Olga Mazur, Natalia Moskwa, Aleksandra Olchowik, Dominika Przygodzka, Mateusz Suwiński, Klaudia Szewczyk, Anastazja Wasilewska, Bartłomiej Zawadzki; KGUJ: Magdalena Bajer, Katarzyna Filip, Wojciech Haska, Agnieszka Kafel, Agnieszka Kozioł, Mateusz Pysz, Anna Rudnik, Patrycja Wójtowicz; Opiekunowie: Magdalena Gus-Stolarczyk, Michał Jankowski, Aleksandra Loba, Łukasz Musielok, Marcin Sykuła, Marcin Świtoniak, Mateusz Stolarczyk.

Soil cover of selected grassland communities in the central part of the Obra Valley

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Keywords: murshic soils, gleysols, grasslands

The objects of the study were grasslands (meadows) located between the North, Middle and South channels of the Obra River, in the areas of Błock, Kotusz, Przemęt and Ziemin. They have been developed on soils of peat character, the surface levels of which have been subject to mucking processes for many decades. In the study area, 5 plant communities (I-V) were selected, on which 4 soil profiles each were exposed. Based on their morphological structure, the soil cover can be characterized as follows:

Community I *Molinietum caeruleae*
It is formed by soils belonging to the semimurshic soils. Their topsoil horizons are *arenimurshic* epipedons (less than 6% C_{org} in the postmurshic soils subtype and 6-12% C_{org} in the typical semimurshic soils subtype). They were formed from completely mucky peat formations overlying mineral formations of fluvioglacial or alluvial sands.

Community II *Poa pratensis-Festuca rubra*
Here there are mainly semimurshic soils in association with shallow semimurshic soils, the upper horizons of which show the character of organic formations (>12% Corg) with diagnostic *murshic* epipedons. It rests on a gleyed mineral bed of sandy nature, of fluvioglacial and alluvial origin.

Communities III *Arrhenatheretum elatioris* and IV *Lolio-Cynosuretum*
These areas are also dominated by semimurshic soils, typical semimurshic soils subtype and postmurshic soils, however, in a complex with ground-gley soils formed in local depressions, subtypes of ground-gley murshic soils. Their surface horizons belong to organic *murshic* epipedons with a thickness of less than 30 cm. Below them lie gleyed mineral formations, often showing pronounced ground-gley properties.

Community V *Alopecuretum pratensis*
In this area, one encounters mainly subtypes of shallow murshic soils, the top levels of which are organic murshic horizons not exceeding a thickness of 50 cm. They are bedded with mineral materials of the silty and sandy formations, showing ground-gley properties. Less frequent in this area are soils with *arenimurshic* epipedons.

The influence of crop rotation and fertilization on the content and quality of humus compounds

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Keywords: crop rotation, fertilization, soil organic carbon, fractional composition, humic acids

The content and properties of organic matter in the soil is an accepted indicator of soil quality.The aim of the research was to determine changes in the content and quality indices of organic matter under the influence of different fertilization and crop rotation.

The research was carried out on the basis of soil samples taken from many years of experience, including the assessment of: the reaction of various soil types to manure fertilization; the effect of the dose and frequency of straw fertilization; the impact of crop rotation (depleting and enriching the content of humus in the soil) and the varied level of fertilization with manure and nitrogen. Contents of organic carbon, total nitrogen, fractional composition of humus and properties of humic acids were determined.

The assessment of the relationship between the type of soil and their reaction to the applied fertilization showed that soils have a certain capacity to be absorbed and included in the undisturbed cycle of external organic matter transformations. The use of straw twice in rotation in combination with nitrogen fertilization had the most favorable effect on the content of organic carbon. Including plants enriching the soil with humus in crop rotation increased carbon sequestration in the soil. Fertilization with manure and straw, as well as the introduction of humus-forming plants into rotation, increased the share of labile fractions and humins in the fractional composition, increased the value of the ratio of carbon of humic acids to carbon of fulvic acids. Fertilization with straw and manure, as well as the introduction of humus-forming plants into rotation, resulted in the formation of humic acids with a lower degree of aromatization and a higher proportion of aliphatic structures, which were characterized by a lower degree of internal oxidation, higher values of absorbance coefficients and higher total acidity.

Organic carbon stock in sandy soil on sandpit excavation after forest reclamation with varied tree species

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Keywords: sandy soil, SOC, afforestation

The accumulation of soil organic carbon (SOC) plays an important role in soil development during reclamation after degradation by human activity. This parameter is widely used as an indicator of soil quality and gives feedback about soil microbial activity and SOC dynamics. The aim of our research was to present the stock of organic carbon (Cstock) in the reclaimed mine soil developing on sandpit excavation. In this study, we compared the impact of varied tree species on Cstock in topsoil (0-30 cm) and in soil pedon up to 150 cm depth. We chose a 40-year-old forest on an opencast sand mine pit as the research area afforested with four tree species like the Scots pine (*Pinus sylvestris* L.), European larch (*Larix decidua* Mill.), Silver birch (*Betula pendula* Roth), and European oak (*Quercus robus* L.). The stock of organic carbon was estimated according to the equation: $SOCstock = H(depth) \times BD(bulk\ density) \times OC \times 10$, and bulk density was measured using Kopecky cylinders.

Selected soils have been classified as Arenosols according to WRB classification. In the A-horizon, soils under oak and birch had higher content of SOC compared to SOC under pine and larch. About 60-80% of Cstock of entire soil pedon is stored in the topsoil. There are also differences between other physical properties of tested soils. Our results indicate that the tree species used for the afforestation of post-mining areas are crucial to restoring the ecological functions of soils.

This research was funded by The National Science Centre, Poland, grant No. 2021/42/E/ST10/00248.

Long-term effects of wheat-rapeseed cultivation on chemical properties of Technosols in a lignite post-mining area in central Europe

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Keywords: Technosols, agricultural reclamation, chemical properties

Open-pit lignite mining causes significant disturbance to the natural environment. Not only the vegetation cover but also the soil cover is destroyed. The place of soils is occupied by heaps with materials that differ significantly from the properties of natural soils. The characteristics of these materials are low nitrogen and phosphorus content and sometime potassium content, low pedogenic carbon and admixture of geogenic carbon. It is necessary to rehabilitate these areas, which are usually carried out as forestry treatment. This study presents the effect of forty-three years of agricultural reclamation involving alternating winter wheat and winter rapeseed in 3 fertilization variants (0NPK, 1NPK and 2NPK) on the chemical properties of Technosols. The study showed that the Ap (Ap1 and Ap2) developed on 1NPK and 2NPK combinations. In a plot without fertilization (0NPK) it was not clearly developed (AC and CA). In Ap, there was an improvement in chemical properties compared to 1978: SOC (soil organic carbon) increased by 60–83%, TN (total nitrogen) by 144–160%, P (available phosphorus) by 1400–2760%, K (available potassium) by 39–74%, $CaCO_3$ content decreased (statistically insignificant) and SOC/TN ratio declined but pH and CEC remained unchanged. For the Technosols surface horizon of the 0NPK plot, there were also temporal increases in TN and SOC content with a decrease in the SOC/TN ratio, while P, K, pH, CEC and $CaCO_3$ values did not change significantly. The 43-year-old post-mining Technosols fertilized (1 NPK, 2 NPK) had significantly higher SOC, TN, P and K values in the surface horizon than minesoils without fertilization (0NPK). In the subsurface horizons, the properties of minesoils were similar regardless of fertilization. The changes that occurred in the analyzed Technosols during the 43-year period of agricultural reclamation resulted in distinct profile variations in SOC, TN, SOC/TN, P and K.

Properties of technogenic soils formed on the external heap of Brown Coal Mine Bełchatów

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Keywords: lignite, post−mining sites, reclamation, SUITMA

The paper presents the characteristics of the initial soils formed on the summit of the Bełchatów Field external heap. For this purpose, three research plots were designated, which differentiated the geological formations stored on the heap. Research area No. 1 was established on sandy sulfurous formations neutralized with lacustrine chalk, research area No. 2 was located on sandy-clay formations and plot No. 3 on silt-clay formations. The results indicate that initial soils formed on silt-clay formations characterized the best physicochemical properties. The distinguished genetic horizons the tested soils were generally characterized by an low pH, low values of electrical conductivity, and low content of calcium carbonate. They were also characterized by low contents of nitrogen, available phosphorus, and potassium. Only in the case of soils formed on the study plot no. 3 (silt-clay formations) an average content of available potassium was found. The best physicochemical properties (the highest content of C and N, exchangeable cations, and the content of available elements, as well as the highest water availability) were found in the soils formed on silt-clay formations (research area No. 3), while the soils formed on sandy formations neutralized with lake chalk had the worst (research area No. 1). The obtained results clearly confirm that sulfated sand formations should not be deposited on the outer layers of heaps, but only inside the heap body being formed.

Properties of arable Luvisols in the young-glacial landscape

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Keywords: soil erosion, Luvisols, agricultural production

Luvisols cover almost 30% of arable soils in Poland. The objective of this study was to determine the physical and chemical properties of Luvisols developed from moraine loams affected by tillage erosion. The study area is characterized by a specific young-glacial landscape (Vistula glaciation). The soils were classified into the various complexes of agricultural suitability. Agricultural practices, particularly tillage, influence the erosion process with the transfer of soil material and its accumulation at the foot slope. The samples were taken from the Ap horizon and from other genetic horizons (from a depth of 25–150 cm) after the harvest of cereals. Standard methods were used to determine the grain size composition, content of organic carbon and nitrogen, and aggregate size distribution. Parameters such as the content of carbonates, pH, and cation exchange capacity were also determined. The presented results are part of a study on Luvisols from Krajeńskie Lake District, northern Poland.

Environmental effects of coal combustion in the Siekierki and Żerań Thermal Power Stations

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Keywords: contamination, fly ash, metal(loid)s, root exudates

Coal combustion in Thermal Power Stations (TPSs) still remains the main source of energy and heat in Poland. The major environmental problem raised in the frame of TPSs operation is CO_2 emission. Coal combustion in TPSs generates also ashes, that are collected in dumps, and can be dispersed by the wind around TPSs and dumps, posing an environmental hazard. Therefore, the aim of the study was: (a) to assess soil contamination with metal(loid)s (b) to determine the effect of artificial root exudates (AREs) on the mobilization of selected metal(loid)s in ashes, and (c) to determine the mobility of metal(loid)s in soils. The study was executed around Siekierki and Żerań TPSs (Warszawa), where soils were collected at randomly selected points. In soils, selected properties were measured (i.e. $CaCO_3$ content, pH). Furthermore, soils were digested in aqua regia, and metal(loid)s concentrations in solutions were measured using ICP-OES. The effect of root exudates on the mobilization of metal(loid)s was determined by the extraction of two types of fly ashes (Siekierki-conventional coal combustion, Żerań-fluidized bed coal combustion) with AREs solution. Mobility of metal(loid)s was determined using 0.05 M EDTA extraction. The study revealed that: (a) soils around Siekierki and Żerań TPSs are not contaminated with metal(loid)s relative to Polish regulations, (b) Cd content in soils increases according to the wind direction, (c) AREs increase metal(loid)s mobilization in ashes compared to control H_2O with pH corresponding to that of AREs (3.5), (d) AREs (pH 6.7) increase metal(loid)s mobilization relative to AREs (pH 3.4) at the first contact between AREs and ashes, (e) fly ash from conventional coal combustion is more susceptible to dissolution with AREs as compared to ash from technology where coal is combusted in fluidized bed, and (f) the As, Cd, Co, Mn, and Ni are more mobile in soils around Siekierki TPS compared to Żerań TPS.

The approach to calculating and mapping organic carbon stock in mineral soils of agricultural use

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Keywords: SOC, carbon sequestration, mineral soils, digital soil mapping, GWR

Soil organic carbon is a key indicator influencing soil quality and fertility. Reduction of its losses and increase agricultural soils' potential to its sequestration is crucial for present agriculture management. In Poland, more than half of the soils area under agricultural use are developed on sands indicating low clay fraction share and acidic reaction. Therefore, the substantial increase of organic carbon content and maintaining its high level for next decades appears as a real challenge for Polish agriculture. The study aims to calculate the organic carbon stock in the upper layer of mineral agricultural soils and delineate the areas of its highest share.

All digital maps were generated from the datasets collected by IUNG-PIB under various national programs. We used the method of Geographically Weighted Regression with the Poisson regression model. This geostatistical method was used to create the national map of bulk density and soil organic carbon content. The organic carbon stock was calculated according to the method adopted by Khan and Chiti (2022). The final map was based on the sum of the mean values in 75th (feasible scenario) and 90th (maximum scenario) percentiles (Padarian et al. 2022) and ranks of monthly NDVI coefficient of variation (highest variation corresponds with the lowest sequestration potential).

The results show that the majority of mineral soils from Polish rural areas have the potential to increase C stocks. The C increase positively depend on clay fraction content. Very heavy soils have the highest potential (27t/ha in the maximum scenario and 18 t/ha in the feasible scenario). Average C value decrease between very light, light, medium, heavy and very heavy soil agronomic categories is 1,5 t/ha. The method identifies areas with the greatest potential for increasing organic carbon stocks, but the study should be extended to include organic soils for comparison with EU Member States.

Profile changes of carbon-degrading enzymes in soils with differentiated texture and carbon content

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Keywords: C-cycling enzymes, microbial biomass, soil texture, soil profile, soil carbon

Most studies concerning enzymatic activity focus on surface soils, while relatively little is known about how they vary with depth in a soil profile, which is critical to the aim of revealing the ecosystem processes in deep soils. That is why the current research aimed to study how the soil C-transforming enzymatic activity varied with depth as affected by soil texture and different forms of soil carbon. Texture is considered to be one of the most important factors affecting the soil environment, since many soil processes and properties depend on how clayey or sandy the soil is. However, the connections between soil texture and enzymatic activity remain less understood. Changes to the studied properties were determined across five Phaeozem profiles which differed in their parent material (sand, till) and soil texture (loam – L, loamy sand – LS, fine sand – FS). The activity of endo-cellulase, exo-cellulase, endo-xylanase, exo-xylanase, α-amylase and glucosidases was determined. Moreover, soil texture and the contents of various forms of soil carbon (microbial biomass C, total and dissolved organic carbon -TOC, DOC) were assessed. The enzymatic activity and the content of C forms were the highest in the Ap horizon and in some subsurface layers and generally decreased with depth. The enzymatic activity was significantly higher in L and LS as compared to the FS texture. In the C-rich horizons (above 5 g kg^{-1} of TOC) the enzyme activities were correlated with soil carbon forms as compared to the subsurface layers. In the deeper, C-low horizons (below 5 g kg^{-1} of TOC) the enzymatic activity was significantly correlated with the silt and clay content. It was concluded that the enzyme activities were primarily determined by carbon content in the Ap and in some subsurface horizons, while in the deeper horizons the clear effect of soil texture was also pronounced.

The research was financially supported by the National Science Centre, Poland (project no 2018/29/B/NZ9/00982)

Trace element contamination of soils in the Molotov Line fortified area, Southern Roztocze, Poland

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Keywords: pollution, trace elements, fortified area

Armed conflicts and military activities can contribute to environmental pollution. Soil in areas of direct warfare is often contaminated with heavy metals and other trace elements. Extensive research in this area indicates a significant accumulation of heavy metals in particular on battlefields, firing ranges, small arms ranges, artillery ranges, mortar ranges and rocket ranges. The aim of the study was to determine the content of selected trace elements in soils of the Molotov Line fortified area in southern Roztocze in south-eastern Poland. The study covered the artillery shelling zone in the vicinity of three bunkers. The sites were characterised by varying degrees of destruction as a result of artillery and rifle fire during the Second World War. In the zone of each site, surface (0-20 cm) and subsurface (20-40 cm) soil samples were collected at 4 transects and distances from the bunkers: 0m, 10m, 20m, 30m, 40m, 50m, for a total of 126 soil samples. The study material was collected in 2022. The contents of Cd, Cu, Mn, Pb, Zn, Ni, Cr, Bi were determined by ICP-OES after soil extraction with aqua regia (method ISO 11466:2002). It was found that the content of selected heavy metals in the analysed soils does not exceed the standards specified in the "Regulation of the Ministry of the Environment on the manner of conducting the assessment of pollution of the earth surface" (Law Gazette 2016, No. 1395, date 05.09.2016). The average concentrations and ranges of the analysed elements are respectively: Cd: 0.3 $mg \cdot kg^{-1}$(0.05-1.35), Cu: 3.05 $mg \cdot kg^{-1}$(0.36-21.7), Mn: 97.1 $mg \cdot kg^{-1}$(6.01-533.9), Pb: 7.8 $mg \cdot kg^{-1}$(0.59-143.1), Zn: 17.8 $mg\text{-}kg^{-1}$(1.7-98.4), Ni: 11.7 $mg \cdot kg^{-1}$(0.8-38.5), Cr: 21.2 $mg \cdot kg^{-1}$(0.31-44.2), Bi: 5.1 $mg \cdot kg^{-1}$(0.0-20.0). The results indicate low contamination with the trace elements studied.

Enzymatic activity of lessive soils in the Kuyavian-Pomeranian Voivodship

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Keywords: dehydrogenases, FDA, urease, nitroreductase, β-glucosidase

Soil enzymes are taken part in transforming of biogenic elements (e.g. carbon, nitrogen, sulphur). They are secreted into the soil by microorganisms, animals, plants and fungi living in it. The enzymatic activity of the soil is considered a good indicator of changes in the soil under the influence of factors natural and anthropogenic. Enzyme tests are considered as one of the most sensitive indicators of ecosystem functioning.

The main aim of the study was to compare biochemical activity lessive soil in during spring wheat (Triticum aestivum) grown according to the organic farming system in two (places in Kujavian - Pomeranian Voivodship: Budziszewo (53° 37′N; 19° 12′ E) and Minikowo (52º 21' 20" N; 16º 56' 35" E).

Dehydrogenase activity (DH) depended mainly on the experimental locality; in the soil taken from Budziszewo, it was on average 4 times higher than in the soil from Minikowo. DH activity was within a wide range of 85.27 - 227.0 mg TPF $kg^{-1} \cdot 24\ h^{-1}$. The activity of FDA during the study was higher in Budziszewo soils in the range of 15.94 - 18.14 mg F $kg^{-1} \cdot h^{-1}$. β-glucosidase is a soil enzyme that catalyzes the hydrolysis of cellulose. The activity of β-glucosidase in the tested soils was in the range of 0.333 to 0.598 μg pNP. $g^{-1} \cdot h^{-1}$ in Minikowo and 0.461 to 0.556 μg pNP $g^{-1} \cdot h^{-1}$ in Budziszewo. Urease is an enzyme that converts urea to CO_2 and NH_3 so has a contribution to the transformation of nitrogen in the soil. The activity of urease was similar in two places collected soils (0.343 - 5.510 μg NH_4-N $g^{-1} \cdot h^{-1}$). The process of nitrate reduction to ammonia occurs with enzymes of nitroreductases participating. Nitroreductase activity was higher in Budziszewo soils was 0.810-5.511 mg NO_2 $kg^{-1} \cdot 24\ h^{-1}$.

Long-term impact of nitrogen and sulfur application on basic soil properties

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Keywords: nitrogen and/or sulfur fertilization, soil fertility indicators, content of basic nutrients

Due to the use of high-percentage mineral fertilisers, the reduction of the use of natural fertilizers and the reduction of sulfur emissions into the atmosphere, both a sulfur deficit and a low level of macroelements are observed in the soils of Poland. In connection with the above, research was undertaken to assess whether and to what extent the different doses of nitrogen applied against or without sulfur fertilization determine the indicators of soil acidification and the content of basic macroelements in the soil (total nitrogen, assimilable forms of phosphorus, potassium and magnesium). The test plant was maize grown in a monoculture. The experiment was carried out in concrete cambers in 2008-2016 at the UTP (BUT) Research Station in Bydgoszcz located in Wierzchucinek (17º 51'E, 53º 13'N). The cambers were filled with four soils which, according to American systematics, belong to the following types according to their genetic profiles: Typic Hapludolls, Typic Hapludalfs, Typic Haplorthods, Typic Endoaquolls.
It was found that the 8-year application of nitrogen doses with or without sulfur resulted in a change in the classification of the tested soils in terms of their pH, which concerned mainly light soils. It also reduced the content of total nitrogen and available forms of phosphorus, potassium and magnesium in relation to the content before the establishment of the experiment. Such a tendency was not noticed in the case of heavy soils. It should be noted that the contents of the tested macronutrients were definitely lower than the national average and depended on the type of soils tested. In the final conclusion, it can be stated that the problem of changes in soil pH, total nitrogen content and assimilable forms of macronutrients present in the tested soils should be considered not only with regard to mineral fertilization and fertilizers containing organic matter.

Soil phosphorus fractions in desert and steppe grasslands in Mongolia

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Keywords: available phosphorus, desert and step grasslands, phosphorus fractions, sequential P extraction

The total phosphorus content and its distribution in relation to various components of the soil solid phase is essential to understand phosphorus transformations and availability for plants. The research was conducted on soils samples taken from extensively used desert and steppe grasslands in Mongolia. In this paper soil phosphorus fractions in steppe and desert soils of Mongolia belonging to seven soil types (Calcisols, Cambisols, Solonetz, Phaeozems, Umbrisols, Kastanozem, Chernozems) was analyzed. In the study we used the Hedley method for soil P fractionation, separating the following five fractions: water soluble – P_{H2O}, exchangeable – P_{EX}, bound to Fe and Al – $P_{Fe/Al}$, bound to Ca – P_{ca}, and residual P – P_{res} and plant-available forms of phosphorus using the CAL method. On the distribution of soil phosphorus fractions various among forms was strongly influenced by soil type and soil horizon. The total content of phosphorus in the studied soils was very varied and was in the range from 208.4 to 2673.3 mg $P \cdot kg^{-1}$. Based on the obtained results, it was found that a very small amount of phosphorus was present in labile fractions, i.e. easily available to plants (water soluble – P_{H2O}, exchangeable – P_{EX}). The share of these fractions in relation to its total content ranged from 0.66 to 10.0%. Phosphorus was present mainly in combination with calcium and in the so-called residual fraction, and the share of these fractions in relation to total content of phosphorus ranged from 79-99%. It was found that although the analyzed soils were rich in total forms of phosphorus, the share of forms available to plants was in most cases at a low level.

The influence of organic additives on the microbiological state and basic properties of mineral soil structure

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Keywords: soil microorganisms, enzymatic activity, soil aggregation, organic additives

The aim of the experiment was to determine the effect of selected organic additives on the microbiological state and basic properties of the mineral soil structure (resistance to the dynamic action of water and the state of secondary aggregation). In the pot experiment, the following organic additives were applied to the brown soil made of loess: manure, straw, compost and sewage sludge. The number of the main groups of soil microorganisms was determined in three terms on selective substrates: the total number of bacteria, fungi, actinomycetes, oligotrophs, copiotrophs, proteolytic and cellulolytic bacteria. In addition, the enzymatic activity of dehydrogenases and urease was determined spectrophotometrically. Fifty models of soil aggregates were cut out from each combination. The models were at once brought to an air-dry state and underwent a full analytic procedure. On the basis of the conducted microbiological analyses, a differentiated reaction of particular groups of microorganisms to organic additives was observed. Their number also changed during the experiment. However, for most groups of microorganisms, the stimulating effect of straw and sewage sludge on microorganisms was demonstrated. The greatest increase in dehydrogenase and urease activity was observed in combinations with the addition of sewage sludge, while protease activity in combinations with the addition of straw.

Results which show changeability of a quantitative and qualitative secondary aggregation after a dynamic water action (ADR), draw that the sewage sludge was the strongest factor which influenced that feature. Additives usually enlarged the share of each fraction in the total secondary aggregation by increasing (when compared to control combinations) a summary content of macroaggregates in the mass of secondary aggregates. What seems especially valuable, is the increase of share of secondary aggregates of 5-3 and 3-1 mm diameter.

The effect of roots of different tree species and their exudates on soil the properties and microorganisms in a temperate forest ecosystem

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Keywords: enzyme activity, fungal and bacterial diversity, next-generation sequencing (NGS), root characteristics

The species composition of tree stands plays an important role in shaping the properties of forest soils. The aim of our research was to determine the influence on soil properties of the root systems of six species of trees forming forest stands in the temperate climatic zone. The research covered areas containing six species of trees– Scots pine (*Pinus sylvestris* L.), European larch (*Larix deciduas* Mill.), English oak (*Quercus robur* L.), English ash *(Fraxinus excelsior* L.), European beech (*Fagus sylvatica* L.) and European hornbeam (*Carpinus betulus* L.). In our study, we determined the characteristics of the roots and the amount of carbon excreted alongside their exudates. In addition to the basic physicochemical properties of the soil samples, the enzymatic activity, and the composition and diversity of the fungi and bacteria, were also determined. A strong relationship between the root characteristics and the soil properties, including the pH, basic cation content and phosphorus content, was confirmed. In addition, the enzymatic activity of phosphatase, β-glucosidase, N-acetyl-β-D-glucosaminidase and β-D-cellobiosidase was positively correlated with the root characteristics. This analysis of the root systems and soil properties confirmed the distinctness of ash stands, which also had a greater diversity of microorganisms. It was also found that soils under the influence of different stands were characterised by diverse compositions of fungi and bacteria, with differences in these compositions observed in relation to the coniferous species (pine, larch).

Reinterpretation of agricultural soil maps and their usefulness for determining location preferences of Stone Age settlement

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Keywords: agricultural soil maps, Kuyavia, geoarcheology, prehistoric settlement

Polish agricultural soil maps (ASM), developed at the beginning of the second half of the XXth century, are being used by specialists in various fields. In the decades since their publication, however, much has been learned about soil genesis and the approach to the classification of soils has changed as well. As a consequence, ASM have lost their relevance. The maps have to be reinterpreted "on the fly" by the user, which requires extensive knowledge and experience or can be reinterpreted using a reinterpretation key.

This study compares the usefulness of the original ASM data as well as the reinterpreted results to determine the Stone Age settlement distribution in relation to soil conditions. Two areas in the Kuyavia region were analyzed, Kuyavian Lakeland and Inowrocław Plain. These areas represent two distinct soilscapes, one with a mosaic of clay-illuvial soils (Luvisols), rusty soils (Brunic Arenosols), and various types of hydrogenic soils, typical of young morainic landscapes (Kuyavian Lakeland), while the Inowrocław Plain is dominated by black earths (Gleyic Chernozems/Phaeozems).

13 sheets of Polish Archaeological Record were analyzed, covering approximately 500 km^2. More than 1000 Stone Age settlement records were digitized. A clear preference for the distribution of Stone Age settlements in relation to soil texture classes, and soil types and sub-types was observed. Settlements tend to be located on soils having sandy topsoil, mostly clay-illuvial soils and rusty soils. Black earths were preferred only during certain periods of the Stone Age. Although similar trends are also seen using the original ASM data, the maps without reinterpretation show much less detailed information and much less suitability for such purposes.

Heavy metals content (Cd, Cu, Mn, Pb, Zn, Ni, Cr, Fe) of the edifisols in Lublin

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Keywords: edifisols, heavy metals, technosols, technogenic soils, urban ecosystems

The paper deals with the concentration of trace elements in edifisols in the city of Lublin (eastern Poland). The study included 6 soil profiles, occurring on structures of different ages, different purposes and constructed with different building materials. The content of heavy metals (Cd, Cu, Mn, Pb, Zn, Ni, Cr, Fe) was determined using the FAAS method after soil mineralisation with aqua regia (method ISO 11466:2002). In addition, the following were determined in the analysed samples: granulometric composition using the areometric-sit method, reaction in distilled water using the potentiometric method and Corg by the Tiurin method.

The predominant granulometric fraction in the studied edifisols was found to be sand (2-0.05 mm), originating from physical weathered mortar. The reaction of the studied edifisols is mainly alkaline (pH $_{H2O}$: 7.65 - 8.23), while the organic matter content ranged from 1.49% to 11.49%.

In addition, it was found that the content of selected heavy metals in the analysed soils generally does not exceed the standards set out in the "Regulation of the Ministry of Environment on the manner of conducting the assessment of pollution of the earth surface" (Journal of Laws 2016, item 1395, dated 05.09.2016). Only in the profile, located on the foundations of the road bridge, exceeded permissible contents of Pb were observed (for horizons A and Ada - 759.6 mg-kg^{-1}, 475.8 mg-kg^{-1}, respectively). The average concentrations and ranges of the analysed elements are respectively: Cd: 2,9 mg·kg^{-1} (0,8 – 6,1), Cu: 23,6 mg·kg^{-1} (2,9 – 61,5), Mn: 230,8 mg·kg^{-1} (72,8 -457,7), Pb: 342,1 mg·kg^{-1} (16,2 – 759,6), Zn: 173,5 mg·kg^{-1} (24,5 – 432,6), Ni: 27,6 mg·kg^{-1} (20,3 – 39,3), Cr: 33,0 mg·kg^{-1} (21,8 – 44,1), Fe: 10057,0 mg·kg^{-1} (2503,6 - 11668,9). The results indicate low contamination with the trace elements studied.

Bioavailability and phytoavailability of arsenic in soils of allotment gardens in Zloty Stok

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Keywords: arsenic, soil contamination, urban soils, plant uptake

Arsenic is considered one of the most toxic elements and its presence in soils can cause serious environmental risks. In Złoty Stok (that was for over two centuries, until 1962, one of the largest producers of arsenic in Europe) there are two groups of allotment gardens, divided into hundreds of parcels cultivated individually, where gardeners not only cultivate grasslands and ornamental plants, but grow vegetable and fruits as well. In this work we dealt with the content of arsenic in soils and its uptake by selected vegetable species grown in garden soils in Zloty Stok. Soil samples from the depth of 0-30 cm as well as vegetables (beetroot, carrot, sorrel, onion, dill, parsley, celery) were collected for analysis. Total concentrations of arsenic were extremely high in all investigated soil samples and varied from 222 mg kg^{-1} to 1809 mg kg^{-1}. Actually soluble forms of arsenic in soils, determined by extraction with 1 M NH_4NO_3, proved to be generally low, i.e. 0.33% of total As on average. The concentrations of As in plants differed among the species and between aboveground and underground parts of plants. Most of the vegetables contained low concentrations of arsenic, which confirms its generally low mobility and phytoavailability. In some cases, however, for instance in the aboveground parts of beetroot, considerably higher arsenic concentrations were found. The highest arsenic content was found in the leaves of sorrel, which can be explained by the oxalic acid content of this plant which can affect the reduction of iron oxides present in soils and the release of arsenic. The values of As translocation factor (TF) and bioaccumulation factor (BAF) calculated for the aboveground and underground parts of most vegetables were below 1.0.

Micromorphology of Technosols developed on historical mining and metallurgical sites in the Tatra Mts., southern Poland

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Keywords: soil micromorphology, mountains, technogenic soils, mining, smelting

The study aimed to determine the main micromorphological properties of Technosols formed on historical mining and metallurgical sites in the Tatra Mts., southern Poland. Thirteen soil profiles were located in areas where mining (exploitation of Cu, Ag, Fe and Mn ores) and metallurgical activities were conducted between 15th and 19th century. The sites varied in type of anthropogenic parent material (mining wastes and metallurgical slags), vegetation cover (meadow, dwarf mountain pine, forest), altitude (918–1590 m a.s.l.) and landform (slope 0–45º). Studied Technosols were poorly developed with simple soil morphology (mainly A and C horizons). As a result of vegetation development, soil organic matter was accumulated in the topsoil. There were abundant rock fragments in the subsoil such as sedimentary carbonate rocks and metamorphic rocks, as well as metallurgical slags. The soil substrates had intergrain micro-aggregates, single grain and complex microstructure. Their microporosity was characterized by the presence of complex and single packing voids. The groundmass was dominated by coarse fragments (rock and mineral fragments, slags, charcoals). The micromass was not an abundant component of substrate of the studied Technosols. The micromass was characterized by crumb aggregates and sub-angular blocks in which organ residues and charcoals were found. Identified pedofeatures were as follow: organic compound coatings, iron compound coatings, hypocoatings and sulphide pseudomorphoses. The main effect of the pedogenesis processes was the formation of soil aggregates. The study showed the great influence of the parent material on physicochemical properties and on the micromorphological features of the studied soils.

Acknowledgements
This research was funded in whole by the National Science Centre, Poland (grant no. 2021/41/N/ST10/03129).

Iodine in Polish soils from the Baltic Coast to the Bieszczady Mountains

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Keywords: arable soils, iodine content

The extensive field of research enabled the iodine content of arable soils to be traced across most of the major landscape types (from lowland to highland to mountainous landscapes). The content of iodine in agricultural land soils in the changing natural environment of Poland was determined (as in the title).
The arsenic-cerium method was used. Correlation and coefficient of determination (Pearson's method) between iodine content in soils and other measured physical and chemical properties of soils were calculated.
Each of the measurement points helped to carry out an analysis taking into account the variability of the surface relief, location in the relief, age and origin of the relief, climate variability, as well as in relation to the variability of landscape types in a given fragment of Poland. However, it is possible that it will be too difficult, because the scope of laboratory work and the number of samples is insufficient to make such a conclusion.
In the Surfer program, a cartogram showing the variability of the iodine content with the distance from the sea was made. In a descriptive form, it can be stated that the iodine content in the humus horizons of the examined arable soils ranged from 1.6 to 5.0 mg/kg of soil. The highest values of 3.2–5.0 mg(I)/kg of soil were found in the soils of Pobrzeże Szczecińskie and in the soils of Pogórze Karpackie. The smallest amounts of iodine are found in arable soils in central Poland and range from 1.6 to 3.4 mg(I)/kg of soil.

The research was funded by the NCN research project 2017/01/X/ST10/01777.

Effect of rock fragments on soil hydraulic conductivity

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Keywords: rock fragments, hydraulic conductivity, soil matrix, permeability

The influence of rock fragments on soil permeability is not fully settled. It is generally assumed that the presence of rock fragments causes an increase in the tortuosity of water flow in the soil, thereby reducing the infiltration rate. On the other hand, it also may accelerate infiltration by forming new pores at the boundary between rock fragments and soil matrix. The research aimed to determine the effect of various shares of rock fragments and their average diameter on the hydraulic conductivity of the soil matrix known to be the soil's water-carrying medium. Experiments were carried out on artificial samples using calibrated sand with a diameter of 0.10 to 0.25 mm and Magura sandstone fragments with different volume fractions in the samples (31.7, 21.2, 15.1, 10.3, 7.1 and 2.9%) and average diameter.

The results showed that the soil matrix's infiltration capacity was affected by the volume and average diameter of rock fragments in the sample. With a relatively low share of rock fragments (2.9 and 7.1%), the water infiltration rate slowed down, while with a share of 31.7%, the flow accelerated by an average of 13.8%. With the share of rock fragments equal to 10.3%, the average value of the percentage loss of water flow rate was 0.01%. It suggests that with a rock fragment ratio of 10.3%, the influence of factors inhibiting and accelerating water flow in the soil is probably equal. Furthermore, it was found that the average rock fragments diameter of 20 mm had the lowest effect on the water permeability. In turn, diameters smaller than 10 mm caused a significant acceleration of water infiltration through the soil matrix, reaching up to 25% with a rock fragment content of 31.7%.

Production of bio-fertilizers based on organic waste and microorganisms in processes supporting sustainable development of crop plants

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Keywords: drought-resistant bacteria, humic substances, compost, biochar, digestate, inoculation technologies

The objective of EU food safety policy is to keep food undisturbed production chain lines. One of the fundamental measures is the use of bio-fertilizers or plant growth promoters instead of chemical or synthesized fertilizers, pesticides, and herbicides that poise several dangers to human and animal health. Bio-fertilizers are cost-effective and ecofriendly in nature, and their continuous usage enhances soil fertility.

In response to these needs, certain key actions as part of the LIDER XII project have been taken to develop innovative technologies for the production of microbiologically enriched bio-fertilizers. The final bio-fertilizer product will support the development and resistance of crop plants in conditions of water shortage, through (1) the use of organic matter and humic substances of biofertilizers from compost, biochar or digestate, (2) appropriate selection of drought-resistant bacteria, (3) introduction of phytohormones such as auxins, cytokinins, and abscisic acid and others contained in digestates and composts which supporting plant immunity. The effectiveness of developed bio-fertilizers in supporting drought resistance of plants will be tested in greenhouse and plot experiments simulating real environmental conditions.

Projekt finansowany w ramach konkursu Lider XII Narodowego Centrum Badań i Rozwoju; Nr LIDER/36/0184/L-12/20/NCBR/2021 „„Opracowanie innowacyjnej technologii wytwarzania wzbogaconych mikrobiologicznie bionawozów wspomagających zrównoważoną produkcję roślinną i jej adaptację do zmian klimatu„

Plant cover as an important soil-forming factor controlling Technosol evolution: a case study from a dump of the abandoned iron ore mine in Czarniecka Góra, south-central Poland

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Keywords: Technosols, mining wastes, spontaneous plant succession, soil evolution

The objective of the study was to examine the transformations of chemical and microbiological properties of Technosols following spontaneous development of forest habitats on dumps of the former Fe ore mine in Czarniecka Góra, south-central Poland. Despite the similar age (about 60 years), the soils showed differences in chemical and biochemical properties (enzymatic activity), which was related to the different degree of development of the plant cover appearing on the dump due to natural succession. The emergence of vegetation and its further development caused acidification and leaching carbonates from the topsoil, as well as the accumulation of soil organic matter (SOM) manifested by an increase in the content of total organic carbon (TOC) and total nitrogen (TN) in the topsoil. Vegetation influenced the amount of TOC and TN, especially of the light SOM fraction in the surface horizons, and in the mineral horizons (the accumulation of the heavy C fraction). The highest magnetic susceptibility was found in the topsoil of Technosols in places with the most advanced succession. This suggests that the progress of pedogenesis caused by the development of vegetation probably caused the transformation of minerals towards phases with higher magnetic susceptibility. The development of vegetation on the dump promotes the development of microorganisms in technogenic soils, which is manifested by an increase in the enzymatic activity of soils in the topsoil. The regenerating plant cover provides the necessary substrates for enzymatic reactions. High activity of enzymes involved in the cycle of C, N and P was determined in the studied Technosols. The conducted research has shown that plant cover is one of the most important soil-forming factors controlling the direction of changes in the properties of Technosol substrate and the course of soil-forming processes in the initial technogenic soils on post-industrial waste dumps.

Diversity of Technosols developed on mine dumps of the historical copper mines in Miedziana Góra and Miedzianka, Holy Cross Mts., south-central Poland: pedological, mineralogical and geochemical approach

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Keywords: Technosols, mining wastes, toxic trace elements, mineral transformations

The aim of the study was to determine 1) properties, mineral transformations and chemical composition of Technosols developed on historical mine dumps of the Miedziana Góra and Miedzianka post mining areas, Holly Cross Mts., as well as 2) chemical forms of Cu, Zn, Pb, Cd, As, Cr, and Ni based on sequential extraction. The studied Technosols were weakly developed soils with a simple soil profile comprising (1) C horizons in the subsoil, and (2) thin organic (O) and humic (A or AC) horizons in the topsoil. One profile contained a buried humic horizon. The pH_{H2O} of soils was 5.5–8.1. High pH_{H2O} values in the soils were due to occurrence of carbonates (up to 25%). The highest content of total organic carbon (TOC) and total nitrogen (TN) was found in Oi horizons (31.4–48.7% of TOC, 1.0–1.9% of TN), as well as in A and AC horizons, including buried A horizon (1.2–10.3% of TOC, 0.13–0.95% of TN). Magnetic susceptibility (χ) of soils was in the range between 6.0 and 171.3 $\times 10^{-8}$ m^3 kg^{-1}. In each profile, the highest χ values were typical of A horizons, including the buried humic horizons. The most common minerals present in all profiles were quartz, kaolinite and mica. There were also admixtures of carbonates (dolomite, calcite), feldspars (orthoclase and albite), jarosite, goethite and traces of Fe sulphides. Microscopic analyses showed that soil substrate was subject to transformations of sulphides into Fe oxides. Moreover, pedogenic Cu carbonates were detected. Technosols were enriched in Ag, As, Cd, Co, Cu, Hg, Mo, Ni, Pb, Sb, Zn, U and Th. Zinc, Cu, Pb and Ni occurred in medium-mobile or hardly mobile forms. Cadmium showed high percentage of mobile forms. Arsenic was mostly bound with Fe oxides. Chromium occurred mostly in immobile forms.

Mineral composition of clay fractions from soils on long-term agricultural experiments in Skierniewice and Chylice, central Poland – preliminary studies from selected fertilization and tillage combinations

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Keywords: long-term experiments, soil, clay minerals

The objective of the study was to examine the mineral composition of clay fractions from soils on long-term agricultural experiments in Skierniewice and Chylice, central Poland. The experiments belong to the Institute of Agriculture, Warsaw University of Life Sciences – SGGW. Soil samples were taken from topsoil within plots representing selected fertilization and tillage combinations. Fine clay (<0.2 μm) and coarse clay (2–0.2 μm) fractions were separated from soils using Jackson's procedure involving e.g. removal of carbonates and soil organic matter (Fe oxides were not removed) followed by centrifugation. Clays were saturated with Mg and K and oriented mounts were prepared on glass slides. Mineral composition of clay fractions was determined by X-ray diffraction (XRD) method.

Mica and kaolinite were predominating phases in 2–0.2 μm fraction from soils in Skierniewice. Significant amount of quartz and feldspars (orthoclase and albite) occurred in that fraction. Admixtures of mixed-layer minerals (MLMs) (probably mica-smectite), chlorite, amphibole and lepidocrocite were also identified. Mineral composition of <0.2 μm fraction from Skierniewice soils was dominated by MLMs followed by mica and kaolinite. Moreover, lepidocrocite and traces of quartz and feldspars occurred in fine clay fraction. The 2–0.2 μm clay fraction from soils in Chylice was dominated by MLMs followed by mica and kaolinite. Small amounts of quartz and feldspars were identified. There were also admixtures of amphibole. The <0.2 μm fraction from Chylice soils was overwhelmingly predominated by MLMs. Also, admixtures of mica and kaolinite occurred in that fraction. Preliminary studies shows that soils from long-term experiments in Skierniewice and Chylice differ in mineral composition of clay fractions. This may influence other soil properties (e.g. water-air conditions, structure, sorption properties).

Research works are co-financed by the National Center for Research and Development – NCBiR, Poland (EJPSOIL/I/78/SOMPACS/2022).

Soil diversity of European beech (*Fagus sylvatica*) communities of Western Pomerania

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Keywords: Natura 2000, calcium content

European beech (*Fagus sylvatica* L.) forests are a characteristic element of forest plant communities in Western Pomerania. The studied beech forests belong to the Natura 2000 protected habitats 9130-1 (*Galio odorati-Fagetum*), 9110-1 (*Luzulo pilosae-Fagetum*) and 9130-2 (*Fagus sylvatica* - *Mercurialis perennis*). Compared to the other plant communities, the soils of the *Fagus sylvatica* - *Mercurialis perennis* community showed the most distinct characteristics. Characteristic features include: a high organic carbon and calcium content and a high thickness of the humus horizon. The calcium content in the humus horizon was very high. Surprising for the tolerance range of beech was the high moisture content of the investigated soils. The increased moisture content favoured the accumulation of organic carbon. The carbon content in some cases was close to values characteristic of organic horizons.

The influence of long-term organic fertilization on the optical properties of the humin fraction

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Keywords: humic substances, organic fertilization, UV-Vis, fluorescence properties

The method of soil management and fertilization may impact the amount of humin (HM) – the most recalcitrant fraction of SOM. The aim of the research carried out under the SOMPACS project was to determine the effect of organic fertilization on the properties of HM on the basis of its optical parameters (UV-Vis and fluorescence).

The research was based on long-term field experiment continuously running since 1921 in Skierniewice on plots with four fertilization variants: NPK (H1); NPK + manure (H2); NPK + legumes (H3) and NPK + manure + legumes (H4). All field experiments were carried out in crop rotation on luvisol derived from loamy sand on loam. Manure was applied every 5 years in dose of 30 $t.ha^{-1}$.

Soil samples were taken in three repetitions from humus horizon. HM was isolated by exhaustive extraction of fulvic and humic acids with NaOH, then remaining material was digested with 10% HF/HCl. Finally, HM was dialyzed and freeze-dried. UV-Vis and fluorescence spectra were recorded after HM dissolution in a DMSO+H_2SO_4 (v.v. 94% : 6%), with constant carbon content in the solution of 10 $mg.dm^{-3}$. Based on the obtained spectra, several UV-Vis and fluorescence coefficients were calculated.

The obtained results indicate that the use of legumes had the greatest impact on the optical properties of HM. The obtained results revealed a general trend (H3 > H4 > H1 = H2) indicating different ability of studied HM to absorb electromagnetic radiation and to emit in the form of fluorescence. The calculated specific fluorescence coefficients revealed a greater degree of transformation of organic matter in H3 and H4, where legumes were used. The structures of these HM are characterized by greater conjugation of double bonds and a larger molecular size compared to those originated from other fertilization variants.

The research was financed by NCBR (EJPSOIL/I/78/SOMPACS/2022).

The influence of different doses of sewage sludge and sewage sludge used together with mineral wool on the content of organic carbon in light soil

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Keywords: light soil, organic carbon, sewage sludge, mineral wool

The unsatisfactory quality of soils in Poland, the processes of their dehumus removal, the need for reclamation of degraded soils and the insufficient production of natural fertilizers justify the need for natural management of municipal sewage sludge. This direction of their use is justified by the high abundance of sludge in organic matter and fertilizing components.

The aim of the study was to assess the impact of different doses of municipal sewage sludge and sewage sludge used together with mineral wool on the formation of organic carbon content in light soil.

The tests were carried out in pots with a capacity of 12 dm^3, in which soil with a granulometric composition of slightly loamy sand was mixed with municipal sewage sludge in doses of 10 and 100 $Mg \cdot ha^{-1}$ d.m. and sewage sludge in doses of 10 and 100 $Mg \cdot ha^{-1}$ d.m. used together with mineral wool. The control objects were unfertilized soil and soil fertilized with NPK. A mixture of grasses was grown in the vases for 3 growing seasons. Soil samples were taken for laboratory analyzes at the beginning of the research and at the end of each growing season. Total organic carbon (TOC) was determined in the collected samples by the combustion method using the TOC-VCSH apparatus with the SSM-5000A module (Shimadzu).

The obtained results showed that the addition of sewage sludge and mineral wool had a significant effect on the organic carbon content in the soil. Sewage sludge applied at a higher dose (100 $Mg \cdot ha^{-1}$) increased the organic carbon content compared to the lower dose (10 $Mg \cdot ha^{-1}$) by 2.45 $g \cdot kg^{-1}$, i.e. by 32.5%. These ratios in the case of a mixture of sewage sludge and mineral wool were 2.07 $g \cdot kg^{-1}$ - 25.3%, which should be associated with a more intensive process of mineralization of the organic matter.

Buffer capacity of soils - a key soil properties influencing soil resistance toward chemical degradation

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Keywords: Soil buffering capacity, acidification, soil alkalization

One of the key factors determining the soils resistance to chemical degradation is their buffer capacity. Taking into consideration that over 90% of parent materials of Polish soils are acidic and additionally alkaline metals are leached out by migrating water these soils are very prone for accelerate acidification. As soil pH is important factor controlling elements mobility, microorganisms activity, soil resistance for hydrogen or hydroxides ions inputs determine soil quality.

The aim of this work was to depict which soil properties shaped soil buffering capacity in agricultural areas. For this study 11 soil profiles in catenary system were chosen from the high terrace of the Warta River. Soil buffering capacity was done by modified Arrheniuos method.

Soil resistance to acidification depended on: calcium carbonate and iron oxides contents and the degree of base saturation. The qualitative composition of the sorption complex was more important than its size in shaping soil buffer capacity toward hydrogen cation. Whereas, soil resistance toward alkalization was shaped by: organic carbon, clay fraction contents, hydrolytic acidity and CEC. Soil buffer capacity toward hydroxide ions was more related with the capacity alone rather than its composition.

Granite and gneiss: long-term bioweathering study

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Keywords: *Pseudomonas fluorescens*, root exudates, dissolution, rock, environment

Number of factors influencing bioweathering causes that the rates of rocks and minerals dissolution are not yet fully predictable. In addition, for many years, microbial influences on solid materials have been underestimated, and their real impact may, in fact, be more important than previously expected. Granite (igneous rock) and its metamorphic counterpart gneiss reveal similar chemical and mineralogical compositions, but these rocks differ in texture. Thus, research hypothesis stated that bioweathering of rocks characterized by similar mineralogical compositions, but various textures takes place at different rates and leads to different bioweathering sequences of individual minerals. One-year long bioweathering experiment considered rock exposure to organic rich solutions (artificial root exudates pH 3.5 and pH 6.7), organic-free solutions (pH 3.5 and pH 6.7) and siderophore producing bacteria *Pseudomonas fluorescens*. Bioweathering was analyzed tracking elements dissolution and alteration features on rock surface. The results demonstrated that artificial root exudates show the most important impact in terms of rock dissolution. Iron was found to be more easily mobilized as compared to other elements regardless of bioweathering conditions. It has also been demonstrated that bacteria play an important role in bioweathering of granite and gneiss affecting dissolution and elements capturing in biomass. We conclude that individual minerals react differently under specific bioweathering conditions, and any reaction is strongly governed by: (i) the type of agent acting, (ii) the proportions between each mineral present in a rock sample as well as (iii) rock texture.

The problems with procedure applied to the soil's land valuation system in Poland

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Keywords: land valuation, procedure of land valuation

The developing economy, buildings and renewable energy sources construction have created a demand for land. However, the state government must ensure that the best soils, in the interest of all of us, are used for agriculture and are not devastated. But how to determine which soils should be protected and which can be used for other purposes? This was the purpose of the regulation related to the rules of land valuations (Journal of Laws of 1956, No. 19, item 97), called basic of land classification in Poland.

In 2012, a new Regulation of the Council of Ministers was published (Journal of Laws of November 14, 2012) on the land valuation of soils classification. The regulation currently in force does not specify the procedure in administrative proceedings in the process of soil's land's valuation. In principle, the entire procedure depends on the decision of the local self-government authorities.

Therefore, individual local country authorities independently developed procedures that differ significantly in individual offices.

The NIK (Supreme Audit Office) has dealt with the problem of soil's land valuation. As a result of the inspection, a report was prepared on July 13, 2021, in which the current legal status, the skills of classifiers in the surveyed area were analyzed and a program was formulated to correct the existing status quo. The NIK auditors suggest that Mayor's Offices should "announced the tender" to select a classifier so that the ordering principal couldn't choose a classifier on his own hand, because, there could be a conflict of interest. Most local mayors have introduced such an element to the procedure, while some have not. The presentation will discuss the main problems in the applied procedures together with a proposal to unify them.

Effects of reclamation on organic carbon sequestration in post-mining soils

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Keywords: post-mining soil, reclamation, organic carbon sequestration

Increasing anthropopressure is causing disruptions to ecosystems, changes to the earth's surface and global cycles of elements, including carbon. The consequences are global environmental crises, such as the greenhouse effect or progressive environmental degradation. In post-mining soils, the organic carbon content is up to 83% lower compared to undisturbed areas. Exposed or deposited post-mining substrates become the parent rock of the soils that are being formed. Reclamation of mining areas improves their productivity, sequestration of lost carbon (C) and reduction of CO 2 emissions.

The assessment of the potential of reclaimed soils for carbon sequestration was carried out in: (i) a plot experiment in which the reclamation efficiency of sewage sludge, mineral wool and compost was assessed, taking into account the method of use and the time elapsed since its completion; (ii) the overburden heap of an open-pit sulfur mine, taking into account the type of land and the species composition of the tree stand. In soil samples from the depth of 0-20 and 20-40 cm, the content of organic carbon was determined, the obtained results were converted into humus content expressed in $Mg \cdot ha^{-1}$.

The results showed that reclaimed mine soils have a significant potential for carbon sequestration. Exogenous organic matter significantly and permanently increased the content of humus in the reclaimed soil, to the greatest extent in the soil fertilized with sewage sludge applied together with mineral wool and compost. The unequivocal effect of the method of use was not demonstrated, only within the variant without organic fertilization a tendency to a more favorable effect of grassland was observed. On the overburden heap the highest sequestration of organic carbon was recorded on clays, and the smallest in loose sands. Forest species composition had a greater impact on carbon sequestration in soils with a lighter granulometric composition.

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Organization of the 31st Congress of the Soil Science Society of Poland "Soil in the changing World", 11-16 September 2023, Poznań - task financed under contract DNK/SN/546998/2022 from the funds of the Minister of Education and Science

Ministerstwo Edukacji i Nauki

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