ADAPTATION STRATEGIES FOR SOIL AND WATER CONSERVATION IN A CHANGING WORLD

Proceedings

Bořivoj Šarapatka, Marek Bednář and Patrik Netopil
(Eds.)

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and the Dean of the Faculty of Science of Palacký University in Olomouc

present

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ADAPTATION STRATEGIES FOR SOIL AND WATER CONSERVATION IN A CHANGING WORLD

Bořivoj Šarapatka, Marek Bednář and Patrik Netopil
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CONTENTS

Dear colleagues,

Before the Covid pandemic came along, we had already decided, together with Czech and international organizations, that we would organize a conference in the university city of Olomouc on the topic of adaptation strategies for soil and water conservation. We discussed the definitive focus for a long time, including whether to prioritize the changing climate in the title. In the end, we took the title more broadly to emphasize the changing world and the many changes taking place within it. In Olomouc, we are thus following on from the international conference on "Degradation and revitalization of soil and landscape", which we organized at the same venue in 2017 in cooperation with soil science associations of the V4 countries. We are meeting in Olomouc, where you will feel the genius loci of the historical and academic city. As early as prehistoric times, the area above the floodplain of the Morava River provided an attractive place for settlement. Over time, the city gradually developed, and in the Middle Ages it became the center of power of the whole of Moravia, one of the three historical lands of today's Czech Republic. In the mid 16th century, a university was founded here, the second oldest in the Czech Republic. So we meet at a time when the university is celebrating 450 years of existence.

Agricultural and partly also forested land has always been the wealth of the region known as Haná, and has ensured the livelihood of the local population. It is no different today. Unfortunately, as in other countries, we are witnessing many degradation influences that disrupt the land's productive and non-productive functions. This applies not only to the area in which we will meet for a few days, but globally. I am glad that experts in soil and water protection, from a number of countries with different natural conditions, will gather at the conference. It will be an opportunity for meaningful discussion and exchange of experience from all around the world. I am pleased that people who work in the landscape, or who influence the face of the landscape with their decisions, are participating in the conference or are interested in its conclusions. This is evident in the organizations which have helped in the preparation of the event.

When planning annual professional events, in which the soil science societies of the Czech and Slovak Republics cooperate, we always try to propose a variety of excursions so that the participants can get to know the issues discussed during the lectures and discussions. It is no different for this international conference, where excursions will provide an opportunity to visit two areas with different conditions for management and landscape protection. One is in the agricultural production area of South Moravia, and the other is in the higher altitudes of the Beskydy Mountains.

I am convinced that the organizing team will succeed in creating a pleasant atmosphere for you in Olomouc, where we will not only gain new insight into important issues, but will also enjoy four pleasant days of interesting discussion and accompanying events.

On behalf of the organizing and scientific committee of the conference.

Bořivoj Šarapatka
Chairman
of the Czech Society of Soil Science

PROGRAM

MONDAY 19th JUNE 2023

17:00–18:00 Registration
18:30 Welcome drink

TUESDAY 20thJUNE 2023

10:00–10:45 Opening ceremony

10:45–12:00 Keynote speakers

10:45 **Possible policies and actions to protect the soil cultural and natural heritage of Europe (*Costantini*)**

11:15 **Soil Erosion Monitoring of Agricultural Land of Czech Republic *(Pavlík, Hřebíčková, Kapička, Šarapatka, Dumbrovský, Bednář)***

11:45–12:00 Discussion

Lunch

Session: **ANALYSIS OF SOIL AND WATER PROTECTION ON A GLOBAL AND LOCAL SCALE**

13:15 **Understanding and mitigating extreme diffuse pollution from Norwegian agricultural watersheds (*Confesor, Øygarden, Bechmann*)**

(Lectures marked in bold are introductory lectures in individual thematic blocks)

13:35 Topography-based detection of Ephemeral Gullies suitable for protection by Grassed Waterways in Eastern Austria (*Brunner, Schmaltz, Steger, Strauss*)

13:50 Ephemeral gullies and its characteristic in conditions of the Czech Republic (*Dumbrovský, Sobotková*)

14:05 Comparison of the Physical Properties of Soils on Transverse Profiles along the Gullies (*Živanovič, Rončevič, Ćorluka, Čebašek, Rupar*)

14:20 Natural and bio-technical water retention measures in the Švihov reservoir catchment – watershed management, researchers, designers and farmers work together (*Zajíček, Fučík, Hejduk, Kvítek*)

14:35–15:00 Discussion

15:00–15:30 Coffee break

15:30 **The effect of concentrated flow on sediment and nutrient retention in vegetated filter strips (*Schmaltz, Ramler, Strauss*)**

15:50 Impacts of climate change on erosion processes (*Podhrázská, Kučera, Karásek, Pochop*)

16:05 Erosion modelling in Norway: changing needs and opportunities (*Barneveld*)

16:20–16:30 Discussion

16:30–17:30 Poster session

19:00 Social evening

WEDNESDAY 21st JUNE 2023

Session: **ANALYSIS OF SOIL AND WATER PROTECTION ON A GLOBAL AND LOCAL SCALE**

9:00 **Changes in soil fauna (Acari: Oribatida, Mesostigmata; Nematoda) communities in Scots Pine (*Pinus sylvestris L.*) forests across S-N European gradient (*Kamczyc, Pers-Kamczyc, Wierzbicka, Dobies, K. Urbanowski, Malica, Skorupski, Oleksyn*)**

9:20 Tolerance of ectomycorrhizal mycelium of *Paxillus involutus* exposed to Pb (*Szuba*)

9:35 Vegetation growth dynamics in the water level fluctuation zone of the Three Gorges Reservoir and its responses to habitat stressing (*Rao, Tang*)
or
An experimental study on snowmelt – wind – rainfall compound erosion on sloping farmlands of Chinese typical Mollisol region (*Zheng, Zhao*)

9:50 Precious Soil and Water Resources – Sustainable Land Management (*Zlatić*)

10:05–10:20 Discussion

10:20–10:50 Coffee break

Session: **RESEARCH INTO THE IMPACT OF ANTHROPOGENIC AND NATURAL INFLUENCES ON SOIL AND WATER FROM THE POINT OF VIEW OF PRODUCTION AND NON-PRODUCTION**

10:50 **Possible hazards associated with the use of wastewater and sludge from wastewater treatment plants in agriculture (*Kodešová, Švecová, Klement, Fér, Fedorova, Nikodem, Grabić*)**

11:10 Economic Effects of Applying the Future Agricultural Production Structure Model (FAPSMS): The Case of Barička River Basin (*Tričković, Rončević, Živanović, Grujić, Stefanović, Jovanović, Zlatić*)

11:25 Methodology to quantify the global agricultural crop footprint including soil impacts (*Ascaso, Palacino, Valero, Valero*)

11:40 The Effects of Water Erosion on Soil Properties and Crop Yield in a Highly Exploited Agricultural Area of South Moravia, Czech Republic (*Šarapatka, Bednář, Černohorský*)

11:55–12:15 Discussion

Lunch

13:30 How effective are undersown crops and strips-tillage at mitigating soil erosion and pesticide transfer in maize crops? Results and insights from field trials (*Clement, Bielders, Degré, Manssens, Foucart, Pigeon, Blondel, Huyghebaert*)

13:45 Impact of plastic pollution on the quality of arable soils in the Sava and Danube river valleys (*Saljnikov, Grujić, Jovković, Stanković, Krnjajić, Marjanović*)

14:00 Soil organic carbon stock in a Colluvisol profile: application of hyperspectral imaging to study soil organic carbon variability in a deep soil profile (*Reyes Rojas, Žížala, Matoušková, Zádorová*)

14:15 Forest logging residues as an important source of nutrients and carbon sink on the clear-cuts area (not only) after the bark beetle calamity (*Šrámek, Fadrhonsová, Neudertová Hellebrandová, Novotný*)

14:30 Application of biochar in a Chernozem in northern Kazakhstan: effects on soil properties and spring wheat yield (*Lo Papa, Toktar, Conte, Shayakhmetova, Bakirova, Ahmetov, Mukanova, Balakhmetova, Dazzi*)

14:45 Development of soil organic carbon stock on agricultural soils of Slovakia (*Barančikova, Koco, Makovníková, Halas, Skalský, Kobza*)

15:00–15:20 Discussion

15:20–15:40 Coffee break

NATIONAL AND INTERNATIONAL GOALS, STRATEGIES AND DIRECTIONS FOR SOIL AND WATER CONSERVATION FROM THE POINT OF VIEW OF PRESENT AND FUTURE GENERATIONS

15:40 **UNCCD – the Rio Convention for binding the issues with soil and water conservation (*Houšková*)**

16:00 Watershed health monitoring-based strategy: A tool for watershed adaptive management (*Sadeghi, Meisina, Maeker*)

16:15 Living labs and lighthouses lead towards healthy soils in Europe (*Sobocká*)

16:30 Strategy and priorities of soil cover development research and monitoring in Slovakia (*Kobza*)

16:45–17:00 Discussion

17:00–18:00 Poster session

18:00 Meetings of ESSC, Czech Society of Science, Societas Pedologica Slovaca, etc.

THURSDAY 22nd JUNE 2023

PROFESSIONAL EXCURSIONS

FRIDAY 23rd JUNE 2023

9:00–11:00 Keynote speakers

9:00 **Mapping of soil-based ecosystem services and soil threats of European arable lands – A systematic review and new approaches (*Reyes Royas, Coblinski, Cornu, Piccini, Saby, Vašát, Borůvka*)**

9:30 **Changing paradigms in combating desertification. A perspective from Mediterranean Europe (*Rubio*)**

10:00 **Forest soils of the Czech Republic – current state and change expected after the bark beetle outbreak (*Šrámek, Borůvka, Neudertová Hellebrandová, Vašát, Sáňka O., Fadrhonsová, Novotný, Sáňka M.*)**

10:30 **A win-win strategy for consolidating soil awareness in politics and reaching an effective soil governance in society (*Dazzi, Lo Papa*)**

11:00–11:30 Discussion

11:30–12.30 Conclusion and Closing Ceremony

Lunch

POSTER PRESENTATIONS

Session: **ANALYSIS OF SOIL AND WATER PROTECTION ON A GLOBAL AND LOCAL SCALE**

The Potential of Hyperspectral Aerial Surveys for Identifying Waterlogged Areas in Agricultural Landscapes (*Bednář, Netopil, Šarapatka*)

Enhancing direct runoff estimates through modification of the NRCS-CN method (*Caletka, Drbal, Fučík*)

Evaluation of the agroecosystem service potential – regulation of the soil erosion (*Pálka, Makovníková*)

Drop Size Generated by Dripping Rainfall Simulators for Soil Research–Review (*Rončevič, Živanovič, H. van Boxel, Iserloh, Štrbac, Kašanin-Grubin, Antić*)

Measures for water retention in landscape in the Czech Republic (*Štěpánková, Dzuráková, Osičková*)

Interactive effects of wind velocity and slope gradient on splash erosion (*Kallehouei, Sadeghi, Khaledi Darvishan*)

Long-term agrochemical testing of agricultural soils related to natural and socio-economic conditions of Czech Republic (*Houška, Šipoš, Kaláb, Vašát, Pavlů, Penížek, Bednář, Václavík, Šarapatka, Borůvka*)

Monitoring of soil properties and groundwater level in alluvial floodplain forest (*Sedlák, Pospíšilová, Prudil, Basu*)

Multi-level nitrogen balance at temperate forests in the territory of the Czech Republic (*Samec, Rychtecká, Sirota*)

Migration of organic carbon and Ca in soddy-podzolic soil limed by chalk: laboratory trial (*Litvinovich, Lavrishchev, Bure, Zhapparova, Aisakulova, Gömöryová*)

Potentially toxic elements in agricultural soils in the Czech Republic – state and development (*Poláková, Reininger, Kubík*)

A study of salinization of agricultural soils in the Maisky district of the Pavlodar region of Kazakhstan, using remote sensing data (*Rakhmanov, Šarapatka, Alibekova, Hekera, Černohorský, Bednář, Smanov*)

Response of soil chemical and biochemical properties to biochar and (biochar + compost) application under Zea mays in a degraded environment (*Notario Del Pino, González Correa, Raya Ramallo, Arco Lázaro, Haroun Tabraue*)

Impact of black cherry (*Prunus serotina Ehrh.*) on soil mites (*Acari: Mesostigmata*) in Scots pine (*Pinus sylvestris L.*) stands growing on post-agricultural lands (*Malica, Urbanowski, Raczka, Skorupski, Kamczyc*)

Determination of soil losses by wind erosion to support proposals for optimal measures to protect soil from wind erosion (*Kučera, Podhrázská, Blecha*)

Session: **RESEARCH INTO THE IMPACT OF ANTHROPOGENIC AND NATURAL INFLUENCES ON SOIL AND WATER FROM THE POINT OF VIEW OF PRODUCTION AND NON-PRODUCTION**

Byzantine agricultural terraces and their impact on soil conservation water distribution and fruit trees growth in the central Negev Highlands desert south Israel (*Ashkenazi, Chen*)

Degradation of traditional vineyards in Slovakia by abandonment and soil erosion: A case-study of Vráble viticulture district, Slovakia (*Lieskovský, Kenderessy*)

Soil cover change since Systematic Agricultural Soil Survey in the 1960s – Czech Republic (*Pavlů, Penížek, Zádorová, Žížala, Houška, Borůvka, Biney*)

Soil cover around the world's deepest flooded abyss near Hranice (*Vlček, Šimečková, Oppeltová, Sedláček, Geršl*)

Updates in the land evaluation of the agricultural land fund of the Czech Republic (*Blecha, Pavlík, Hřebíčková*)

Climate regulation ecosystem services in selected regions of Slovakia (*Makovníková, Pálka, Kološta*)

Changes in watershed sustainability due to air pollution (*Mirchooli, Zabihi Seilabi, Sadeghi*)

Vertical distribution of radionuclides in soil and its effect on groundwater vulnerability (*Kratina, Juranová, Marešová, Sedlářová, Kadlecová, Novák, Pohlová, Datel*)

The influence of different tillage methods in the interrow of vineyards on soil erosion (*Čížková, Zemánek, Burg*)

Effects of inoculation of soil microorganisms on organic matter, stability of aggregates and soil available phosphorus under freeze-thaw cycle (*Gharemahmudi, Hamidreza Sadeghi, Najafinejad*)

Do soil properties reflect the changes in a forest stand structure? A case study from the primeval beech forest in Havešová, Slovakia (*Židó, Šumichrast, Kucbel, Gömöryová*)

Changes of chemical properties and carbon stock in forest soils after clearcutting (*Fadrhonsová, Šrámek, Novotný, Tejnecký, Valtera*)

The effect of forest management on physico-chemical properties of sandy soils (*Gömöryová, Židó*)

Relationship between forest management and soil water content dynamics as a forest ecosystem services factor (*Homolák, Kašiar*)

Soil development on metamorphic rocks in the conditions of protected and anthropogenically affected areas of forest ecosystems (*Žigová, Šťastný, Mikysek*)

The effect of whey-based hydrogel addition on soil water holding capacity and availability of nutrients (*Čechmánková, Skála, Horvátová, Vácha*)

Chemical changes in Chernozems as affected by water erosion (*Pospíšilová, Boturová, Plisková, Menšík*)

Pesticides in soil and water in chosen agricultural catchments in the Czech Republic (*Konečná, Karásek, Zajíček, Nováková, Sáňka, Halešová*)

Preliminary results of the geochemical, hydrogeological and pedological study of the Javoříčko–Mladeč karst area (*Novotný, Novotná, Kryštofová, Hadacz, Baldík, Buriánek, Rez, Sedláček, Janderková, Müller, Drahoš*)

ORAL PRESENTATIONS

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

Edoardo A. C. COSTANTINI[1)]

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Keywords: soil health, world heritage sites, soil literacy, soil strategy, landscape

Soils are healthy when they can continuously provide several ecosystem services. Among them, there are cultural services for humans and the archive of geological, geomorphological, and archaeological heritage. Yet strategies and policies aimed at preserving and enhancing the cultural and natural heritage of the soil are partial and rare.

This lecture provides a state of the art and sets a framework to give inspirational ideas for designing policies and actions to promote soil cultural and natural heritage protection, with particular reference to Europe.

Through an online and documental analysis, the arguments treated in the published papers dealing with soil as a natural or cultural heritage are summarized, and the current main policies and actions to preserve our natural and cultural heritage at the global and European levels are reported and analysed. A focus on the national level has been also introduced, to exemplify policies and actions aimed at protecting the natural and cultural heritage and including reference to soil features.

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

In this context, some of the main values that characterize the cultural and natural heritage are excluded by soil policies, namely, the scientific and didactic interest, recreational, scenic, and aesthetic values, and the inspirational, religious, identity, ethnical and ethical relevance, which are acknowledged instead for other natural bodies, such as geological and geomorphological sites.

Among the possible European strategies that could be implemented to valorise the 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 to increase soil literacy, which is one of the scopes of the Soil mission. In the Natura 2000 program, the inclusion of the descriptions of the presence of pedosites could be an immediate action. This inclusion would not only increase both the cultural and naturalistic values of the areas but also favour soil literacy and the collaboration between soil scientists and professionals from other disciplines, thus enhancing a transdisciplinary approach to soil health, as well as its societal connectivity.

Soil erosion monitoring of agricultural land of the Czech Republic

František PAVLÍK[1] – Iva HŘEBÍČKOVÁ[1] – Jiří KAPIČKA[2]
Bořivoj ŠARAPATKA[3] – Miroslav DUMBROVSKÝ[4] – Marek BEDNÁŘ[3]

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Keywords: monitoring of erosion, erosion event, water erosion, agricultural land, probability model

Water erosion is one of the most widespread damaging and degrading process of agricultural land of the Czech Republic, followed by other processes reducing production and nonproduction soil capacity. To reduce a negative impact of the erosion on agricultural land a suitable agricultural practice should be applied. It is also necessary to have sufficient information about repeatedly affected locations. Consistent and well-targeted implementation of stricter soil protection management in problematic areas leads to eliminations of the damages caused by water erosion. These reasons required an innovative process named Monitoring of soil erosion of agricultural land followed by Solution for repeated soil erosion events.The State Land Office (SLO) in cooperation with Research Institute for Soil and Water Conservation (RISWC) established the project 'Monitoring of Soil Erosion of Agricultural Land' in 2012. This is a unique nationwide monitoring based on the notifying of erosion events by the public. Since 2012, in this system, have been recorded so far 2.574 erosion events from which 264 were repeated. This project is financed by state budget through SLO.

Anybody can notify erosion event to authorized employee of SLO. SLO has 100 such employees who are regionally distributed (this is not a full-time

job task). The regionally relevant employee consequently ensure a field reconnaissance, take the photo documentation and record results via web site (https://me.vumop.cz) to the database. RISWC workers check the record in the database and, if necessary, add other relevant information. The outputs of the monitoring represent basis for effective state administration and decision-making processes, as feedback for the setting of soil erosion control measures in the agricultural subsidy policy, design of soil erosion control measures in Land Consolidation process and for the preparation of new policies in the field of soil protection. Since 2017, evaluation of selected erosion events (repeated and events with more significant economic damage) is in progress. If the evaluated erosion event meets the selected criteria, the rules for farming within the agricultural subsidy policy are tightened at this recorded area. Thus, the stricter conditions for growing in respect of soil erosion unfavourable crops and using agrotechnical soil erosion control measures and practices will have to be respected. So far, the management of approximately 5.500 ha of the areas have been tightened in this way.

From 2021, it is also part of the national legislation in protecting of agricultural land against soil erosion. We still lack a clearer overview of the real extent of soil erosion, in the Czech Republic. That is why SLO and RISWC developed, and this year implemented, the Probability Model of Soil Erosion. This model is using the processing and evaluation of satellite images (see Fig. 1) and relevant precipitation episodes and is applied to the entire territory of the Czech Republic. This system therefore detects erosion events in an automated way and provides a realistic view of the extent of emerging erosion events in the Czech Republic.

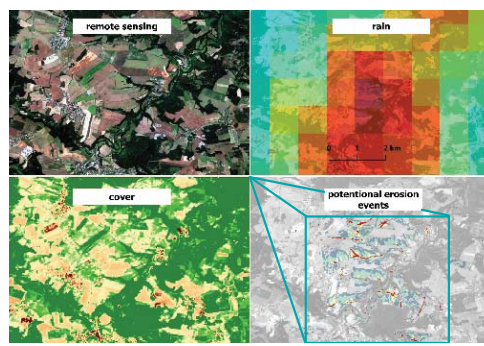

Figure 1: Probable Erosion identified by the Model of Soil Erosion

The main result of this project is nationwide data collection of erosion events which provides feedback of the effectiveness of control measures and are used to define measures for reduction of the negative effects of erosion events. Also it could be the basis for setting the subsidy policy.

Acknowledgement

The web portal Monitoring of Soil Erosion of Agricultural Land was created by the order of Minister of Agriculture in 2012 to ensure protection of agricultural land against degradation due to soil erosion.Thanks to cooperation between state administration and non-profit research and educative institution the function of the project is ensured. The state administration has the role of an executor, the research side represents a professional guarantor. For more information, a detailed description of working methods and contacts visit the website https://me.vumop.cz.

Understanding and mitigating extreme diffuse pollution from Norwegian agricultural watersheds

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Keywords: diffuse pollution, sediments, nutrients, extreme events, climate change

The agricultural areas are known to be the main source of diffuse pollution (sediments, nitrogen, and phosphorus). The magnitude of these non--point source losses is often influenced by antecedent land conditions and prevailing agricultural practices. In the future, the expected increase in precipitation intensity and magnitude would result in frequent wetter conditions and the increase in temperature would result in longer growing season in the Nordic countries. These changing climate conditions could further exacerbate the pollutant loads. Extreme events that can lead to high losses are also projected to occur more frequently as well as different winter conditions (e.g., more snow-melt frequency). Thus, it is essential to evaluate the occurrence of large to extreme events and their associated nutrient and sediment losses for planning and implementing of efficient measures to mitigate these losses. In Norway, the Norwegian Agricultural Environmental Monitoring Programme JOVA (Program for jord- og vannovervåking i landbruket) monitors the precipitation, agricultural runoff, nutrient loads, and management practices in several catchments since 1991. The precipitation, runoff, diffuse losses (sediment, nitrogen, and phosphorus), and agricultural practices from four agricultural catchments: Mørdre, Skuterud, Time, and Vasshaglona representing cereal, cereal, pasture/dairy, and vegetable areas, respectively, were evaluated in this study. The four catchments were also characterized by different climatic regimes.

Preliminary analysis showed that the top 5-percentile daily sediment loss events occur more frequently in April for Skuterud (98×, 19 %) and Mørdre

(102×, 26 %) and in October for Time (78×, 17 %) and Vasshaglona (94×, 23 %) in the 30-year period of record. The high sediment losses in Skuterud and Mørdre could be attributed to cereal-based production with tillage in Autumn that is prone to snowmelt erosion in Spring. In contrast, the Time catchment has livestock production and grasslands protecting from erosion, thus, it has the lowest magnitude of average daily loss (~ 10 kg/ha). Furthermore, Vasshaglona has the highest average daily loss (270 kg/ha) in October, most probably due to the high frequency of extreme rainfall events in Autumn and loose soil conditions due to recurrent tillage in vegetable crop production. The average daily total phosphorus losses tend to follow the sediment losses trend. The frequency of top 5 percentile daily total nitrogen loss events tends to increase from September to November in all the catchments, however, the occurrence of these events is also substantial in Mørdre in April. Furthermore, the magnitude of these daily losses is highest in Vasshaglona (1.25–2.05 kg N/ha) and lowest in Mørdre (0.48–0.80 kg N/ha). On the average from 2011 to 2020, the top 5-percentile daily sediment losses in Mørdre, Skuterud, Time, and Vasshaglona contributed to 58 %, 45 %, 33 %, and 44 % of annual loads, respectively. However, the 2016 top 5-percentile daily sediment losses in Time were 75% of the annual load. The 5-percentile daily total phosphorus in Mørdre, Skuterud, Time, and Vasshaglona also contributed 65 %, 52 %, 32 %, and 43 % of the annual loads from 2011 to 2020.

These results could help in the identification, effective implementation, and adoption of appropriate measures for non-point source pollution reduction from Norwegian agricultural areas in a changing climate. Specifically, the different catchments have their unique agricultural practices and climate regimes, thus, conservation measures should be site-specific and account these factors.

Acknowledgement
These research is funded by the Norwegian Agriculture Ministry (Landbruksdirektoratet) through the project "Ekstreme avrenningsepisoder i norske jordbruksområder" (project no. 163329) and in part by the Norwegian Agricultural Environmental Monitoring Programme JOVA (Program for jord- og vannovervåking i landbruket).

Topography-based detection of ephemeral gullies suitable for protection by grassed waterways in Eastern Austria

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Keywords: grassed waterways; ephemeral gullies; topographical indices; GAM

Ephemeral gully (EG) erosion in crop land is a serious problem, brought about by concentrated surface runoff and largely controlled by topography. In contrast to permanent gullies, EG are erosional features that can be traversed by agricultural machinery and closed by regular tillage practices. Unless additional measures within the catchment area of an EG are taken, this is only a temporary remedy, as they tend to form again and expand with each sufficiently large runoff event and can evolve into permanent gullies.

An effective measure to mitigate EG formation is the implementation of grassed waterways (GWW) in their location, i.e. strips of permanent grassland along the thalweg. This is challenging from two perspectives: 1) locations of likely EG formation have to be identified, and 2) since an EG might cross multiple individual fields, mitigation might not be effective if only implemented on single field parts. For the current period of the EU common agricultural policy, Austria has decided to include GWW as a measure eligible for subsidies under its agri-environmental scheme ÖPUL. In order to define areas where the implementation is desirable, an appropriate map had to be developed.

In this study, a set of 11 topographical indices (TI) was created for the area of interest and combined into a generalised additive model (GAM). An

EG inventory was newly created, using optical high-resolution satellite imagery, and the GAM was trained to predict the inventory with sufficiently high accuracy (AUROC > 0.8).

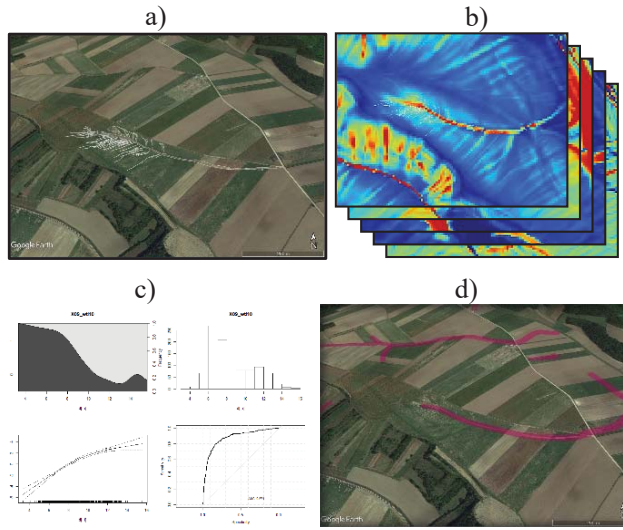

Figure 1: a) digitized ephemeral gully crossing several fields; b) raster stack of topographical indices; c) GAM training for a single topographical index: WTI; d) final output – GAM prediction turned into polygons (image credit: © Google Earth and contributors)

Since the prediction had to be made for a large part of the main cropping areas in Eastern Austria, which represent different landscapes, three separate EG inventories were created for small training areas in Lower Austria, Upper Austria, and Styria. The separate trained GAMs were then cross--validated both spatially and non-spatially. The predictive performance of each of the trained GAMs in predicting the EG inventories from the other locations was investigated. In the end, the best-performing GAM was selected to do the prediction for the whole area of interest. A buffering procedure was applied to generate GWW polygons that can be intersected with field polygons.

Sufficient agreement of the predictions in between the separate training EG inventories and GAMs could be achieved, and both spatial and non-

-spatial cross-validation were performed satisfactorily. This lends credibility to applying the chosen trained best-performing GAM to the whole area of interest.

We consider this approach to be a valuable tool for large-scale prediction, with little demand for input data. Apart from an EG inventory for training, only a digital elevation model (DEM) is required. Including additional information (land use, soil properties, rainfall) might improve the prediction, but can also introduce new challenges.

Ephemeral gullies and its characteristic in conditions of the Czech Republic

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Keywords: ephemeral gully, soil erosion, concentrated surface runoff, conservation measures

Soil erosion, including ephemeral gully erosion, is a serious degradation process in the Czech Republic. It currently threatens more than half of arable land acreage. In the Czech Republic, not much attention has been paid yet to the problem of ephemeral gullies (EGs). Relevant conservation measures to stabilize EGs are very rarely designed and implemented. A set of data, collected in a maize-growing area, especially on deep loess soils in the South Moravia Region, was used to analyse characteristics of ephemeral gullies (EGs). The relationship was confirmed between ephemeral gully (EG) length and the size of its contributing drainage area. Defining and verifying the basic causal factors, determining their location, catchment area characteristics and predicting their length is important for planning conservation measures and proposal of their stabilization, especially in the process of Land Consolidation. A research effort to better understand EG mechanism and causal factors over a wide range of watershed conditions is fundamental to the establishment of basic rules for the adoption of optimal conservation strategies.

Acknowledgement
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Comparison of the physical properties of soils on transverse profiles along the gullies

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Keywords: soil erosion, physical soil parameters, gully, geotechnics, forest

Natural processes and anthropogenic activity threaten soil as a resource. Soil degradation is a global problem intensified by climate change, population growth and economic development. Soil erosion is one of the most prevalent forms of degradation in Serbia. Soil resistance to erosive processes largely depends on the soil's physical properties. Erosion processes affect changes in the physical characteristics of the soil. Therefore, the hypothesis is established: There is a difference between the physical parameters of soil affected by erosion processes and soil on which there are no visible indicators of the action of these processes.The investigated area is located in the southern, hilly part of Belgrade, in a degraded forest area vegetated by Hungarian and Turkey oak (Quercetum frainetto – cerris). Intensive landslide and gully erosion processes affect this area. The mechanism of occurrence of the erosion process is piping-erosion. Thirteen transverse profiles were selected on gullies where soil sampling was performed. Sampling was performed on each profile in the gully bed, in the left and right banks at two fixed depths, zone 1, depth 5–10 cm and zone 2, depth of 10–25 cm. Laboratory analyses included tests of volume weight, specific weight, soil particle size distribution, consistent states and humidity. Parameters porosity and clay activity were also analysed. Soil sampling and laboratory testing were done in accordance with SRPS.U.B1 geotechnical testing standards. The comparison of the

obtained results was made between the banks and the gully bed, as well as between the zones using tests: t-test of mean values; W (Mann-Whitney; Wilcoxon) – median test. Hypothesis testing was performed with a significance threshold p of 95.0 %. Testing was conducted in the statistical analysis program Statgraphics centurion XVIII (StatPoint Technologies, Inc. 2019). Comparison of soil parameters in zone 1 had shown a statistically significant difference for percentage of clay and sand, liquid limit, humidity and clay activity. Results of conducted comparison showed that in the zone 2, a statistically significant difference found for the parameter percentage of clay and sand, between banks and gully bed soil samples. While no significant statistical difference found for the other parameters. Analysing the results between zones, a significant statistical difference was found for the gully bed, left and right banks soil samples for the parameters volume weight (dry and humid) and porosity while for gully samples there was significant statistical difference for liquid limit, plastic limit, humidity and clay activity. Comparing all samples of the zones 1 and 2, a significant statistical difference was found for the parameters volume weight (dry and humid), porosity, percentage of sand particles, plastic limit and current humidity.

Based on the obtained results, the hypothesis was confirmed. Physical soil parameters can be used as indicators of the possibility of occurrence of erosion processes.

Acknowledgement
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Natural and bio-technical water retention measures in the Švihov reservoir catchment – watershed management, researchers, designers and farmers work together

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Keywords: non-point agricultural water pollution; surface runoff; drainage water management; critical point; water retention measures

This contribution presents a new approach applied by the Vltava River Basin Management Authority, state enterprise to reach the WFD requirements and to contribute to climate change adaptation within the area of Švihov reservoir catchment. The Švihov potable water reservoir on the Želivka river is the most important source of drinking water from surface sources in the Czech Republic. The main purpose of this water work is to ensure the supply of drinking water for the capital city of Prague, the Central Bohemian region and parts of the South Bohemian and East Bohemian regions of the Czech Republic. The reservoir is exceptional not only for its importance for the supply of drinking water to the population, but also for its location in the landscape which is intensively utilized in terms of agriculture. At present, 54 % of the catchment area is used for agriculture, out of which 77 % is made up by arable land. Intensive agriculture, together with the high proportion of drained land, puts this source of drinking water, as well as the local water resources at risk from accelerated surface and subsurface runoff and associated pollution. The Vltava River Basin Management Authority, State Enterprise then has set out the series of projects aimed to enhance water infiltration, retention and to improve the water quality within the Švihov reservoir catchment.

The solution started with the delimitation of critical points related with agricultural pollution and categorization of its source areas. The term Critical Point (CP) comes from the term HACCP (Hazard Analysis and Critical

Control Point), and it was defined as the place/point of intersection of potentially polluted water from surface runoff (from rainfalls) and sub--surface runoff (from drainage systems) with recipients. In the next step, first 1 037 measures were proposed as hydrologically integrated systems into the selected most threatened areas. The measures, their design and placement, were based on the catalogue of protective measures (Natural Small Water Retention Measures, NSWRM), adjusted for the Czech conditions, and prepared within the project. The precise location and type of these measures was discussed with the farmers. Further, the effectiveness of the measures after their potential implementation wastested and implementation and maintenance costs were evaluated. All measures were prepared in the form of Type-A Measure Lists which are part of the River Basin Management Plans for the Vltava River Watershed.

The next step was to assess the feasibility of proposed measures with a respect to land ownership and public funding possibilities. High efficiency of measures in sites with sufficient number of measures was proposed, was proved by mathematical (surface sources) and empirical (sub-surface sources) model. On the other hand, some uncertainties emerged during the solution, which objectively reduced the willingness of the owners of the affected land to implement the measures:

1) Financing the maintenance of the measures after their implementation
2) Compensation for any loss of crop production for farmers
3) Compensation for the reduction in arable land from the landowner's point of view.

Recently, the ways how to implement the measures proposed appears to be the process of Land consolidations. At the same time, other measures are proposed so that the entire catchment area is sufficiently covered.

The novelty of the presented approach lies primarily in the comprehensive concept of addressing water retention, infiltration and accumulation in the landscape, together with the reduction agricultural water pollution from surface and subsurface sources. Furthermore, the involvement of a wide range of stakeholders as River Basin Management Authorities, farmers, municipalities, and landowners. This approach gives a possible direction towards adopting and ful-filling the WFD requirements in the Czech Republic and in Central Europe and towards adapting the landscape to climate changes and related societal challenges.

Acknowledgement
The paper was elaborated with a financial support of Povodí Vltavy, State Enterprise and the research project QK21010341 "Optimisation of a set of measures for agricultural catchment areas in the framework of the land consolidation process" supported by the National Agricultural Research Agency (NAZV) and with the support of the Czech Ministry of Agriculture institutional support MZE-RO0223.

The effect of concentrated flow on sediment and nutrient retention in vegetated filter strips

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Keywords: soil cores, runoff, phosphorus, erosion, vegetated filter strips

Vegetated filter strips (VFS) are often-used measures for the protection of surface waters from erosion and nutrient inputs from agricultural areas. However, VFS design recommendations provided by agri-environmental agencies are often (over-) simplified one-type-fits-all solutions that neglect important aspects. For instance, most VFS designs assume uniformly distributed sheet flow. In reality, however, the runoff from a field is often concentrated due to flow convergence (e.g., along a thalweg), which severely affects the retention effectivity of a VFS for water, sediment, and nutrients. To this end, we conducted artificial runoff experiments and extensive soil core sampling to assess the effect that flow concentration may have on sediment and nutrient transport, retention, and distribution in VFS and other field-grassland transitions.

Artificial runoff experiments on grassland plots in the laboratory and field showed that increasing flow concentrations lead to higher proportion of surface runoff (at the expense of infiltration), a faster onset of runoff, and a higher flow velocity. This entails not only a higher erosive force, but also less time for soil-water interactions necessary for nutrient retention processes. Additionally, infiltration was strongly linked to the presence of preferential flow pathways, e.g., formed by edaphic activity. The soil core samples revealed an accumulation of nutrients along the concentrated flow pathway, both in the field and in the grassland. Thereby, the differences of areas inside and outside the concentrated flow varied between nutrient pools, e.g., easily soluble fractions of phosphorus (P), such as water- or CAL-soluble P, showed more distinct gradients than the total amount of P. Nutrient retention and accumulation was, however, also strongly site-specific, depending on factors such as soil texture, slope,

or cropping and management of field and grassland soils. At some sites, nutrient accumulation lead to high degrees of phosphorus saturation (DPS) in the grassland. The risk of a release of P from the soil to the runoff increases with the DPS. Consequently, VFS may switch from nutrient sinks to sources, exemplifying the negative effects of concentrated flow.

The results of our experiments strongly call for more flexible, sophisticated, and site-specific designs of VFS, to address the challenges imposed by concentrated field runoff. Our results are, however, not restricted to VFS, but concern also grassed water ways, conservation farming, or generally all instances were a field runoff runs into a grassland.

Impacts of climate change on erosion processes

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Keywords: snow thawing; erosion potential; soil erosion lost; temperature

Since the mid–20th century, warm days have been increasing (and cold days have been decreasing) in frequency and intensity (IPCC, 2013).

As air temperatures rise, snow cover will melt more rapidly. The warming trend is more frequent between November and March (Huang et al., 2012).

The annual average precipitation in the Czech Republic is projected to increase by 10–13 % by the end of the century. There will be an increase in autumn and winter and spring precipitation, while summer precipitation will decrease (CzechGlobe, 2019).

The Czech Republic is in a climate where snow falls practically only in the cold half of the year. However, the winter weather is not so cold that significant snowmelt cannot occur at any time during the winter, which has the potential to cause an erosion event or flood.

The impacts of erosion events caused by snowmelt are not yet included in the balance of soil erosion, sediment transport, and sediment deposition in the lower parts of slopes, in water bodies, although their contribution may be significant. In winter, the soil is less covered by vegetation, and meltwater runoff can last much longer than the duration of erosive rainfall during the growing season. However, methods for calculating water erosion cannot be used to assess erosion processes in the non-vegetation period. The intensity of erosion caused by snowmelt is determined by the rate

of snowmelt, the amount of meltwater, the permeability of the soil, the breakdown of soil aggregates by freezing, and the moisture content of the soil. The determination of snowmelt erosion intensity by Zachar (1982) is based on the universal equation for calculating long-term soil loss from land as given by Wischmeier and Smith (1978), in which the factor R is replaced by the factors snowmelt rate and the amount of water produced by snowmelt over a 20-day period. These values are collectively referred to as erosion potential. The erosion potential of the water accumulated in the snow cover can be derived from the CHMI database on SVH (snow water value) and SCE (total snow cover) data. This approach was used to evaluate the erosion potential of snowmelt and compare its evolution for two normal periods 1961–1990 and 1991–2020 and to draw a map of current values of erosion potential for the Czech Republic.

To determine the total amount of erosive shear in the selected foothill area, the calculation of erosive shear in the growing season was performed according to the USLE (Wishmeier-Smith) equation and the calculation of erosion from snowmelt according to the modified Zachar equation. The results show a significant contribution of snowmelt erosion to the total amount of erosion shear throughout the year. The average erosion shear during the growing season was about 5.3 t/ha/year, considering snowmelt erosion the total shear is 15.2 t/ha/year. In the context of climate change and the predicted increase in autumn, winter, and spring precipitation, it will also be necessary to consider the need to increase the protection of agricultural land in the non-growing season.

Acknowledgement
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Erosion modelling in Norway: changing needs and opportunities

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Keywords: soil erosion, hydrology, numerical simulation, conservation measures, sediment

Soil conservation strategies in Norway are mainly directed at off-site effects, most notably fresh and coastal water quality. Acute problems with coastal water quality in the 1980s led to a series of policies to reduce the impact of agricultural land use on ecological quality that are still in place today. Prioritisation of conservation measures is based on reliable soil erosion risk maps. Norway's agricultural area, totalling approximately 10,000 km^2, is spread over a sizeable land mass with heterogeneous soil and climate conditions. Measurements cannot represent this variability, so erosion risk mapping requires process understanding to scale up measured rates to the national level.

Norway's first national erosion risk map, based on an adaptation of the Universal Soil Loss Equation, was published in the 1990s. Since that time, advancements in research methodology, data collection and the availability of ever increasing computing power have facilitated the development of more process oriented erosion models. In 2021, Norwegian Institute of Bioeconomy Research (NIBIO) published a new erosion risk map based on an adaptation of the Pan-European Soil Erosion Risk model (PESERA); a hybrid of empirical and process based approaches. The results of this sheet erosion model were supplemented with an empirical drainage erosion model and a national map of gully prone areas.

Continuing the trend of improved process simulation, NIBIO is developing a process based, spatially explicit gully erosion model that is designed to run at the national level. This model allows for sediment source process differention at different spatial scales, and can therefore be used to assess the relative importance of sheet, gully and drainage erosion in changing climatic conditions.

This presentation will be a reflection on the increasing focus on process approximation by means of examples of model studies undertaken by NIBIO. It will illustrate how a changing climate influences the comparative effectiveness of different soil conservation strategies. The presentation will conclude with an outlook on how recent trends in environmental research (big data, high-performance computing, and multi-scale harmonisation of observations) will change the needs that model developers are facing in the near future.

Changes in soil fauna (*Acari: Oribatida, Mesostigmata; Nematoda*) communities in Scots Pine (*Pinus sylvestris* L.) forests across S-N European gradient

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Keywords: invertebrates, European gradient, edaphon, *Pinus sylvestris* L.

Recent publications show that climate and climate change influence the location, composition, structure and function of forests in many parts of the world, including the high-latitude forests dominated by boreal species with Scots pine (*Pinus sylvestris* L.) forests. Although, the literature on the influence of global environmental changes on terrestrial ecosystems is generally large, most of this literature pertains to aboveground ecosystem components and belowground organisms or processes are investigated scarcely. Herein we provide preliminary data on the soil mites (decomposers and predators), and nematodes (various feeding groups) of Scots pine forests, based on soil fauna sampling along a 2 000 km latitudinal transect. We were focused on Scots pine forests because they are formed by the most prevalent tree species in Europe and one of the most widespread conifer species on Earth. These forests also plays a considerable role in temperate and boreal carbon cycling as well as in providing vast ecosystem and economic services. Additionally, we were focused on various soil fauna groups as they greatly increase the global turnover of dead organic matter and provide key ecosystem processes such as the decomposition of organic matter and the recycling of nutrients.

We aimed to characterise the mite and nematode communities from soils of mature Scots pine forests (*Pinus sylvestris* L.) based on samples collected during summer field campaign in 2013. We collected soil samples from 22 forests located between west Poland and northern Finland. Our data analysis based on 308 soil cores for mite and 110 for nematodes. Mites were processed in „portable extractor", whereas nematodes using the centrifugal method. After extraction soil fauna was preserved in liquid solution and finally mounted on slides and identified. We analysed relationships between soil fauna characteristics and environmental factors such as longitude and meteorological data. We recorded that soil fauna density in Scots pine forests depended on latitude, annual temperature, precipitation but the responses are differentiated within analysed soil fauna groups.

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Tolerance of ectomycorrhizal mycelium of *Paxillus involutus* exposed to Pb

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Keywords: heavy metal, lead, tolerance, ectomycorrhizal fungi, biochemical status of mycelium

As key symbionts of vascular plants, ectomycorrhizal fungi (ECMF) are some of the most important organisms influencing forest soil biology. It is also well known that ectomycorrhizal symbiosis generally enhances the growth of the poplar host as well as its resistance to stress conditions. However, interactions between the two living organisms are varied and depend on numerous conditions, such as the characteristics of individual symbiotic partners, and especially their tolerance to stress factors.

ECMF, with *Paxillus* as one of the most frequently analyzed ECMF genera, are known to increase the phytoremediation properties of their plant partners, but vary between genotypes in terms of hyphae stress tolerance. Selection of the most tolerant ectomycorrhizal fungal strain is therefore one of the important first steps of successful remediation of the heavy metal polluted areas, frequently performed under fully-controlled conditions. The correct assessment of the HM-tolerance of the analyzed fungal strains is crucial for this process.

The biochemical mechanism underlying the ECMF response to abiotic stress conditions, as well as ECMFs influence on plant host biometry and plant cell biochemical status, are yet largely unknown.

This study analyzed the impact of the abiotic stress factor on the Pb-tolerance of the ectomycorrhizal fungus *Paxillus involutus* growing in vitro. Indexes of tolerance (ITs) based on growth parameters are one of the most common indicators of heavy metal tolerance of various organisms, including ectomycorrhizal fungi. In the presented study, ITs of *Paxillus involutus* mycelia exposed to Pb calculated according to the most frequently

used parameters: mass and perimeter of mycelium were confronted with selected biochemical features of mycelium.

In this work, I present also the results of an experiment performed on anin vitro growing poplar, *Populus* × *canescens* exposed tolead ions and inoculated with two strains of *Paxillus involutus*. The field-collected strains were selected according to their ITs values for lead ions. Those *Paxillus involutus* strains showed also significantly different levels of mycorrhization of poplar roots. The differences affect not only the biometric features of inoculated *Populus* × *canescens* but also the biochemical status of plant partners and their lead uptake.

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Vegetation growth dynamics in the water level fluctuation zone of the Three Gorges Reservoir and its responses to habitat stressing

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Keywords: vegetation dynamics, habitat stressing, water level fluctuation zone, Three Gorges Reservoir

Since the middle of the 20th century, the new global trend of stepped and large-scale dam constructions has impeded the hydrological connectivity of rivers, threatening the health of riverine ecosystems and contributing to riparian habitat fragmentation. The Three Gorges Reservoir (TGR) on the Yangtze River is the world's largest hydroelectric project with a total storage capacity of 39.9 billion m^3 and a controlled watershed of more than 1.05 million km^2, and serves multiple social and economic needs of flooding control, power generation, navigation improvement, and irrigation. Its full impoundment of has created an artificial riparian zone with a vertical height of 30 m and a total area of 349 km^2. Riparian vegetation has been identified as a key structural and functional unit in riparian zones, capable of performing a buffer strip and ecological corridor functions/goods, such as retaining sedimentation, relieving associated non-point source pollutants, regulating runoff and maintaining regional biodiversity, etc. However, riparian vegetation has been susceptible to the synergistic effect of compound habitat stressing caused by inundation, soil erosion, sedimentation, extreme drought, and soil substrate conditions.

This study combined UAV-based remotely sensed data and field surveys during the exposure period to systematically illustrate the vegetation growth dynamics, clarify its dominant force in various growth stages, and ultimately propose important directions for vegetation restoration in the water-level fluctuation zone. The vegetation above-ground biomass (AGB) presented a typical increasing tendency along elevation gradient in the early to mid-growth period, while the difference of vegetation

AGB with elevations was not significant in the mid to late growth period. Additionally, the distribution characteristics of vegetation communities, as well as the erosion-deposition dynamic transformation process, had a spatial redistribution effect on vegetation AGB. Throughout the growing season, the vegetation AGB presented a single-peak variation pattern, overall peaking in August and then falling back to a relatively low value in late September. At the spatial scale, seasonal water level fluctuation by reservoir operation was the dominant factor, which exerted a considerable negative influence on vegetation growth dynamics in the early to mid-growth period. Erosion-deposition processes played a secondary role in vegetation dynamics via altering soil layer thickness, water holding capacity and fertility conditions. Soil moisture and nitrogen, the essential soil properties affecting material and energy cycles among vegetation and soil, were restrictive factors for vegetation distribution. Eventually, the differences in the physiological characteristics of the vegetation types determined the vegetation growth cycle and became an important biological factor driving the spatial variation of vegetation AGB. At the spatial scale, water level fluctuation and climatic conditions were the two main forces that influenced inter-monthly variation in vegetation AGB. Among them, the former played dominant roles, whereas the latter was secondary.

Consequently, the priority task of vegetation restoration in the water-level fluctuation of TGR is the selection and breeding of high-quality resilient species for aforementioned compound habitat stressing. Then, soil substrate conservation is emphasized. Thirdly, the optimal configuration of vegetation pattern is implemented to enhance the comprehensive ecological benefits and circumvent the negative environmental effects brought by excessive restoration. Continuous long-term monitoring and a well-established strategical framework are required to quantitatively track the vegetation dynamics for future ecological function reconstruction of riparian zones.

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An experimental study on snowmelt – wind – rainfall compound erosion on sloping farmlands of Chinese typical Mollisol region

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Keywords: Compound erosion; snowmelt erosion; wind erosion; rainfall erosion; Chinese Mollisol region

Research on the processes and mechanisms of compounded soil erosion by multiple erosion forces can provide scientific guidance for precisely controlling cropland soil erosion. According to the seasonal alternation of freezing-thawing, snowmelt, wind and rainfall erosion agents on sloping farmlands under natural conditions from November to next October of each year, this study applied a set of indoor simulated experiments of multi-force superpositions to investigate compound soil erosion processes on sloping farmlands and analyse erosion effects of multi-force superpositions. The results showed as follows: (1) for single snowmelt erosion, an increase in snowmelt flow had a greater effect on sloping snowmelt erosion intensity than that of sloping runoff rate; when sloping snowmelt flow increased from 1 L/min to 2 L/min, sloping runoff rate and erosion intensity increased by 2.7 and 4.0 times, respectively. (2) For snowmelt-wind superimposition erosion, previous sloping snowmelt erosion inhibited late wind erosion occurrence; as sloping snowmelt flow increased from 1 L/min to 2 L/min, the inhibiting action subsequently increased and wind erosion intensity caused by previous snowmelt reduced by above 50 %. (3) Both wind erosion and snowmelt--wind superimposed erosion intensified late rainfall erosion. For wind--rainfall superimposition erosion, previous wind erosion enhanced late

sloping rainfall erosion intensity, rainfall erosion intensity caused by previous wind erosion increases by 24.5 %. For snowmelt-wind-rainfall superimposed erosion, the snowmelt-wind superimposed effect increased the later slope rainfall erosion by 132.8 % and 465.4 % under 1 L/min and 2 L/min snowmelt runoff rates, respectively. (4) The compound soil erosion amount driven by each erosion force superimposition was not the sum of the corresponding erosion amount caused by single erosion force, while the promoting or inhibiting effects of erosion force superimposition existed; and the erosion effect of snowmelt-wind superposition was negative, but the erosion effects of wind-rainfall superposition and snowmelt-wind-rainfall superpositions were positive.

Acknowledgement
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Precious soil and water resources – sustainable land management

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Keywords: degradation, sustainability, management, economic effects, environmental effects

According to the natural characteristics, Balkan peninsula, and especially Western Balkan countries (WB) are predisposed to erosion processes. However, both worldwide and in WB, a large percentage of erosion processes are contributed by anthropogenic factors, as well as natural. The activity of man can be both negative and positive, depending on the degree of awareness of the importance of using natural resources on the principles of sustainability. Sustainably managed land resources are imposed as a necessity to preserve humanity and the planet.

As a contribution to sustainable land management (SLM), the paper presents three directions in this sense: Disaster risk reduction (DRR), Community based natural resources management (CBNRM) and the Sustainable land management model.

Current nature-based DRR solutions practiced in the region are varied, building on a long tradition of erosion and torrent control in Yugoslavia, but to a lesser degree in Albania. While the expertise to implement nature-based DRR solutions is present in the region, many of the specialised enterprises that historically implemented hazard management works no longer exist. Mainstreaming of DRR into sectoral policy is generally limited. Nature-based DRR is also generally framed as part of the climate change agenda (adaption and mitigation) and within the EU accession framework (Waters Directive, Habitats Directive, etc).

Preventing the degradation of torrential floods and erosion processes contained in the sustainable management of land resources, which includes the use of participatory methods. The paper presents the participation

of the community in the management of natural resources (CBNRM), according to which the community becomes the primary implementer, with the assistance and under the supervision of professional services. In the case of public participation in the sustainable management of land resources of the part of South Morava river Basin shows the socio-economic and ecological approach of the local population.

This paper also presents a model of sustainable management of land resources, adapted to the conditions of hilly-mountainous areas of Serbia, which includes the planning of production on sloping terrain from the aspect of land resources, then the needs of the population for certain localities particular production, and profitability of planned production. Regarding ecological effects of the model of SLM, soil loss is reduced under the level of tolerance in the researched area. Economic effects of the established model of SLM, proved by Benefit-Cost Analysis, are on the satisfactory to significant level. These reasons are enabling people to stay and survive in these regions.

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Possible hazards associated with the use of wastewater and sludge from wastewater treatment plants in agriculture

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Keywords: treated wastewater, sewage sludge, composted sewage sludge, irrigation, plants

Recently, treated wastewater is due to a water scarcity used for irrigation. Sewage sludge from wastewater treatment plants (WWTPs) is used as a fertilizer. These sources contain a large amount of nutrients, which can enhance conditions for plants' growth, but they also contain various micropollutants. Several studies have shown that some of these micropollutants can be taken up by plants. Previous studies were usually carried out in controlled conditions, i.e., greenhouses, etc. This study aimed to find out how the monitored compounds would behave in real conditions. For this purpose, nine raised beds were constructed at WWTP for České Budějovice, in which a mixture of vegetables (lettuce, onions, and carrots) or maize was grown in 2021. Only vegetables were grown in two beds with the Arenosol, which were irrigated with either tap water or treated wastewater. Of the seven beds with the Cambisol, one of the beds with either vegetables or maize was irrigated with tap water and the other pair of beds (vegetables or maize) was irrigated with treated wastewater. In another pair of beds (vegetables or maize), composted sewage sludge from WWTP was mixed in the soil. Finally, in one bed with maize soil was mixed with sewage sludge. Samples of treated wastewater and water drained from the beds, soil, and plants were taken during the year and analyzed.

Of the 77 substances analyzed, 59 were detected in wastewater and 11 in water that percolated through the beds irrigated with wastewater (e.g.,

telmisartan, gabapentin, and 1H-benzotriazole). Fourteen and ten compounds were found in sewage sludge and composted sewage sludge, respectively, but only two substances (sertraline and 1H-benzotriazole) in water that leached through the beds with these sources of contamination. Compounds mostly did not accumulate in soils irrigated with wastewater. Low concentrations were found for telmisartan, carbamazepine, venlafaxine, and tramadol. In the case of both biosolids, gradually decreasing concentrations were observed for citalopram, sertraline, and telmisartan. Five substances were identified in lettuce and onion leaves and eight in carrot roots irrigated with wastewater (e.g., gabapentin, carbamazepine, and tramadol). In the case of corn plants, the compounds' concentrations were mainly below the limits of their quantification.

The results show a potential threat to groundwater and contamination of vegetables when watering crops with treated wastewater. In the case of sludge, it was shown that some micropollutants that these sludges contain are very persistent and can persist in the soil environment. However, with the exception of some of them, thanks to their high sorption in soils their percolation in the soil environment and uptake by plants is restricted.

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Ecological and economic effects of applying the Future Agricultural Production Structure Model (FAPSMS): The case of Barička river basin

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Keywords: sustainable land management, soil erosion, soil conservation, RUSLE, model of future production, economic analysis

It is necessary to harmonize the needs of society in terms of agricultural production and land protection from various forms of degradation. Assessing the justification of investment in sustainable management of land resources is an important step in that process. Consequently, in the suburban area of the morphological unit of the Barička river basin, an analysis of soil erosion risk was carried out using the Revised Universal Soil Loss Equation (RUSLE) method, with the existing and projected structure of agricultural production according to the Future Agricultural Production Structure Model from the Aspect of Preserving Land Resources for Mountain Catchment Areas of Serbia (FAPSMS). The value of the existing and projected production structure from the economic aspect was also examined, using dynamic economic methods. In order to assess the risk and uncertainty of investments, a sensitive analysis of dynamic methods was carried out. The results of the research showed that soil erosion losses are already below tolerance values with the existing production structure and that they could be reduced even more by applying the designed structure. Economic indicators have shown that the investment is justified and that it is more sensitive to changes in income.

Methodology to quantify the global agricultural crop footprint including soil impacts

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Keywords: agriculture, soil degradation, soil fertility, exergy, sustainability

In recent years, concern about the environmental problems generated by agriculture has increased significantly. Among them, the degradation of soil is a worldwide problem. However, due to the complexity of soil systems, it is not considered in the existing sustainability evaluation methodologies used for agriculture production.

In this work, a methodology to evaluate all the impacts of an agroecosystem including those occurring in the soil is presented. This methodology is based on exergy and the replacement cost. Exergy is a physical property based on the second law of thermodynamics and unifies into a single indicator the different inputs of the agriculture and the soil parameters relevant for soil fertility assessment. The overall impacts of the different inputs of the agricultural process (fertilisers, water, diesel consumption) are included by means of their exergy. The production obtained by the agroecological system is the main output. Accordingly, this methodology evaluates agroecosystem processes considering all exergy flows entering and leaving the system allowing for a detailed analysis of the parameters that may have been affected by crop generation.

The impact on soil is quantified by means of the replacement costs that determine the exergy that soil needs to recover its fertility and quality before harvest. This way, it is possible to analyse the difference between soil before and after the agricultural process and estimate the exergy costs necessary to recover the initial or optimal conditions. Understanding the fertility of soils as an avoided cost that nature provides leads us to propose exergy replacement cost as a tool for the assessment of the loss of soil fertility due to agriculture practices. The replacement cost of soil evaluates different factors: properties such as nutrients and organic matter, as well as common problems in agricultural soils such as salinity, acidification. The exergy replacement costs considered for each factor will be determined based on the energy required to carry on an ideal process to return the soil to the initial or ideal conditions. Therefore, the exergy replacement costs required to restore the optimal or initial soil conditions before cultivation will be assessed.

This tool will evaluate the sustainability of an agricultural system, as it will enable the comparison between different cultivation systems considering the effects on the quality and composition of the soil, penalising situations where over-exploitation of the soil takes place.

This work is an opportunity to further improve soil quality evaluation by introducing a thermodynamic indicator that will contribute to a rigorous assessment of agricultural processes' impact. The determination of a single comparable, reliable, accurate, and globally accepted indicator will be essential in the near future for the evaluation of soil fertility and agricultural processes efficiency and environmental sustainability.

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The effects of water erosion on soil properties and crop yield in a highly exploited agricultural area of South Moravia, Czech Republic

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Keywords: erosion, soil quality, yield, remote sensing

Soil erosion is a major issue that affects various soil properties and non-productive soil functions worldwide. In particular, water erosion is a global problem that threatens agricultural land in many countries, including the Czech Republic, where approximately half of the agricultural land is at risk. This research article focuses on South Moravia, one of the most agriculturally exploited areas in the country that is also highly endangered by erosion. The aim of this study was to identify changes in soil properties due to erosion and examine the effects of erosion on crop yield.

Our study found clear changes in the physical, chemical, and biochemical characteristics of the soil in erosional areas compared to depositional areas, which can have a negative impact on crop production as well as non-productive functions of the soil. Significant changes were observed in organic matter and related properties, such as biological activity.

Additionally, the study examined the effects of erosion on crop yield using a method based on satellite imaging and vegetation indices. Specifically, Sentinel 2 satellite images and NDVI or NBR2 indices were used to identify erosional areas. The Enhanced Vegetation Index (EVI) was used to analyze plots of winter wheat, and Pearson's correlation was used to express the relationship between yield and erosion. The results showed a statistically significant linear reduction in yield depending on the level of degradation, with higher levels of degradation resulting in lower yields. Finally, the study classified the plots into high, medium, or low states of degradation based on their EVI values. The results showed that non-de-

graded soil had an average yield that was 16 ± 1% higher compared to degraded soil. Similar values were obtained using vegetation container experiments. These findings have important implications for sustainable land management practices and can aid in discussions with farmers and policymakers.

Acknowledgement
This research was carried out with the help of grants from the Technology Agency of the Czech Republic (projects No. SS02030018 and SS06010290).

How effective are undersown crops and strip-tillage at mitigating soil erosion and pesticide transfer in maize crops? Results and insights from field trials.

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Keywords: undersowing; strip-tillage; maize; erosion; pesticides

Silt loam soils of the European loess belt are vulnerable to erosion and intensively cropped with a large share of spring crops in rotation. Besides the soil conservation issue, the transfer of runoff, sediment and associated pollutants from cropland cause acute off-site impacts such as muddy floods and pollution of surface water bodies. There is thus increasing pressure on the farming sector to implement alternative cropping practices to alleviate environmental externalities. To this end, as part of the Intell'eau project, we assessed the efficiency of two soil conservation practices at mitigating water, sediment, and pesticide flows in forage maize by means of erosion plots under natural rainfall during the 2021 and 2022 cropping seasons. A control treatment, representing conventional maize farming practices, was compared to:

1) red fescue or white clover sown in the inter-row at the same time as the maize and
2) strip-tillage, which consists in preparing the seedbed by tine-tilling the maize row only, leaving the inter-row surface undisturbed. All treatments were implemented in triplicate.

Results from the undersown plots showed no statistically significant difference in seasonal runoff, soil and pesticide (sulcotrione) losses compared to the control practice (bare inter-row), both in 2021 and 2022. Most soil and pesticide losses occurred in the spring (May–June), when the undersown crops and maize were still poorly developed (< 5 % total vegetation cover). Both treatments combined, the average soil loss rate reaches 12.9 ± 6.2 t/ha in 2021 and 4.7 ± 1.6 t/ha in 2022. After two years, we observed severe weed pressure in the undersown maize plots, strongly affecting maize yields (–28 % compared to conventional maize). This was caused by the limited spectrum of action of sulcotrione, which was selected to control weeds without killing the undersown crops.

When strip tillage was performed after a well-developed winter cover crop (mustard in 2021, or oats-phacelia in 2022), a statistically significant difference ($p<0.1$) between strip-tillage and the conventional practice (rotary harrow) was observed regarding seasonal runoff (mean mitigation effect in 2021 and 2022 of –69 %), soil (–85 %) and sulcotrione (–66 %) losses. In contrast, when strip-tillage was performed on soil left bare during winter or after a poorly-developed winter cover crop (0.55 t dry matter/ha), no significant differences were observed in terms of runoff, soil and pesticide losses. Considering all trial sites and years, yield losses in strip-tillage compared to conventional farming ranged from –8 % to –28 %. Further investigations (additional years and locations) are needed to better assess the effectiveness of these two techniques. Quantifying the relationship between the amount of winter cover crop residues and the surface flows mitigation effect thanks to strip-tillage is of particular interest. Further investigation of the benefits of undersown crops in pluri-annual experiments must also be considered, since benefits are expected on the one hand from a well-established cover during the winter period, and on the other hand from the supply of organic matter to the soil upon destruction in late winter – early spring, with likely benefits in terms of improved soil structure.

Acknowledgement
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Impact of plastic pollution on the quality of arable soils in the Sava and Danube river valleys (Serbia)

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Keywords: microplastics, soil quality, river valleys, soil respiration, pollution

Plastic pollution is fast becoming a serious global environmental problem with the increase in plastic waste over recent decades. Plastic pollutants in the soil environment have an impact on the cycling of organic matter, global CO_2 production, crop production, and soil properties. Crop production in plastic greenhouses is one of the serious sources of plastic pollution in the environment all over the world and particularly in Serbia. One of the first investigations of plastic and microplastic materials in the soil on the territory of Serbia is currently underway and is being carried out within the project „Evaluation of the Microplastic in the Soils of Serbia – EMIPLAST – SoS" funded by the Science Fund of the Republic of Serbia. The aim of the research was to reveal the impact of the presence of plastic materials on soil's main chemical, physical and biological properties. Soil sampling was carried out in 2022 from two depths (0–15 cm and 15–30 cm), side by side from the plastic greenhouse and non-greenhouse agricultural production as a control in the first project year. The research sites are located on the alluvial plains of the two largest rivers in Serbia, the Danube and the Sava. The following chemical parameters were determined on all samples: electrical conductivity, pH, CEC, total C, as well as nutritional status of the soil (N, P_2O_5, K_2O, Cu, Zn, Mn and $CaCO_3$). Concentrations of some microelements were also analyzed. Physical parameters determined were: particle size distribution, volumetric mass, specific mass and porosity. Microbial respiration, which serves as an indicator of enzymatic microbial activity in the soil, was measured by the alkaline trap method from surface soil.

The values of electrical conductivity and pH were higher in all soil samples from plastic greenhouses compared to the control samples in both depths at both sites, while the measured values of CEC, carbon, nitrogen, P_2O_5, and K_2O are higher in samples from the control arable soils.The content of $CaCO_3$ was higher in the samples from the greenhouse compared to the control at both depths at the site in the Sava basin, while it wasn't significantly different in the samples from the Danube basin. The content of Cu, Zn and Mn was higher in the control samples at both depths in both sites, except for the sample from a depth of 15–30 cm from the location in the Danube basin where the Mn content is higher in the greenhouse. No significant difference in volumetric mass between the samples from the greenhouse and the control samples at both sites was detected. However, the specific mass, porosity, and particles >0.02 mm were higher in the soil from the greenhouse at both sites. The microbial activity expressed by soil respiration at the Sava basin wasn't significantly different between the plastic house and control arable soil. On the contrary, in the Danube valley respiration was by 78 % higher in the control samples compared to the samples from the plastic house. Preliminary results showed that soil chemical and biological properties are significantly affected by the presence of plastic materials in the arable soil in plastic greenhouses. In order to establish the level of the negative impact of microplastics (MP) on soil properties and microbial activity in the longer term, the study is ongoing. Further research is focused on the isolation of microplastics from river valleys' soils and their potentially detrimental effect on soil biogenicity and the environment. The results of the project will contribute to a better understanding of the biological and environmental effects of MP, which is very important for environmental safety.

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Soil organic carbon stock in a Colluvisol profile: application of hyperspectral imaging to study soil organic carbon variability in a deep soil profile

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Keywords: Colluvisol, hyperspectral imaging, soil organic carbon

Colluvisols are an important component of the soil cover, occupying concave slope elements, particularly in landscapes with undulating relief. They act as reservoirs of soil organic carbon (SOC) and can be used to study the intensity of actual soil erosion and the influence of long-term agricultural management on the SOC content along the profile. Colluvisols profiles descriptions have relied on morphometrics by which soil attributes are mechanically measured and visually observed. Nevertheless, the conventional laboratory analyses and visual assessments used to analyse SOC in deep soil profiles are often destructive, cost-intensive, and time-consuming. Hence, alternative techniques such as laboratory--based hyperspectral imaging (HSI) across the visible and near infrared region (VNIR: 400–2500 nm) appears to be a promising technique for the quantification of Colluvisol profile attributes due to their fast and reliable measurements. This study aimed to investigate the potential of laboratory--based hyperspectral imaging (HSI) spectroscopy to predict SOCcontent in six meters depth colluvial profile with a high resolution. The soil profile was split in six sub-cores and the HSI images were captured. The linear (i.e., partial least squares regression, PLSR) and nonlinear (i.e., RF, Cubist and SVMR) multivariate models were compared to assess their ability to predict the SOC content in the profile with the full spectral subset and after spectral variable selection. A spectral variable selection technique

(i.e., Genetic Algorithm-GA) was applied and the models were performed with 56 spectral variables. Overall, the results showed that the PLSR model performed better (PLSR R^2=0.76, RMSE=0.074) than the nonlinear models (RF R^2=0.58, RMSE=0.17; Cubist R^2=0.34, RMSE=0.15; SVMR R^2=0.26, RMSE=0.18). All optimized multivariate models with GA improved their prediction performance. It was concluded that HSI spectroscopy integrated with PLSR and spectral variable selection is suitable for the prediction of SOC distribution in the Colluvisol profile.

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Forest logging residues as an important source of nutrients and carbon sink on the clear-cuts area (not only) after the bark beetle calamity

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Keywords: forest soils, logging residues, nutrient sustainability, forest management

The area of forest clear-cuts has increased enormously in the Czech Republic reaching more than 100 000 ha, due to unprecedented bark-beetle calamity, which peaked in 2020. Such area of (temporary) deforestation represents several kind of risk for environment as well as for future forest management and production. We can mention changes in micro-climate, local and regional water balance, biodiversity, carbon management and – last but not least – for the sustainability of soil nutrients. One of important forest decision in this view is management of forest residues, which are often removed for energy production. Selling of logging residues can at least partly cover owner's expenses for site preparation, on the other hand it can conflict the principle of sustainability in term of the ecosystem nutrients stock. Although the weight of branches, and thin wood represents usually less than 15 % of the total (aboveground) tree biomass, it may contain more than 50 % of nitrogen and phosphorus, 40 % of potassium, 35 % of magnesium and 30 % of calcium stock.

We have assessed soil chemical properties from the Aggregated Forest Soil Database for 27 "Target Management Units" (CHS) – categories used to plan forestry management procedures according to forest typology for the risk of removing logging residues. Phosphorus and calcium were detected as the most limiting nutrients. Only 4 CHS representing 7 % of forest area of the Czech Republic were characterized by "low risk" for nutrient removal by use of logging residues. Results suggest that uncontrolled use of logging residues can lead to discrepancies in forest nutrition in close future.

The need of reforestation, however, requires some management procedures for handling of logging residues on the clear-cut areas. We recommend to chop forest residues and to use e.g. soil milling cutter for their distribution. If needed, just an appropriate part of logging residues – preferably without the foliage – should be removed and deficient nutrients should be supplied by adequate use of soil fertilizing, liming, or wooden ash distribution.

For the forest state administration we suggest to support management of logging residues in situ as chopping and soil milling; legally regulate the possibility of use of wooden ash as fertilizer in forest stand and support fertilizing and liming of forest soils in justified cases.

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Application of biochar in a Chernozem in northern Kazakhstan: effects on soil properties and spring wheat yield

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Keywords: Chernozems, biochar, soil properties, wheat yield, anthropic soils

From the beginning of the soil use transformation (i.e., from virgin to agricultural soils) in the North Kazakhstan region, the mean quantity of humus in cultivated soils has decreased up to 30 %. Massive transformation of virgin soils of the North Kazakhstan took place between 1954 and 1960, and such a trend started again in the last 30–40 years. The long-term use of monoculture in the farming system, the systematic violation of any crop rotations, and the low use of organic and bio-fertilizers, have caused a notable decrease of organic matter in cultivated soils. Consequently, these soils are interested by consistent deterioration in terms of fertility and are facing serious degradation processes, such as loss of soil organic carbon, soil erosion, loss of biodiversity, soil permeability, reduction of the soil filtering and buffering capacity. Biochar is one potential amendment to improve soil properties. It is used as a soil amendment for its well-researched benefits, such as increasing soil fertility and immobilizing contaminants in agricultural soils. Generally, biochar is referred to as "biomass derived black carbon" or "charcoal" with the potential to act as a sink for carbon over an extended period. It is believed to have been first used by the pre-Columbian indigenous people of the Amazon region, as part of a series of soil amendments that produced 'terra preta', a more nutrient-rich and high pH agricultural soil than the existing acidic and infertile soils of the region. Various studies reported improvements in soil properties beyond carbon sequestration that were related to biochar application. Currently, there is increasing interest in biochar as a promising organic fertilizer, since its application allows to simultaneously solve two major

problems of our time: long-term improvement of soil fertility and the need for atmospheric carbon sequestration. Recent studies have shown when biochar is introduced into the soil as a biocompatible, it increases soil fertility and increases the moisture-retaining capacity, pH of the soil, cation exchange capacity, structure, porosity, permeability. The rate of decomposition of biochar in the soil is 0.03 % per year. Once introduced into the soil, it helps to retain water and nutrients for the next 5–8 years. In addition, biochar can reduce the risk of environmental pollutants (organic and inorganic) by forming complexes. Nevertheless, in the conditions of the North Kazakhstan region, the importance of introducing organic and biological fertilizers that prevent soil erosion is very high. In this research we evaluate the variation of physical and chemical properties after application of different quantities of biochar in a cultivated leached Chernozem. Thus, we evaluated the crop yield (spring wheat) after one year. Results show an improvement of soil fertility, and consequently an increase in crop yield, proportional to the dose provided in the first soil horizon.

Development of soil organic carbon stock on agricultural soils of Slovakia

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Keywords: soil organic carbon, agricultural soils, arable land, grassland, soil monitoring

Despite of fact that soil organic matter (SOM) on intensively used agricultural soil represents only a small percentage of soil mass, SOM is a key component for biomass production, soil physical structure, water holding capacity and climate regulation- atmospheric greenhouse gas emissions. Soil organic carbon (SOC), as a basic component of SOM, is often considered as a primary indicator of soil quality and soil health in relation to agricultural and environmental functions of soil and SOC is also a key indicator in several groups of ecosystem services. The information about SOC concentration on agricultural soils of Slovakia are available in the database of the Partial Soil Monitoring System (ČMS-P). SOC concentration data of basic monitoring network ČMS-P were used for calculation of SOC stock in topsoil (0-30 cm). SOC stock was calculated for four monitoring cycles 2002, 2007, 2013 and 2018 to find out development of SOC stock during 2002–2018 time period.

Obtained results show that during observed time period average SOC stock on agricultural soils of Slovakia increase from 63,9 t/ha in 2002 to 70,5 t/ha, which represents sequestration rate 0,41 t C/ha/yr. However, in lowland and on hilly/mountains soils development of SOC stock was

different. In lowland (<600 m a.s.l.) an average stock of SOC is substantially lower compared to localities in higher altitude (>600 m a.s.l.). Average SOC stock in last monitoring cycle (2018) on lowland is 67,4 t/ha and in higher altitude is 83,2 t/ha. During observed time period SOC stock in lowland gradually increase, but on soils in higher altitude changes in SOC stock were negligible.

SOC stock changes on arable land (AL) and grassland (G) are also different. On grassland SOC stock is higher compared to AL and sequestration on G is considerably higher (0,63 t C/ha/yr) in comparison to AL (0,27 t C/ha/yr). Similarly to all agricultural land, SOC stock on AL and G in lowland is lower (64,9 t/ha on AL, 79,7 t/ha on G in 2018 year) than in hilly/mountains soil (76,8 t/ha on AL , 86,6 t/ha on G in 2018 year) and also sequestration rate was substantially lower on AL than on G. Sequestration rate on AL and G depends also on altitude. On lowland sequestration rate on G and AL was significantly higher than on hilly/mountains soil. Actually, on AL in higher altitude decrease of average SOC stock was observed.

SOC stock depends also on soil types. On AL and G SOC stock is higher on soil types with deeper humus horizon (Chernozems, Phaeozems, Andosols) than on soil types with shallow humus horizon (Cambisols, Stagnosols, Luvisols and Regosols) and also sequestration rate on humus-rich soils is higher than on soils with shallow humus horizons. Based on obtained results we can conclude, that altitude, soil types and soil use are a main factors that to a significantly extent, affect stock and development of SOC. With no doubts, the ČMS-P provides for Slovakia a solid basis for an accurate and up-to-date evaluation of the current topsoil SOC content and its dynamics at national scale.

Acknowledgement
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UNCCD – the Rio Convention for binding the issues with soil and water conservation

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Keywords: Rio Conventions, UNCCD, The UNCCD 2018–2030 Strategic Framework

The United Nations Convention to Combat Desertification (UNCCD) was created as one of the three Rio conventions, which were agreed at the Earth Summit held in Rio de Janeiro in June 1992. Land, biota - especially biodiversity and climate change were classified as three main environmental factors which must be monitored, assessed and treated. Thus, UNCCD is dealing with desertification but also with land degradation and two more conventions are dealing with climate – United Nations Framework Convention on Climate Change (UNFCCC) and biodiversity – Convention on Biological Diversity (CBD). UNCCD strategy for the time interval of 2018–2030 was created to contribute to achieving the objectives of the Convention and the 2030 Agenda for Sustainable Development. In particular UNCCD is focused on Sustainable Development Goal (SDG) 15 and target 15.3: "by 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world" and other interrelated SDGs. It is taking into consideration also improving the living conditions of affected populations and enhancing ecosystems services. UNCCD goals are mirrored also in European context – in the initiative A Soil Deal for Europe, which is one of the five missions under Horizon Europe programme. One of the Soil mission objective is actually to reduce desertification. Context of healthy soils was elaborated. Healthy soils represent soils, which are essential for all life-sustaining processes on Earth and support ecosystem services. Crucial life-sustaining process are also the relations between soil and water. The necessity to solve water agenda was recognised already in the past but the necessity to solve soil issues is coming more intense to the international and European level in this few years. UNCCD is contributing to this process.

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Watershed health monitoring-based strategy: A tool for watershed wdaptive management

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Keywords: health assessment; healthy watershed; integrated watershed management; watershed zoning; watershed planning.

An essential component of adaptive management has traditionally been monitoring. Adaptive management is an iterative method for planning future management activities, facilitating decision-making, and improving results by applying the knowledge gained from prior management actions and experiences. Iterative, learning-based management in two phases, each with its systems for feedback and adaptation, is how adaptive decision-making is defined. Since many years ago, adaptive management has been used to describe learning about natural resources via flexible management practice. However, such a practical approach has yet to be adequately considered, particularly in developing countries where significant challenges exist between human and ecological well-being. The present study aimed to provide a framework for adaptive management, which contains an operational definition, a step-wised procedure in which it may be implemented effectively at the watershed scale. The productivity performance of the idea has been then exemplified for a study watershed in Iran and LIFE DRIVE study area in Italy as well.

Living labs and lighthouses lead towards healthy soils in Europe

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Keywords: Soil strategy to 2030, Living labs and lighthouses, Soil Deal for Europe, goals of the Mission

EU Mission A Soil Deal for Europe is one of the five missions Linking EU's research and innovation to major societal needs; with strong visibility and impact. Soils support ecosystem services and provide vital functions: i) producing nutritious and safe food, ii) hosting biodiversity, iii) purifying and regulating water, thus providing protection from droughts and floods; iv) cycling nutrients; v) storing and cycling carbon, supporting climate mitigation and adaptation; vi) supporting human activities, landscapes and cultural heritage. Soil is a finite resource, meaning its loss and degradation is not recoverable within a human timespan. Soils are threatened: 60–70 % of soils in Europe are considered to be unhealthy due to current management practices, pollution, urbanisation and the effects of climate change. In Slovakia the percentage of threatened soil is approximately 45–55 % predominantly agricultural land. Living labs present a new concept od research project which active involvement of (end) users in the activities of living laboratories so that they can have a clear impact on the innovation process; co-creation, joint design and joint development of solutions; testing and experimentation in real conditions; the participation of a large number of stakeholders (e.g. including the involvement of land managers, technology providers, service providers, relevant institutional actors, professional or residential end-users), use of multiple methods and tools from different discipline. Lighthouses are individual, local sites that key places for demonstration of solutions, training and communication, which are exemplary in their performance and record improvement in terms of soil health (one farm, one logging, one industrial area, one urban green, etc.). They can to include in the life of the laboratory or to be outside the living laboratory space. After all, all living lab experimental sites strive to achieve beacon performance and become demonstration

examples. As an example is regenerative agriculture which still has a long way to go if it can offer an alternative to current conventional agriculture. But it is equally clear that it is a source of important ideas that can offer farmers new profitable and environmentally friendly economic models.

Strategy and priorities of soil cover development research and monitoring in Slovakia

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Keywords: soil policy, strategy and priorities, soil research, soil monitoring, Slovakia

Based on EU Soil Strategy for 2030 and in synergy with the other EU policies stemming from the European Green Deal would be implemented national soil policies (especially Act No 220/2004 Z. z. about protection and agricultural land use) and updated Decree No 59/2013 with strategy of protection of agricultural soils in Slovakia. These ones consist of taking care on agricultural soils, their protection against degradation and protection of agricultural soils at non-agricultural land use and advances at change of land use.

The main priorities of soil research are listed in the following professional areas in Slovakia:

- significance and evaluation of soil functions (productional and non-productional) including ecosystem services;
- capacity of soil and landscape in relation to quality of food production, bioenergy, waste recycling and economical development of regions in Slovakia;
- capacity of soil and landscape at mitigation of global and regional environmental phenomenas (e.g. draught, floods, pollution of water sources, etc.);
- evaluation of soil parameters in relation to development of soil quality using remote sensing and LUCAS (Land Use-Land Cover Area Frame Survey);
- identification of suffered areas from pollution, erosion, compaction and decline in soil organic matter;
- development of information systems (including soil monitoring system) to support decision-making with regard to mitigation/elimination

of soil degradation processes and sustainable land use in conditions of global climatic change;
- increase quality and availability of information for their application in soil and environmental EU policy.

Database of soil monitoring system in Slovakia allows to create and maintain data on the monitoring sites (318) of agricultural land and prepare them for further processing through specialized programmes (statistical programmes, spreadsheets and other databases). The new structure of soil monitoring database represents a significant step forward, as it opens the possibility of restructuring other soil information system databases and to fulfill the INSPIRE Directive in Slovakia.

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Mapping of soil-based ecosystem services and soil threats of European arable lands – A systematic review and new approaches

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Keywords: soil ecosystem services; soil threats; bundles; mapping; continental scale

The soil-based ecosystem services (SESs) are the ecosystem services provided by soils and their chemical, physical and biological properties, processes and functions, e.g. carbon sequestration, biomass production, hydrological control, or soil erosion control. However, soil and SESs are threatened by rapid environmental changes and anthropic activities identified as soil threats (STs). Soil erosion, soil organic carbon loss, and soil compaction are among the most important soil threats in agricultural landscape. This study analyses the existing maps of SESs and STs on arable land at European scale based on a systematic review of existing scientific literature. After filtering, only 21 documents on SESs and 23 papers on STs were found. The most commonly mapped SESs and STs were climate regulation including carbon sequestration (57 %), primary biomass production (19 %), erosion control (14 %), soil erosion (16 %), and compaction (17 %). Overall, process-based models and data integration were the most frequently used methods for SES assessment and mapping,while for STs, statistical, rule-based and process-based models were the most frequently used. Only 17 studies of all SES mapping cases were validated with uncertainty assessment. In case of STs, 16 studies were validated

with uncertainty assessed. The common lack of validation and uncertainty estimation is noteworthy. A high level of detail and accuracy at spatial and temporal scales is required to use ecosystem services assessment as a basis for spatial planning and decision-making.

The SESs and STs are often related to each other, showing mutual synergistic or antagonistic effects. They can be thus combined into bundles, either *a priori,* using expert knowledge, or *a posteriori*, when the bundles are created automatically using computer (statistical) tools, which can reveal relationships between SESs and STs that are hidden or not so clear. This contribution presents several approaches to create and map the bundles of SESs and STs at European scale based on the literature review described above and on the collection of available European data. Several methods of spatial clustering were applied. The results show the spatial distribution of various SESs/STs bundles and combinations showing effect at various scales. This approach should provide a more complex view on the SESs and STs issue.

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Changing paradigms in combating desertification. A perspective from Mediterranean Europe

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Desertification is as old as civilization.There are references of great historical-environmental value from the very beginning of western culture (e.g. in the Mediterranean basin), which demonstrate early concern for problems of intense environmental degradation which today we associate with the concept of desertification. There are rich quotations from prominent Greek, Roman and Spanish authors which show very early awareness of land degradation and the wisdom to appraise the dimension and consequences of mismanagement of the land. This trend of diagnosis and concerns for landscape and agri-forest degradation problem was maintained during the period of Medieval Age to 19th Century. More recently, an abundant literature on extreme land degradation problems flourished in highly varied world ecological environments during the thirties and forties of last century, particularly from English and French authors. It is generally recognized that A. Aubreville (1949) was the author who first scientifically used the word desertification in relation to soil erosion processes in humid tropical regions. During this period important initiatives in research of soil degradation processes were undertaken providing fructiferous conceptual advances in soil conservation, land planning and adopting measures for reducing soil erosion problems. In 1977 UNCOD--UNEP initially established some simple definitions on desertification. This was the beginning of a period with an enormous proliferation of different definitions and approaches on desertification from a number of authors and countries. The many existing definitions give raise to confusion and to endless discussions. As a result of controversies the whole issue was losing strength and losing social and institutional recognition. In 1991, in order to have a better and more scientific conceptual framework for programmatic activities, UNEP redefined desertification looking for new paradigms and improvement in the clarification of the concept of desertification. During the Rio de Janeiro Earth Summit (1992) some modification

where introduced in the definition in the sense of placing more emphasis on the implications of climatic variations. This definition was adopted by UNCCD in 1994 providing booth a great basis of consensus but also some controversies. The year 2006 was declared by UN as International Year of Desert and Desertification and some conceptual revisions were adopted. Also the period 2010–2020 was declared the UN Decade for Deserts and the fight against Desertification. During the elaborations of the conceptual approaches to the Decade some expansion of the range of geographical, climatic and processes were incorporated giving room to more consideration to drought aspects. As a results of Rio + 20 Conference some innovative conceptual dimensions where incorporated in a new strategical approach identified as Zero Net Land Degradation. More recently, with the evolution and increase of knowledge on factors affecting desertification new conceptual and paradigmatic views were incorporated. Some of them are: Changing understanding of climate factors and processes; Changing paradigms in rangeland ecology or Dryland Development Paradigm; Incorporating Ecosystems Services of MEA 2005; Tipping points and non-linear responses; Changes in our understanding of socio-economic processes and its integration with desertification processes, between others. In 2018, in the context of the UN Agenda 2030, the Sustainable Development Goals were established dedicating number 15 to desertification problems, although these are also related to several other SDGs.

Forest soils of the Czech Republic – current state and change expected after the bark beetle outbreak

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Keywords: forest soils, logging residues, nutrient sustainability, forest management

Forest soils in the Czech Republic developed mostly on relatively pure and acid crystalline rocks of Bohemian Massif that are more than 300 million years old. The Central European region was significantly impacted by air pollution and acid deposition during 20th century, which led to further loss of base cations and acidifying of soil horizons. Productive forestry aimed on planting of even-age stands of Norway spruce and Scots pine has partly contributed to increased input of acidifying compounds to forest soils as well. On the other hand, significant decrease of air pollution has been observed since 1990's. To describe the current situation, we have compiled a large national "Aggregated soil chemical properties database" combining harmonized results from several surveys from the period 2000–2020.

Using new sets of models updated maps for soil reaction (pH/H_2O, pH/KCl), main nutrients (P, K, Ca, Mg), soil carbon concentration and stock were processed. Concentration of base cations (Ca, K, Mg), pH and base saturation were used also for defining forest categories with different risk of soil acidification: slightly-, moderately-, strongly-, and extremely endangered. According to our results, more than half of forest soils exhibit extremely low content of exchangeable Ca (<150 mg.kg^{-1}), Mg (<20 mg.kg^{-1}) and available P (<10 mg.kg^{-1}) in the upper 30 cm of mineral soil.

Consequently, 18 % of forest area can be characterized as extremely – and 75 % as strongly endangered by soil acidification.

Current situation in forestry in the Central Europe is determined by ongoing bark beetle outbreak, which led to extreme spread of clear-cuts and temporary loss of forest cover in range of hundred thousands of ha. Such a rapid change may have considerable effect also on soil properties mainly due to processes in the upper organic (humus) layer. Changes in carbon stock as well as in other chemical properties can be expected. Recent results comparing soil analysis before and after clear-cut, however, are rather hazy – probably due to high variability on cleared areas and input of logging residues that are often mixed with the upper soil layers. Notwithstanding serious risk of (temporal) deforestation, current situation can have also a positive effect to the future by giving a chance for accelerated change of tree species composition and increased forest diversity. Such (potential) positive development can be beneficial also for several qualities of forest soils – e.g. for carbon sequestration, soil biodiversity or hydrological features due to more complex rooting in deeper soil layers.

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A win-win strategy for consolidating soil awareness in politics and reaching an effective soil governance in society

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Keywords: soil awareness; soil governance; soil definition; science communication

Though most will agree that it is important for scientists to be able to communicate to non-scientists, this is a difficult skill that many practicing scientists lack, likely due to the combination of increased specialization over time and the absence of formal training in science communication. In these last decades, the awareness that soil is a very important resource for humans has noticeably increased. Many actions and initiatives to promote soil governance, aiming at sustainable soil management and soil security have been undertaken by several national and international institutions and in many countries.

Analysis of the changes of soil perception over the centuries allows highlighting a perfect harmony between the evolution of soil awareness and the level of knowledge and technology achieved by humans during their history and evolution. Notwithstanding these many achievements, soils continue to be scarcely considered in politics and society.

We suggest some thoughts and reflections that could lead to an up-to-date and effective definition of soil that directly focuses the public attention on its economic value. In our opinion, soil economic value could be the only aspect that truly attracts the attention of politicians and administrators, which could increase soil awareness and encourage soil sustainability, security and Sustainable Development Goals and finally promote soil governance. Labelling soil as an "economic" resource that influences deeply the "social" and "political" systems, could be a win-win strategy in attracting the attention of people because such label recalls a fundamental aspect of mental experience with which people have the subjective sense of knowing or being conscious of something that is of paramount importance for the people's everyday life, i.e. economy or, in a more explicit term, financial resources.

POSTER PRESENTATIONS

The potential of hyperspectral aerial surveys for identifying waterlogged areas in agricultural landscapes

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Keywords: agricultural production, waterlogged areas, hyperspectral aerial surveys, sustainable agriculture

Agricultural production is critical for food security, yet climate change is having a severe impact on agricultural landscapes, with droughts being a significant stress factor. To ensure sustainable agricultural practices and protect soil health, identifying and restoring waterlogged areas that have been drained and transformed into agricultural parcels in the Czech Republic is becoming increasingly important. In this study, we investigate the potential of using hyperspectral aerial surveys to identify and restore these waterlogged areas, which not only enhances landscape resilience but also serves multiple environmental purposes. We evaluated 33 spectral indices related to waterlogging of soil using the maximum entropy model (MAXENT) in the South Moravian region of the Czech Republic, a region where water retention in the landscape is highly relevant. Our results show that chlorophyll-based indices, particularly NVI and CARI, are the most useful for identifying waterlogged areas in both spring and autumn. Restoring these waterlogged areas will not only contribute to building landscape resilience against future climate shocks but also protect soil health and support sustainable agricultural practices while also serving other environmental purposes. Our findings highlight the potential of using hyperspectral aerial surveys and MAXENT analysis for identifying and restoring waterlogged areas in agricultural landscapes for multiple environmental benefits.

Acknowledgement
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Enhancing direct runoff estimates through modification of the NRCS-CN method

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Keywords: direct runoff; initial abstraction ratio; rainfall-runoff modelling; NRCS-CN

The Natural Resources Conservation Service Curve Number (NRCS-CN) method, formerly known as Soil Conservation Service Curve Number (SCS-CN), was developed in the USA for estimating direct runoff in small agricultural watersheds. Given its relative simplicity and feasibility, the method became globally known and has been commonly used in hydrological modelling and other environmental applications. Over the decades of its existence, the NRCS-CN method has undergone a number of different modifications with the aim of improving the accuracy of the results in diverse geographical conditions. In Czech Republic the NRCS-CN method is usually employed in the unchanged form, i.e. through tabulated CN values characterizing the hydrological properties of soils, land cover and antecedent moisture conditions classes. However, previous experience shows that using the method in its original setting is problematic. This contribution therefore presents an overview of some modifications of the NRCS-CN method, which aimed to enhance the direct runoff estimates in predominantly agricultural experimental catchments in Czech Republic:

(1) Modification of initial abstraction coefficient λ using the tabulated CN values;
(2) event analysis based on empirical parameters of rainfall-runoff events;
(3) derivation of direct runoff from rainfall and catchments' physiographic characteristics through stepwise and least trimmed square regressions.

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the Moravian-Silesian Region landscape to climate change adaptation“). The rainfall and runoff data for the Kopaninský Creek watershed were provided by the Research Institute for Soil and Water Conservation. The rainfall data for the Husí Creek watershed were provided by the Odra River Basin, state enterprise.

Evaluation of the agroecosystem service potential – regulation of the soil erosion

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Keywords: remove potential of soil, USLE erosion model, water erosion of soil, LAU 1 (district of Slovakia)

The concept of ecosystem services (provisioning, regulatory and cultural services) represents a mutual interaction, and it is a link between ecological and economic (social) approaches. In principle, it is a connection between natural capital and human well-being, which contributes to the fulfillment of human needs. For analysis and evaluation of potential of agroecosystem (arable land and grassland) services (provisioning, regulating and cultural) in Slovakia we have created a mapping unit combining differently input layers. In our paper, we focus on the assessment of the one regulatory ecosystem services, the potential of the territory to regulate the loss of agricultural soil used at the level of LAU 1 (NUTS 4 – districts). The evaluation of the agroecosystem services potential and its mapping is processed on the selection of biophysical indicators in combination with slope topography, soil texture and landuse in four climatic regions. The soil bearing is evaluated according to the model for the erosion layer of the soil combined with the value of the permissible soil loss and is expressed as the degree of soil erosion risk. The result of this procedure is to classify the potential of the soil loss into 5 index classes (from very low potential to very high potential of this service).

Agroecosystems of arable soils have a high to very high potential for regulation of water soil erosion. Arable land is located mainly in flat areas where low risk of water erosion occurs. These values of soil erosion significantly correlate with the attribute of slope ($r=-0.72$, $p=0.0008$). Another prerequisite for higher potential for regulation of water erosion on arable land is presence of deep soils, and consequently higher limit for acceptable soil loss. When considering the overall coverage of land by per-

manent grassland (land registered in LPIS as permanent grasslands), can be achieved very high potential for soil erosion control. The potential to regulate soil transport is increasing with warmer climate in case of arable land as well as permanent grassland. This is related to the occurrence of deep soils in lowland areas, where warm and very warm climatic regions predominate, and the limit for acceptable loss of soil is higher. In case of arable soils, there is a potential for regulation of soil erosion at approximately the same level in moderate cool (MC) and moderate warm (MW) climatic zone. In general, grassland potential to regulate soil transport rises from the MC climatic zone to the very warm (VW) climatic zone. The grassland potential is over 80 % in the VW climatic zone.

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Drop size generated by dripping rainfall simulators for soil research–review

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Keywords: dripping rainfall simulator, drop size, metal drippers, plastic drippers, dripping speed

Dripping rainfall simulators (DRS) are important instruments in soil research. Depending of their performance they could be appropriate for some soil research or not. Therefore, a large number of non-standardized DRS have been developed. The major component of simulator are drippers that come in a various type and size with different modifications. The aim of research is to provide insight into the mechanism and ability of DRS drippers to generate drops of different diameters and the factors that affect it as are dripper size, type and dripping speed. Drippers performance was analysed integrally, for simulators with more than one dripper (DRS>1) and with one dripper (DRS=1). The analysis showed that DRS can provide drops that corresponds to natural rainfalls. The sizes of the drops generated by drippers are mostly in the range between 2 and 6 mm, while the number of drops smaller than 2 mm is relatively small. Metal tubes (MT) are the most present, after which plastic tubes (PT) follow. They showed strong correlation of outer diameter (OD) with drop size, while ID correlation is moderate to weak. It is observed that with the increase of the ID of PT the relation deviates from the logarithmic curve that represents all dripper types together. Also, although the applied dripping intensity difference

is quite big for MT, drop size does not differ much. On the other hand, PT generate much bigger difference in drop size for less drastic change in dripping intensity. Considering MT drippers generally have a thinner wall then PL or glass tube (GT) drippers the thickness of tube wall is imposed as a reason for such deviation.

Acknowledgement
This research has been financially supported by the Ministry of Science, Technological Development and Innovation of Republic of Serbia (Contract No: 451-03-47/2023-01/200026, 451-03-47/2023-01/200169).

Measures for water retention in landscape in the Czech Republic

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Keywords: water retention, erosion, measures

Hydrological extremes – long dry periods alternated by short heavy rainfall events – call for a solution to this problem. The Government of the Czech Republic has adopted strategic documents that should help to mitigate the situation. One of the goals in these documents is to define measures which are able to retain as much water as possible in landscape in case of heavy rainfall event and also during dry periods. Existing measures were collected and some new have been proposed as a result of a project financed by the Ministry of Environment of the Czech Republic.

It is important to emphasize that all measures should be proposed as a part of complex system for landscape adaptation for extreme rainfall--runoff events. Single-purpose devices (measures) are the least effective. All collected measures follow basic goals:

- supporting infiltration of water into the soil,
- limitation of concentrated surface runoff,
- decreasing of water velocity to avoid soil erosion,
- increasing of water retention of the landscape.

The measures are presented in an identical format which contains basic characteristic, description of theirs effects, interactions and impacts on the environment. Some technical schemes and photos of real realisations are included. Estimations of costs and time required for implementation, is also presented.

This paper introduces the categorisation of the collected measures and details some chosen examples of realisations.

Important
All measures should be proposed as a part of complex system for landscape adaptation for extreme hydrological events. Single-purpose devices (measures) are the least effective.

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Interactive effects of wind velocity and slope gradient on splash erosion

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Keywords: aggregate breakdown, rainfall simulation, soil conservation, soil erosion, splash cups.

Splash erosion caused by raindrops is the first step of water erosion that detaches and transports soil particles and considerably impacts soil erosion. Soil erosion, especially splash erosion, has been influenced by many factors, including the climatic factors and slope of the land. The slope of the land is a significant factor affecting soil erosion. In addition, the slope steepness can impact upward and downward particle splash and total splash. However, the combined effect of slope steepness and wind has to be studied yet. The current research has therefore investigated the effects of different slopes of the laboratory plots and wind velocities on the splash of soil particles. The corresponding experiments were conducted at two slopes of about 12 and 30 %, with approximate rainfall intensity of 50 mm h^{-1} with durations of 30 min under two upward wind velocities viz., 3 and 6 m.s^{-1}. The study was carried out on a soil collected from the upper layer (0–20 cm) of Kojour summer rangelands, Mazandaran Province, and transported to the Rainfall and Erosion Simulation Laboratory of the Faculty of Natural Resources, Tarbiat Modares University, Iran. Then, the soil was sieved at an 8-mm sieve to increase the homogeneity of the soil samples.The laboratory simulations were conducted using three 6×1 m erosion plots with a depth of 0.5 m. The plots were filled with different sizes of mineral pumice (thick of 30 cm) to simulate natural drainage conditions. The remaining depth of the plot was then filled with air-dried soil. A hand roller compacted the soil surface to reach the bulk density of the original undisturbed soil sample. Three splash cups were used to measure splash erosion, and each cup was placed on the soil surface at a distance of 1.5, 3.0, and 4.5 m from the plot outlet. The results showed that the

mean net splashin slope 12 % increased considerably with the increase of wind velocity, ranging from 9.58, 14.93, and 18.63 g, respectively, as wind velocity changes from 0 to 3 and then 6 $m.s^{-1}$. The percentage of changes for the velocities of 3 and 6 $m.s^{-1}$ were 55.84 and 94.36 %, respectively. The mean net splash in the 30% slope was from 14.98, 30.91, and 39.08 g, respectively, as wind velocity changes from 0 to 3 and then 6 $m.s^{-1}$. The percentage of changes for the velocities of 3 and 6 $m.s^{-1}$ were 106.34 and 160.88 %, respectively. The amount of net splash has increased with the increase in wind velocities. The results displayed the significant effects of wind ($P<0.01$) on splash erosion. Besides that, with the increase of the slope from 12 to 30 %, the amount of net splash has increased. Though, more investigations and understanding of soil erosion processes will improve understanding of soil erosion and sediment yield and ultimately soil erosion and sediment transport modelling.

Long-term agrochemical testing of agricultural soils related to natural and socio-economic conditions of Czech Republic

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Keywords: Colluvisol, hyperspectral imaging, soil organic carbon

Since 1999 in the Czech Republic, agrochemical testing of agricultural soils (ATAS) has been carried out in accordance with Act No. 156/1998 Coll., on fertilizers, auxiliary soil substances, auxiliary plant preparations and substrates and on agrochemical testing of agricultural soils. Details, including chemical analyses and criteria for evaluating the results, are laid down underby-law No. 275/1998 Coll., on agrochemical testing of agricultural soils and determination of soil properties of forest land. ATAS manages the Central Institute for Supervising and Testing in Agriculture (ÚKZÚZ) and transmits information through the LPIS (Land Parcel Identification System) geographic information system to agricultural entities, the Ministry of Agriculture and other state administration bodies.

The primary purpose of ATAS is to provide a basis for processing a rational fertilization system and to compare the changes and development of the nutrient supply. In general, the ATAS is an effective tool for the Ministry of Agriculture for streamlining agrarian policy in the field of plant nutrition

and fertilization (it enables evaluation of the development of soil fertility, the effect of fertilization, etc.).

This paper aims (in addition to the above) to evaluate the development of soil properties in the period from1999 to 2019 in relation to selected factors of natural and socio-economic conditions. They comprise mainly soil unit (genetic type), size of part of the land block (PLB, elementary unit in LPIS), size of the farm (according to the area (in ha) that the farm manages), type of agricultural management (conventional, organic farming, transition) and type of farm, degree of susceptibility to erosion.

Soil sampling is carried out on all agricultural crops: arable land (1 mixed sample per 7–10 ha depending on the production area), permanent grassland (same density of samples), hop fields (1 mixed sample per 3 ha), vineyards (1×/2 ha), orchards (1×/3 ha). The sampling depth for arable land corresponds to the thickness of the topsoil. DPBs larger than 2 ha are sampled, the frequency of sampling is once every 6 years (tens of thousands of samples each year). Tested soil properties include pH/$CaCl_2$, $CaCO_3$+$MgCO_3$, content of nutrients P, K, Ca, Mg in later years and microelements B, Cu, Zn, Mn, Fe, Al, S, Cd (mg/kg) according to Mehlich III method, content of oxidizable carbon – Cox (later also total carbon and nitrogen), glomalin.

The size of the soil block does not indicate a major influence on the measured soil properties, or show a similar trend: either complex, non-linear (carbonate content), positive (K content), or negative (Cox and glomalin in 2014–2019). The technology used and land management probably have a greater influence here. The size of the economic entity is a crucial factor in some parameters and in some soil types: e.g. pH on Chernozem soils, where faster acidification of soils with a lowering content of Ca and carbonates is evident in larger enterprises. Organic farming shows either the same (e.g. glomalin) or slightly better soil parameters compared to conventional agricultural management (e.g. Cox). Farm typology is a very complex factor as well as susceptibility to erosion (composite samples).

ATAS represent a valuable information source of data, which with careful interpretation can be a strong professional basis for the creation and reflection of the agrarian and environmental policy of the Czech Republic.

The results of analyses of the development of soil properties and the resulting recommendations will be part of the output of the DivLand project, WG Agrosystems & Soil.

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Monitoring of soil properties and groundwater level in alluvial floodplain forest

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Keywords: underground water, Fluvisols, forest

The research of alluvial soils in the alluvial basin of the rivers Dyje and Morava indicates that the sediment deposits were not formed continuously, and the inundation process was regularly interrupted by no flood periods. That inundations and the appropriate groundwater level are essential factors of the alluvial soil-forming process. The meandering river Dyje is the axis of the studied region. The right river bank is covered by floodplain forests and the left bank is covered by meadows and permanent grasslands. The exploratory area of Mendel University Brno is situated in the floodplain forest near the town Lednice na Moravě (Czech Republic). Long-term systematic monitoring aims to follow changes in soil properties and forest growth as affected by climate change. Especially, the reduction of natural inundations after hydro-technical measures of the river bed directly affects the soil and the whole ecosystem. Moreover, the drop in the groundwater level caused many problems with drinking water for municipalities. Monthly monitoring of groundwater level, soil chemical and physical properties, and climatic conditions, is important for floodplain forest management. The studied soil was classified as Gleyic Fluvisol Clayic. It was found that the heterogeneity of alluvial deposits and variability of the stand composition influenced the uneven distribution of nutrients and organic carbon in the soil profile. Similarly, the bulk density and porosity values display a broad fluctuation with depth. Measured results

were evaluated by one-way analyses ANOVA, followed by the Fisher test ($p=0.05$). The software Statistica 12.0 was applied. Obtained results also showed an increase in average temperature and drought periods during 2019–2022. The drop in groundwater level was observed especially during the summer and autumn periods. Floodplain forest growth was affected by drought periods as well. Continual measurements are important for preparing better forest management strategies such as artificial floods and legislation for the protection of this area.

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The study was supported by project No. FW0601006 "Semi-autonomous system for optimizing degraded soils by deep grouting" (TAČR MoACzechia), project No QK 21010124 "Soil organic matter – evaluation of selected quality parameters" (NAZVA MoACzechia), and by the Institutional support of the MoACzechia.

Multi-level nitrogen balance at temperate forests in the territory of the Czech Republic

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Keywords: forest ecosystem, tree-species composition, soil nitrogen, surface humus, nutrient balance

Deviations at nitrogen balance became the most spread cause of forest ecosystem damage under polluted air. Forests are more endangered due to acidifying nitrogen deposition than agricultural soils because of interception by difficult structure and of prevailing occurrence at broken relief. Nevertheless, forest ability to bound acidifying substances in organic matter is unrepresentable for protection of surface water resources and of agricultural soils subsequently. In presented study, we have compared tree-species effects on forest nitrogen balance among various area scales from topic level of forest stands, grid micro-level of small catchments with 1×1 km cells to mezo-level of forest areas of the Czech Republic. The tree-species selection took into acount economic perspective and equal proportion of azonally spread species between clear or mixed stands. The topic level was composed from homogeneous stands of Norway spruce (*Picea abies*), Scots pine (*Pinus sylvestris*), European larch (*Larix decidua*), Common beech (*Fagus sylvatica*), English oak (*Quercus robur*), European birch (*Betula pendula*), European hornbeam (*Carpinus betulus*), Common ash (*Fraxinus excelsior*), small-leaved linden (*Tilia cordata*), sycamore maple (*Acer pseudoplatanus*), alders (*Alnus sp.*) and willows (*Salix sp.*) that were 40–80 years old with continual area >1 ha. The nitrogen inputs into forest ecosystem were summarized through surface humus, modelled deposition and estimated fixation. The outputs were calculated through nitrogen volume at tree stocks, soil nitrogen access and estimations of gasesous releases as well as leaching.

The nitrogen inputs were the most presented at the topic level by fixation (99.82 %) and marginally by litter (0.17 %) and by deposition (0.01 %). The outputs from topic level were represented by 36.09 % of accessing, 30.17 % of gaseous releases, 28.31 % of tree volume increment and 6.85 % of leaching. While mean micro-level inputs were represented similarly, the outputs were divided in very different way by 80.57 % of tree increment, 17.20 % of soil accessing, 0.01 % of gas release and 2.22 % of leaching. Dominant static compounds of nitrogen biological fixation caused, that forest nitrogen balance appeared to be positive always. However, distribution of nitrogen total input and output values differed, thus they did not indicate distribution of resulting balance. Elimination of total soil nitrogen from static compounds and simplification of available forms to dissolved ions have suggested that forest ecosystems were able to release more nitrogen than to fix. Proportion of variable inputs has included 1.31 % of deposition, 21.12 % of litter and 77.57 % of surface humus, while simplified outputs have included 35.23 % of tree increment, 21.73% of soil accessing, 37.84 % of gas release and 8.51 % of leaching. The inputs became either very high (32.81 %) or very low values (30.42 %) the most often. In contrast, output values were predominantly medium (54.73 %). The nitrogen balance was more often very low (36.95 %) than very high (32.03 %). Generalization of forest nitrogen balance to mezo-level confirmed distribution of high and very high values to mountain areas and of very low values to upland areas according to presence of high inputs. Forests affect nitrogen balance the most through total content in soil. Mountain forests cover soils with higher nitrogen content than submountain forests despite higher vulnerability to nitrate release. A change in this distribution toward preserved water resource protection is based on tree-species composition similar with submountain altitudes.

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Migration of organic carbon and Ca in soddy-podzolic soil limed by chalk: laboratory trial

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Keywords: liming, calcium, water-soluble OM, migration, optical density

Reclamation of acid soils are often faces various problems related to the losses of organic matter and calcium via downward migration in humid regions. In a model experiment on columns, a study of the conjugate migration of water-soluble organic substances (WSOM) and calcium in soddy-podzolic soil was studied. The soil was limed by two doses of chalk calculated by hydrolytical acidity (Hy) of the soil: the dose of 0.9 Hy is scientifically calculated dose and the dose of 2.5 Hy is deliberately overestimated dose. In total, 16 washing were conducted and the leachates were analysed for leached organic C and Ca. Optical density of the lichates were also determined. From the soil limed with a 0.9 Hy dose of chalk, 133 mg of Ca and 469 mg of organic C were removed. From the soil reclaimed with a 2.5 Hy dose of chalk – 637 mg of Ca and 510 mg of organic C were removed. An increase in the dose of chalk by 2.7 times led to an increase in calcium migration by 4.8, and organic carbon by 1.2 times. The

enhancement of calcium migration to the eluviation of WSOM in the treatment with 2.5 Hy dose of chalk was more pronounced compared to the 0.9 Hy dose, with the coefficients of determination $R^2 = 0.81$ and $R^2 = 0.41$, respectively. Over the entire period of study in the soil from the treatment using chalk at a dose of 0.9 Hy, the fluctuations in the optical density index ranged from 1.43 to 0.6, while in the treatment with 2.5 Hy, from 2.0 to 0.4 units. The optical density of migrating solutions significantly related with the migrating WSOM and Ca. In the treatment reclaimed with the 0.9 Hy dose of chalk, an increase in the calcium content in drainage waters and a decrease in organic C caused an increase in the optical density of solutions. In the treatment with the 2.5 Hy dose of chalk, an increase in the calcium content and a decrease in WSOM amount in solutions was accompanied by a decrease in their optical density.

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Potentially toxic elements in agricultural soils in the Czech Republic – state and development

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Keywords: soil, soil monitoring, potentially toxic elements, temporal change

Contents of potentially toxic elements are part of long-term soil monitoring programme. The monitoring net consists of 214 locations. The system was set up in 1992, the sampling methodology was optimised in 1995, the last regular sampling campaign was carried out in 2019. Now one period of sampling campaign lasts six years.

Our results from 2019 sampling campaign confirmed increased load of potentially toxic elements in three main areas – surroundings of Louny, Kutná Hora, Příbram. Except these there are areas with higher contents of Cr and Ni in South Bohemian Region and Vysočina Region. Increased contents of Cu have been detected in South Moravian vineyards and high contents of Hg in Moravian-Silasian Region around town of Nový Jičín.

The next step consisted of assessing any changes between individual campaigns. Put simply, As, Co, Mo, Ni, Pb, Zn contents were higher in 2019 than in 1995 at most of our monitoring locations while contents of Be, Cd, V, Hg have decreased since the monitoring programme had started. The differences between sampling periods are significant only for some elements and land uses.

More detailed information at www.ukzuz.cz.

A study of salinization of agricultural soils in the Maisky district of the Pavlodar region of Kazakhstan, using remote sensing data

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Keywords: arid region, soil, salinity, remote sensing, clay

Soil salinization is one of the most widespread land degradation processes, especially in arid and semi-arid regions. Saline soils make up 20 % of developed land in the world, and half of all irrigated land is saline. There is a tendency towards an increase in the extent of soil salinization. The total area of Kazakhstan is 272 million hectares, of which 180 million hectares (60 % of the total area of the country) are currently under threat of degradation, which is accompanied by processes of intensive soil salinization, such as salinization of irrigated land and the growth of saline desert areas. In such climatic conditions, soluble salts accumulate in the soil, which worsens its properties and ultimately reduces crop yield.

To monitor the state of agricultural land, it is necessary to improve access to information on the state of vegetation and growing conditions. One method is remote sensing (RS), which provides data that can be used to independently assess the state of vegetation over large areas based on reflection from the Earth's surface. However, factors influencing reflective properties should be taken into account: the phenological state of the plant, the prevailing plant species, the degree of plant damage, the prevalence of weeds in the fields, as well as the observation conditions (observation angle, distance from the sun, light conditions, atmospheric transparency, calibration of scanning cover, weather conditions and soil).

The purpose of this study was to analyze the relationship between the level of soil salinity and the main spectral indicators obtained from Landsat satellite data. The study area was the Maisky district, located in the southeastern part of the Pavlodar region of Kazakhstan. To analyze the relationships, we used the NDVI vegetation index, salinity and soil indices such as SI I, SI II, SI III, SI IV, SI V, NDSI, SAVI, VSSI, and BI. The normalized difference salinity index (R–NIR)/(R+NIR), using a quadratic statistical relationship, showed the best correlation with laboratory data. Due to aridity or underdevelopment of agricultural plants, the vegetation index NDVI showed the least correlation.

As a result of the lack of clear control over irrigation and chemistry in agricultural practice, the soil granulometric composition on irrigated land, where flood methods are used, has deteriorated. When irrigating, it is necessary to ensure conditions under which water and fertilizers supplied to the irrigated field will have a beneficial effect on the soil.

The methods used can be useful in mapping and recording saline soils using satellite data in natural and climatic conditions similar to this study.

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Response of soil chemical and biochemical properties to biochar + compost) application under Zea mays in a degraded environment

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Keywords: biochar, sodic soil, compost, corn, soil enzymes.

From February to September 2022, a field experiment was carried out at Vecindario (SE Gran Canaria, Canary Islands, Spain), to check the performance of biochar as a soil amendment to ameliorate soil chemical and biochemical properties. Plants of corn (Z. mays) were seeded in plots placed in an area where soils are alkaline (soil pH > 9), moderately saline (E.C.≈1 dS/m), poor in organic C (<1%) and fine-textured (% clay > 40). Two blocks were set: the first one only received biochar as amendment, whereas the second one also received a previous application of compost. In both areas, biochar from Canarian palm trees (pH = 9.8, E.C. = 39.8 $dS.m^{-1}$, total C = 62.7 %, total N = 0.91 %, oxidizable C = 7 %) was applied in lines at four rates, equivalent to 0, 10, 20 and 40 tm/ha. Within each block (i.e., compost/no compost), plots were set following a randomized design with three replicates per treatment. Three soil sampling surveys were carried out at February (pre-seeding), June (blooming) and September (cropping). Soil samples were kept at low temperature (≈ 4 ºC) and taken to our lab in Tenerife Island for analysis. In each sample, relevant chemical and biochemical properties were measured, including: soil pH (1:5 soil:-water extract), soil oxidizable C (wet oxidation with 1N $K_2Cr_2O_7$), available P (extracted with 0.5M $NaHCO_3$), water-extractable NO_3- (1:5 soil: water extract) microbiological activity (hydrolysis of fluorescein diacetate assay) and three enzymatic activities (urease, dehydrogenase and alkaline phosphatase). Given the high heteroscedasticity in our results, non-parametric

statistical analyses were used for comparisons between sample groups. In compost-treated plots, a significant decrease in soil pH was detected (Kruskall-Wallis test, $p < 0.01$) with the application rate of biochar. Something similar was found for dehydrogenase activity ($p < 0.05$) in the same plot block (previously treated with compost). No further statistical differences due to the biochar doses were observed. As far as compost application is concerned, it was shown to determine significant differences in oxidizable C and available P levels, at any application rate. Also, statistically significant differences were detected for soil pH (application rate of 10 t biochar/ha), as well as for hydrolysis of fluorescein diacetate and dehydrogenase activity, both at the highest dose of biochar (40 t/ha). Finally, significant variations for almost all the soil properties studied were found along the three samplings, thus suggesting a high influence of seasonality and/or plant/root growth on the global variability of soil properties. Particularly, microbiological activity (as revealed by the results of the diacetate fluorescein assay) and soil enzymatic activities showed great differences along the experiment. Soil urease activity was found to be 10-fold higher by the end of the experiment with regard to the initial sampling, regardless the occurrence of compost and the biochar application rate. Conversely, dehydrogenase and phosphatase activities were higher at the blooming stage (June 2022), whereas total microbiological activity was higher at the initial (pre-seeding) stage (February 2022), all of it regardless the application of any soil amendment at any rate. Our results suggest that a joint application of biochar and mature compost may be a better choice with regard to biochar alone, at least for the soil properties examined in this work. Further investigation should be carried out to verify the performance of biochar at the mid and long term.

Acknowledgement
Research supported by the Programme of Trans-border Cooperation Madeira-Azores-Canary Islands (POMAC), through the VERCOCHAR MAC2/3.5B/307 project.

Impact of black cherry (*Prunus serotina* Ehrh.) on soil mites (Acari: Mesostigmata) in Scots pine (*Pinus sylvestris* L.) stands growing on post-agricultural lands

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Keywords: ecology, afforestation, succession, invasive species, edaphon

One of the major problems of modern forest management is afforesting-former agricultural areas. Post-agricultural land has been afforested on a large scale for several decades, but they differ from forest land in terms of many physico-chemical parameters, such as the C: N ratio, calcium, nitrogen and carbon content, and pH. This fact is reflected in the poor sanitary condition and low economic value of the trees introduced on them. The basic tree species introduced to the former agricultural lands are pine and birch. The overall circulation of matter between forests on forest and former farmland also maintains a different character. This finds expression in the species composition of soil organisms at all trophic levels, which, through the analysis of these, enables the monitoring of the current stages of forest succession. An additional factor influencing the regeneration of the forest on former farmland may also be the expansion of the black cherry, having a significant impact on the soil environment. The aim of our studies was comparing the communities of soil mites occuring in scots pine stands growing on post-agricultural land with and without black cherry understory.

The experiment was done in south-western Poland (51°45'55.5"N, 15°56'47.7" E). A total of 72 soil samples were collected from managed and mature (c.a. 100 y/o) Scots pine stands (*Pinus silvestris* L.) growing on post-agricultural and forest lands. Both stand types, were accompanied

by black cherry (*Prunus serotina* Ehrh). An equal number of soil samples were collected from 18 plots. Soil fauna was extracted in Berlese-Tulgreen funnels and classified to species level. In the collected samples, a total of 325 mites were shown, representing 29 taxa (25 species and four genera) classified within 11 families. The highest average abundance was found in post-agricultural stands without black cherry (5.75 ± 1.09), followed by stands on post-agricultural land dominated by black cherry (5.1 ± 1.04). The lowest abundance per sample was found in the forest stand, devoid of black cherry (3.05 ± 0.87). Overall, Parasitidae, Veigaidae, Laelapidae and Zerconidae were the most abundant families. The most abundant species were *Leptogamasus suecicus*, *Paragamasus* sp. and *Veigaia nemorensis*. The highest species diversity was noted in soils on post-agricultural lands with black cherry, and the lowest in forest land without black cherry. Additionally, the highest species richness was noted from the stands on former farmland with black cherry and without black cherry. The lowest species richness concerned the stand without black cherry on forest land.

In conclusion, growing of broadleaved tree species, black cherry in our case, in coniferous stand may enhance diversity of Mesostigmata communities on post-agricultural lands.

Acknowledgement
The studies were financed by the Faculty of Forestry and Wood Technology of the Poznań University of Life Sciences in 2021 from the program for the development of young scientists.

Determination of soil losses by wind erosion to support proposals for optimal measures to protect soil from wind erosion

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Keywords: soil degradation, wind erosion, climatic factors

The aim of the article is to provide information on new findings in the issue of wind erosion in the conditions of the Czech Republic with an emphasis on proposals for adaptation measures in connection with climate change. The post represents an ongoing project QK21010191 is presented, which is focused on the evaluation of the manifestations of wind erosion through the determination of soil losses due to wind erosion in t/ha/year for the territory of the Czech Republic. The assessment of soil loss is based on the use of the method using the Woodruff-Chepil equation (WEQ -Wind erosion theory), which comprehensively assesses all influences on the wind erosion process. The output of the equation is the determination of soil loss expressed in t/ha per year. The main outputs of the project are: a map of the soil erodibility factor for the needs of the WEQ equation, a map of the climatic factor C for the needs of the WEQ equation, the spatial delimitation of the prevailing wind directions for the needs of wind erosion, the creation of a map of the L factor – the length of the plot and determination of soil loss due to wind erosion in t/ha/ year for the territory of the Czech Republic. The outputs of the project solution will contribute to the fulfillment of the program goal by improving the Czech Republic's position in environmental protection and increasing competitiveness. The conceptual solution of the area, identifying the most risky areas in terms of adaptation needs and protection against the adverse effects of climatic factors (wind, drought), will enable effective, economically and administratively less demanding management of decision-making processes.

The results will enable the planning of a sequence of investments aimed at reducing and limiting the effects of climate change on the environment and landscape.

Acknowledgement
The contribution was supported by the project of Ministry of Agriculture CR RO0223 and NAZV QK21010191.

Byzantine agricultural terraces and their impact on soil conservation water distribution and fruit trees growth in the central Negev Highlands desert south Israel

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Keywords: groves, Byzantine era, runoff

Thirty-seven sites with fruit tree groves some of which are presently maintained by the Bedouin population of the Negev living in the in the Negev Highlands desert- south Israel. In this desert region, the average annual rainfall is only 90–130 mm/annum. Most of the older groves were planted in pre-existing agricultural systems based on terraces built in historical times, mainly during the Byzantine era, some 1500 years ago. In these groves a variety of domesticated fruit trees were planted such as: Date--palms, figs, pomegranates, almonds, carobs, pistachios, bitter oranges, grapevines and olives: Some of these trees are still growing. The trees are strictly rain fed and therefore depend on the amount of runoff water accumulating from the surrounding runoff harvesting systems, built by the ancient population of the Negev. The runoff water was directed into ancient terraces still functioning in spite their antiquity. The existing trees growing in the Negev Highlands can be classified into several periods. The oldest olive trees are apparently descendants of trees planted during the Byzantine period, while the youngest trees of a variety of species were planted by Bedouin during recent decades.

This paper will focus on the impact of the ancient agriculture terrace system, their adaptation to the local environment of the Negev Highlands and the mechanism standing behind their long survival and function as well as the survival of fruit trees grown in these terraces. Long term soil conservation and appropriate water distribution and their impact on the growth and survival of various species of demonstrate a successful case study for sustainable agriculture.

Degradation of traditional vineyards in Slovakia by abandonment and soil erosion: A case-study of Vráble viticulture district, Slovakia

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Keywords: vineyards, soil erosion, degradation, abandonment

The study examines the impact of increased erosion events and decreased management intensity on the degradation of traditional vineyards in an area near Vráble, Slovakia. For the erosion measurements, we used the pole height method, which uses vineyard poles as a passive soil-surface marker. The erosion of a tilled vineyard increased from 33.47 t/ha.yr^{-1} in the period 1983–2010 to 55.34 t/ha.yr^{-1} in the period 2010–2021. In comparison, the erosion of the hoed and grassed vineyard has not changed significantly. We also quantified the regeneration of soil in abandoned vineyards. An average increase in level of the soil surface level after abandonment in 2010 was 0.56 mm yr^{-1}. A control plot showed minimal change in the average exposed pole height over 10 years and confirmed the reliability of the pole height method. Land cover and management practices have dramatically changed in the study area over the last decade. Only 27.16 % of the total vineyard area is currently tilled and potentially threatened by soil erosion. On the other hand, 35.73 % of the vineyards are abandoned; abandonment is expected to continue into the future. Therefore, the loss of management associated with vineyard abandonment is more strongly linked to their degradation than increased soil erosion intensity.

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Soil cover change since Systematic Agricultural Soil Survey in the 1960s – Czech Republic

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Keywords: soil survey, land use, organic carbon, soil properties

In this contribution, we would like to present the preliminary results of the DivLand – Centre for landscape and biodiversity project. Main research tasks that the DivLand project focuses on are understanding the current development of nature and landscape, evaluating current trends in changing ecosystems or revealing the spatial distribution of biodiversity and threatening factors. The project should culminate in a proposal for strategic measures to be taken for sustainable landscape management, ecosystem management and biodiversity protection in the context of climate change. One of the branches of this project deal with agrosystems and soil, especially with agricultural soil cover change in the period after World War II.

Systematic Agricultural Soil Survey (SASS; took place in the 1960s in Czechoslovakia) data from selective soil pits were used for this purpose as detail information set describing historical land use, soil cover and soil chemical conditions. Five areas with the typical soil types in the Czech Republic were selected and recently resampled in the same sampling network as in SASS. Comparison of historical and recent soil condition thus takes place in two Cambisol regions (one with a still high proportion of arable land, and the second with a significant change in land use – an increase in the proportion of permanent grasslands), a Luvisol region, a Chernozem region, and a region with frequently occurring hydromorphic

soils. Approximately 50 points were resampled in each area. Samples from surface horizon (topsoil) and at least one sample from deeper mineral horizon were collected and actual land use was recorded. Samples was air dried, sieved through a 2-mm sieve for analysis of selected soil properties. All used analytical methods were in accordance with SASS methodology. The oxidizable organic carbon content (Cox) was measured using the dichromate oxidation technique. Carbonates content was measured using the volumetric calcimeter method. Soil pH was measured in distilled water extract (w/v – 1/2.5) and in 0.2M KCl extract in the same w/v ratio. Cation exchange capacity was measured using index ion (Ba) method with pH adjusted to 8.2.

Preliminary results show significant but not unidirectional changes in soil properties over time, respectively the 70-year study period. For example, average Cox value decreased in the time from 1.47 to 1.38 % in the Cambisol region, stayed approximately same in hydromorphic soil region (SASS – 0.68 %; present – 0.64 %), and increased in Luvisol region from 0.79 % to 0.93 %. Average pH values also changed differently at different locations. They increased from 4.6 to 5.5 in Cambisol region, from 5.2 to 5.6 in hydromorphic soil region, and they decreased from 6.4 to 5.9 in Luvisol region. The variation of soil characteristics values themselves and their changes is large even within each region. Therefore, it cannot be clearly stated or generalised that soil conditions have improved or worsened in the studied period. It is necessary to consider a number of influences (land use change, land management, change in the size of cultivated land blocks, or also a change in climatic conditions) that can cause changes in soil properties,what is the subject of further investigation within the presented project.

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Soil cover around the world's deepest flooded abyss near Hranice

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Keywords: Hranice Abyss, soil cover

The pedological survey was based on maps and documents from the 1960s. On that basis were create in later years 1:100,000 and 1:50,000 soil maps of the Czech Republic. For the needs of the project, these maps were confront with the current state in 2021 and 2022 and it was adding data for a large-scale map. The world classification IUSS WRB (2015) was using for that pedological survey. The walls of the chasm are made from the limestones of Upper Devonian – Famennian age (358.9±0.4 million years). The slope of the precipice of the lake is made up of slope sediment of various thicknesses, clayish, in places with a considerable amount of stones. From the point of view of WRB soil classification, it would be RSG Rendzic Leptosols, or Regosols (Leptic or Colluvic). The upper parts of the abyss and the Great Sinkhole are made up of Miocene sandstones, so the immediate forested surroundings of the abyss form RSG Arenosols. The slopes to the south and west of the chasm consist of limestone outcrops with Rendzic Leptosols or the filling of the Great Colluvic Regosols. RSG Arenosols extends up to several tens of meters into the agriculturally used land forming the eastern edge of the National reservation Hůrka. On arable land, they are then mixed with a heavier soil-forming substrate, loess/

loess loam. The loess loam was deposited here as a result of the eolian activity of the late glacial period. The agriculturally used soil on the slopes between the active Černotín quarry, the abyss itself (national reservation Hůrka) and the National reservations Velká and Malá Kobylanka are made up mainly of representatives of the RSG Haplic Luvisols in various stages of erosion or accumulation (in extremes up to Colluvic Regosols). Towards the south from the abyss, representatives of RSG Leptosols (shallow soils on outcrops of Miocene sandstones) can also be found on the Vápenka elevation. As mentioned above, the National reservation Hůrka in the southern part of the surroundings of the Hranická Abyss is made up of RSG Arenosols, which towards the north quite quickly transitions to large areas of Rendzic Leptosols on limestone, which are often „submerged" in a layer of loess loam of varying thickness. The middle part of the reservation Hůrka consists mainly from Rendzic Leptosols. The northern part of the Hůrka reservation, approximately from the ruins of Svrčov Castle consists from a combination of different parent material (greywacke, limestone and conglomerate), which creates conditions for the formation of RSG Cambisols, Leptosols, and to a limited extent of Luvisols (in places of larger loess loam overlays). In the area of the ruins of Svrčov Castle is a mozaic of RSG Anthrosols.

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Updates in the land evalution of the agricultural land fund of the Czech Republic

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Keywords: The System of Evaluated Soil Ecological Units, The State Land Office, geoportal

The land evaluation has more than two-hundred-year-old tradition in the Czech Republic, dating back to the time of Emperor Joseph II. The main aim of the land evaluation was (and to a certain extent still is) to assess the soil bonity, which refers to the performance rate of the soil and its ability for crop production. The System of Evaluated Soil Ecological Units (BPEJ in Czech) is the basic pillar for many formal legislative instruments as well as for setting up the support within the departments of the Ministry of Agriculture, the Ministry of Finance and the Ministry of the Environment of the Czech Republic. Due to the wider linkages of the System of Evaluated Soil Ecological Units, the soil bonity has the impact on both theowners of farmland and the operators. The update of BPEJ is mainly done on the whole cadastral territories or on their parts. Furthermore, the requests for review of BPEJ are processed, BPEJ mapping is carried out and the National database BPEJ is maintained.

Updating of BPEJ polygons from the seventies of the 20th century has been done consistently since 1994. The update process has so far been carried out on 25.2 % of the Agricultural Land Fund area of the Czech Republic. After the delimitation of the work activity from the Research Institute for Soil and Water Conservation (VUMOP, v.v.i. in Czech), the updating has been managed by The State Land Office (SPU in Czech) since 2016. The procedure of BPEJ codes determination is based on expert evaluation of the soil profiles, particularly using soil sample probes directly in the field. The sampling density is given by the land cover and it varies from 1 to 4 samples per 1 hectare. After processing and digitizing BPEJ contour lines, the data are finally validated by the record into the Cadastre of Real Estate. The BPEJ data are available for consultation on Geoportal of SPU or for download from SPU website.

SPU, in cooperation with the expert public (primarily VUMOP, v.v.i.), continues to develop the BPEJ systemin terms of content (pedagogical), as well as in terms of legislative and economic aspects. Anthrosols, including their new BPEJ codes and valuations, will be added into the system sometime in the near future. Necessary legislative amendmentsare being prepared in cooperation with the Ministry of Agriculture, Ministry of the Environment and the Ministry of Finance.

Climate regulation ecosystem services in selected regions of Slovakia

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Keywords: climate regulation ecosystem services, matrix assessment, landscape, mapping

The practical application of tools for evaluating ecosystem services is necessary to meet the ever-increasing demands for human well-being that necessitate a sustainable approach to landscape management. Carbon stored in ecosystems is an important indicator of regulation services potential whose amount depends on land use and land management practices. In agroecosystems of agricultural land, soil organic matter represents the largest share of total organic carbon found in the soil. Agroecosystems contribute to climate regulation by sequestration of organic carbon in the soil. The aim of the article is to evaluate regional differentiations in the values of climate regulation as one of regulating ecosystem services in relation to natural potential in 4 small pilot regions of the Slovak Republic (Krupina district, Michalovce district, Piešťany district and Brezno district) with the application of the modified matrix approach. Matrix approach is based on a matrix table where the capacity of each ecosystem types to provide ecosystem service is quantified. At the regional and national levels, the matrix approach is proving to be one of the suitable options for landscape planning and protecting nature. Potentials of local and global climate regulation services are scored on a scale from 0 (no relevant potential) to 100 (very high relevant potential). In the investigated regions, forest ecosystems, protected areas, fast-growing trees on arable land and wetlands of national importance had the highest value of the potential of natural capital for the provision of climate regulation. Permanent grasslands, agroforestry areas and water bodies had an average capacity to provide climate regulation services. The arable land, vineyards

and fruit trees ecosystems had a low capacity of climate regulation. The results in the pilot regions of the Slovak Republic indicated that the spatial localization of individual ecosystems in the country in combination with a higher altitude and a larger area of forests and protected areas can represent significant factors influencing the potential of the territory to provide benefits resulting from climate regulation ecosystem services. Mountain areas generally have a higher capacity to provide climate regulation, which is mainly due to its rich forest vegetation, as is the case in the Brezno model region. The comparison of the model regions showed the most significant regional differences between the pairs of regions, namely Brezno and Krupina on the one hand (regions with rural character at an altitude mostly above 300 meters), and on the other hand Michalovce and Piešťany (regions in the area with a warm climate at an altitude mostly up to 300 meters where arable land ecosystems are represented to a higher exten). Of the agro-ecosystems, primarily fast-growing trees on arable land and grassland ecosystems participate in climate regulation at higher altitudes.

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Changes in watershed sustainability due to air pollution

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Keywords: air pollution, environmental assessment, integrated watershed management, sustainability criteria, sustainable development

In recent decades, the watershed's condition, especially in developing countries, has experienced critical problems due to human interventions. Strong and unsustainable demand for different agricultural and industrial products and services will increase the destruction of ecosystems and watersheds. Therefore, awareness of watershed sustainability is crucial for properly managing the watershed and receiving consistent services. However, recognizing determinant factors for watershed health and sustainability needs to be studied yet. The current study has therefore been planned to investigate the dimensional sustainability of social, economic, environmental, and policy, and impacts of air pollution indices of NO_2, CMO, and absorbing aerosol on the sustainability of the Shazand-Watershed, Iran. Towards that, the sustainability-associated information and data, viz. climatic, hydrological, population, and satellite images and corresponding effectiveness, were collected from the previous investigations to cover different aspects of environmental, social, economic, and policy sectors of the study watershed. Considering all old and new input factors, the sustainability conditions and corresponding determinant factors were re-assessed. The results of the dimensional sustainability assessment showed an uneven distribution over the Shazand Watershed in which social and policy dimensions had the highest and the lowest effectiveness, respectively. In addition, air pollution criteria had a low impact on sustainability in most sub-watersheds except in sub-watersheds

23 and 24, where national-level petrochemical factories and industries are established. These findings help decision-makers designate appropriate preventive and curative strategies to boost watershed sustainability and help them recognize the consequence of the management implementation.

Vertical distribution of radionuclides in soil and its effect on groundwater vulnerability

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Keywords: radioactivity, caesium-137, soil, contamination, vertical distribution

Artificial radionuclides, with some exceptions, do not occur naturally in the environment and their presence is caused exclusively by human activity. The main sources of these radionuclides in the Czech Republic territory were atmospheric nuclear weapons tests (1945 to 1980, with the maximum in 1962) and the Chernobyl power plant accident (1986). The aim of the work was to determine the current degree of contamination of the topsoil and the depth that this contamination has reached in the vertical soil profile and to evaluate the possible vulnerability of groundwater. The paper summarizes the results of monitoring of the ^{137}Cs and ^{90}Sr vertical distribution at selected locations. The sampling sites were chosen in the locations of Hatín, Krašlovice, Veltruby, Veltrusy, Ivančice, Přítluky and Kyselovice, there were soils with the same or similar properties, but they differ in the type of landscape cover and land use (deciduous forest, coniferous forest, meadow, pastures, arable land, edge of residential buildings).

The collection of soil samples at each site was carried out by mixing of 17 sub-samples taken in a square of 5×5 m to a depth of 100 cm, in a thickness of 5 cm in the upper 50 cm of the soil profile, and in layers of 10 cm in the lower part. The gamma spectrometry method was used in the laboratory to determine artificial radionuclides. Furthermore, soil texture (results evaluated according to USDA) and the amount of oxidizable carbon – Cox (and humus content) were determined in the soil samples. The soils were classified as fluvisols in all cases. The soil texture in the case of the Hatín locality was determined as loamy sand, Krašlovice as sandy loam, Veltruby and Ivančice silt loam, Přítluky, Veltrusy and Kyselovice as loam.

The highest ^{137}Cs activities ranged from 21.0 Bq/kg to 32.2 Bq/kg in the upper layers of soils (to a depth of 10 cm). ^{137}Cs migrates very slowly in the vertical profile; is firmly tied to the soil. Decrease of ^{137}Cs activity with depth is typical for uncultivated soils with an intact soil profile. Most of the contamination is concentrated in the surface layer of the soil (upper 10 cm) and then gradually declines. In the case of soils flooded, cultivated, or otherwise affected by human activity, the distribution of ^{137}Cs in the soil profile is different. Where the soil was cultivated by plowing, the even ^{137}Cs activity distribution in the upper layers can be expected due to mechanical mixing. The situation is completely different at sites where larger mechanical interventions have taken place, for example in the Přítluky locality, where the measured activity is highest in the bottom layer up to 100 cm. The maximum activity value of ^{90}Sr was significantly lower compared to ^{137}Cs (the ^{90}Sr maximum was 4,26 Bq/kg). Compared to the vertical distribution of ^{137}Cs, it was not possible to define general depth with the maximum activity of ^{90}Sr. This depth varied in different locations. The measured results show greater mobility of ^{90}Sr in the vertical soil profile, as measurable activities (activities greater than detection limit) were often found even at depths greater than 50 cm.

The results of the ^{137}Cs and ^{90}Sr vertical distribution monitoring in the soil confirmed that soil contamination with these radionuclides is still measurable in the Czech Republic, even though 35 years have passed since the last significant deposition event (accident in Chernobyl). Most of the ^{137}Cs activity is firmly bound in the soil, so the transport into the deeper layers of the soil profile is very slow, and most of the detected ^{137}Cs activity is found in the surface layer of the soil. Nevertheless, depending on the local characteristics of the soil and other conditions, the contamination gradually penetrates to a greater depth. With regard to the evaluation of the vulnerability of groundwater, it can be stated, that the majority of ^{137}Cs is captured by the top layer of soil in localities with natural soil formation, and penetration of ^{137}Cs almost does not occur. In the case of ^{90}Sr, although the measured activity values in the soil are lower, it is clear that ^{90}Sr is more mobile in the soil and is more easily transported to deeper layers and can potentially also penetrate into groundwater.

Acknowledgement
This paper was written within project No. VI20192022142 entitled "Innovative Methods of Detecting Ultra-low Radionuclide Concentrations for

the Purposes of Evaluating the Vulnerability of Drinking Water Sources during a Nuclear Accident" funded by the Ministry of the Interior of the CR within the framework of the Security Research Programme of the Czech Republic 2015–2022.

The influence of different tillage methods in the inter-row of vineyards on soil erosion

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Keywords: tillage equipment, inter-row machines, vineyard, rainfall simulation, soil washdown

The aim of the research was to verify the bulk of soil particles in the surface runoff of water from the vineyard inter-row during a different tillage of the soil surface. The experiments were carried out in 2018–2020 at an experimental site in Velké Bílovice. Prior to the implementation of the experimental measurements, using the method of rainfall simulation, the soil surface in the inter-row of the experimental vineyard was treated with various types of tillage machines. These were a ploughshare cultivator with working depth 40 mm (var. I), a rotary cultivator with working depth 120 mm (var. II), and a disc stubble cultivator with working depth 150 mm (var. III). For rainfall simulations, a rainfall simulator of the VÚZT type was used, the simulations were selected intensity of 60 mm/h. The obtained results indicate that the highest values of surface washdown were found in var. I, on the contrary, the lowest in var. III. The obtained results thus confirmed the influence of different methods of soil surface treatment on the washing of soil particles in vineyards.

Acknowledgement
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Effects of inoculation of soil microorganisms on organic matter, stability of aggregates and soil available phosphorus under freeze-thaw cycle

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Keywords: bacterial community, ecological restoration, soil quality, soil stabilizers, soil structure

Freeze-thaw is an essential factor that can change the soil structure and quality, leading to soil and water loss and decreases in farmland productivity in seasonal frozen soil regions, impacting soil erosion. Maintaining soil stability conditions at slope levels by maintaining or strengthening the topsoil with active soil organisms is crucial for ecosystem management. Production and compaction of soil microorganisms, especially bacteria, and cyanobacteria, can be an excellent biological solution to protect soil and water resources. Based on this, the present study was planned to investigate the development of biological crusts and surface soil stability by inoculating native bacteria and cyanobacteria into surface soil under a freeze-thaw cycle. For this purpose, the studied soil was prepared from dryland and prone to erosion area of Badranloo in North Khorasan Province, and native bacteria and cyanobacteria were extracted and identified from the soil of the region. Extracted and identified bacteria and cyanobacteria were evaluated and analyzed based on various biological, physical, chemical, functional, and health criteria. Finally, among the bacteria of the region, *Bacillus subtilis* and *Azotobacter* sp. and cyanobacteria *Nostoc* sp. and *Nostoc* sp., *Oscillatoria* sp., *Microcoleus* sp., *Lyngbya* sp., *Phormidium* sp. were selected as the most suitable. After preparation, purification, and

propagation were inoculated in six treatments on plots. After 60 days from inoculation, the results showed that the amount of organic matter, phosphorus, and aggregate stability in inoculation treatments was significantly higher ($p<0.001$) than in the control treatment. Thus, the amount of organic matter and phosphorus in the control treatment was 0.91 % and 7.04 %, respectively. In the bacterial and cyanobacterial inoculation treatments, organic matter was 1.53 % and 1.67 %, respectively; Phosphorus levels were 8.28 and 8.33 ppm. Comparative analysis of aggregate stability in control and treated plots also indicated an increase in treated plots by 99.54 and 170 % for bacterial and cyanobacterial treatments compared to non-inoculated conditions, respectively. Evaluation of the results showed that inoculated treatments had statistically significant effects on improving soil quality. Naturally, its development is vital for managing ecosystems in cold and mountainous areas.

Acknowledgement
The Tarbiat Modares University Agrohydrology Research Group (Grant No. IG-39713) and the Islamic Republic of Iran's Technology Development Council assisted the corresponding and first authors in part (Grant No. 971201). We are grateful to Tarbiat Modares University's Rainfall Simulation and Soil Erosion Laboratory for carrying out the experiments entirely. The Iranian National Science Foundation (Grant No. 96013194) and Gorgan University of Agricultural Science and Natural Resources also provided financial support for this study.

Do soil properties reflect the changes in a forest stand structure? A case study from the primeval beech forest in Havešová, Slovakia

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Keywords: forest soil, soil microorganisms, stand structure, beech, primeval forest

Positive as well as negative relationships between the soil microbial attributes and plants have been documented in plenty of experiments. Understanding the spatial distribution of the soil characteristics influenced by forest structure in primary forests is important for forest management practices. Only the application of such silvicultural treatments that mimic natural processes, including soil nutrient andwater cycles, biodiversity, etc., can offer more resilient stands under changing environmental conditions. The objectives of this study were (1) to analyze and findout whether the differences in stand structure of the primary beech forest are reflected in the soil properties and microbial communities; and (2) to evaluate the dependence of the soil biological properties on the stand structure and physico-chemical properties of soil. The study was conducted in the natural reserve Havešová (Bukovské vrchy Mts., East Slovakia). Soil samples were taken from the surface organic layer (the O-horizon) and from the depth of 0–10 cm of the A-horizon on 40 sampling plots. In soil samples, basic physico-chemical (soil pH, the concentration of carbon, nitrogen, available potassium, calcium, and magnesium) and microbial properties (microbial biomass carbon, basal respiration, catalase activity, N-mineralisation, community-level physiological profiles) were analysed. Moreover, stand structural characteristics (volume of trees, additive stand density index, coefficient of homogeneity, tree influence potential, development stage indices, etc.) were calculated based on data measured in the field. We did not confirm any strong effects of the stand structure on the topsoil characteristics. The effect of stand structure was more pronounced in the physico-chemical properties than in the microbial characteristics. We found that the soil pH, N, P and K content in the forest floor was higher at plots where trees had a higher volume or higher density per plot. The effect of tree influence potential also had a positive effect on the pH

and K content within the forest floor, but in the A horizon, it had a negative effect or was indifferent to these parameters, which means that soil pH and K content was higher in the vicinity of bigger trees. The development stages expressed by the indexes based on the diameter structure were reflected especially by the soil pH, Ca content, and C/N ratio in the A-horizon.The diameter structure significantly influenced the soil properties, e.g., the dominance of trees in the initial growth stage (7 < DBH < 40 cm) contributed to higher values of soil pH, the dominance of mature trees (40 < DBH < 70 cm) caused lower values of soil pH and Ca content but higher values of P content, while the plots with a dominance of over-mature trees (70 cm < DBH) exhibited alower C/N ratio and a higher Ca content. When evaluating the effect of stand structure on the soil microbial community descriptors, we found that some of the correlation coefficients showed a weak but significant effect of the structural characteristics on microbial attributes. The results indicate that different aspects of stand structure have different effects on the microbial community: e.g. in the forest floor, the richness of functional groups increases with the increasing size of trees in the vicinity of the sampling plot; in turn, basal respiration was higher where trees had a homogenous structure, and microbial biomass and N-mineralization were higher where regeneration was more abundant. Regarding the community-level physiological profiles based on the Biolog® assay, significant differences were observed especially in the utilization of D-cellobiose, which positively correlated with the presence of the optimum stage index. Generally, the effect of soil physico-chemical properties on microbial characteristics was more pronounced than the effect of stand structure.

The lack of a distinct effect indicates that other factors than forest structure can drive the spatial distribution of soil properties and suggests that the present structural features of the canopy, including the deadwood and live tree structure, have no or limited ability to predict topsoil parameters in beech forest. On the other hand, the study demonstrates the distinct effect of soil properties on microbial communities, especially in the upper organo-mineral horizon.

Acknowledgement
The study was funded by the Slovak Research and Development Agency, project numberAPVV-19-0142, and the Scientific Grant Agency of Ministry of Education, Science,Research and Sport of the Slovak Republic, projects VEGA1/0115/21 and VEGA 1/0810/21.

Changes of chemical properties and carbon stock in forest soils after clear-cutting

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Keywords: carbon, sequestration, forest soils, clear-cuts

Ongoing project of National Agency of Agricultural Research (NAZV) is focused on evaluation of soil properties changes after massive temporary deforestation caused by bark-beetle calamity. This calamity led to emergence of large clear-cuts, which don't have any parallel in modern history of Central European forestry. Area of calamity clear-cuts it is in order from units to hundreds of hectares, which influence landscape, water regime, microclimate, forest soils, principles of forestry management (soil preparation, afforestation), availability of planting material and price as well as quality of timber.

Important changes of microclimate, water regime and biological composition occur on clear cuts accelerating decomposition of organic matter, which may be connected with the release of nutrients or potentially toxic compounds that were immobilised in organic bindings in organic and organo-mineral soil layers. The decomposition of organic matter is connected also with CO_2 release to atmosphere due to accelerated biological activity.

Within the project, we evaluate changes in carbon stock, in quality and amount of upper organic (humus) layer and risks of nutrient loss as well as release of toxic compounds to the surface water. Obtained results will be used for prediction and modelling of change of forest soil properties and for practical recommendations to minimize the potential risk.

Soil survey is carried out on ICP Forest monitoring plots, which were included in European soil survey „Bio Soil" in 2005–2008. On many of them forest stands were cutdown in last five years due to the bark-beetle calamity. In such a case, soil samples were taken following the same methodology as in the previous "BioSoil" survey. Evaluation thus enables us to compare soil properties before and after clear-cutting of the area. First results of analyses confirmed supposed changes in C, N and other elements content, especially trend of slightly decreasing C stock in humus layer and minor changes in pH values of upper soil layers. Results, however, exhibit very high variability, which is caused by the various site management after logging especially by treatment of logging residues (chopping, removal or leaving on the plot), tillage of soil and quick development of ground vegetation.

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The effect of forest management on physico-chemical properties of sandy soils

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Keywords: close-to-nature forestry, *Pinus sylvestris* (L.), soil physico-chemical properties, regosols

Climate has changed markedly worldwide over the past decades. Extreme events such as extended drought periods and heat waves, strong winds, etc. are occurring more frequently and are predicted to increase in their frequency and severity in many regions of the world in the future. Forest ecosystems are becoming increasingly vulnerable to dieback caused by heat and drought-induced physiological stress. Especially, on sandy soils, exhibiting high infiltration rates and low water holding capacity, it has become a serious problem. Moreover, sandy soils usually retain only a few nutrients. One of the ways how to improve this unfavourable condition is by increasing the organic matter content in soils, e.g. using suitable management of forest stands and soils. The main goal of this study was to find out whether the forest management, including close-to-nature forestry approach, can lead to the improvement of soil properties on sandy soils. Soil samples were taken in mature pine forest stands managed by traditional even-aged management (full and reduced canopy) and by close-to--nature approach. All types of forest in three replications were situated in the Záhorská nížina lowland in West Slovakia and growing on sandy soils. Soil profiles were excavated to a depth of 100 cm at each plot and samples were taken in 10 cm intervals down the soil profiles. In soil samples, soil moisture and basic physico-chemical characteristics (pH, the concentration of C, N, S, P, K, Mg, and Ca) were determined.

The results showed that the effect of the type of forest significantly affected all measured characteristics except Ca and Mg content. We observed significant changes with soil depth in the soil reaction, carbon, nitrogen, sulphur, and C:N ratio. We also found significant interactions between the type of forest and soil depth in the case of soil moisture, C:N ratio,

carbon and nitrogen content. Generally, soils in the close-to-nature managed stand exhibited higher concentrations of carbon, nitrogen, and higher soil moisture, but lower soil reaction (pH = 3.36 in the top 10 cm of the soil profile) and lower K concentration than other forest stands. The pine stands with a reduced canopy exhibited the lowest C:N ratio, the highest pH values, and the highest available P concentration. The results of this work can help to better understand managing of forest stands on sandy soils. The results indicate that the application of such silvicultural treatments that mimic natural processes could offer more resilient stands under changing environmental conditions.

Acknowledgement
The study was funded by the Slovak Research and Development Agency, project number APVV-19-0142, and the Scientific Grant Agency of Ministry of Education, Science, Research and Sport of the Slovak Republic, projects VEGA 1/0115/21 and VEGA 1/0810/21.

Relationship between forest management and soil water content dynamics as a forest ecosystem services factor

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Keywords: ecosystem services of forests, forest management, soil water content, water retention

From the point of view of functions and services of forest ecosystems, services affecting the quantity and quality of water are among the most important ecosystem services. The management of water resources and the provision of sufficient quality water has become a much-discussed topic under the climate change, mainly due to the uneven distribution of precipitation and subsequently long periods with a precipitation deficit. The topic of the contribution will be to monitor and evaluate the dynamics of the water regime in natural forest stands as well as in stands managed by different forest management system. The dynamics of the water regime will be monitored by non-destructive geophysical methods (electrical resistivity tomography) in 2D as well as in 3D space. For a more detailed description on the meso- to micro-scale, the measurement of soil moisture by the time domain reflectometry method – Time domain reflectometry (TDR) in short time periods will be used (at the level of seconds to minutes). The research sites were selected regarding different types of management system. For determining the spatial variability of soil moisture, we calibrated the soil resistivity information to the current soil moisture values obtained by the TDR method. The location of the TDR probes was at the edge of the investigated area, at a depth of 10 to 80 cm with a step of 10 cm. The measurement was carried out continuously every hour during the growing season. We performed ERT measurements at monthly intervals during the growing season on the same profiles (firmly fixed in the field), while the results were subsequently evaluated in the form of time series – time lapse resistivity. These results will then be displayed in the form of a 3D image of changes in desiccation and bulk soil moisture during the growing season.

Acknowledgement
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Soil development on metamorphic rocks in the conditions of protected and anthropogenically affected areas of forest ecosystems

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Keywords: Cambisol, serpentinite, granulite, paragneiss, clay minerals

Pedogenesis on rocks the Moldanubian Zone of the Bohemian Massif was analyzed. The objective of this study is to determine individual stages in soil profile development on metamorphic rocks at sites affected by human activity to different degrees. Aspects of pedogenesis were studied at three representative sites with different parent rocks. The site of Bořinka is located in the Blanský les Protected Landscape Area. This site is covered by a pine forest. Parent material is serpentinite. The representative soil profile at Buglata is also situated in the Blanský les Protected Landscape Area, being dominated by spruce forests. Parent material is granulite. The soil sequence of Chmelná is situated in a spruce forest affected by human activity. Parent material is paragneiss. The soil developed on serpentinite (Bořinka) was classified as Skeletic Eutric Cambisol (Loamic). The soils on granulite (Buglata) and paragneiss (Chmelná) were classified as Skeletic Eutric Cambisol (Loamic). The process of pedogenesis was evaluated using a set of methods which allow to analyze the properties of rocks and soils. Methods characterizing soil properties included macromorphological analysis, determination of pH, cation exchange capacity, base saturation, particle size distribution, texture class, organic carbon, total nitrogen, and mineralogy of clay fraction. The rocks were evaluated using petrographic and X-ray analyses. The pH and base saturation values indicate that the soil development on granulite and paragneiss takes place in more acid conditions than on serpentinite. Soils located in protected areas show the thickness of the O horizon of 1 cm and the thickness of the Ah horizon of 10 cm. The O horizon with a thickness of 6 cm and the Ah horizon with a thickness 2 cm were identified at Chmelná. Qualitative parameters of

soil organic matter, such as the distribution of carbon, nitrogen and the C/N ratio, show some differences among individual sites. These parameters are more favorable in the protected areas of Bořinka and Buglata. A prevalence of sand fraction in soils was observed at the all sites. The most characteristic texture class is sandy loam, which probably results from the type of rock. This fact is also supported by the distribution of mineral grains in the matrix of individual parent rocks, as shown by petrographic analysis. The most characteristic mineral of Skeletic Eutric Cambisol (Loamic) developed on serpentinite is smectite. Chlorite and kaolinite occur in smaller quantities. Illite is absent. Skeletic Dystric Cambisol (Loamic) developed on granulite shows high contents of illite, chlorite, and a relatively high content of kaolinite. Smectite was not detected in this soil. In contrast, Skeletic Dystric Cambisol (Loamic) developed on paragneiss is characterized by high contents of illite. Kaolinite and chlorite occur in smaller quantities, smectite is absent. Soils developed on metamorphic rocks are characterized by the prevalence of clay minerals in various assemblages and a smaller portion of quartz. K-feldspar, plagioclase and other minerals occur as accessories. The configuration of diagnostic horizons of individual soil sequences indicates some differences in the intensity of pedogenesis. Variations in the formation of the Bw horizon are controlled by the character of parent material. Soil profile development is more intensive in Skeletic Eutric Cambisol (Loamic) than in Skeletic Dystric Cambisol (Loamic). The transformation of soil material in situ with the formation of the Bw horizon on individual parent rocks decreases in the order: serpentinite>granulite>paragneiss.

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The effect of whey-based hydrogel addition on soil water holding capacity and availability of nutrients

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Keywords: whey, hydrogel, soil quality, chemical soil properties, hydro-physical soil properties

Agricultural production is influenced by the water content in the soil and the availability of nutrients. Recently, changes in the quantity and seasonal water availability are expected to impact agriculture due to climate change.

Hydrogels on a natural basis mean the perspective for agriculture, due to their usability for the supply of nutrients or positive effect on water retention. Whey-based hydrogels are promising materials for solving ecological and environmental problems. On the one hand, it is a way of recycling waste products from the dairy industry with a high ecological benefit and on the other hand it has potential for environmental protection. The specific properties of hydrogels are important especially where it is necessary to retain more water than the soil itself, which is especially the case of agricultural and horticultural soils.

Our paper is focused on testing the effect of whey-based hydrogels on chemical and physical soil properties. Prepared hydrogel analysed and its potential impact on soil properties was assessed in a pot trial. The artificial soil, suitable for pot experiment, was selected. The necessary volumes of soil were prepared in the laboratory. A control and three hydrogel variants were studied. In the next phase, pot trial was set up; subsequently soil samples were taken from the different variants. The samples were analysed by accredited methods in the Research Institute for Soil and Water Conservation. By adding the elements important for plant nutrition, whey hydrogels can directly contribute to plant nutrition both by directly adding microelements to the soil and by increasing binding sites

and can be economically helpful in reducing the cost of further nutrition of plant production. Our results showed the perspective of whey-based hydrogel for practical use in agriculture because the natural nutritional benefits of agricultural utilization of whey are enhanced by water retention abilities via the chemical cross-link of whey with citric acid. In the soil experiment, the positive effects of 1 %, 2 %, and 3 % hydrogel addition on both water-holding properties and the temporal availability of nutrients were determined.

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Chemical changes in Chernozems as affected by water erosion

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Keywords: Chernozems, chemical properties, degradation

Chernozems are the most intensively used agricultural soils in the Czech Republic. They are negatively influenced by degradation processes, especially water erosion and pedocompation.The main hypothesis of this research is that the maintenance of soil organic matter and appropriate agrotechnical practices can reduce the negative consequences of intensive land use and can increase the stability of agroecosystems. In this paper, the changes in organic matter content and quality and nutrient contentwere studied. The studied locality was selected near the village of Bošovice (South Moravia, Czech Republic). The soil type was classified as Calcic Chernozem (IUSS Working Group WRB, 2022). Total organic carbon content was determined by the oxidimetric titration method. Total nitrogen content was determined according to the Kjeldahl method. Available nutrients content was determined by Mehlich III method. Humic substances quality was evaluated by UV-VIS and infrared spectroscopy. Results were processed by one-way ANOVA analysis and Fisher test ($p<0,05$). Obtained results documented, that during the period 2018–2022, there were significant changes in studied parameters. There was a statistically significant decrease in content and quality of humic substances and available nutrient content on eroded site. Improving of agro-technical measures and the application of organic manure or exogenous organic material is recommended. Increase of soil organic matter is essential to supply plants with nutrients and water, to prevent water erosion and overall stabilize the whole agro-ecosystem.

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Pesticides in soil and water in chosen agricultural catchments in the Czech Republic

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Keywords: soil, sediment, water, glyphosate, AMPA, parent pesticides, metabolites

Intensive farming in the Czech Republic brings a manifold spectrum of pesticides into the arable land. They remain and degrade in soil, but they can enter water bodies and negatively affect water quality and the aquatic ecosystem.

Research on pesticides in soil, sediment and surface water has been proceeding in two experimental catchments since 2019: Němčice (Drahanská highland) and Uhřice (Litenčická hilly land). They represent different natural conditions of the Czech Republic. Sampling and analytical methods were unified in both catchments. The pesticide concentrations in soils were monitored in transects covering the basic slope zones of each catchment. Samples were collected as mixed takings from 5 sites from the topsoil and subsoil four times per year.The surface water samples were taken at gauging profiles in the stream and from the reservoirs every month during vegetation season.

Both catchments have slopy relief and soil erosion processes are quite intensive there. Soil and climate conditions are different. In the Němčice catchment (Cambisols, av. year temp. 6 °C, av. precip. total 660 mm), mainly cereals and rape seed are grown on the arable land. The Uhřice catchment represents a fertile Chernozem area (av. year temp. 8 °C, av. precip. total 600 mm). The farming is predominantly focused on corn, sunflower, beet, soy but also cereals and rapeseed are grown here.

The soils in both studied catchments contain mainly parent pesticide matters. Glyphosate, epoxiconazole and tebuconazole were detected in all sites. Of the metabolites, the most often detected is AMPA. All pesticide concentrations in topsoil were markedly higher than in subsoil. Spectrum of detected pesticide matters in soils is wider in the Uhřice catchment. Pesticides average sum in topsoil in the Uhřice (1 mg/kg) is higher comparing to the Němčice catchment (0.6 mg/kg). These findings reflect mentioned different farming conditions.

Metabolites dominated over parent substances in surface waters. A lot of them (atrazine, 1,2,4-triazole…) represent a risk for water ecosystems. Parental compounds in surface water were detected mostly during extreme outflow events. A prerequisite for parental matters leaching is that the rainfall-runoff episode occurs relatively shortly after their application. Water quality in the Uhřický stream (av. pesticides sum 7 µg/l) is worse than in the Němčický stream (av. pesticides sum 2 µg/l).

Obtained results showed a need to pay close attention both to parent substances and metabolites in the environment, considering the transport processes in agricultural catchments and potential mutual influences on various environment components. The ongoing climate change is manifested, among other things, by a higher extremity of precipitations. More frequent occurrence of rainstorms causes the degradation of soils, deterioration of their physical and chemical properties, acceleration of surface runoff and increasing of substances transport into water bodies. Therefore, the protection of soil and water has to be solved complexly, using implementation of polyfunctional measures, considering the requirements for the sustainable use of the agricultural landscape.

Acknowledgement
The study was created with the state support of the Ministry of Agriculture CR within projects QK1910282 and RO0223.

Preliminary results of the geochemical, hydrogeological and pedological study of the Javoříčko-Mladeč karst area

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Keywords: karst, water sources, hydrological maps, groundwater flow model; Javoříčko-Mladeč

The new project of the Czech Geological Survey is focused on studying the rock environment, natural resources, geohazards and geological information throughout the Czech Republic. One of the essential parts of this research will be to determine the impacts of anthropogenic activity and climate change on hydrogeological karst structures. This part of the project addresses the issue of potentially endangered water sources bound to the limestone structures of four selected karst areas of the Czech Republic (Moravian karst, Hranice karst, Javoříčko-Mladeč karst and Chýnov karst). The project's first outputs are the hydrogeological maps of karst areas and their subsidised background. The maps show the phenomena occurring in the karst areas of interest and their assumed subsidising backgrounds. They show the areal distribution of the basic hydrogeological units, the assumed main water inputs to the karst aquifer systems and the main drainage areas. Furthermore, the maps show other relevant layers describing the hydrological and hydrogeological characteristics of areas of interest or the main interests of nature protection. We interpreted direct dominant directions of water supply karst areas. As a rule, they are entire hydrological basins of a higher order, and water is subsidised indirectly through other hydrogeological structures.

In the first step, we focused on the hydrogeological regime in the area of the Javoříčko-Mladeč Karst, which belongs geologically to the Drahany Facies Domain (Development) of the Moravian-Silesian Paleozoic sedimentary sequence. Jesenec limestone, basaltic volcanic and volcanoclastic

rocks of the Famennian to Tournaisian age form the SW – NE oriented belt surrounded by Early Carboniferous flysch rocks in the Bouzovská Highlands. The Cenozoic sediments partially cover these Palaeozoic sedimentary sequences. Cenozoic sediments have a significant thickness, mainly in the NNW–SSE-trending Mohelnice Graben. Sedimentary and volcanic rocks in the study area are characterised by a low degree of elements with potential toxicity (Cd up to 0.7 ppm, Cr up to 287 ppm, Pb up to 43 ppm). Locally elevated content was found for As in Palaeozoic siltstones (up to 38 ppm).

Based on the geophysical surveys, geochemistry and isotopic composition of surface and groundwater, a new groundwater flow model in the Javoříčko-Mladeč karst drainage area was proposed. According to the results of a detailed study of water in the Řimičské vyvěračky and the water source Čerlinka, and the absence of active zones of groundwater in the cave systems of the Javoříčko-Mladeč karst, we suppose that most likely source of karst water is from the deep part of the sedimentary fill of the Mohelnice Graben.

Acknowledgement
This project is supported by the The Technology Agency of the Czech Republic (Rock Environment and Mineral Resources SS02030023).

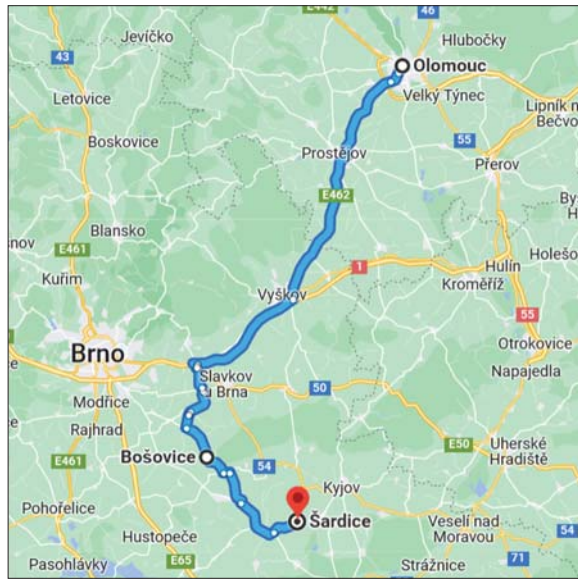
EXCURSIONS

ROUTE 1 – SOUTH MORAVIA (BOŠOVICE, ŠARDICE)

ROUTE 2 – BĚLOTÍN AND BESKYDY MOUNTAINS

ROUTE 1 – SOUTH MORAVIA (BOŠOVICE, ŠARDICE)

Garant and author: *Miroslav DUMBROVSKÝ*
Brno University of Technology, Faculty of Civil Engineering,
Department of Landscape Water Management



Route 1 – Bošovice, Šardice – map

Bošovice

The programme of the excursion will start with a visit to sites with implemented strip cropping management in the Vyškov District.

Strip cropping along contours, which is the rotation of conservation and protected strips, is applied by the Agricultural Company Rostěnice in the South Moravian Region in the Vyškov District on an area of about 1000 ha, mainly in the cadastral areas of Bošovice, Lovčičky and Otnice. Strip cropping is a method of farming which involves cultivating a field partitioned into long, narrow strips which are alternated in a crop rotation system.

Locations with implemented strip cropping along contours

Strip cropping

Strip cropping – plant protection

Strip cropping – winter wheat harvest

Šardice

Locality Description: Petr Marada

The excursion programme will then continue in the Šardice municipality in the Hodonín district, where we will visit sites with the system of soil and water conservation practices, designed and implemented in the process of Land Consolidation.

The territory of the Šardice cadastre is very strongly threatened by water erosion. Intensive conventional farming on large and sloping land has caused significant degradation of the complex soil properties of arable land. Water erosion in recent decades has resulted in large areas of severely eroded arable land.

Arable land heavily degraded by water erosion

The main elements of the system of conservation measures are flood protection reservoirs. Infiltration grass strips and biobelts are also part of the design of the measures. These measures are complemented by local bio-centres and bio-corridors in the territorial system of ecological stability.

System of protective water reservoirs

To protect the built-up area of the municipality of Šardice threatened by floods from three catchment areas:

Šardický stream – 1, Loučkový stream – 3 and Červenice stream – 2, a system of protective flood protection reservoirs was designed in the process of land development (see situation and spatial location on the orthophoto map).

Spatial location of the protective water reservoirs

Situation before and after the design of the protective water reservoir on the Šardický stream – total volume of the water reservoir 182 000 m³

Protective reservoir on the Červenice stream – total volume of the reservoir 67 400 m³

Protective water reservoir on the Loučkový stream – total volume of the water reservoir 94 000 m³

Territorial system of ecological stability – Local Biocorridors and Biocentres

The implementation of the Territorial Ecological Stability System can provide a permeable, mosaic, water and wind resistant agricultural landscape with an appropriate species diversity of wildlife and wild plants. The main benefits for agricultural landscapes are a very significant increase and strengthening of biodiversity, improved possibilities for animal migration, a positive effect on water retention in the landscape, soil conservation functions and, last but not least, an increase in the aesthetic value of the landscape.

Location of the local bioccorridor

Location of the local biocentre before implementation

Location of the local biocentre after implementation

Location of the local biocentre 9 years after implementation

Sedimentation basin – part of the local biocentre site

Water pools and wetlands

The biotechnical facilities consist of 5 pools with associated wetlands an expected water depth in the pools between 0.5–2.0 m and 3 micro pools with an expected water depth of up to 0.5 m. In the north-western part of the site there is a 5×1 m stone wall serving as a shelter for reptiles. For this group of animals, a reptile house of approximately 1 m high made of wooden logs, branches and topsoil was also designed, mainly for the breeding of the highly endangered hen harrier. In the central part of the site, 2 beetle boxes are proposed, consisting of a set of side-by-side tree trunks, which can become a home or refuge for different developmental stages of insects, but also small mammals, birds or reptiles.

Vegetation Management – includes planting of trees and seeding of permanent grasses. Willows are planted in the form of cuttings and rods in the places of the rugged shoreline of the largest pond between the other ponds there are other soft meadow tree species (sticky alder, alder crust, etc.), in the place of temporary but also in the north-western part of the site there is a hard meadow to oak (oaks, ash, lime, etc.). The permanent grassland is divided into areas for intensive and extensive management.

Arable land for water pools before the implementation of measures

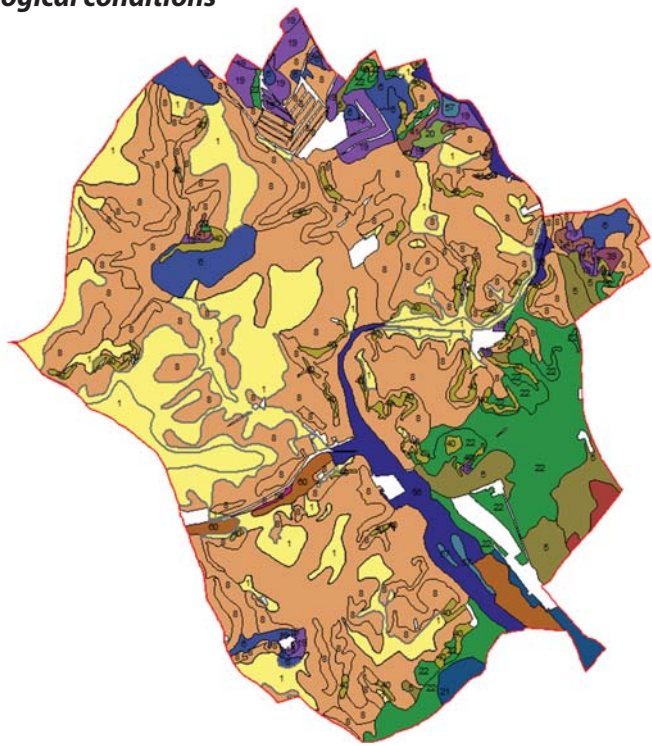
Water pools immediately after implementation of the measure

Water pools 3 years after the implementation of the measure

Situation of the construction

Current view of the site from aerial photograph

Pedological conditions



Spatial localization of the three most represented soil types in the Šardice cadastre

Yellow: Modal Chernozem, carbonate Chernozem, on loess or Carpathian flysch, medium-heavy soils, without skeleton, very deep, mostly with a favourable water regime

Brown: Modal and Pelican chernozems, eroded, on loess, loess and slope clays, medium and heavier, mostly without skeleton and at higher gradients

Green colour: Soils of the arenic subtype on slightly heavier substrates such as loamy sand or sandy loam with a water regime slightly more favourable than the preceding.

Within the excursion in the Šardice cadastre, soil profiles of 2 pedological sonds will be realized and described on Chernozem soil-type forms – Chernozem modal and Chernozem eroded – washed by intensive agricultural activities leading to severe degradation due to water erosion.

Benefits of the implemented measures in Šardice

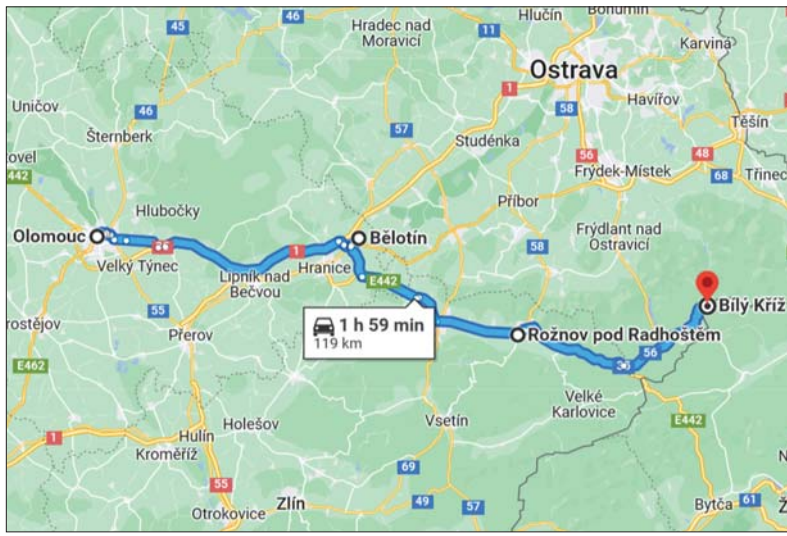
- Increase in landscape retention capacity
- Improvement of water quality in watercourses
- Reduction of sediment transport
- Increased landscape diversity
- Promoting biodiversity

ROUTE 2 – BĚLOTÍN AND BESKYDY MOUNTAINS

Garant and author: Bořivoj ŠARAPATKA
Department of Ecology and Environmental Sciences,
Palacký University in Olomouc

During the excursion from Olomouc to the Beskydy Mountains we will visit

- the village of Bělotín and view landscape restoration
- the Wallachian Open Air Museum in Rožnov pod Radhoštěm
- the Bílý Kříž Experimental ecology study site



Route: Olomouc – Bělotín – Rožnov pod Radhoštěm – Bílý Kříž

Bělotín and landscape restoration in the village cadastre

Locality Description:
Eduard Kavala, the Mayor of Bělotín and
Renáta Brundová, Head of State Land Office, branch Přerov

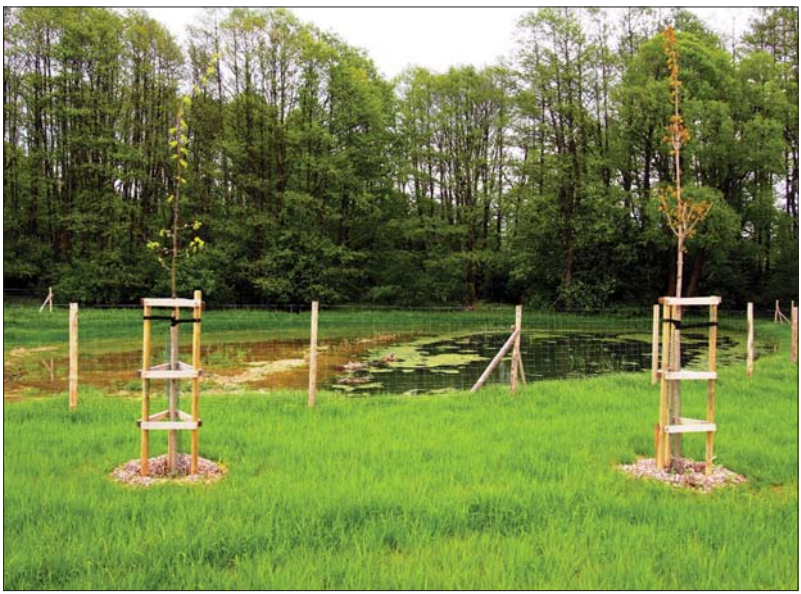
Bělotín is a village within the Přerov district, about 38 km east of Olomouc, the regional capital. It has approximately 1,800 inhabitants, and

the area of the cadastre is also approximately 1,800 hectares. The first written mention of the village dates from 1201 in a document of the Margrave of Moravia, and in the following centuries the area experienced a rich, and often dramatic history.

The present day village is adorned with 15 sandstone sculptures by the academic sculptor Michal Moravec.

When visiting Bělotín, we will gain a brief insight into the village's development up to the present day, but we will pay particular attention to the development of the landscape and the restoration which has been carried out. This project was undertaken in the area about 5 years ago and included a number of measures ensuring the permeability of the landscape (field roads), protecting agricultural land from the negative effects of erosion, increasing the retention capacity of the landscape, and measures contributing to increasing the diversity and ecological stability of the landscape. The following images show some of the measures we will observe.

Even major transport infrastructure can coexist with the cultural landscape. The Malý and Velký Bělotín ponds were built on the site of a historical medieval pond in the lower part of the village.



Constructed ponds and pools are an important element for retaining water in the landscape and a significant biotope for a number of organisms.

Erosion was a significant factor in soil degradation after the collectivization of agriculture. Nowadays, the municipality successfully „fights" erosion in cooperation with farmers, even in a completely unconventional way – by planting plum trees and currant bushes with grassy strips between them.

Wallachian Open Air Museum in Rožnov pod Radhoštěm

The Wallachian Open-air Museum, the first museum of its type in this country and the only one of its kind until the 1970s, is situated in the town of Rožnov pod Radhoštěm in the foothills of the Beskydy Mountains. The Open Air Museum has three parts – Little Wooden Town, Wallachian Village and Water Mill Valley. We will visit this last mentioned part as part of the excursion.

Water Mill Valley

Water Mill Valley is a unique collection of living structures and pieces of machinery that are operated by the power of mountain water and also human hands. It is situated in a flat valley meadow by an old millrace where technical buildings documenting the development and specialisation of the village economy from the second half of the 17th century to the 19th century were built from the 1970s onwards.

A visit to Water Mill Valley, which opened to the public in 1983, offers a unique chance of seeing a water mill, a sawmill and a fulling machine in motion. You can see how the blacksmith worked at the tilt-hammer.

The heavy hammers are put into operation on special occasions. Oil pressing also only takes place during special events in view of the age of the machine. The beginning of the tour of the depot from Ostravice will acquaint you with old means of transport and agricultural machinery from the end of the 19th century and the first half of the 20th century.

The Bílý Kříž Experimental ecology study site

Locality Description:

Michal V. Marek, Marian Pavelka
Global Change Research Institute, Czech Academy of Sciences, Brno

Experimental ecological study site of Bílý Kříž (further EESS) is located in the region of the Moravian-Silesian Beskydy Mts. (Czech Republic) and its coordinates are 49°30′ N and 18°32′ E. Geological subsoil is formed by flysch layer with dominant sandstones. In 1998–2013 the mean annual air temperature amounted to 6.8 ± 1.0 °C, mean annual relative air humidity to 84 ± 4 % and mean annual sum of precipitation to 1265 ± 216 mm.

EESS is a part of international measuring network FLUXNET. In 2007 EESS was included into significant infrastructures within ESFRI (European Strategy Forum on Research Infrastructures), project ICOS (Integrated Carbon Observation System).

The study site is operated by Global Change Research Institute CAS. EESS was established in 1986 within the framework of the project „Complex Research of Immission Impact on the Forests and Forestry of the Beskydy".

Currently, multiple research teams operate at EESS applying various methods with different scientific aims. Among the most important initiatives belong 1) long-term monitoring of matter and energy fluxes; 2) ecophysiological research focusing on better understanding of photosynthesis, respiration and transpiration; 3) estimation of spruce stand productivity combined with forest management development that would improve its resilience and carbon capture; 4) remote sensing hyperspectral imaging for mapping of physiological characteristics with high spatial resolution; 5) integration of the acquired information in order to better understand the studied ecosystems and to predict their future response to changing climate.

Measurements are carried out at the following plots:

- climatological station
- spruce stand
- grassland
- cultivation glass domes
  - stand within cultivation glass domes with ambient CO_2 concentration
  - stand within cultivation glass domes with elevated CO_2 concentration

Climatological station

The altitude of the climatological station is 894 m above sea level and there are operational buildings, a meteorological booth and an automatic station for air quality measurement. There are sensors for incident solar radiation measurements placed on the roof of the operational building. Sensors for air temperature and relative humidity are placed inside the meteorological booth. Rain gauges are placed on the open space area and sensors for soil temperature measurement are placed in several soil depths. Automatic station for air quality measurement, whose owner is Czech Hydrometeorological Institute, is used for CO_2, NO_x, O_3, heavy metals, radioactivity and volatile particles measurements. The station is a part of measuring networks EUROAIRNET and IRIS

Spruce stand

Research in spruce stand started in 1994. Studied stand was established in 1981 using row planting of 4-year-old seedlings of Norway spruce (*Picea abies* [L.] Karst.) in planting spacing of 2×1 meter and row orientation in N-S direction. Stand belongs to forest site complex 5S – Nutrient-medium Fir-Beech. Stand consists of pure and evenaged Norway spruce. Forest

growth stage is pole stand. The forest is geobiocenologically classified as Abieti-Fageta. There is a meteorological mast (height of 36 meters) placed in the stand. The altitude of the mast placement is 875 m above sea level. Mean slope of the stand is 13° with SSW exposition.

Geological subsoil is formed by flysch layer with dominant sandstones. Haplic and Entic Podzols are the soil types in the stand. The soil is moderately deep up to *Holcus mollis* shallow, from loamy-sand to sandy-loam with high content of soil skeleton in the low layers. The soil depth is maximum 60–80 cm. The densest root layer is 5–15 cm.

Grassland

The research in the grassland started in 2003. By 2008 the studied grassland was divided into two parts – mown grassland (mowing was done once during the growing season) and non-mown grassland. The originally mown grassland was formed by phytocenose of Nardus-Callunetea (dominating plants: *Festuca rubra* agg. L., *Nardus stricta* L., *Veronica officinalis* L., *Hieracium laevigatum* Froel.) and the originally non-mown grassland was formed by phytocenose of Molinio-Arrhenatheretea (dominating plants: *Rumex acetosa* L., *Hypericum maculatum* Crantz., L., *Achillea millefolium* L.). There is a meteorological mast (height of 6 meters) placed in the grassland.

The altitude of the mast placement is 860 m above sea level. Grassland is on the slope of 8.5° and it is exposed towards the south-east. Geological subsoil is formed by claystone. Soil type is Gleyic Luvisol.

Cultivation glass domes

Experiment determining influence of elevated CO_2 concentration started at EESS in 1992. In 1992–1995 open-top chambers were placed in the spruce stand for planting an individual tree of Norway spruce in elevated CO_2 concentration. Research of influence of elevated CO_2 concentration on forest tree stand has been carried out at EESS since 1996 using cultivation glass domes.

The platform of the cultivation glass domes is 9×9 meters. CO_2 concentration is maintained ambient in the first cultivation glass dome (A – ambient). Conditions expected in the second half of the 21st century are simulated in the second one (E – elevated) – it is approximately double CO_2 concentration in comparison to the concentration at the end of 20th century. At first there was spruce stand planted in cultivation glass domes, since 2007 mixed stand of spruce and beech has been planted.

Bořivoj Šarapatka
Marek Bednář
Patrik Netopil
(Eds.)

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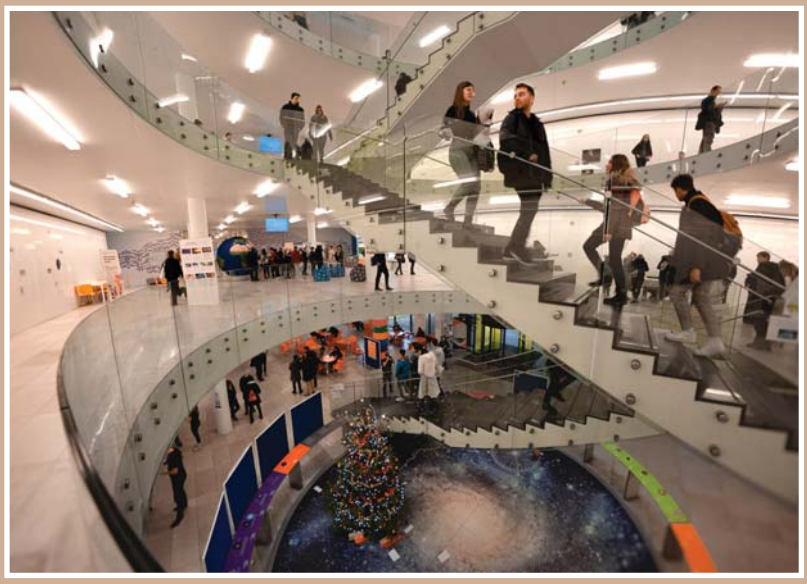

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