VODOHOSPODÁŘSKÉ TECHNICKO-EKONOMICKÉ INFORMACE
(WATER MANAGEMENT TECHNICAL AND ECONOMIC INFORMATION)

VTEI / 2023 / 2

Sixty years ago in VTEI

Although at the end of the 1950s research activities were directed more towards the then USSR, TGM WRI experts at that time drew their findings and knowledge from specialist literature also from overseas. An example is a short article on the topic of strengthening the banks of watercourses.

Strengthening of banks

Strengthening banks of watercourses in our country and abroad is still an open problem. The use of building types (rafts, fascines, fascine filling, gravel drums, etc.) in securing the bank is supplemented in the foreign technical literature by an article from the "Civil Engineers 13" journal, No. 2, pp. 82–84, on flexible protection of the Mississippi river bank.

Strengthening of the bank in the lower section of this large river with frequent flooding is successfully carried out with pliable "mats" made of articulated concrete prefabs. Concrete blocks 7.5 cm thick, measuring 7.6 × 1.22 m, consisting of 20 individual blocks 38 cm wide, are placed on the endangered evened-out slopes. The blocks, separated from each other by a 2.5 cm gap, are connected to each other by a steel mesh reinforcement protected against corrosion.

In our country, on smaller, especially torrential streams, the economically advantageous stabilization of streambeds by planting riparian vegetation has proven successful. In recent years, WRI has also been engaged in research into the suitability and resistance of woody species for this purpose. The combination of technical and biological measures to strengthen the banks of watercourses should become the subject of keen interest of our water managers.

From the TGM WRI archive.

VTEI Editorial office

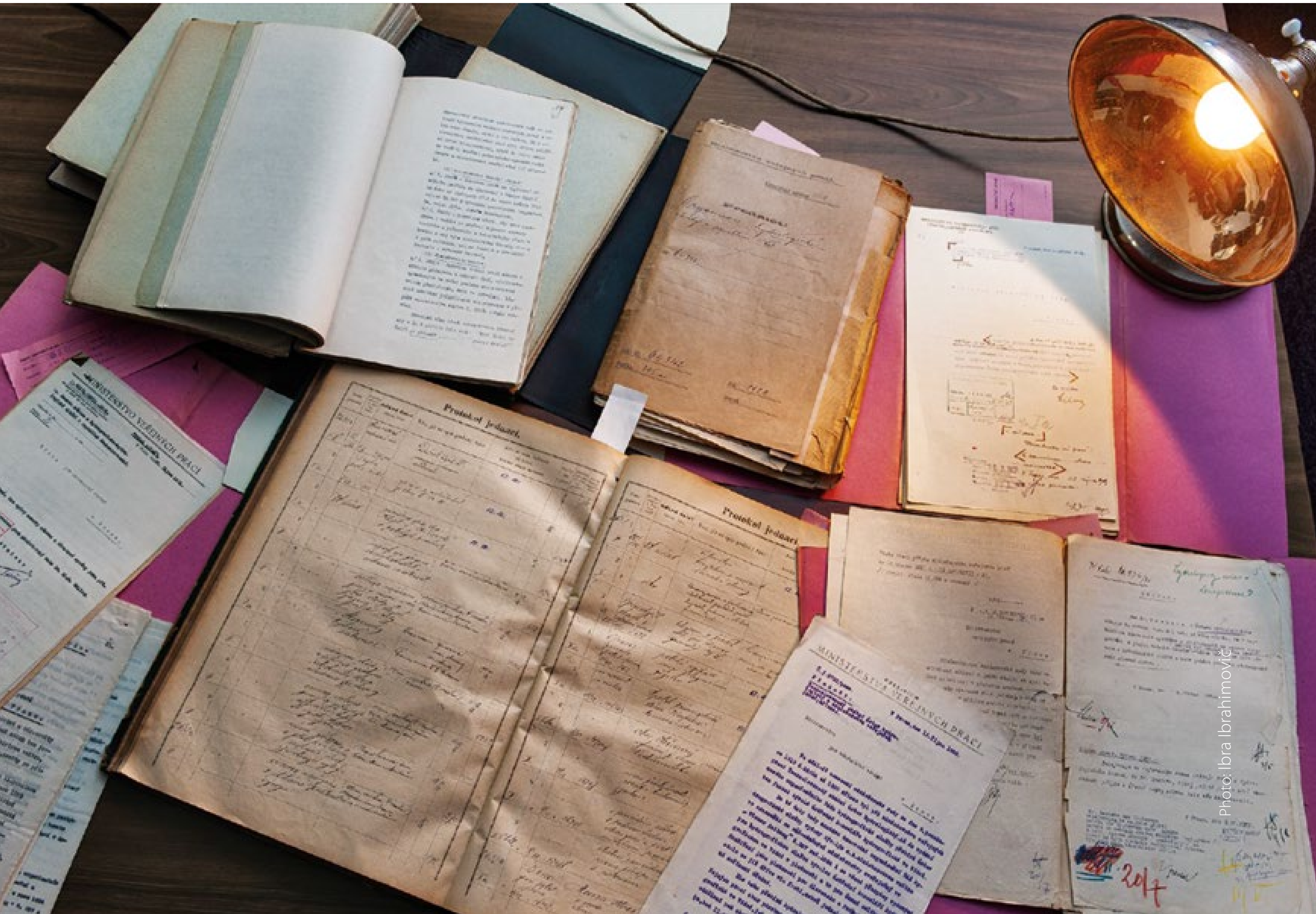

Photo: Ibra Ibrahimovič

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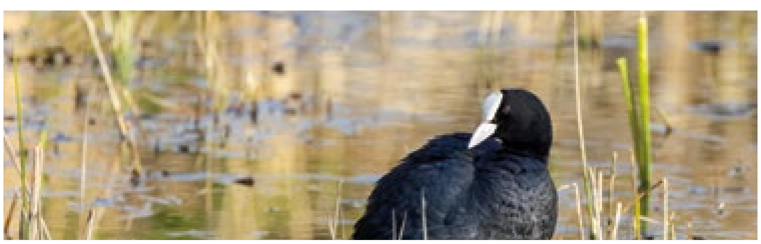

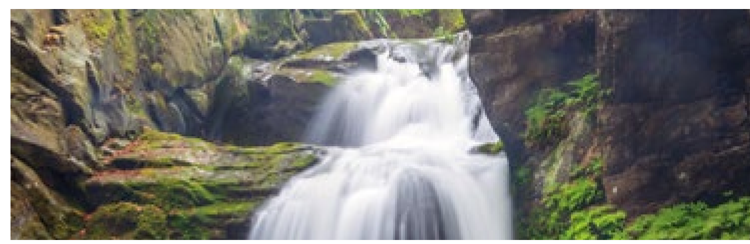

Dear readers,

VTEI journal has been published since 1959. What were the beginnings of our professional journal, what it informed about more than 60 years ago, and what was the impetus for its creation? The best answers to these questions can be found in the editorial by Ing. Josef Jiroušek, the Director of our institution between 1958 and 1962. Below are a few sentences from his first editorial:

"As the central documentation centre for water management, the Water Research Institute in Prague was commissioned by the Ministry of Power Engineering and Water Management to ensure, in cooperation with other central water management organizations, regular quarterly publication of technical information in the field of water management, starting in 1959.

The published 'Technical Information' is intended to regularly and timely inform our water management public nationwide about all technical news in water management, domestic and foreign, whether it concerns inventions, improvement proposals, research and development outputs, professional articles on new topics, the latest publications, etc. The scope and content of 'Technical Information' should be very broad so that all employees in water management can find what they need for their work and are constantly and regularly informed about everything new in their field.

Please note that we regard this year as a trial year in the publication of 'Technical Information' and that, based on the experience gained and on the basis of reader feedback, 'Technical Information' will be improved and modified in 1960 so as to fulfil its purpose as best as possible – to introduce readers as quickly and fully as possible to new technology in water management."

While reading the first editions, we at the editorial office had an idea to share some historical information that filled the front pages of the VTEI journal more than 60 years ago. Through short articles, we will gradually introduce you, the readers of our journal, to some selected contributions on various topics in the field of water management research.

Just a few words about the issue that you now have in your hands, or in front of you in the electronic version. We included a total of ten articles in the April issue, four of which have been peer-reviewed while the remaining six are so-called informative. The specialist part of the April issue is thematically diverse: wetlands, agroforestry, the issue of radioactivity indicators in surface waters. The informative part will introduce you to the upcoming publication on historical floods in the Rakovnický stream basin and the planned restoration of water ecosystems in Prague 4. An interview for our journal was given by Mr. Michal Broža, long-time head of the UN Information Centre in Prague.

We wish you a good start to the fresh spring days.

VTEI Editorial

Radioactive indicators in surface waters of the Ploučnice river basin

PAVEL STIERAND, LIBOR MIKL

Keywords: radioactive indicators — surface waters — Ploučnice river basin — uranium deposit — Stráž pod Ralskem — the trends of the time series — Mann-Kendall test

ABSTRACT

The Czech Hydrometeorological Institute (CHMI) is engaged in systematic monitoring and evaluation of radiological indicators in surface waters. The article describes changes in the values of radiological indicators in surface waters in the time series from 1967 to the present. The evolution of total volume alpha and beta activity, uranium concentration, and radium activity (^{226}Ra) is described on characteristic profiles in the area of uranium-containing raw materials mining, in the vicinity of Stráž pod Ralskem, where the mining of radioactive raw materials has already been suppressed. The Ploučnice river flows through this mining area and flows into the Elbe river in Děčín near the Hřensko border crossing, where activities of radiological indicators are also monitored and documented. Following the cessation of uranium mining at the Stráž pod Ralskem deposit, uranium concentrations dropped by two orders of magnitude, and surface waters on the Ploučnice – Mimoň profile have been classified as Class I – unpolluted water for the last five years. The values of Kendall's correlation coefficient τ for the profiles evaluated on the selected profiles during the mining period are characterized by an increasing trend (+0.7) for the indicator of total volume beta activity; after the end of mining, a decreasing trend is indicated (-0.5).

INTRODUCTION

This article presents the results of long-term monitoring of radiological indicators in surface waters in the Ploučnice river basin. Uranium mining took place in the past in this basin in the area around Stráž pod Ralskem. The determined values of radiological indicators are predetermined by the geological structure of the area, with the occurrence of uranium mineralization and the method of extraction of raw materials containing uranium.

The aim of the article is to present the development of the activity of radiological indicators in surface waters for the entire monitored period 1967–1989 and after 1990, using archival data stored in the collection database of the Water Quality Monitoring in the Czech Republic information system (Is ARROW), which is provided and evaluated by CHMI [1].

Deposit characteristics

Uranium mineralization in the sediments of the Czech Cretaceous Basin was investigated in the first half of the 1960s. Deposit accumulations of uranium are associated with sediments of the lower (freshwater) and upper (marine) Cenomanian. The Hamr and Břevniště deposits were deep mined while the Stráž deposit was mined by the underground leaching method by wells from the surface. The Stráž mining area was gradually expanded to 24.1 km^2 [12]. Descriptive data on the uranium deposit are given in a number of reports of the mining organization (DIAMO, State Enterprise) and other publications [8, 10, 11, 13, 16, 27]. A government resolution from 1990 changed the concept of energy raw material mining and, on the basis of subsequent government decisions and resolutions [23–26], uranium mining slowed down. Chemical extraction at the Stráž deposit was stopped as of 1st April 1996; in the following period, uranium was extracted from remediation of chemical extraction.

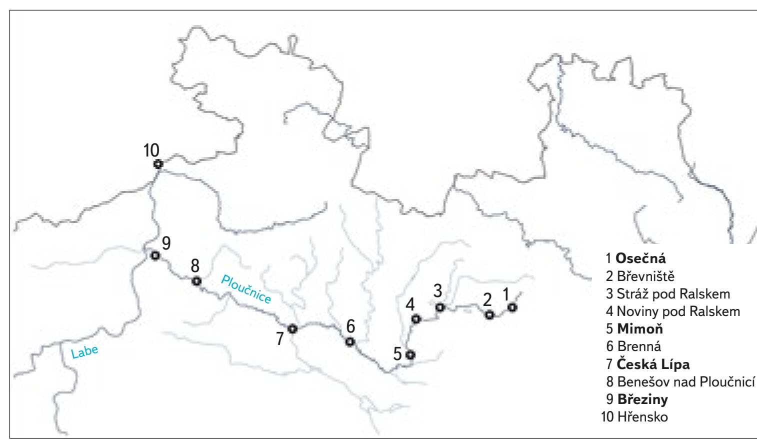

Fig. 1. Map of the area of interest with marked profiles in Ploučnice basin (those assessed in detail are highlighted)

METHODOLOGY

Radiological indicators in surface water samples in the Ploučnice basin have been analysed in a laboratory since 1967, coinciding with the start of uranium mining in the vicinity of Stráž pod Ralskem, which is located in the same basin.

In Ploučnice sub-basin, surface water sampling is documented on the profiles of Ploučnice, Ještědský stream, Ploužnický stream, Mlýnský náhon, Robečský stream, Dobranovský stream, and Svitávka. Mine water samples were taken during active uranium mining at the Stráž pod Ralskem deposit.

Uranium contents are determined as metal concentrations in dissolved substances (DS), in non-dissolved substances (NS), and in all substances according to ČSN 75 7614 standard [6].

Monitoring of radioactive load is carried out on the basis of determination of radioactive indicators, i.e., total volume beta activity in dissolved (DS) and non-dissolved substances (NS). In DS, the correction of total volume beta activity to the ^{40}K isotope content is made. Monitoring of radiological indicators is also extended and supplemented by determination of the total volume alpha activity (DS, NS) and the activity of ^{226}Ra isotope (DS, NS) [4, 5, 7].

Classification of profiles into quality classes is carried out according to ČSN 75 7221 standard [2] from October 1998; this standard was updated in 2017 [3]. The characteristic value for inclusion in quality classes, or quality according to the updated standard, is a value with a probability of not exceeding 90 %. The frequency of sampling for the entire period of more than 55 years varied in the interval from once a week to once a month, exceptionally once every two months. For statistical processing, a characteristic value defined in the mentioned standard was used, which represents a representative value for individual years. For the calculation, the values of those indicators that were analysed on representative profiles throughout the evaluated period in a continuous series were used.

Due to the nature of the statistical distribution of the values of radioactive indicators, when describing annual activity value, the mean value of activity measurement results is calculated, and when displayed in graphs, the value of the lower (25%) and upper (75%) quartiles is also shown.

Using the non-parametric Mann-Kendall test [12, 14], the values of the correlation coefficient τ and the probability measure were calculated to determine the trend of detected values of radiological indicators on the selected profiles.

RESULTS AND DISCUSSION

An overview of monitored profiles in Ploučnice river basin (*Fig. 1*) and the time range of their monitoring is shown in *Tab. 1*. For a number of profiles, samples were not analysed in some periods (1 to maximum 5 years).

Tab. 1. Time range of monitored profiles

Watercourse	Profile	Monitoring range
Ploučnice	Osečná	1970–present
Ploučnice	Břevniště	1976–present
Ploučnice	Horka	1970–present
Ploučnice	Stráž pod Ralskem	1967–1991
Ploučnice	Noviny pod Ralskem	1992–present
Ploučnice	Mimoň	1967–present
Ploučnice	nad Svitavami	1967
Ploučnice	Brenná	2007–present
Ploučnice	Česká Lípa	1967–present
Ploučnice	Stružnice	1967
Ploučnice	Benešov nad Ploučnicí	1967–2000
Ploučnice	Březiny	1966–present
Ještědský potok	Stráž pod Ralskem	1971–present
Mlýnský náhon	Hamr	1971–1997
Mlýnský náhon	Stráž pod Ralskem	2007–present
Ploužnický potok	Ploužnice	1971–present
Panenský potok	Mimoň	1971–present
Svitavka	Brenná	1971–present
Dobranovský potok	Dobranov	1975–1997
Robečský potok	Dubice	2007–present
důlní voda	Břevniště	1976–1981
důlní voda	Hamr 3	1972–1996

The highest uranium content of up to 15 mg/l were found in mine water in the 1980s, when the highest total volume beta activity was up to 684.5 Bq/l (*Fig. 2*). The highest volume beta activity on the monitored profiles was documented in the 1980s at Ploučnice on the Mimoň profile (81.64 Bq/l), in Stráž pod Ralskem (19.1 Bq/l), and at Mlýnský náhon on the Hamr profile (47.25 Bq /l). A clear reduction in total volume beta activity, or of this indicator, corrected for the activity of the ^{40}K isotope, has been recorded since the 1990s. For example, on the already mentioned Mimoň on the Ploučnice profile, in the 1980s, the mean values of the total volume beta activity were in the range of 1.04–1.88 Bq/l, or in the range of 0.9–1.7 Bq/l after correction to ^{40}K. After mining stopped in the 1990s, the mean value for the mentioned indicators decreased to 0.22–0.4 Bq/l and to 0.05–0.29 Bq/l in the case of correction to ^{40}K. At the beginning of the 21st century, the values of total volume beta activity decreased; according to the classification of ČSN 75 7221 standard, the quality of surface water already meets the inclusion in class I (unpolluted waters) to class II (mildly polluted waters) in a number of consecutive years. In recent years, the characteristic value of beta activity for inclusion in the quality class, as well as the mean value of the monitored indicator, have not decreased significantly.

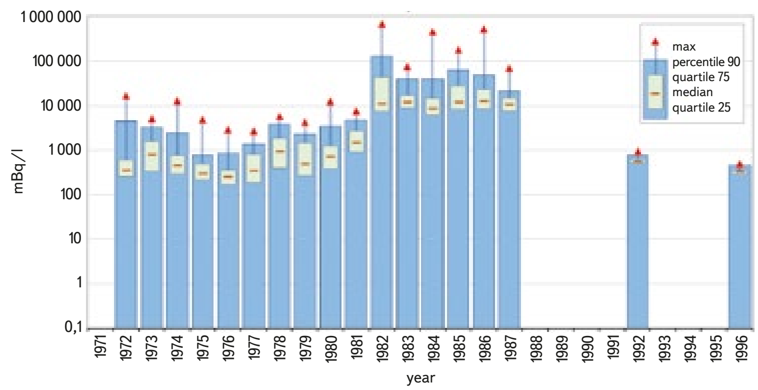

Fig. 2. Total volumetric beta activity in mine water (Hamr 3 deposit)

According to ČSN 75 7221 standard, the characteristic value of uranium classifies the quality of surface water on the Mimoň profile on the Ploučnice river during the 1980s into class V – very heavily polluted water. In the course of the 1990s, after the change in the use of uranium deposits, an improvement of one qualitative class to class IV – heavily polluted water – was recorded on this profile as well. Uranium concentrations decreased by one order of magnitude and did not exceed 10 µg/l on this profile in the last 20 years (*Fig. 3*). Only in Stráž pod Ralskem on Mlýnský náhon, uranium concentration of 54.5 µg/l was detected even after 2000.

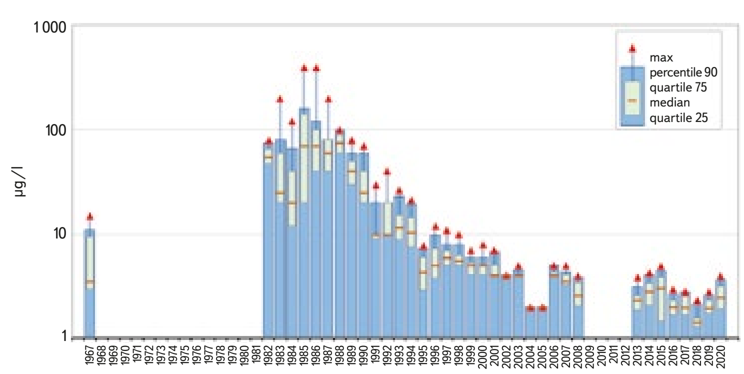

Fig. 3. Uranium content, Ploučnice – Mimoň profile

Reduction in radiological indicator activity is demonstrable on profiles located lower in the direction of the Ploučnice river flow. On the higher Mimoň profile on the Ploučnice River, in the 1980s, the mean value of the total volume beta activity after correction to ^{40}K is in the range of 0.6–1.66 Bq/l; based on the characteristic value it belongs to class V – very heavily polluted water (*Fig. 4*). On the lower profile in Březiny, the surface water is classified as class IV – heavily polluted water, the mean value is 0.182–0.405 Bq/l (*Fig. 5*). On the Hřensko border profile below the outlet of the Ploučnice to the Labe/Elbe, the mean value is 0.053–0.092 Bq/l, and in the 1980s, the water was classified on the basis of the characteristic value into class III – polluted water; in the last 10 years the characteristic value is suitable for classification into class I – unpolluted water (*Fig. 6*).

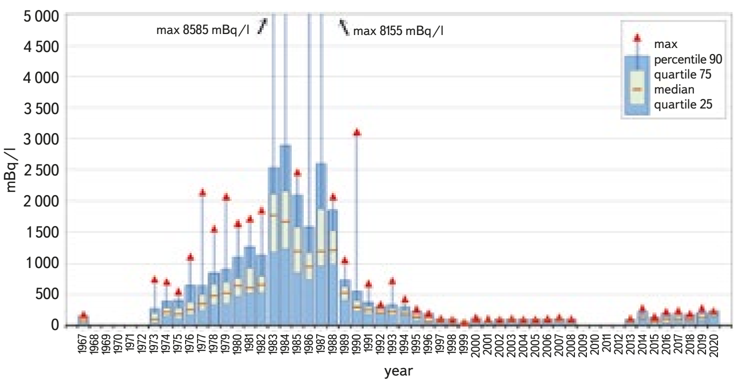

Fig. 4. Total volume activity of beta cor. ^{40}K, Ploučnice – Mimoň profile

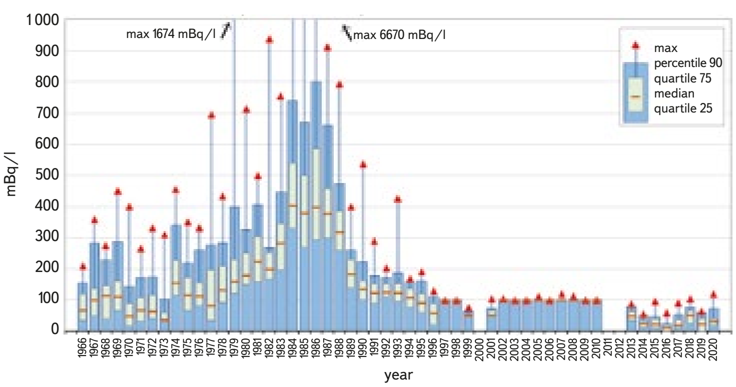

Fig. 5. Total volume activity of beta cor. ^{40}K, Ploučnice – Březiny profile

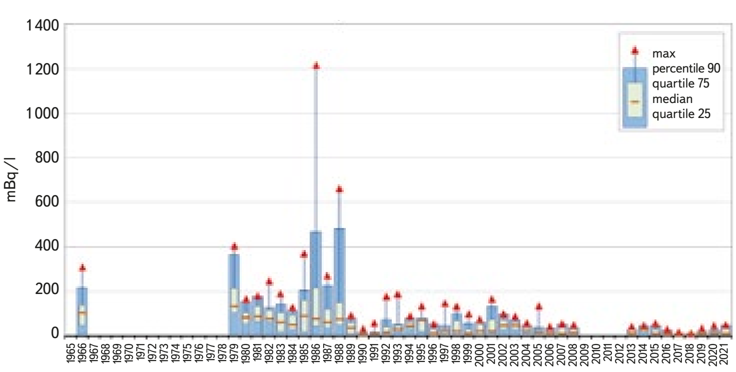

Fig. 6. Total volume activity of beta cor. ^{40}K, Labe – Hřensko profile

The value of total volume alpha activity was not determined before 1990. Alpha activity has been decreasing since the mid-1990s; in the last 10 years, for example, increasing values of volume alpha activity have been recorded on the Ploučnice – Mimoň profile (*Fig. 7*).

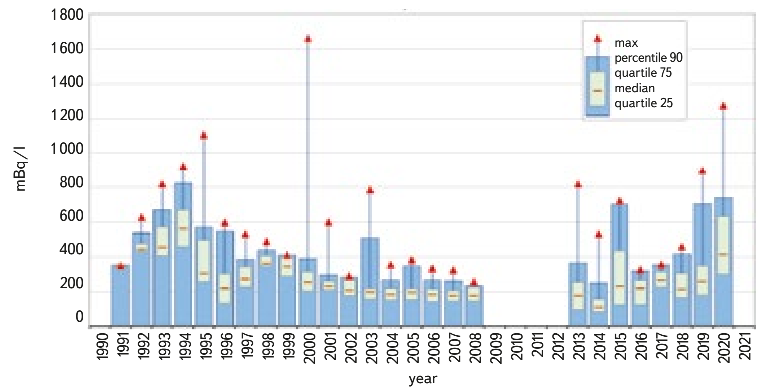

Fig. 7. Total alpha volume activity, Ploučnice – Mimoň profile

Activity of ^{226}Ra isotope on the monitored profiles during the period of intensive mining reached high values; on the Ploučnice – Mimoň profile up to 9,104 mBq/l, according to the classification, the surface water quality corresponded to class V – very heavily polluted water. After the end of intensive mining, activities decreased significantly in the 1990s. After a short period of interruption of monitoring and after its resumption about 10 years ago, the activity of the ^{226}Ra isotope increased, and in the last few years, based on the detection of the activity of this isotope, the water quality is classified as class II – slightly polluted water (*Fig. 8, 9*).

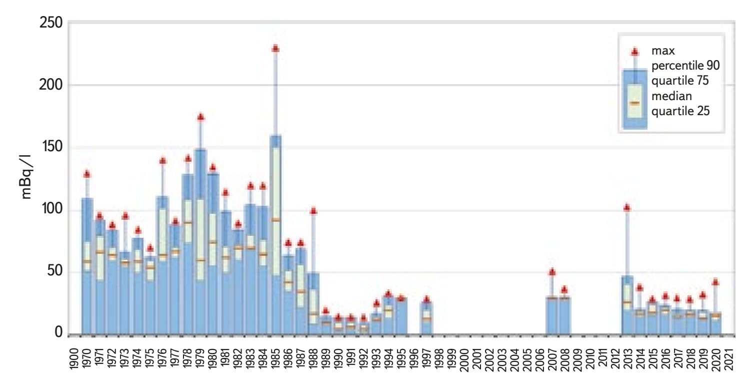

Fig. 8. Activity of ^{226}Ra, Ploučnice – Osečná profile

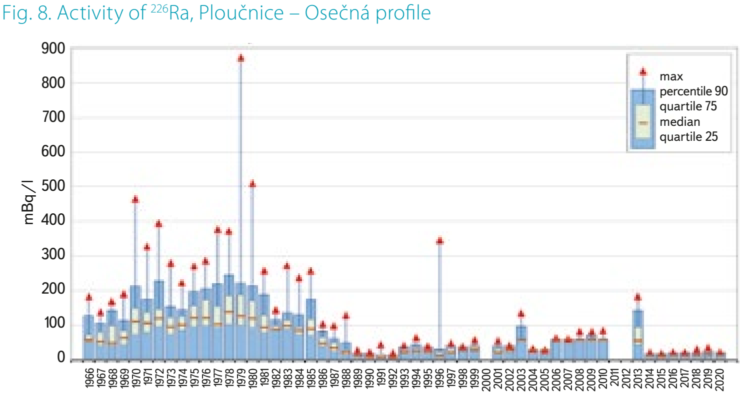

Fig. 9. Activity of ^{226}Ra, Ploučnice – Březiny profile

Tab. 2. Mann-Kendall test results

Profile	**Total volume beta activity**			**Total volume beta activity cor. ^{40}K**			**Radium 226**		
(Ploučnice)	**tau**	**trend**	**2-sided pvalue**	**tau**	**trend**	**2-sided pvalue**	**tau**	**trend**	**2-sided pvalue**
	period until 1989								
Mimoň	0.708	I	< 0.001	0.721	I	< 0.001	0.163		0.36
Česká Lípa	0.768	I	< 0.001	0.705	I	< 0.001	-0.095		0.54
Březiny	0.780	I	< 0.001	0.642	I	< 0.001	-0.217		0.14
	period after 1990								
Mimoň	-0.140		0.317	-0.151		0.297	0.159		0.26
Česká Lípa	-0.543	D	< 0.001	-0.596	D	< 0.001	0.023		0.88
Březiny	-0.544	D	< 0.001	-0.602	D	< 0.001	0.166		0.23

I = increasing, D = decreasing

For the selected profiles, a trend analysis was performed for the monitored indicators. The results of the Mann-Kendall test and the values of the Kendall correlation coefficient τ for the evaluated profiles and selected indicators are shown in *Tab. 2*.

Based on previous evaluation of analytical data, the year 1990 was chosen as the turning point; due to societal changes, there was also a change in the use of energy resources. For the total beta volume activity and total beta volume activity corrected to ^{40}K, an increasing trend was confirmed before 1990 on each of the three evaluated profiles. After 1990, a downward trend was confirmed for the above-mentioned indicators; however, the trend can be confirmed by statistical calculation with high probability only for two profiles. For the ^{226}Ra isotope, neither a decreasing nor an increasing trend was confirmed in any of the defined periods.

CONCLUSION AND EVALUATION

Based on monitoring of radioactive indicators for the period 1967–2021, the following can be evaluated from the results of laboratory determinations of surface water samples on profiles in the Ploučnice river basin:

- significant influence of the occurrence of uranium ore mined in the Stráž pod Ralskem deposit on surface water quality;
- at the time of active mining in the period 1967–1996, increased values of radioactive indicators were detected in surface waters, decreasing in the direction of the flow;
- the distant Hřensko profile on the Labe/Elbe River showed the influence of radioactive indicators during the active mining of uranium ores;
- based on a statistical calculation, a downward trend was confirmed for the total volume beta activity and total volume beta activity after correction to ^{40}K after the end of uranium ore mining;
- in the last 10 years, increasing values of volume alpha activity have been recorded on the Mimoň profile on the Ploučnice;
- the normative trend was not confirmed for the activity of ^{226}Ra isotope.

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Landscape changes in selected locations of the Polabí lowlands with a focus on wetlands

PAVEL RICHTER

Keywords: archival maps — wetlands — water retention in the landscape — floodplains of watercourses — ponds

ABSTRACT

This article presents three typologically different sites from Polabí where large-scale wetland sites were located in the past, including ponds. These sites were chosen in order to present disappeared floodplain meadows, disappeared "field" wetlands, disappeared ponds or pond systems, and, simultaneously, to present sites where wetland habitats have been at least partially restored. The main aim was to present easily accessible archival maps, on the basis of which it is possible to assess the spatio-temporal dynamics of wetland habitats in the places of disappeared wetlands with regard to their possible restoration. The article presents the map of the 2nd military mapping as best suited for primary detection of historic wetlands. This map shows the state of the landscape in the mid-19th century rather accurately. It was, among other things, a landscape of almost unregulated watercourses, including their floodplains, as well as wetlands and springs where there is arable land nowadays. However, even the spatially less accurate map of the 1st military mapping from the second half of the 18th century provides suitable information for rough identification or detection of wetlands. Müller's map of Bohemia from 1720, which is spatially inaccurate, can also be used as a supplement to newer documents because it shows water bodies (ponds). The information obtained can be used, for example, in landscape planning, especially with regard to the restoration and management of wetland habitats. There is an increase in landscape biodiversity at the sites restored in this way, which is in line with the EU Biodiversity Strategy for 2030.

INTRODUCTION

It is known from history that people first settled and transformed the landscape around watercourses in the lowlands. Currently, water is still perceived as a self-evident and completely normal part of life, however, despite the destructive manifestations of floods, there is a shortage of water in the current Czech landscape. Prolonged periods of drought have occurred here almost continuously since 2015. One of the main factors influencing the water regime in the landscape is agriculture. However, agricultural management is still not adapted to climate change and the result is a landscape that cannot cope with excessive rainfall and long periods of drought. Contemporary society perceives agriculture as the primary activity in the landscape, regardless of other, especially non-productive landscape functions, which are largely suppressed. In particular, agricultural management in the landscape determines the main flows of energy and substances, which are important factors for the overall functioning of landscape units [1].

At present, the area of Polabí lowland suffers from a lack of groundwater and there is a large seasonal drying of small watercourses, the vast majority of which are straightened and deepened. It is necessary to pay increased attention to the restoration of landscape features with a positive effect on the water regime in the landscape and to water management in the landscape itself. This current problem will very probably worsen in the future in connection with the expected continued occurrence of extreme climatic events.

Wetlands are one of the most significant types with a positive effect on the water regime in the landscape and water management in the landscape itself. Wetlands can also include ponds [2]. From the point of view of water management, these are one of the categories of water bodies, but from the point of view of landscape ecology, they can also be classified as wetlands. This is due to the existence of a littoral zone near the ponds and also their shallow depth. These facts meet the definition of a wetland for ponds. The main aim of the research, the results of which are presented in this article, is to assess the spatio-temporal dynamics of wetland habitats at the sites of disappeared wetlands at selected locations in Polabí with regard to their possible restoration.

STUDIED SITES

Three typologically different sites from Polabí are presented here, where there used to be large wetland areas, including ponds. All three sites are located in the sub-basin of the Upper and Middle Elbe in the Central Bohemia region [3].

Mlynařice floodplain and the disappeared Hladoměř pond near Stará Lysá

This site is located in the III order basin 1-04-07 Elbe from Výrovka to Jizera in the Stará Lysá cadastral area, and partly also in the Benátecká Vrutice cadastral area and the Lysá nad Labem cadastral area in the Nymburk district [3]. The geological subsoil consists of calcareous claystones, marlstones, and less clayey limestones [4], the predominant soil type is arenic regosol; in the Mlynařice nad Starou Lysou floodplain is it organosol [5].

Disappeared wetland near Libenice

This site is located in the III order basin 1-04-01 Elbe from Doubrava to Cidlina in the Libenice cadastral area and the Nebovidy cadastral area in the Kolín district [3]. The geological subsoil consists of claystone, siltstone, sandstone, conglomerate [4], the predominant soil type in the Libenice cadastral area is gley fluvisol, and in the Nebovidy cadastral area modal chernozem [5].

Doubrava floodplain and the disappeared Kmotrov pond near Sulovice

The disappeared Kmotrov pond is located in the III order basin 1-03-05 Doubrava in the Sulovice cadastral area. In addition, the Doubrava and Čertovka floodplains in the assessed area are also a part of th Žehušice, Horka u Žehušic, Rohozec u Žehušic, Lišice u Sulovic, and Habrkovice cadastral areas in the Kutná Hora district [3]. The geological subsoil consists of calcareous claystones, marlstones, and less clayey limestones [4], the prevailing soil types are arenic chernozem (in the vicinity of Sulovice) and arenic cambisol, and in the Doubrava floodplain, it is modal and gley fluvisol [5].

METHODOLOGY

The sites presented here were chosen in such a way as to present all the important problems and facts on which the research in the Polabí lowland was focused, i.e., to present disappeared alluvial meadows, disappeared "field" wetlands and also disappeared ponds or pond systems, and, at the same time, sites where wetlands have been restored at least partially could be presented here. The pond landscapes in Pardubice and Chlumec districts were not taken into account; they will be presented separately.

The first step was the selection and subsequent comparison of the current and historical state of disappeared wetland sites, including ponds in Polabí, based on the interpretation of map data. The next step was a field survey of these sites to verify their current condition. For the primary detection of the occurrence of wetlands, a map of the 2nd military mapping was used, which is available as a WMS service from the INSPIRE National Geoportal [6]. It is the most suitable for this purpose, as it is the first relatively spatially accurate map [7].

The current basic map of the Czech Republic 1 : 10,000 (ZM10) and the current orthophoto map of the Czech Republic were used to show the current state. Both are available as a WMS service from the ČÚZK Geoportal [8]. Subsequently, the condition of the sites recorded in the LPIs Public Land Register [9] and in the cadastre [10] was verified.

For a more accurate understanding of the development of the landscape between the state recorded on the map of the 2nd military mapping and current maps, the map of the 3rd military mapping was used, available as a WMS service from the INSPIRE National Geoportal [6], an orthophoto map of the Czech Republic from the 1950s, available within the map browser of the INSPIRE National Geoportal [11], and archival orthophoto maps available as a WMS service from the ČÚZK Geoportal [8].

To understand the state of the landscape before the 2nd military mapping, maps of the 1st military mapping and Müller's mapping were used, which are less spatially accurate. The map of the 1st military mapping is available within the oldmaps.cz application of the Geoinformatics Laboratory of the Faculty of the Environment of the J. E. Purkyně University in Ústí nad Labem [12], while Müller's mapping is most easily available within the map browser of the Land Surveying Office archive [13].

Current maps used

CURRENT ZM10 OF THE CZECH REPUBLIC AND ORTHOPHOTO MAP OF THE CZECH REPUBLIC

These maps are available as a WMS service from the ČÚZK Geoportal, where they are continuously updated as needed. The displayed status on the ZM10 may differ according to the individual segments that are updated separately (e.g. road network), i.e., it may not show the real state of the landscape in a given period in all aspects. The entire orthophoto map of the Czech Republic is updated in a 2-year cycle. Approximately one half of the area of the Czech Republic is updated annually; since 2020, the borders of the regions have been taken into account during the update. Currently, both maps should correspond to the state of the landscape in 2021–2022 [8].

LPIS PUBLIC LAND REGISTRY

The LPIs consists primarily of records of agricultural land use, i.e., for determining the type of agricultural land, as well as records of landscape features, records of the location of farm buildings, and records of grass cover restoration. It shows the actual condition of the areas of agriculturally used land [9, 14].

CADASTRE

In the cadastre, it is possible to obtain selected data on plots, buildings, units (apartments or non-residential premises), and building rights registered here. In contrast to the LPIS, the entire area is captured, not just agricultural land. Since this record is not subject to automatic updating, it may happen that the recorded land type does not correspond to the actual state. This can be verified, for example, by comparing it with the current orthophoto map of the Czech Republic, which is available here as one of the maps [11].

Archival maps used

MÜLLER'S MAPPING

The oldest map used here is Müller's map of Bohemia from 1720 at a scale of approximately 1 : 132,000 [15]. The disadvantage for a detailed comparison of the development of the landscape with the following map documents is its unsatisfactory spatial accuracy. Therefore, it can only be meaningfully used to display water bodies (ponds) as a supplement to newer documents. Not all watercourses are shown here and the drawing is not accurate [7].

1ST MILITARY MAPPING

The basis of the 1st military mapping was Müller's map enlarged to a scale of 1 : 28,800. The mapping itself took place between 1764 and 1768, and then between 1780 and 1783 (rectification). It captures the area of Bohemia, Moravia and Silesia as a whole in the period before the onset of the industrial revolution, at the time of the greatest flourishing of the cultural baroque landscape and its highest diversity [16]. As with Müller mapping, the disadvantage is low spatial accuracy, and therefore this map base can only be used for rough identification or detection of wetlands in a given location [7].

2ND MILITARY MAPPING

For the primary detection of the occurrence of large wetlands and water bodies (i.e., ponds), the relatively spatially accurate map of the 2nd military mapping [7] is the most suitable. It was created on a scale of 1 : 28,800 between 1836 and 1852. Its creation was preceded by military triangulation, which served as the geodetic basis of this map; it was based on maps of the Stable Cadastre (*Franziszeischer Kataster*), so compared to the 1st military mapping, its accuracy increased. The content of both military mapping maps is essentially the same, but the situation is significantly different. The map of the 2nd military mapping was created at the time of the onset of the industrial revolution and the development of intensive forms of agriculture, when the area of arable land increased by half in 100 years and the area of the forest reached the smallest extent in history; the first railway lines are also recorded here [17].

3RD MILITARY MAPPING

The map of the 3rd military mapping was prepared for Bohemia between 1877 and 1880 on a scale of 1 : 25,000. The reason was the fact that the 2nd military mapping was no longer sufficient to meet the army's requirements for the maps that were accurate, and mainly up-to-date [18].

ORTHOPHOTO MAP OF THE CZECH REPUBLIC FROM THE 1950S

The historical orthophoto map includes layers of aerial photographs mainly from the years 1952–1954, supplemented by images from the years 1937–1970 and 1996, where there are no relevant photographic documents in the given period. Historical aerial photographs were provided by the Military Geographical and Hydrometeorological Office (Vojenský geografický a hydrometeorologický úřad, VGHMÚř) [19].

ARCHIVAL ORTHOPHOTO MAPS OF THE CZECH REPUBLIC

These maps are available as a WMS service from the ČÚZK Geoportal, where they are updated as needed, i.e., layers are added replacing the ones from the years that were replaced in the layer of the current orthophotomap of the Czech Republic. Each layer of the service always contains aerial photography from one calendar year on the part of the area where the aerial photography was carried out. The archival black-and--white orthophoto is displayed from 1998 to 2001, colour from 2002 to 2019 [8].

RESULTS

Mlynařice floodplain and the disappeared Hladoměř pond near Stará Lysá

In the past, in the vicinity of Stará Lysá, there was the Hladoměř pond with an area of 64 ha on the Mlynařice stream (marked as Wlkawa Bach on the map of the 2nd military mapping, i.e. Vlkavský stream), which was located in a wide floodplain formed by wet meadows and swamps with marshes. The area of the wetland site from Benátecká Vrutice to Dvorce, including the pond, was almost 150 ha.

Fig. 1. Mlynařice floodplain and the extinct Hladoměř pond near Stará Lysá on a map of the 2nd military mapping (top) and on BM10 (bottom)

Currently, the regulated watercourse of Mlynařice flows through land made up of arable land, and at Benátecká Vrutice, it also flows through meadows. The Hladoměř pond was land-filled (*Fig. 1*). Between Stará Lysa and Dvorce, between 2009 and 2011, a system of several pools and a riverbed named Mokřad Hladoměř (Hladoměř Wetland) was created on the site of historical swamps and marshes. It is 700 m long and covers an area of about 10 ha. There is a sluice at the edge of the pool system, which can be used to regulate the water level. The site should attract back birds, fish and amphibians. It should be a relaxation zone for nature-watching. It cost around 20 million crowns; Stará Lysá received 18 million from EU subsidies within OPE in priority axis 6 – Improving the state of nature and landscape [20–22]. According to the entry in the land registry, this site is still on arable land, however, proceedings are being conducted here due to the discrepancy between the type of land and the actual condition. Beneath this site (behind the road to Dvorce in the Lysá nad Labem cadastral area), there is a water reservoir, which is registered as permanent grassland in the cadastre; proceedings due to discrepancy in the type of land are not conducted here. None of these sites is registered in LPIS.

Fig. 2. Mlynařice floodplain and the extinct Hladoměř pond near Stará Lysá on an orthophotomap of Czechoslovakia from the 1950s (top) and on the archival orthophotomap of the Czech Republic from 2004 (bottom)

When clarifying the historical development of this site, it was found that on the map of the 3rd military mapping, the Hladoměř pond is already land-filled. In 1954, there was arable land with a classic mosaic of small plots in the Mlynařice floodplain and at the site of the Hladoměř pond. Only at the site of the Hladoměř Wetland, there was a site with wet meadows. In 2004, both sites showed signs of waterlogging (*Fig. 2*). In 2010, there is the Hladoměř Wetland under construction, the water reservoir under it is already built. On the current orthophoto map, waterlogged sites can be seen at the site of the disappeared pond and, to a much lesser extent, in the vicinity of the wetland (*Fig. 3*).

Fig. 3. Mlynařice floodplain and the extinct Hladoměř pond near Stará Lysá on the archival orthophotomap of the Czech Republic from 2010 (top) and on the current orthophotomap of the Czech Republic (bottom)

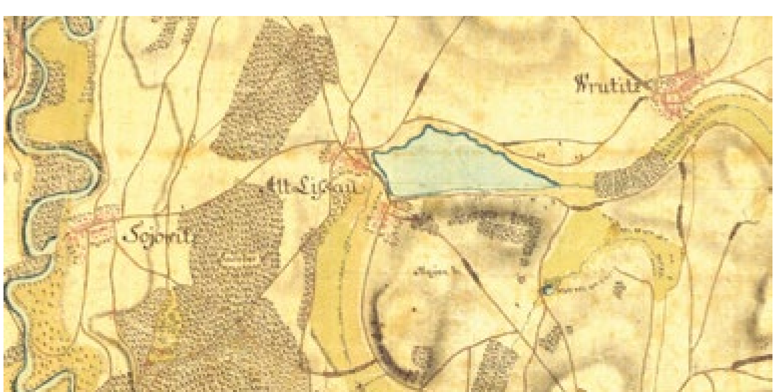

Fig. 4. Mlynařice floodplain and the extinct Hladoměř pond near Stará Lysá on the map of the 1st military mapping

The Hladoměř pond was already recorded on the maps of the 1st military mapping (*Fig. 4*) and on Müller's map of Bohemia, where, however, the Mlynařice stream is apparently incorrectly recorded (*Fig. 5*).

Fig. 6 and *7* show the current state of the landscape at the site of the Hladoměř pond, and Fig. 8 shows a view of the Hladoměř Wetland with already stratified bank vegetation.

Fig. 5. Mlynařice floodplain and the extinct Hladoměř pond near Stará Lysá on Müller's map of Bohemia

Fig. 6. Current landscape in Mlynařice floodplain at the site of the extinct Hladoměř pond near Stará Lysá, view from Benátecká Vrutice (December 2022)

Fig. 7. Current landscape at the site of the extinct Hladoměř pond near Stará Lysá, view from Stará Lysá (December 2022)

Fig. 8. Bird's-eye view of Hladoměř Wetland (April 2020; Photo: J. Kolomazník) [22]

Disappeared wetland near Libenice

Between Šťáralka and Libenice, along the road to Kolín, there used to be a large site consisting of wet meadows with an area of almost 100 ha. It reached almost to the railway line to Kolín, beyond which there was a wide waterlogged floodplain of the Elbe. Currently, there is mainly arable land here. The bed of the Elbe was straightened due to its navigation and several water bodies were created in its floodplain. In the part of the "U Studánky" site, restoration of the area was started in 2014 named "Anti-erosion measures in the Nebovidy cadastral area – building object SO 03 – "U studánky" site, co-financed by the EU from the European Agricultural Fund for Rural Development as part of sub-measure I. 1.4. Land improvements. At the time of project approval, a subsidy of approximately 15,250,000 CZK was allocated. A system of three pools, a perimeter ditch, and vegetating the "Wetland forest" by planting trees, shrubs and grass was implemented according to the approved proposal for comprehensive land management in the Nebovidy cadastral area. The site has an area of 8.3 ha [23, 24]. It is not registered in LPIS. In the cadastre, it is registered as the land type of "other area with the greenery type of use".

Opposite this site, located in the Libenice cadastral area, is the site "V rybníce", where there is currently uncultivated agricultural land, an actual wetland site (*Fig. 9*). In LPIS, it is registered as fallow land, i.e., a temporarily intentionally uncultivated field. The site has an area of 7.5 ha. In the cadastre, the land type is arable land.

When clarifying the historical development of this site, it was found that in 1954 there was arable land on the site of the wetland site with a classic mosaic of plots smaller than at present. In 2004, there were signs of waterlogging at both sites; at the site of the future implementation of the anti-erosion project "U studánky" it is more pronounced (*Fig. 10*). In 2015, we can see the newly implemented anti-erosion project "U studánky" and waterlogging with successional vegetation in part of the disappeared wetland in the site "V rybníce" in the Libenice cadastral area. The current orthophoto map shows the full stratification of the newly planted vegetation in the "U studánky" site and the wetland site, registred as fallow land in the Libenice cadastral area (*Fig. 11*).

On the map of the 1st military mapping, this site is recorded as a meadow (wet meadow) with a spring, and partly with trees. No water body is recorded here (*Fig. 12*). The same situation at this site can be found also on the map of the 3rd military mapping and on Müller's map of Bohemia.

Fig. 13 shows the current status of the implementation of the anti-erosion project in the "U studánky" site, and *Fig. 14* shows the view of the "V rybníce" wetland site, registered in LPIs as fallow land.

Fig. 9. The extinct wetland near Libenice on a map of the 2nd military mapping (top) and on BM10 (bottom)

Fig. 10. The extinct wetland near Libenice on an orthophotomap of Czechoslovakia from the 1950s (top) and on the archival orthophotomap of the Czech Republic from 2004 (bottom)

Fig. 11. The extinct wetland near Libenice on the archival orthophotomap of the Czech Republic from 2015 (top) and on the current orthophotomap of the Czech Republic (bottom)

Fig. 12. The extinct wetland near Libenice on the map of the 1st military mapping

Fig. 13. Site "U Studánky" (December 2022)

Fig. 14. Site "V rybníce" (December 2022)

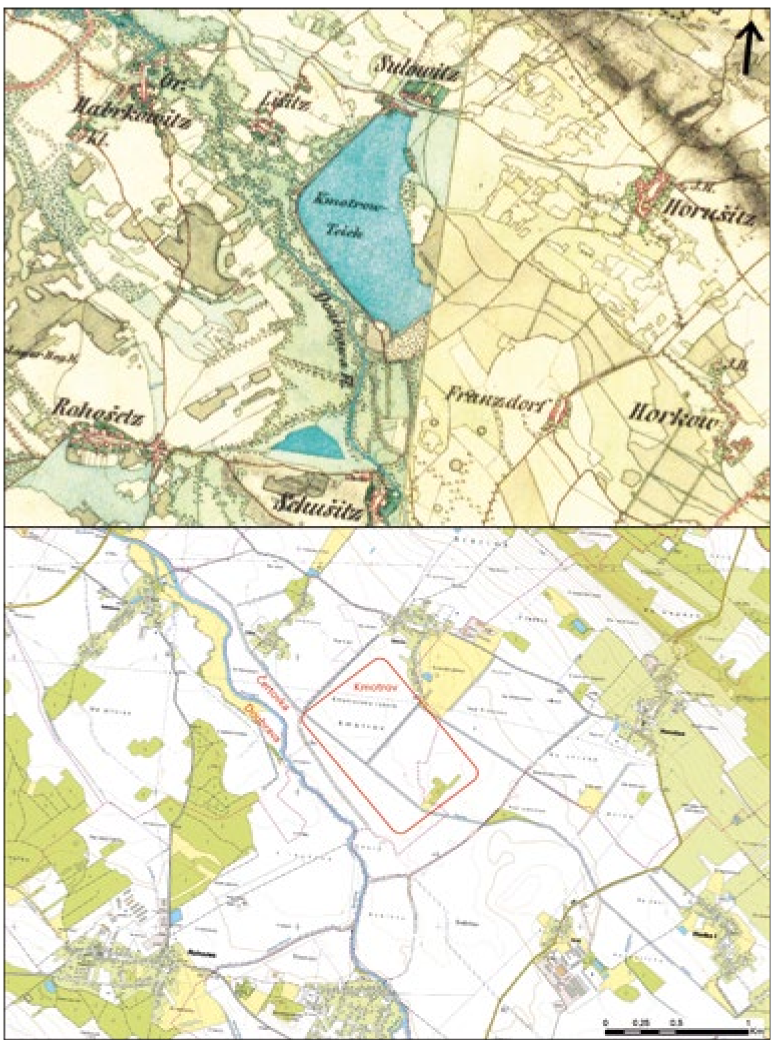

Fig. 15. Doubrava floodplain and the extinct Kmotrov pond near Sulovice on a map of the 2nd military mapping (top) and on BM10 (bottom)

Fig. 16. Doubrava floodplain and the extinct Kmotrov pond near Sulovice on an orthophotomap of Czechoslovakia from the 1950s (top) and on the current orthophotomap of the Czech Republic (bottom)

Fig. 17. Doubrava floodplain and the extinct Kmotrov pond near Sulovice on a map of the 1st military mapping

Fig. 18. Doubrava floodplain and the extinct Kmotrov pond near Sulovice on Müller's map of Bohemia

Fig. 19. The current landscape at the site of the extinct Kmotrov pond near Sulovice (July 2022)

Doubrava floodplain and the disappeared Kmotrov pond near Sulovice

Near the village of Sulovice, there used to be the Kmotrov pond with an area of 87 ha in the immediate vicinity of the Doubrava river, which was located in a wide floodplain formed by wet meadows with woody plants. Between Žehušice and Habrkovice in the neighborhood of the Kmotrov pond, wet meadows with woody plants spread over an area of over 160 ha. Currently, there is arable land, which is also in the immediate vicinity of the Doubrava river, which is bordered only by a narrow strip of riparian vegetation. Similarly to the wet meadows with woody plants in the Doubrava floodplain, the Kmotrov pond also disappeared (*Fig. 15*).

When clarifying the historical development of this site, it was found that on the map of the 3rd military mapping that the Kmotrov pond is already landfilled. In 1954, arable land with a classic mosaic of small plots of land was located on the site of the pond, and the Doubrava floodplain was already used as arable land. The current orthophoto map shows a change in the landscape mosaic as well as several small waterlogged areas at the site of the disappeared Kmotrov pond (*Fig. 16*).

In addition to the Kmotrov pond and a smaller pond near Žehušice (similarly to the 2nd military mapping), another 4 ponds are shown on the map of the 1st military mapping (*Fig. 17*). The same situation at this site can be found also on Müller's map of Bohemia, although the Kmotrov pond is drawn further from Sulovice (*Fig. 18*).

DISCUSSION AND CONCLUSION

It has been known for a long time that it is advisable to look for inspiration in old maps for landscape planning. These can be used as a basis for the restoration of springs, ponds, wetlands or alleys [25].

Due to the different times, the technical aids used, the way of recording the state of the landscape, the circumstances of the creation of the maps used here, as well as due to the different interpretation of the landscape cover, or wetland habitats on these maps, the results of landscape development presented here cannot be taken completely uncritically. However, the basic landscape changes and the trends of these changes are evident from the individual maps at the sites presented here. It involved the gradual drainage of the landscape by the elimination or significant reduction of water-retaining elements such as wetland habitats, including ponds and other types of vegetation such as meadows and woody plants, especially in the floodplains of watercourses.

The map of the 2nd military mapping was chosen as the initial historical map source. It is a map that is most suitable for the primary detection of the occurrence of wetlands, relatively spatially accurate, with an available understandable legend. This map is the most suitable for the identification of historical large wetlands, or meadows in floodplains, and ponds. It is based on the same concept as the more detailed maps of the Stable Cadastre (Franziszeischer Kataster) cadastre; in terms of landscape development in the studied sites, there have been no significant changes, with the exception of the first railway lines. For this type of analysis in this type of landscape, maps of the Stable Cadastre (Franziszeischer Kataster) cadastre do not offer any significant advantage. Other archival maps, both of older and more recent date, were used as supplements to verify the temporal stability of historical wetlands, especially ponds.

In the evaluated site near Stará Lysá, there is a long-established wetland site of the source of the nameless Mlynařice tributary. It is found on all maps, except for Müller's mapping, which is, however, the least reliable and on the smallest scale of all the maps used. On the edge of this spring there was a small water reservoir (pond), which was drawn on all three maps of military mapping, but is no longer shown on newer documents. The main topic of this article is disappeared wetland sites, therefore this stable landscape feature is only mentioned in the discussion. On Müller's mapping, the watercourse of Mlynařice is apparently wrongly drawn as a tributary of the Jizera, not the Elbe, but this does not in any way reduce the credibility of the drawing of the Hladoměř near Stará Lysá pond on this map.

In the evaluated site near Libenice, there are currently two wetland sites instead of one large one: "V rybníce" in the Libenice cadastral area, and "U studánky" in the Nebovidy cadastral area. While at the "V rybníce" site it was not possible to identify at least a hint of the presence of a water body on any of the maps used, at the "U studánky" site a spring is visible on the map of the 1st military mapping. Similar to the two previous military mappings, only the site "U studánky" is recorded on map the 3rd military mapping. In addition to the watercourse, only arable land is recorded at the "V rybníce" site on map the 3rd military mapping. However, the significant transformation of the landscape from the one recorded on the first two military mappings, the large changes recorded on the orthophoto map from the 1950s, and up to the present day, is clearly visible.

In the assessed site near Sulovice, the disappearance of the Kmotrov pond was recorded from the 3rd military mapping. In addition to the Kmotrov pond, four other ponds were recorded on Čertovka on the map of the 1st military mapping and Müller's mapping (unlike the 2nd military mapping). It was therefore a pond system on Čertovka, which is recorded on the two oldest maps used as a channel feeding this pond system from the river Doubrava and then returning back. However, on Müller's mapping the Čertovka is recorded as the main stream, while on the map of the 1st military mapping it is the Doubrava. It is possible that at the time of Müller's mapping, Čertovka could have appeared to be carrying more water due to the supply of the pond system, or it is an erroneous drawing, which is not unusual with watercourses on this mapping.

At the two sites presented in this article, an example of good practice is shown, where the restoration of the landscape was carried out in places of historical occurrence of wetlands, and this confirms the fact that the most suitable places for the restoration of wetlands are their historical locations, if the character of the current landscape does not differ diametrically from the past (e.g., by building development, construction of transport infrastructure, mining). This applies mainly to agriculturally used landscapes. At Stará Lysá, it is a system of pools built on the disappeared floodplain meadows (wet meadows) in the Mlynařice floodplain. It was primarily built to increase the landscape biodiversity. Beneath this newly constructed wetland is a reservoir designed for sport fishing. At the "U pramene" site, the wetland habitat was restored on the site of an disappeared wetland, which in the past was documented on maps as a spring. There are several hunter's chairs at this site, which shows it is also used for hunting.

The restoration of these sites involved large financial costs, mainly from EU funds. The restoration took place since 2009, or 2014, i.e., quite a long time ago. It is obvious that if there was the will to do so, it was possible to use the financing for the restoration of wetlands in the places of their historical occurrence to a much greater extent. One of the biggest obstacles for any activities of this type is, apart from political and social pressures, the ownership of the land in question, where it is necessary to obtain the consent of a large number of land owners.

Neither at the site of the disappeared Kmotrov pond nor in the Doubrava floodplain any restoration has yet taken place. If we only take into account the current state of the landscape, it would certainly be possible to build small wetlands, especially pools, on waterlogged small sites on the area of the current arable land where reeds grow. There are types of very fertile soils at the site of the disappeared pond, but if the crop sown on the waterlogged site does not grow and is replaced by reeds, it would be appropriate to use this fact to restore stable water-retaining elements in the landscape.

A problem in the restoration of wetlands, even in the places of their historical location, could be drainage structures, so-called "reclamation". However, to determine the extent and condition of these buildings is complicated; complete documentation has not been preserved. So if there are no documents for the implementation of drainage structures in a certain area, it does not automatically mean that they have never really been implemented there. It is also impossible to determine the degree of functionality of these buildings with absolute precision. There are currently two publicly available registers of implemented drainage structures. The first concerns constructions implemented within the scope of the ZVHS (Zemědělská vodohospodářská správa, Agricultural water management) on the Farmer's Portal (Portál farmáře) [26], the second is on the Information System of Reclamation Constructions (ISMS, within the Research Institute for Soil and Water Conservation) [27], where, in addition to the above-mentioned structures, there are also constructions implemented outside the scope of the ZVHS or after it became defunct. Neither of the registers provide completely identical data even in the case of constructions implemented within the scope of the ZVHS, however, these documents are sufficient for an idea of the extent and condition of drainage constructions implemented in the sites presented in the article. At the site of the Hladoměř Wetland and the disappeared Hladoměř pond near Stará Lysá, reclamation structures built between 1968 and 1969 are recorded on the data from the Farmer's Portal, while the extent of drained areas is larger on the ISMS, the year of construction is 1981 and they are marked as in operation. If the data is still up-to-date, from this point of view it may seem that functional drainage structures may not be an obstacle for a certain type of landscape restoration. At the site of the disappeared wetland near Libenice, data are only available from the Farmer's Portal; they are drainage structures from 1931, according to the state of the landscape clearly now defunct. According to the Farmer's Portal, there are drainage structures from 1979 and 1989 on part of the disappeared pond Kmotrov near Sulovice, while according to the ISMS, the extent of drained areas is larger, the year of construction is 1982 and they are marked as not in operation; in the Doubrava floodplain, drainage structures are registered on on the left bank of the Doubrava near Rohozec from 1983 marked as in operation.

The methodology "Measures to strengthen infiltration processes in the landscape" [28] responds to the above-mentioned issue; among other things, draft solutions in the field of regulation of runoff in drainage systems and strengthening of water retention in the soil are presented, where wetlands are also considered. The solution to the current situation is also outlined in the "Measure Plan for Solving Drought through Land Modifications and Hydromelioration Adaptations in the Horizon 2030" [29]. Four types of adaptation measures are considered. First, rebuild the existing structures into so-called regulation systems, which retain water in the dry season and make it accessible to plant roots; second, remove parts of the existing systems (only where the system is defunct or should not have been established); third, supplement the drainage systems with retention reservoirs or wetlands with the possibility of further treatment of drainage water (removal of N and P, possibly pesticides) and subsequent reuse. As a last option, the total reconstruction of the system is proposed.

The results presented here could make a practically usable basis for the restoration of wetland habitats in the place of those that have disappeared, because the historical location of such features is a strong argument for their restoration. These landscape features are also a fragment of the mosaic of all solutions for adapting to the problems caused by current climate change. A living and varied landscape contributes significantly to water retention in the landscape and is a prerequisite for maintaining a more stable climate. In the case of landscape restoration in places of disappeared wetlands, there is also an increase in biodiversity, which is in line with the EU Biodiversity Strategy until 2030 [30]. This is a long-term plan to protect nature and stop the degradation of ecosystems, whose main objective is to show the way to restore biodiversity in Europe.

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Multi-Criteria Analysis of the Dyje basin

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Keywords: multi-criteria analysis — adaptation measures — Dyje basin — arable land — drainage

ABSTRACT

This article deals with applications of the specific method of multicriteria analysis (MCA) and its use in the identification of areas within the Czech Republic where adaptation measures to the consequences of climate change would be most effective. MCA was chosen due to its comprehensive approach and the simplicity of working with available data in the Czech Republic. The first MCA have already been applied in the Pilsen and Pardubice Regions within the framework of the creation of the strategic document Regional Strategy of Adaptation Measures (Regionální strategie adaptačních opatření, ReSAO), whose aim was to assess the vulnerability of the entire area of these regions. The results from both strategies are expedient from the point of view of drafting adaptation measures, and it was therefore decided to use MCA as part of a larger project in the Dyje basin. In the first phase, the implemented analyses were evaluated to improve MCA for the studied area. In the second phase, MCA was applied to the area of agricultural land. Several thematic indicators were evaluated, namely surface drainage, land use, erosion risk, and occurrence of erosion events. The aim was to focus on IV order basins, in which the priority of implementing measures on agricultural land is the highest. The result was a list of IV order basins with a partial and summary assessment of problems within the total studied area of the Dyje basin.

INTRODUCTION

The topic of adaptation measures has recently become very topical as a result of climatic and hydrological extremes (floods, drought). Approaches to finding optimal solutions differ as there is a lack of effective connection not only between the academic sphere and the actual measures' investors, but also the wider public. Given the state of the Czech Republic's landscape, which has been extensively altered by man in the past, as well as due to limited resources and work capacities, the key task is to identify areas where adaptation measures will be most effective.

Areas with a defined flood risk [1], areas of critical points [2], or areas defined from the sub-basin plan can be the basis for selecting the most endangered places; however, it is always an assessment of a partial issue. Due to the large amount of geospatial data describing the entire scope of the landscape of the Czech Republic, using multidisciplinary and multicriteria analysis, which would allow creating a synergistic overall view, seems ideal.

METHODOLOGY

Multicriteria analysis (MCA) is a set of systematic procedures for drafting, evaluating, and selecting alternatives, most often based on conflicting criteria. It is used in various fields, such as water management, e.g., within the MEDIATION (Methodology for Effective Decision-Making on Impacts and AdaptaTION) project [3], which focused on the evaluation of various approaches and methods (e.g., weighted average methods, pairwise comparison, or even more complex mathematical models), and identified MCA as the most optimal option for evaluating adaptation measures. Abroad, it was used, for example, as part of the BINGO case study [4], which, using MCA, evaluated the appropriateness of implementing adaptation measures in several selected countries (Germany, Cyprus, Portugal, the Netherlands, Norway, and Spain).

The basic starting points for the application of MCA in the Czech Republic are:
- use of existing data only,
- use of commonly known and simple operations,
- easy replicability,
- finding and validating new connections between used data.

As part of digitization, more and more information and data (raster and vector freely available data) are accessible worldwide which can be used in geospatial analyses. The advantage of using the mentioned methods is their easy replicability, which is primarily aimed at their use in other regions where MCA has not yet been implemented. Thanks to the individual analyses, as well as the feedback from the investors of the first two regional adaptation strategies, it will be possible to find new connections between the most frequently used environmental data. These new connections are the greatest added value of the presented research. The aim is to define such indicators that describe logical links within geospatial or landscape functioning in the broadest sense of the word. One of the specific examples is the application of MCA to one of the basic adaptation measures, namely to the seepage and transformation of surface runoff into underground runoff. The aim is to find an area with suitable soil and geological properties. However, it was often improperly drained in the past, and therefore no longer fulfils its natural function. However, on the basis of MCA, such suitable locations can be searched for both in floodplains, where similar drainage facilities are located, as well as in areas with a very gentle slope. Another example of the use of MCA is the effort to establish effective anti-flood measures, where MCA can help to find critical points in catchment areas and in areas with significant flood risk, manifested by intensive runoff from agricultural land and erosion events.

Multicriteria analysis in the Pardubice and Pilsen regions

For the first time, MCA was applied in this form during the development of the adaptation strategy of the Pardubice region [5] and then the Pilsen region [6]; the investors of both strategies were the relevant regional authorities. The starting point was the combination of geospatial data per unit of IV order basin. The MCA itself was divided into three main topics (problem, potential, need), while each topic had its own subtopic expressed by indicators. The problem expressed the difficulties of the area (e.g., flood risk), the potential expressed natural and social prerequisites for improvement, and the need expressed the demands of the socio-economic sphere on the area (water abstraction).The total number of indicators in the Pilsen region reached 135 and in the Pardubice region 97, although their exact enumeration is not the purpose of this article. Subtopics were related to soil, climatic drought, drought in watercourses, floods, land cover, watercourses, floodplains, human space, ecosystems, water abstractions, and water status.

The evaluation of individual indicators was added up; the basic criterion was the equal weight of all indicators. The assessment set up reflects the principles of the topics – i.e., the higher the assessment, the greater the problem, potential or need. Assessment of the problems as well as the potential and needs was established for each individual IV order basin.

After three or even two years, it can be concluded that this system has been successful. On the basis of the MCA, 20 priority areas were selected in the Pilsen Region, and in the Pardubice Region up to 24 priority areas were selected in several stages in which adaptation measures are currently being implemented. Since the MCA process was tested from its inception to implementation, it is possible to proceed to a critical evaluation of the analyses themselves and the data used for them.

Areas that have not yet received sufficient attention within the MCA include:

1. The issue of drought and its impact on both the natural and socio-economic spheres, expressed, for example, by the number of localities reporting problems with water supply. The information of the integrated rescue system was not sufficiently used either, for example on visits to erosion events or floods from torrential rainfall.
2. Another topic that would deserve more overall attention has been forests and their condition after the bark beetle outbreak has essentially ended, and the effect of other burdens, such as their drainage by buildings and mining technology.
3. In both regions, the identification of social need, will, and demand for the implementation of measures was neglected, which is absolutely essential for the successful application of adaptation strategies. In the Pilsen region, a survey was conducted among municipalities, but its limit was the respondents' activity. Subsequently, the MCA for the Pardubice region was supplemented with a survey, where, according to published information, the response rate was approximately 25 %.
4. Large reserves also lie in the possibilities of dealing with state land. These plots of land can be very well identified using data from the property cadastre. It goes without saying that the implementation of adaptation measures is in a national interest, if these measures are properly substantiated. However, it shows that the preparation and implementation of adaptation measures on state land is not easier. One of the ways could be complex land improvements, but they are also not a universal solution to this problem.
5. In the Pardubice Region, the outputs of the HAMR project (Hydrology, Agronomy, Meteorology and Retention) [7], which is focused on the issue of drought, were also not used; however, they were subsequently used in the Pilsen Region.
6. The aspect of the energy use of the landscape, which is topical especially with regard to the energy crisis, was also insufficiently evaluated. Indicators characterizing known alternative energy sources (i.e., wind and solar potential, geothermal potential, and the potential of water energy use) should be further incorporated into the adaptation strategies. However, it is necessary to work with both the positive and negative impact of their use. It is necessary to monitor the effect of an increase in the number of solar farms on changes in runoff conditions, as well as the effect of the operation of hydroelectric power stations on the state of the relevant watercourses.

In conclusion, we can summarize that the use of MCA in the Pardubice and Pilsen regions has been successful. It showed that there is a lot of freely available background data in the Czech Republic. They have a different level of accuracy, timeliness and, above all, availability, however, after modifications and spatial homogenization, they can be successfully used in MCA. Thanks to these facts, there is a detailed manual for approximately 16 % of the area of the Czech Republic on which problem to deal with, and in which area.

Since countless indicators were evaluated in both strategies, not all connections have been described yet, nor has there been sufficient interpretation of the main conclusions of both strategies. Both regions therefore currently have an amount of data that should subsequently be applied to spatial planning documentation; however, with the exception of selected priority areas with specific draft measures, it has not yet been determined exactly how.

A clear contribution of MCA in both regions is the finding that intensively used agricultural land and river floodplains have the greatest potential for effective drafting of adaptation measures. It must be emphasized here that the delineation of river floodplains was very careful in both strategies.

Our project *"Evaluation of the landscape water regime and revision of critical points as a basis for drafting adaptation measures and evaluation of their effectiveness using rainfall-runoff models"*, implemented at the Institute of Landscape Water Management, University of Technology in Brno, is also based on the above-mentioned findings. It includes a wide range of topics and subtopics related to soil, climatic drought, drought in watercourses, floods, landscape cover, watercourses, floodplains, human space, ecosystems, water abstractions, and water status; compared to the MCA carried out in the Pilsen and Pardubice regions, the number of monitored indicators will be expanded. Of these, only indicators focused on agricultural land are presented below, where the topics of the primary production sector, landscape quality, and denudation forces such as soil erosion intersect, as well as measures to eliminate them. One of the most important and, simultaneously, the most problematic indicators is drainage of agricultural land. This issue is so topical that the elimination of the negative effects of drainage is one of the supported activities of the current OPE programme period. However, it is also a very controversial topic [8] which does not have a simple solution. On the basis of the MCA carried out as part of our project, it can be said that the rate of drainage of agricultural land in the Czech Republic is so great that it must have an effect on the water regime of the landscape. The MCA also showed that there are areas where the elimination of drainage would be a suitable type of adaptation measure. In addition, methodologies on how to deal with drainage have already been developed [9–11].

Application of multicriteria analysis to the Dyje basin

The validity of the above conclusions can be documented on the application of MCA in the Dyje basin, which extends into 11 order III basins (outside of the state border is not considered), located in a total of six regions (*Tab. 1*). The area was chosen in connection with the scope of Povodí Moravy State Enterprise, which has long been trying to improve the situation not only on watercourses, but also in the catchment area, in cooperation with other organizational components of state and public administration.

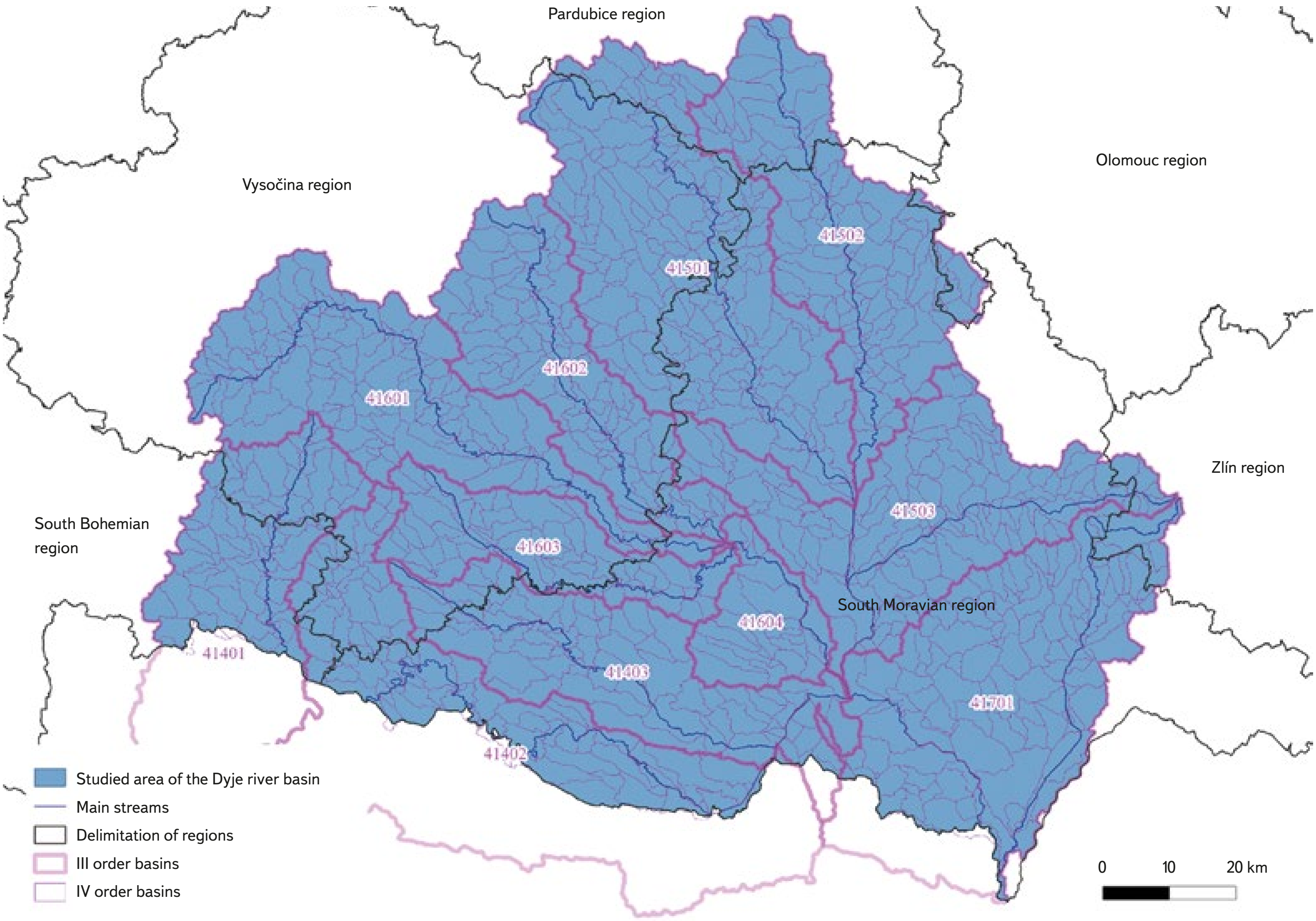

Fig. 1. Map of studied area of Dyje river basin in Czech Republic

Tab. 1. III. Order basin in the area of interest

Hydro-climatic agreement number	Name	Number of IV order basins
4-14-01	Moravian Dyje and German Dyje	65
4-14-02	Dyje from the confluence of Moravian and German Dyje to Jevišovka	81
4-14-03	Jevišovka and Dyje from Jevišovka to Svratka	74
4-15-01	Svratka to Svitava	165
4-15-02	Svitava	110
4-15-03	Svratka from Svitava to Jihlava	134
4-16-01	Jihlava to Oslava	112
4-16-02	Oslava and Jihlava from Oslava to Rokytná	105
4-16-03	Rokytná	60
4-16-04	Jihlava from Rokytná to the mouth and Svratka from Jihlava to the mouth	28
4-17-01	Dyje from Svratka to the mouth	126

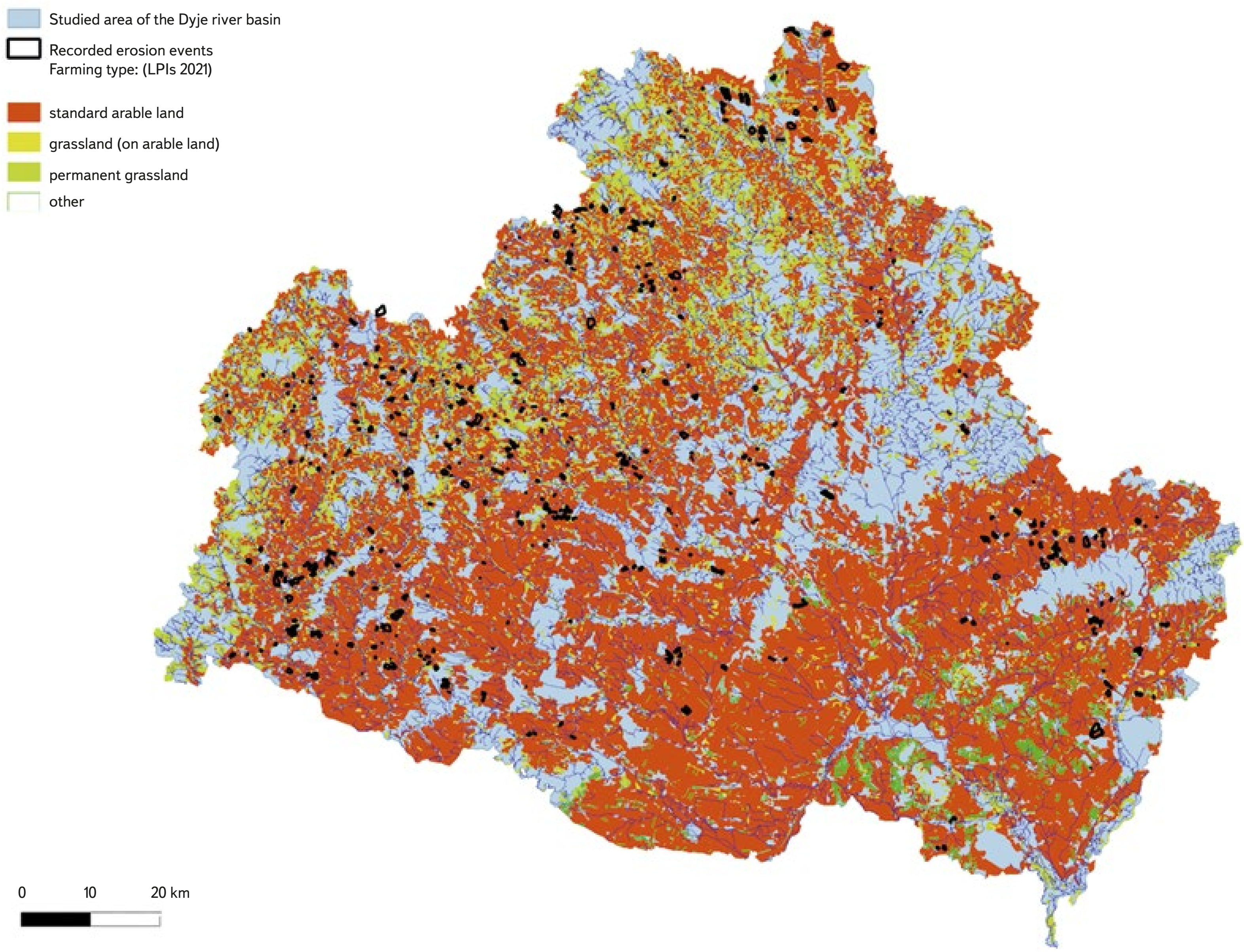

Fig. 2. River modification and the main reclamation facility in the area of interest

Tab. 2. Comparison of the length of various river modifications

Code	Name	Length in the studied area [km]	Percentage of total watercourse length [%]
ZV110	Main drainage facility	70.8	0,6
ZV200	Watercourse regulation	2 153.4	17,2
ZV210	Treatment of the watercourse by piping	170.4	1,4
ZV300	Main reclamation facility open	362.3	2,9
ZV310	Main reclamation facility piped	276.5	2,2
	TOTAL	3 033.4	

As already mentioned above, MCA was applied in the studied area of the Dyje basin similarly to the above mentioned regional adaptation strategies, in the same form of three main topics (problem, potential, need) and subordinate subtopics, which are expressed by indicators. The evaluation of individual indicators was added up, with each indicator having the same weight.

The basic input data was: IV order basin layer [12], obtained from TGM WRI; layer of soil blocks (LPIS) [13] from the Ministry of Agriculture; data on drained and irrigated areas [14], from vectorized data of the Agricultural Water Management Administration, which is currently managed by the Ministry of Agriculture; and data of monitored erosion events [15]. All the mentioned background data were in shapefile format, which was used in all subsequent analyses related to the entire studied area of the Dyje basin as well as to individual IV order basins.

In the "problem" topic, agricultural land was evaluated according to the following indicators:

- Z1 extent of surface drainage,
- Z2 total length of reclamation channels in the basin,
- Z3 total length of watercourse regulation,
- Z4 extent of arable land,
- Z5 extent of soil blocks slightly at risk of erosion according to LPIS,
- Z6 extent of soil blocks strongly at risk of erosion according to LPIS,
- Z7 occurrence of erosion events.

For the purposes of MCA, individual indicators were given points, expressing the area or the total length of the catchment area. Specifically, by overlaying the layers in the ArcMap program (using the "Intersect" command), it was determined which area is located in a specific IV order basin. The given indicator was subsequently divided into categories on a scale of 0 to 5 points, where 0 = the indicator does not occur here either at all or only negligibly, and 5 = significant influence and occurrence of the indicator. In the case of indicator Z7, only two categories were created, namely 0 = the indicator does not occur here, 1 = the indicator occurs here. The resulting assessment was the sum of the values of the above-mentioned indicators (i.e., $Z_{total} = Z1 + Z2 + Z3 + Z4 + Z5 + Z6 + Z7$). The highest value meant the greatest problem in the area of agricultural land. Data evaluation took place in the environment of geoinformation systems (ArcMap from ESRI and the open-source program QGIS), in which all map outputs were subsequently created.

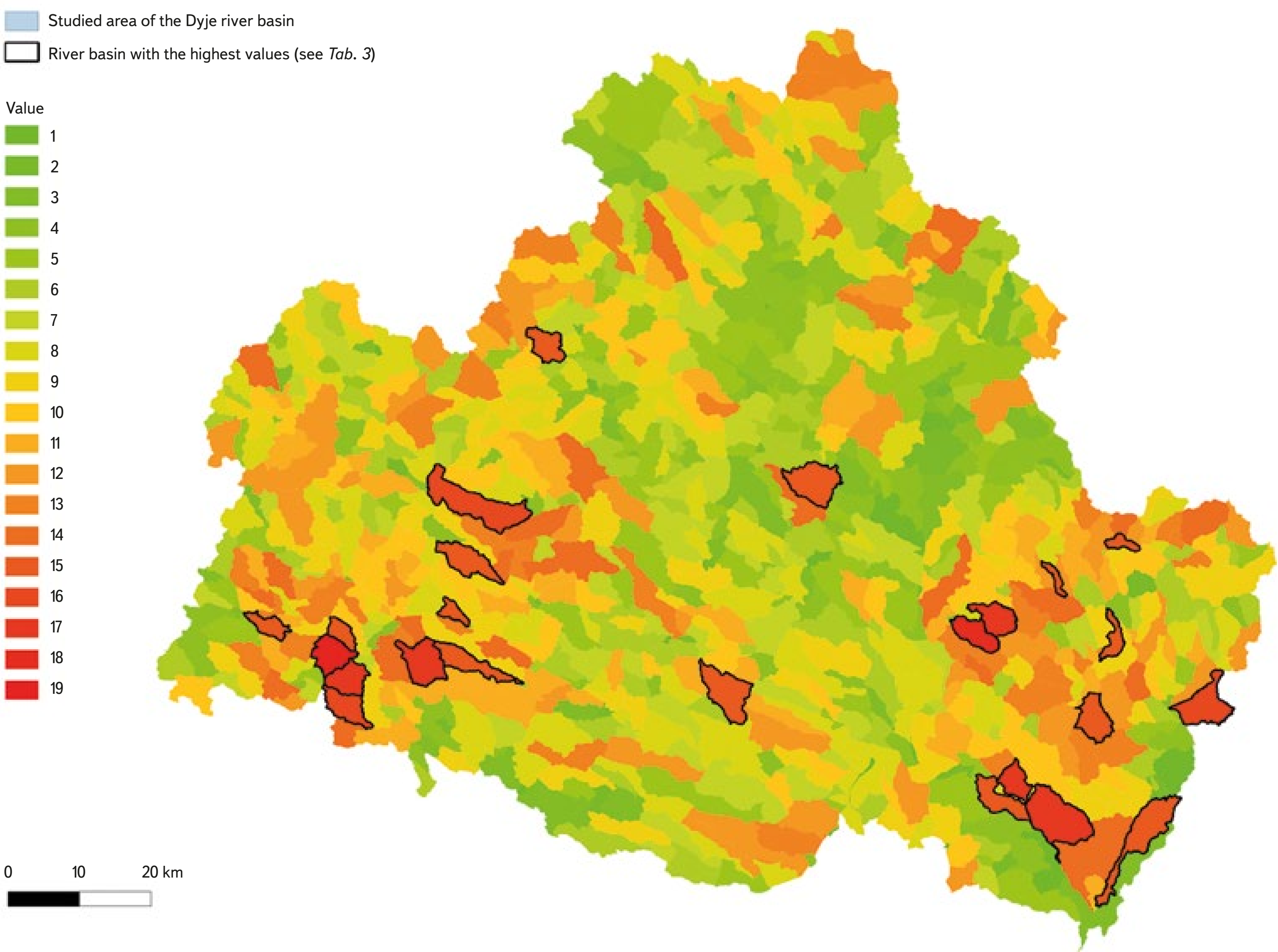

Fig. 3. Types of management on agricultural land

RESULTS AND DISCUSSION

According to the central register of watercourses, there are 12,527 km of watercourses in the studied area of the Dyje basin. From a historical point of view, the majority of watercourses in the landscape were under the management of the Agricultural Water Management Administration, namely 5,669 km of the length of watercourses and drainage facilities (approximately 45 % of the length of all watercourses in the studied area); after its operation ceased, responsibility for the condition of these watercourses were mainly taken over by Povodí Moravy State Enterprise, Lesy České republiky State Enterprise, and the State Land Office. The Agricultural Water Management Administration mainly carried out maintenance work on watercourses. This involved modifying riverbeds, dredging sediments, removing trees, mowing banks, etc.; however, under political and economic pressure, watercourses were also straightened, piped, agriculturally usable areas were drained, and possible restoration was suppressed. In 1983, adversarial proceedings of the technical and operational development plan of Povodí Moravy State Enterprise was held in Brno, which dealt with the issue of making adjustments to watercourses that meet the ecological conditions of the landscape in the given area, but without significant results. According to the analyses, almost 12 % of the total studied area of the Dyje basin was completely drained. From the point of view of modifications of watercourses and main reclamation facilities, approximately 3,000 km of their length was affected and modified, i.e., almost a quarter of all watercourses in the monitored basin. However, it must be taken into account that this data does not contain complete information about all watercourses and from all administrators, so it can be assumed that the total length can be significantly greater. Another factor affecting the currently existing documents is the shifting of responsibilities between institutions, both in terms of the transfer of physical project documentation and their electronic recording.

Area drainage was included in indicator Z1, which was subsequently related to the catchment area. The sum of the lengths ZV110 (main drainage facility), ZV300 (main melioration facility open), and ZV310 (main melioration facility piped) was included in the Z2 indicator, and the sum of the lengths ZV 200 (watercourse adjustment) and ZV210 (watercourse adjustment by piping) was included in the Z3 category.

Information from the public land register (LPIS) was included in the evaluation of indicators "Z4 extent of arable land", "Z5 extent of MEO according to LPIS", and "Z6 extent of SEO according to LPIS". According to the public land register, 53 % of the total area is used as agricultural land, of which 43 % is standard arable land. Since 2014, there has been a decrease in standard arable land by about 80 km2, which is a negligible amount in terms of the total area.

Within the framework of the Agricultural Land Fund, the occurrence of recorded erosion events was also addressed, which were part of the indicator "Z7 extent of erosion events". According to background data, 622 erosion events took place in the Dyje basin (on a total area of 80.7 km^2), of which 99 % were on standard arable land. However, the quality of recording of erosion events is problematic. The almost 100 % occurrence of events on standard arable land can be affected by the subjectivity of recording, for example. The observer can better see furrows in arable land or in wide-row crops. Also, greater damage to roads occurs during erosion events on arable land without vegetation cover, especially during the period of soil preparation for sowing and within one month of sowing. It is also estimated that only 10 % of all erosion events are recorded in the erosion monitoring database, and even here a certain degree of subjectivization plays a role from the point of view of reporting, or the degree of citizen activity.

On the basis of the MCA methodology, a summary assessment regarding the area of agricultural land was created as a sum of partial indicators. 1,033 IV order basins were evaluated. The maximum value achieved in this area was 19, specifically in basin 414020280 (Ostrojkovický stream), west of the town of Jemnice in the Vysočina region, and the value 18 in basin 415031062 (Moutnický stream), east of the town of Židlochovice in the South Moravian region. The high level of threat of these basins is also evidenced by the fact that basin 414020280 was included in the study of semi-natural flood control measures in the Želetavka basin and in other critical basins above the Vranov water reservoir [16], whose investor was Povodí Moravy State Enterprise; in basin 414020280, the most extensive erosion event was recorded in the entire studied area. *Tab. 3* shows an overview of IV order basins which reached the highest values in terms of the given indicators, namely values 15 and above.

Tab. 3. Final results of the indicators

Resulting order	Hydro-climatic agreement number	Z1	Z2	Z3	Z4	Z5	Z6	Z7	total
1	414020280	3	4	5	4	2	0	1	19
2	415031062	2	5	4	4	1	1	1	18
3	417010453	2	5	5	4	1	0	0	17
4	414020310	3	1	5	5	2	0	1	17
5	414020430	2	3	5	4	2	0	1	17
6	415030900	2	3	5	5	1	1	0	17
7	416010880	1	4	5	2	2	1	1	16
8	414020330	3	1	5	4	3	0	0	16
9	417010920	1	4	5	3	1	1	1	16
10	415011460	1	3	4	3	2	1	1	15
11	417011120	2	5	5	3	0	0	0	15
12	417010442	1	5	5	3	1	0	0	15
13	416020330	2	2	5	3	2	1	0	15
14	416030060	1	4	5	3	2	0	0	15
15	414030020	1	2	5	4	2	0	1	15
16	417010210	1	0	5	4	2	2	1	15
17	417010390	1	2	5	4	2	1	0	15
18	414020270	3	2	4	4	2	0	0	15
19	414030410	1	1	5	4	3	0	1	15
20	414010410	3	1	4	4	3	0	0	15
21	415030510	1	0	3	5	3	2	1	15
22	416030120	3	2	3	5	2	0	0	15
23	415030650	1	0	3	5	4	2	0	15

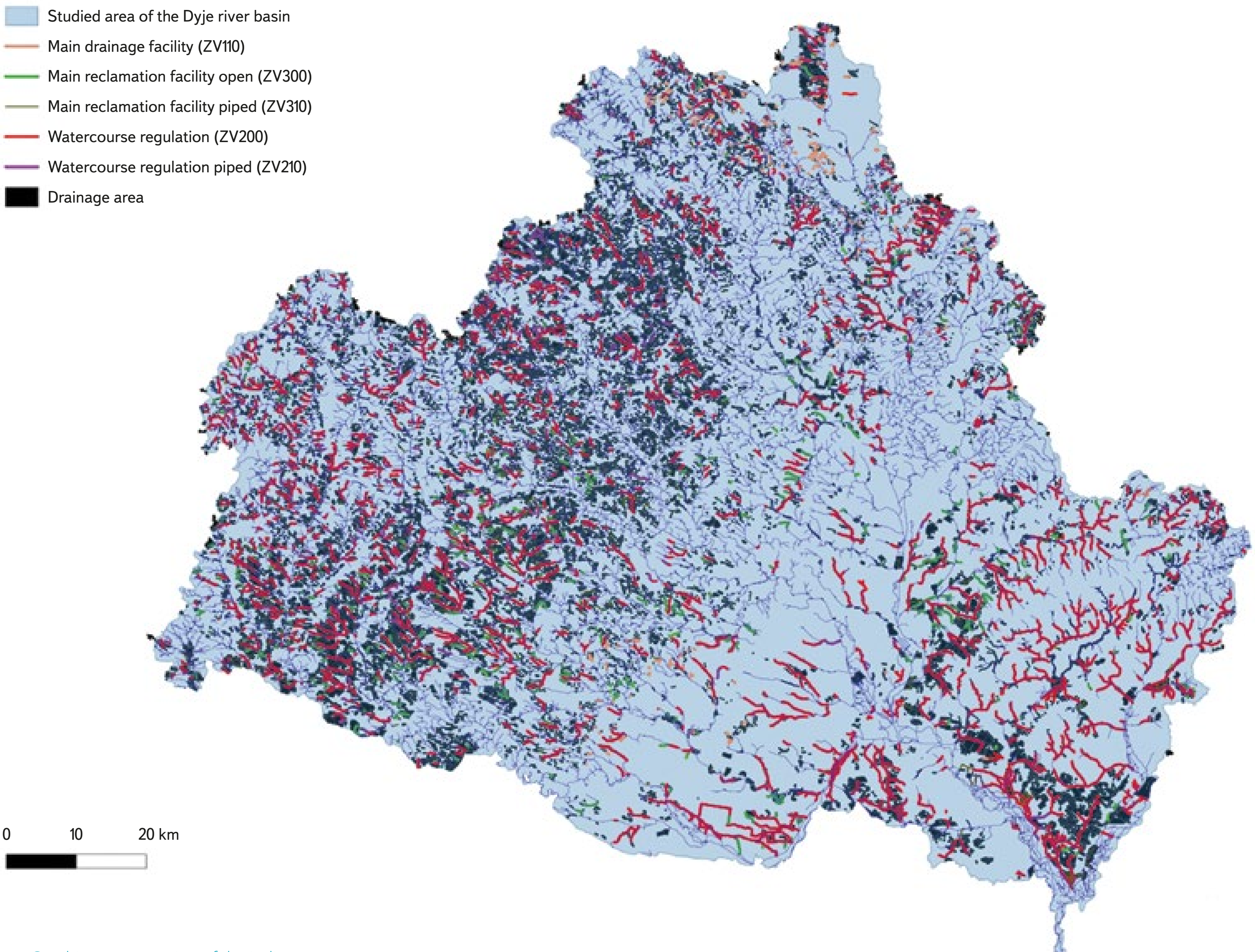

Fig. 4. Graphic representation of the indicators

CONCLUSION

MCA application is effective for the Czech Republic in terms of drafting adaptation measures. This is indicated by the results from both the Pardubice and Pilsen regions. The advantage of applying MCA in the Czech Republic is a large amount of background data which, although of varying accuracy, timeliness and, in particular, availability, can be used successfully after adjustments and above all after spatial homogenization. The biggest shortcoming in both regions proved to be the delay in identifying the social need and demand for the implementation of adaptation measures; it was proven that information about the possibility of implementing these measures should not only be directed to the representatives of cities and municipalities, but also to the wider public. As we already mentioned, the highly topical aspect of the energy use of the landscape was not evaluated within an MCA in the Pardubice or Pilsen region. The knowledge gained from both MCAs will be further taken into account when using MCA for the studied area of the Dyje basin, where an MCA related to agricultural land has already been carried out. An evaluation based on seven indicators, namely in the field of drainage of soil blocks (three indicators), their use, erosion risk (two indicators) and the occurrence of erosion events, was carried out in 1, 033 IV order river basins. Basin 414020280 (Ostojkovický stream) and basin 415031062 (Mutěnický stream) appear to be the most threatened within the MCA. In these basins, the priority of implementing adaptation measures on agricultural land is the highest.

The comprehensive MCA in the Dyje Basin will continue for the next three years, based on all the indicators used in the evaluation of both of the above-mentioned strategies, supplemented by an evaluation of the impact of the energy use of the landscape, the expansion of research in the area of forests, but also state land, and also with greater public involvement.

Acknowledgments

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Agroforestry and its effect on the complex of hydropedological properties of the soil

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Keywords: agroforestry — water retention — Šardice — humidity — soil

ABSTRACT

The aim of this article is to evaluate landscape retention capacity based on the use of soil protection technology at the chosen site and to compare selected hydropedological characteristics in the context of land management. Therefore, broken and intact soil samples are taken regularly and laboratory analyses are carried out. The chosen site is located in the Šardice cadastral area, Hodonín district, South Moravian region. At the chosen site it is possible to consider grass strips with one or more rows of trees as a possible agroforestry system, where temperature and humidity are measured continuously by TOMST TMS-4 moisture sensors. The results show that the way land is used and cultivated has an impact on hydropedological properties of the land. We can influence them both positively and negatively.

INTRODUCTION

Due to current climate change, where increasing average annual temperatures are leading to more frequent extremes such as torrential rainfall and longer periods of drought, great emphasis is placed on returning the landscape to its original state, or at least as close to this state as possible. Over the past few decades, our agricultural landscape has not been managed in an ideal way, and therefore it is necessary to pay attention to this issue, especially the design of protective and adaptation measures. Land is the most valuable natural resource that every country has, and it is also non-renewable [1].

In the Czech Republic, soil is mainly threatened by water and wind erosion [2]. The effect of water erosion on the soil is manifested by leaching of organic and mineral particles from the soil and the transport of sediments from eroded areas. Subsequently, when the terrain slope decreases, they are stored in places of accumulation [3]. Other negative effects include damage to built-up areas, siltation of watercourses and reservoirs, and penetration of residues from agrochemicals and hazardous substances into the aquatic environment.

With intensive agricultural production on arable land and livestock production, it is possible to achieve high yields per unit of area and work, but they can negatively affect the environment. The design and implementation of agroforestry systems can be a contribution to mitigating climate change, improving landscape water management, supporting landscape biodiversity, and also creating a friendlier environment for humans.

The aim of this article is to evaluate the influence of agroforestry systems, the method of cultivation, and land use on the complex of soil hydropedological properties and the flow of moisture.

METHODOLOGY

Agroforestry system and its effect on the landscape

Agroforestry takes advantage of the combination of trees, shrubs, and livestock and their interaction. Agricultural and forestry technologies are both used. Agroforestry systems (AFS) use trees and shrubs in a targeted manner in agriculture, or possibly use forest products other than wood [4].

There are several definitions of agroforestry according to the time and place of origin. Despite many partial ambiguities in its definition, common guidelines for all agroforestry systems are the following:

— economic activity including both agricultural production and that provided by trees or shrubs,
— interconnectedness between these sub-components of the systems,
— emphasis on other non-production functions, or persistence of the system,
— the importance of the human role in the system.

There are a number of agroforestry systems. The methodology according to Dupraz et al. was used for basic classification of agroforestry and the European Agroforestry Federation EURAF. Using it, it is possible to define the basic categories of agroforestry on agricultural land [5]:

Agrisilvicultural – cultivation of woody plants on arable land, agricultural-forestry system, including woody plants and agricultural crops on the same plot of land. Some commonly used agrisilvicultural systems are thus made up of cultivated lanes and hedges (*Fig. 1* and *2*).

Silvopastoral – cultivation of woody plants on permanent grasslands, grazing-forestry system, grazing, animals grazing grass in AFS (*Fig. 3*).

Agrosilvopastoral – Agricultural-grazing-forestry system – i.e., cultivation of crops and trees combined with animal breeding.

AFS has the potential to be a tool for combining climate change, protecting people and property, and creating the foundations for a more sustainable economy and for social development. Sustainable forest management provides a framework for planning at international and national levels and is one way to address an ever-changing climate. At the same time, AFS has the potential to contribute to the field of adaptation strategies. These support sustainable management and community practices and have the potential not only to protect land and people from the adverse effects of climate change, but also provide an opportunity for greater and more sustainable rural development. These systems offer farmers opportunities in production diversity, risk reduction in farming (production), food security, and much-needed income generation. Further on, they can satisfy the commercial need for wood and improve environmental conditions. Thanks to agroforestry measures, a large number of trees are now harvested outside conventional forest plots [6].

Fig. 1. Research area of INRAE, Restinclieres – a hybrid of royal walnut and black walnut in combination with an agricultural crop (Photo: V. Horáková)

Fig. 2. Research area of the INRAE, Restinclieres – pines in combination with vines (Photo: V. Horáková)

Fig. 3. Silvopastoral system – La Losse farm sheep breeding (Photo: V. Horáková)

The interaction between trees and crops can be studied in positive, negative, and neutral way. These interactions are dependent on the type of model used involving different variants of species, their nature, and arrangement. The interaction is further defined as the influence of one part of the system on the behaviour of another part of the system and/or the entire system [7]. Various interactions occur between trees and plants (crops and pastures). Studying the interaction between trees and crops within agroforestry could help find appropriate ways to increase overall soil productivity. The main positive effects of interaction are increased productivity, better soil fertility, nutrient cycling, and soil protection. The main negative effect of interaction is their competition, which reduces crop yields. This can be due to the space, light, nutrients, and moisture they need. The ecological sustainability and success of any agroforestry system is dependent on the interaction and complementarity between positive and negative effects. An agroforestry system can bring an overall positive result only when positive effects outweigh negative ones [8].

Soil properties in agroforestry systems depend on tree species and their intermingling, management practices, arrangement, quantity and quality of litter, and its rate of decomposition. Trees are planted in rows parallel to arable land with crops. These trees provide food, wood, fuel, fodder, building materials, raw materials for small forestry enterprises, and in some cases enrich the soil with essential nutrients [9].

Planting trees and their sustainability can help protect soil against the adverse effects of torrential rainfall. In addition, agroforestry systems can be used to recultivate degraded land and maintain water quality by capturing sediments, nutrients, and toxic substances. They also have the potential to move water from significantly deeper layers where water is found to layers that are drier and in a higher soil profile. This process has been described both in naturally occurring compositions of trees and grasses and in agroforestry systems [10].

In general, unprotected soil receives more sunlight than protected soil, and temperature follows the same trend. Many studies have shown that agroforestry systems perform better than a stand-alone cropping system in areas where there is either a shortage of groundwater or less atmospheric precipitation. Agroforestry is a good tool for crops that like shade and lower temperatures. Trees bring favourable changes in microclimatic conditions due to the influence of radiation flow, air temperature, wind speed, and saturation deficit of supplementary crops, which can have a significant impact on modifying the rate and duration of photosynthesis and subsequent plant growth, transpiration, and soil water use [11]. The shade of trees plays an important role in reducing evapotranspiration, reducing temperature, and increasing humidity. By removing trees, soil temperature can increase by about 4 °C and the relative humidity of the air can decrease by about 12 % up to 2 m above the ground [12].

Research site

As part of complex land improvements in the plan of common facilities (in addition to the design of the field/farm track network) in the Šardice cadastral area, anti-flood and anti-erosion measures were proposed in connection with the territorial system of ecological stability. As part of these multifunctional measures, in five locations – in order to adjust erosion and runoff conditions – ecological balance was achieved and various types of degradation of agriculturally used land were mitigated. Among the measures applied within the plan of common facilities are organizational measures (i.e., optimal delimitation of land types), protective grassing on erosion-prone locations, anti-erosion distribution of crops on slopes, belt rotation of crops, and anti-erosion distribution of crops. As part of the agrotechnical measures, there was sowing in a protective crop, stubble, mulch or post-harvest residues, grassing the erosion-threatened intermediate rows in orchards and vineyards in order to retain rainwater on the soil surface, and contour cultivation. The key proposed part are biotechnical and technical measures such as anti-erosion overhangs and boundaries, waterlogging strips, and stabilization of the paths of concentrated surface runoff by means of grassing the thalwegs. As part of the KPÚ (Krajský pozemkový úřad, Regional Land Office), four catchment anti-flood reservoirs and a system of field/farm tracks were also created.

Fig. 4. View of the agroforestry systems research site, September 9/2022 (Photo: V. Horáková)

The research site is located in the Czech Republic in the South Moravian region, Hodonín district, Šardice cadastral area (*Fig. 4*). Due to the extensive nature of the measures and the size of the studied area, one specific site with implemented agroforestry systems was selected, which is located north to northeast of the village of Šardice (indicated by a blue dot in *Fig. 4*). The model site includes a system of buffer grass strips with linear planting of trees alternating with strips of agricultural crops (*Fig. 5*). The studied site falls into a warm and low-rainfall climate region.

Fig. 5. Comprehensive map and detail of the location of interest (Source: mapy.cz)

Between 2020 and 2022, the following aspects were monitored: soil physical properties, soil moisture, and soil temperature. *Fig. 6* shows the location of individual humidity sensors and the locations of sampling for laboratory analyses. Broken (granular analysis) and intact (physical soil properties and hydrolimits) soil samples were taken. Placement and sampling were carried out at two depths, namely 20 cm (topsoil layer) and 50 cm (sub-soil layer).

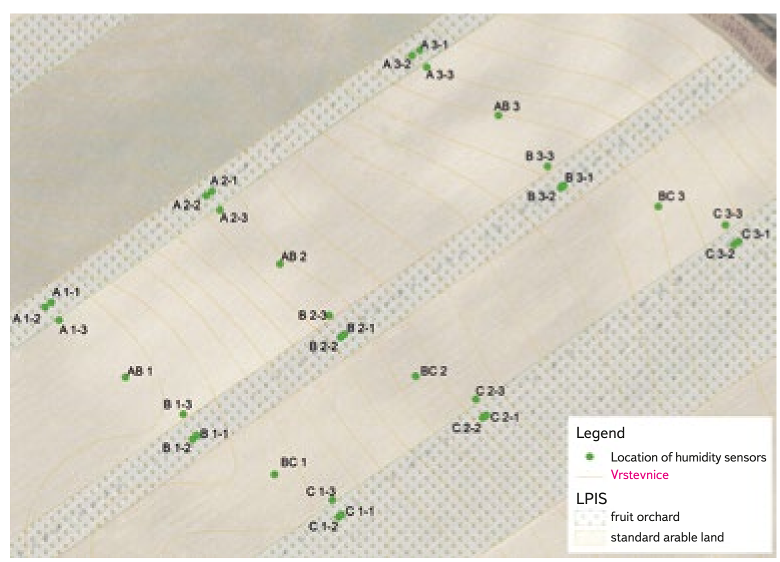

Fig. 6. Location of humidity sensors and sampling points (Photo: V. Horáková)

Humidity sensor reading takes place in the field (*Fig. 7*) by connecting the humidity sensor and the laptop using the cable with the reading device, which is supplied with the humidity sensors.

Fig. 7. Reading sensors in the field: in the middle of arable land (left), grass strip between trees (right) (Photo: V. Horáková)

RESULTS AND DISCUSSION

Due to the large amount of data, only a part of the results was selected, namely humidity with precipitation for the period 03/2021–11/2021, a comparison of humidity in strip a with respect to the position at depths of 20 and 50 cm, i.e. between trees (1), near a tree (2) and at the edge of arable land (3). The first number in the marking indicates the position on the slope, i.e. 1 = top, 2 = in the middle, and 3 = bottom; the second number in the marking is the location within the position on the slope (see the previous sentence). Furthermore, a comparison of the physical properties from strip A, from the first (4/2020) and the last (4/2022) spring collection, will be presented.

In *Fig. 8*, *10*, and *12* (which are graphs for a depth of 20 cm) it can be seen that there is a rapid increase in soil moisture after rainfall. In the period without precipitation it is then reduced. The values for a depth of 20 cm range from 0.1–0.55 (i.e., 10–55 %), depending on the intensity and amount of precipitation. At a depth of 50 cm (*Fig. 9*, *11*, and *13*), soil moisture is quite balanced throughout the period and there are no sudden changes depending on the current precipitation; the values range from 0.05 to 0.4 (i.e., 5–40 %). Compared to a depth of 20 cm, the values are lower, but more balanced. The exceptions are two positions, namely a 3–2 (the lower part of the slope near the tree – *Fig. 11*) and a 3–3 (the lower part of the slope, the edge of arable land – *Fig. 13*). This jump increase can be explained by their location on the slope. Both positions are located in the lower part, which means that there is surface runoff within this area, and in this place the water is retained and absorbed to a greater extent.

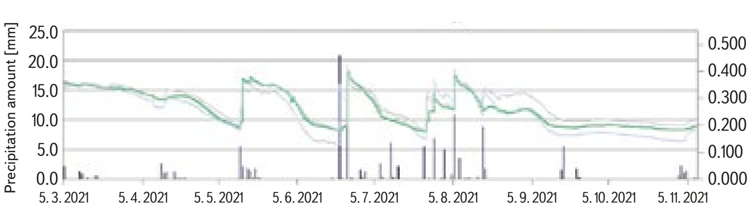

Fig. 8. Precipitation and moisture course of the position between the trees belt A, depth 20 cm, period 03–11/2021

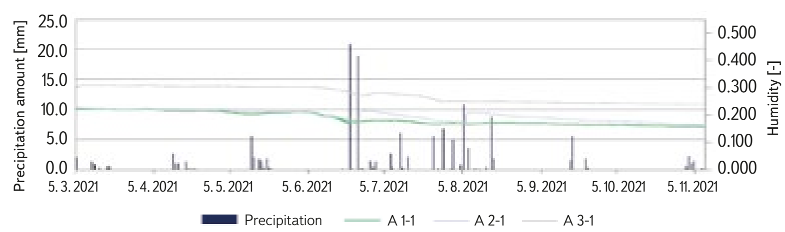

Fig. 9. Precipitation and moisture course of the position between the trees belt A, depth 50 cm, period 03–11/2021

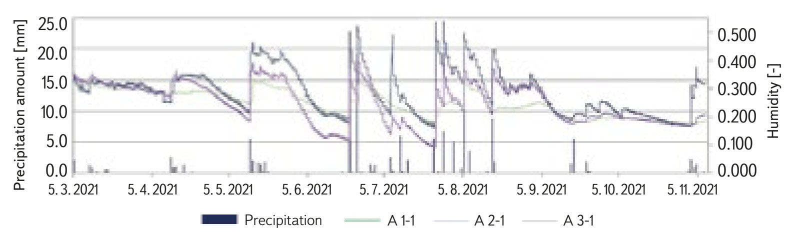

Fig. 10. Precipitation and moisture course of the position near the tree, belt A, depth 20 cm, period 03–11/2021

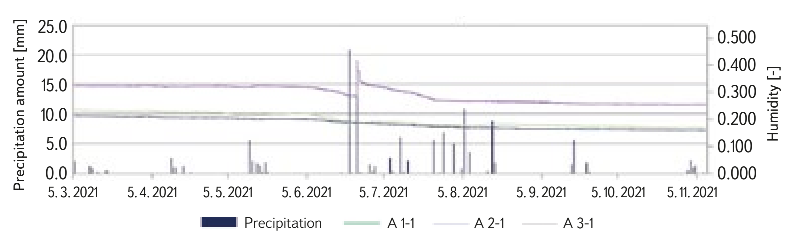

Fig. 11. Precipitation and moisture course of the position near the tree, belt A, depth 50 cm, period 03–11/2021

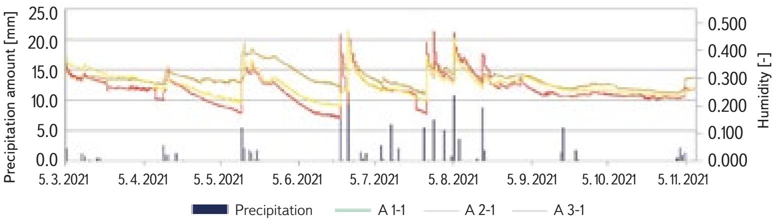

Fig. 12. Precipitation and moisture course position edge of arable land zone A, depth 20 cm, period 03–11/2021

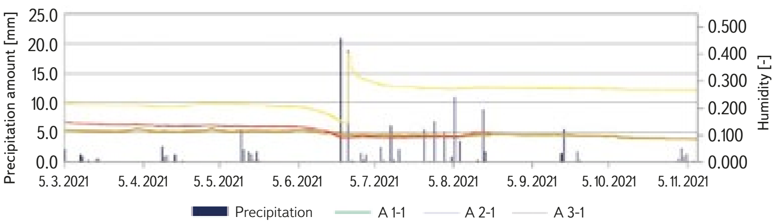

Fig. 13. Precipitation and moisture course position edge of arable land zone A, depth 50 cm, period 03–11/2021

Between 2020 and 2022, broken and intact soil samples were taken, which were subjected to relevant analyses in the pedological laboratory of the Institute of Landscape Water Management of the Faculty of Civil Engineering, Brno University of Technology. The granularity of broken soil samples was determined by grain size analysis using the densitometric method according to Cassagrande. According to Novák, the samples were then classified (*Tab. 1*) as either light – loamy sand (LS), medium – sandy loam (SL), or loam (L) soil. Limit values for physical properties and hydrolimits are then determined on the basis of grain size analysis (see below in the text).

Selected physical properties and hydrolimits were evaluated from intact soil samples. The results from April 2020 and 2022 were selected for the example. Changes in the evaluated parameters are visible from them (*Tab. 2* and *3* – depth 20 cm, *Tab. 4* and *5* – depth 50 cm). Below the tables, the individual evaluated parameters are described and explained.

Tab. 1. Classification of granularity according to Novák

Position		A_{1-1}	A_{1-2}	A_{1-3}	A_{2-1}	A_{2-2}	A_{2-3}	A_{3-1}	A_{3-2}	A_{3-3}
Depth [cm]	20	medium – SL	medium – SL	medium – SL	light – LS	light – LS	medium – SL	light – LS	medium – L	medium – L
	50	medium – SL	medium – SL	light – LS	medium – SL	light – LS	light – LS	light – LS	medium – L	light – LS

Tab. 2. Comparison of physical characteristics for belt A, depth 20 cm for the period 4/2020 and 4/2022 – Part 1

Experimental area		**A 1–1 (SL)**		**A 1–2 (SL)**		**A 1–3 (SL)**		**A 2–1 (LS)**		**A 2–2 (LS)**	
Date		**4/2020**	**4/2022**	**4/2020**	**4/2022**	**4/2020**	**4/2022**	**4/2020**	**4/2022**	**4/2020**	**4/2022**
Depth	**h [cm]**	**20**									
Volumetric mass reduced	ρ_d [g.cm^{-3}]	1.48	1.63	1.59	1.73	1.49	1.61	1.58	1.66	1.56	1.56
Current humidity	θ [%]	9.64	18.50	7.17	12.43	11.75	14.48	9.86	18.14	6.19	18.80
Water absorption	$\theta_{NS} = \theta_S$ [%]	33.76	30.40	31.61	25.39	35.28	24.47	30.64	26.80	29.52	32.15
Humidity 30´	θ_{30} [%]	30.20	29.02	28.95	24.57	31.83	22.95	28.42	25.73	26.51	29.42
Maximum water capacity	θ_{KMK} [%]	28.07	27.69	27.03	23.47	29.03	21.72	26.67	24.68	24.37	27.70
Water retention capacity	θ_{RK} [%]	19.08	24.32	18.36	19.50	18.14	16.63	19.01	21.60	15.29	23.06
Porosity	P [%]	43.98	38.48	40.08	34.70	43.81	39.26	40.27	37.44	41.26	41.11
Capillary pores	P_K [%]	19.08	24.32	18.36	19.50	18.14	16.63	19.01	21.60	15.29	23.06
Semicapillary pores	P_S [%]	11.13	4.70	10.59	5.07	13.69	6.32	9.41	4.12	11.22	6.36
Non-capillary pores	P_N [%]	13.78	9.45	11.13	10.13	11.98	16.31	11.84	11.71	14.75	11.69
Aeration	V_Z [%]	34.35	19.98	32.91	22.27	32.06	24.78	30.40	19.30	35.08	22.30
Maximum air capacity	K_{MKKVZ} [%]	15.91	10.79	13.05	11.23	14.77	17.54	13.59	12.76	16.90	13.41
Air retention capacity	K_{RVKKVZ} [%]	24.91	14.15	21.72	15.20	25.67	22.63	21.25	15.84	25.97	18.05

Tab. 3. Comparison of physical characteristics for strip A, depth 20 cm for the period 4/2020 and 4/2022 – Part 2

Experimental area		**A 2–3 (PH)**		**A 3–1 (HP)**		**A 3–2 (H)**		**A 3–3 (H)**	
Date		**4/2020**	**4/2022**	**4/2020**	**4/2022**	**4/2020**	**4/2022**	**4/2020**	**4/2022**
Depth	**h [cm]**	**20**							
Volumetric mass reduced	ρ_d [g.cm^{-3}]	1.30	1.71	1.51	1.56	1.56	1.60	1.44	1.67
Current humidity	θ [%]	9.67	16.95	16.12	21.17	10.51	24.09	14.29	21.20
Water absorption	$\theta_{NS} = \theta_S$ [%]	36.48	22.36	31.58	30.84	30.16	30.77	36.28	23.31
Humidity 30´	θ_{30} [%]	31.20	21.71	29.28	28.81	28.43	30.02	31.72	22.51
Maximum water capacity	θ_{KMK} [%]	27.07	21.23	27.53	27.55	27.07	29.23	31.43	21.91
Water retention capacity	θ_{RK} [%]	16.29	17.56	19.95	23.83	18.60	26.75	18.44	19.69
Porosity	P [%]	50.97	35.53	43.13	41.13	40.95	39.46	45.84	36.99
Capillary pores	P_K [%]	16.29	17.56	19.95	23.83	18.60	26.75	18.44	19.69
Semicapillary pores	P_S [%]	14.91	4.15	9.33	4.98	9.83	3.27	13.28	2.82
Non-capillary pores	P_N [%]	19.78	13.82	13.85	12.32	12.52	9.44	14.12	14.48
Aeration	V_Z [%]	41.30	18.57	27.00	19.96	30.44	15.37	31.55	15.79
Maximum air capacity	K_{MKKVZ} [%]	23.90	14.30	15.60	13.58	13.88	10.23	14.42	15.08
Air retention capacity	K_{RVKKVZ} [%]	34.69	17.97	23.18	0.00	22.35	12.71	27.40	17.31

Tab. 4. Comparison of physical characteristics for strip A, depth 50 cm for the period 4/2020 and 4/2022 – Part 1

Experimental area		**A 1–1 (PH)**		**A 1–2 (PH)**		**A 1–3 (HP)**		**A 2–1 (PH)**		**A 2–2 (HP)**	
Date		**4/2020**	**4/2022**	**4/2020**	**4/2022**	**4/2020**	**4/2022**	**4/2020**	**4/2022**	**4/2020**	**4/2022**
Depth	**h (cm)**	**50**									
Volumetric mass reduced	ρ_d [g.cm^{-3}]	1.56	1.60	1.33	1.65	1.52	1.66	1.37	1.62	1.44	1.63
Current humidity	θ [%]	15.55	16.90	12.70	11.18	14.17	13.81	15.95	16.16	13.09	14.55
Water absorption	$\theta_{NS} = \theta_S$ [%]	35.35	34.88	37.83	21.68	36.67	29.49	34.14	30.87	32.58	31.67
Humidity 30´	θ_{30} [%]	33.33	32.74	33.29	29.98	34.54	26.93	30.06	29.05	28.95	29.19
Maximum water capacity	θ_{KMK} [%]	31.92	31.31	30.95	28.54	32.65	25.54	27.61	27.55	26.39	27.27
Water retention capacity	θ_{RK} [%]	22.56	28.56	21.26	25.56	23.89	19.62	19.01	25.22	16.77	20.57
Porosity	P [%]	41.10	39.46	49.95	37.90	42.74	37.35	48.22	38.71	45.76	38.45
Capillary pores	P_K [%]	22.56	28.56	21.26	25.56	23.89	19.62	19.01	25.22	16.77	20.57
Semicapillary pores	P_S [%]	10.77	4.17	12.03	4.43	10.65	7.31	11.05	3.83	12.18	8.62
Non-capillary pores	P_N [%]	7.77	6.72	16.66	7.92	8.20	10.42	18.16	9.65	16.81	9.25
Aeration	V_Z [%]	25.55	22.56	37.25	26.73	28.57	23.54	32.27	22.54	32.67	23.90
Maximum air capacity	K_{MKKVZ} [%]	9.18	8.15	19.00	9.36	10.09	11.81	20.61	11.16	19.37	11.18
Air retention capacity	K_{RVKKVZ} [%]	18.54	10.90	28.69	12.35	18.85	17.73	29.21	13.49	28.99	17.87

Tab. 5. Comparison of physical characteristics for strip A, depth 50 cm for the period 4/2020 and 4/2022 – Part 2

Experimental area		**A 2–3 (HP)**		**A 3–1 (HP)**		**A 3–2 (H)**		**A 3–3 (HP)**	
Date		**4/2020**	**4/2022**	**4/2020**	**4/2022**	**4/2020**	**4/2022**	**4/2020**	**4/2022**
Depth	**h [cm]**	**50**							
Volumetric mass reduced	ρ_d [g.cm^{-3}]	1.56	1.63	1.54	1.58	1.68	1.69	1.49	1.70
Current humidity	θ [%]	13.95	17.45	22.54	24.31	23.50	29.68	17.55	21.74
Water absorption	$\theta_{NS} = \theta_S$ [%]	21.20	29.21	33.85	35.23	28.85	33.56	34.84	28.76
Humidity 30´	θ_{30} [%]	19.29	27.17	31.67	33.41	27.43	32.30	30.89	27.13
Maximum water capacity	θ_{KMK} [%]	18.23	26.06	30.31	32.11	26.30	31.59	29.05	26.43
Water retention capacity	θ_{RK} [%]	15.55	21.04	22.26	27.85	18.96	28.71	21.04	23.48
Porosity	P [%]	40.96	38.32	41.86	40.38	36.52	36.24	43.84	35.75
Capillary pores	P_K [%]	15.55	21.04	22.26	27.85	18.96	28.71	21.04	23.48
Semicapillary pores	P_S [%]	3.74	6.13	9.41	5.56	8.47	3.60	9.85	3.65
Non-capillary pores	P_N [%]	21.67	11.15	10.19	6.98	9.10	3.93	12.95	8.62
Aeration	V_Z [%]	27.01	20.87	19.32	16.08	13.03	6.56	26.29	14.02
Maximum air capacity	K_{MKKVZ} [%]	22.73	12.26	11.54	8.28	10.23	4.64	14.79	9.33
Air retention capacity	K_{RVKKVZ} [%]	25.41	17.28	19.60	0.00	17.56	7.53	22.80	12.27

Critical volumetric mass (ρ_d) after drying according to Lhotský is: for loamy sand soil > 1.6 g.cm^{-3}, for sandy loam soil > 1.55 g.cm^{-3} and for loam soil > 1.45 g.cm^{-3}.

Minimum value of volumetric mass to limit root growth is: for loamy sand soil 1.8 g.cm^{-3}, for sandy loam soil 1.75 g.cm^{-3} , and for loam soil 1.7 g.cm^{-3}. No sample exceeded this value, which means that there is no limitation of root growth.

Current humidity (θ) indicates the current water content in the soil, expressing the ratio of the volume of water in the sample V_w to the intact volume V_s. Soil moisture changes throughout the year and is dependent on precipitation, evaporation, plant consumption, runoff, and groundwater seepage.

Water absorption (θNS = θS) is the condition when all pores are filled with water. This is effectively a condition that occurs immediately after rain.

Humidity 30' (θ30) expresses how much water the soil is able to hold after 30 minutes of suction with filter paper from an initially fully saturated sample.

The maximum water capacity (θKMK) should not exceed the value of 31 % for loamy sand soils in topsoil and 30 % in subsoil, 35 % for sandy loam soils in topsoil and 31 % in subsoil, and 36 % for loam soils in topsoil and 34 % in subsoil; if it exceeds this value, it means that the water will not soak into the soil well. At a depth of 20 cm, the value was not exceeded for any of the samples. At a depth of 50 cm the situation was different and several samples exceeded this value.

The water retention capacity (θRK) expresses the maximum amount of water that the soil can retain by capillary forces after 24 hours of suction from the originally fully saturated soil.

Porosity (P) has a decisive influence on soil fertility, the existence of soil microorganisms, it allows the penetration of roots, water, and air into the soil and their movement in the soil. It increases with increasing humidity and, conversely, decreases with drying. In topsoil, it usually ranges from 40 to 60 % by volume and decreases with increasing depth. The critical value of porosity according to Lhotský is < 40 % for loamy sand soil, < 42 % for loamy sand soil, and < 45 % for loam soil.

Aeration (VZ) ranges between 18–24 % vol in topsoil horizons in good condition and 9–12 % vol in meadows. The aeration value must not fall below 10 % vol in arable soil and below 6 % vol in meadows, otherwise air exchange stops and anaerobic processes begin to take place in the soil. In such a case, an agrotechnical intervention must be carried out to increase the amount of air in the soil. No sample exceeded the threshold value, but the vast majority of samples were not in the optimal range that indicates a good condition of the topsoil horizon, which implies that the soil is not in good condition.

Values that do not meet the above critical values in *Tab. 2–5* are highlighted in orange and values outside the optimal range are highlighted in grey.

CONCLUSION

Research has been ongoing since 2020, and every year data is collected both from moisture sensors, which measure continuously, and from regular collection of intact soil samples at the beginning and end of the growing season. The data obtained from the moisture sensors will be subjected to statistical analysis, which will examine and compare whether and to what extent slope position, habitat location (arable land, grass strip), season, and amount of precipitation affect change in humidity (at both depths).

The above data show that slope position (slope of the land) and the way the land is used has an influence on the course of moisture and resulting physical parameters of the soil. For the selected periods of 4/2020 and 4/2022, the best values are at a depth of 20 cm for the position A 2–2 (in the middle of the slope near the tree) and a 3–1 (the lower part of the slope between the trees), both from the point of view of the course of humidity, as well as in terms of physical parameters. For both positions, only the aeration value is not satisfactory; it is outside the optimal value for a topsoil horizon in good condition. However, when comparing results from the first sampling with the last one, values for the positions in the grass strip with trees worsened. On the other hand, for arable land, the values are rather balanced, without major fluctuations.

The final evaluation of agroforestry systems shows that they cannot avert ongoing climate change, but they can help mitigate negative impacts on the landscape, especially by mitigating erosion (both wind and water) and by retaining precipitation in the landscape, i.e., by increasing infiltration and reducing direct surface runoff, which is important due to the volatility of rainfall (long periods without rainfall or torrential rainfall). Overall, it can be concluded that the landscape is returning to a better appearance and wildlife is also returning to it.

The research is still ongoing and will be expanded by experiments using a deep aeration device, which should help in aerating the soil horizon at the required depth, thereby improving the infiltration capacity of the soil. Both broken and intact soil samples will be taken at the experimental sites before and after the intervention for laboratory analysis, so that the effect on hydropedological properties of the soil can be evaluated. Furthermore, a soil sample will be taken for analysis of edaphon (i.e. animals and organisms living in the soil) in order to assess whether and what effect this intervention has on them.

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(Inter)nationality of VTEI journal

LIBOR ANSORGE

Keywords: Index of National Orientation — national journal — citation rate — bibliometric indicator

ABSTRACT

The article describes an analysis of the national orientation of the Vodohospodářské technicko-ekonomické informace (VTEI) journal using the bibliometric indicator Index of National Orientation (INO). This analysis builds on a citation analysis performed in 2022. Based on data on published articles, the Index of National Orientation of Publishing Authors (INO-P) is calculated. For VTEI journal citations in the Scopus database, the Index of National Orientation of Citing Authors (INO-C) is calculated. The analysis shows that again there has been an increase in the number of citations recorded in the Scopus database, although the number of citations for 2022 is slightly lower than in 2021 and 2020. The values of both INO-P and INO-C show that both the publishing authors and the citing authors mainly come from the Czech Republic, and the VTEI journal thus falls into the category of national journals. In 2022, there is a decrease in the values of both INO-P and INO-C, i.e., a shift towards the internationalization of the VTEI journal. However, it remains to be seen in the following years whether these are statistically outlying values or whether this marks the beginning of a trend towards internationalization of the journal.

INTRODUCTION

Last year's article [1] presented a citation analysis of the VTEI journal, which identified 108 citations from authors from a total of 16 countries. However, it did not contain any quantitative expression of the VTEI journal (inter)nationality. Monitoring of the VTEI journal citations continues; as of 16/02/2023, 126 articles citing the VTEI journal by authors from 22 countries (excluding the Czech Republic) can be found in the Scopus database. Does this increase mean that VTEI journal is going international? The way a journal reflects the internationalized nature of science can be determined by many methods [2]. In 2005, Moed introduced a new bibliometric indicator called the Index of National Orientation (INO). This indicator is defined as "the share of articles from the country that most often publishes in the journal, relative to the total number of articles published in the journal" [3]. A purely national journal will have an INO index = 100 %. Subsequently, the concept of the Index of National Orientation was extended to the Index of National Orientation by Country of Publishing Authors (INO-P) and the Index of National Orientation by Country of Authors Citing the Journal (INO-C) [4]. In the study by Hladchenko and Moed [5], the level above which a journal will be considered national is expressed by a value of the Index of National Orientation of Publications (INO-P) greater than 50 %.

The advantage of the INO bibliometric indicator is the relative simplicity of its determination. In connection with the Scopus bibliometric database [6], the INO indicator can be calculated only on the basis of information displayed via the web interface with the help of a calculator. On the other hand, it should be noted that the simplicity of determining the indicator is compensated by some limitations. One of the possible limitations of the INO indicator in connection with Scopus data is the possibility of missing data on the author's country. To solve this problem, Moed et al. [7] suggested not to include articles without author affiliation in the total number of articles, i.e., divide the number of articles published from the author's most productive country by the number of articles for which at least one author's country of origin is available in the database.

This article presents the updated citation values of the VTEI journal in the Scopus database. Simultaneously, the values of the INO bibliometric indicator were calculated both for published articles (INO-P) and especially for citing articles (INO-C).

DATA AND METHODS

The basic search query that is used to find articles in the Scopus database:

REF ("technicko-ekonomick* inf*") Or REF ("Vodohosp* techn*") Or REF ("Wat* manag* tech* econ* inf*") Or REF ("Wat* manag* tech* and econ* inf*") Or REF (vtei) Or REF ("Vodoh* Tech.-Ekon* Inf*")

This query returned a total of 148 results as of the data collection date (16/02/2023), which were checked to see if they actually contained a citation to the VTEI journal or not. Records that do not cite articles in the VTEI journal were excluded from these results. These were citations containing, for example, "vtei.edu.ua" (5x), "bulletin technicko-ekonomických informací" (4x), "vtei.com" (3x), "Virtually Transparent Epidermal Imagery (VTEI)" (3x), etc.

In order to obtain data for calculating INO-C from Scopus, a final query was prepared in the following form:

REF ("technicko-ekonomick* inf*") Or REF ("Vodohosp* techn*") Or REF ("Wat* manag* tech* econ* inf*") Or REF ("Wat* manag* tech* and econ* inf*") Or REF (vtei) Or REF ("Vodoh* Tech.-Ekon* Inf*") AND NOT (EID (2-s2.0-85118100770) Or EID (2-s2.0-85119513282) Or EID (2-s2.0-85085736011) Or EID (2-s2.0-85108030163) Or EID (2-s2.0-84973924385) Or EID (2-s2.0-84925854167) Or EID (2-s2.0-84924498258) Or EID (2-s2.0-84907092087) Or EID (2-s2.0-84872836403) Or EID (2-s2.0-48549110693) Or EID (2-s2.0-0021581908) Or EID (2-s2.0-0342981642) Or EID (2-s2.0-85085120720) Or EID (2-s2.0-84857860744) Or EID (2-s2.0-79951730485) Or EID (2-s2.0-78651589193) Or EID (2-s2.0-85057190296) Or EID (2-s2.0-85123534519) Or EID (2-s2.0-85124286157) Or EID (2-s2.0-85130140120) Or EID (2-s2.0-85140134104) Or EID (2-s2.0-85143800032) Or EID (2-s2.0-85146311962)

This query returned 126 records, for which the number of citations of articles in the VTEI journal was subsequently determined. These data were processed in a spreadsheet and used to generate *Fig. 1*, which shows the numbers of cited and citing articles according to the Scopus database. Simultaneously, the number of citing articles written by Czech authors was determined. Considering the number of articles in individual years, only the years 2019 to 2022 were assessed separately. Due to a small number of citing articles between 1986 and 2028, this period was evaluated in one block (*Tab. 1*). Similarly, the only citing article in 2023 was included in the 2019–2023 block.

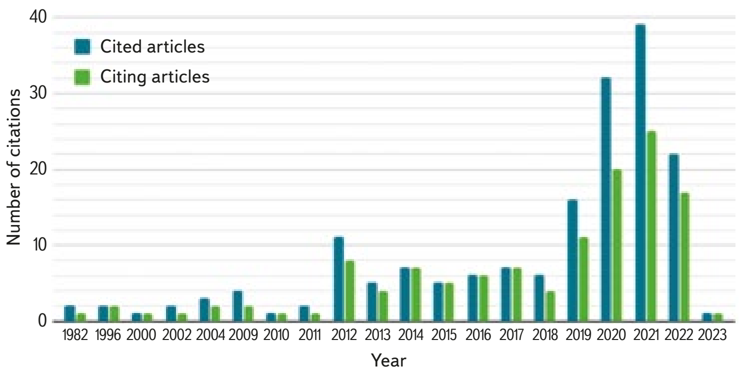

Fig. 1. Number of articles according to the Scopus database that cite articles published in VTEI, and the numbers of these cited articles (data source: Scopus 16 February 2023)

Tab. 1. Numbers of articles citing VTEI journal and affiliation of their authors

Year	Number of citing articles	From Czech authors	"Undefined" affiliation
2019	11	10	0
2020	20	18	1
2021	25	23	0
2022	17	13	0
2019–2023	74	65	1
1982–2018	52	46	1

Source: Scopus 16. 2. 2023

Two cases where the citing author's affiliation is not indicated in the query result were identified, i.e. Scopus returns the value "undefined". In these cases, the relevant article was searched and manual correction of the data was performed. In 2020, an article with no defined author affiliation was published by Czech authors. An article was published in 1996 (included in the period 1982–2018), which, according to Scopus data, is published only by foreign authors.

The VTEI editorial office provided data for the calculation of the INO-P indicator (*Tab. 2*). Considering the time difference used to calculate the INO-C indicator, the INO-P indicator was calculated only for the years 2019 to 2022 due to data comparability.

Tab. 2. Number of articles published in VTEI journal and affiliation of their authors

Year	Number of articles published	From Czech authors
2019	59	59
2020	52	51
2021	51	51
2022	53	48
2019–2022	215	209

Source: VTEI editorial office

RESULTS AND DISCUSSION

The results of calculations of the bibliometric indicator INO-P and INO-C are presented in *Tab. 3*. Two INO-C values are given. The first value (INO-C) gives the calculation when undefined affiliations are included in the result in accordance with the procedure recommended by Moed et al. [7], i.e., reducing the total number of articles by the number with "undefined" affiliation. The INO-C* values indicate the values of the bibliometric indicator after finding the actual affiliation of the authors of the article with the data "undefined" in the Scopus database.

The INO-P results show that the VTEI journal is used especially by Czech authors as a channel for knowledge transfer and dissemination of research results. This is not a surprising finding when we consider that full texts in English (bilingual publishing) was introduced in 2022, and in previous years articles contained only English abstracts and captions for figures and tables. Even then, articles were occasionally published in English [e.g. 8] or bilingually [e.g. 9, 10], but these were isolated cases.

High INO-P indicator values may not be a bad thing. Regionally focused scientific journals have a significant role in the dissemination of scientific information or serve mainly as a means of disseminating research findings towards national or regional communities.

In recent decades, English has become the universal language, the so-called "lingua franca" of international scientific communication. A Spanish study showed that authors publish in English mainly because they wish to (I) communicate the results of their research to the international scientific community, (II) achieve recognition of their research work, and (III) meet the requirements for professional promotion [11].

High INO-C values also correspond to the publication of articles primarily in Czech. The decrease in the INO-C indicator in 2022, i.e., the year when bilingual publishing of full texts of articles was introduced, seems interesting. The 2022 INO-C values can be explained precisely by the start of bilingual publishing. A bibliometric study of journals published in post-Soviet countries also confirms the higher citation rate of texts written in English, even in national journals [12]. Taking into account the deadline of data collection, when the final numbers for 2022 may not be in the Scopus database, as well as the fact that this is the first year of publication of the VTEI journal in bilingual form, these values have to be taken with a pinch of salt! It may still be a statistically outlying value. However, this will have to be confirmed only by bibliometric analysis in the following years. Bilingual publishing is used by journals from the non-English speaking countries to gain wider recognition. A study of medical journals published bilingually [13] showed that bilingual publications helped to index in important databases (e.g. Medline), obtain or improve the Impact Factor, and attract authors.

Tab. 3. Values of INO-P and INO-C

Year	INO-P	INO-C	INO-C*
2019	100.0 %	90.9 %	
2020	98.1 %	94.7 %	95.0 %
2021	100.0 %	92.0 %	
2022	90.6 %	76.5 %	
2019–2022	97.2 %	88.9 %	89.0 %
2019–2023	–	89.0 %	89.2 %
1982–2018	–	90.2 %	88.5 %
1982–2022	–	89.4 %	88.8 %

* Values after finding "undefined" affiliation

Due to the small number of articles without a citing author affiliation, these affiliations were traced and compared both to the results for the "undefined" affiliation exclusion procedure in accordance with the recommendation of Moed et al. [7] (INO-C in *Tab. 3*), as well as to manually added data (INO-C* in *Tab. 3*). *Tab. 3* clearly shows that, in the case of a small number of unidentified affiliations, the procedure of Moed et al. [7] brings sufficiently accurate results.

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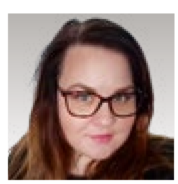

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Conference World 2030, Litoměřice, October 2022

Interview with Michal Broža, head of the UN Information Centre in the Czech Republic

Mr. Broža, you have been working at the United Nations in various positions since 1995. What brought you to work at the UN? Do you remember when you decided on it? And what topic did you deal with after joining the UN?

It was a coincidence of many different circumstances. I studied information science and political science at Charles University, and at the University of Amsterdam I studied a wider range of social sciences, including international relations. I had travelled to foreign countries and learned about various cultures. At the time the offer came, there was war in the former Yugoslavia, and the UN was being discussed a lot in Europe in relation to that – for better or for worse. I found working for the global system a great challenge. The opportunity presented itself – it wasn't a dream job, but it seemed cool given my interests and experience. Big, global, beneficial, and controversial at the same time. From the very beginning, my task was to find ways to communicate complex topics connected with a global organization; in that first phase it was mainly the aforementioned war in Yugoslavia.

You worked in a number of foreign missions. Is there anything that surprised you that sticks out the most from these missions?

Missions are a specific job. Often in difficult, sometimes extreme conditions, far from everything. From one's own way of life, from family, friends, culture. UN missions are mainly about helping the civilian population in extreme economic, social, and political situations. You can't avoid feeling like a real missionary doing good and saving the world. The sooner this feeling is gone, the better for everyone, including you. It is a professional job that requires not only practical or technical skills, but also the ability to empathize and show solidarity with those you help and those you work with. And these are people literally from all over the world. You must have the ability to adapt and be resilient enough. This is the only way to do your best and contribute, at least in a small way, to the stabilization of countries affected by war or some other disaster. What struck me the most was how many fantastic people you get to meet doing this kind of work. Both among local residents and among collaborators from the UN and international non-governmental organizations.

Within the UN, you specialize in the issue of global risk communication, which undoubtedly includes the protection of water and water resources. Can you assess where this communication has moved during your tenure at the UN?

Water is one of the three main things necessary for survival. Its meaning is obvious to everyone. In rich countries, we have become accustomed to the fact that the availability of quality water is not a problem. But it is a problem for 800 million people and almost 2 billion people use water from unsafe sources. The water problem has worsened dramatically in recent years due to the climate crisis. If we fail to prevent warming above 1.5 degrees, so-called water stress will affect us all. Somewhere and sometimes it will be too little water, other times and in other places too much. Flooding, increased ocean levels. Ten per cent of the world's population lives in low-lying coastal areas. If the current trend continues, they will have to find new homes. Some places on Earth will become uninhabitable due to temperature, but also due to the unavailability of water. Water must be a reason for greater cooperation between countries, but we often see the opposite. This means that the issue of water also has a strong security aspect. The situation of the water ecosystem is also critical. In the last 300 years, 85 per cent of the world's wetlands have disappeared.

At the 34th UN-Water Meeting, member countries agreed that the theme for World Water Day 2023 would be "Accelerating change through partnerships and cooperation". What do you personally expect from this theme, and how can the discussion about it further advance the global perception of water protection and water resources?

It follows from the development of recent decades that in a connected world, it is impossible to exist without global cooperation. However, the reality is different. Covid has shown that countries tend to deal with common problems either individually, or bilaterally, or in coordination with allied countries. However, it is no longer sufficient for the problems of the 21st century. Russia's war with Ukraine or the long-term increase in tensions between the two main powers – the US and China – reinforces the risk of geopolitical confrontation. The world needs more cooperation and coordination and stronger global institutions. Certainly the UN, more powerful and in line with the current world. Therefore, we need to improve, deepen and expand cooperation, including water protection and management. Cooperation is the key word for the 21st century.

One of the main topics of today is the SARS-CoV-2 and the epidemiological situation. During discussions at the UN level, have you noticed an increased interest in the topic of wastewater monitoring as a medium for estimating the development of epidemiological situations?

Covid, but also the climate crisis and the growth of global population is related to an increase in the risk of threats to global health. And this is also connected with the topic of wastewater. Wastewater cannot be viewed as waste, but as a resource. Again, we are literally condemned to work together to actually solve common problems. The development of cooperation in the field of wastewater, hygiene, and sanitation is key. After all, 3.6 billion people in the world either live without a toilet or use toilets that are not connected to a safe sewage system. This is a huge problem for human health and the environment.

Another topic is the Russian-Ukrainian conflict. In this context, much is also written about environmental damage. Is it possible to describe to what extent the UN is currently involved in the issue of the environment, i.e. the protection of water and water resources in this conflict?

This is a huge topic for a separate interview. The United Nations Environment Programme (UNEP) released the first report mapping the environmental problems related to the war last autumn. This is a preliminary summary for now and work on the evaluation and solution plan continues. Due to the war, Ukraine is facing many simultaneous environmental crises, whether it is the issue of chemicals, ammunition and military equipment, pollutants, damage to infrastructure, including water management, energy and waste systems, but also, for example, fuel storage. Just assessing all the damage will be a huge task; as well as developing recovery plans. I must add that the obligation to protect the environment in times of armed conflict is reflected in international law, including the UN Charter or the Geneva Conventions, and it is desirable that justice be achieved in this area.

It is well-known that you are involved in educational activities at the school level. You are a long-term partner and supporter of the "Success for every pupil" conference, which includes, among other things, the topic "Children as co-creators of the future". Do you see a shift in the development of the topic of environmental protection at the level of secondary and primary schools? Namely, what, from your point of view, would be appropriate to change in the school curriculum in the field of environmental protection?

The shift is significant in terms of both quality and quantity. In particular, there has been a boom in climate change education. New books are being published (a new one on climate solutions is to be printed soon, I am looking forward to it), programmes and methodologies are being created, there are a number of active teachers (including the "Teachers for the Climate" initiative), many schools have taken up the topic very actively. But are we already where we should be? Far from it. Climate must rise to the top of the political agenda before we can see the desired impact on climate education.

Please tell us what you are currently working on and what awaits you in 2023.

Our priorities for this year will remain similar to last year. Ending the war in Ukraine, including the protection of refugees from Ukraine, but also other conflicts in the world, climate change – in March we will hold a press conference with our Czech partners to publish the final synthesis of the 6th IPCCC assessment report – biodiversity protection. Furthermore, the equality of women and men, the issue of violence against women and girls, human rights protection – this year we will commemorate the 75th anniversary of the adoption of the Universal Declaration of Human Rights – Sustainable Development Goals and many other topics. The never-ending war in Syria, the deteriorating situation in Afghanistan. Within the Czech Republic, we will continue to maintain and deepen cooperation primarily with schools and non-governmental organizations, but also with other institutions and enterprises of the state and private sector.

For all of them, I will mention one project that makes me very happy. At the end of this year, together with the Learned Society of the Czech Republic, we will award the Climate Change Communication Award for the fifth time. It is intended for scientists and experts for their educational activities. It is our small contribution to strengthening climate action, to bridging differences of opinion and to supporting the culture of critical discussion within various scientific fields in the Czech Republic.

Thank you for taking the time to do this interview.

Ing. Josef Nistler

Michal Broža

Michal Broža was born on 13 May 1965 in Sušice. He graduated from Charles University in Prague and also studied at the University of Amsterdam in the Netherlands. Since 1995, he has worked at the UN in various positions. Since 2004, he has been the head of the UN Information Centre in Prague. He participated in missions in Africa and working stays in the former Yugoslavia and the Middle East. He also worked as a World Bank consultant and researcher in the private sector. He specializes in UN issues, communication of global risks and megatrends. He is the author and co-author of publications and articles related to these areas, and he also gives lectures.

Subsidies from the Operational Programme Environment 2021–2027

On 15 December 2022, calls from the Operational Programme Environment (OPE) 2021–2027 were finally launched for projects in the field of nature conservation and landscape protection, which will be financed through the so-called simplified reporting methods (hereinafter SRM). Simplifying the administration of subsidies was one of the main requirements of the European Commission, which it set as mandatory for all projects with total expenditures of up to EUR 200,000. SRM are nothing new, but most operational programmes have not yet used this method, or only to a small extent in the form of flat rates for a specific group of expenses. The aim is to reduce the administrative burden on applicants and beneficiaries for smaller projects in the field of nature and landscape, as this administrative burden which subsidies undoubtedly bring often discourages people to use them.

What exactly are SRM? It is a method that is based on a predetermined amount or percentage related to certain project expenses to which the beneficiary is entitled, regardless of how much the project actually cost them. The beneficiary does not submit any accounting documents to the subsidy provider to verify the funds spent. However, it may happen that the predetermined amount will not be needed in full for the implementation of the project (e.g., due to competition for a lower price). In such case, the beneficiary does not have to return the remaining money to the subsidy provider and can use it to finance other activities related to the implementation of the approved project. Compared to the method of actually reported expenses (proven on the basis of invoices and other accounting documents), dominating in previous programme periods, SRM may seem revolutionary. In the field of nature and landscape, the basis for determining such a "predefined" amount will be the so-called Costs of usual measures of the Ministry of the Environment (CUM MoE), which have already been used for the second programme period to evaluate the cost-effectiveness of OPE projects, and even longer for national subsidies.

It is important to emphasize that the one-time amount according to the CUM MoE will be used only for selected types of projects in 1.3 and 1.6 specific objectives and, at the same time, for projects with total expenses not exceeding EUR 200,000. Among the types of measures to which SRM will be applied are: construction and restoration of water elements (pools, wetlands, small water reservoirs) and vegetation elements (planting and maintenance of greenery inside and outside settlements); restoration of peatlands; restoration of waterways and river branches; removal or elimination of the negative functions of drainage facilities; management of grassland ecosystems (mowing, grazing, clearing self-seeding woody plants); preparation of plans for Territorial System of Ecological Stability (TSES) and regional studies (regional landscape study, study of the residential greenery system); support of species and specific habitats; elimination of invasive plant and animal species; and, building and restoring visitor infrastructure. As part of the projects, a one-time amount according to the CUM MoE will be determined for direct implementation expenses, i.e. the costs of implementing the project. However, the project budget may also include another group of expenses, namely indirect expenses. These are costs associated with project preparation, supervision (technical, copyright, biological), project coordination, mandatory publicity, etc., which will be reported simply in the form of a flat rate of 7 % of the lump sum.

Let us see how the flat rate works on a specific project: the project includes planting trees with a cost of CZK 1 million, which represents direct eligible implementation costs. The amount for indirect expenses that the beneficiary can use is therefore CZK 70,000 (7 % of CZK 1 million). The total project budget is the sum of both amounts, i.e. CZK 1,070,000.

The applicant submits the application in the electronic interface called "Jednotný dotační portál" (Unified subsidy portal, JDP), where they fill in all the necessary data and attach the mandatory appendices. The applicant generates their application from the JDP and sends it electronically or in print, or brings it in person to the regional office of the Nature Conservation Agency of the Czech Republic (NCA CR). The submitted application will be checked for formal requirements (filling in all data, documenting mandatory appendices, etc.) and acceptability (meeting the basic conditions from the point of view of nature conservation and landscape protection). If the application is in order, it proceeds to the next stage of checking before a decision on the provision of a subsidy (Decision) is issued, which consists of an assessment of public support, verification of the material proposal and economic parameters (evaluation of the criteria of a company in difficulty). If the application is in accordance with all the conditions, a Decision will be issued specifying the obligations for the beneficiary, in particular what the project output should look like, both quantitatively and qualitatively. The Decision is usually issued four months after the submission of the subsidy application. Reimbursement of funds will depend on the fulfilment of the project output, which will be checked in 100 % of cases. After completion of a project (or a project stage), the beneficiary submits a request for payment, which also includes a report describing the progress of project implementation, including mandatory appendices. The beneficiary does not submit any invoices, other accounting documents, or documents such as contracts with suppliers or tender documents. Based on the submitted request for payment, an NCA CR employee will verify the project output at the place of implementation (for studies, the study document itself is checked). If the project is carried out with quality and in accordance with the terms of the Decision, funds will be released to the beneficiary's account. As a rule, funds will be disbursed two months after the request for payment is submitted.

Detailed rules for projects financed in the form of SRM in the field of nature and landscape are listed in the NCA CR Handbook, which is published together with other appendices and samples on https://nature.cz/web/dotace/opzp-v-prs-aopk-cr. You can discuss the project preparation with the relevant regional offices of NCA CR, or ask questions using the following email: AOPK-Dotazy-OPZP21@nature.cz.

Due to its freshness, we do not yet have practical experience with drawing subsidies through the SRM method. However, we can look at the projects that were submitted in the two previous OPE periods. In the first OPE period (2007–2013), a considerable part of the projects was administered directly by the beneficiaries. In the second OPE period (2014–2020), the structure of subsidy administrators changed significantly. Beneficiaries usually no longer applied for it themselves, but through various entities. Here, logically, part of the information was lost during communication, and the whole process was prolonged and undoubtedly more expensive. A classic example was when the project evaluator from NCA CR called on the administrator to supplement the opinion, and this request for supplementation was forwarded to the applicant with a delay. There was thus less time left for the preparation of the opinion than if the beneficiaries had administered the project themselves. In the current period, the SRM method offers some hope that some applicants will once again administer their applications themselves. This could speed up the whole process again and, as a result, make the subsidy application cheaper.

Another advantage of applicants who apply without an intermediary is that they are logically more interested in their project and know exactly what they want to achieve and what the possibilities are for obtaining a subsidy.

Returning water to the peatland as part of the *"Ensuring care for EVL Jizerské spruce"* project implemented in 2019–2020.
The total eligible expenses of the project were 2,322,789 CZK, while the EU subsidy amounted 1,947,371 CZK (Photo: Š. Mazánková, AOPK CR)

More than once a potential applicant was approached by a design and administration company with the vision of creating a project to improve the environment in settlements and arrange a subsidy for this project. As a result, it showed that the project is of a very general nature and cannot be targeted at a specific grant title. The funds spent were thus logically not returned to the applicant. On the one hand, OPE subsidy titles are relatively wide-open to various measures, whether for adaptation to climate change or for the protection of biodiversity; however, it is not possible to apply for a subsidy for any project that aims at an increase in biodiversity, but actually relates to a completely different activity. It happened repeatedly that a flood protection project was submitted to the grant title for the restoration of small water reservoirs etc. Such poorly specified projects are subsequently difficult to support with subsidies.

It also showed that consulted projects have a demonstrably significantly higher chance of receiving a subsidy than projects submitted without consultation. In the ideal case, the applicant addresses their intention to the relevant NCA CR office, where they discuss their plan. In more complicated cases, a local investigation will also be performed in order to optimize the project in such a way that it suits both biodiversity and the applicant as much as possible, and it is possible to support it from OPE. Subsequently, the detailed project documentation is processed. If, even at the time of processing the project documentation, a consultation is needed, NCA CR staff are also willing to help. Projects prepared in this way are in the vast majority suitable for submitting a subsidy application, and the applicant knows directly how much subsidy support they can expect.

As part of the administration of received applications for OPE support, non-consulted projects focused on the reconstruction of small water reservoirs were often excluded. The planners, who had no idea that the plan would be submitted to OPE, could not take into account some of the specifics of this subsidy title. Very often, suitable bank slopes were not designed, the littoral zone was not taken into account (shallow water to a depth of about 0.5 m), technical objects were often significantly oversized, and all banks were often paved with stones, even in places where such a measure was absolutely pointless. As a result, the small water reservoir itself looked more like a paved "washtub" than a natural-looking pond. In addition, paving and redundant technical objects also disproportionately increase the costs of such a project, and when comparing the project with the CUM MoE, it became clear that the given type of measure is disproportionately expensive.

Similar problems also occurred with terrestrial projects. This mainly concerned landscaping in municipalities, mostly parks. Many projects related to park improvements are based more on cutting down trees and adding furniture and playground features. OPE takes a very critical view of the felling of existing trees. If there is no serious reason for it, which is thoroughly justified, felling is not possible. Projects based primarily on cutting down existing greenery and establishing a completely new park did not meet the project acceptability criteria and were excluded from the evaluation process. Another frequent shortcoming was the lack of opinions necessary for implementation from various authorities. As part of the greenery restoration, there was often a lack of a decision and permit for felling with the acquisition of legal force. Therefore, if the applicant did not forget to attach the decision authorizing felling to the application, there is no realistic possibility of obtaining this decision with the current deadline of five days for supplementing the application from the call by the evaluator.

In conclusion, we can say that the consulted projects, which are prepared specifically for the OPE subsidy title, are much more successful in obtaining subsidies than projects that were created without specific targeting on the subsidy source. There is a certain assumption that, as a result of the simplification of subsidy application submission, the subsidy title of OPE (especially within the SRM) could again attract smaller applicants.

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Planned restoration of aquatic ecosystems in Prague 4

Prague 4 district in accordance with the National Action Plan for Adaptation to Climate Change [1], Concept for Protection from the Effects of Drought of the Czech Republic [2], Strategy for Adaptation of the Capital City of Prague to Climate Change [3] and Methodology for Rainwater Management in the City [4, 5], similarly to other progressive-minded parts of Prague, is preparing investment actions to support and strengthen green-blue infrastructure in the city. One of the most visible measures with truly demonstrable effects on the support of biodiversity and water retention in the landscape is the restoration of aquatic ecosystems. In the case of the capital city of Prague and its most populous district of Prague 4, these are mainly the restoration of canalized (straightened or piped) streams, or desilting, strengthening or comprehensive restoration of ponds and small water reservoirs in a highly urbanized landscape. A specific area is newly emerging bodies of water in places where water naturally tends to be retained after longer periods of rainfall and the area thus cannot be used for any other purpose, or even in places where there was no body of water before (although here in the narrower sense of the word it is not restoration). For such areas created by human intervention in order to strengthen the diversity of aquatic and wetland vegetation, the name artificial aquatic biotope has been adopted. Let us have a look at the differences and specific pitfalls of individual restoration using three specific examples.

CONSTRUCTION OF THE BRANÍK AQUATIC BIOTOPE

The idea of an aquatic biotope in Za Mlýnem street in Prague's Braník district arose from the initiative of the councillor for the environment of Prague 4 district, based on an example of good practice from Prague's Lysolaje district, where a similar cold-water biotope was put into operation in 2017 (*Fig. 1*). It was created by rebuilding the already non-functioning fire reservoir on the Lysolajský stream under the so-called "Miraculous spring" (Zázračná studánka) under Housle natural monument, which with a yield of 3.5 l/s is one of the strongest springs in Prague. In contrast to the Lysolaje natural source of water for the biotope, only two solutions were possible in the anthropogenically raised floodplain of the artificially deepened Kunratický stream (*Fig. 2*): supply the future biotope with a channel/pipeline directly from the stream, or its own water source (well). Due to the highly variable water quality of Kunratický stream, which is affected by overflows from storm water overflow higher up in the basin, it was decided to build an 8 m deep well and to pump groundwater from the floodplain under the Braník structural slope.

The biotope on the artificially lowered terrace will have a free water area of 240 m^2 with an average depth of 145 cm, and the maximum depth of 180 cm (*Fig. 3*). The lake basin will be divided into a deep-water and a littoral zone for planting aquatic and wetland vegetation (*Fig. 4*). The estimated groundwater abstraction will be 0.3 l/s, with the possibility of its strengthening and regulation with regard to the seasons and maintaining the positive water balance of the biotope. The overflow will be handled via a classic monk sluice with a short, shallow bed with stone steps opening into Kunratický stream. The inflow of water from the well to the biotope is planned on the surface through a system of flat stones in order to ensure the sound effect of running water. Considering the size and depth of the biotope, a year-round low water temperature of up to 16 °C can be expected.

The biotope should gradually become a refuge for psychrophilic species (amphibians, invertebrates), and the natural biocorridor of Kunratický stream should function as a source of these organisms. The aquatic biotope will not be intended for swimming; in addition to its ecological function it will serveas part of the mini educational trail and for educational purposes in the topic of adaptation measures of the capital city of Prague. The immediate surroundings, including the park furniture, will be appropriately landscaped so that the biotope becomes a natural part of Za Mlýnem park.

The total cost of building the biotope, including subsequent vegetation adjustments, will reach around 8 million CZK; running costs (regular cleaning, pump drive, fees for groundwater abstraction) will be paid from the operating budget of the Prague 4 Municipal Council. Completion of the biotope is planned for May of this year. More information about the project can be found on the PinCity website [6].

Fig. 1. Aquatic biotope in Prague's Lysolaje

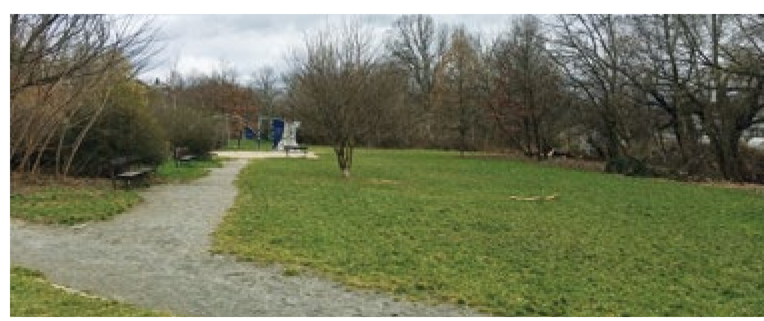

Fig. 2. Site for Braník aquatic biotope in Za Mlýnem park (view to the east)

Fig. 3. Visualization of Braník aquatic biotope (view from the same place as in *Fig. 2*)

Fig. 4. Status of earthworks as of 1. March 2023 (view to the east, in the foreground is the future lake basin with an already established monk sluice)

Fig. 5. Anthropogenically straightened lower part of Kunratický stream in Braník

RESTORATION OF KUNRATICKÝ STREAM

Kunratický stream is a right-hand tributary of the Vltava, flowing through Braník in its lower reaches and creating a valley through which the southern link (Jižní spojka) from Barrandovský bridge leads to north-south motorway (Severojižní magistrála). In its entire lower section, from Kunratický forest to the confluence with the Vltava, Kunratický stream is heavily improved and channelized. The water draining into the straightened narrow, partlially concrete channel does not interact with the groundwater level for most of the year (*Fig. 5*), which causes very small flows in the dry season. In 2017, the Department of Environmental Protection of the City of Prague decided to restore part of the lower section (approx. 650 m) of Kunratický stream gradually in several stages, taking into account its length. The first of the three parts above Vrbova street was supposed to be implemented in 2021; however, in view of the re-opening of the construction procedure due to the concurrent Braník biotope project, implementation with an expected investment of 25–30 million CZK was postponed until 2024 at the earliest. In the meantime, at least part of the so-called zero phase took place below Vrbova street, consisting of a change in the material and structure of the banks and bottom of the riverbed (*Fig. 6*), which significantly increased diversification of the riverbed, reduced of water flow velocity and increased the clarifying (self-cleaning) ability of the stream. This year, the second part of the zero phase of restoration of the stream should take place in a similar way, up to its piping below Modřanská street.

As part of the above-mentioned first phase, on the other hand, overall restoration of the stream will be started, including the anthropogenically raised river floodplain of the right bank (*Fig. 7*), which will be artificially lowered, widened and slope conditions adjusted in such a way as to allow not only future public access to the water, but also creating a floodplain (*Fig. 8*). Contact with the groundwater level will become possible in the channel made from loose granite blocks, the roughness will be increased, and water outflow velocity will be reduced; together with a smaller artificial pool, this will create a suitable refuge for new species of aquatic fauna, for which the existing channel with fast water outflow is unsuitable (*Fig. 5*). Due to the limited space given by the complex ownership structure of the land on the banks of the stream, more generous meandering of the riverbed will not be possible, only slight undulation. The newly created floodplain and riverbed will be supplemented with dead wood from trees growing today high above the stream bed. As part of the third phase, a short section of riverbed and floodplain between the existing riverbed and the emerging Braník biotope will be restored in a similar way, so that both structures interact and a synergistic effect is achieved [7].

Fig. 6. Restored part of Kunratický stream below Vrbova street

Fig. 7. Anthropogenically raised floodplain in Za Mlýnem park with an artificially incised Kunratický stream bed intended for restoration (view to the west)

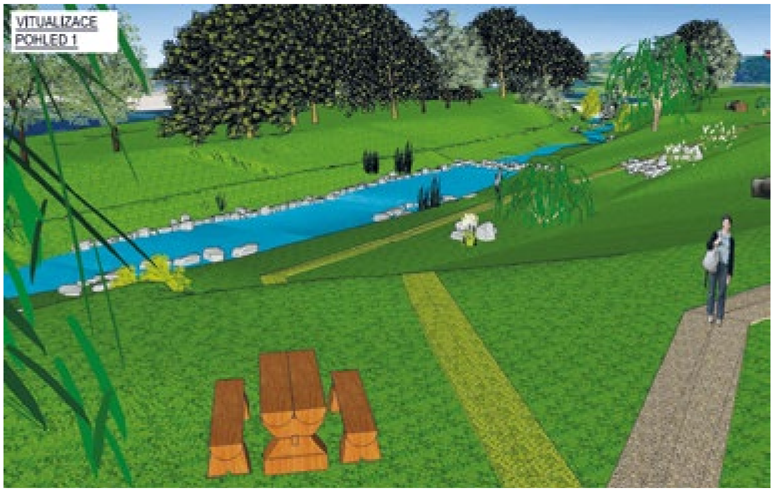

Fig. 8. Visualization of the restored part of the stream and the river floodplain (1st phase, view from the same place as in *Fig. 7*)

RESTORATION OF THE WATER BODY IN JEZERKA PARK

The vision of the restoration of Jezerka Park in Nusle was presented in a landscape study [8], which emerged from a competition of three architectural proposals, developed on the basis of extensive participation with the public. Due to the size of the park, restoration will take place in several stages; the first stage will involve the restoration of the dried water body ("lake") and its immediate surroundings, including the restoration of the small watercourse above it, flowing from the drainage below the Na Jezerce theatre (*Fig. 9*).

The main reason for the pond being non-functional for several years is the total loss of the yield of the source of water due to the progressive climate change and the broken stream bed, through which the remnants of the inflowing water seep into the ground (*Fig. 10*). In the summer months, the inflow of water into the reservoir usually stops completely. That is why Prague 4 Municipal Council is working on a proposal to collect rainwater from the roofs of the Na Jezerce theatre buildings and to supply the lake (water reservoir) with water through an underground storage tank with an infiltration gallery throughout the year. It is cheaper, and above all, more ecological than the water supply from a borehole or the theatre water supply line that was considered in the original project design. The total area of the theatre roofs is sufficient enough in terms of rainwater runoff so that it covers the annual balance of the water reservoir; therefore, it should have a year-round flow, which will have a fundamental positive effect on the water quality in the reservoir. That is why a camera survey of the drainage and sewerage network around the theatre took place last year, which will have to be restored as part of the project due to its damage and clogging. At present, most of the rainwater from the theatre roofs is drained to the sewer without any further use.

The restoration itself will consist of restoration of the lake basin (the bottom and walls of the reservoir) in the current or only slightly modified layout and, above all, in its deepening in order to improve water quality in the lake (currently, the maximum depth would be only about 1 metre). The banks will be restored, including the possibility to sit on the slopes, but overall the location should appear peaceful, not recreational. The sound effect of burbling water using a system of small artificial dams and the construction of a bridge over the restored small watercourse above the reservoir should also contribute to this sensation (*Fig. 11* and *12*). At the same time, healthy mature and preserved trees in the vicinity should be preserved, and the area should be sensitively complemented with other wetland and park vegetation with appropriate furniture.

At the moment, the city district has requested a water management assessment for the preparation of project documentation, which will be the subject of a competition in the spring of 2023, and then a joint zoning and construction procedure will be initiated. The Municipal Council of Prague 4 subsequently assumes the inclusion of the investment in the action plan for 2024, so earthworks could start the following year in autumn. Comprehensive restoration should lead to the restoration of the former glory of the lake, which is the centre of the historical park and whose sensitive restoration is also an absolute priority according to the opinion of the citizens in the polls.

Fig. 9. Today's situation of the outlet of the groundwater drainage as an occasional inflow into the water reservoir (downstream view)

Fig. 10. Dried and long-term defunct reservoir in Jezerka Park

Fig. 11 Visualization of the restoration of the inflow into the reservoir with a bridge and wetland vegetation (view from the same place as in *Fig. 9*)

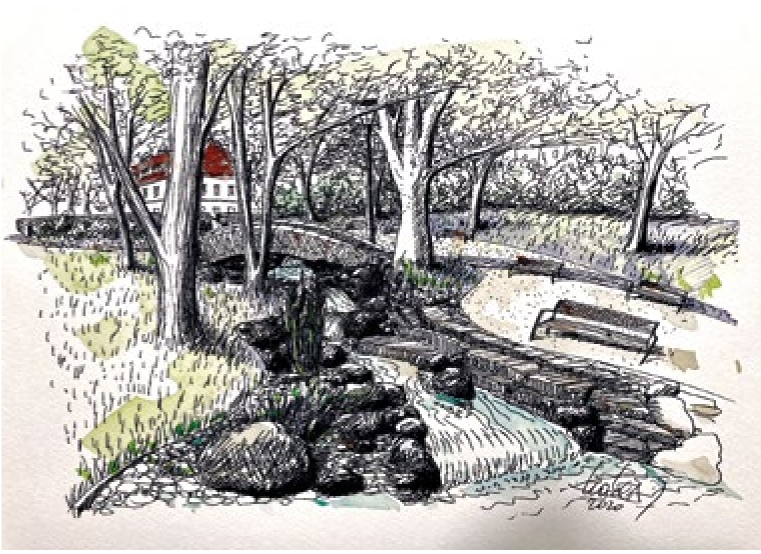

Fig. 12 Visualization of the cascading concept of the inlet to the restored reservoir with the sound effect of falling water

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Dewatering sewage sludge using sludge drying beds with wetland vegetation, the so-called Sludge Treatment Reed Bed units

At present, the problem of waste disposal is growing worldwide; its secondary use is therefore more than desirable. A pressing problem for many small municipalities that need to build or reconstruct a wastewater treatment plant (WWTP) is solving the issue of processing the resulting sludge and its stabilization, sanitation, and further application. It is not unusual for small municipal WWTPs to lack a complete *in-situ* sludge management (including dewatering etc.). Sewage sludge is thus often pumped out at high cost and transported to a large WWTP. The main goal for the real application of sewage sludge is to prevent future damage to soils, plants, and the health of animals and people. For this reason, taking into account the substances currently present in the sludge (e.g., organic micropollutants), it is advisable to sufficiently pretreat the sludge, not just sanitize it to eliminate above-limit microbial pollution.

Since 1 January 2021, the possibility of direct application of sludge is newly established under the Waste Act No. 541/2020 Coll., and Decree No. 445/2022 Coll., which amends Decree No. 273/2021 Coll., on the details of waste management, as amended by Decree No. 78/2022 Coll., and other related Decrees in the field of waste management. This Decree is valid from 1 January 2023.

Conversely, the correct use of sludge can be very useful for the soil because treated sludge is a rich source of organic matter, basic nutrients (nitrogen, phosphorus, potassium, calcium, etc.), and trace elements.

The Sludge Treatment Reed Bed (STRB) technology of so-called "Reed Bed" (RB) units is intended for the passive dewatering of sewage sludge, taking into account the economic point of view directly at the place of their origin. The principle of the technology is the gradual dosing of raw sewage sludge originating from activation tanks of mechanical-biological WWTP, or from objects of mechanical pre-treatment of water (sand traps, septic tanks, settling tanks of various types), so-called constructed wetland, and its gradual dewatering based on filtration through the drainage layer and evapotranspiration with the help of planted wetland plants. Sludge is dosed in certain periods and, in the period between dosing, both the humidity of the sludge is reduced and it is gradually stabilized. After filling the sludge field to the operational maximum, the system is shut down and the phase of mineralization of the matrix and reduction of the sludge volume occurs, so that "fresh" sludge can be dosed again. In this way, the maximum operating capacity of the sludge field is gradually reached after several years, and it must be shut down. The final stage is stabilization and, as has been proven to a certain extent, sanitation of the mixture of sludge and decomposable biomass of wetland plants, after which the mixture can be extracted for use. The time required for the entire filling cycle is several years but, based on experience, a maximum of ten, depending on the projected volume. The resulting material resembles compost.

As part of research supported by TA CR, this technology was tested in semi-operation both for mechanical-biological (activation) WWTP up to 1,000 p.e. and for the so-called constructed wetland of the same size category. Research has shown that the use of technology based on extensive dewatering of sludge and its stabilization in sludge fields with suitable wetland vegetation, possibly with the use of protection against dilution of the dried mixture by precipitation (greenhouse, canopy), can represent an alternative to other technologies, especially in combination with a constructed wetland. A condition is a sufficiently large area of land, which is often an example of small municipalities that use constructed wetland.

The following diagram (*Tab. 1*) shows a simplified SWOT analysis for the possible use of STRB unit technology in the Czech Republic. A detailed analysis of the possible use in a specific case will be tailored to local conditions as part of the decision-making analysis to solve the issue of sludge management in a given location.

The described sewage sludge dewatering technology can be the first stage of treatment which, by ensuring subsequent appropriate steps (e.g., standardization of substrates by the addition of other additives or processing into pellets) opens the way for the sensible use of sludge on arable land.

Tab. 1. Simplified SWOT analysis for the possible use of STRB unit technology in the Czech Republic

STRENGTHS	**THREATS**
Low energy requirements	Threat of clogging the biological process
Low operational demands	Odour in the event of a change in decomposition processes
Output material with suitable properties for use in agriculture	
Lower operating costs	
WEAKNESSES	**OPPORTUNITIES**
High surface area requirements	Suitable for decentralized areas
Low volume capacity of the device	Fewer technological elements = lower risk of breakdowns
Dependent on meteorological conditions	Possible follow-up to the production of agricultural crops

The following photos show examples of the use of STRB units for sludge dewatering:

Fig. 1. STRB unit with controlled pipe system for filling and ventilation, larger WWTP with SBR reactor, France

Fig. 2. STRB unit for village WWTP, size below 200 p.e., Austria

Fig. 3. An example of the construction of the basic structure of two STRB units to ensure the alternating operation of filling, dewatering, and stabilization of sludge from the settling tank of the constructed wetland, Czech Republic

More information can be found on the website of Dekonta [5]. The site also contains e-learning material that was processed as part of project TH02030532. It includes basic information about the research and presentations on the subject in PDF format, which are free to download and can serve as educational material for the professional public and operators of small municipal sewage sludge sources, as well as basic information about the certified methodology for the practical implementation and operation of RB unit systems.

Fig. 4. Structure of the dewatered and stabilized mixture of sludge and wetland vegetation after 7 years of operation of the STRB unit and after shutdown for one season to complete the process of stabilization and sanitation of the mixture

In case of further interest in practical use or implementation, do not hesitate to contact Ing. Petra Najmanová, Ph.D., Head of the R&D Department at Dekonta, a. s. (najmanova@dekonta.cz) or Mgr. Michal Šereš (michal.seres@gmail.com). If you are interested in the theoretical and research part of the issue, do contact the authors of the article.

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Historic floods on Rakovnický stream

This year, TGM WRI is planning to publish a book by Kašpárek, Elleder, Šírová, Dragoun, and Kašpárek Jr., dedicated to floods in the Rakovnický stream basin. It is primarily focused on the occurrence of floods before the start of instrumental observation, that is before 1898. Its purpose is to maximally expand knowledge about the frequency, seasonality, and most significant flood cases, their causes, extent, impact, and damage over the last 500 years.

In periods from which less data and descriptions have been preserved in the studied basin, the authors try to follow up on documented floods in another, lower part of the basin, or in another, geographically close basin.

The oldest mentions and documents of the occurrence of floods that have affected the area of the current Czech Republic usually come from the 15th and 16th centuries (with the exception of the capital city of Prague, where floods are documented since the 12th century), which also applies to flood events in the Rakovnický stream basin. The authors of the book divided the observed period into three time stages, mainly according to the preservation of sources, which was positively influenced by the period of Renaissance humanism in the 16th century, and negatively by protracted wars during the 17th century.

The first period covers the years 1496 to 1620, while the first traceable record of the flood situation in Rakovník and the surrounding area describes the demolition of the so-called "Jilhánek mill", whose location, however, is uncertain today. For example, the flood in the summer of 1531 is significant, which had extreme consequences and was somewhat similar in scope to the much better-known and later flood in 1872.

The subsequent dry period is also worth mentioning, especially the years 1536 and 1540, which was known throughout Central Europe as the driest year of the 16th century.

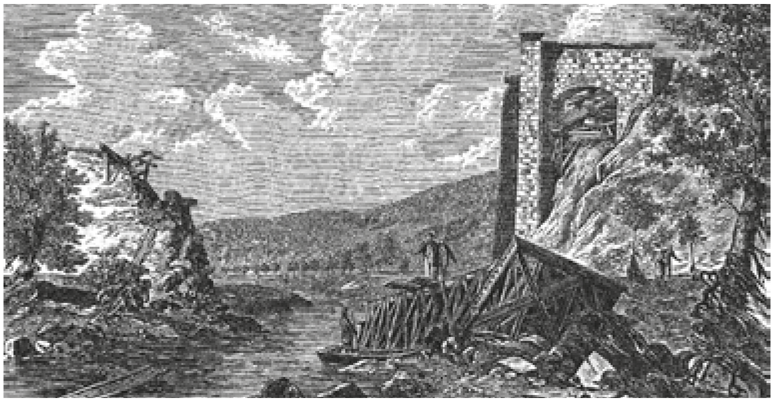
The preservation of reports and documents about the occurrence of floods in **the second period** (after the Battle of White Mountain in 1620), is strongly influenced by unfavourable political developments, especially the 30 Years War and the subsequent deep transformation of society. The adverse circumstances of this coldest period, the so-called "Little Ice Age", led to a decline in chronicling. In the available historical annals, there are only documents and references to significant regional floods in May 1651 and February 1655, but they are only very brief or indirect. It was not until the end of the 17th century that two catastrophic torrential floods are documented, occurring not long after each other. The first one occurred on 30 June 1694, and probably the worst flood in the history of Rakovník took place after midnight on 22 July 1698. As a result of the torrential rain, the Jesenice ponds burst and it caused severe damage to the town of Rakovník, including deep flooding of the square, as well as loss of life.

The third period – and best documented – is the 18th and 19th centuries. In the third chapter, an overview of archival sources on floods is supplemented by inundation in some nearby basins (Loděnice, Bakovský stream, Střela, and Javornice), which document the occurrence of more frequent flash floods, for example in 1743, 1744, 1752, 1762, 1763, 1783, and 1796. In the 19th century, more significant summer floods occurred in 1824, 1837, 1852, 1872, and 1882. The flood event of June 1824 is important, extremely affecting both the entire Berounka basin and Prague on the Vltava river. The well-known March flood of "European dimensions" from 1845 had severe effects on Rakovník as well; it shows from the context that it surpassed previous events in the 19th century. In addition to the May flash flood of 1852, the study looks in detail at the well-documented and exceptionally extreme event of 1872. It is one of the biggest Czech disasters that affected the Berounka basin below Pilsen, with huge flows on the Litavka, Střela, Rakovnický stream, and other tributaries of the Berounka. The flood was caused by torrential downpours of an exceptionally large area and intensity. From the point of view of Rakovnický stream, it is important that the area affected by the extreme rainfall reached from Jesenice district up to Senomaty. Since the study was created more than ten years ago, we will leave some details until the final text. The authors clarified or expanded some facts against the original manuscript. Some of the historical cases (1872) are already included in the Krolmus-MEF (Map of Extreme Floods) application [https://chmi.maps.arcgis.com/apps/MapSeries/index.html?appid=dc50b65b4483465cb98c50d4b55df75d], others will be added to it in the near future (1531, 1824, and 1845).

Documentary sources also reveal the interesting fact that the flood of May 1872 in Rakovník, despite its extraordinary and devastating nature, apparently did not reach as high a water level as that of the summer of 1698. This follows from the description of the flooding of the square, the height of which did not undergo significant changes. In 1698, the water level reached a height of about 150 cm in the square and a number of houses there were completely destroyed.

As far as damages are concerned, then telling proof of dynamic effects, or reached speeds and high-water level, there is damage or collapse of ponds. This is, on the one hand, a consequence, and on the other, an aggravating factor of the flood.

As for the number of victims, the figures for the two most significant floods from 1872 and 1698 are quite comparable. However, it is difficult to compare the material damage caused by these two floods; in 1698 it was estimated at 3,000 guldens in Senomaty, and in 1872 at 80,000 guldens. The authors documented and targeted markers in the lower part of the basin and attempted to estimate the peak flow of 25 May 1872.



The destroyed bridge of the Buštěhrad Railway, the flood of 1872

The seasonality of floods is also worth mentioning. Summer cases significantly predominate, with floods in May, June, and July. As for the cause, it was often short torrential rains, to a lesser extent also regional and more permanent. Significant winter floods are recorded only in 1595 and 1845, although we can assume that the absence of evidence of extreme floods is more indicative of the insufficiency of chroniclers' sources of that time.

The forthcoming book about Rakovnický stream basin will also contain many quotes from old chronicles as well as beautiful period pictures and photographs; the basin has changed significantly over time, especially with regard to the disappearance of ponds, the disappearance of coal mining, and changes in agriculture.

The materials for the book are based on the results of the project *"Possibilities of mitigating the current consequences of climate change by improving the storage capacity in the Rakovnický stream basin (pilot project)"*, financed under No. QH 91247 by the National Agricultural Research Agency (NAZV) of the Ministry of Agriculture of the Czech Republic in 2009–2011.

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WEISSHUHN MILL RACE IN ŽIMROVICE

This mill race is located in the valley of the Moravice river about 10 km southwest of Opava. It was built at the turn of the 1880s to 1890s by the prominent Silesian manufacturer Carl Weisshuhn (1837–1919) to drive machines, float wood, and supply technological water to his Žimrovice paper mill. The approximately 3.6 km long mill race winds along the left side of the Moravice valley and passes through three tunnels and over two aqueducts on its way to the factory. Two original Francis turbines, with an output of 950 kW, drive the paper mill premises. The mill race below the hydroelectric power station was later extended to the so-called Hradec weir, so its total length is 5.5 km. In its lower part, a timber sanding plant and another hydroelectric power station also once operated, but their operation ceased over time due to low profitability. The mill race, together with the weir, the hydroelectric power station and the paper mill represents one functional unit. Despite the high level of preservation, the authenticity of the material, and more than 130 years of continuous operation, Weisshuhn mill race is not listed.

Text by Mgr. Martin Caletka, Ph.D., and Ing. Miriam Dzuráková, photograph by Ing. Radka Račoch.

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