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

VTEI/2025/1

60 years ago in VTEI

B. A. Southgate published an article on wastewater in Great Britain in 1962 in the 6th issue of *Wastes Engineering* journal, page 288.

Of the 32,000 kilometres of streams for which information is available, according to an estimate from 1958, 73 % are unpolluted or recovering, 15 % are of questionable quality and in need of improvement, and 12 % are of poor quality or grossly polluted. Wastewater treatment methods used in the UK are conservative, as high cleaning efficiency is required (undissolved solids below 30 mg/l, BOD below 20 mg 0/l). Therefore, efforts are being made to improve final purification by disc filtration, microfiltration, etc. Highly loaded processes are expected where untreated wastewater is still discharged from river mouths into the sea or directly into the sea.

The discharge of all radioactive wastewater is under government control. There is a need for instruments to record water quality. Development in this direction has not yet progressed much. Instruments to record dissolved oxygen are already widely used.

Devices for recording the concentration of suspended solids are beginning to be widely used for research purposes. The London wastewater treatment plant in Mogden has a prototype device for automatic regulation of desliming the sedimentation tanks, based on the principle of electrical conductivity characterizing sludge density.

Generated by artificial intelligence (Midjourney), edited by Zoner Photo Studio

Storm drains are usually designed to operate when the flow exceeds six times the flow of "dry" sewage. They are a significant source of watercourse pollution. Wastewater treatment plants in large cities, especially the older ones, usually have biofilters. Biofilters are also used in smaller municipalities. Two-stage biological filtration is often used with alternating filter order to reduce the risk of biofilter clogging. Careful attention is paid to the distribution of the inflow to the biofilter.

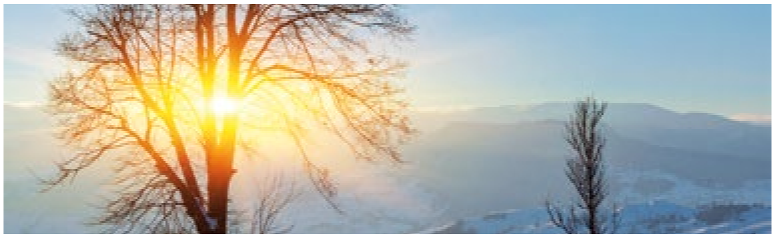
The weak point of biological treatment plants is the operation of secondary settling tanks. Therefore, efforts are being made to improve it or replace secondary settling tanks with other equipment. The following methods are used to process sewage sludge: vacuum filtration of filter presses, thermal drying, incineration, and composting with municipal waste.

It is recommended to pump the rotten sludge with mammoth pumps to avoid breaking the sludge particles and creating difficulties with its drainage. The problem of synthetic detergents is being solved by the development of biodegradable detergents.

From the TGM WRI archives

VTEI Editorial office

Content



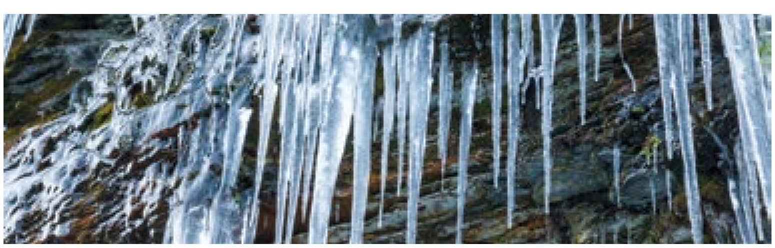



Photo: 123rf.com

Dear Readers,

In 2024, the VTEI journal closed its 66th season and this year it will celebrate 67 years of continuous existence. We must say that last year was very significant for our journal. We managed to defend its quality, which was confirmed in particular by the acceptance of VTEI into the Scopus and DOAJ databases. This, as well as the fact that the journal is published in English, was reflected in the number of visitors to the website and the number of citations of individual articles. Thanks to inclusion in both databases, the VTEI journal has significantly expanded its scope and has become a unique periodical in the Czech Republic and Slovakia in the field of water management, offering researchers the opportunity to present the results of their work to a wide Czech and foreign professional audience. This year, the journal development will definitely continue. As publishers, we have set ourselves the goal of succeeding in the evaluation process that will condition the journal's acceptance into the Web of Science database, and thus once again expand the importance of VTEI and its attractiveness in the field of scientific journals. We would also like to focus on increasing the number of expert articles, especially from foreign authors.

Let us now introduce the content of this issue. The expert article by Věra Očenášková, Danica Pospíchalová, and Eva Bohadlová from TGM WRI entitled "Selected licit and illicit drugs in surface water in sampling profiles near wastewater treatment plant outlets" focuses on municipal wastewater monitoring, providing interesting information about the population. Over 80 percent of the Czech Republic's population is connected to nearly 3,000 wastewater treatment plants, making the Czech Republic one of the most advanced countries in the EU in terms of water management. Since treatment plants do not remove all contaminants discharged into the recipient, the study monitored the load on the recipient with selected legal and illegal drugs.

The second expert article by Pavel Richter (TGM WRI) is entitled "Flash flood in Brdy PLA in June 2024"; it documents the course of last year's flash flood in June in Brdy PLA, including reflections on its causes, which include, for example, the expansion of development into areas of the original mosaic of dry and wet meadows and small fields, as well as the straightening and piping of watercourses. The article also deals with options for significantly reducing the adverse consequences of this type of flood in the future.

The third expert article of the February VTEI is by Libor Ansorge (TGM WRI) and Anna Ansorgeová (Faculty of Science, UJEP): "Geographic data citations: case study of DIBAVOD – systematic review", which is based on evaluating the success of the open data policy. Citing datasets is a relatively new issue and still faces a number of methodological and technical challenges, including limited awareness among the scientific community about the positives of this type of citation. Government and scientific institutions invest considerable resources in the creation, management, and access to datasets. Monitoring the ways and frequency of citations of datasets within the research community allows, among other things, verification of the usefulness of these financial means.

The article "Jewels of our flowing waters and their protection" by Jana Hronková (NCA CR), Kateřina Římalová (NCA CR), and Jitka Svobodová (TGM WRI) did not go through the standard peer review process; however, due to its nature and topicality, we have included it in the VTEI expert section. Using the examples of freshwater pearl mussel and stone crayfish, it addresses the issue of plant and animal species that are threatened with extinction in the Czech Republic. This threat is the result not only of climate change, but also of countless anthropogenic influences that directly affect the degradation of freshwater ecosystems.

As usual, the February issue also includes an interview. The editorial team interviewed an expert in water management and a long-time employee of the Moravy Basin State Enterprise, Dr. Ing. Antonín Tůma. The interview focused not only on Antonín Tůma's professional beginnings and his professional growth, but also on his experience with managing floods, especially those that affected our country in the autumn of last year.

Jiří Kučera's article "The *Water Centre* project is in its second half and presents its results" returns to the successful 4th conference *Water Management in the Czech Republic in the Conditions of Climate Change (Water Centre)*, which focused on defining future needs and issues of water management and water protection – including the impact of climate change – as well as possible measures to cover these needs and minimize problems.

The last article to the February VTEI is "*Czech Copernicus User Forum and Remote Sensing Conference 2024* and the opening of *Czech Space Week 2024* with participation of the President of the Czech Republic", by Jan Unucka and his colleagues from the Czech Meteorological Institute in Ostrava; it tell us about both the ceremonial opening of the largest festival of space activities in the Czech Republic as well as the conference focused on remote sensing, which has recently been increasingly associated with environmental issues.

Dear readers, even though you are reading these lines in February, we wish you a successful year 2025.

VTEI Editorial Office

Selected licit and illicit drugs in surface water in sampling profiles near wastewater treatment plant outlets

VĚRA OČENÁŠKOVÁ, DANICA POSPÍCHALOVÁ, EVA BOHADLOVÁ

Keywords: surface water — illicit substances — THC — methamphetamine — amphetamine — MDMA — cocaine — nicotine — cotinine — *trans*-3-hydroxycotinine

ABSTRACT

The majority of the population (85 %) in the Czech Republic is connected to the public sewerage network of almost 3,000 wastewater treatment plants (WWTPs). Municipal wastewater contains a number of substances providing information on the state of the population. This information is evaluated by Wastewater-Based Epidemiology (WBE). A WWTP does not remove all contaminants that are discharged into the recipient. In this study the loading of a recipient with selected licit and illicit drugs was monitored. Concentrations of the following drugs were monitored: tetrahydrocannabinol (THC), methamphetamine, ecstasy (MDMA), cocaine, and selected metabolites. i.e. amphetamine and benzoylecgonine, methadone and EDDP and nicotine, including its metabolite cotinine and *trans*-3-hydroxycotinine. The monitored locations were Vltava – Trojská lávka (control profile), Vltava – Podbaba, Drahanský brook, Podmoráňský brook, and Únětický brook. All samples were positive; therefore, it depends on the ability to remove the monitored substances in the given WWTP. In the recipient, the treated waters are diluted, yet the residues of the monitored substances have an impact on the environment. Therefore, it is desirable to continue monitoring these substances in surface waters.

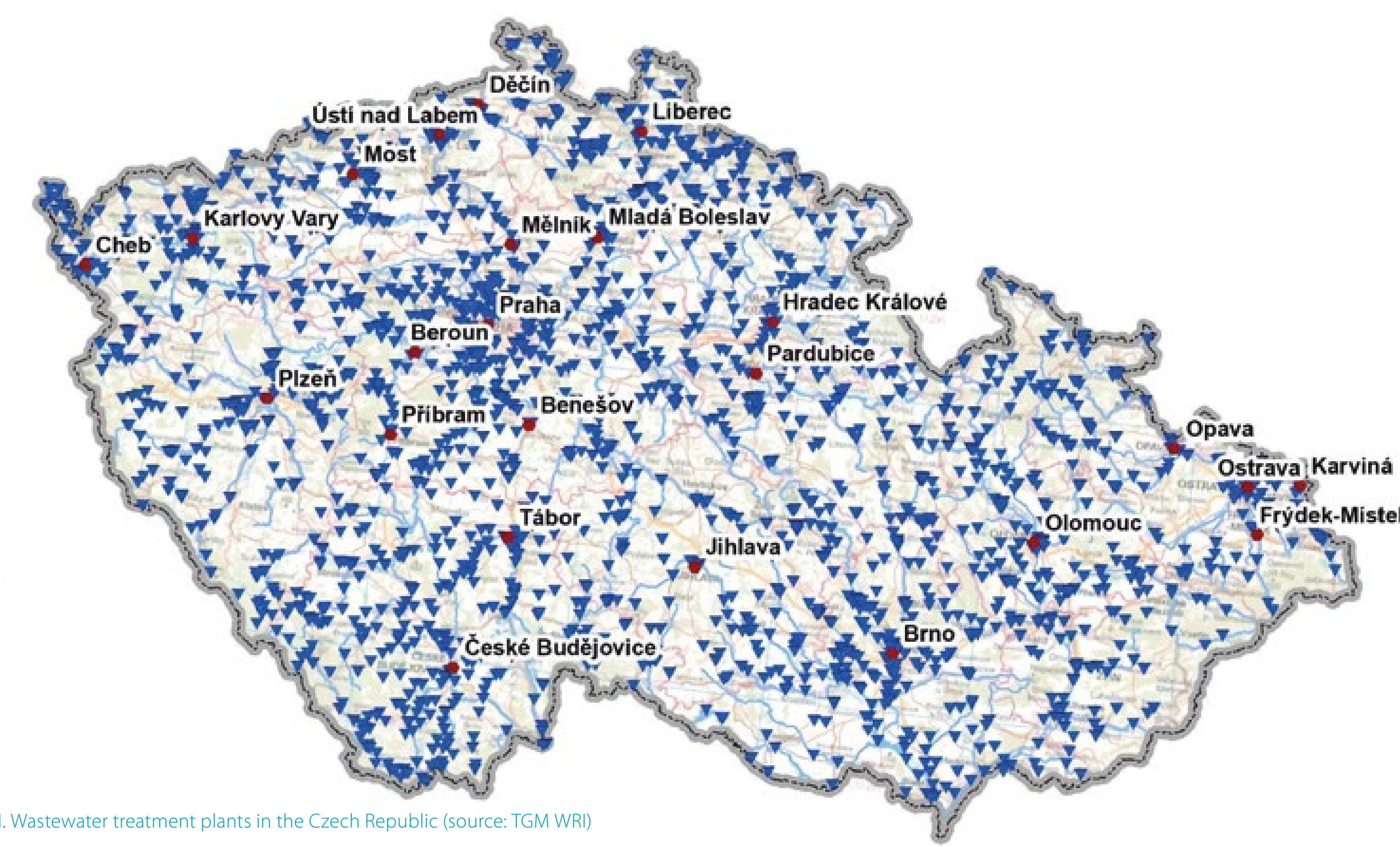


Fig. 1. Wastewater treatment plants in the Czech Republic (source: TGM WRI)

INTRODUCTION

85 % of the population in the Czech Republic is connected to almost 3,000 wastewater treatment plants (WWTPs; *Fig. 1*). These figures rank the country among the most advanced countries in the EU in terms of water management, as even many original EU member states do not reach these figures [1]. Municipal wastewater contains a number of substances that, when analysed, provide very significant information about the state of the population. This is being exploited by the recently rapidly developing multidisciplinary scientific discipline of Wastewater-Based Epidemiology (WBE). The hypothesis that wastewater could be treated as a very diluted urine sample led to the emergence of this field [2, 3]. This approach was first applied in the Po River basin to detect cocaine consumption [4]. The WWTP does not remove all contaminants contained in municipal wastewater; with the treated wastewater, residues of illegal substances – drugs – enter surface waters as well.

Monitored streams and characteristics of the relevant WWTPS

For this article, we selected several profiles on smaller streams that flow into the Vltava in Prague and below Prague and which are affected by WWTP outlets into these streams. A sampling point above Prague Central Wastewater Treatment Plant (CWWTP) was chosen as the control profile; the sampling was carried out from Trojská lávka (*Fig. 2*). Another sampling point was below both outlets from Prague CWWTP in Podbaba (*Fig. 3*).

Fig. 2. Vltava control profile – Trojská lávka (source: Mapy.cz)

Treated wastewater from Dolní Chabry WWTP is discharged into Drahanský brook, a right-hand tributary of the Vltava. The sampling point was approximately 1 km from its mouth into the Vltava. Drahanský brook (*Fig. 4*) is 3.3 km long, and its catchment area is 6.7 km^2. The average flow rate is 7.7 m^3/s. The long-term average flow rate Qa at the outlet of Dolní Chabry WWTP (at river km 3) is 83 l/s. Q355 (the average daily flow rate reached or exceeded during 355 days of the year) is 12.0 l/s. The average amount of treated wastewater discharged into the recipient is 10.6 l/s. In the immediate vicinity of Chabry there are several protected areas, such as Drahanské údolí, in the lower part also called Drahanská rokle. The data are taken from the *Sewerage Rules of the WWTP-Dolní Chabry* [5].

Fig. 3. Output from the Prague CWWTP to the Vltava (source: ŠJů / Wikimedia Commons. This file is licensed under the Creative Commons Attribution-Share Alike 4.0 International license)

Fig. 4. Drahanský brook (source: ŠJů / Wikimedia Commons. This file is licensed under the Creative Commons Attribution-Share Alike 4.0 International license)

Fig. 5. Podmoráňský brook (photo: Horakvlado / Wikimedia Commons. This file is licensed under the Creative Commons Attribution-Share Alike 4.0 International license)

The left-hand tributary of the Vltava, the Podmoráňský brook (*Fig. 5*), is affected by treated wastewater from Velké Přílepy WWTP discharged into the recipient at river km 2.8; the sampling profile was before the stream's influx into the Vltava. The length of the stream is 4.1 km, and the average flow rate is 24 l/s. The catchment area is 9.6 km^2. The average amount of wastewater discharged is 11.8 l/s. The data are taken from the *Sewerage Rules of the Velké Přílepy WWTP* [6].

The next left-hand tributary, the Únětický brook (*Figs. 6* and *7*), receives treated wastewater from Horoměřice and Tuchoměřice WWTPs; in this case, too, the sampling profile was before the stream influx into the Vltava. The Únětický brook originates in Kněževes, flows through Tuchoměřice. Statenice. Černý Vůl, and Únětice, and then flows into Prague, where it forms its border. This part is home to Údolí Únětického potoka (Únětický Brook Valley) natural monument and Tiché údolí and Roztocký háj nature reserves. In Roztoky. Únětický brook flows into the Vltava. The stream is 4.1 km long; the catchment area is 19 km^2. The average flow rate is 100 l/s.

Fig. 6. Únětický brook in Tuchoměřice (source: Aktron / Wikimedia Commons. This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license)

Fig. 7. Únětický Brook Valley Nature Reserve (source: Meruzalka / Wikimedia Commons. This file is under Creative Commons license)

METHODOLOGY

The sampling points are marked in *Fig. 8* and described in *Tab. 1*; the characteristics of individual WWTPs on the monitored streams are given in *Tab. 2*. The data are taken from the publication by Zvěřinová Mlejnková et al., focused on microbial contamination of the Vltava below Prague [7].

Illicit substances and their metabolites are not routinely monitored in wastewater or surface waters and are not subject to relevant legislation. In surface waters, these substances can have an impact on the environment, as shown, for example, by studies on fish behaviour [8–11].

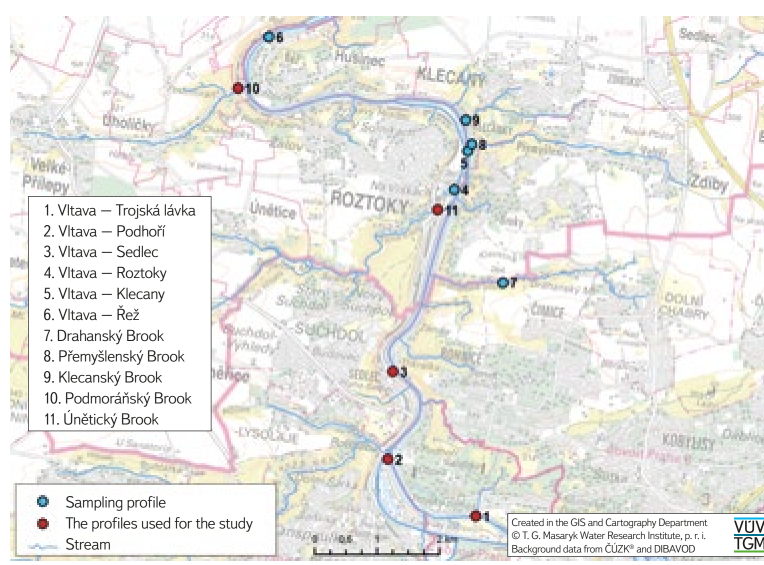


Fig. 8. Map with marked sampling profiles; the profiles used for this study are marked with a red dot (source: H. Zvěřinová Mlejnková [7])

Tab. 1. Sampling place description (source: H. Zvěřinová Mlejnková [7])

Profil No.	Name of sampling profile	Decription of sampling profile
1	Vltava – Trojská lávka	Controle profile above CWWTP Prague, sampling from Trojská lávka
2	Vltava – Podbaba	Sampling below both outlets from CWWTP Prague, from the left bank at the end of Císařský ostrov. Water below outlets is not sufficiently mixed
7	Drahanský brook	Right-hand tributary of the Vltava, outlet of the Prague – Čimice WWTP, sampling is carried out about 1 km before the mouth to the Vltava
10	Podmoráňský brook	Left-hand tributary of the Vltava, outlet of the Velké Přílepy WWTP, sampling is carried out before the mouth to the Vltava
11	Únětický brook	Left-hand tributary of the Vltava. outlets of Horoměřice and Tuchoměřice WWTPs, sampling is carried out from the road bridge about 150 m before the mouth to the Vltava

Tab. 2. Characteristics of WWTPs on monitored streams (source: H. Zvěřinová Mlejnková [7])

Name of WWTP	Category according to PE	Recipient	Number of persons connected to WWTP (2021)	Annual volume of treated water [thous. m^3/year]
CWWTP Prague OWL	More than 100,000	Vltava	491,633	44,989
CWWTP Prague NWL	More than 100,000	Vltava	706,012	64,601
WWTP Dolní Chabry	2 to 10,000	Drahanský brook	4,632	264
WWTP Velké Přílepy	2 to 10,000	Podmoráňský brook	2,935	190
WWTP Horoměřice	2 to 10,000	Únětický brook	3,450	274
WWTP Tuchoměřice	2 to 10,000	Únětický brook	1,816	149

The method for determining trace substances in water used for the analyses in this project was developed according to the procedure published by Postigo et al. [12]. This method has been used in the hydrochemical laboratory of TGM WRI for more than ten years, and new substances are gradually being included among the determined compounds depending on the current situation on the drug scene. Fully automated on-line SPE and LC-MS/MS methods of determination in ESI+ or ESI- mode are accredited for surface and wastewater. The laboratory annually participates in the international comparison of tests, which takes place within the framework of the global drug situation monitoring under the auspices of the SCORE-network (https://score-network.eu/).

The concentrations of a selected group of substances listed in *Tab. 3* were monitored in the samples.

Tab. 3. List of monitored substances

Group of substances	Name. abbreviation and limit of determination
"Classic" drugs	11-nor-9-carboxy-delta-9-THC (nor-THC); 0.2 ng/l
	3.4-methylene-dioxy-methamphetamine (MDMA); 0.1 ng/l
	Methamphetamine (MAMP); 0.1 ng/l
	Amphetamine (AMP); 0.3 ng/l
	Cocaine (CO); 0.04 ng/l
	Benzoylecgonine (BE); 0.06 ng/l
Substitution treatment	Methadone (MET); 0.2 ng/l
	EDDP (2-ethylidene-1,5-dimethyl-3,3-diphenylpyrrolidine); 0.3 ng/l
Nicotine and its metabolites	Cotinine (COT); 10 ng/l
	trans-3-hydroxycotinine (T3H-COT); 10 ng/l

Collection and pretreatment of surface water samples

Sampling was carried out by employees from the TGM WRI Department of Hydrobiology. In the same profiles, they monitored the effect of wastewater on microbial contamination of the Vltava [7]. For hydrochemical analyses, samples taken during 2022 and 2023 at approximately two-month intervals were used.

Samples were collected in polypropylene containers. After transport to the laboratory, these samples were further processed according to the relevant standard operating procedures. After collection, the samples were kept cool and dark at a temperature of up to 8 °C. If samples could not be analysed within 72 hours of collection, they were frozen and stored at -20 ± 4 °C. Before analysis, samples were centrifuged (4,500 rpm, 15 minutes) and solid particles were removed from the sample by filtration through disposable regenerated cellulose membrane filters with a porosity of 0.45 µm.

Based on the chemical properties of the substances, the following procedures were used for analysis:

- Determination of selected drugs by liquid chromatography with on-line preconcentration and mass detection in ESI+ mode (MDMA, MAMP, AMP, CO, BE, MET, EDDC).
- Determination of selected drugs by liquid chromatography with on-line preconcentration and mass detection in ESI– mode (nor-THC).
- Determination of nicotine and its selected metabolites by liquid chromatography with on-line preconcentration and mass detection in ESI+ mode (NIC, COT, T3H-COT).

Analytical procedures are described in detail in Pospíchalová et al. [13].

RESULTS AND DISCUSSION

When we analyse untreated wastewater, the findings of the drugs listed in *Tab. 2* are positive in all samples. In the case of surface water analysis, the situation is different. Ecstasy, benzoylecgonine, cotinine, and *trans*-3-hydroxycotinine were found in all samples analysed in this pilot study. Methadone and its metabolite EDDP were determined only in some sampling profiles. Amphetamine was found sporadically, mostly at the limit of detection. This is also consistent with our findings within the DRAGON project (No. VG20122015101), in which we had the opportunity to compare the concentration of selected drugs in the influent and effluent of some WWTPs [14]. Amphetamine was removed most successfully (85–100 %), methamphetamine, ecstasy and benzoylecgonine only 40–50 % (*Tab. 4*, *Fig. 9*). Other compounds were not monitored in the DRAGON project.

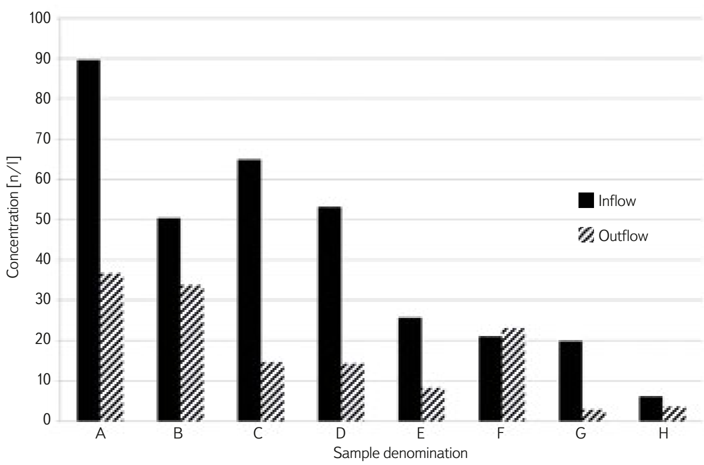


Fig. 9. Removal of benzoylecgonine. the main metabolite of cocaine. at different treatment plants [14]

Vltava — Trojská lávka control profile

In the Vltava – Trojská lávka control profile, all monitored substances occurred in very low concentrations, mostly close to the limit of detection. Concentrations of nor-THC, a metabolite of marijuana, ranged from the limit of detection of 0.2 ng/l to 2.8 ng/l, with 45 % of findings below the limit of detection. From the group of amphetamines, methamphetamine was determined in all samples; the concentrations ranged from 0.3 ng/l to 2.9 ng/l. The limit of detection for MAMP is 0.1 ng/l. AMP was below the limit of detection (0.3 ng/l) in all samples. From the perspective of the Czech drug scene, amphetamine is primarily a metabolite of MAMP, not a drug used on its own. At the same time, it is successfully removed in wastewater treatment plants (*Tab. 3*). The party drug ecstasy (MDMA) was detected at concentrations between the detection limit of 0.1 ng/l and 8.3 ng/l, with 50 % of the findings below 1.0 ng/l. The samples were taken on weekdays and MDMA is a typical weekend drug. The concentrations of this drug may have influenced by this. Cocaine and its main metabolite benzoylecgonine were detected in all analysed samples (*Fig. 10*), the determined amounts ranged between 0.8–2.03 ng/l (BE) and 0.22–0.59 ng/l (CO). Apart from the findings on 5 June 2023 and 24 October 2023, the ratio of concentrations of these compounds corresponds, as only 1–9 % of cocaine is excreted unchanged, while 35–53 % leaves the body as benzoylecgonine. The reasons for the unusual findings on the above-mentioned days cannot be explained. On 5 June 2023, the concentration of cocaine was 4.48 ng/l and benzoylecgonine was 4.69 ng/l, while on 24 October 2023 it was 1.82 ng/l and 1.71 ng/l, respectively. Methadone used for substitution treatment and its metabolite EDDP were also found in the control profile; methadone in only three samples at values close to the limit of detection (0.2 ng/l), its metabolite in all samples. Its concentration in water was very stable, between 0.4 and 0.6 ng/l. The concentration of the licit drug nicotine and its metabolites is always higher than that of illicit drugs, with both metabolites occurring in surface waters in particular.

Tab. 4. Examples of removal of illicit compounds at wastewater treatment plants [14]

Analyte	**Methamphetamine**			**Amphetamine**			**Ecstasy**		
Sample denom.	Inflow [ng/l]	Outflow [ng/l]	Residual content [%]	Inflow [ng/l]	Outflow [ng/l]	Residual content [%]	Inflow [ng/l]	Outflow [ng/l]	Residual content [%]
A	4,070	392	10	173	11.3	7	17	3.9	23
B	1,410	319	23	24.4	0	0	4.04	2.33	58
C	1,030	449	44	62.2	3.23	5	2.99	1.08	36
D	1,120	193	17	102	15.9	16	61.9	16.8	27
E	484	148	31	44.8	3.12	7	7.98	8.72	109
F	232	202	87	36	3.72	10	10.7	18.1	169
G	250	139	56	28.4	2.12	7	4.36	3.62	83
H	276	151	55	36.6	0	0	7.86	4.74	60

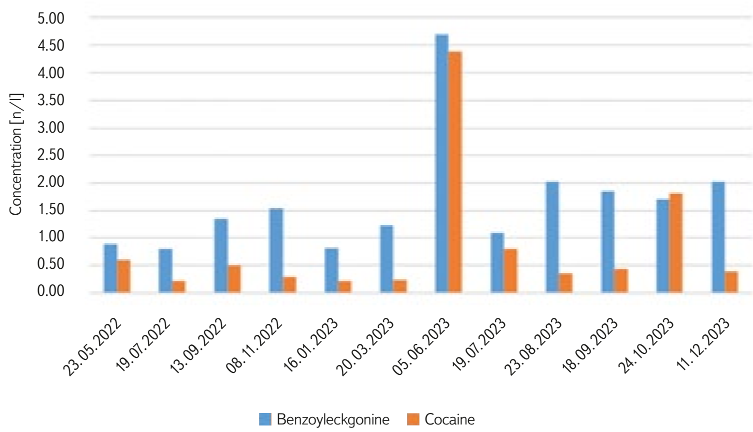


Fig. 10. Concentrations of cocaine and benzoylecgonine in the Vltava control profile Vltava – Trojská lávka

Vltava — Podbaba profile

The Vltava – Podbaba sampling profile, situated below both outputss of treated wastewater from the Prague WWTP into the recipient, shows significantly higher findings of individual monitored substances. Concentrations of the marijuana metabolite nor-THC are in the range of 0.7–4.4 ng/l, i.e. approximately 2× higher. Again, amphetamine was not present in detectable amounts, with concentrations slightly above the limit of detection in only two cases. Methamphetamine was detected in all samples, at concentrations ranging from 7.9 to 36.0 ng/l, i.e. at concentrations up to 10 times higher than in the control profile. Methamphetamine is removed significantly less than amphetamine in the treatment process (*Tab. 3*). Another of the monitored amphetamines, ecstasy, was also found in significantly higher concentrations in the Vltava – Podbaba profile; from 10.5 ng/l to 65.4 ng/l, i.e. up to 8 times higher concentrations. MDMA is removed approximately as successfully as pervitin (MAMP), i.e. 40–50 %. Cocaine and benzoylecgonine concentrations were also higher in this profile than in the control profile, with the exception of the sample from 5 June 2023, which ranged between 0.4 ng/l and 2.2 ng/l (CO) and 1.1 to 3.4 ng/l (BE). The concentration of cocaine on 5 June 2023 was 21.6 ng/l and benzoylecgonine 19.0 ng/l, again in an unusual ratio, approximately 4 times higher than in the control profile. A higher concentration of cocaine metabolite (BE) was also detected on 23 August 2023, at 19.3 ng/l, but the concentration of cocaine in this case was low (0.4 ng/l). Methadone and EDDP were determined in all samples; methadone between 1.4–5.4 ng/l and EDDP between 2.8–8.9 ng/l, again in concentrations several times higher. The concentration of these two substances is always relatively stable, which results mainly from the regular use of methadone as an opioid for substitution treatment. Nicotine metabolites were determined in all samples; cotinine at concentrations of 13–74 ng/l, and *trans*-3-hydroxycotinine at concentrations of 18–46 ng/l. In this profile, relatively high nicotine findings were also found in more than half of the samples. The highest concentration was determined in the sample taken on 25 March 2022, at 1,040 ng/l, which also corresponds to the highest values for COT and T3H-COT.

Fig. 11 compares the concentrations of cocaine metabolites in the Vltava – Trojská lávka control profile and in the profile below the wastewater outlet from Prague CWWTP.

Drahanský brook profile

WWTPs discharging treated wastewater (WW) into monitored streams are in the same category according to population equivalent (PE); see *Tab. 2*. The characteristics of individual streams are presented in the previous chapter. The average flow rate of Drahanský brook is the lowest of the monitored streams, but the number of people connected to Dolní Chabry WWTP is the highest of the monitored WWTPs (with the exception of Prague WWTP) and the annual volume of treated water discharged is also large. Therefore, the stream experiences the least dilution of this treated WW.

Positive THC metabolite findings were found in 75 % of the samples taken, with the concentrations ranging between the values at the detection limit, i.e. 0.2 ng/l and 4.2 ng/l. Illicit substances from the amphetamine group MDMA and MAMP were found in all analysed samples; again, amphetamine did not occur in values above the limit of detection. Ecstasy (MDMA) concentrations ranged from 0.3 to 17.4 ng/l, with 92 % of samples containing up to 9.4 ng/l. Pervitin was present in the tested samples at concentrations of 12.5 to 90.7 ng/l.; these values are higher than in the Vltava – Podbaba profile. Cocaine and benzoylecgonine were present in detectable amounts in all analysed samples, and their ratio was consistent. Cocaine concentrations ranged from 0.85 to 5.89 ng/l, while benzoylecgonine values ranged from 2.4 ng/l to 51.7 ng/l. These values are also higher than in the Vltava – Podbaba profile. Substitution treatment contributes to the Drahanský brook contamination in the case of methadone, with concentrations of 1.5–15.6 ng/l, and its metabolite EDDP, with 5.0–26.2 ng/l. The situation is the same as for the previous analytes; the values are higher than in the Vltava profile below Prague CWWTP. Nicotine metabolites were also present in all tested samples, with concentrations ranging between

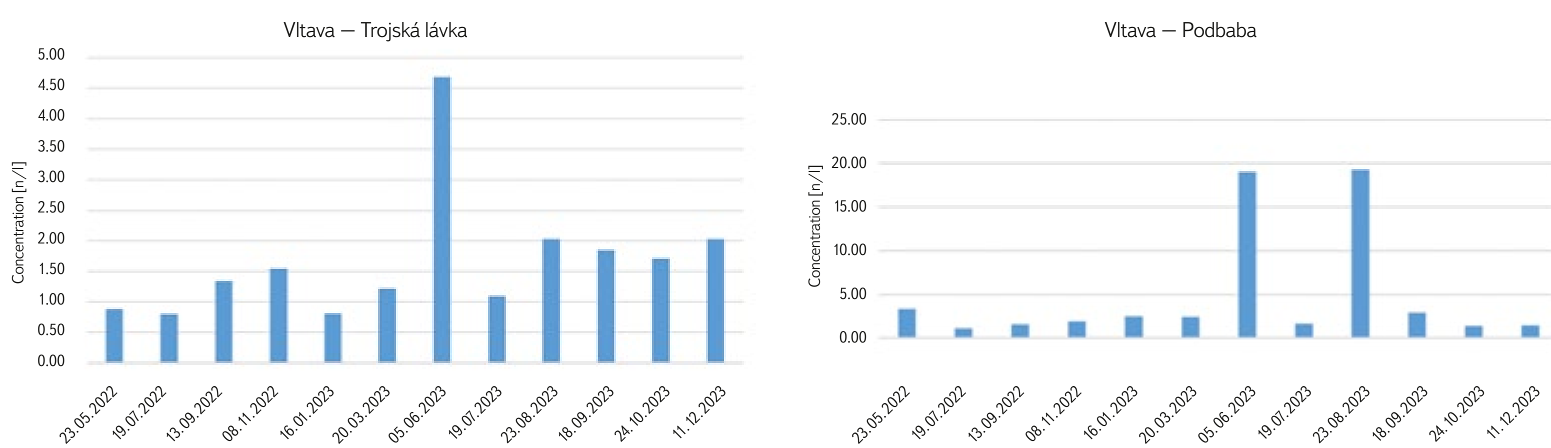


Fig. 11. Comparison of the concentration of the main metabolite of cocaine, benzoylecgonine, in the Vltava control profile above the Prague CWWTP Vltava – Trojská lávka and in the Vltava profile below the outlet of the treated wastewater from the Prague CWWTP into the Vltava river

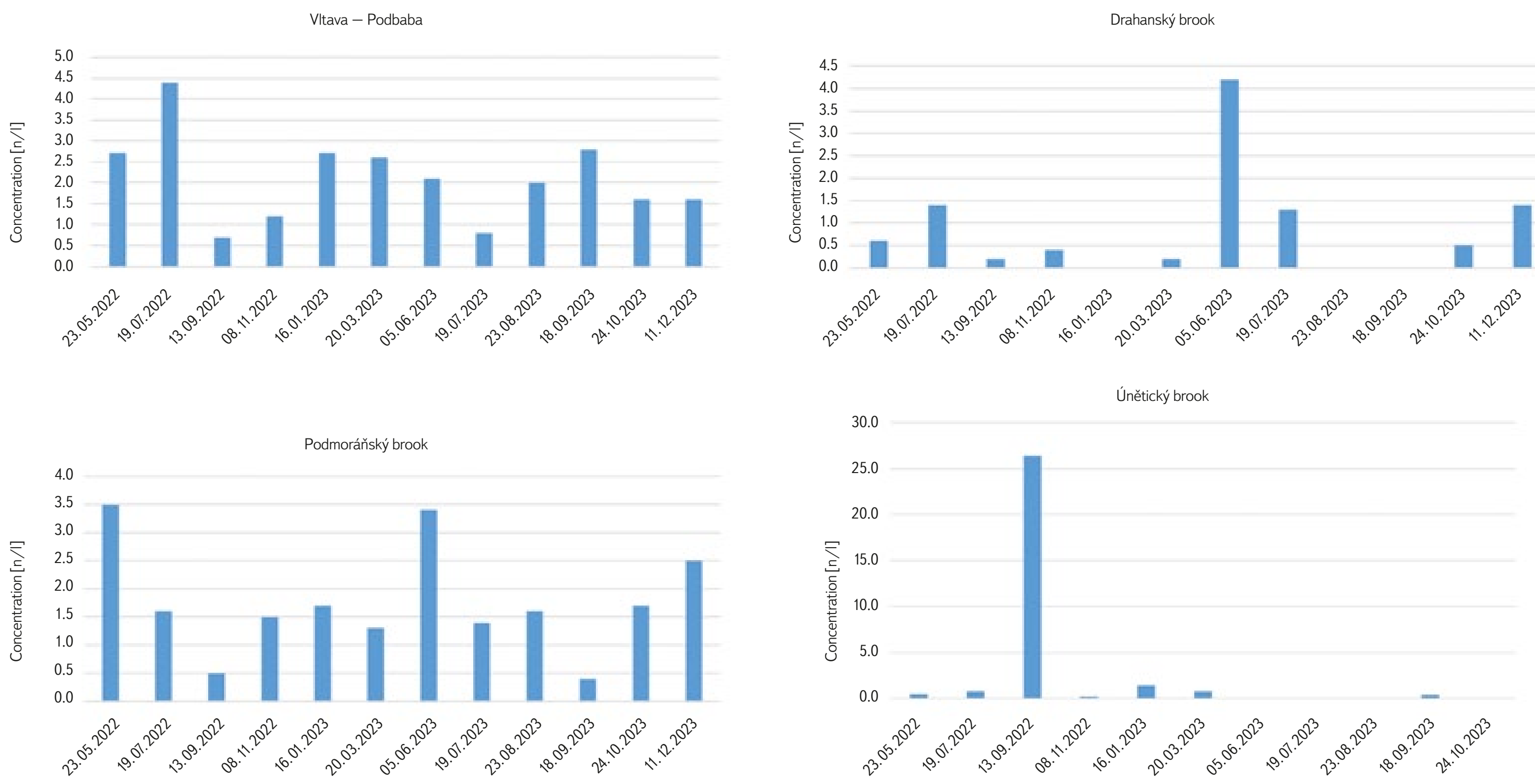


Fig. 12. Comparison of THC metabolite concentrations in monitored streams

15 and 53 ng/l for cotinine and 21–107 ng/l for *trans*-3-hydroxycotinine. Nicotine was detectable in 42 % of samples, with concentrations of 120 to 525 ng/l. In this case, the values were lower than in the recipient below Prague CWWTP.

Podmoráňský brook profile

The average flow of Podmoráňský brook is 24 l/s; the average amount of discharged wastewater is 11.8 l/s; the number of people connected to the treatment plant in Velké Přílepy is almost half lower than in the Drahanský brook. Therefore, the treated water in Podmoráňský brook is more diluted than in Drahanský brook. The metabolite nor-THC, which represents marijuana, was found in surface water samples at concentrations of 0.4–3.5 ng/l in all tested samples. The concentrations are similar to those in samples of Vltava water below Prague CWWTP. Ecstasy was also found in all samples, at values between 2.2 and 34.2 ng/l. Methamphetamine at concentrations of 18.5–168 ng/l was also detected in all samples, and its metabolite amphetamine was present in detectable amounts in two-thirds of the tested samples, at concentrations between 0.3 and 2.5 ng/l. Cocaine and benzoylecgonine were also present in 100 % of samples, with cocaine concentrations ranging from 0.06 to 11.1 ng/l, and the respective metabolite in concentrations of 0.54 to 17.0 ng/l. Methadone was detectable in only three samples, EDDP in all but one sample, ranging from the limit of detection to 1.0 ng/l. The findings of these substances representing substitution treatment are related to the numbers of people using this treatment in the monitored area. Substances representing the legal drug nicotine were present in all samples in the case of both metabolites, nicotine was determined in two thirds of the samples. Their concentrations ranged from 122 to 685 ng/l (NIC), 21 to 74 ng/l (COT) and 31 to 206 ng/l (T3H-COT). The Podmoráňský brook therefore burdens the Vltava less than the Drahanský brook.

Únětický brook profile

The Únětický brook has the largest water content of all the monitored tributaries of the Vltava; the average flow rate is 100 l/s. At 19 km², the catchment area is also the largest, and the length of the stream is similar or the same as that of the other tributaries – 4.1 km. The Únětický stream is fed by the outlets of two WWTP, Horoměřice and Tuchoměřice, which serve a total of 5,266 connected residents. The annual volume of discharged water is 423,000 m³/year. Due to the high flow rate, the greatest dilution of treated WW occurs in the recipient, 64 % of the samples contained the THC metabolite, nor-THC, above the limit of detection; the concentrations were below 1.0 ng/l, with the exception of the sample taken on 13 September 2022 with the concentration of 26.4 ng/l. Ecstasy was determined in all samples, at concentrations between 0.9–5.1 ng/l. In one analysed sample, from 18 September 2023, the MDMA concentration was higher – 15.4 ng/l. During this period, social events were taking place in the monitored location, which, given that ecstasy is a typical party drug, could have influenced the concentration found. Pervitin was in detectable amounts in all collected and analysed samples. Amphetamine was always below the limit of detection, while pervitin concentrations were in the range of 2.9 to 14.1 ng/l. Cocaine (CO) and benzoylecgonine (BE) were detected in all samples of surface water collected; measured values for CO ranged between 0.27–17.5 ng/l and 1.25–59.3 ng/l for BE. The findings of this drug are relatively high, which may again be related to the sociodemographic and socioeconomic characteristics of the monitored locations; for example, in Horoměřice, it can be assumed that the residents belong to an affluent population in which cocaine is popular. The opioid methadone, used for substitution treatment, and its metabolite EDDP were present in 100 % of the samples; their concentrations were relatively stable throughout the project, which is related to its method of application. For methadone, concentrations were between 0.6 and 1.3 ng/l, for EDDP between 2.2 and 5.1 ng/l. Nicotine was determined in 55 %

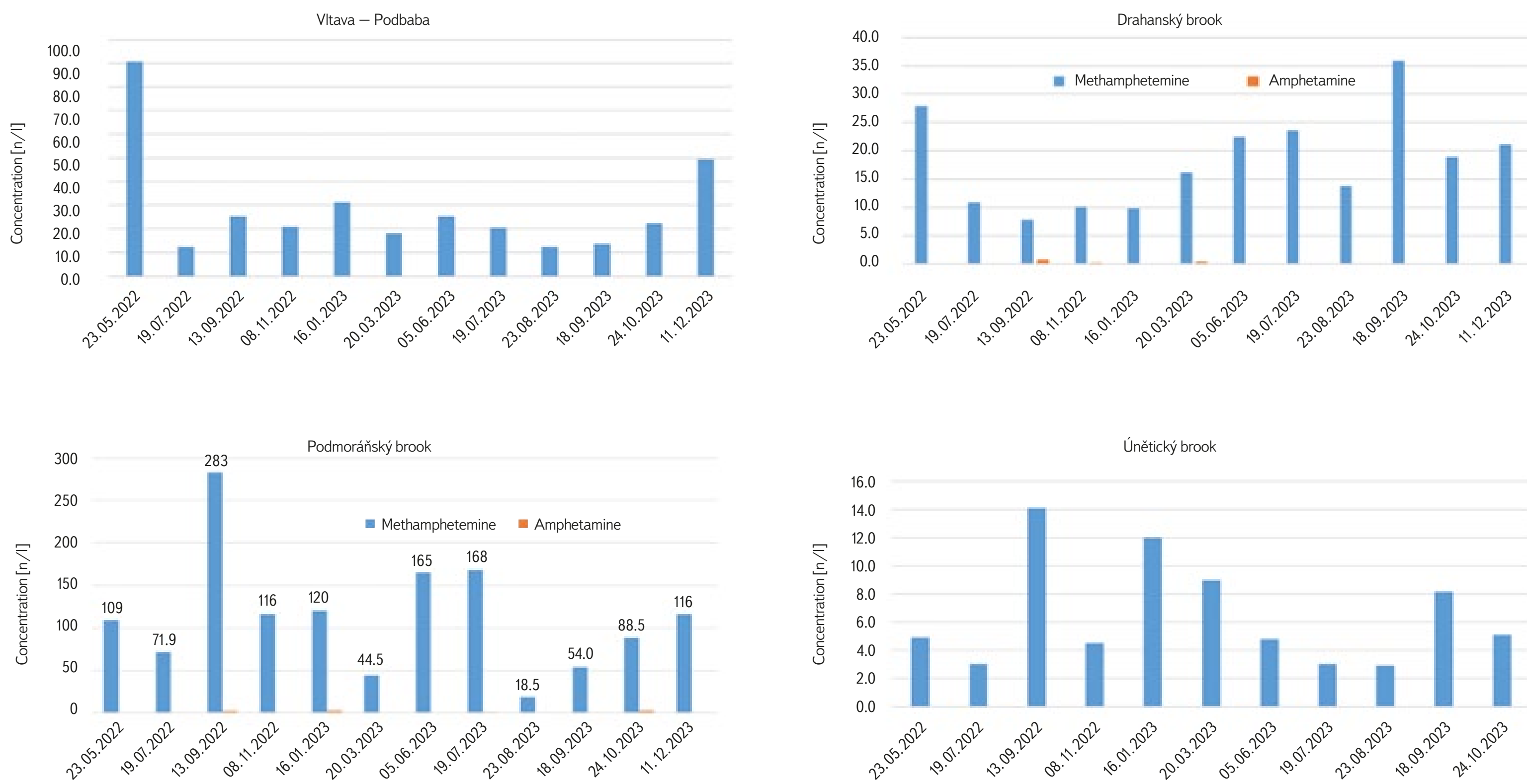


Fig. 13. Comparison of methamphetamine and amphetamine concentrations in monitored streams

of the analysed samples, with values ranging between 138–415 ng/l. All samples were positive for both cotinine and *trans*-3-hydroxycotinine, at concentrations of 13–142 ng/l and 15–277 ng/l, respectively.

At the end of this chapter, *Figs. 12* and *13* compare the concentrations of the most commonly used drugs in the Czech Republic, marijuana and methamphetamine, in the monitored streams.

CONCLUSION

The study is small in scope, however, it does confirm that even treated wastewater contains drug residues and their metabolites and is thus a source of both licit and illicit drugs entering into surface waters. Their quantity is influenced by the character and quality of the specific WWTP, the concentration of monitored substances in untreated urban wastewater and, last but not least, the ratio of the amount of discharged water to the size of the recipient. It also depends on the sociodemographic and socioeconomic characteristics of the monitored locations, which have an impact on the type of drugs used. Studies focusing, for example, on the influence of these substances on the behaviour of aquatic animals, have shown that these compounds have an undesirable effect on the environment as well.

We expect that this will change in the future thanks to the fundamental revision of Council Directive 91/271/EEC of 21 May 1991, on urban wastewater treatment, which introduces new principles for the treatment of urban wastewater, including quaternary treatment, which should remove micropollutants present in urban wastewater. These micropollutants undoubtedly include both illegal and legal drugs.

Acknowledgements

The article was written with the support of Institutional Funds for the Development of the Research Organization TGM WRI under internal grant No. 3600.52.24/2022 and project No. SS02030008 "Centre for Environmental Research: Waste and Circular Economy and Environmental Safety" (CEVOOH) and other institutional funds.

References

[1] WANNER, J. Čištění odpadních vod v ČR: Vývoj a současná situace. In: *Vodní hospodářství*. 2017. [accessed 2024-11-13]. Available at: http://vodnihospodarstvi.cz/cisteni-odpadnich-vod-cr/

[2] DAUGHTON, C. G., TERNES, T. A. Pharmaceuticals and Personal Care Products in the Environment: Agents of Subtle Change? *Environmental Health Perspectives*. 1999, 107(6), pp. 907–938. ISSN 0091-6765 [accessed 2024-11-10]. Available at: https://doi.org/10.1289/ehp.99107s6907

[3] DAUGHTON, Ch. G. Illicit Drugs in Municipal Sewage. In: DAUGHTON, Ch. G., JONES-LEPP, T. L. (eds.). *Pharmaceuticals and Care Products in the Environment*. ACS Symposium Series. Washington, DC: American Chemical Society, 2001, pp. 348–364. ISBN 9780841237391. Available at: https://doi.org/10.1021/bk-2001-0791.ch020

[4] ZUCCATO, E., CHIABRANDO, Ch., CASTIGLIONI, S., CALAMARI, D., BAGNATI, R. et al. Cocaine in Surface Waters: A New Evidence-Based Tool to Monitor. *Environmental Health: A Global Access Science Source*. 2005, 4(1), 14. ISSN 1476069x. Available at: https://doi.org/10.1186/1476-069X-4-14

[5] *Kanalizační řád kanalizace pro veřejnou potřebu na území městské části Praha – Dolní Chabry v povodí čistírny odpadních vod Dolní Chabry*, 2016. [accessed 2024-11-06]. Available at: https://www.pvk.cz/vse-o-vode/odpadni-voda/kanalizacni-rad/

[6] *Kanalizační řád stokové sítě obce Velké Přílepy*. VAK Beroun, 2023. [accessed 2024-11-06]. Available at: https://www.vakberoun.cz/documents/verejne/velke_prilepy_539813/kanalizacni_rad/kr-velke-prilepy_2023.pdf

[7] ZVĚŘINOVÁ MLEJNKOVÁ, H., ŠMÍDA, A., VALÁŠEK, V. Vliv odpadních vod na mikrobiální kontaminaci Vltavy pod Prahou. *Vodohospodářské technicko-ekonomické informace*. 2023, 65(4), pp. 4–12. ISSN 0322-8916. [accessed 2024-11-05]. Available at: https://doi.org/10.46555/VTEI.2023.05.002

[8] SANCHO SANTOS, M. E., HORKÝ, P., GRABICOVÁ, K., STEINBACH, Ch., HUBENÁ, P. et al. From Metabolism to Behaviour – Multilevel Effects of Environmental Methamphetamine Concentrations on Fish. *Science of the Total Environment*. 2023, 878, 163167. ISSN 00489697. [accessed 2024-07-24]. Available at: https://doi.org/10.1016/j.scitotenv.2023.163167

[9] FALFUSHYNSKA, H., RYCHTER, P., BOSHTOVA, A., FAIDIUK, Y., KASIANCHUK, N. et al. Illicit Drugs in Surface Waters: How to Get Fish off the Addictive Hook. *Pharmaceuticals*. 2024, 17(4), 537. ISSN 1424-8247. [accessed 2024-11-05]. Available at: https://doi.org/10.3390/ph17040537

[10] MAASZ, G., MOLNAR, E., MAYER, M., KUZMA, M., TAKÁCS, P. et al. Illicit Drugs as a Potential Risk to the Aquatic Environment of a Large Freshwater Lake after a Major Music Festival. *Environmental Toxicology and Chemistry*. 2021, 40(5), pp. 1491–1498. ISSN 0730-7268. [accessed 2024-11-05]. Available at: https://doi.org/10.1002/etc.4998

[11] HORKÝ, P., GRABIC, R., GRABICOVÁ, K., BROOKS, B. W., DOUDA, K. et al. Methamphetamine Pollution Elicits Addiction in Wild Fish. *Journal of Experimental Biology*. 2021, 224(13), jeb242145. ISSN 0022-0949. [accessed 2024-11-05]. Available at: https://doi.org/10.1242/jeb.242145

[12] POSTIGO, C., LOPEZ DE ALDA, M. J., BARCELÓ, D. Fully Automated Determination in the Low Nanogram per Liter Level of Different Classes of Drugs of Abuse in Sewage Water by On-Line Solid-Phase Extraction-Liquid Chromatography–Electrospray-Tandem Mass Spectrometry. *Analytical Chemistry*. 2008, 80(9), pp. 3123–3134. ISSN 0003-2700. [accessed 2024-11-10]. Available at: https://doi.org/10.1021/ac702060j

[13] POSPÍCHALOVÁ, D., MAREŠOVÁ, D., OČENÁŠKOVÁ, V., ŠAFRÁNKOVÁ, T., BOHADLOVÁ, E. Stanovení vybraných drog a jejich metabolitů v odpadních vodách metodou kapalinové chromatografie. *Vodohospodářské technicko-ekonomické informace*. 2020, 62(2), pp. 42–47. ISSN 1805-6555. Available at: https://www.vtei.cz/2020/05/stanoveni-vybranych-drog-a-jejich-metabolitu-v-odpadnich-vodach-metodou-kapalinove-chromatografie/

[14] OČENÁŠKOVÁ, V., TUŠIL, P., POSPÍCHALOVÁ, D., SVOBODOVÁ, A. Nezákonné drogy v odpadních vodách. In: *Pitná voda 2014. 12. pokračování konferencí Pitná voda z údolních nádrží 26. 5.–29. 5. 2014 v Táboře*. České Budějovice: DOLEJŠ, P. – Water and Environmental Technology Team, 2014, pp. 217–222. ISBN 978-80-905238-1-4.

Authors

Ing. Věra Očenášková
✉ vera.ocenaskova@vuv.cz
ORCID: 0000-0001-8692-2417

Ing. Danica Pospíchalová
✉ danica.pospichalova@vuv.cz
ORCID: 0000-0002-5803-3302

Ing. Eva Bohadlová
✉ eva.bohadlova@vuv.cz
ORCID: 0000-0002-0518-4705

T. G. Masaryk Water Research Institute, Prague (Czech Republic)

The Czech version of this article was peer-reviewed, the English version was translated from the Czech original by Environmental Translation Ltd.

DOI: 10.46555/VTEI.2024.11.003


Photo: 123rf.com

Flash flood in Brdy PLA in June 2024

PAVEL RICHTER

Keywords: archival maps — floods — water retention in the landscape — forest management — watercourse management

ABSTRACT

The article documents the course of the flash flood at the beginning of June 2024 in Brdy PLA, in the Příbram Region, including reflection on its causes and possibilities for limiting the consequences of this type of flood in the future. Publicly available information was evaluated from the hydrometeorological situation in the Archive of weekly reports on the CHMI website for the nearest station to the flood-affected area, namely Neumětely station. In that week, the highest weekly precipitation total for the Czech Republic was recorded at Neumětely station. When evaluating landscape development based on archival maps or orthophoto maps, changes with some negative effects on water retention in the landscape were observed. It was mainly the gradual expansion of urban development into the original mosaic of dry or wet meadows and small fields, straightening and piping of watercourses, ploughing their floodplains, land reclamation of spring areas, and their subsequent replacement with arable land.

INTRODUCTION

The Brdy Highlands are over 70 km in length and cover an area of 827 km^2. The highest point is Tok hill (865 m above sea level), which is part of the central Brdy hills. This is the highest part of the Brdy, which was part of a military district and is now the centre of a PLA [1–3]. The Brdy hills are characterized by poor subsoil, which does not allow the formation of more fertile soils. These are concentrated only in the valleys of watercourses. This is why, during medieval colonization of the Brdy region, settlements appeared only in these lower-lying locations, and the rest of the range remained forested [4]. Although the landscape in Brdy PLA seems unaltered at first glance, it has undergone many changes over the last two centuries. These were not only the changes in the species composition of the extensive Brdy forests, but especially the non-forest areas around settlements, whether existing or disappeared. The Brdy landscape was also significantly influenced in the 20th century due to military activities [5].

Extreme hydrological phenomena are recorded in the oldest historical sources. From the perspective of dealing with the consequences of floods and droughts, various technical and organizational measures have been proposed which are intended to protect mainly built-up areas from floods or, conversely, retain water in the landscape for periods of drought. In the past, people had to rely on their observations and the experience of their ancestors, who knew where the water caused damage during floods. If they did not do so, they would lose crops, livestock, property, or even their lives. If necessary, they built small water management structures in forests, fields, in and along streams. They knew where not to build their homes and what to do when a flood or drought came. It was the so-called "flood memory", which they could rely on. Currently, awareness of flood memory is declining, and long-term experience is often no longer shared and respected, whether it is due to people becoming more detached from nature, focusing on other life priorities, or perhaps because of expectations of government help in times of emergency.

The following text documents the course of a flash flood in Brdy Protected Landscape Area in the Příbram region, specifically in the cadastral areas Drahlín and Sádek, on 2 June 2024. Several such flash floods normally occur in the Czech Republic during a year; some years there are more, others fewer. As a rule, they do not occur in the same locations, but given ongoing climate change, previous experience cannot be completely relied on. There are certainly locations that are more susceptible for various reasons. These types of floods are usually not as publicized and will not cause such overall damage as the catastrophic regional floods affecting a large part of the Czech Republic, which occurred in July 1997, August 2002, June 2013 or most recently in September 2024, or as in Spain at the end of October 2024 in the Valencia area, or at the beginning of November 2024 in the Barcelona area.

LOCATION DESCRIPTION

The flood described here is documented in the area of the cadastral area Drahlín and the neighbouring, lower-lying cadastral area Sádek, which are located in the municipalities of Drahlín and Sádek in Příbram district in the Central Bohemian Region. This cadastral unit directly borders Brdy PLA, where the cadastral areas Drahlín in Brdy and Sádek in Brdy are located on the site of the former Brdy Military District. From a hydrological point of view, this area is located in the Berounka sub-basin, in the second order basin 1-11 Berounka from Úslava to the estuary in the third order basin 1-11-04 Litavka and Berounka from Litavka to Loděnice, and in the fourth order basin 1-11-04-0100 Drahlínský stream. Drahlínský stream itself is 4.81 km long and its catchment area covers 7.85 km^2 [6] (*Figs. 1* and *2*).

The geological subsoil consists of gravels, sands, conglomerates, and sandstones [7]. According to the MKSP classification, the predominant soil types are pseudogley cambisol and primary pseudogley. In the floodplain of the Drahlínský stream and its nameless left-hand tributary, typical gley predominates, while in forest stands, it is dystric cambisol and ranker [8]. Based on the geomorphological division, the area is located on the border of the Třebská pahorkatina and Třemošenská vrchovina districts, which are part of the Brdy Highlands geomorphological unit, located in Brdy region [1, 2, 9]. Drahlín cadastral area contains Drahlínské louky Nature Monument, which is also a European Site of Importance (ESI) in the Natura 2000 system. It was declared as an ESI covering 12.6 ha on 3 November 2009 and as a Nature Monument covering 13 ha on 22 July 2016. It consists of two separate meadows on the eastern and western edges of the built-up area near both ponds in Drahlín cadastral area. On 19 April 2024, Licitanta Nature Monument was declared in the same cadastral register covering 2.7 ha, which also belongs within Brdy PLA [10].

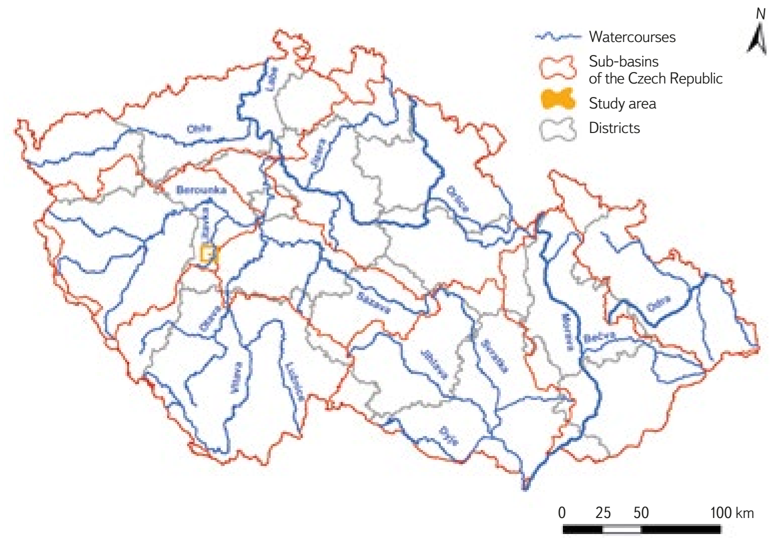


Fig.1. The researched area in a hydrological context

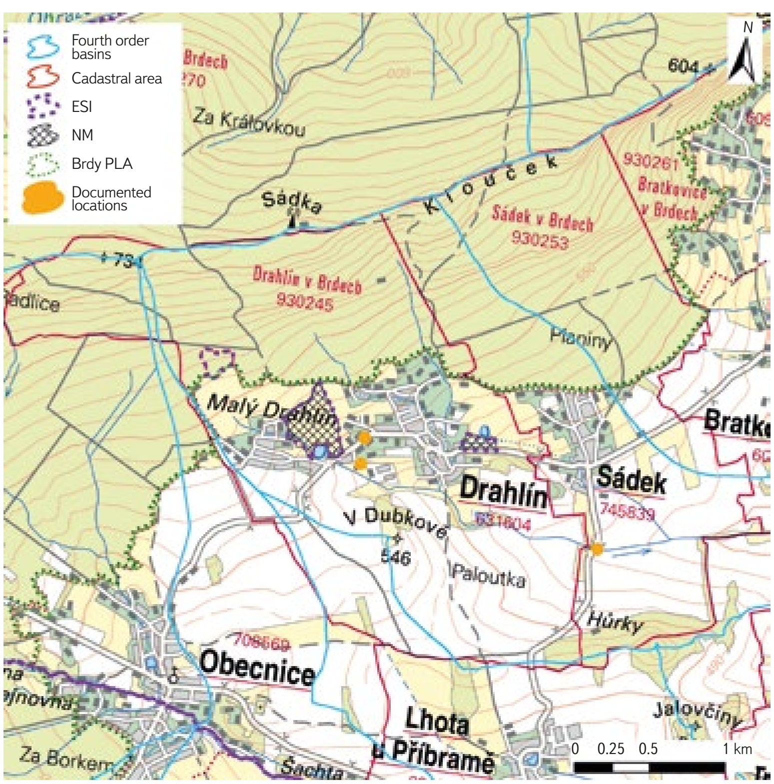


Fig. 2. The researched area on current ZTM 50

Brdy PLA and the former Brdy Military District

The history of the Brdy Military District began in the 1920s, when the then Ministry of Defence of Czechoslovakia established a new artillery range to increase the amount of artillery and modernize weapons. Brdy was chosen as the new area for the training ground as its terrain resembled border areas and seemed to be an ideal location for military purposes. However, this did not please the civilian population, which led to a strong wave of resistance [2, 11]. The creation of the shooting range was protested against not only by residents, who were threatened with eviction, but also by a number of prominent national figures – scientists, writers, poets, and others. A group of parliament members also rebelled, submitting a proposal in 1920 to establish a national park in the Brdy hills, which would prevent the area from being occupied by the army. However, the protests (the strongest in 1924 and 1925) were in vain and, on 19 February 1926, the government approved the project. The construction of the shooting range began on 14 July 1927 and was completed in the same year [2, 12]. The following year, the headquarters of the military artillery training ground and the headquarters of military forestry enterprises were established. In 1929, barracks and residential buildings for military employees were built and a section of forest was cut down to build new target impact areas [2, 11]. However, the army did not prohibit anyone from entering the area at that time; the place was busy with tourists. A ban was limited to the target impact areas only. The German army, which began using Brdy shooting range during the occupation, expanded it westward and evicted the original inhabitants. However, because the German army left all the buildings in the area, the inhabitants were able to return after the war. In the early 1950s, the entry ban was reinstated and, in 1952, the area began to expand again. Most of the buildings were razed to the ground and only a few gamekeepers' lodges remained [2, 12]. Other buildings included the Tři Trubky hunting lodge and the ruins of Valdek Castle. In the 1990s, there were further attempts to abolish the military district or reduce the military area, to declare Brdy a protected area and to open it to tourists. However, the Ministry of the Environment rejected these proposals, as the military area was protected from the influences of civilization [13]. After long negotiations, based on Act No. 15/2015 Coll., on the abolishment of the Brdy military district, on the determination of the borders of military districts, on the change of regional borders and on the amendment of related laws (the Act on the Borders of Military Districts), Brdy military district was finally abolished on 1 January 2016 and changed to PLA. After its abolishment, it was divided into 27 cadastral areas of which 11 cadastral areas fell under Příbram district, six under Beroun district, seven under Rokycany district, and three under Plzeň-south district [14].

METHODOLOGY

The first step was to select areas suitable for observing and documenting the onset of flash floods so that they would be relatively quickly accessible from Prague. The presented locations of Drahlín and Sádek, on the borders of Brdy PLA, meet these conditions. The next step was a field survey of these locations to verify their current condition, both during the ongoing flood and under standard conditions. After that, publicly available hydrometeorological situation information in the weekly reports archive on the CHMI website were evaluated [15].

Subsequently, a comparison of the current and historical state of the study area was carried out based on the interpretation of map data. To display the historical state of the landscape within various types of comparison, the following maps were used: Maps of the Stable Cadastre, the Map of the 2nd Military Mapping, the Historical Orthophotomap from the 1950s, and archival orthophotomaps. To display the current state, the current Basic Topographic Map of the Czech Republic 1 : 10,000 (ZTM 10) and 1 : 50,000 (ZTM 50) and the current Orthophotomap of the Czech Republic were used.

Current map data used

Current ZTM 10, ZTM 50 and Orthophotomap of the Czech Republic

These maps are available via WMS or WMTS from the ČÚZK Geoportal [16], where they are continuously updated as needed. The displayed state on ZTM 10 and ZTM 50 may differ according to individual segments, which are updated separately (e.g. road network), and therefore may not display the actual state of the landscape in all respects in a given period. Currently, both maps should correspond to the state of the landscape in 2020–2023. The entire Orthophotomap of the Czech Republic is updated in a two-year cycle. Approximately one half of the Czech Republic is updated annually, and since 2020, regional borders have been taken into account in the update.

Archival map data used

Stable Cadastre

The oldest usable map material with a detailed depiction of landscape cover is maps of the Stable Cadastre, or more precisely, Imperial Imprints of the Stable Cadastre. They record the historical state of the landscape from the mid-19th century. They were produced at a scale of 1 : 2,880, or 1 : 5,760 in mountainous areas. The original maps were drawn in the field and capture the actual state of the landscape before the industrial revolution, i.e. in 1824–1836 (Moravia and Silesia) and 1826–1843 (Bohemia). Their disadvantage when used for landscape change analyses in a GIS environment is the need to georeference individual map sheets. Viewing and ordering is possible on the website of the Archive Maps of the Central Archives of Surveying and Cadastre [17].

Map of the 2nd Military Mapping

This is the first relatively precise topographic map. It was drawn on a scale of 1 : 28,800 in 1836–1852. Its creation was preceded by military triangulation, which was the geodetic basis of this work. The material used were the Maps of the Stable Cadastre. 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 forest reached a historical minimum. The first railway lines are also recorded here [18]. It is available for viewing on the National Geoportal INSPIRE [19] and also as WMTS [20]. Individual map sheets can be searched within the oldmaps.geolab.cz application of the Geoinformatics Laboratory of the Faculty of Environmental Sciences of J. E. Purkyně University in Ústí nad Labem [18].

Historical orthophotomap from the 1950s

The historical orthophoto map includes layers of aerial photographs mainly from 1952–1954, supplemented by images from 1937–1970 and 1996 where relevant photographic data do not exist for the given period. The Orthophotomap of the Czech Republic from historical images of the first nationwide aerial photography from the 1950s was created as part of the *National Inventory of Contaminated Sites (NIKM)* project. Aerial survey images were provided by the Military Geographical and Hydrometeorological Office (VGHMÚř) Dobruška and processed by GEODIS BRNO, s. r. o. It is available for viewing on the National Geoportal INSPIRE [19] and also as WMTS [20].

Archival orthophotomaps

These orthophotomaps are available as WMS from the ČÚZK Geoportal. Only the part of the area that was photographed within one year is always displayed, according to the stages of photography in the Czech Republic in 1998–2021. In the layers from 1998 to 2001, the data is displayed in black and white, the layers from 2003 contain colour images [16].

FLASH FLOOD ON 2 JUNE 2024 IN THE DRAHLÍN AND SÁDEK MUNICIPALITIES

On 2 June 2024, there were thunderstorms and torrential rain in the Brdy region. This precipitation wase very intense and the Litavka inundated in Příbram, Bratkovice, and further downstream. The Litavka is the main river in the area, so its inundation was quite expected in this meteorological situation. However, the onset of the flood was also very rapid in the Drahlínský stream basin. Torrential rainfall in the villages of Drahlín and Sádek and their surroundings caused the basements of several houses in these villages to flood. Water poured from the forest, which is part of Brdy PLA, and also caused temporary impassability of some sections of roads, which complicated the work of firefighters in pumping water out of flooded basements [21]. The consequences of this flood were documented in the area of the piping and canalization of a small stream below the main road in the village of Drahlín, where the stream inundated. The sewerage system was not able to absorb such a large amount of water, causing it to overflow across the main road and subsequently flood the basements of several properties in the area. The situation as of 2 June 2024 compared to standard situation is shown in *Figs. 3* to *6*. In built-up areas, a very common issue in recent years has been undercapacity of riverbeds, undercapacity of bridges and culverts, clogged culverts that are not sufficiently managed, and undercapacity of watercourse piping (often all together). The above-mentioned situation only confirms this issue.

Fig. 3. Situation in the area of piping and canalization of a small stream below the main road in the village of Drahlín during the flash flood in June 2024 compared to standard situation at the end of August of the same year

Fig. 4. Situation in Drahlín on the main road towards Obecnice in the area of piping and canalization of a small stream during the flash flood in June 2024

Fig. 5. Situation in Drahlín below the main road in locality No. 121 and 122 during the flash flood in June 2024 compared to standard situation at the end of August of the same year

The pond in the eastern part of the village could not hold such a large amount of precipitation either. Drahlínský stream below this pond inundated and the adjacent local road was flooded (*Fig. 7*) [21]. The above-mentioned documented sites in the Drahlín cadastral area in the context of landscape development are shown in *Fig. 8*.

Fig. 6. Minor watercourse near the main road, standard situation (October 2024)

Fig. 7. Flooding of local roads in Drahlín in June 2024 (*Drahlínský zpravodaj* [21]) compared to standard situation in November of the same year

Drahlínský stream in the Sádek cadastral area also caused temporary traffic inaccessibility of the municipalities of Sádek and Drahlín towards Lhota u Příbramě and Příbram, as water overflowed the road bridge. The situation on 2 June 2024, after the peak had subsided, compared to the usual state, is shown in *Figs. 9* and *10*. The location in the context of landscape development is shown in *Fig. 11*.

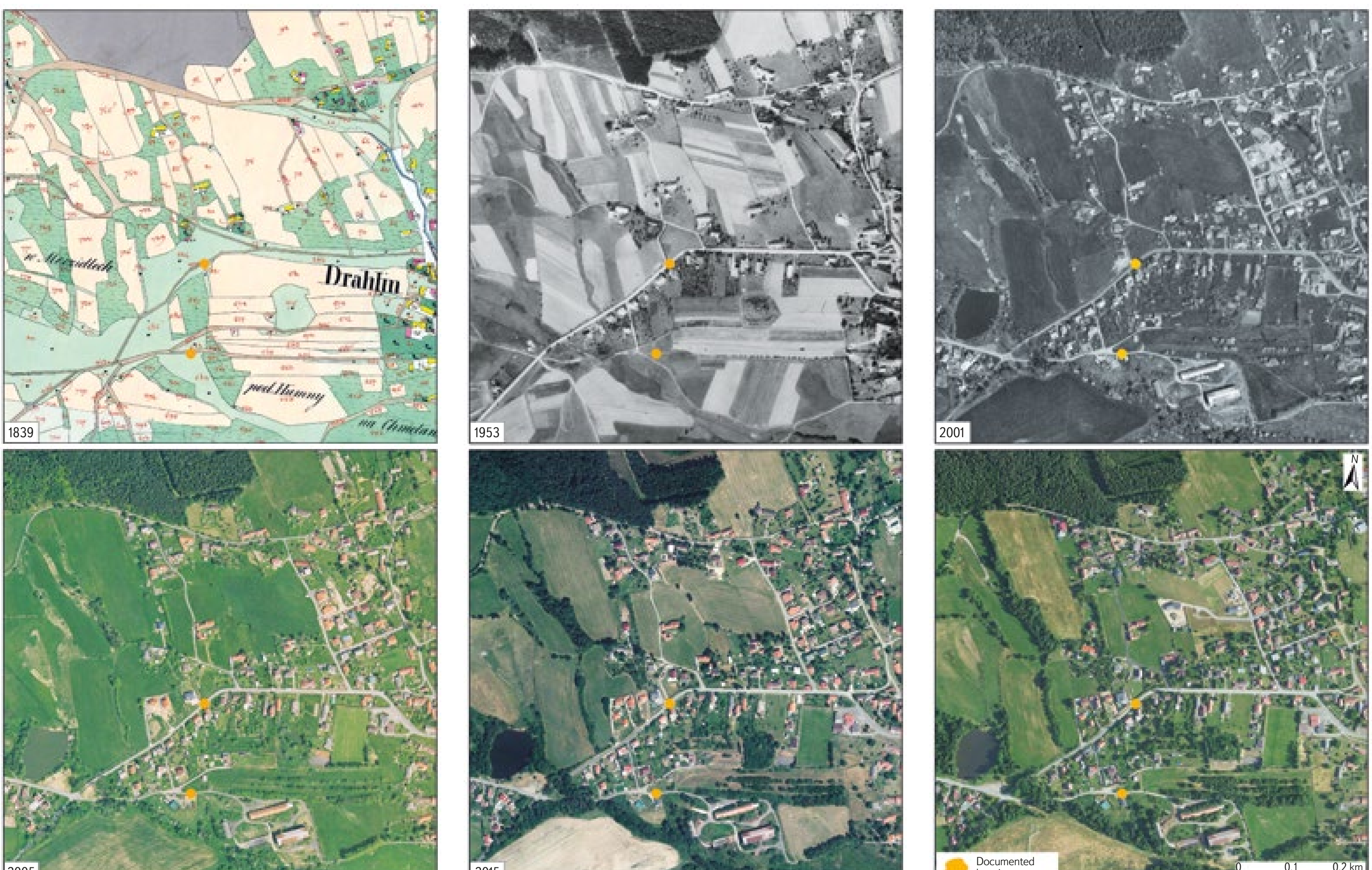


Fig. 8. Documented localities in Drahlín cadastral area in the context of landscape development on the Stable Cadastre, Historical Orthophotomap from the 1950s, Archival Orthophotomaps from 2001, 2005 and 2015 and current Orthophotomap of the Czech Republic

Fig. 9. Situation near the road bridge over Drahlínský stream during the flash flood in June 2024, compared to standard situation at the end of August of the same year

Fig. 10. Situation behind the road bridge over Drahlínský stream during the flash flood in June 2024, compared to standard situation at the end of August of the same year

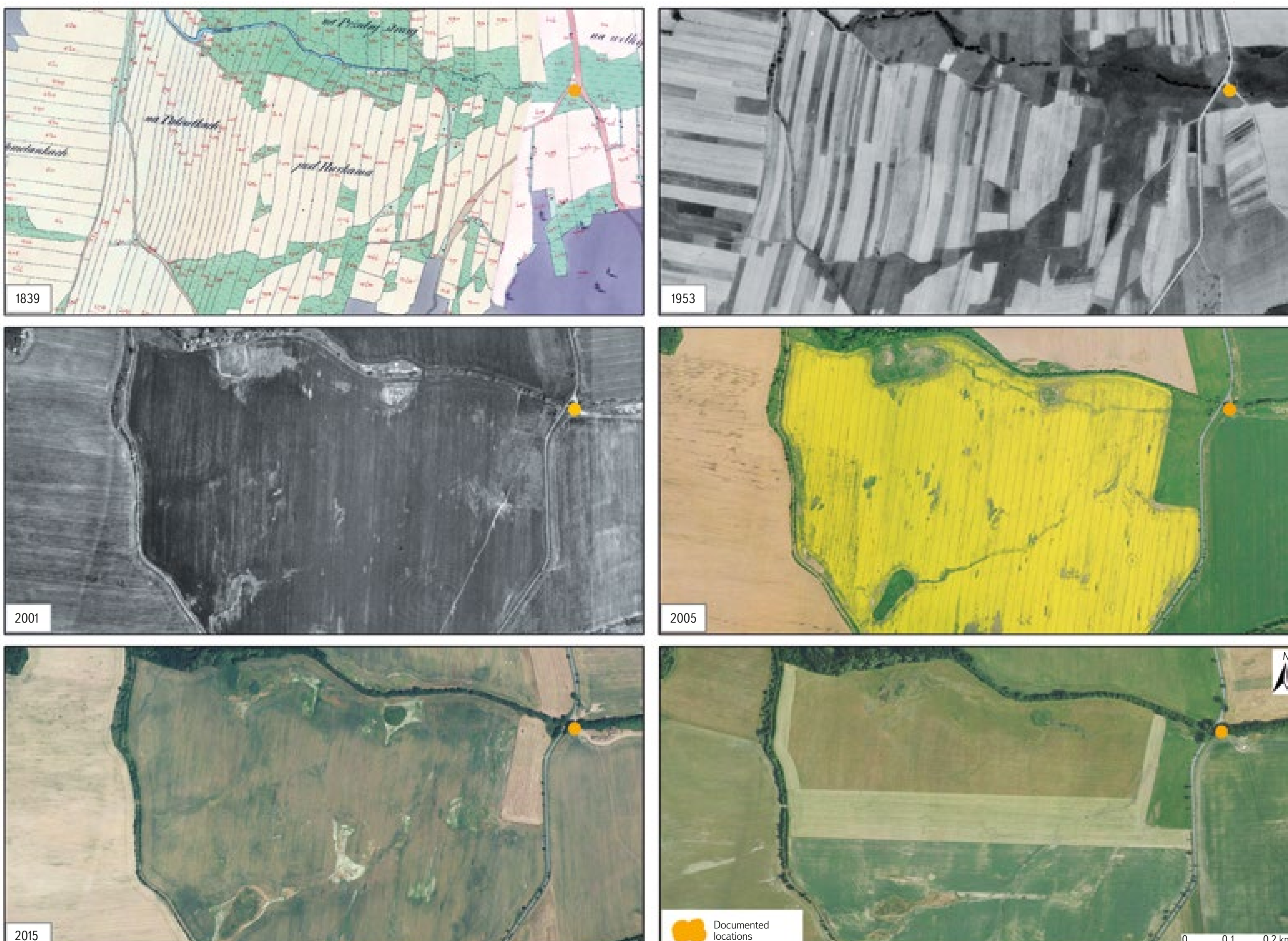


Fig. 11. Documented localities in Sádek cadastral area in the context of landscape development on the Stable Cadastre, Historical Orthophotomap from the 1950s, Archival Orthophotomaps from 2001, 2005 and 2015 and current Orthophotomap of the Czech Republic

The forest stands were not able to contain these torrential rainfalls. Therefore, a field survey was carried out in this area as well. Since these forests were part of Brdy Military District until the end of 2015, there is a relatively dense network of paved roads and intensive forest management was also carried out here. A comparison of the area and condition of forest stands in the study area and its surroundings is shown on maps and orthophotomaps in *Figs. 12* and *13*, respectively. The current state of the forest, marked by the effects of erosion, is shown in *Fig. 14*.

Subsequently, publicly available hydrometeorological situation information in the weekly report archive on the CHMI website [15] were evaluated. Not all stations with recorded gauging are listed here, only selected ones. The closest such station to the study area is in Neumětely. In the *Report No.: 22/Week: 27 May to 2 June 2024*, this station reports a weekly precipitation total of 84 mm, which is 400 % of the normal with six rainy days per week. This is the highest weekly precipitation total of all the stations listed here and the second highest percentage of the normal after Doksany station (440 %). In the previous week (*Report No.: 21/Week: 20 May to 26 May 2024*), this station reported a weekly precipitation total of 14 mm, which is 83 % of the normal with five rainy days per week. In the following week (*Report No.: 23/Week: 3 June to 9 June 2024*), this station reported a weekly precipitation total of 4 mm, which is 24 % of the normal with one rainy day per week. Although weekly precipitation statistics can be misleading, as they do not consider the distribution or intensity of precipitation (or other quantities) on individual days, and Neumětely station is not in the immediate vicinity of the study area, these data can confirm the enormous amount of precipitation in Brdy PLA in the Příbram region, including Drahlín and Sádek municipalities.

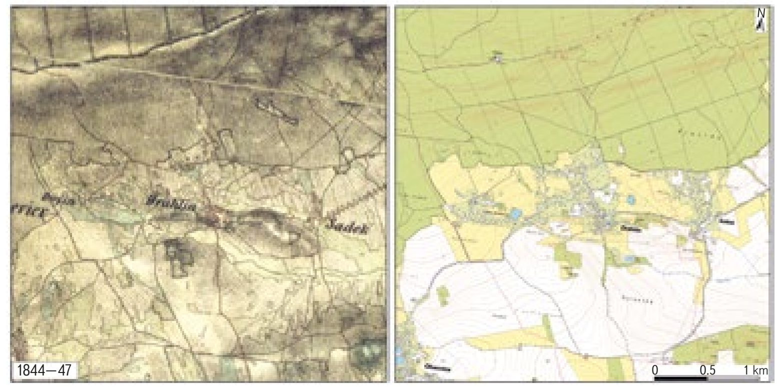


Fig. 12. Comparison of the forest stands state, including the surrounding landscape, shown on Map of the 2nd Military Mapping and on current ZTM 10

Fig. 13. Comparison of the forest stands state, including the surrounding landscape, shown on Historical Orthophotomap from the 1950s, Archival Orthophotomaps from 2001, 2005, 2015 and 2019 and current Orthophotomap of the Czech Republic

Fig. 14. The current state of the forest marked by the effects of erosion in Brdy PLA (October 2024)

DISCUSSION

Given the location of this June flash flood in the headwaters of Drahlínský stream in the immediate vicinity of Brdy PLA, it can be clearly concluded that this landscape cannot accommodate such an amount of torrential rainfall, especially after previous rainfall. At first glance, this is a landscape that has been relatively little altered by human activity. However, a comparison of maps (*Figs. 8, 11,* and *13*) shows that significant changes have occurred in this location, with a negative impact on the retention and purity of water in the landscape. This mainly involved the gradual expansion of a built-up area into the original mosaic of dry and wet meadows and small fields, as well as the reduction of the historical road network, the straightening and piping of watercourses and the ploughing of their floodplains. The land reclamation of spring areas and their replacement with arable land also had an impact; in some locations, after the destruction of land reclamation structures, the original landscape cover was partially restored with the help of succession (*Fig. 11*).

Fig. 12 indicates that the area of forest stands has slightly expanded in the study area; however, the orthophotomaps in *Fig. 13* clearly show that, due to intensive forest management, a large number of extensive clearings were created – this is most noticeable in the image from 2015. This was coincidentally the last year when this area was under the administration of the Military Forests and not under the Nature Conservation Agency of the Czech Republic (NCA CR).

A comparison of the development of the location of watercourses and water bodies in the area shows that both the largest ponds in Drahlín cadastral area were founded only after 1953. In addition to the straightening – and in some sections even the piping – of the Drahlínský stream and its tributaries, the designation of the main stream also changed. On the current ZTM 10 and ZTM 50, the section that originates above Malý Drahlín, in the eastern part of the municipality of Drahlín, is designated as the main flow (*Figs. 2* and *12*). On the Maps of the Stable Cadastre, the current – partially piped – left-sided tributary of the Drahlínský stream, which rises in the northern part of the area in the current Brdy PLA and flows along the Drahlín village square, is drawn as the main stream. The current spring section is not drawn here (however, a group of mostly wet but also dry meadows is shown, indicating a possible small stream or spring area). On the Maps of the Stable Cadastre, the Drahlínský stream is listed under the name "Potuczek" (*Figs. 8* and *11*). At the borders of the cadastral areas Drahlín and Sádek, the usual watercourse outline only passes into a small line and is then not drawn in the mosaic of wet meadows at all (*Fig. 11*). The Maps of Stable Cadastre are reliable; however, they have shortcomings in depicting small streams. In some locations where it is obvious that a small stream should be located (wet meadows are placed in the way that indicates a stream or a spring area), however, it is not there. Either it was a blanket spring area where no main stream existed, or some small streams were simply recorded only from a certain width [22, 23].

A comparison of precipitation totals in the week from 27 May to 2 June 2024 at Neumětely station and at other published stations with the week from 9 to 15 September 2024, when catastrophic floods occurred in a large area of the Czech Republic (especially in the Oder basin) clearly shows that from these data alone and without direct observation, the actual intensity of precipitation cannot be determined, and thus episodes leading to floods or flash floods cannot be indicated directly on individual days. Neumětely station itself reports a weekly precipitation total of 93 mm, which is 870 % of the normal with six rainy days per week. Compared to the week from 27 May to 2 June 2024, there was an increase of 9 mm, but in May, 84 mm was "only" 400 % of the normal with the same number of rainy days. The data from this week in September clearly confirms the extraordinary precipitation situation over almost the entire area of the Czech Republic; however, there was no flash or "standard" flood in the Drahlínský stream basin. The saturation of the area also has a significant impact on the amount of runoff in the basin. This is determined not only by precipitation, but also by the temperatures and evaporation in the previous period. When the affected area is significantly saturated, a large amount of water flows away during torrential rainfall not only from impervious surfaces, but also from other surfaces that would otherwise absorb at least a significant part of the rainfall. Before the flood in September 2024, the area was very slightly saturated and it rained for several days with less intensity than in June 2024. On the CHMI website [24], daily precipitation totals can be found at all (historical and currently gauging) meteorological stations; however, for current gauging stations, it is only until 31 December 2023 at present. The closest stations to the study area are Podlesí and Příbram. When the data are also available for 2024, it will be possible to describe in more detail the precipitation episode from the beginning of June in the municipalities of Drahlín and Sádek and compare it with the situation in mid-September.

So far, we have mentioned the freely available archive data managed by the CHMI on the precipitation situation in a given area within the Czech Republic. However, if citizens would like to actively monitor the risk of impending flash floods, they can use the Flash Flood Indicator operated by CHMI. It has been available to the public for several years now; it provides information on both the current area saturation and a potential precipitation (in one, three, and six hours) and calculates the current risk of flash flooding in our country every 15 minutes [25]. This shows both the risk of local flooding in 3 x 3 km grids and the risk of flash flooding on small streams. In the application, it is marked with a coloured flag, including the expected approximate time of culmination. The results of the calculation of the aggregate risk of flash floods are presented in a polygon layer of municipalities with extended powers (ORP), which are coloured according to the currently achieved maximum risk level. The calculated risk level always attributed to the entire ORP territorial district, even if only a smaller part of it may be affected. However, the Flash Flood Indicator application is operated only in the convective season (approximately April to October) and is available from the Flood Reporting and Forecasting Service website [26]. To monitor actual and expected precipitation, an application designed for detailed weather analysis and short-term precipitation forecasting (nowcasting) can also be used. This application displays, among other things, measured data (station gauging) and area-wide combined quantitative precipitation estimates (MERGE) [27]. Currently, a modernized version of MERGE2 is used, which allows updating the precipitation calculation every 10 minutes [28]. These websites only provide current data; archived data are available at the CHMI upon request.

CONCLUSION

In built-up areas, it would be desirable to pay more attention to issues with under-capacity piping and culverts and clogged or under-capacity channels of small watercourses.

It would also be appropriate to focus on landscape restoration in Drahlínský stream basin outside the PLA, especially on the restoration of wetland habitats in place of those that have disappeared, as the historical location of such elements is a very strong argument for their restoration (the designation of the NM/ESI Drahlínské louky can serve as an example of good practice). It is also necessary to restore the beds of small streams and restore their floodplains where possible. These landscape elements are also part of the solution to adapt to the issues caused by ongoing climate change. Their restoration should primarily lead to higher water retention in the landscape and an increase in landscape diversity.

This is in line with the *EU Biodiversity Strategy to 2030* [29], which is a valid long-term plan for nature conservation, halting ecosystem degradation and restoring biodiversity in Europe. The Strategy recalls that biologically diverse ecosystems, such as wetlands as well as freshwater, forest, and agricultural ecosystems, when in good condition, provide a number of essential ecosystem services, and the benefits of restoring damaged ecosystems to good condition far outweigh the costs of their restoration. The *EU Biodiversity Strategy for 2030* sets a commitment to legally protect at least 30 % of land and inland waters. The text also calls for greater efforts to restore freshwater ecosystems and natural river functions, including restoring at least 25,000 km of free-flowing rivers compared to 2020, when the *EU Biodiversity Strategy for 2030* was adopted.

Hopefully, these will not be just declarations and the measures mentioned will actually be implemented in practice. In some parts of the Czech Republic, truly comprehensive changes are needed. Maybe it is not too late...

Acknowledgements

The article was created within the framework of the internal grant of the TGM WRI No. 3600. 23/2024 (Research support – institutional support, department 230).

References

[1] ČIHAŘ, M. *Brdy tajemné hory v srdci Čech*. Prague: Otto publishing house, s. r. o., 2018. 191 pp. ISBN 978-80-7451-697-9.

[2] *Vojenské újezdy Armády České republiky*. Brno: Ministry of Defence – Avis, 2006. 376 pp. ISBN 80-7278-345-9.

[3] DVOŘÁK, O. *Pustinami středních Brd*. Prague: Regia publishing house, s. r. o., 2015. 239 pp. ISBN 978-80-878661-18-4.

[4] CÍLEK, V. et al. *Střední Brdy*. Příbram: MoA, MoE, ČSOP Příbram, Kancelář pro otázky ochrany přírody a krajiny, 2005. 376 pp. ISBN 80-7084-266-0.

[5] SKOKANOVÁ, H., HAVLÍČEK, M. Vývoj krajinného pokryvu v chráněné krajinné oblasti Brdy za posledních 180 let. *Bohemia Centralis*. 2018, 34, pp. 31–49.

[6] Hydroekologický informační systém (HEIS VÚV TGM). *Mapa Vodní hospodářství a ochrana vod* [on-line]. [accessed 2024-10-12]. Available at: https://heis.vuv.cz/data/webmap/isapi.dll?map=mp_heis_voda/

[7] Národní geoportál INSPIRE. *Mapy – ČGS – Geologická mapa České republiky 1 : 500 000* [on-line]. [accessed 2024-10-15]. Available at: https://geoportal.gov.cz/web/guest/map/

[8] NĚMEČEK, J. et al. *Taxonomický klasifikační systém půd České republiky*. Second edited version. Prague: Czech University of Life Sciences, 2011. ISBN 978-80-213-2155-7.

[9] DEMEK, J., MACKOVČIN, P. (eds.). *Zeměpisný lexikon ČR*. Third edited version. Brno: Mendel University Brno, 2014. ISBN 9788075091130.

[10] *Digitální registr Ústředního seznamu ochrany přírody* [on-line]. [accessed 2024-10-15]. Available at: https://drusop.nature.cz/

[11] *Vojenský újezd Brdy. Historie před rokem 1989* [on-line]. [accessed 2024-10-10]. Available at: https://www.vojujezd-brdy.cz/Historie-pred-1989/

[12] *Vojenský výcvikový prostor Brdy* [on-line]. [accessed 2024-10-16]. Available at: https://www.mo.gov.cz/scripts/detail.php?id=6696

[13] *Vojenský újezd Brdy. Historie po roce 1989* [on-line]. [accessed 2024-10-10]. Available at: https://www.vojujezd-brdy.cz/Historie-po-1989/

[14] *Vojenský újezd Brdy. Rušení újezdu* [on-line]. [accessed 2024-10-16]. Available at: https://www.vojujezd-brdy.cz/Ruseni-ujezdu/

[15] ČHMÚ. *Archiv týdenních zpráv o hydrometeorologické situaci a suchu na území ČR* [on-line]. [accessed 2024-10-18]. Available at: https://www.chmi.cz/files/portal/docs/meteo/ok/SUCHO/Tydenni_zpravy.html

[16] Geoportál ČÚZK. *Prohlížecí služby – WMS* [on-line]. [accessed 2024-10-18]. Available at: https://geoportal.cuzk.cz/(S(lcsguqwsq1my1rvbg3qy5suw))/Default.aspx?mode=TextMeta&side=wms.verejne&text=WMS.verejne.uvod&head_tab=sekce-03-gp&menu=311

[17] *Archiv Zeměměřického úřadu* [on-line]. [accessed 2024-10-28]. Available at: https://ags.cuzk.cz/archiv/

[18] Laboratoř geoinformatiky Fakulty životního prostředí Univerzity J. E. Purkyně v Ústí nad Labem. *II. vojenské mapování* [on-line]. [accessed 2024-11-24]. Available at: http://oldmaps.geolab.cz/map_root.pl?lang=cs&map_root=2vm

[19] Národní geoportál INSPIRE. *Mapy* [on-line]. [accessed 2024-11-06]. Available at: https://geoportal.gov.cz/web/guest/map/

[20] Národní geoportál INSPIRE. *Prohlížecí služby* [on-line]. [accessed 2024-11-08]. Available at: https://geoportal.gov.cz/web/guest/wms/

[21] *Drahlínský zpravodaj* 2/24. Drahlín village, Příbramská tiskárna, s. r. o., 2024. 20 pp.

[22] RICHTER, P. Analýza vývoje zemědělské krajiny ve vybraných katastrálních územích v horní části povodí Výrovky. *Vodohospodářské technicko-ekonomické informace*. 2021, 63(4), pp. 18–27. ISSN 0322-8916. Available at: https://doi.org/10.46555/VTEI.2021.05.004

[23] RICHTER, P. Problematika interpretace archivních mapových podkladů v případě mokřadních biotopů. *Vodohospodářské technicko-ekonomické informace*. 2021, 63(5), pp. 32–38. ISSN 0322-8916. Available at: https://doi.org/ 10.46555/VTEI.2021.07.002

[24] ČHMÚ. *Archiv týdenních zpráv o hydrometeorologické situaci a suchu na území ČR* [on-line]. [accessed 2024-11-23]. Available at: https://www.chmi.cz/historicka-data/pocasi/denni-data/Denni-data-dle-z.-123-1998-Sb#/

[25] ŠERCL, P., PECHA, M., SVOBODA, V., VLASÁK, T. Indikátor přívalových povodní – zkušenosti z provozu. *Meteorologické zprávy*. 2023, 76(5), pp. 138–147. ISSN 0026-1173.

[26] ČHMÚ. *Hlásná a předpovědní povodňová služba* [on-line]. [accessed 2024-11-25]. Available at: https://hydro.chmi.cz/hpps/ppov

[27] ČHMÚ. *ČHMÚ Nowcasting Webportal* [on-line]. [accessed 2024-12-03]. Available at: https://www.chmi.cz/files/portal/docs/meteo/rad/inca-cz/short.html#

[28] NOVÁK, P., KYZNAROVÁ, H. MERGE2 – modernizovaný systém kvantitativních odhadů srážek provozovaný v Českém hydrometeorologickém ústavu. *Meteorologické zprávy*. 2016, 69(5), pp. 137–144. ISSN 0026-1173.

[29] EK. *European Commission Biodiversity Strategy for 2030* [on-line]. [accessed 2024-11-11]. Available at: https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en

Author

Ing. Pavel Richter, Ph.D.
✉ pavel.richter@vuv.cz
ORCID: 0000-0001-6338-3481

T. G. Masaryk Water Research Institute, Prague (Czech Republic)

The Czech version of this article was peer-reviewed, the English version was translated from the Czech original by Environmental Translation Ltd.

DOI: 10.46555/VTEI.2024.11.002

ISSN 0322-8916 (print), ISSN 1805-6555 (on-line).


Photo: 123rf.com

Geographic data citations: case study of DIBAVOD – systematic review

LIBOR ANSORGE, ANNA ANSORGEOVÁ

Keywords: DIBAVOD – data citations – GIS – geographic database

ABSTRACT

Society, mainly through state and public institutions, spends considerable funds on the acquisition, management and sharing of data acquired with public funds, including scientific data. Evaluating the success of an open data policy is very problematic. One possibility is to use the citations of these datasets to track the use of open data. Dataset citation is a relatively new field and still faces a number of methodological and technical challenges, including little awareness in the scientific community of the positives of dataset citation. Also problematic is the low level of skill in citing datasets, which generally leads to different forms and ways of citations. In this study, an analysis was performed of the citations of the geographic database DIBAVOD, which is managed by T. G. Masaryk Water Research Institute. In total, 122 citing documents were included in the study. The study showed that the forms and methods of citation vary widely and do not show any discernible trends over time. Only the number of citations shows a slightly increasing trend. Almost a quarter of the papers then only mentioned the use of DIBAVOD without indicating the source of this data or citing it in another form.

INTRODUCTION

The issue of data citation

In today's digital era, data – including geographic data – play a key role in science. Both government and scientific institutions invest significant resources in dataset creation, management, and access. As the digital environment has developed and the size of datasets increased in recent decades, the cost of this data has also steadily increased. Monitoring the use of datasets within the research community allows us to verify the value of the resources invested in creating datasets, their administration, and providing them to the public and other users.

Current public policies encourage or even stipulate that publicly funded datasets be shared and used for other types of analysis. Costello [1] has mapped a number of positive aspects of sharing research data, as well as the concerns and arguments of scientists who oppose it. The willingness to share research data varies across disciplines, and in addition to data repositories, personal websites of individual scientists are still widely used [2]. Zhao et al. [3] analysed 600 papers published in the journal PLoS One and concluded that scientists still prefer to create their own sets rather than analyse already collected data. In VTEI journal, one can also find very few articles that are based on the reuse of already published data [4, 5].

The requirement to make research data available in the Czech Republic is enshrined in Act No. 130/2002 Coll., on the support of research and development from public funds and on amendments to certain related acts (the Act on the Support of Research and Development). Act No. 130/2002 Coll. introduced in Section 12a the obligation to provide research data, including research data that is an annex to or part of scientific publications, free of charge upon request. The data have to be provided no later than one year after the end of the project public funding. Information on acquired research data is recorded through the Research & Development Information System (R&D IS). The goal is that the considerable resources provided for the acquisition and management of research data are demonstrably spent "for the public good", i.e. so that other scientists can deal with other scientific tasks using already acquired datasets, whether based on individual datasets or combinations of multiple data sources [6]. Of course, Act No. 130/2002 Coll. also introduces certain exceptions that regulate when research data does not have to be provided.

Citations are a way of appreciating the work of cited authors in the scientific community; in the contemporary world they are used as a tool for evaluating science, which often serves for career advancement and as a basis for allocating funding for science. However, data citation is not intended to replace citation of relevant literature, but rather to provide verifiable and reusable information about the availability of research data that support published conclusions and claims. The lack of proper citation of datasets makes peer-reviewed publications less transparent, jeopardizes reproducibility, and hinders open science [7].

Citation of the dataset used is also necessary to comply with Act No. 121/2000 Coll., on copyright, rights related to copyright, and on amendments to certain acts (Copyright Act). Datasets fall under copyright works. According to Section 31 of the Copyright Act, the use of a copyrighted work for scientific purposes is permitted only "if possible, the name of the author, unless the work is anonymous, or the name of the person under whose name the work is made public, as well as the title of the work and the source are stated".

Data citation is therefore an important tool for acknowledging the work of data creators and curators and allowing them to track how their data is used. Data citation allows scientists and other users to easily find data that have been used in a particular piece of research, and to replicate that research and verify its results. Without proper data citation, it would be difficult to achieve the goals of open science, which seeks to share data and scientific knowledge to accelerate scientific progress. Finally, data citation helps to ensure that data sharing is fair and that the creators and curators of datasets receive due credit for their work [8].

Citing datasets faces a number of issues [9], such as the uniqueness and verifiability of the citation, i.e. how to cite datasets so that the citation allows for the precise identification of the dataset used and so that it can be verified that the data cited were used. Another issue is how to cite dynamic datasets that change over time, or whether to cite the dataset or the article that describes the dataset. Citing an article that describes the dataset contributes to the author's H-index, which can be beneficial for their scientific career. Conversely, citing a dataset, even if relevant to research, usually does not directly affect the author's H-index. This disparity in impact on academic metrics may influence decisions about the recommended form of citation. Last but not least, the scientific community is addressing the question of how we can track and evaluate the use of datasets.

To address these issues, a number of standards and best practices for data citation have been developed. The most well-known are the Data Citation Principles, developed by FORCE11 [10]. Adherence to the proposed standards contributes to increasing the impact of both the cited and citing work [11]. However, the basic task of a data citation system is to guarantee the permanence of the cited data and the citations themselves [12], i.e., to ensure that the cited dataset remains available in the cited form in the future.

In recent years, a number of studies have been conducted to examine how datasets are cited. Gregory et al. [13] examined the practices, preferences, and motivations for citing data; they distinguish three types of dataset citation. The first type is data citation in the references. This means that datasets are cited like any other bibliometric source, with an abbreviated citation in the text of the article and a full citation in the reference list. This form of citation allows for easy tracking of citations using citation analysis tools and specialized citation services. The second type of data citation is a simple mention of the data used in the text of the publication. The last type is an indirect citation, where the reference to the data is given in the form of a citation of another related publication (e.g. a data article describing the data or a data document).

Smith et al. [14] point out another issue with citation of datasets, using the *Paleobiology Database* as an example. The problem is that collective works, such as large datasets composed of contributions from many authors (and articles based on them), are cited more often than the original data contributors to these large datasets.

Digital water management database

The *Fundamental Base of Geographic Data of the Czech Republic* (ZABAGED) is the primary geographic data set in the Czech Republic. The administrator of ZABAGED is the Land Survey Office, which administers and expands it in the public interest in accordance with Act No. 200/1994 Coll. The financing of the ZABAGED administration is thus ensured from the Czech state budget. In addition to ZABAGED, there are other geographic datasets. In the field of water management, this is mainly the *Digital Base of Water Management Data* (DIBAVOD). DIBAVOD is managed by the T. G. Masaryk Water Research Institute (TGM WRI) public research institution and its administration is ensured from the internal resources of this institution.

DIBAVOD is a reference geographic database created primarily from the corresponding ZABAGED layers. It is used to create thematic cartographic outputs in the field of water management and water protection over the base map of the Czech Republic 1 : 10,000. DIBAVOD is used, for example, for spatial analyses in the geographic information systems (GIS) environment and for processing reporting data under the Water Framework Directive 2000/60/EC in the field of water policy.

DIBAVOD can be characterized as a dynamic database containing 75 different objects that describe water management elements for the creation of basic water management maps. The objects are divided into ten focus groups:

A. Basic phenomena of surface and groundwater
B. Focus classification of surface and groundwater
C. Protected areas
D. Floodplains
E. Surface water gauging and monitoring points
F. Groundwater gauging and monitoring points
G. Water use subsystem objects
H. Abstraction and discharge points
I. Objects in streams
J. Meteorological observation objects

As part of sharing individual objects with the general public or interested parties, a web map application was created on the dibavod.cz website. This application is a synoptic interactive tool for publishing data and services with online access via a web browser. It can contain raster and vector datasets and allows the use of analytical and publication tools.

Currently, the system-wide stable financing of DIBAVOD is not ensured [15], which leads to some objects being unavailable or not updated for a long time. Information on the use of DIBAVOD is therefore an important aspect when deciding on further financing of DIBAVOD administration. TGM WRI does not have detailed information on the use of this database by the scientific community as the DIBAVOD data can be downloaded for free from the dibavod.cz portal. The aim of this study is therefore to map the citation rate of DIBAVOD and analyse the types of citations of this dataset. On the main page of the dibavod.cz application, the DIBAVOD authors themselves recommend citing the DIBAVOD dataset in the form of an indirect citation of the article *GIS and Cartography at the TGM WRI* [15], published in 2022 in the VTEI journal.

DATA AND METHODS

A systematic literature review was chosen as the primary research method for this study. A systematic literature review is a specific type of review that focuses on finding an answer to a pre-formulated research question by analysing the proof collected in the literature search [16]. The fundamental difference compared to so-called "narrative" literature reviews is the limitation of subjectivity through clearly defined rules for selecting and including literature in the review [17, 18]. Systematic literature reviews use the PRISMA methodology [19]. Due to their complexity, systematic literature reviews are suitable for cases where several dozen or a few hundred contributions are analysed.

The bibliometric databases Dimensions.AI [20], Scopus [21], and Web of Science [22] were selected for citation analysis. Data collection was carried out via the web interface of all three databases. Data collection was carried out on 7 March 2024 by searching for the string DIBAVOD in all fields and then repeated on 1 July 2024. A total of 216 scientific publications were found in the Dimensions.AI database, their metadata were exported in csv format and loaded into a spreadsheet. A total of 47 scientific publications were found in the Scopus database, which were again exported in csv format and loaded into a spreadsheet. Three articles were found in the Web of Science – Core collection database, and when the query was expanded to all databases in the Web of Science, five references were found to two datasets derived from DIBAVOD. Records for these datasets were not included in the analysis.

In the first step, duplicates were eliminated, resulting in a list of 231 scientific publications for screening. As part of the screening, each document found was checked to see if it actually contained a DIBAVOD citation. 104 records that did not cite DIBAVOD were excluded from further analysis, as were five records for which it was not possible to verify whether they cited DIBAVOD (e.g. due to the unavailability of the paper for the authors).

The citation analysis included 122 papers citing DIBAVOD. A modified typology described by Gregory et al. [13] was used to monitor the types of citations. For each paper citing DIBAVOD, the form of citation and the method of citing the source were checked. The form of citation was classified into one of two categories – "citation in the text" or "citation in the list of references". In the case of the form of citation in the references, categories of the method of citing the source were created: "no source is cited", "a recommended article is cited" (i.e. the article *GIS and cartography at TGM WRI* [15] is cited), "TGM WRI is cited", "the website dibavod.cz is cited"). Based on the analysis of citations, a new category "TGM WRI Hydroecological Information System is cited" (alias HEIS TGM WRI) was added. HEIS TGM WRI is another information system operated by TGM WRI, which provides attribute data on water management in the Czech Republic. In the case of the "citation in text" form, the same categories of source citation methods were chosen, but logically, "a recommended article is cited" cannot appear in this DIBAVOD citation form. Citation analysis was performed by both authors of this study; the second author was in charge of the initial analyses, the first author checked the results and made decisions in the case of unclear classifications.

Subsequently, these data were statistically processed and the content analysed.

RESULTS AND DISCUSSION

Citations according to individual categories of citation form and method of citing the source are shown in *Fig. 1*. A total of 122 papers citing DIBAVOD were found. In DIBAVOD citations, citations in the form of links in the list of references slightly predominate; there are 64 (i.e. 52.5 %). This can be considered a good result, since in-text citations generally prevail over citations in the list of references [23]. However, the presented results are difficult to generalize because the number of citing articles is low. As Rogers et al. [24] point out, samples of 1,000 documents provide a good guide for relative (but not absolute) citation analyses; studies with fewer than 200 documents suffer from high variability in results.

Citing in the form of a link in the list of references is preferable from the perspective of dataset curators, as it allows for easier tracking of the use of the dataset using specialized bibliometric databases. However, this does not mean that citations of the dataset in the text of the citing document should be considered inappropriate. Data citation is still in its infancy and authors are still learning how to use it. It is therefore important that citing the datasets used becomes part of general "citation skills" and good publishing practices.

A somewhat unpleasant finding is the 29 papers (23.8 %) that only mention DIBAVOD in the text without providing any acknowledgement to the authors and curators of DIBAVOD, or a reference to this source. Although 23.8 % may not seem like a high percentage, it is still a manifestation of ignorance or non-compliance with citation rules. Inaccurate, incomplete or careless citation, where it is not possible to identify the cited source, is considered by most publication ethics manuals [e.g. 25] to be a violation of publication ethics, or plagiarism. Moreover, it is a de facto violation of Czech copyright law, which requires the author and source to be cited in addition to the title of the paper used.

In this context, the question arises whether currently not citing the exact source can be considered a violation of publication ethics if the (non-)citing work indicates that a specific dataset was used that can be easily found on the Internet. With regard to compliance with the FAIR principles [8], the citation of datasets should also contribute to finding the dataset used, its accessibility, interoperability and reusability. Citations of data play an important role in ensuring their findability and accessibility, especially when persistent identifiers such as DOI are used in the citations. Groth et al. [26] discuss the benefits of citing datasets for their reuse. In our view, more frequent data citations will also have an impact on their interoperability, as data with higher interoperability should be used and cited more. Recognizing the importance of data citations, for example by including data citations in rating systems, will put pressure on data curators to ensure greater interoperability of the datasets they manage.

A total of 54 papers referenced the dibavod.cz website, which was the most common way of citing a source in the DIBAVOD dataset. Of these, 46 references to dibavod.cz were in the form of a link in the list of references, while eight references to dibavod.cz were listed directly in the text of the citing article. The descriptive article [15], which is recommended to be cited by the curators of the DIBAVOD database on the dibavod.cz website, was cited only five times, which is a very small number. This may be due to the fact that the article was written relatively recently (in 2022), and also to the fact that data articles are not yet widely used for citing datasets, but there is still a steady increase in citations of data articles [27]. However, the overall citation of datasets is still at a very low level, regardless of the data repository from which the data is uploaded [28].

Two articles cited DIBAVOD as part of the HEIS TGM WRI. In both cases, these were relatively old citations, the first from 2009, the second from 2021, but citing a source from 1965. Two other articles cited the HEIS TGM WRI; however, because both of these articles also cited TGM WRI or dibavod.cz, they were included in the categories citing these sources.

The last way of citing a source is represented by citations stating that DIBAVOD is managed by the TGM WRI. There were 32 such citations in total, 21 of which were in the form of in-text citations and 11 in the form of citations in the references. This method of citation cannot be considered optimal; however, it at least acknowledges the TGM WRI for the management of the DIBAVOD dataset.

Fig. 2 shows that a certain increasing trend can be seen in the total number of citations, but not in whether the share of citations in the form of in-text citations and citations in the references is changing. Similarly, *Fig. 3* shows that the way of citing the source does not indicate any noticeable trend either, and the individual categories are randomly represented in individual years. This suggests that dataset citation is not yet widely practiced in the Czech scientific community. However, education in the field of dataset citation is essential for supporting academic integrity, developing critical digital skills, and improving the ethical and effective use of data.

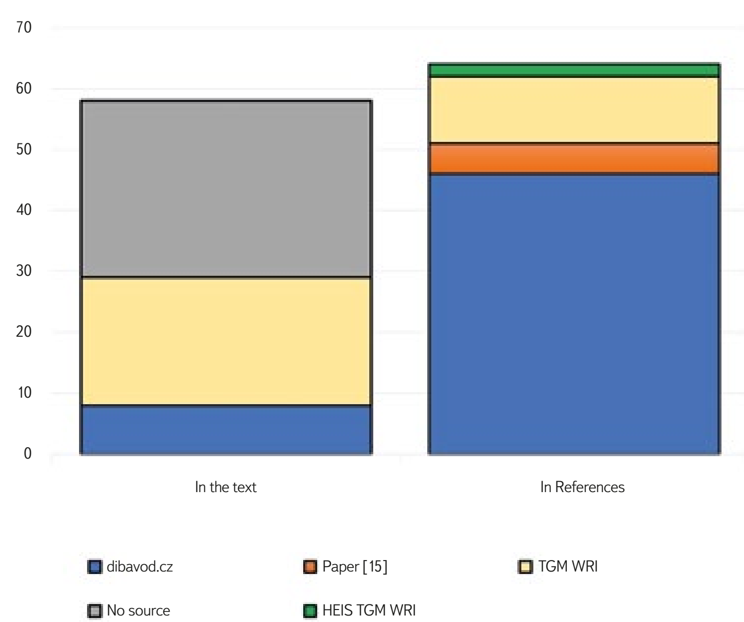


Fig. 1. Structure of DIBAVOD citation types

In this study, we focused on citations in scientific journals that are included in citation databases, which allowed for relatively simple data processing. However, geographic datasets such as DIBAVOD or ZABAGED are created primarily with the aim of providing data for the lay public. One of the challenges for systems for assessing the reuse of research data is the way in which these data are used by the general professional public outside the academic sphere. This includes in particular citations in the so-called grey literature, in strategic documents and policies, in decisions of administrative bodies, etc. However, these citation analyses are highly demanding because, unlike scientific publication production, there are no easily usable sources of information for these types of documents. The easiest way to do this is to use web search engines such as Google. However, the subsequent analysis of the search results is very difficult to automate. Citation of datasets may not be the only way to demonstrate the use of research data. Other options include download counts, usage agreements, etc. The biggest complication here is again the lack of readily available information on these types of indicators.

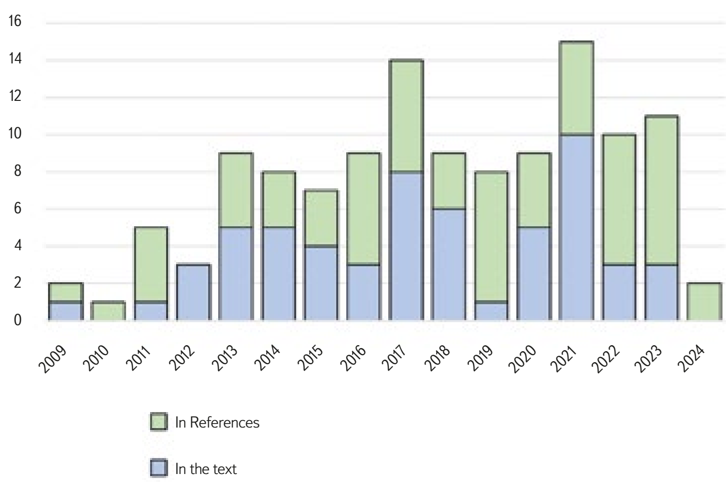


Fig. 2. Development of DIBAVOD citations over time

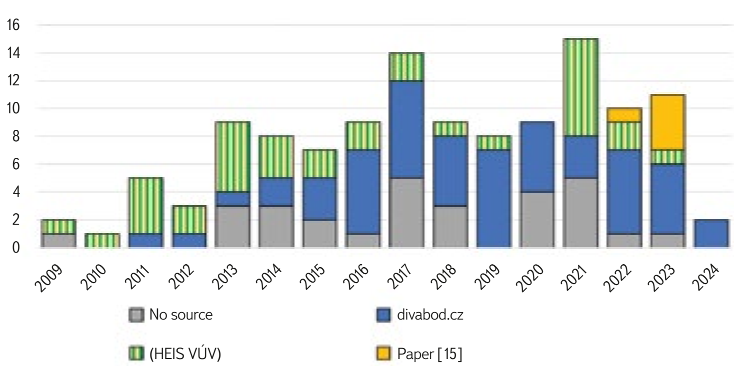


Fig. 3. Distribution of citation types over time

CONCLUSIONS

The analysis showed that citing the DIBAVOD dataset cannot be considered optimal. Of the 122 papers analysed, 58 only used the reference in the text and, of these, only 29 mentioned the use of DIBAVOD without more detailed information about the dataset or its authors or originator. A total of 54 papers provided a link to the dibavod.cz website and 34 papers cited DIBAVOD in the form of a reference to the originator, i.e. TGM WRI. Only five papers used the recommended citation via the article *GIS and Cartography in TGM WRI*; however, this may be mainly due to the fact that this recommended article is quite new. The study thus demonstrated that citing water management datasets, such as DIBAVOD in particular, is not widespread in the Czech Republic, and there is no established form and method of citing these datasets. The importance of citing geographic data should therefore be emphasized both within university study programmes and through public events and professional committees. Similarly, the study demonstrated high heterogeneity in the form of citations of the DIBAVOD dataset. Much more awareness-raising is needed in this regard as well.

All data used in the study can be obtained from Dimension.AI, Scopus, and Web of Science databases using the procedures described in this study. The source file in MS Excel format in which all analyses were performed is available upon request from the corresponding author.

Acknowledgements

The authors would like to thank both reviewers for their very insightful comments and recommendations.

Conflict of interest declaration

The corresponding author is part of the TGM WRI management, which publishes the VTEI journal, and the chairman of the VTEI journal Editorial Board. However, these facts had no influence on the results of the presented study. TGM WRI did not provide any funds for the preparation of this study.

References

[1] COSTELLO, M. J. Motivating Online Publication of Data. *BioScience* [on-line]. 2009, 59(5), pp. 418–427. ISSN 0006-3568. Available at: https://doi.org/10.1525/bio.2009.59.5.9

[2] KHAN, N., THELWALL, M., KOUSHA, K. Data Sharing and Reuse Practices: Disciplinary Differences and Improvements Needed. *On-line Information Review* [on-line]. 2023, 47(6), pp. 1 036–1 064. ISSN 1468-4527. Available at: https://doi.org/10.1108/OIR-08-2021-0423

[3] ZHAO, M., YAN, E., LI, K. Data Set Mentions and Citations: A Content Analysis of Full-Text Publications. *Journal of the Association for Information Science and Technology* [on-line]. 2018, 69(1), pp. 32–46. ISSN 2330-1643. Available at: https://doi.org/10.1002/asi.23919

[4] ANSORGE, L., STEJSKALOVÁ, L., SOLDÁN, P. Nové znečišťující látky v odpadních vodách – výsledky Společného průzkumu Dunaje 4 pohledem šedé vodní stopy. *Vodohospodářské technicko--ekonomické informace* [on-line]. 2024, 66(1), pp. 38–45. ISSN 0322–8916, 1805-6555. Available at: https://doi.org/10.46555/VTEI.2023.11.002

[5] ANSORGE, L., STEJSKALOVÁ, L. Srovnání šedé vodní stopy způsobené běžným znečištěním a mikropolutanty: případová studie ČOV Bandung v Indonésii. *Vodohospodářské technicko-ekonomické informace* [on-line]. 2024, 66(4), pp. 20–27. ISSN 0322–8916, 1805-6555. Available at: https://doi.org/10.46555/VTEI.2023.11.00210.46555/VTEI.2024.05.001

[6] BORGMAN, C. L. The Conundrum of Sharing Research Data. *Journal of the American Society for Information Science and Technology* [on-line]. 2012, 63(6), pp. 1 059–1 078. ISSN 1532-2890. Available at: https://doi.org/10.1002/asi.22634

[7] GERASIMOV, I., SAVTCHENKO, A., ALFRED, J., ACKER, J., WEI, J., BINITA, K. C. Bridging the Gap: Enhancing Prominence and Provenance of NASA Datasets in Research Publications. *Data Science Journal* [on-line]. 2024, 23(1). ISSN 1683-1470. Available at: https://doi.org/10.5334/dsj-2024-001

[8] WILKINSON, M. D., DUMONTIER, M., AALBERSBERG, Ij. J., APPLETON, G., AXTON, M., BAAK, A., BLOMBERG, N., BOITEN, J.-W., DA SILVA SANTOS, L. B., BOURNE, P. E., BOUWMAN, J., BROOKES, A. J., CLARK, T., CROSAS, M., DILLO, I., DUMON, O., EDMUNDS, S., EVELO, C. T., FINKERS, R., GONZALEZ--BELTRAN, A., GRAY, A. J. G., GROTH, P., GOBLE, C., GRETHE, J. S., HERINGA, J., 'T HOEN, P. A. C., HOOFT, R., KUHN, T., KOK, R., KOK, J., LUSHER, S. J., MARTONE, M. E., MONS, A., PACKER, A. L., PERSSON, B., ROCCA--SERRA, P., ROOS, M., VAN SCHAIK, R., SANSONE, S.-A., SCHULTES, E., SENGSTAG, T., SLATER, T., STRAWN, G., SWERTZ, M. A., THOMPSON, M., VAN DER LEI, J., VAN MULLIGEN, E., VELTEROP, J., WAAGMEESTER, A., WITTENBURG, P., WOLSTENCROFT, K., ZHAO, J., MONS, B. The FAIR Guiding Principles for Scientific Data Management and Stewardship. *Scientific Data* [on-line]. 2016, 3(1), 160018. ISSN 2052-4463. Available at: https://doi.org/10.1038/sdata.2016.18

[9] PARSONS, M. A., DUERR, R. E., JONES, M. B. The History and Future of Data Citation in Practice. *Data Science Journal* [on-line]. 2019, 18(1), pp. 52. ISSN 1683-1470. Available at: https://doi.org/10.5334/dsj-2019-052

[10] DATA CITATION SYNTHESIS GROUP. *Joint Declaration of Data Citation Principles* [on-line]. San Diego CA: FORCE11, 2014. Available at: https://doi.org/10.25490/A97F-EGYK

[11] COUSIJN, H., FEENEY, P., LOWENBERG, D., PRESANI, E., SIMONS, N. Bringing Citations and Usage Metrics Together to Make Data Count. *Data Science Journal* [on-line]. 2019, 18(1), 9. ISSN 1683-1470. Available at: https://doi.org/10.5334/dsj-2019-009

[12] SILVELLO, G. Theory and Practice of Data Citation. *Journal of the Association for Information Science and Technology* [on-line]. 2018, 69(1), pp. 6–20. ISSN 2330-1643. Available at: https://doi.org/10.1002/asi.23917

[13] GREGORY, K., NINKOV, A., RIPP, C., ROBLIN, E., PETERS, I., HAUSTEIN, S. Tracing Data: A Survey Investigating Disciplinary Differences in Data Citation. *Quantitative Science Studies* [on-line]. 2023, 4(3), pp. 622–649. ISSN 2641-3337. Available at: https://doi.org/10.1162/qss_a_00264

[14] SMITH, J. A., RAJA, N. B., CLEMENTS, T., DIMITRIJEVIĆ, D., DOWDING, E. M., DUNNE, E. M., GEE, B. M., GODOY, P. L., LOMBARDI, E. M., MULVEY, L. P. A., NÄTSCHER, P. S., REDDIN, C. J., SHIRLEY, B., WARNOCK, R. C. M., KOCSIS, Á. T. Increasing the Equitability of Data Citation in Paleontology: Capacity Building for the Big Data Future. *Paleobiology* [on-line]. 2024, 50(2), pp. 165–176. ISSN 0094-8373, 1938-5331. Available at: https://doi.org/10.1017/pab.2023.33

[15] FOJTÍK, T., JAŠÍKOVÁ, L., KURFIŘTOVÁ, J., MAKOVCOVÁ, M., MAŤAŠOVSKÁ, V., MAYER, P., NOVÁKOVÁ, H., ZAVŘELOVÁ, J., ZBOŘIL, A. GIS a kartografie ve VÚV TGM. *Vodohospodářské technicko-ekonomické informace* [on-line]. 2022, 64(1), pp. 47–52. ISSN 0322–8916, 1805-6555. Available at: https://www.vtei.cz/2022/02/gis-a-kartografie-ve-vuv-tgm/

[16] SNYDER, H. Literature Review As a Research Methodology: An Overview and Guidelines. *Journal of Business Research* [on-line]. 2019, 104, pp. 333–339. ISSN 0148-2963. Available at: https://doi.org/10.1016/j.jbusres.2019.07.039

[17] HODGKINSON, G. P., FORD, J. K. Narrative, Meta-Analytic, and Systematic Reviews: What Are the Differences and Why Do They Matter? *Journal of Organizational Behavior* [on-line]. 2014, 35(S1), pp. S1–S5. ISSN 1099-1379. Available at: https://doi.org/10.1002/job.1918

[18] TRANFIELD, D., DENYER, D., SMART, P. Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. *British Journal of Management* [on-line]. 2003, 14(3), pp. 207–222. ISSN 1467-8551. Available at: https://doi.org/10.1111/1467-8551.00375

[19] PAGE, M. J., MCKENZIE, J. E., BOSSUYT, P. M., BOUTRON, I., HOFFMANN, T. C., MULROW, C. D., SHAMSEER, L., TETZLAFF, J. M., AKL, E. A., BRENNAN, S. E., CHOU, R., GLANVILLE, J., GRIMSHAW, J. M., HRÓBJARTSSON, A., LALU, M. M., LI, T., LODER, E. W., MAYO-WILSON, E., MCDONALD, S., MCGUINNESS, L. A., STEWART, L. A., THOMAS, J., TRICCO, A. C., WELCH, V. A., WHITING, P., MOHER, D. The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews. *BMJ* [on-line]. 2021, 372, n71. ISSN 1756-1833. Available at: https://doi.org/10.1136/bmj.n71

[20] THELWALL, M. Dimensions: A Competitor to Scopus and the Web of Science? *Journal of Informetrics* [on-line]. 2018, 12(2), pp. 430–435. ISSN 1751-1577. Available at: https://doi.org/10.1016/j.joi.2018.03.006

[21] BAAS, J., SCHOTTEN, M., PLUME, A., CÔTÉ, G., KARIMI, R. Scopus As a Curated, High-Quality Bibliometric Data Source for Academic Research in Quantitative Science Studies. *Quantitative Science Studies* [on-line]. 2020, 1(1), pp. 377–386. ISSN 2641-3337. Available at: https://doi.org/10.1162/qss_a_00019

[22] BIRKLE, C., PENDLEBURY, D. A., SCHNELL, J., ADAMS, J. Web of Science As a Data Source for Research on Scientific and Scholarly Activity. *Quantitative Science Studies* [on-line]. 2020, 1(1), pp. 363–376. ISSN 2641-3337. Available at: https://doi.org/10.1162/qss_a_00018

[23] PARK, H., YOU, S., WOLFRAM, D. Informal Data Citation for Data Sharing and Reuse is More Common than Formal Data Citation in Biomedical Fields. *Journal of the Association for Information Science and Technology* [on-line]. 2018, 69(11), pp. 1 346–1 354. ISSN 2330-1643. Available at: https://doi.org/10.1002/asi.24049

[24] ROGERS, G., SZOMSZOR, M., ADAMS, J. Sample Size in Bibliometric Analysis. *Scientometrics* [on-line]. 2020, 125(1), pp. 777–794. ISSN 1588-2861. Available at: https://doi.org/10.1007/s11192-020-03647-7

[25] FOLTÝNEK, T., ČERNIKOVSKÝ, P., FONTANA, J., GOJNÁ, Z., HENEK DLABOLOVÁ, D., HOLEČEK, T., HRADECKÝ, J., KOZMANOVÁ, I., MACH, J., PRUSEK, O., ŘÍMANOVÁ, R., TESAŘÍKOVÁ, K., VOREL, F., VORLOVÁ, H. *Jak předcházet plagiátorství ve studentských pracích: příručka pro akademické pracovníky*. Praha: Karolinum – Charles University Press, 2020. ISBN 978-80-246-4786-9.

[26] GROTH, P., COUSIJN, H., CLARK, T., GOBLE, C. FAIR Data Reuse – the Path through Data Citation. *Data Intelligence* [on-line]. 2020, 2(1–2), pp. 78–86. ISSN 2641-435X. Available at: https://doi.org/10.1162/dint_a_00030

[27] JIAO, H., QIU, Y., MA, X., YANG, B. Dissemination Effect of Data Papers on Scientific Datasets. *Journal of the Association for Information Science and Technology* [on-line]. 2024, 75(2), pp. 115–131. ISSN 2330-1635, 2330-1643. Available at: https://doi.org/10.1002/asi.24843

[28] NUMAJIRI, H., HAYASHI, T. Analysis on Open Data As a Foundation for Data-Driven Research. *Scientometrics* [on-line]. 2024, 129, pp. 6 315–6 332. ISSN 1588-2861. Available at: https://doi.org/10.1007/s11192-024-04956-x

Authors

Ing. Libor Ansorge, Ph.D.[1]
✉ libor.ansorge@vuv.cz
ORCID 0000-0003-3963-8290

Anna Ansorgeová[2]
✉ st102751@students.ujep.cz

[1]T. G. Masaryk Water Research Institute, Prague (Czech Republic)
[2]Faculty of Science, Jan Evangelista Purkyně University in Ústí nad Labem (Czech Republic)

The Czech version of this article was peer-reviewed, the English version was translated from the Czech original by Environmental Translation Ltd.

DOI: 10.46555/VTEI.2024.11.001


Photo: 123rf.com

The jewels of our running waters and their protection

JANA HRONKOVÁ, KATEŘINA ŘÍMALOVÁ, JITKA SVOBODOVÁ

Keywords: freshwater pearl mussel — stone crayfish — rescue programmes — freshwater ecosystems — critically endangered species — bioindicator — umbrella species

Freshwater ecosystems are among the most threatened habitats in the world [1]. This is the result of many factors that, individually and in combination, directly affect the degradation of freshwater ecosystems. The biggest problem for these habitats is climate change. Its consequence is drying up, as well as many anthropogenic negative impacts, such as eutrophication, drainage, introduction of invasive species, and overall environmental degradation [1]. Given these facts, species inhabiting sensitive aquatic environments are among the most endangered plant and animal species in the world.

The Czech Republic is home to many plant and animal species that are threatened with extinction. The goal of nature conservation is to ensure that all of these species survive in their natural habitats. The ways to achieve this goal can be different: passive (legislative) protection, delimitation of protected areas, the necessary management. However, for some species, these tools alone are not sufficient and need to be carefully complemented and coordinated with other types of measures, including, for example, captive breeding and reintroduction into the wild. For these species, rescue programmes (RPs) are being prepared. These RPs aimed at conserving endangered species are a very popular tool, increasingly used both in our country and abroad [2]. Their advantage is that, for example, the protection of one species often has a positive effect on other species inhabiting the same habitat – the concept of the so-called umbrella species [3].

Fig. 1. The Blanice River – habitat of the freshwater pearl mussel (photo: K. Římalová)

Therefore, RPs are understood as temporary projects at the national level, the purpose of which is to achieve an increase of abundance of the affected species above the level of threat of extinction by combining various types of measures. This level varies for individual species due to the different types of distribution of residual populations, the species ecology, the strength of the influence of threatening factors, etc. After achieving the set quantitative goals, the RP is terminated. However, it can also be terminated in the event of its failure (extinction of the species) or its inoperability proven during implementation [4]. Other active instruments in nature conservation include regional action plans (RAPs). These are essentially RPs at the regional level, which are developed for regionally endangered species or for nationally endangered species with a regional occurrence. In addition to the RP and RAP for the most endangered species, there is a need to address in a coordinated manner issues related to the protection of other specially protected species, where there is a conflict between human economic interests and the impact of these species. So-called management plans have been proposed for these species [4].

There are many plants and animals in the Czech Republic that are directly threatened with extinction, and many of them would certainly deserve the support of RPs. However, in order for a species to be a so-called candidate species for an RP, it must meet several criteria that are given by Act No. 114/1922 Coll., on Nature and Landscape Protection; e.g., it must be included among specially protected species according to Decree No. 395/1992 Coll. [19], or the criterion is determined by the *Concept of Active Species Protection Instruments* [5], such as the fact that the causes of the threat to the species are permanent and removable, etc. These currently selected candidate species are also part of the aforementioned Concept [5], which summarizes the approach to the preparation and implementation of RP, management programmes, and RAP.

Each RP includes chapters on the species taxonomy, biology, and ecology, which describe the demands on the environment, way of life, and the cause of the threat to the species. This is followed by the chapter RP objectives and RP action plan, which is its most important and practical part. The action plan deals with specific measures in the management of the habitat and the species, species monitoring, and research and education, which are an integral part of the RP.

There are currently 14 RPs adopted in the Czech Republic (seven for plants and seven for animals), two of which are RPs for animals related to water. The first is *The Freshwater Pearl Mussel Rescue Programme*. The current version was approved in 2013 and is now the third stage; the first stage of the *Margaritifera* rescue programme [6] was running from 1993, followed by the second stage [7] from 2000. The Freshwater Pearl Mussel Rescue Programme is thus the oldest approved and still ongoing programme. The second water-related programme is the *Stone Crayfish Rescue Programme*, which is the newest approved programme in the Czech Republic (in 2024).

FRESHWATER PEARL MUSSEL

The freshwater pearl mussel (*Margaritifera margaritifera*) is a long-living freshwater mussel that is protected in the Czech Republic by Act No. 114/1992 Coll., on the Protection of Nature and Landscape [20] and the European Habitats Directive – 92/43/EEC [21] within the NATURA 2000 system. In the Czech Republic, the freshwater pearl mussel was previously found in the Vltava, Elbe, Oder, and Danube river basins, often in colonies of 10,000 to 100,000. Currently, its main distribution is limited to a few sites in southern and western Bohemia.

The average lifespan of freshwater pearl mussels in our conditions is around 50 to 80 years, depending on the quality of the water environment. The freshwater pearl mussel life cycle is quite complicated; for its successful development, the parasitic larval stage of the species needs a healthy population of host fish – brown trout (*Salmo trutta* m. *fario*). Juvenile freshwater pearl mussels spend the first part of their lives buried in the gravel-sand riverbed and only emerge on the surface when almost adult (*Fig. 2*). In all developmental stages, the freshwater pearl mussel is dependent on the quality of the aquatic environment and the associated natural communities. In addition to the requirements for water without pollution, its existence and reproduction depend on the availability of food, which is organogenic detritus arising in adjacent habitats. In practice, therefore, the protection of the freshwater pearl mussel includes not only measures supporting the population of the species and its hosts but also measures improving the quality parameters of the aquatic environment, including the surrounding terrestrial habitats with a connection to this environment. Due to the significant decrease in the number of sites and the overall deterioration of their condition in the recent past, which has been documented since at least the 1950s, systematic activities aimed at protecting the populations and habitat of the freshwater pearl mussel were initiated in the 1980s. These were mainly locations in the Prachatice region, where the largest colonies of freshwater pearl mussel of Central European importance have been preserved to date. The decline of freshwater pearl mussel populations and the loss of quality habitats is not just a matter for the Czech Republic, but a pan-European problem [4].

The RP objectives are based on the idea of nature conservation ecosystem concept, which consider the conservation of *Margaritifera margaritifera* to be successful only if it is conserved in the Czech Republic in such a state that it is viable as a species and capable of independent reproduction in natural conditions. The conservation of the species in the Czech Republic can be considered successful if at least two of the three Conservation Units (Aš, Blanice, Malše populations; division based on genetic tests) manage to achieve a state where natural reproduction of the freshwater pearl mussel will successfully take place in conditions close to nature.

Currently, in all locations in the Czech Republic where freshwater pearl mussels occur, semi-natural breeding of old freshwater pearl mussel populations is taking place in parallel with targeted interventions to improve the condition of entire freshwater pearl mussel streams. Targeted interventions include, in particular, measures to improve water quality, anti-erosion measures, and changes in vegetation cover around springs and other parts of the stream, associated with the adjustment of forest management plans. Physico-chemical water parameters are measured at all monitored locations with the freshwater pearl mussel occurrence. Management of the breeding and reproductive features in the Blanice, Lužní stream, and Zlatý stream continues in the form of the cross-section maintenance, food channels, mowing, and subsequent composting of the mowed material, including the return application of compost to breeding or food features. The total number of freshwater pearl mussels at individual monitored sites in the Czech Republic is approximately 14,500 individuals. Subadult individuals, which originate from natural reproduction, are currently found in very small numbers in the Blanice, Malše, and Rokytnice near Aš town [2].

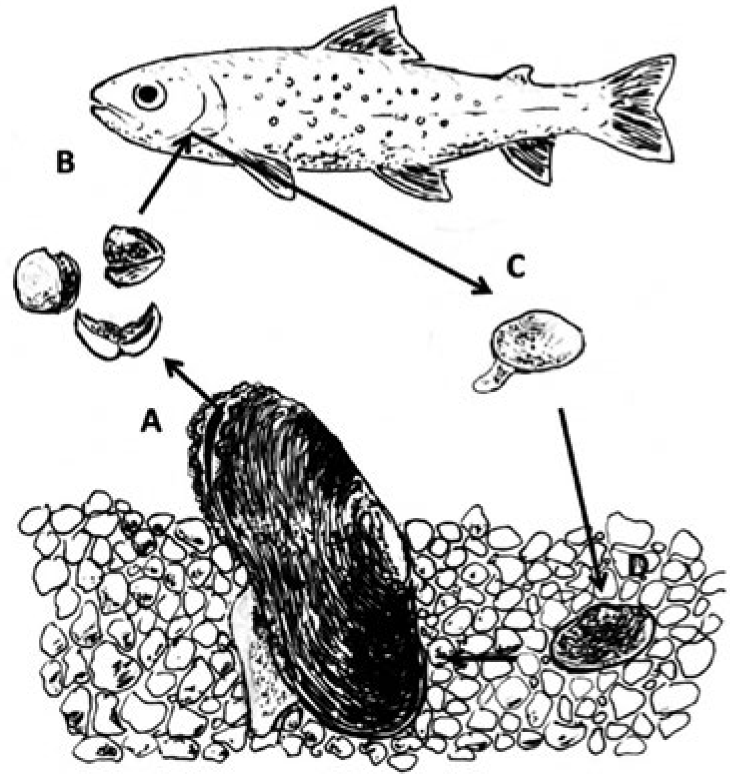


Fig. 2. The freshwater pearl mussel reproductive cycle. A – a sexually mature freshwater pearl mussel excreting a parasitic juvenile stage (glochidia), B – the glochidia attach to the gills of the host fish, where they metamorphose, C – after approximately a year, the juvenile freshwater pearl mussel falls off the host and subsequently burrows into the bottom substrate – D (illustration: M. Bílý)

Fig. 3. A colony of freshwater pearl mussels (photo: O. Simon)

STONE CRAYFISH

The stone crayfish (*Austropotamobius torrentium*) is a specially protected species according to Act No. 114/1992 Coll., on the Protection of Nature and Landscape, classified as critically endangered according to Decree No. 395/1992 Coll., and a critically endangered species according to the *Red List of Invertebrates of the Czech Republic* [8]. At the European Union level, it is a priority species protected by Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora [9, 10].

Although the occurrence of the stone crayfish in our country is rarer than the occurrence of the noble crayfish (*Astacus astacus*), its original distribution in the Czech Republic is not known. The stone crayfish used to be even considered a non-native species and its sites of occurrence are being constantly discovered. As of the end of 2024, 38 sites of its occurrence were registered [10].

As a critically endangered species, the stone crayfish faces many negative factors. The most significant of these are crayfish plague and habitat loss. Crayfish plague, a disease caused by the oomycete *Aphanomyces astaci*, is fatal to our crayfish species [11]. There is currently no effective treatment for this disease and under current conditions it is essentially impossible to prevent its spread. However, it is necessary to try to limit or slow down this spread. The primary host of this pathogen is non-native and invasive species of crayfish originating from North America, which are themselves resistant to the infection but are its vectors. There are currently three invasive crayfish species in the Czech Republic – signal crayfish (*Pacifastacus leniusculus*), spinycheek crayfish (*Faxonius limosus*), and marbled crayfish (*Procambarus virginalis*). However, crayfish plague can also be transmitted by the Chinese mitten crab (*Eriocheir sinensis*) [12, 13]. Moreover, these species are strong competitors of native crayfish species (e.g. in food, shelter, etc.). A fundamental problem is that to transmit crayfish plague to a location, the presence of infected crayfish is not necessary; the spores can survive in water for up to one month without a host [14]. Therefore, infected water, fishing equipment, machines, or animal fur are sufficient to spread the disease. In the last five years alone, we have lost up to 20 % of the stone crayfish population in the Czech Republic due to crayfish plague [15].

Although crayfish plague is a major threat, habitat loss is often a more fundamental problem; however, it has a much higher potential for elimination. These include inappropriate interventions in riverbeds, water pollution, and siltation of riverbeds with fine-grained material. These negative factors are also responsible for the disappearance of several locations where stone crayfish occur [10, 16].

Fig. 4. An example of stone crayfish habitat (BRDY PLA, photo: J. Hronková)

For these reasons, the RP for the stone crayfish establishes measures which can positively influence the population status of this critically endangered crustacean in the Czech Republic. Given the negative factors affecting the stone crayfish, most of the measures concern management of its habitat. It is necessary to ensure satisfactory water quality, which will be influenced by the construction and parameters of new and existing wastewater treatment plants, to further eliminate poisoning, to prevent silting of the riverbeds, and also to actively manage the hydromorphological properties of the riverbeds. Active species management (i.e. the individual as such), such as *ex situ* breeding, is not the goal of this RP. Management of the species will only be carried out in the event of a crisis, such as necessary rescue transfers in the event of watercourse poisoning, drying out, during riverbed modifications, or as prevention against approaching crayfish plague [10]. However, species management is also related to efforts to slow the spread of crayfish plague and to eliminate and eradicate invasive crayfish species, as well as mammals, such as the northern raccoon [17].

Despite all these measures, public outreach and research activities cannot be neglected. Education is essential in the fight against invasive species, and greater awareness among fishermen, watercourse managers, and the general public can have a very significant impact on the spread of invasive crayfish species. People often rescue invasive crayfish species, thinking they are our protected species, and unknowingly help spread the devastation that crayfish plague brings to populations of native crayfish species [10, 18].

Fig. 5. Stone crayfish (photo: M. Štambergová)

As already mentioned, watercourses are one of the most endangered habitat types worldwide. They represent a complex and highly sensitive environment that is home to a huge number of protected and unprotected plant and animal species. By protecting specially protected species, such as the freshwater pearl mussel and the stone crayfish, we protect all animal and plant species associated with this habitat. With their sensitivity to environmental conditions and bioindication abilities, the freshwater pearl mussel and stone crayfish are very important umbrella species for aquatic habitats [3, 4, 10].

Detailed information on the annual evaluation of the RP for the freshwater pearl mussel and the exact wording of both RPs can be found on the Nature Conservation Agency website – www.zachranneprogramy.cz for individual species in the "Download" section.

Acknowledgements

This article is implemented within the framework of project No. SS02030027 "Water systems and water management in the Czech Republic under climate change conditions (Water Centre)" with state support from the Technology Agency of the Czech Republic and the Ministry of the Environment within the "Environment for Life" Programme.

References

[1] DUDGEON, D., ARTHINGTON, A. H., GESSNER, M. O. Freshwater Biodiversity: Importance, Threats, Status and Conservation Challenges. *Biological Reviews of the Cambridge Philosophical Society*. 2006, 81, pp. 163–182.

[2] AOPK. *Záchranné programy*. 2024. Available at: https://www.zachranneprogramy.cz/

[3] ROBERGE, J.-M., ANGELSTAM, P. Usefulness of the Umbrella Species Concept as a Conservation Tool. *Conservation Biology*. 2004, 18, pp. 76–85.

[4] AOPK ČR. *Záchranný program perlorodky říční Margaritifera margaritifera v České republice.* 2013. 77 pp., 10 Appx.

[5] BLAŽEJOVÁ, E., HIDALGOVÁ, Š., HRUŠKOVÁ, K., JELÍNKOVÁ, J., REITSCHLÄGER, J. D. *Koncepce aktivních nástrojů druhové ochrany v České republice 2023–2032*. Prague: MoE CR, NCA CR, 2023. 88 pp.

[6] HRUŠKA, J. *Záchranný program Margaritifera*. Prague: ČÚOP, 1993. 20 pp.

[7] ABSOLON, K., HRUŠKA, J. *Záchranný program Perlorodka říční (Margaritifera Linneaeus, 1758) v České republice*. Prague: NCA CR, 1999. 27 pp.

[8] HEJDA, R., FARKAČ, J., CHOBOT, K. *Červený seznam ohrožených druhů České republiky. Bezobratlí.* Prague: NCA CR, 2017. 612 pp.

[9] ŠTAMBERGOVÁ, M., SVOBODOVÁ, J., KOZUBÍKOVÁ, E. *Raci v České republice*. Prague: NCA CR, 2009. 255 pp.

[10] HRONKOVÁ J. (ed.). *Záchranný program pro raka kamenáče v ČR*. Prague: NCA CR, 2024. 87 pp.

[11] SÖDERHÄLL, K., CERENIUS, L. The Crayfish Plague Fungus: History and Recent Advances. *Freshwater Crayfish*. 1999, 12, pp. 11–35.

[12] SCHRIMPF, A., SCHMIDT, T., SCHULZ, R. Invasive Chinese Mitten Crab (*Eriocheir sinensis*) Transmits Crayfish Plague Pathogen (*Aphanomyces astaci*). *Aquatic Invasions*. 2014, 9, pp. 203–209.

[13] SVOBODA, J., STRAND, D. A., VRÅLSTAD, T., GRANDJEAN, F., EDSMAN, L., KOZÁK, P., KOUBA, A., FRISTAD, R. F., KOCA, S. B., PETRUSEK, A. The Crayfish Plague Pathogen Can Infect Freshwater-Inhabiting Crabs. *Freshwater Biology*. 2014, 59(5), pp. 918–929.

[14] OIDTMANN, B. Diseases in Freshwater Crayfish. In: ROGERS, D., BRICKLAND, J. (eds.). *Crayfish Conference, Leeds, 26th–27th 2000,* pp. 9–18.

[15] VLACH, P., FISCHER, D. *Závěrečná zpráva, rak kamenáč, rok 2017. Nepublikovaná zpráva*. Prague: NCA CR, 2017.

[16] SVOBODOVÁ, J., ŠTAMBERGOVÁ, M., VLACH, P., PICEK, J., DOUDA, K., BERÁNKOVÁ, M. Vliv jakosti vody na populace raků v České republice – porovnání s legislativou ČR. *Vodohospodářské technicko-ekonomické informace*. 2008, 50(6), pp. 1–5.

[17] ANDĚRA, M., HORÁČEK, I. *Poznáváme naše savce.* Prague: Sobotáles, 2005. 327 pp.

[18] SVOBODOVÁ, J., KOZUBÍKOVÁ BALCAROVÁ, E., FISCHER, D., VLACH, P., ŠTAMBERGOVÁ, M., PICEK, J., SEMERÁDOVÁ, S., ŠTRUNCOVÁ, E., BERÁNKOVÁ, T. *Metodika regulace a eradikace invazních druhů raků: výběr vhodných metod v závislosti na charakteru vodního útvaru.* Prague: T. G. Masaryk Water Research Institute, p. r. i., 2020. 117 pp.

[19] *Vyhláška č. 395/1992 Sb.* Vyhláška ministerstva životního prostředí České republiky, kterou se provádějí některá ustanovení zákona České národní rady č. 114/1992 Sb., o ochraně přírody a krajiny.

[20] *Zákon č. 114/1992 Sb., o ochraně přírody a krajiny.*

[21] *Směrnice Rady 92/43/EHS ze dne 21. května 1992 o ochraně přírodních stanovišť, volně žijících živočichů a planě rostoucích rostlin.*

Authors

Ing. Jana Hronková[1]
✉ jana.hronkova@nature.cz

Ing. Kateřina Římalová, Ph.D.[1]
✉ katerina.rimalova@nature.cz

RNDr. Jitka Svobodová[2]
✉ jitka.svobodova@vuv.cz
ORCID: 0000-0002-4811-503X

[1]Nature Conservation Agency of the Czech Republic, Prague (Czech Republic)
[2]T. G. Masaryk Water Research Institute, Prague (Czech Republic)

An informative article that is not subject to peer review.

ISSN 0322-8916 (print), ISSN 1805-6555 (on-line).

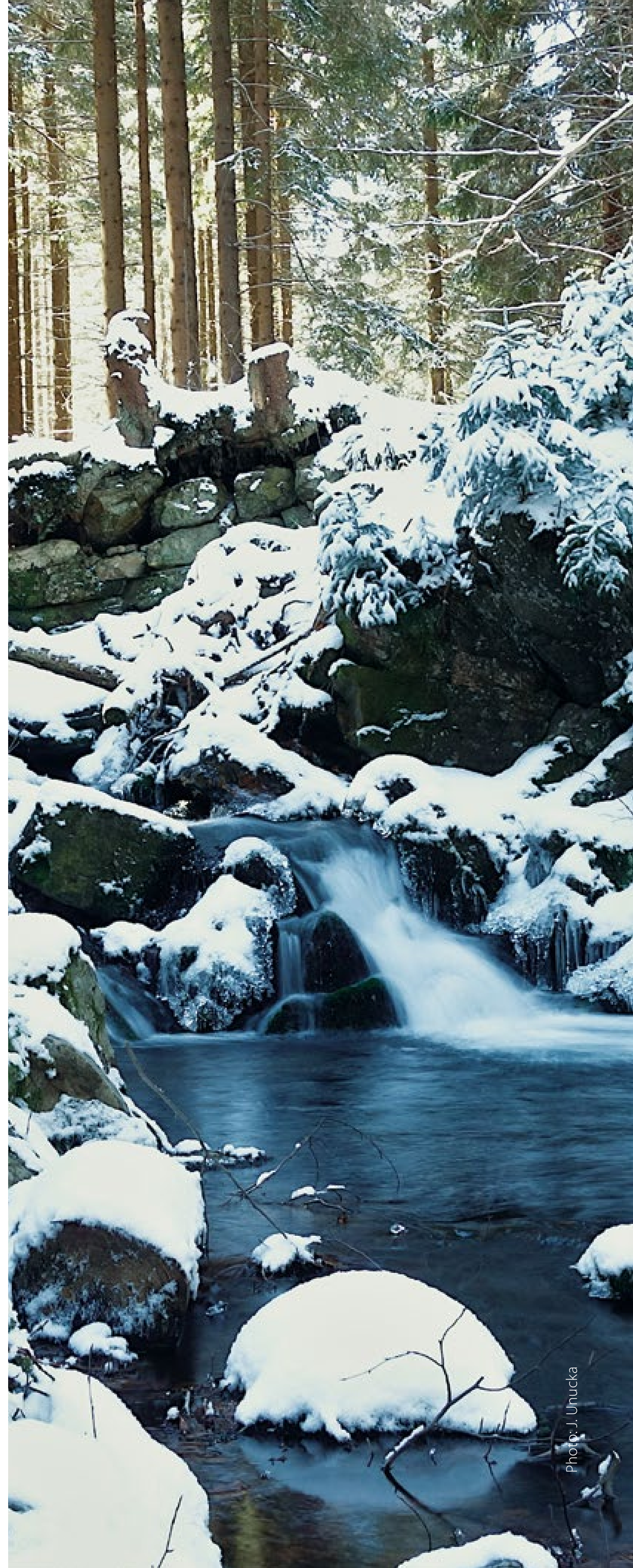


Photo: J. Unucka

Photo: J. Unucka

Authors of VTEI

Ing. Libor Ansorge, Ph.D.
TGM WRI, Prague (Czech Republic)
✉ libor.ansorge@vuv.cz
www.vuv.cz

Ing. Libor Ansorge, Ph.D., has been a TGM WRI employee since 2011, and since 2018 he has been Deputy Director for Research and Professional Activities. In 1997 he completed his engineer studies at the Faculty of Civil Engineering of the Czech Technical University in Prague, majoring in Water Management and Water Structures, and in 2017 he completed a doctoral study programme in Environmental Engineering at the same faculty. Within his profession, he deals with a wide range of issues related to water use, focusing on future water needs for society and environmental assessment of water use. As a principal investigator or a research team member, he has participated in several research projects.

Ing. Věra Očenášková
TGM WRI, Prague (Czech Republic)
✉ vera.ocenaskova@vuv.cz
www.vuv.cz

Ing. Věra Očenášková is a long-time employee of the T. G. Masaryk Water Research Institute. She graduated from the University of Chemical Technology in Prague, Faculty of Food and Biochemical Technologies. In 2008–2013, she was the head of the Department of the Reference Laboratory of Environmental Components and Waste, now the Department of Analysis and Evaluation of Environmental Components; she still works at its hydrochemical laboratory. She represented the Czech Republic in the CMPE (Chemical Monitoring and Emerging Pollutants) working group under the Common Implementation Strategy WFD. She cooperates with the international association NORMAN and SCORE Network. She mainly deals with monitoring environmental contaminants, especially components of the hydrosphere. She is the researcher in several projects and the author of a number of publications. In recent years, she has been working on the issue of an epidemiological approach to wastewater (WBE – Wastewater-Based Epidemiology).

Ing. Jana Hronková
Nature Conservation Agency of the Czech Republic, Prague (Czech Republic)
✉ jana.hronkova@nature.cz
www.nature.cz

Ing. Jana Hronková has been working at the Nature Conservation Agency of the Czech Republic since 2021, in the Department of Animal Species Protection. She graduated from the Faculty of Environmental Sciences of the Czech University of Life Sciences in Prague, majoring in Applied Ecology, and then obtained a master's degree in Nature Conservation. She is currently studying for a PhD in Ecology. Within her studies, she mainly deals with hydrobiology, focusing on aquatic invertebrates.

Ing. Pavel Richter, Ph.D.
TGM WRI, Prague (Czech Republic)
✉ pavel.richter@vuv.cz
www.vuv.cz

Ing. Pavel Richter, Ph.D., has been an employee of the Department of Water Protection and Informatics at TGM WRI since 2007. In 2008, he completed the Regional Environmental Administration study programme at the Faculty of Environmental Sciences of the Czech University of Life Sciences in Prague in the Landscape Engineering Master's degree programme. In 2015, he successfully completed Applied and Landscape Ecology in the Environmental Sciences doctoral study programme. At the Czech University of Life Sciences in Prague, he currently teaches Landscape Ecology and Basics of Landscape Ecology and works as a supervisor of bachelor's and diploma theses. He focuses on the issue of water retention in the landscape and the development of the landscape based on the interpretation of archival map data, especially on landscape changes in wetlands, water surfaces, and watercourses, including their floodplains. Within the operation of the Hydroecological Information System, he mainly deals with ISVS-VODA records and records of administrative divisions, protected areas, watercourses, water surfaces, and hydrological river basins.

Mgr. Jan Grolich, Governor of the South Moravian Region, awards a silver commemorative medal to Dr. Ing. Antonín Tůma for his selfless commitment in managing the flood in September 2024

Interview with Dr. Ing. Antonín Tůma, Deputy General Director of the Morava Basin State Enterprise

For the February issue of VTEI, we interviewed a long-time employee of the Morava Basin State Enterprise, the director of the Basin administration, and since 2006 the deputy general director of this organization. A man for whom water management is not a job, but a mission. "Water is the carrier of not only life, but also information and energy. Something so simple, yet so extraordinary, irreplaceable…," says Dr. Ing. Antonín Tůma.

Dr. Tůma, you graduated from the Brno University of Technology, majoring in Water Management and Hydraulic Structures. Why did you choose this field?

The field of Water Management and Water Structures at the Brno University of Technology was a continuation of Water studies that I had started at the Secondary Technical School of Civil Engineering in Brno. It was decided by a personal interview with the then principal of the technical school, Heřman Šťastný. I applied for Civil Engineering and was not accepted due to the large number of applicants. I appealed, my appeal was granted and I was offered an interview with the school management. Although I had already been accepted, I took advantage of the offer of an interview and I will never forget it. The principal was interested in the reasons for my appeal, my interests, why I did not apply, for example, to Geodesy or Water Management Structures, which were offered to me. He was able to speak knowledgeably about all the fields, about their importance, necessity, and application in practice. He was not trying to influence me; he just expressed his opinion on these fields and told me what he would choose if he were me and why. He told me that I had been accepted to the Department of Civil Engineering and that I should decide for myself and on the appointed date. And even though Water studies lasted a year longer, it was his words that water management was not a job but a mission that decided. So, I asked to be transferred to the Department of Water Management and his words about the mission still ring in my head; he was absolutely right.

You have been working for the Morava Basin State Enterprise for more than three decades. Can you remember your professional beginnings?

It is impossible to forget. I joined the Water Development Department and the interviews, as well as the first weeks and months still come back to me and are inspiring to me. Once again, luck played a role in the personalities who accompanied me throughout my professional life. In our very first interview, the head of the department, Ing. Pavel Rotschein was able to explain the mission that the principal of the industrial school had spoken about ten years before. He introduced me not only to all the department's agendas, but also to all the company's professional activities. I remember it like it was today. It was a time before the Velvet Revolution and he already said back then that water management is a lifelong job, that water will continue to be the most essential element in the future and the need to protect it will be increasingly crucial.

What ambitions did you have when you started working for the Morava Basin, and have these ambitions changed over time based on your experience?

I would not say ambitions. I was young, did not have much experience, but I knew that I wanted to stay in the field of water. I chose to work at the Morava Basin because of the complexity of the management of water resources, watercourses and, above all, the entire river basin; as I say, from Poland to Austria. The only thing that has changed is that water needs more care, it is becoming increasingly important, it is increasingly vulnerable. We have little of it, none flows into our country, and what we have we must share responsibly with the landscape; it needs it for its survival just as much as humans do. Climate change constantly brings new challenges, for example in the area of water quality. In the past, we set limits on the extent to which wastewater needs to be treated in order to establish an optimal equilibrium state; however, conditions in watercourses have changed. Climate change is increasing air and water temperatures, flows are decreasing, many watercourses – even significant ones – are becoming intermittent streams, and there is literally nothing to discharge into. For weeks, only treated, and often untreated, water flows in our streams. The result is surface water trophism, accompanied by fish deaths and accidents.

In the last few years, the Morava Basin State Enterprise has implemented a number of semi-natural restoration measures. For example, restoration of the Jihlávka stream in the village of Prostředkovice near Jihlava, the restoration of the Banínský stream near Svitavy that began last year, or the restoration of the Svratka near Jimramov. How do you personally perceive these measures?

I do not understand why non-governmental, ecological, and other organizations are fighting over the form of flood protection, as well as the fact that other entities and organizations are getting involved in this fight. There is nothing to argue about, nothing to measure. Semi-natural measures and technical flood protection measures cannot be compared. Measures in the landscape (infiltration, changes in landscape management and so on) are intended to prevent surface runoff and ensure that floods do not occur in the network of watercourses. If a flood comes, it means that all of the above could no longer function, and then we have large flows in watercourses, high levels, and we must either protect ourselves from the negative effects of this element or run away, move out. There is no other solution. We must realize that all property owners, both natural and legal persons, as well as towns and villages, are responsible for flood protection, according to the Government-approved *Flood Protection Strategy in the Czech Republic* from 2000. In order to reduce the burden on protected entities, the state has created a number of subsidy titles under the responsibility of the Ministry of Agriculture and the Ministry of the Environment in connection with this strategy. And the protected entity must prepare for the worst – that is, even for a period when the landscape is frozen, vegetation is not growing and the area is fully saturated. This is precisely where we can see that the two parties are waging an unnecessary fight, because the measures complement each other – where semi-natural measures with regard to the amount of precipitation end, technical measures begin; flood protection depends on both. It is necessary to realize why we are proposing these measures. If we are to protect ourselves from a flood caused by precipitation totalling 50 mm or even 100 mm, then we must have realistic measures that can accommodate this volume of water – the landscape, the valley floodplain without development – and at the same time prevent this mass from moving down the slope. Today, we are able to model and predict the situation well, including processes in watercourses and interaction with groundwater. To give an example, last September above Vranov, the landscape functioned well; it was not frozen and the area is partially forested, so the soil had the ability to infiltrate well and the excess water that the landscape did not retain was 126 million m^3. This volume was already in the watercourses and no measures other than technical ones could solve the problem. Part of it was discharged in advance before the rainfall, part was released through capacious dammed watercourses during the rainfall and the rest after the rainfall, so that villages and towns were not flooded. Thanks to the flow control at the Vranov reservoir, the Thaya was flowing at 220 m^3/s; without the reservoir it would have been 435 m^3/s. It was similar on the Svratka below the Vír reservoir. Due to the flow control, it was possible to discharge 40 m^3/s, without the reservoir it would have been 138 m^3/s – that is why the city of Brno was not under water. In both cases, however, the landscape retained the precipitation, capturing some of it, but only in the volume possible.

What other projects are you currently implementing and planning within the basin management?

Our priority is to mitigate both hydrological extremes, i.e. both the impacts of floods and increasing the security of raw water supplies for the water industry. The public is not aware of these impacts at all; people do not have basic information. More than half of the Czech population does not have access to quality drinking water and is dependent on drinking water from reservoirs – that is, surface water. How is it possible that there are people who fight against reservoirs? They are actually fighting against humans having the opportunity to drink water in the future. And not only humans, but all animals and plants. Groundwater supplies are decreasing, and their quality is threatened by all kinds of pollution. What about water? I will try to put it simply. Previously, the planet was able to manage the water cycle itself. It has lost this ability due to human intervention, and it is up to us to try to help this management. Extremes are getting worse, and we can mitigate them by participating in water management. In times of surplus, we will accumulate it and in times of shortage, we will use the accumulated water. We can only do management in reservoirs from which we are able to abstract water during a long-term drought, ensure the supply of raw water, improve minimum residual flows, for example for diluting wastewater, etc. To be specific: we are preparing the construction of the Vlachovice reservoir, which will be a source of drinking water for the Zlín region but can also provide other functions – protect against floods, improve ecological flows below the reservoir, and more.

As part of our efforts to mitigate the impacts of floods, our next major project is the preparation of the Skalička reservoir on the Bečva. At the moment, towns and villages on the Bečva have the opportunity to protect themselves from a maximum of fifty-year water. This is due to the floodplain morphology and the size of floods on the Bečva. That is why the reservoir is important; it will help ensure or supplement protection up to the level of a hundred-year water. It is incomprehensible to me that the public, especially those who are environmentally focused, blocked the construction of a multi-purpose reservoir and pushed through a dry reservoir. Such a reservoir can capture flood, but it cannot manage water. In the future, we will increasingly lack water. We can expect the same amount of water from annual precipitation, but it will be unevenly distributed and we will share the water with nature. Nature is already consuming more and more of it to cope with climate change. We have greater evaporation, evapotranspiration, and only less than half of the water reaches the watercourse network. This is how it should be, because the landscape is able to manage the water – due to higher temperatures and a longer growing season, it will take in enough water to survive. Humans should do the same – they should not lose the opportunity to retain spring water and rainwater in a reservoir and use it for all the purposes described above in the summer, during drought. Flood protection is always a combination of a number of measures, from retaining water in the landscape to technical measures such as dam systems, controlled inundations, and the construction and operation of large reservoirs. The measures therefore complement each other; do not compete with each other but build on each other.

If I am not mistaken, it is mainly thanks to your efforts that the Soutok area is flooded in a controlled manner every spring.

Climate change impact is most evident in South Moravia in the area of the confluence of the Morava and the Dyje, which is called Soutok. The unevenness of precipitation and, above all, the decline in flow rates in watercourses due to high water consumption in the landscape in the dry months also cause a decline in groundwater levels. The crystalline rocks of the Vysočina cannot retain much water and do not release it into the basin below. The Quaternary of the Morava River suffers equally during times of low flow, and so the alluvial forests at the confluence suffer as well. I consider this to be the worst impact of climate change; the upper parts of the centuries-old oaks dry up and the entire area suffers. And so, based on the requirements of the Soutok administrator, Forests of the Czech Republic, we are trying to use the capabilities of the Nové Mlýny reservoir system, accumulate surface spring water in reservoirs and create an artificial flood, which will allow the alluvial forest to be flooded with increased flows and a system of canals. However, this can only be done when there is enough water. The Forests of the Czech Republic state enterprise responded to this fact and prepared the project titled "*Restoration of the natural water regime of the restored system in Soutok – Podluží SCI*", which will include not only the restoration of the entire historical system of canals and equipment, but also the construction of a reservoir on the Thaya, the aim of which will be the effective use of water for "flooding". I personally estimate that this measure will ensure approximately 80 percent water savings. I am talking about saving water that must flow through the Thaya in to be able to "flood". This water is not lost but flows via the Thaya to the neighbouring countries. However, thanks to the dam, "flooding" will be possible almost at any time and with less demand on flow rates, and the "saved" water can then be used, for example, in times of drought.

In September last year, floods hit the Czech Republic, largely in the area managed by the Morava Basin State Enterprise. Although forecasts indicated that floods would occur, the extent of the floods surprised everyone.

The scale really surprised us. No one expected that catastrophic floods like those in 1997 could be repeated so soon with this intensity and in the same place. It is becoming evident that flood extremes are deepening and that they can be expected with a much greater probability than statistics indicate. A five-hundred-year flood can thus occur much more often than once in five hundred years, but then the time for the next flood to arrive should be extended; these are statistics. However, I myself think that a lot has changed and that floods will occur more often, as will dry periods. We should be wise enough to realize this, learn to live with floods and droughts, prepare for them, and not fight them. We will not win over floods or droughts, we will not stop them, we can only reduce their impacts and in some cases even eliminate them.

From your perspective, how did these latest floods compare to previous ones and what additional experience did they bring you?

Last year's floods were significantly different from the floods of 1997 – not so much in their volume, but especially in the communication and coordination of individual components: the Reporting and Forecasting Service, responses of water managers to the control and transformation of floods by waterworks, rescue services, coordination between crisis teams, implementation of preventive measures, and evacuation of residents. This is called flood management; a process of effectively responding to a flood with the aim of minimizing its negative impacts.

Compared to other floods, all these measures were exceptional. Starting with the forecasts, which were not only accurate, but especially timely. Everyone could prepare for the floods well in advance, and where we had reservoirs available, we were able to pre-drain them sufficiently, literally create an artificial flood in the watercourses even before the rain started (but only up to the capacity of the riverbeds) and prepare sufficient space for the flood transformation in the reservoir. For this, all reservoirs have free retention space, but here, considering the size of the expected flood, it was necessary to free up the reservoir's storage space so that the extreme flood could be dampened as much as possible. However, if the flood had not occurred, it would have had an impact on drinking water supply – mainly reservoirs for water supply were pre-drained, especially Vír, Vranov and others. These reservoirs saved a number of towns and villages, especially on the Svratka and Thaya rivers. We gradually gain experience with all floods. After a flood, we have enough time for calculations and evaluations. During floods, dispatchers have to make decisions within a few seconds or minutes and consider an incredible amount of information. Every flood is different, so it is necessary to know the saturation of the area, which changes its finish and influences its transformation, to consider the culmination of tributaries, their time distribution, to exclude their confluence by controlling reservoirs, to know the capacities not only of watercourses with dam systems, but also inundation volumes, free spaces in water reservoirs, to address the impact of rainfall dilution effect during floods... It would be an endless list.

In September 2024, all this experience was put to good use and the floods in the Thaya-Svratka system were transformed into harmless flows. The capacities of the dammed watercourses were used to the maximum extent, water was pre-drained in a timely manner and with great precision before the rainfall, water was maintained in the riverbeds and active zones during the flood period by controlling, and reserves were even created in the event of repeated extreme rainfall. The lowest reservoirs – the Nové Mlýny reservoir system – were pre-drained in a timely manner – the upper reservoir even up to the inactive storage water level, in order to create a greater gradient for the drainage of the area in the basin above the reservoirs, which is always extremely and for a long time saturated by the passage of the flood. On the Morava, where there is a large absence of reservoirs, it was not possible to create retention and it was necessary to rely on flood control measures that were built after 1997. They all worked very well, as long as the flood in the area was not greater than the design flow for the built protection. The Branná, Krupá, Desná and the upper reaches of the Morava had to withstand up to a five-hundred-year flood and larger; there, the dam systems were exceeded and overflowed. However, there was no break in dams, as the media mistakenly reported. The same applies to the Oder river basin area. It is necessary to realize that at the moment, the repair of the water management infrastructure damaged by the flood is our top priority, and I estimate, this will take more than ten years.

In the case of floods and droughts, water managers and the state often face criticism from the public that they are not doing enough to fight it. What do you think of this criticism and what message would you send to the public?

It is a misunderstanding of basic natural processes. People believe what they hear, what someone presents, without checking whether it is true. Then they evaluate our work, which they do not understand, subjectively. I have already mentioned this in my previous responses. People want sensations; for example, in the media, local citizens, who usually only have local experience, give their opinions to reporters about the course of the flood, and experts are not given space. People believe simple statements and do not try to ask themselves questions and use common sense to find answers. How much did it rain? How long did it rain? What would happen if those five hundred millimetres fell on my garden? Where would the water flow if it also flowed from the neighbours? How much would it be? etc. Then they would not believe that farmers or the head of the dispatch centre are to blame; this happens as well. People call, saying that we are to blame, that we let it in, that it is our water (even if there are no reservoirs there). What would I say to them? Educate yourselves, be interested, and feel free to call or write if something is unclear. But most importantly, trust the experts. They do this work so that water does not harm, so that there is enough of it not only for humans, but also for nature, and so that future generations have the same access to water as we do. There will be less and less of it, and we cannot do without it.

Raising awareness of your work is not just a matter of issuing press releases. For example, your colleague is behind the interesting project "*Water with a Brush and a Poem*", which seeks to promote the topic of water and water management among the children. Especially in terms of its reach, I personally think that a project like this not only makes your work and the work of your colleagues more visible, but that also other river basin managers should join in.

We commemorate water and its importance every year in March as part of World Water Day. My assistant Ivana Frýbortová has been a co-organizer of these celebrations within the Svratka River Basin Council for more than two decades and wanted to do more to raise awareness of the importance of water. It is surprising how little we know about water, how we take it for granted. That is why a competition was created for schools whose themes are intended to bring the importance of water closer not only to children but also to their parents. It is gratifying to see more and more schools interested in participating in this competition. It is obvious that water and its importance are not only the subject of the competition, but also of teaching. Water deserves more awareness, from preschools to primary schools, and later as well. Education in this area is insufficient, as evidenced by public opinion, survey results, as well as discussions on flood protection, especially in the Oder river basin, and on the protection of Opava and other cities.

What do you think should be the focus of attention in water management in the future?

Attention needs to be focused on sustainable management of limited water resources. I have described this in detail in previous answers. It is not and will not be just a question of quantity, but especially of quality, and it will become increasingly difficult to maintain a balanced state in the water cycle.

Tell our readers what you want to work on in the future.

I would be happy if I could "infect" as many people as possible with the love of water. Caring for water, in any profession, is not a job, but a mission. And it is the most beautiful mission – to preserve something so exceptional and beautiful in all its forms for future generations, for the functioning of the planet and all ecosystems. Water is the carrier of not only life, but also of information and energy. Something so simple, yet so extraordinary, irreplaceable…

Dr. Tůma, thank you very much for the time you have made for our interview.

Ing. Josef Nistler

Dr. Ing. Antonín Tůma

Dr. Ing. Antonín Tůma, born on December 11, 1963 in Třebíč, graduated from the Brno University of Technology, majoring in Water Management and Water Structures, then continued his doctoral studies with a specialization in Water Protection. He is a long-time employee of the Morava Basin State Enterprise and has been the deputy general director of this organization since 2006. He is a member of many expert organizations, such as the chairman of the Commission for the Dyje Sub-Basin Plan and the vice-chairman of the Crisis Technical Staff of the Morava River Basin. He is the Czech representative on the editorial board of the Slovak water management journal *Vodohospodársky spravodajca*, and the director of 11 completed international projects within the framework of cross-border cooperation with the Slovak Republic and Austria. He was the head of the delegation of water managers of the Czech Republic at the World Water Technology and Environmental Control (WATEC) Conference Israel in 2009. He participated in many important professional water management lectures and conferences in the Czech Republic and abroad as a chairman, lecturer, or expert guarantor. He has completed countless training courses in managerial communication and presentation skills; he is an examiner and a certified engineer.

The "*Water Centre*" project is in its second half and presents its results

The Environment for Life programme, funded by the Technology Agency of the Czech Republic, has created research centers focused on environmental issues. One of them is the "*Water Centre*", which is the acronym of the *"Water Management in the Czech Republic in the Context of Climate Change"* project. The lead organization is T. G. Masaryk Water Research Institute, p. r. i. (TGM WRI). Other seven partner organizations are the Nature Conservation Agency of the Czech Republic (NCA CR), Czech University of Life Sciences (CZU), Czech Technical University in Prague, Faculty of Civil Engineering (FCE CTU), Czech Hydrometeorological Institute (CHMI), CzechGlobe, The Silva Tarouca Research Institute for Landscape and Ornamental Gardening, p. r. i. (VÚKOZ), and the University of Chemistry and Technology, Prague (UCT). The project duration is from July 2020 to December 2026, so currently halfway through its duration.

"Water Centre" deals with defining future needs and issues in the field of water management and water protection (including the impact of climate change) and possible measures to meet these needs and minimize problems.

Interesting solutions and partial results are presented annually at the "*Water Centre*" conferences. The fourth conference took place at the TGM WRI on November 19, 2024. The morning presentations focused on more comprehensive topics, as two work packages (WP) were to be completed in 2024.

In WP 1, the research team addressed the questions of how much water will be available in the future, how much will be needed, and where the biggest problems with securing it will arise. The analyses cover a longer time period, but the main conclusions were formulated for the year 2050. Prof. Miroslav Trnka from the CzechGlobe presented current climate change scenarios and their use for forecasting water availability. Dr. Adam Vizina compared the results of hydrological balance forecasts provided by global climate models (GCM) and the regional model ALADIN, and Ing. Ladislav Kašpárek, CSc., supplemented this presentation with a brief summary of how, from today's perspective, predictions from older climate models from the 1990s have come true. Ing. Jiří Dlabal summarized scenarios of future water needs by individual sectors of human activity (water consumption by the population, in crop and livestock production, in industry, and in the energy sector). He pointed out that permitted water abstractions are much higher than current needs (more than double), and the use of permitted quantities would cause problems in the water balance. Ing. Petr Vyskoč presented the results of the comparison of future water resources and needs and pointed out in which areas the greatest water shortage can be expected in the Czech Republic. The search for adaptation measures that can respond to these findings is mainly addressed by WP 3, which is currently being solved. The summary report for WP 1 was completed at the end of 2024 and published.

The recently completed WP 6 focused on the search and assessment of sources of surface water pollution, focusing on nutrients, polyaromatic hydrocarbons, and heavy metals. The research team organized a workshop on this issue in September 2024. At the "*Water Centre*" conference, Assoc. Prof. Ivana Kabelková from FCE CTU presented the results of the assessment of point sources of pollution from the pilot urbanized area of the town of Pečky. Based on a series of detailed measurements, the proportion of pollution entering surface waters through wastewater treatment plant (WWTP) discharges, from floodways, and also from storm water overflows was shown. Subsequently, Mgr. Silvie Semerádová summarized all key findings from this work package. A draft version of the summary report was published on the project website, the final version is available from the end of 2024.

The afternoon presentations were devoted to topics from other work packages.

Dr. Jan Bindzar from UCT, outlined the theses of the prepared methodology of possible progressive procedures and techniques for reducing pollutant concentrations in industrial wastewater, which are not commonly detected in urban WWTPs. It turns out that technologies for removing specific pollutants purify the water to such an extent that it is too clean for sewage and has rather the character of ballast water, and therefore its reuse should be considered.

Fig. 1. The floor is given to Dr. Adam Vizina…

Fig. 2. …and Ing. Ladislav Kašpárek, CSc.

Dr. Josef V. Datel talked about the use of artificial infiltration to replenish water sources (especially in the Káraný water treatment plant) and showed a selection of locations in deficit areas where the possibility of controlled groundwater replenishment will be assessed in more detail in the future.

Dr. Pavla Štěpánková analyzed possible approaches to defining the active zone of floodplains, which was commissioned this year as operational research within the "*Water Centre*". She then used examples to show how the results differ according to individual methodologies. The conclusions serve as a basis for the Ministry of the Environment decision on changes to regulations.

Ing. Jana Hronková from NCA CR and Dr. Jitka Svobodová presented the rescue programme for the stone crayfish, which was created based on the results of research conducted by the "*Water Centre*" and was approved by the Ministry of the Environment in July 2024.

All presentations are published on the "*Water Centre*" website, where a video recording of the conference is also available (www.centrum-voda.cz).

The fifth "*Water Centre*" conference will be held in autumn 2025.

Fig. 3. View into the hall

Fig. 4. Ing. Jiří Dlabal

Author and project researcher

Ing. Jiří Kučera
✉ jiri.kucera@vuv.cz
ORCID: 0000-0002-7540-4750

T. G. Masaryk Water Research Institute, Prague (Czech Republic)

An informative article that is not subject to peer review.

ISSN 0322-8916 (print), ISSN 1805-6555 (on-line).

Fig. 5. Presentation of Dr. Jitka Svobodová and Ing. Jana Hronková

Fig. 6. Author of the paper and the project researcher Ing. Jiří Kučera

Czech Copernicus User Forum and Remote Sensing Conference 2024 and the opening of *Czech Space Week 2024* with participation of the President of the Czech Republic

JAN UNUCKA, LUCIE BURSOVÁ, ANETA BERÁNKOVÁ

ABSTRACT

In November 2024, a conference was held focused on the use of satellite data, organized by the Czech Hydrometeorological Institute (CHMI) and the Ministry of Transport (MoT), under the auspices of the President of the Czech Republic, who delivered the opening speech. In addition to expert workshops and panel discussions, the conference also featured several interesting contributions from the Transport and Environment Ministries, which illustrated the real-world use of remote sensing data in applications focused on ecological burdens and hydrological forecasting, as well as climate change, transport monitoring, and landscape planning. One of the most important conclusions of the conference is the confirmation of the importance of remote sensing data in the daily work of not only state institutions, but also commercial companies. These data give us the spatial context of selected natural phenomena and processes that would be monitored only partially or not at all without these data.

INTRODUCTION

The topic of remote sensing (RS) has recently been increasingly associated with environmental issues. Copernicus is the European Union Earth observation programme which uses data from its own fleet of satellites called Sentinels. These satellites provide high frequency and precise data on the Earth's surface, atmosphere, oceans, and climate. The programme offers valuable information not only for scientific research, but also for practical applications, such as monitoring air quality, deforestation, urbanization, changes in the marine environment, and for crisis management in the event of natural disasters. Copernicus data is freely available, which supports its broad use across sectors from public administration to commercial use. More information can be found at: https://www.copernicus.eu/en

Copernicus has several important hydrological applications, not only at CHMI:

- Flood and drought monitoring:
  Data from the programme is implemented into GIS analyses, rainfall-runoff and hydraulic models, and helps predict extreme hydrological events and minimize their impacts through early warning and crisis management planning.
- Water resource monitoring:
  The programme contributes to accurate analysis of the state of surface and groundwater, which is key to sustainable water management.
- Water quality management:
  The Sentinel system allows monitoring of pollution in watercourses, lakes and seas, which is essential for protecting the environment and human health.
- Support for modelling the impacts of climate change scenarios:
  Copernicus provides input data for hydrological and environmental models that serve to better understand the dynamics of water systems, ecosystems, and the impacts of climate change.

National Secretariat of GEO/Copernicus (NSGC)

The Ministry of the Environment of the Czech Republic (MoE), in accordance with the Resolution of the Government of the Czech Republic No. 303 of 19 April 2017, established and manages the interdepartmental working body, the National Secretariat of GEO/Copernicus. The Secretariat is a permanent coordinating, initiating, and advisory body of the Minister of the Environment and members of the National secretariat of GEO/Copernicus and its partners, as well as the international Group on Earth Observations (GEO) initiative and other related space activities. The mandate and main activities of the National Secretariat are determined by its statute. Its main objective is to coordinate GEO and Copernicus activities in the Czech Republic, ensure the implementation of both programmes, and generally support the use of Copernicus data and services in the Czech Republic. From January 2024, the coordination of this agenda falls under the CHMI.

Conference history

As part of the promotion of RS activities and the Copernicus programme, a conference has been organized annually in the Czech Republic since 2012, previously under the name GMES (Global Monitoring for Environment and Security). Today, this programme is known only as Copernicus.

2024 Conference

The *Czech Copernicus User Forum and Remote Sensing Conference 2024* took place on 4–5 November in the Fanta Building in Prague. The main organizers were CHMI and MoT. Before the conference itself, an event on space activities in the Czech Republic was held – *Czech Space Week 2024* (CSW). Among other things, the Czech President Petr Pavel said that: "Space exploration and the space industry are exactly the sector that I am convinced that the Czech Republic should pay great attention to. It is an area with high-quality technology, high added value, and huge potential not only for the Czech Republic, but also for international cooperation."

Meeting of experts under the auspices of the President of the Czech Republic took place at Fant's Café in Prague (photo: A. Beránková)

First day of the conference

The first day of the conference was divided into five parts:

1. Outlook for European Earth Observation Programmes 2025+
This part featured presentations on the possibilities of participating in InCubed programmes in the Czech Republic under the auspices of the European Space Agency (ESA). One example was the ongoing SKAISEN programme, which is run by the start-up ZAITRA.

2. Copernicus Academy
This part presented the activities of the Copernicus Academy network, which connects universities, research institutions, and other entities. The possibilities of education, research, and cooperation in the field of RS were discussed. There were also presentations from Czech universities, for example on selected approaches for detecting the cooling effect of urban vegetation using RS (Palacký University), the use of Sentinel-1 data and machine learning for forest monitoring (Charles University) and others.

3. Remote sensing at the Czech Hydrometeorological Institute and departmental organizations of the Ministry of the Environment
This part included the following topics – presentation of the third-generation Meteosat satellite system (CHMI), use of spatial data for inspection activities of the Czech Environmental Inspectorate (CEI), analysis of river basin runoff conditions and use of RS data (CHMI). In this case, it was the use of satellite data in forest hydrology and also for verification and calibration of hydraulic models simulating the course of the September floods in the Opava, Bělá, and Vidnávka river basins.

4. Panel discussion on digital twins
The panel discussion, chaired by Ondřej Šváb from the MoT, focused on the role of digital twins in the Czech Republic. The concept of a digital twin has established itself in industry, where it includes simulations of the production and life cycles of machines or components; however, it is also being used in environmental applications. An example is the digital twin Earth-2 from Nvidia.

5. Promising applications of Earth observation
It is clear not only from the presentations and workshops at the seminar that the use of RS in environmental applications already has a firm place in the research sphere and in operational practice. In the Czech Republic, this data is used on a daily basis in the departments of transport, security or the environment. This includes not only monitoring short-term phenomena (weather, floods, fires, slope deformations and movements or traffic collapses), but also long-term ones (changes in forest health, changes in land use or volumetric and qualitative changes in water bodies or glaciers).

Each part offered a unique perspective and contribution to the issue, allowing everyone to find what interests them.

Second day of the conference

The second day of the conference was designed as an international half-day workshop organized by the Copernicus Atmosphere Monitoring Service (CAMS). A total of 82 participants discussed the use of data for monitoring and forecasting air quality in the Czech Republic.

Richard Engelen from the European Centre for Medium-Range Weather Forecasts (ECMWF) presented the Copernicus Atmosphere Monitoring Service (CAMS), its architecture and innovations in atmospheric data modelling, including improvements to aerosol analysis and reanalyses at the global and European levels. A new version of the system was also presented, with improved chemical schemes and tools for data visualization and analysis.

Cristina Ananasso from ECMWF explained the functioning of the National Cooperation Programme (NCP), which helps Member States implement and adapt CAMS data at the national level. Subsequently, Thomas Popp from the Deutsches Zentrum für Luft- und Raumfahrt (DLR) presented the results of interviews with Czech CAMS users, which showed specific applications for air quality assessment and smog warnings.

The workshop also opened a discussion on the possibilities for improving the modelling of atmospheric transport of Saharan dust and other challenges associated with air pollution forecasting.

Authors

doc. RNDr. Jan Unucka, Ph.D.[1]
✉ jan.unucka@chmi.cz
ORCID: 0000-0003-4339-0726

Mgr. Lucie Bursová[2]
✉ lucie.bursova@chmi.cz

MgA. Aneta Beránková[2]
✉ aneta.berankova@chmi.cz

[1]Czech Institute of Hydrometeorology, Ostrava (Czech Republic)
[2]Czech Institute of Hydrometeorology, Prague (Czech Republic)

An informative article that is not subject to peer review.

ISSN 0322-8916 (print), ISSN 1805-6555 (on-line).

Content of VTEI — Year 2024

1

2

3

4

5

6


Photo:123rf.com


Photo: J. Unucka

VTEI/2025/1

Since 1959

VODOHOSPODÁŘSKÉ
TECHNICKO-EKONOMICKÉ INFORMACE

WATER MANAGEMENT
TECHNICAL AND ECONOMICAL INFORMATION

A scientific bimonthly journal specialising in water research. It is included in the List of peer-reviewed non-impacted periodicals published in the Czech Republic

Volume 67

Published by: Výzkumný ústav vodohospodářský T. G. Masaryka, veřejná výzkumná instituce, Podbabská 2582/30, 160 00 Praha 6

Sources of photographs for this issue:
VÚV TGM, 123RF.com, doc. RNDr. Jan Unucka, Ph.D., Ing. Jana Hronková, Mgr. Ondřej Simon, Ph.D., Mgr. Monika Štambergová, Ing. Kateřina Římalová, Ph.D., Mgr. Michal Bílý, Ph.D. (kresba), ŠJů / Wikipedia Commons, Horakvlado / Wikimedia Commons, Meruzalka / Wikimedia Commons, Aktron / Wikipedia Commons, Mapy.cz, RNDr. Tomáš Hrdinka, Ph.D., MgA. Aneta Beránková, Artificial Intelligence

Graphic design, typesetting and printing:
ABALON s. r. o., www.abalon.cz

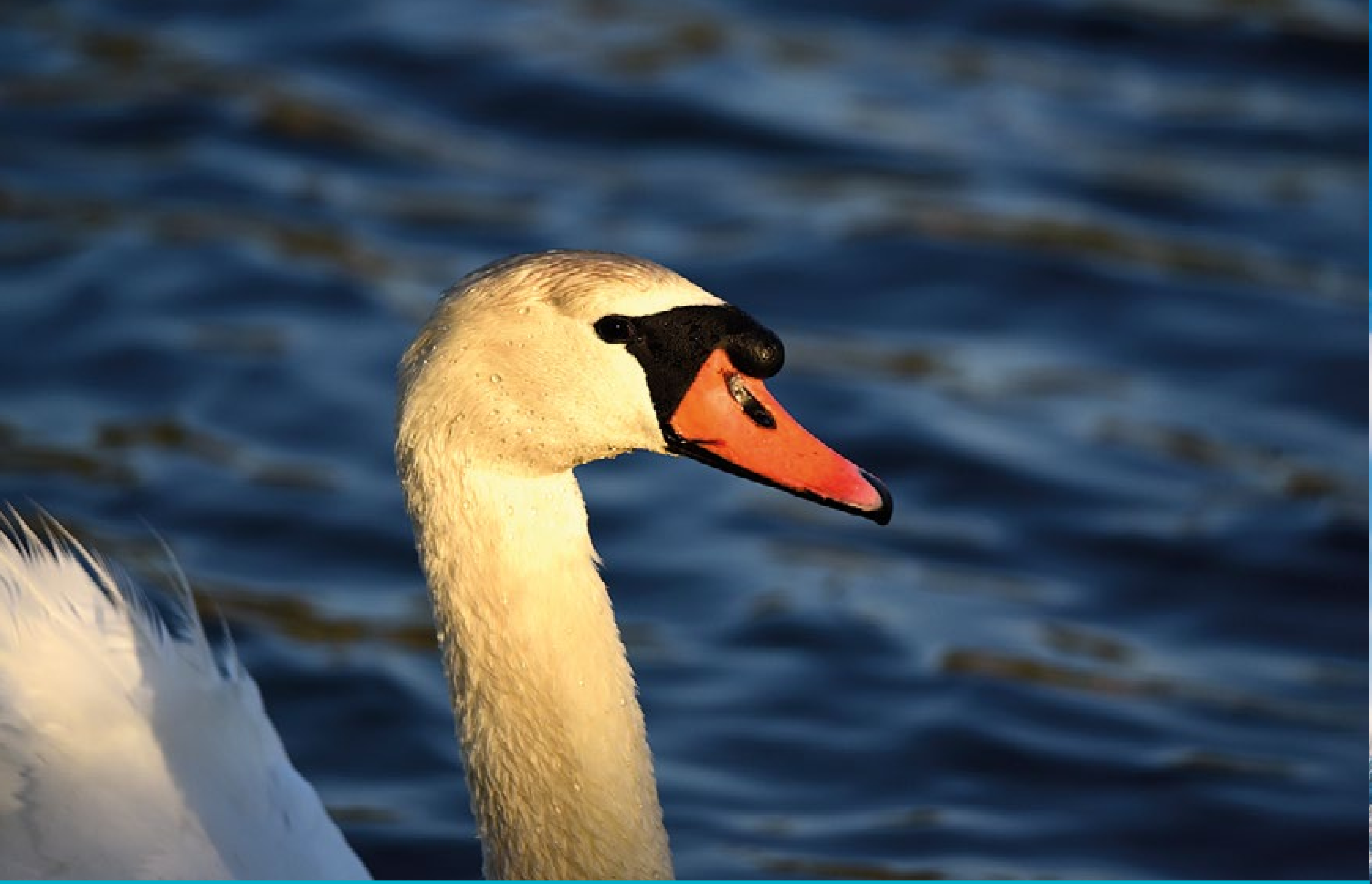
Number of copies: 400.
Since 2022, the VTEI journal has been published in English at https://www.vtei.cz/en/

The next issue will be published in April 2025. Instructions for authors are available at www.vtei.cz

VTEI is part of Scopus and DOAJ databases.

ISSN 0322-8916
ISSN 1805-6555 (on-line)
MK ČR E 6365

VTEI.cz



WHEN FROST COVERS THE LAND

The importance of water in the landscape is evident not only on hot summer days, but also on short and cold winter days. Water bodies and streams that do not freeze are a refuge and source of water and food for many animal species. This can be seen especially well in birds, which, due to climate change, have shortened their migration routes or completely stopped flying to their wintering grounds. In addition to small wintering passerines, birds of prey, kingfishers and waders, such as various species of ducks and swans, we can encounter species that we would not expect to see in our landscape in the winter months. For example, we can see common cranes (*Grus grus*) or greylag geese (*Anser anser*), which in recent years have postponed their flight south until December. Similarly, the European robin (*Erithacus rubecula*) is postponing its departure, and sometimes even staying throughout the winter. In contrast, the first northern lapwings (*Vanellus vanellus*) arrive at their nesting grounds as early as January. On the other hand, the numbers of rooks (*Corvus frugilegus*) arriving in our country are decreasing. For all these species, in particular on frosty days or days with heavy snow cover, the possibility of obtaining food directly in the water or on the edge of water bodies is absolutely essential. That is one of the reasons why it is important to protect aquatic ecosystems in the landscape. With suitable food supply, we can do a lot for the landscape and the creatures that share it with us.

Text and photo by RNDr. Jan Unucka, Ph.D.

VÝZKUMNÝ ÚSTAV
VODOHOSPODÁŘSKÝ
T. G. MASARYKA
veřejná výzkumná instituce

VTEI.cz